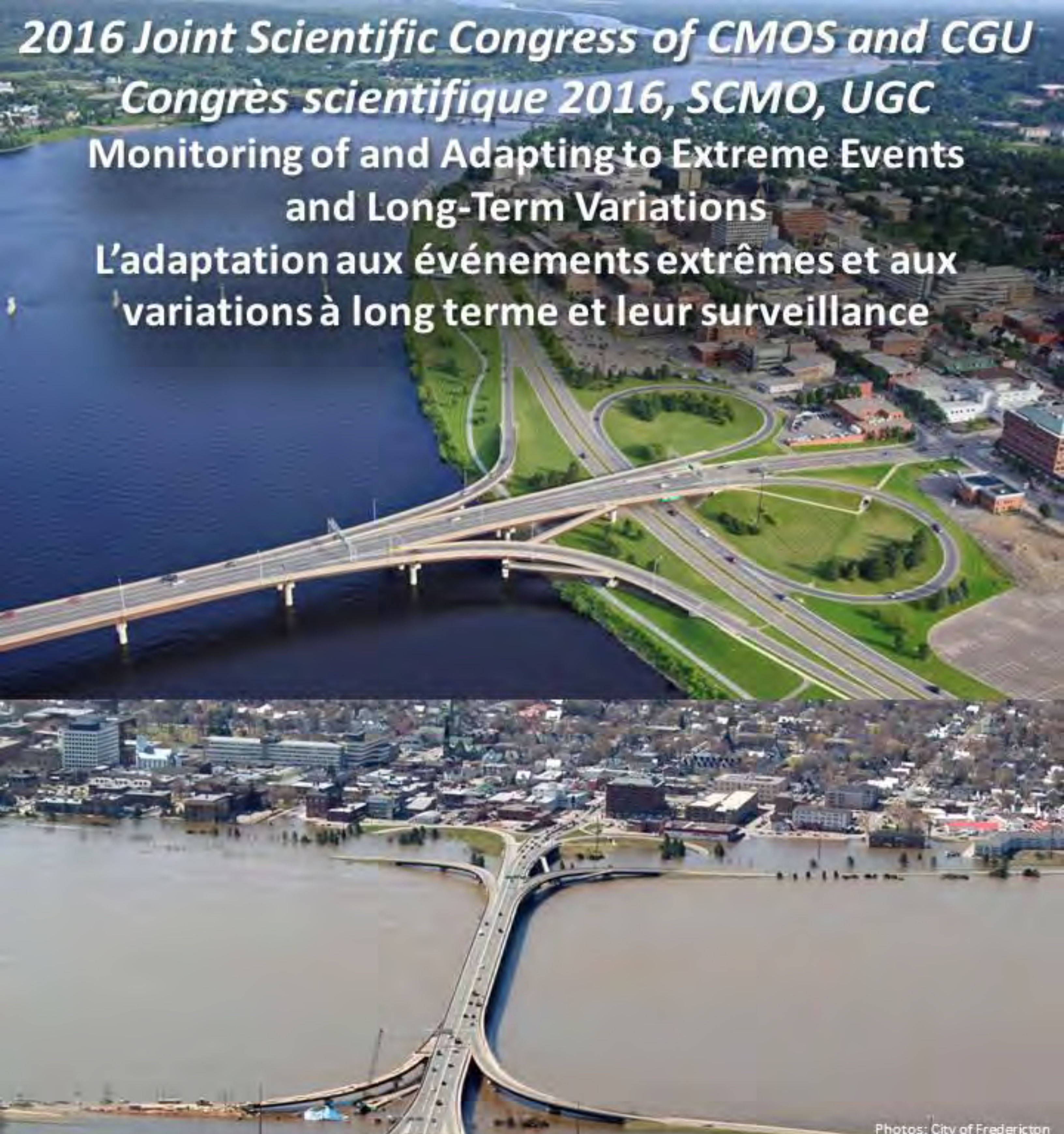
2016 Joint Scientific Congress of CMOS and CGU
Congrès scientifique 2016, SCMO, UGC
Monitoring of and Adapting to Extreme Events and Long-Term Variations
L'adaptation aux événements extrêmes et aux variations à long terme et leur surveillance



Photos: City of Fredericton
Art: MCS

Fredericton, NB

29 mai – 2 juin / May 29 – June 2, 2016

http://congress.cmos.ca

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

Canadian Geophysical Union
Union Géophysique Canadienne

Sponsors

Gold Sponsors / Commanditaires d’or

Silver Sponsors / Commanditaire d’argent

Other Sponsors / Les autres Commanditaires

Contents

Editors | Éditeurs – David Themens, Rick Fleetwood
Translators | Traducteurs – David Themens

ISBN 978-0-9880587-4-3

Welcome from the New Brunswick Environment Minister | Mot de bienvenue du ministre de l’environment de la Nouveau-Brunswick

Welcoming Letter

50th Annual Canadian Meteorological and Oceanographic Society Scientific Congress on *“Monitoring of and Adapting to Extreme Events and Long-Term Variations”*

As the New Brunswick Minister of Environment and Local Government it’s my pleasure to welcome you to the 50th Annual Canadian Meteorological and Oceanographic Society Scientific Congress on *“Monitoring of and Adapting to Extreme Events and Long-Term Variations.”*

Certainly the theme of the congress this year is very important and timely as globally we look for ways to adapt to our changing climate. Climate change is one of the greatest challenges that we are facing, in particular, adapting to the impacts of future climate conditions. Average temperatures are rising, high intensity precipitation events are more common, sea level is rising and inland and coastal areas are suffering more erosion and flooding. Climate models are telling us that in the future it will be warmer, wetter and stormier. Climate change adaptation hinges on how we adjust our thinking, decisions and activities to account for future climate conditions.

Events such as this one organized by the Canadian Meteorological and Oceanographic Society and the Canadian Geophysical Union that bring together a wide range of scientists and other professionals with a focus on atmospheric, ocean and earth sciences are very important as we work to share information and build resiliency to climate change.

I want to take this opportunity to thank you all for attending this congress and sharing your expertise and your ideas. New Brunswick’s capital city of Fredericton is happy to host congress delegates and I invite you to explore the city’s many historical attractions, fine craft and cultural exhibits and enjoy a special brand of Maritime hospitality.

Sincerely,

Brian Kenny

Hon. Brian Kenny
Minister of Environment and Local Government

Lettre de bienvenue

50e congrès annuel de la Société canadienne de météorologie et d'océanographie : *L'adaptation aux événements extrêmes et aux variations à long terme et leur surveillance*

En tant que ministre de l'Environnement et des Gouvernements locaux, je suis très heureux de vous souhaiter la bienvenue au 50e congrès annuel de la Société canadienne de météorologie et d'océanographie, ayant cette année pour thème *L'adaptation aux événements extrêmes et aux variations à long terme et leur surveillance.*

Le thème du congrès de cette année est très important et tombe à point, à un moment où nous nous efforçons, à l'échelle mondiale, de trouver des façons de nous adapter aux changements climatiques. Les changements climatiques constituent l'un des plus imposants défis que nous avons à relever, particulièrement en ce qui concerne l'adaptation aux répercussions des conditions climatiques futures. Les températures moyennes sont en hausse, les fortes précipitations sont de plus en plus courantes, les niveaux de la mer s'élèvent et les zones intérieures et côtières sont soumises à des taux d'érosion supérieurs et à des inondations plus fréquentes. Les modèles climatiques prévoient que, dans l'avenir, le temps sera plus chaud et plus humide, et nous serons davantage touchés par les tempêtes. L'adaptation aux changements climatiques dépend de la façon dont nous ajustons notre façon de penser, nos décisions et nos activités en fonction des conditions climatiques futures.

Ce congrès organisé par la Société canadienne de météorologie et d'océanographie permet de rassembler un éventail de scientifiques et d'autres professionnels pour discuter principalement des sciences de l'atmosphère, de l'océanographie et des sciences de la terre. Ce genre d'activités joue un rôle important dans le partage d'information et l'amélioration de la résilience aux changements climatiques.

Je tiens à vous remercier d'avoir accepté de prendre part à ce congrès, ainsi que de partager vos connaissances spécialisées et vos idées. Capitale du Nouveau-Brunswick, la ville de Fredericton est heureuse d'accueillir les délégués du congrès chez elle. Je vous invite à explorer les nombreux attraits historiques de la ville, à visiter ses expositions artisanales et culturelles, ainsi qu'à profiter de la chaleureuse hospitalité des Maritimes.

Sincères salutations,

Le ministre de l'Environnement et des Gouvernements locaux,

Brian Kenny

L'honorable Brian Kenny

Welcome from the Mayor of Fredericton | Mot de bienvenue du maire de Fredericton

On behalf of my City Council colleagues and the citizens of Fredericton, I am pleased to extend a warm welcome to visitors attending the 50th Canadian Meteorological and Oceanographic Society Congress and Joint Canadian Geophysical Union Annual Meeting, being held in Fredericton from May 29th to June 2nd, 2016.

The friendliness of our citizens will help to ensure an enjoyable and memorable stay in Fredericton, and I hope you are able to take some time from your busy schedule to experience some of what we have to offer.

We are proud to be the host City for this event, and trust that it will be a successful one!

MICHAEL G. O'BRIEN
MAYOR

Fredericton

Au nom des membres du conseil municipal et des citoyens de Fredericton, je suis heureux de souhaiter la bienvenue aux visiteurs et visiteuses qui se réunissent à Fredericton du 29 mai au 2 juin 2016 pour le 50e congrès de la Société canadienne de météorologie et d'océanographie et l'assemblée annuelle conjointe de l'Union géophysique canadienne.

Connaissant l'attitude amicale de nos citoyens, je suis persuadé que votre séjour à Fredericton sera aussi agréable qu'inoubliable et je vous souhaite de trouver dans votre horaire un peu de temps pour profiter de ses attraits.

Mes collègues et moi sommes très fiers que Fredericton ait été choisie comme ville hôte de cet événement qui, nous l'espérons, connaîtra un franc succès!

MICHAEL G. O'BRIEN
MAIRE

About CMOS | À propos de la SCMO

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

The Society comprises some 1100 members and subscribers, including students, corporations, institutions, and others who are involved in the educational functions, communications, the private sector and government. Membership is open to all who share an interest in atmospheric and oceanic sciences, their related sciences and applications. The Society addresses a broad range of national and international meteorological and oceanographic concerns including weather and weather extremes, global warming, ozone depletion and surface air quality and their effects on all aspects of life in Canada including forestry, agriculture and fisheries. Special interest groups in the Society consider meteorological aspects of hydrology, agriculture, forestry, meso-scale meteorological phenomena and operational meteorology.

La Société canadienne de météorologie et d'océanographie (SCMO) est une société nationale de personnes et d'organisations vouées à l'avancement des sciences atmosphériques et océaniques liées aux disciplines environnementales au Canada. Un des principaux organismes non gouvernementaux à servir les intérêts des météorologues, océanographes, limnologues, hydrologues et scientifiques cryosphériques, la Société vise à promouvoir la météorologie et l'océanographie au Canada. La SCMO a vu le jour officiellement en 1967 et a adopté son nom actuel en 1977 après que la Société météorologique du Canada ait invité la communauté océanographique du Canada à se joindre à elle. Toutefois, la SCMO a une riche histoire qui remonte à 1939 alors qu'elle était connue sous le nom de Section canadienne de la Société royale des météorologues.

La Société compte 1 100 membres et adhérents, et parmi ceux-ci, des étudiants, des corporations, des institutions et d'autres groupes engagés dans l'éducation, les communications, le secteur privé et le gouvernement. Peut devenir membre de la SCMO toute personne qui a un intérêt dans les sciences atmosphériques et océaniques, ainsi que dans les disciplines connexes et leurs applications. La Société s'intéresse à une vaste gamme de questions nationales et internationales qui touchent la météorologie et l'océanographie, et en particulier, le temps et les conditions météorologiques exceptionnelles, le réchauffement de la planète, la diminution de l'ozone et la qualité de l'air à la surface, ainsi que leurs effets sur tous les aspects de la vie au Canada incluant la foresterie, l'agriculture et les pêches. Des groupes d'intérêts spéciaux de la Société étudient les questions météorologiques associées à l'hydrologie, à l'agriculture, à la foresterie, ainsi que les phénomènes météorologiques d'échelle moyenne et la météorologie opérationnelle.

About CGU | À propos de la UGC

The CGU began as a society dedicated to the scientific study of the solid earth, and has evolved into one that is concerned with all aspects of the physical study of Earth and the space environment. With the creation of a Hydrology Section (1993), the Union adopted a structure that allows individual Sections to function as semi-autonomous entities. Since then, four additional sections have been created: Geodesy (2002), Solid Earth (2009), and Biogeosciences (2009), with the most recent being Earth Surface Processes (2014).

Now, with over 400 members, the CGU serves as a national group for geophysical sciences, with annual meetings and an awards program, and significant student involvement. The CGU also carries on the traditional responsibility of representing Canada in the International Union of Geodesy and Geophysics through a Canadian National Committee (CNC/IUGG).

L'UGC a commencé comme une société dédiée à l'étude scientifique de la terre solide et a évolué dans une société qui est concernée par tous les aspects de l'étude physique de la Terre et de l'environnement spatial.Avec la création d'une section d'hydrologie (1993), l'Union a adopté une structure qui permet aux sections individuelles de fonctionner comme des entités semi-autonomes. Depuis lors, quatre sections supplémentaires ont été créés: Géodésie (2002), Terre Solide (2009), et Biogeosciences (2009), avec les plus récents étant les Processus de Surface de la Terre (2014).

Maintenant, avec plus de 400 membres, l'UGC sert en tant que groupe national pour les sciences géophysiques, des réunions annuelles et un programme de récompenses, et la participation des étudiants. L'UGC porte également sur la responsabilité traditionnelle de représenter le Canada dans l'Union Internationale de Géodésie et Géophysique par un Comité national canadien (CNC / IUGG).

Welcome from the President of the Canadian Meteorological and Oceanographic Society

Welcome from the President of the Canadian Meteorological and Oceanographic Society

On behalf of the Canadian Meteorological and Oceanographic Society (CMOS), I welcome you to our 50th Congress. We are very pleased to be partnering with the Canadian Geophysical Union (CGU) for the coming week's event.

I encourage all delegates to make good use of their time this week, and take advantage of all the great science and social programs that have been established by the congress organizers. I especially would like to see all CMOS members attend the Annual General Meeting (AGM) on Monday evening, where plans for the upcoming year and society issues will be discussed. If you are not a member of CMOS, I hope your week with us will entice you to join!

I am very proud of CMOS as our 50th anniversary approaches in 2017. This national not-for-profit organization is largely run by volunteers, and I am always amazed by the dedication and commitment of people across the country who have made CMOS what it is today.

I would like to thank all the people who make this congress week possible, from the students presenting posters up to the invited plenary speakers who all took the time to prepare their material; all the sponsors and exhibitors who are great supporters of CMOS and CGU; and especially the many volunteers led by the Chair of the Local Arrangements Committee, Dr. William Ward, and the Chair of the Science Program Committee, Dr. Paul Yang. Without many hours of work by these local volunteers, this event would not be possible.

Thank you for your ongoing support of CMOS. I wish you a productive and enjoyable congress!

Martha Anderson
President, CMOS

Martha Anderson
President, CMOS

Mot de bienvenue du président de la Société Canadienne de Météorologie et d'Océanographie

La présidente de la Société canadienne de météorologie et d'océanographie vous souhaite la bienvenue.

Au nom de la Société canadienne de météorologie et d'océanographie (SCMO), je vous souhaite la bienvenue à notre 50e Congrès. Nous sommes heureux d'organiser cet événement en partenariat avec l'Union géophysique canadienne (UGC).

J'encourage les participants à tirer pleinement parti cette semaine et à profiter des programmes scientifiques et sociaux qu'étaient préparés par les organisateurs du congrès. Je souhaiterais notamment voir tous les membres de la SCMO participer à l'assemblée générale annuelle (AGA) de lundi soir. Nous y discuterons des plans pour l'année qui vient et des enjeux touchant la Société. Si vous n'êtes pas déjà membre de la SCMO, j'espère que les activités de cette semaine vous inciteront à le devenir.

À l'aube de notre 50e anniversaire, en 2017, je suis fière de la SCMO. Cette organisation nationale sans but lucratif fonctionne largement grâce à ses bénévoles. Je suis toujours agréablement surprise de constater le dévouement et l'engagement des gens qui, partout au pays, ont fait de la SCMO ce qu'elle est aujourd'hui.

Je remercie tous ceux qui ont rendu possible l'organisation de ce congrès, des étudiants qui présentent leur affiche jusqu'aux conférenciers des plénières, qui ont tous pris le temps de préparer leur exposé. Je remercie aussi tous les commanditaires et les exposants qui soutiennent la SCMO et l'UGC. Ma reconnaissance va notamment aux nombreux bénévoles qu'a dirigés le président du comité local d'organisation William Ward et au président du comité du programme scientifique Paul Yang. Sans les nombreuses heures qu'ont investies ces bénévoles locaux, la tenue de cet événement n'aurait pas été possible.

Je vous suis reconnaissante de votre soutien indéfectible de la SCMO. Je vous souhaite un congrès productif et des plus plaisants.

Martha Anderson
Présidente de la SCMO

Welcome from the President of the Canadian Geophysical Union

Canadian Geophysical Union
Union Géophysique Canadienne

17 April 2016

Dear CGU members,

It is with enthusiasm that I am writing this letter to invite you to attend the 2016 annual meeting of our union in Fredericton, New Brunswick, from 29 May to 2 June. This year meeting is the most recent in a series of very successful joint meetings the Canadian Geophysical Union has held over the years with the Canadian Meteorological and Oceanographic Society. The meeting represents an excellent opportunity to be exposed to a wide spectrum of new advances in the geosciences, weather research and oceanography, and to explore links between these interrelated areas of research.

The theme of the 2016 meeting is “Monitoring of and Adapting to Extreme Events and Long-Term Variations”. In the context of a changing climate, the meeting will provide a multidisciplinary forum to address important scientific and societal issues at different time scales and from the perspectives of different disciplines of study.

Please join me in Fredericton to reconnect with colleagues, make new friends, and create new collaborative opportunities. This will be an exciting time when our geoscientific community comes together to share and learn.

Sincerely,

Claire Samson, Ph.D., P.Eng.
CGU President

Mot de bienvenue du président de l'Union Géophysique Canadienne

Canadian Geophysical Union
Union Géophysique Canadienne

17 avril 2016

Chers membres de l'UGC,

C'est avec enthousiasme que je vous invite à assister au congrès annuel 2016 de notre union, à Fredericton (Nouveau-Brunswick), du 29 mai au 2 juin. Il s'agit là de la plus récente édition d'une très fructueuse série de congrès que l'Union géophysique canadienne a tenus conjointement avec la Société canadienne de météorologie et d'océanographie au fil des ans. Cet événement représente une excellente occasion de découvrir un vaste éventail d'avancées récentes liées aux géosciences, et à la recherche en météorologie et en océanographie, ainsi que d'explorer les liens entre ces domaines de recherche interreliés.

Le congrès s'intitule l'« Adaptation aux événements extrêmes et aux variations à long terme et leur surveillance ». Dans le contexte d'un climat en évolution, le congrès offre un forum multidisciplinaire nous permettant d'aborder d'importants enjeux scientifiques et sociaux à diverses échelles temporelles et du point de vue d'une variété de disciplines.

Venez en grand nombre à Fredericton, afin de rencontrer vos collègues, de nouer de nouvelles amitiés et de découvrir de nouvelles occasions de collaboration. Cette rencontre passionnante de la communauté géoscientifique nous permettra de partager nos connaissances et d'apprendre de nos collègues.

Cordialement,

Claire Samson

Claire Samson, Ph. D., Ing.
Présidente de l'UGC

Welcome Message from the Local Arrangement Committee and Scientific Program Committee

The Local Arrangements Committee and Scientific Program Committee welcome you to the joint Canadian Meteorological and Oceanographic Society (CMOS) and Canadian Geophysical Union Congress. We hope you find time to enjoy the city of Fredericton and the province of New Brunswick in addition to the science and interactions with colleagues which are essential features of every congress.

This is the 50th CMOS congress so there will be a number of items to remind you of how the congress and CMOS have evolved. In addition, there will be a number of events and opportunities to socialize and experience Maritime hospitality. This includes the customary icebreaker on Sunday night and Banquet on Wednesday evening, a student pub night on Monday, social activities on Monday morning and tours of the Mactaquac dam and Department of National Defence Joint Meteorological Centre on Thursday afternoon.

This year's theme, "Monitoring of and Adapting to Extreme Events and Long-Term Variations", is intended to direct attention to changes in our environment, understanding the science behind them and how we cope with and adapt to them in pragmatic ways. A scientific understanding is essential for practical and effective responses to these changes. The over 470 abstracts and 72 sessions show how active the international scientific community is in geophysics, atmospheric and oceanographic sciences. The eight plenary talks provide overviews of these fields by internationally known researchers and senior administrators. The public lecture, given by George Porter (B.Sc., B.Eng., MBA), Director of the Mactaquac project, will discuss the future of the Mactaquac dam, a major dam on the Saint John River, a topic both timely for the New Brunswick public and relevant to our theme.

We are pleased to welcome you to this congress and grateful for your participation. We hope that you leave on Thursday with pleasant memories, and new ideas and collaborations which will flourish this coming year.

Professor William Ward
Chair – Local Arrangements Committee

Dr. Paul Yang
Chair – Scientific Program Committee

Professor Brett Eaton
Vice President – Canadian Geophysical Union

Mot de bienvenue du Comité du programme scientifique et du Comité local des préparatifs

Le comité local d'organisation et le comité du programme scientifique vous souhaitent la bienvenue au Congrès conjoint de la Société canadienne de météorologie et d'océanographie (SCMO) et de l'Union géophysique canadienne (UGC). Nous espérons que vous prendrez le temps de visiter la ville de Fredericton et la province du Nouveau-Brunswick, en plus de profiter du programme scientifique et des interactions avec vos collègues : activités essentielles de tout congrès.

Il s'agit du 50e Congrès de la SCMO. Vous y verrez donc des thèmes qui vous rappelleront l'évolution du congrès et de la Société. De plus, il y aura bon nombre d'événements et d'occasions de socialiser et de découvrir l'hospitalité des Maritimes. Il y aura tout d'abord les incontournables soirée d'accueil du dimanche soir et banquet du mercredi, une soirée dans un pub pour les étudiants le lundi, des activités sociales le lundi matin, et les visites du barrage Mactaquac et du Centre météorologique interarmées de la Défense nationale jeudi après-midi.

Le thème de cette année, « L'adaptation aux événements extrêmes et aux variations à long terme et leur surveillance », vise à attirer l'attention vers les changements que subit notre environnement, à comprendre la science qui les sous-tend et à trouver comment les surmonter et s'y adapter de façon pratique. Une compréhension scientifique de ces changements s'avère essentielle à une intervention pratique et efficace. Les 470 résumés, et plus, et les 72 séances montrent à quel point la communauté scientifique internationale de géophysique, de météorologie et d'océanographie demeure active. Les huit conférences plénières que présentent des chercheurs et de hauts dirigeants mondialement connus fournissent un survol de ces domaines d'étude. La conférence publique que donnera George Porter (B. Sc., B. Ing., MBA), directeur du projet Mactaquac, portera sur l'avenir de ce barrage, qui représente un ouvrage majeur sur le fleuve Saint-Jean et un sujet d'actualité pour le public du Nouveau-Brunswick, en plus de correspondre à notre thème.

Nous sommes heureux de vous accueillir à ce congrès et nous vous remercions de votre participation. Nous espérons que vous nous quitterez jeudi en emportant de bons souvenirs et des idées nouvelles, et que vous poursuivrez les collaborations que vous aurez amorcées.

Professeur William Ward
Président — comité local d'organisation

Paul Yang (Ph. D.)
Président — comité du programme scientifique

Professeur Brett Eaton
Vice-président — Union géophysique canadienne

Local Arrangements Committee | Comité des arrangements locaux

William Ward	Chair
Marcelo Santos	Co-Chair; Liaison with CGU and Facilities
Karl Butler	Treasurer
Carolyn McCafferty	Volunteer Lead
Claude Cote	Communications and Publicity and Sponsorship Lead
Bill Richards	Social Program Lead
Brigitte Leblon	Social Program
David Themens	Program Book Lead
Erick Ouellet	Registration Lead
Jon Hoyt-Hallett	Educator's Day Lead
Laura Gillard	Student co-Lead
Dustin Fraser	Student co-Lead
Rick Fleetwood	Congress Webmaster, Sponsorship, Facilities
Oscar Koren	Exhibits Lead
Farida Dehghan	CMOS Webmaster/Congress Database
Qing Liao	CMOS Database/Invoicing
Gordon Griffith	CMOS Exec
David Degardin	Translation and Facilities
Robert Kingdon	Committee Member
Wendy Monk	Committee Member
Ron Bianchi	LAC Chair Toronto 2017

Scientific Program Committee | Comité du programme scientifique

Paul Yang	Chair
Karl Butler	Committee Member
Brett Eaton	Committee Member
Clark Richards	Committee Member
Hal Ritchie	Committee Member
Lucy Chisholm	Committee Member
Paul Myers	Committee Member
Robert Kingdon	Committee Member
Serge Desjardins	Committee Member
Steve Miller	Committee Member

Volunteers | Bénévoles

Alexander Turner	Laura Bell
Antonio Omeiza	Marco Mendonça
Blair Van Andel	Matthew Fung
Bob Rabin	Michael Sheng
Bryan Jansens	Mike Bremner
Chenhao Wang	Mitch Grace
Chris Vail	Oscar Koren
Daniel Lam	Sam Kristoffersen
Dustin Fraser	Sean Studham
Emerson Cavalheri	Shuang Wang
Heather Nicholson	Susan Dean
Ismael Fouroughi	Tana Yun
Janelle Gergely	Thalia Nikolaidou
Joseph Palmulli	Tyler Young

Thank you to all of our amazing volunteers, Local Organizing Committee members, and Scientific Program Committee members. Without the tireless work of the Local Arrangements Committee, the Scientific Program Committee and the Congress Volunteers this congress would not be possible. We thank them for their time, effort and expertise.

Merci à tous nos bénévoles, membres du comité d'organisation local, et les membres du comité du programme scientifique extraordinaires. Sans le travail acharné de ces comités et les bénévoles du Congrès ce congrès ne serait pas possible. Nous les remercions pour tout leur temps, efforts et expertise.

Week at a Glance | La semaine en coup d'œil

Time Heures+A2:	Sunday Dimanche 29 May/mai		Monday Lundi 30 May/mai	Tuesday Mardi 31 May/mai	Wednesday Mecredi 1 June/juin	Thursday Jeudi 2 June/juin
0800 - 0830			**Opening ceremony** **Cérémonie d'ouverture**			
0830 - 0900	Meetings and Workshops Réunions et ateliers		Plenaries 1&2 Plénières 1&2	Plenaries 3&4 Plénières 3&4	Plenaries 5&6 Plénières 5&6	Plenaries 7&8 Plénières 7&8
0900 - 0930		Walking tour Visite à pied				
0930 - 1000						
1000 - 1030			Coffee Break / Pause café			
1030 - 1100			Parallel Sessions Sessions parallèles	Parallel Sessions Sessions parallèles	Parallel Sessions Sessions parallèles	Parallel Sessions Sessions parallèles
1100 - 1130						
1130 - 1200						
1200 - 1230	Lunch (on your own) Déjeuner (à votre choix)		Lunch (on your own) Déjeuner (à votre choix)	Patterson Parsons Luncheon / déjeuner CGU-UGC Luncheon / déjeuner	Lunch (on your own) Déjeuner (à votre choix)	
1230 - 1300						
1300 - 1330						
1330 - 1400	Meetings and Workshops Réunions et ateliers		Parallel Sessions Sessions parallèles	Parallel Sessions Sessions parallèles	Parallel Sessions Sessions parallèles	Hydro Dam and DND Tours Visites de barrage hydroélectrique et DDN
1400 - 1430						
1430 - 1500						
1500 - 1530			Coffee Break / Pause café			
1530 - 1600			Poster Session Session d'affiches	Poster Session Session d'affiches	Parallel Sessions Sessions parallèles	
1600 - 1630						
1630 - 1700						
1700 - 1730			CMOS & CGU AGM AGA de SCMO & UGC	NSERC & Arctic SIG Meetings Réunion de CRSNG & GIS de l'Arctique	CCAR Networks Meeting Réunion réseau CCRA	
1730 - 1800						
1800 - 1830	Ice Breaker Soirée d'ouverture					
1830 - 1900					CMOS / SCMO Banquet CGU / UGC Banquet	
1900 - 1930			Student Night Soirée étudiante	Public Lecture Conférence publique		
1930 - 2000						
2000 - 2030						
2030 - 2100						
2100 - 2130					"Maritime Kitchen Party" "Maritime party de cuisine"	
2130 - 2200						

Social Events | Activités sociaux

Event / Activité	Start Time / Temps de commence	Information / Informations
Icebreaker / Soirée d'accueil	Sunday / Dimanche 6:00:00 PM	- Start the Congress off with a bang by joining the **Icebreaker** at the Convention Centre. Your ticket includes a free drink and snack food. Extra Tickets $25. - Commencez la semaine en grand et prenez part à la soirée d'accueil, au Palais des Congrès. Votre billet inclut une consommation et des amusegueules gratuits. Billet supplémentaire : 25 $
Downtown Fredericton Walking Tour / Visite à pied du centre-ville de Fredericton	Monday / Lundi 9:00:00 AM	- Meet a famous Lord Beaverbrook Persona in the lobby of the Crowne Plaza Hotel. He will lead you on a walking tour of the high spots of downtown Fredericton. This will be a great jump off point for individual explorations the rest of the week. - Venez rencontrer le célèbre Lord Beaverbrook, dans le hall de l'hôtel Crown Plaza. Il guidera vos pas vers les lieux d'intérêt du centre-ville de Fredericton. Cette visite sera le point de départ incontournable de votre exploration personnelle de la ville, au cours de la semaine.
Student Night / Soirée des étudiants	Monday / Lundi 7:00:00 PM	- Students will meet gather at a local pub for refreshments. - Les étudiants se réuniront dans un pub local pour prendre un verre.
Patterson-Parsons Luncheon / Dîner Patterson et Parsons	Tuesday / Mardi 12:00:00 PM	- At this Luncheon you will sit down to a plated meal and be present for the Patterson and Parsons Medals awards. Extra tickets $30. - Ce dîner avec service à la table vous donnera l'occasion d'assister à la remise des médailles Patterson et Parsons. Billet supplémentaire : 30 $
CGU Luncheon / Dîner de l'UGC	Tuesday / Mardi 12:00:00 PM	- CGU affiliates will gather at the Crowne Plaza for a delicious catered lunch. - Les participants associés à l'UGC se réuniront à l'hôtel Crown Plaza où on leur servira un délicieux dîner.
Public Lecture / Conférence publique	Tuesday / Mardi 7:00:00 PM	- An evening lecture open to the general public as well as Congress delegates at the Convention Centre. - Conférence ouverte au grand public ainsi qu'aux congressistes, au Palais des congrès.
CMOS Banquet / Banquet de la SCMO	Wednesday / Mecredi 6:30:00 PM	- At the Convention Centre, CMOS affiliates meet and greet at a cash bar before the evening dinner begins at 19:00. Extra tickets $60. - Palais des congrès. Les participants associés à la SCMO se rencontreront au bar (payant) avant de prendre part au banquet à 19 h. Billet supplémentaire : 60 $
CGU Banquet / Banquet de l'UGC	Wednesday / Mecredi 6:30:00 PM	- At the Crowne Plaza Hotel CGU affiliates meet and greet at a cash bar before the evening dinner begins at 19:00. Extra tickets $60. - Hôtel Crown Plaza. Les participants associés à l'UGC se rencontreront au bar (payant) avant de prendre part au souper à 19 h. Billet supplémentaire : 60 $

NB Welcome Kitchen Party (Calithumpians) / Le Nouveau-Brunswick à la bonne franquette (avec la troupe des Calithumpians)	Wednesday / Mecredi 9:00:00 PM	- After dining on beef or salmon everyone will join us at the Convention Centre for a dynamic introduction to NB in a kitchen party atmosphere. Be prepared for jokes, stories and songs, pomp and circumstance. One never knows what the Calithumpians will do next. - Après s'être repus de bœuf ou de saumon, tous sont invités au Palais des congrès, à une fête à la bonne franquette, façon Nouveau-Brunswick. Attendez-vous à une soirée d'humour, d'histoires et de chansons, sous des allures de grande pompe. Personne ne sait ce que les Calithumpians nous réservent.
Mactaquac Dam Tour / Visite du barrage Mactaquac	Thursday / Jeudi 1:30:00 PM	- Bus transportation to/from NB Power's Mactaquac Dam and Generating Station. - Transport aller-retour par autocar pour la visite du barrage Mactaquac et de la centrale hydroélectrique d'Énergie NB.
Joint Met Centre Tour / Visite du Centre météorologique interarmées	Thursday / Jeudi 1:30:00 PM	- Bus transportation to the Joint Meteorological Centre at Canadian Forces Base Gagetown. - Transport aller-retour par autocar pour la visite du Centre météorologique interarmées de la base des Forces canadiennes de Gagetown.
Tourist Information / Informations touristiques		- Check your conference folder for information on our host city Fredericton. The Fredericton Tourism desk is open at Fredericton City Hall (600 m west of Convention Centre). - Consultez la documentation du Congrès pour en savoir davantage sur la ville de Fredericton. Le bureau de tourisme est situé à l'hôtel de ville de Fredericton, à 600 m à l'ouest du Palais des congrès.
		- Planning to explore New Brunswick? NB Visitor Guides are available at the Registration Desk. - Vous comptez explorer le Nouveau Brunswick? Des brochures touristiques sont offertes au bureau d'accueil.

Fredericton Walking Tour / Visite à pied de Fredericton

When: Monday May 30, 9:00 am-11:00 am
Where: Meet at the Lord Beaverbrook Hotel
Cost: Free!

Spouses can start off their visit to beautiful Fredericton by joining the (free) walking tour of downtown led by Lord Beaverbrook himself (well, sort of). On Monday morning, May 30 at 9:00 am we will start at the Lord Beaverbrook Hotel, see the Beaverbrook Art Gallery, Christ Church Cathedral, Provincial Legislature, City Hall (check out the tapestries) and other high points in a 2 hr introduction to the Capital City.

Lord Beaverbrook (well, sort of) / Lord Beaverbrook (enfin, presque)

Quand : lundi 30 mai de 9 h à 11 h
Où : départ de l'Hotel Lord Beaverbrook
Coût : gratuit!

Les conjoints peuvent commencer leur découverte de la belle ville de Fredericton en profitant de la visite à pied (gratuite), que guidera Lord Beaverbrook en personne (enfin, presque). Le lundi matin 30 mai à 9 h, nous partirons de l'hôtel Lord Beaverbrook. Nous visiterons la galerie d'art Beaverbrook, la cathédrale Christ Church, l'assemblée législative de la province, l'hôtel de ville (tapisseries murales à ne pas manquer) et d'autres sites d'intérêt, durant cette promenade dans la capitale provinciale.

Thursday Afternoon Tours / Visites du jeudi après-midi

When: Thursday June 2nd, 1:30 pm – 4:30 pm
Where: Meet at the Fredericton Convention Center entrance
Cost: Free!

NB Power Mactaquac Dam and Generating Station

Take an afternoon excursion to visit NB Power's Mactaquac Dam and generating station, a 20-minute bus ride from the Convention Centre. NB Power will host attendees at the scenic site of the largest "run-of-the-river" power dam on the St. John River. Learn why the generating station, which started operating in 1968, is at a crucial point in its life as NB Power and citizens work to shape its future.

A bus will transport folks from the Convention centre to Mactaquac and back again. Departure time: 13:30. Signup sheets will be posted at the registration desk (limit 40 passengers). Duration: 3 hours.

Quand : jeudi 2 juin de 13 h 30 à 16 h 30
Où : rassemblement à l'entrée du Palais des congrès de Fredericton
Coût : gratuit!

Barrage Mactaquac et centrale hydroélectrique d'Énergie NB

Prenez l'après-midi pour visiter le barrage Mactaquac et la centrale hydroélectrique d'Énergie NB, à 20 minutes d'autocar du Palais des congrès. Énergie NB accueillera les visiteurs au site panoramique du plus grand barrage au fil de l'eau sur le fleuve Saint-Jean. Vous apprendrez pourquoi la centrale, qui est exploitée depuis 1968, se trouve à un point crucial de son existence, tandis qu'Énergie NB et les citoyens se penchent sur son avenir.

Un autocar transportera les visiteurs du Palais des congrès vers le site du barrage, et les ramènera ensuite. Heure de départ : 13 h 30. Réservez votre place en remplissant la feuille d'inscription au bureau d'accueil (limite de 40 passagers). Durée : 3 heures.

Joint Meteorological Centre at Canadian Forces Base Gagetown

The JMC will offer an inside vision of the different aspects of the life of a military meteorologist. A 20 minute bus ride from the Fredericton Convention Centre, the staff at JMC will offer a tour of the establishment, a meet and greet with refreshments, a question period and briefing about our activities and the services we provide. This is an opportunity to learn about the role and of an active meteorological centre which supports nationally and internationally deployed troops. Visitors will be transported by bus from the Fredericton Convention Centre to the Joint Meteorological Centre and back again.

Departure time: 13:30 from the Fredericton Convention Centre. Signup sheets will be posted at the registration desk (limit 40 passengers). Duration: 3 hours.

Centre météorologique interarmées de la base des Forces canadiennes de Gagetown

Le CMI vous offrira une perspective unique des différentes facettes de la vie d'un météorologiste de l'armée. Après un trajet d'autobus de 20 minutes à partir du Palais des congrès de Fredericton, vous serez reçu par le personnel du CMI, qui vous proposera une visite guidée des lieux. Vous pourrez rencontrer le personnel tout en profitant de rafraîchissements, poser des questions et écouter l'exposé sur les activités et services du CMI. Vous aurez l'occasion d'en apprendre davantage sur la fonction d'un centre météorologique actif qui soutient les troupes déployées au pays et ailleurs. Les visiteurs feront l'aller-retour en autocar entre le Palais des congrès de Fredericton et le Centre météorologique interarmées.

Heure de départ : 13 h 30 (à partir du Palais des congrès de Fredericton). Réservez votre place en remplissant la feuille d'inscription au bureau d'accueil (limite de 40 passagers). Durée : 3 heures.

Student Events | Activités pour les étudiants

Student Pub Night

Are you a student or early career scientist? Interested in meeting and chatting with your fellow peers? Looking for a relaxing evening in New Brunswick's capital city? Come by for an enjoyable evening at a top-notch Fredericton pub, Dolan's, on Monday, May 30 from 7:00 p.m. onward. Engage in discussions with other students and learn from a variety of unique perspectives. Mingle with individuals who share the same interests as you. While here, munch on a delicious assortment of free appetizers, and take in some of Dolan's superb meals. Come early, as you may benefit from Happy Hour's reduced prices! A mere 8 minute walk from the Convention Centre, Dolan's is the Irish pub of Fredericton. This is **the** Congress "Student" Event!

Lunch 'n Learn

Are you a student or an aspiring scientist (recently graduated with a degree)? Fascinated in meeting and hearing the opinions of professionals regarding work in your field? Have any questions or comments you would like to address? Sign up (first 40 to apply) at the registration desk for the Congress Student Lunch 'n Learn at Cora's restaurant, just a short stroll from the Convention Centre in the heart of the capital city. Top individuals in industry, government and academia will be present for discussions on many important issues. Small discussion groups will be set up so that you can present your views and questions and discuss a variety of topics. Lunch will be provided to all attendees; you may select your meal at the desk when you register. Cora's fine selection of breakfast and lunch items will be certain to match your appetite. Mark your calendars for Wednesday, June 1 from 12:00-1:30 for this fantastic opportunity! Please register no later than Monday, May 30.

Field professionals, would you kindly volunteer your lunch hour for this event? We are seeking 4 individuals each from the academic, industry, and government sectors. Thank you!

Sunday Meet and Greet / Pre-Ice Breaker

Get to know your fellow students/early career scientists at the beginning of the congress, pre Ice-Breaker! The Meet and Greet will take place 4:30-6:00 pm Sunday, May 29 in room Marysville B at the Convention Centre. Prepare a 3 minute pitch talk to introduce yourself and your research. Douw Steyn, CMOS Director of Publication, and Lydia Webb, Managing Editor, Geography & Water Research will give presentations on submitting to the CMOS journal, with tips on submitting! They will judge your presentations; a prize will be given to the best pitch-talk!

You can sign up and send in your presentations by emailing students@cmos.ca; convert to PDFs, first! Please sign up for your pitch talk no later than May 20 and submit your slides by May 26. This will allow adequate time for organization of your talks.

This will be an excellent introductory event! We look forward to seeing you all here!

Soirée étudiante au bar
Êtes-vous un étudiant ou un jeune scientifique débutant sa carrière? Êtes-vous intéressé à rencontrer et bavarder avec des jeunes comme vous? Vous cherchez une soirée de détente dans la capitale du Nouveau-Brunswick ? Venez pour une soirée agréable le lundi 30 mai à partir de 19:00 au Dolan, un bar réputé de Fredericton. Engagez-vous dans des discussions avec d'autres étudiants et apprenez sur les différents points de vue. Mêlez-vous aux autres qui partagent les mêmes intérêts que vous. Lorsque vous serez là, vous pourrez grignoter un délicieux assortiment de hors-d'œuvre gratuits ou commander un superbe repas de Dolan. Arrivez-tôt, car vous pouvez bénéficier de prix réduits du 5 à 7 ! À moins de 8 minutes à pied du Centre des Congrès, Dolan est le pub irlandais de Fredericton. C'est **l'événement-phare du** Congrès "Étudiant"!

Apprendre en déjeunant !
Vous êtes un étudiant ou un chercheur junior qui a récemment obtenu son diplôme ? Fasciné à répondre et à entendre les avis de professionnels au sujet de travail dans votre domaine ? Avez-vous des questions ou des commentaires que vous voudriez poser? Inscrivez-vous (les 40 premiers pourront participer) au bureau d'inscription pour le Congrès étudiant « **Apprendre en déjeunant** « au restaurant Chez Cora, à quelques pas du Centre des Congrès au coeur de la capitale. Les meilleurs représentants de l'industrie, du gouvernement et des universités seront présents pour des discussions sur des questions importantes. De petits groupes de discussion seront organisés afin que vous puissiez présenter vos idées et questions et discuter de divers sujets. Le déjeuner sera servi à tous les participants ; vous pouvez choisir votre repas lors de votre inscription à la réception. La sélection soignée de Cora pour les petits déjeuners et déjeuners pourra certainement correspondre à votre appétit. Marquez vos calendriers pour le mercredi 1er juin à partir de 12:00-1:30 pour cette opportunité fantastique ! S'il vous plaît, veuillez-vous inscrire au plus tard le lundi 30 mai.

Professionnels du terrain, voulez-vous bien faire du bénévolat lors de votre pause-déjeuner pour cet événement ? Nous recherchons 4 personnes de chacun des secteurs : universités, industrie et gouvernement. Merci!

Rencontre du dimanche / activité avant l'activité brise-glace
Renconter vos collègues étudiants et scientifiques de début de carrière au début du Congrès, avant de briser la glace ! La rencontre du dimanche aura lieu le dimanche 29 mai entre 16:30 et18:00 à salle de Marysville B du Palais des Congrès. Préparer 3 minutes pour parler de vous-même et introduire votre recherche. Douw Steyn, directeur des publications de SCMO et Lydia Webb, rédacteur en chef, Recherche en géographie et hydrologie présenteront le journal de SCMO, avec des conseils pour la soumission ! Ils jugeront vos présentations ; un prix sera remis à la meilleure présentation!

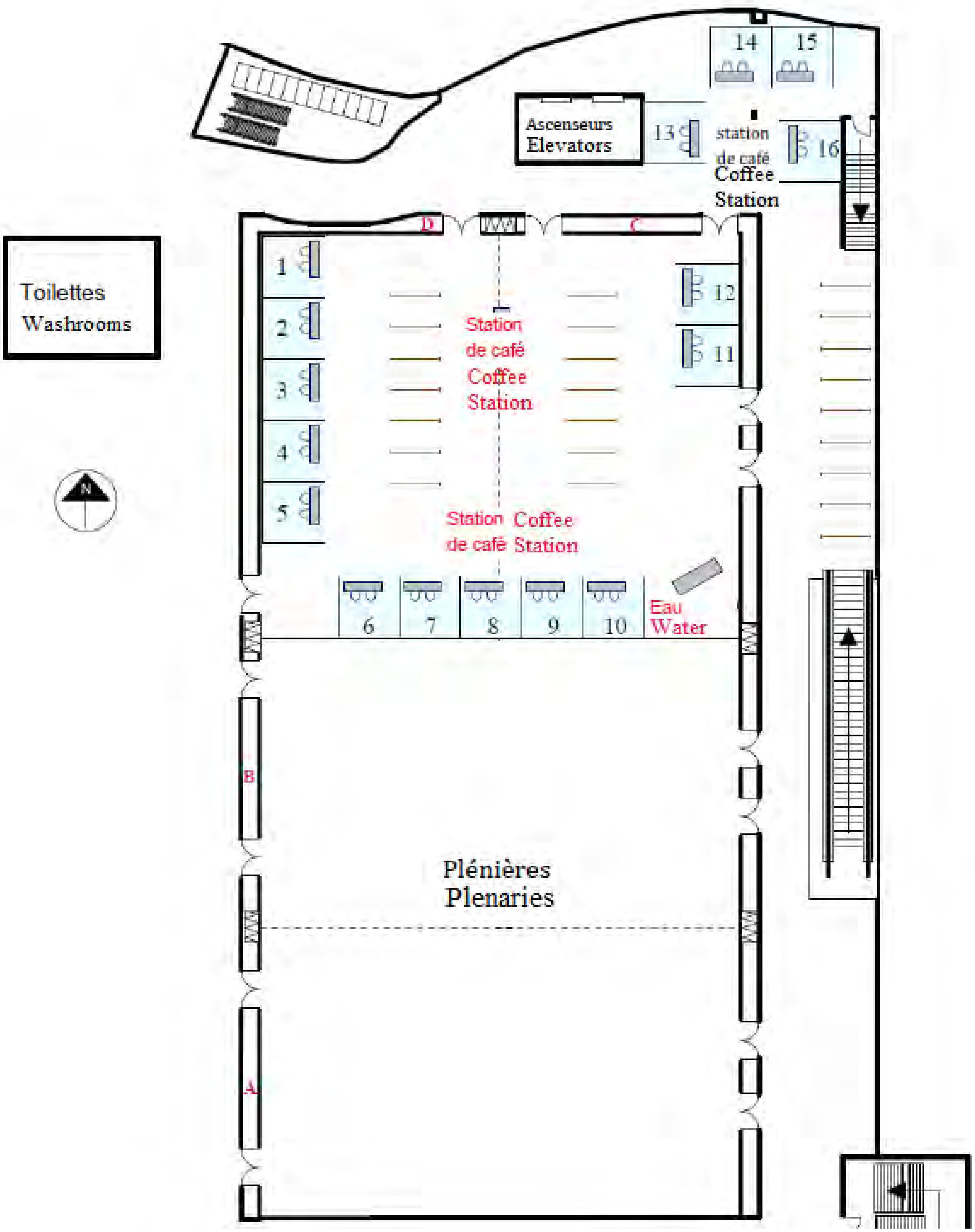
Vous pouvez inscrire et envoyer vos présentations en envoyant un e-mail à tudents@cmos.ca ; la convertir au format PDF d'abord! S'il vous plaît Inscrivez-vous pour votre présentation au plus tard le 20 mai et présenter vos diapositives le 26 mai. Cela permettra d'avioir suffisamment de temps pour l'organisation de vos présentations.

Ce sera un excellent événement d'introduction ! Nous nous réjouissons de vous voir tous ici !

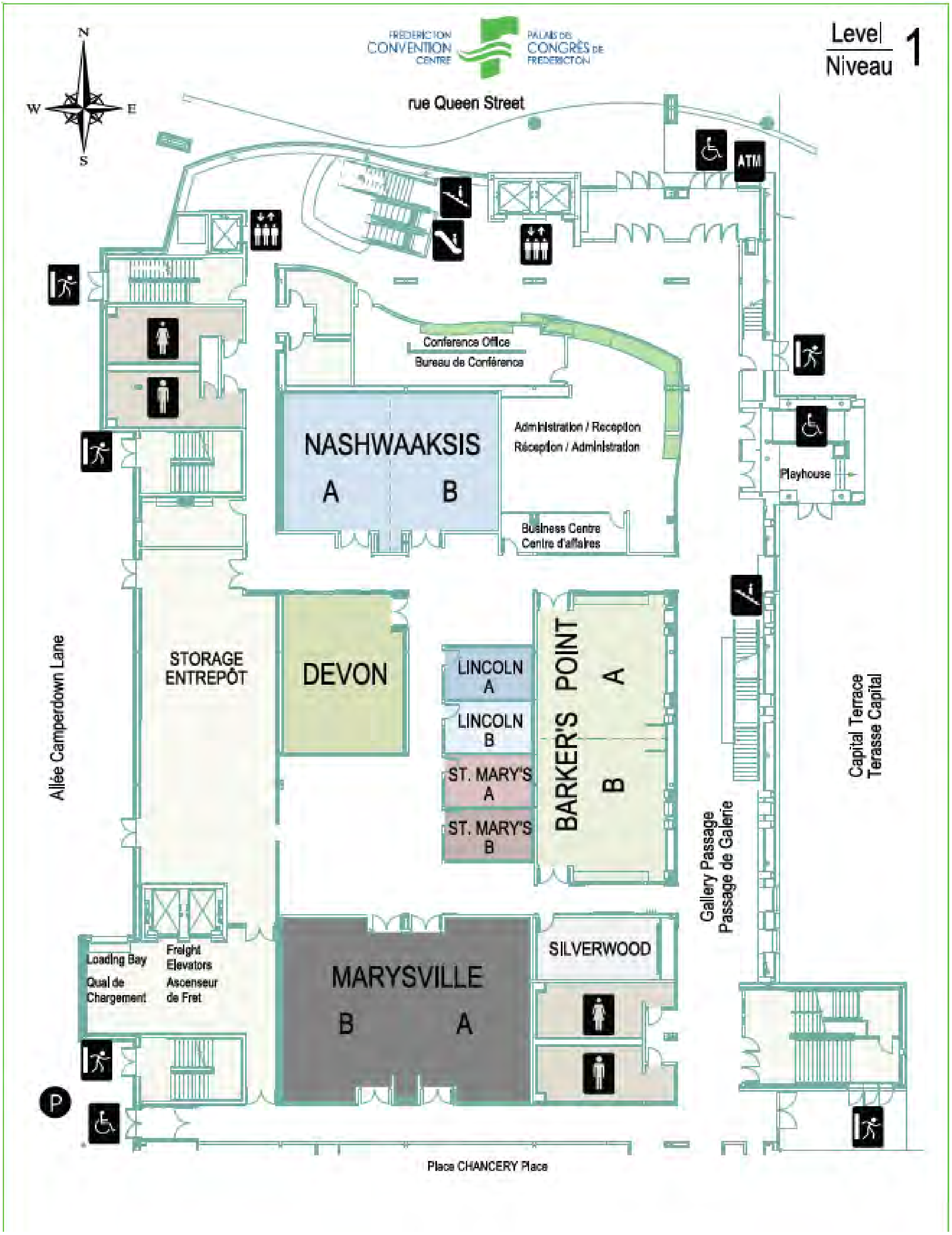
Exhibitors List | Liste des exposants

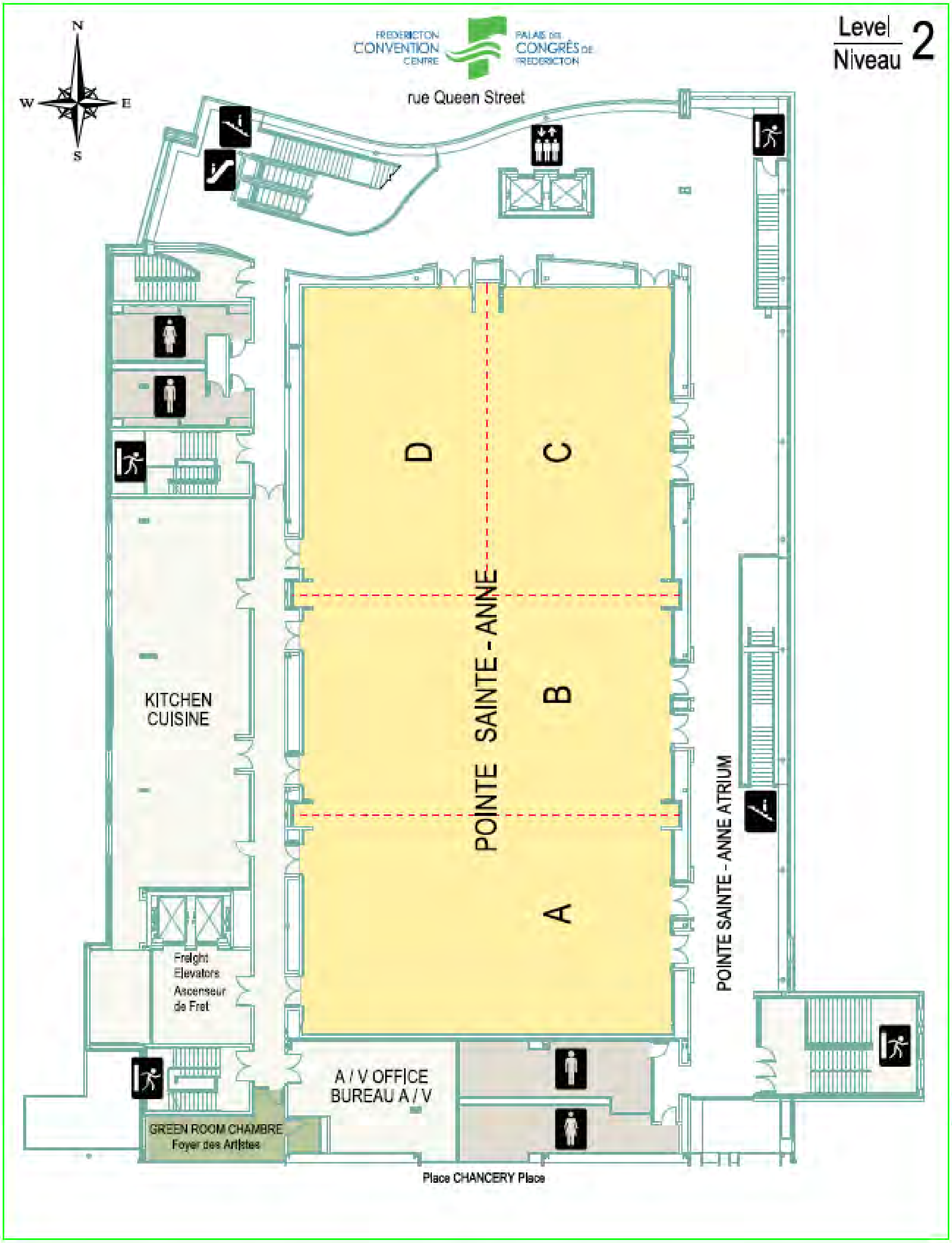
Booth Number	Exhibitor	Website
1	Xeos Technologies	http://www.xeostech.com/
2	Canadian Geophysical Union	http://cgu-ugc.ca/
3	CMOS/SCMO	http://www.cmos.ca/
4	Taylor and Francis	http://taylorandfrancis.com/
5	Info-Electronics Systems Inc.	http://www.info-electronics.com/
6	JouBeh Technologies	http://www.joubeh.com/
7	ROMOR	http://www.romor.ca/
8	RBR LTD.	https://rbr-global.com/
9	CANDAC	http://www.candac.ca/
10	Hoskins Scientific	http://www.hoskin.ca/
11	Campbell Scientific	https://www.campbellsci.ca/
12	LI-COR Biogeosciences	https://www.licor.com/
14	ATS Services LTD.	http://atsservices.ca/

Exhibitor Layout / Plan des exposants



Map of the Fredericton Convention Centre | Plan du Centre de Congrès de Fredericton





FREDERICTON CONVENTION CENTRE
PALAIS DES CONGRÈS DE FREDERICTON
Level
Niveau
2
N
S
W
E
rue Queen Street
D
C
B
A
POINTE SAINTE - ANNE
KITCHEN
CUISINE
Freight
Elevators
Ascenseur
de Fret
A / V OFFICE
BUREAU A / V
GREEN ROOM CHAMBRE
Foyer des Artistes
POINTE SAINTE - ANNE ATRIUM
Place CHANCERY Place

George Porter is an employee of NB Power, having started his career there in 1989. He is currently the Project Director for the Mactaquac Project. He holds a Bachelor of Science degree from Mount Allison University, an electrical engineering degree from the Technical University of Nova Scotia, and an MBA from the University of New Brunswick. His previous experience includes work on policies, business cases, infrastructure projects, regulatory filings, wind power integration, and regional studies.

George Porter travaille pour Énergie NB et y a commencé sa carrière en 1989. Il est actuellement directeur du projet Mactaquac. Il détient un baccalauréat en sciences de l'Université Mount Allison, un diplôme de génie électrique de la Technical University of Nova Scotia et un MBA de l'Université du Nouveau-Brunswick. Il possède aussi de l'expérience relativement aux politiques, aux analyses de rentabilité, aux projets d'infrastructure, à la production de documents réglementaires, à l'intégration de l'énergie éolienne et aux évaluations régionales.

The Future of the Mactaquac Generating Station

The Mactaquac Generating Station began operating in 1968, and has the capacity to generate 670 megawatts of energy using the flow of water through six turbines. The station supplies about 12 per cent of New Brunswick homes and businesses with clean, low-cost power.

The Mactaquac Generating Station is currently expected to reach the end of its service life by 2030. This is due to an ongoing alkali-aggregate reaction (AAR) within its structures that is causing the concrete to expand. To allow enough time for potential construction and regulatory approvals, NB Power must recommend a future path for the station by the end of 2016. The Mactaquac Generating Station is a run-of-the-river hydroelectric generating facility located west of Fredericton on the Saint John River.

Since 2013, NB Power has been working through an evaluation and decision process involving scientists, engineers, environmental experts, First Nations and members of the public. Much of that work has been focused on three end-of-life options for the station, which include building a brand-new generating station across the river from the current site, removing all structures to allow the river to return to a natural flow or leaving the dam in place but without power generation. In addition, NB Power is investigating approaches to allow the Mactaquac structures to generate electricity beyond 2030, perhaps even to its original 100 -year service life. These alternative approaches have arisen from due diligence studies under investigation since 2014. The alternative approaches are supported by ongoing testing and modelling of the impacts of concrete expansion at Mactaquac to gain a better understanding of the station's structural integrity and behavior.

The analysis and decision making on the best path forward for Mactaquac will consider comparative economic, technical, environmental, and social implications of the potential paths.

L'avenir de la centrale hydroélectrique Mactaquac

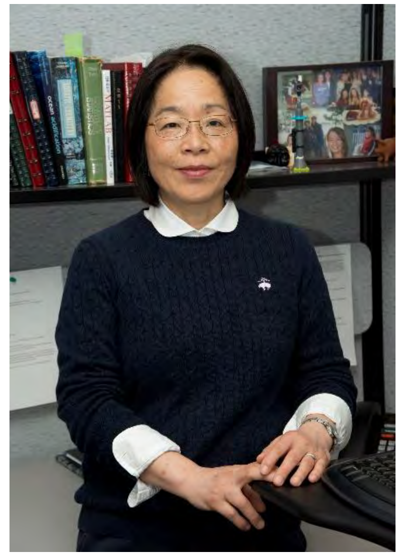
L'exploitation de la centrale hydroélectrique Mactaquac a débuté en 1968. Cette centrale peut générer 670 mégawatts d'énergie en faisant passer l'eau du fleuve à travers six turbines. La centrale fournit une énergie propre et abordable à environ 12 pour cent des foyers et des commerces du Nouveau-Brunswick.

Selon les estimations actuelles, la centrale Mactaquac devrait atteindre la fin de sa vie utile d'ici 2030. La raison? À l'intérieur de sa structure se produit une réaction alcaline des agrégats qui cause l'expansion du béton. Afin de se laisser amplement de temps pour entreprendre la reconstruction potentielle et obtenir les approbations réglementaires, Énergie NB doit recommander un plan pour la centrale, d'ici la fin de 2016. La centrale hydroélectrique Mactaquac est une centrale au fil de l'eau qui se situe à l'ouest de Fredericton, sur le fleuve Saint-Jean.

Depuis 2013, Énergie NB se penche sur une évaluation et un processus de décision auxquels participent des scientifiques, des ingénieurs, des experts en environnement, les Premières Nations et des membres du public. Ces travaux se sont surtout concentrés sur trois options mettant fin à la vie de la présente installation. Celles-ci comprennent la construction d'une nouvelle centrale sur la rive opposée au site actuel, l'enlèvement de toutes les structures afin de laisser le fleuve suivre son cours naturel ou le maintien en place du barrage sans sa capacité de génération d'énergie. De plus, Énergie NB étudie des façons de permettre aux installations de Mactaquac de générer de l'électricité au-delà de 2030, et éventuellement jusqu'à la fin de sa vie utile, originalement prévue pour durer 100 ans. Ces solutions de rechange proviennent d'évaluations de diligence raisonnable entreprises en 2014. Ces solutions sont étayées par des tests et de la modélisation en continu des impacts de l'expansion du béton au site Mactaquac, afin d'acquérir une bonne compréhension de l'intégrité et des comportements structuraux de la centrale.

L'analyse et la prise de décision qui nous mettront sur la meilleure piste pour l'avenir de la centrale Mactaquac se fonderont sur une comparaison des aspects économiques, techniques, environnementaux et sociaux des solutions potentielles.

Plenaries



Dr. Kumiko Azetsu-Scott is a research scientist at Fisheries and Oceans, Canada, Bedford Institute of Oceanography, where she leads a carbon and tracer group. She is also an adjunct in the Department of Oceanography at Dalhousie University. Her research interests include climate change and ocean carbon cycles and ocean acidification in the North Atlantic and the Arctic. She also investigates air-sea interactions, water mass formation and ventilation ages and freshwater composition and fluxes using multiple chemical tracers. She is a lead author of the report on the Arctic Ocean Acidification to the Arctic Council (Arctic Monitoring Assessment Program), a member of Global Ocean Acidification Observing Network (GOA-ON), and Canadian representative for Global Ocean Ship-based Hydrographic Investigations Program (GO-SHIP) and Integrated Marine Biogeochemistry and Ecosystem Research (IMBER)

Abstract: "Ocean acidification in the Arctic"

Accelerated increase of carbon dioxide concentration in the atmosphere due to human activities (anthropogenic CO_2, mainly from fossil fuel burning) affects the ocean by lowering its pH, a phenomenon known as ocean acidification. About a quarter of the anthropogenic CO_2 to the atmosphere since the start of the Industrial Revolution has been taken up by the oceans. Consequently, ocean pH has decreased by 0.1 units over the past 200 years, which is equivalent to a 30% increase in acidity. If global emissions of CO_2 continue at the present rate, ocean pH is predicted to fall an additional 0.3 units by 2100 (150% increase in acidity). Although ocean acidification is a global phenomenon, the Arctic Ocean is especially vulnerable owing to freshwater input and increasing CO_2 uptake from atmosphere as sea-ice cover decreases. Mechanisms of ocean acidification, possible effects on marine organisms and ecosystems and knowledge gaps in the Arctic will be discussed.

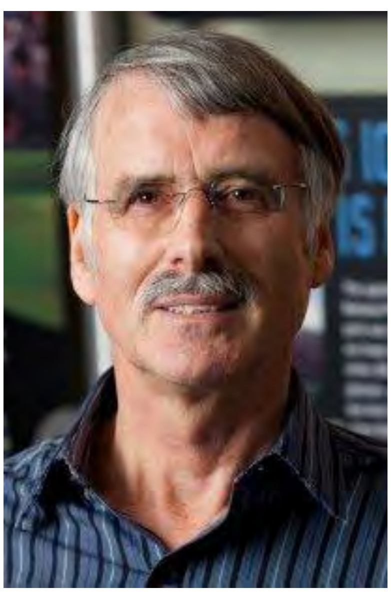
Dr. Alex Hay is a professor and former NSERC Industrial Research Chair in Ocean Acoustic Technology in the Department of Oceanography at Dalhousie University. He is recognized nationally and internationally for his research into continental shelf and nearshore process studies, and in particular for the new insights gained through the development and use of acoustic remote sensing systems. He is Killam Professor of Oceanography at Dalhousie, and a Fellow of the Acoustical Society of America.

Abstract: Dynamic adjustment of the seabed to wave-current forcing in the nearshore

During the past 20+ years, major advances have been made in our knowledge of the response of mobile sediments to the combined action of waves and currents in the nearshore zone. In the context of this presentation the nearshore zone is defined to be that strip of the coastal ocean in which shoreward-propagating surface gravity waves first shoal, then break, and then - diminished in height and energy - progress toward the beach face to dissipate in the swash zone. Associated with this cross-shore transformation of wave energy are changes in the higher-order statistical properties of the wave field: for example, third-order statistics related to wave shape, such as skewness. Consequently, the resulting forces at the bed also exhibit significant cross-shore variations not only in magnitude but also in net direction - seaward or shoreward - over a wave cycle. For the O(100 um) to O(1 mm) diameter grains in sandy beach environments, the cross-shore variation in forcing conditions leads to cross-shore variations in the local response of the mobile bed which - through the development of forcing-dependent bedform types, each characterised by a different bottom roughness - feeds back to morphological evolution at larger scales, such as bar development and migration.

The focus of this presentation is the local response of the bed, as revealed through the use of acoustic remote sensing technologies, developed either by adapting commercially-available systems or in-house in collaboration with colleagues. The account will be largely personal, but will draw upon the work of others. Topics will include: the occurrence of different bedform types relative to moments of the forcing; cross-shore migration; the structure of velocity and stress field above ripples in oscillatory flow; and the surprise occurrence of ripples on a steep beach.

The role of acoustics in model development for these features will also be discussed.



Dr. Kevin E. Trenberth is a distinguished senior scientist in the Climate Analysis Section at the National Center for Atmospheric Research. From New Zealand, he obtained his doctorate from Massachusetts Institute of Technology. He has been prominent in most of the Intergovernmental Panel on Climate Change (IPCC) scientific assessments of Climate Change and has also extensively served the World Climate Research Program (WCRP) in numerous ways, most recently as chair of the WCRP Global Energy and Water Exchanges (GEWEX) project. He has also served on many U.S. national committees. He is a fellow of the American Meteorological Society, the American Association for Advancement of Science, the American Geophysical Union, and an honorary fellow of the Royal Society of New Zealand.

Abstract: Insights into Earth's energy imbalance from multiple sources

The current Earth's energy imbalance (EEI) is mostly caused by human activity, and is driving global warming. The absolute value of EEI represents the most fundamental metric

defining the status of global climate change, and can best be estimated from changes in ocean heat content (OHC), complemented by radiation measurements from space. Sustained observations from the Argo array of autonomous profiling floats and further development of the ocean observing system to sample the deep ocean, marginal seas and sea ice regions are crucial to refining future estimates of EEI. Combining multiple measurements in an optimal way holds considerable promise for estimating EEI and thus assessing the status of global climate change, improving climate syntheses and models, and testing the effectiveness of mitigation actions. Progress can be achieved with a concerted international effort. New estimates of EEI and corresponding rates of change of OHC will be presented to highlight outstanding issues that include lack of sufficient continuity in many OHC estimates.

Mr. Michel Jean
Director General
Canadian Centre for Meteorological and Environmental Prediction
Environment Canada – Meteorological Service of Canada

Mr. **Michel Jean** graduated from the Université du Québec à Montréal (UQAM) in Physics in 1982 and obtained his Masters degree in Meteorology from McGill University in 1987 after working within the Atmospheric Environment Service (AES) as an operational forecaster in various locations in Canada. During his early career with AES, he was an instructor within AES Training Branch and a research meteorologist in observing and forecasting systems, numerical weather prediction and transport and dispersion modeling.

In 2001, he initiated the National Air Quality Modeling Applications Group at the Canadian Meteorological Centre. He has been nominated director of the Canadian Meteorological Center national operations in September 2004. In June 2006, Mr. Jean assumed the responsibility as the Regional Director of the Weather and Environmental Operations of the Meteorological Service of Canada (MSC). In August 2009, he became Director General of the Weather and Environmental Operations of the MSC, a large Directorate responsible for the delivery of monitoring, prediction, services and science Programs across Canada.

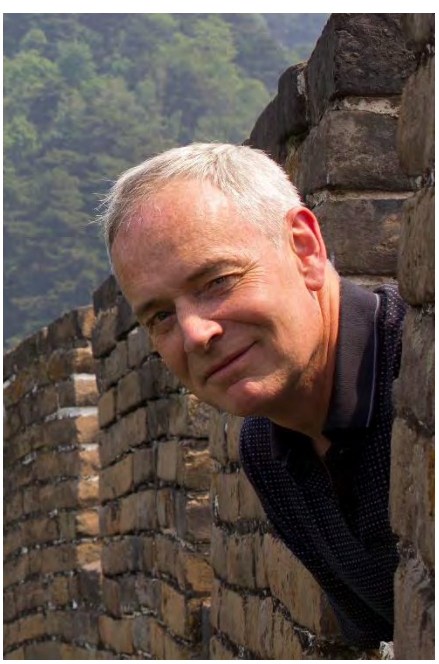
In addition to managing staff from coast to coast to coast, M. Jean was the senior executive functionally responsible for the entire weather and environmental prediction system in Canada, the long term High Performance Computing strategy and the development and implementation of the next generation integrated forecaster workstation. Since 1 April 2014, Mr. Jean has been tasked to establish a new organization, the Canadian Centre for Meteorological and Environmental Prediction, whose objective is to provide Canada with the best human, science and technology infrastructure to analyze and predict atmospheric, ocean and ice conditions for decision making. Over the years, he has led the development of 'man-machine' interaction systems, including automated translation systems.

Aside from his national responsibilities, Mr. Jean has been involved in government wide security and counter-terrorism work under the Chemical, Biological, Radiological and Nuclear Research and Technology Initiative (CRTI) between 2001 and 2006 and a member of the Canadian National Authority for the Comprehensive Nuclear-Test-Ban Treaty (CTBT) since 1995. He has chaired an international working group on atmospheric modeling in support of Nuclear Treaty verification and on interactions with the World Meteorological Organization (WMO) under the Preparatory Commission to the Comprehensive Nuclear-Test-Ban Treaty between 1995 and 2005. He contributed to the establishment of the International Civil Aviation Organization Volcanic Ash Advisory Centre (ICAO-VAAC) Montréal as well as WMO Regional Specialized Meteorological Centre (RSMC) Montréal for emergency response activities and has been involved as a Canadian expert on the WMO expert group on the expansion of the mandate of WMO's Regional Specialized Meteorological Centres for chemical and biological events. He has also been involved with the ICAO International Airways Volcanoes Working Group and with the WMO Emergency Response Activity group. He has been a member of the WMO Commission for basic Systems (CBS) Management Group since 2006 and the rapporteur on the evolution of the Global Earth Observation System of Systems. He is currently rapporteur to the WMO CBS Management Group on the Disaster Risk Reduction program and the chair of an inter-commission task team on Meteorological, Hydrological and Climate Services for Improved Humanitarian Planning and Response and co-chair of a CBS ad-hoc working group on the evolution of the Global Data Processing and Forecasting System (GDPFS).

Mr. Jean is the recipient of several citations and awards within the Public Service of Canada. He is also the 2002 recipient of the Andrew Thompson prize in applied meteorology from the Canadian Meteorological and Oceanographic Society.

Abstract: Big data, Social Media, Crowd Sourcing and the Evolution of the Meteorological Enterprise

We live in a time of brilliant technologies and the rhythm of innovation is increasing at an unprecedented pace. We are flooded by earth observations, social media provides access to contextual information and unprecedented dissemination mechanisms and high performance computing platform allow us to tackle previously unsolvable problems. It is only a matter of time before the fusion of weather, big data technologies and business applications go mainstream and change the way people and businesses view weather and water data, and experience the force-multiplying effects it will have on improving life and weather sensitive business decisions. Not only is this forcing us to rethink our business models, our recruitment and training strategies and our partnership strategies at the national level, it will also have a fundamental impact on the global meteorological enterprise. It will also force us to reflect on how our professional societies can play a facilitating role in this.



Dr. Dan Hutt began his career with Defence R&D Canada in 1983 when he joined the electro-optics division of DRDC Valcartier near Quebec City. There he worked on optical remote sensing and completed a PhD in Physics at Laval University in 1994. In 1997 Hutt transferred to DRDC Atlantic in Dartmouth, Nova Scotia, where he worked on acoustic sensing with novel hydrophone arrays. Since 2007 Hutt has been the head of DRDC Atlantic's Underwater Sensing Section. Presently he is Project Director of a new DRDC project to demonstrate underwater sensing concepts in the Canadian Arctic.

Abstract: Underwater sensing for Canadian defence

The advent of submarines as a serious threat during the 1st World War led to an urgent need to be able to detect them underwater. The field of underwater sensing grew from that requirement and is almost entirely based on acoustics to this day. But the performance of acoustic sensing that can be achieved underwater is dictated by the physical ocean environment – the time and space-dependant density profile and boundary conditions. Conversely, sound has been a primary means of determining the physical characteristics of the ocean from bathymetry to large scale density structure. It may in fact be argued that modern physical oceanography has been largely driven by the military requirement to conduct anti-submarine warfare. This presentation will review Canada’s activities in defence-related underwater sensing, where we are today, and our aspirations to apply what we have learned to underwater sensing in the Canadian Arctic.

Dr. Fiona Darbyshire graduated with a PhD in seismology from Cambridge University, UK, in 2000, studying the crustal structure of Iceland. She moved to Canada in 2000 as a post-doctoral researcher at the Geological Survey of Canada, and joined the Départment des Sciences de la Terre et de l'Atmosphère at the Université du Québec à Montréal in 2006. She has held a Tier II Canada Research Chair since 2011. Fiona Darbyshire's principal research interests lie in the field of structural seismology, investigating the crust and upper-mantle structure using seismic data from global earthquakes recorded at regional seismograph networks. She uses the resulting seismic models to address fundamental questions of continental formation and evolution from the Archean to the present, concentrating primarily on the North American continent and Greenland. She was a member of the POLARIS project steering committee from 2006 to 2013. In recent years she has been involved in a number of experiments and working groups associated with the US EarthScope project and the current Greenland seismograph networks, as well as establishing a new long-term seismograph network across central and northern Québec and Labrador.

Abstract: Illuminating the structure of the North American continent: advances in broadband seismology

Since the beginning of the 21st century, North American seismology has seen considerable advances thanks to nationwide projects such as POLARIS in Canada and EarthScope in the USA (and parts of Canada). The establishment of distributed networks of broadband seismographs on a local, regional and even continental scale has allowed structural seismologists to image the crust and upper mantle of the North American continent in unprecedented detail. The improved data coverage allows us to begin to bridge the gap between geophysics and geology of the solid Earth, and has contributed to valuable new insights into the formation and evolution of North America over the last >3 billion years.

We consider the results and implications of the latest seismological studies of the Canadian Shield and its eastern margin, using data from the POLARIS project and its offshoots, as well as EarthScope Transportable Array and FlexArray projects. We examine the wealth of data now available, and the wide range of imaging methods that provide new information on crust and upper mantle structure.

Of particular interest are the contributions of the new data and models to our understanding of continental formation and evolution over time, and the way in which this may have changed from Archean to Proterozoic to Phanerozoic. Receiver function analysis of the crust suggests a secular evolution in which each time period shows certain characteristics in formation process and composition. The nature of the thick lithospheric keel is probed using tomographic techniques and analysis of seismic anisotropy, all of which show evidence for a multi-stage keel formation process.

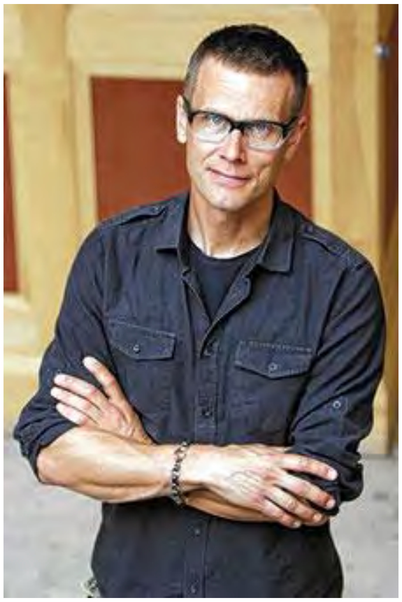
As more data are gathered and analysed, the models and their interpretation are increasingly refined. Much work remains, however, and we consider how to balance the need for broad regional-scale models with targeted local studies in areas of particular geological interest.

Dr. Gordon McBean is President of the International Council for Science (ICSU), Co-Chair of the Governing Council for Future Earth: Research for Global Sustainability and Professor Emeritus of Geography at Western University, London, Canada. From 1994 to 2000, he was Assistant Deputy Minister, Environment Canada with responsibilities for weather, climate and air quality services and sciences. Previously, he was Professor, Atmospheric-Oceanic Sciences at University of British Columbia and a research scientist, Environment Canada. He is a FRSC, FCMOS and received Patterson Medal (1989). He was CMOS President (1993-94) and received the President's Prize in 1975. He attended, as a weather forecaster, the first CMS Congress in 1967 and has attended most Congresses since then. He has been very active in international and national scientific programs: Chair (1988-94), World Climate Research Programme; Chair, Planning/Science Committee, Integrated Research on Disaster Risk Program (2005-2011); and President (2009-15) of START International (environmental capacity enhancement in Africa and Asia).

Abstract: Weather, Climate and Ocean Sciences for a Sustainable Future Earth

Climate change, disaster risk reduction, poverty eradication, social and economic sustainable development are interconnected issues that must be addressed in the development of policy. The 3rd World Conference on Disaster Risk Reduction was held in Sendai (March 2015), governments approved the Sustainable Development Goals (September 2015) and the Paris Agreement was confirmed at Convention on Climate Change Conference of Parties in Paris (December, 2015). A key issue is how can science best provide the inputs to these policy processes and more importantly to help governments and people address the issues? These questions require outputs leading to outcomes that address complex socio-economic, natural, health, engineering, philosophical and cultural issues and most challenging their intersections.

The Program Future Earth: Research for Global Sustainability has as its goal: "To provide the knowledge required for societies in the world to face risks posed by global environmental change and to seize opportunities in a transition to global sustainability". The program has adopted a unique approach of both a Science Committee and an Engagement Committee to co-design and co-produce the scientific research program and to co-deliver the results. The research theme of transformations to sustainability will be a special challenge in dealing with issues such as transformation processes and global and regional governance, including incentives and international law. Future Earth and the World Climate Research Programme are linked, through the International Council for Science and other ways, to the Integrated Research on Disaster Risk and Urban Health and Well-Being Programmes and they need to collectively address the challenges of bringing together interdisciplinary, transdisciplinary teams of scientists to undertake transformative research leading to outcomes that make a difference for global sustainability. Cross-cutting issues in all these agreements are storms, floods, droughts, storm surges and related climatic hazards and their better understanding and prediction for today and tomorrow to the next many decades. This is a scientific challenge for us all.

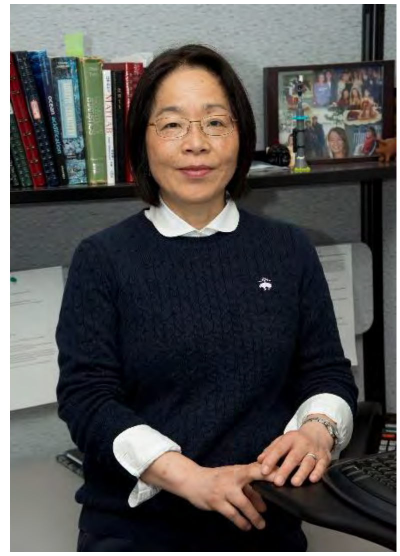


Dr. David Risk's interests lie in the measurement of gas emission from soils, isotope tracers, and sensor techniques. Some of this expertise is applied to natural ecosystems where gas emissions are used to measure soil biological activity. Risk collaborates with researchers on projects from pole to pole, particularly focusing on soil microbial dynamics in cold ecosystems. A large portion of his research is also aimed at improving environmental performance in the energy industry, through development of sensor and tracer techniques.

Abstract: Non-growing season greenhouse gas production in high-latitude soils

Permafrost zones hold about half of the world's organic matter, and several times more carbon than the atmosphere. As permafrost melts, previously frozen organic matter becomes subject to microbial decay, and this process generates greenhouse gases including carbon dioxide (CO2) and methane (CH4). We do know that soil microbes are active in cold soils, and under the right conditions their metabolism may even be active below the freezing point in the non-growing-season (NGS), however the magnitude of their production is unknown and unaccounted for in global carbon cycle models. Using a variety of methods including continuous CO2 measurements (gradient and flux chambers), we have been investigating the potential for CO2 production and release during the NGS within cold region soils in the Arctic, central Canada, and Antarctic Dry Valleys. In some cases we have also used radiocarbon-CO2 measurements as a descriptor of substrate utilization. We have observed substantial NGS CO2 fluxes, particularly in high-carbon environments that receive snowfall. Results suggest that over 50% of the annual CO2 release at many of these sites could come during the winter, which is not currently accounted for in models, or in budgets created from growing season studies. Radiocarbon-CO2 measurements suggest that the microbial community occasionally recruits old soil carbon as a feedstock. New NGS monitoring initiatives will help improve the accuracy of carbon budgets, contribute to our understanding of microbial activity in extreme environments, and improve soil models in cold and permafrost environments.

Plénières



Kumiko Azetsu-Scott (Ph. D.) est chercheure scientifique à l'Institut océanographique de Bedford du ministère des Pêches et des Océans. Elle y dirige un groupe responsable du carbone et des traceurs. Elle occupe aussi un poste de professeur auxiliaire au département d'océanographie de l'Université Dalhousie. Ses recherches portent sur les changements climatiques et le cycle du carbone océanique, ainsi que sur l'acidification de l'océan dans l'Atlantique Nord et l'Arctique. Elle étudie également les interactions air-mer, la formation de la masse d'eau et l'âge de la ventilation, et la composition et les flux d'eau douce, à l'aide de multiples traceurs chimiques. Elle est l'un des auteurs principaux du rapport sur l'acidification de l'océan Arctique destiné au Conseil de l'Arctique (Programme de surveillance et d'évaluation de l'Arctique); elle est membre du Réseau mondial d'observation de l'acidification de l'océan (GOA-ON); et elle est la représentante canadienne du Groupe d'experts pour les études hydrographiques des océans de la planète conduites à partir de navires (GO-SHIP) et du Projet de recherche intégrée sur la biogéochimie marine et l'écosystème (IMBER).

Résumé: Acidification de l'océan dans l'Arctique

L'augmentation accélérée de la concentration de dioxyde de carbone dans l'atmosphère en raison d'activités humaines (le CO_2 anthropique, principalement issu de la combustion d'hydrocarbures fossiles) affecte l'océan en diminuant son pH, un phénomène qu'on nomme l'acidification de l'océan. Les océans ont absorbé environ le quart du CO_2 anthropique relâché dans l'atmosphère depuis le début de la révolution industrielle. En conséquence, au cours des 200 dernières années, le pH des mers a diminué de 0,1 unité, soit une augmentation de l'acidité de 30 %. Si les émissions mondiales de CO_2 continuent au taux actuel, le pH de l'océan pourrait diminuer de 0,3 unité additionnelle dès 2100 (une hausse de l'acidité de 150 %). Bien que l'acidification de l'océan s'avère un phénomène mondial, l'océan Arctique y est particulièrement vulnérable en raison de l'apport en eau douce et de l'augmentation de l'apport en CO_2 atmosphérique qu'entraîne la diminution du couvert de glace. Nous discuterons des mécanismes d'acidification de l'océan, de ses effets possibles sur les organismes et les écosystèmes marins, et de notre connaissance lacunaire de l'Arctique.

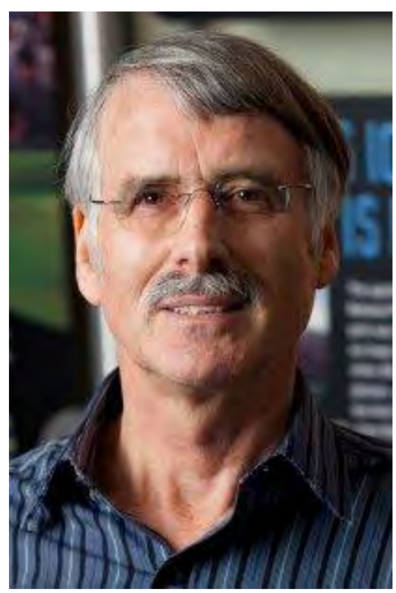
Alex Hay (Ph. D.) est professeur. Il a été titulaire de la chaire de recherche industrielle du CRSNG en technologie acoustique marine du département d'océanographie de l'Université Dalhousie. Il est reconnu nationalement et internationalement pour ses recherches sur le plateau continental et les processus côtiers, notamment pour les découvertes qu'il a effectuées grâce à la mise en place et à l'utilisation de systèmes acoustiques de télédétection. Il est titulaire d'une bourse Killam, professeur d'océanographie à l'Université Dalhousie et membre de l'Acoustical Society of America.

Résumé: Transformation dynamique du lit marin en raison du forçage vagues-courants près des côtes

Au cours des 20 dernières années et plus, des avancées majeures ont été réalisées relativement à nos connaissances sur le déplacement de sédiments mobiles en réaction à l'action combinée des vagues et des courants près du littoral. Dans le cadre de cette présentation, la zone littorale se définit comme la bande marine où les ondes de gravité superficielles se propageant vers la côte touchent le haut-fond, se brisent (leur hauteur et leur énergie diminuent), puis progressent vers le rivage pour se dissiper dans la zone d'écume. La modification des propriétés statistiques d'ordre élevé du champ de vague, par exemple les statistiques de troisième ordre liées à la forme de la vague (comme l'asymétrie), est aussi associée à cette transformation perpendiculaire au rivage de l'énergie des vagues. En conséquence, les forces résultantes au fond de la mer montrent une variation transversale significative, non seulement en magnitude mais aussi en direction nette, vers la mer ou la côte, durant le cycle d'une vague. Pour les grains d'un diamètre de 100 µm à 1 mm constituant les plages sablonneuses, les variations perpendiculaires à la côte en condition de forçage mènent à des variations transversales de la réaction locale du lit mobile qui, en raison du développement de figures sédimentaires de fond dépendantes du forçage, chacune caractérisée par une rugosité de fond différente, agit sur l'évolution morphologique à grande échelle, comme la formation et la migration de barres.

Cette présentation portera sur la réaction locale du lit marin, que révèlent les technologies de télédétection acoustique, conçues en adaptant des systèmes offerts commercialement ou en interne à l'aide de collègues. Ces expériences restent principalement personnelles, mais s'appuient aussi sur les travaux de collègues. Les sujets comprendront la formation de divers types de figures sédimentaires de fond selon le moment du forçage, la migration transversale, la structure des champs de vitesse et de contrainte, au-dessus des rides, dans un courant oscillant et l'occurrence surprise de rides sur un rivage escarpé.

Nous discuterons aussi du rôle de l'acoustique relativement au développement de modèles.



Kevin E. Trenberth (Ph. D.) est un scientifique principal distingué de la section d'analyse du climat du National Center for Atmospheric Research. Originaire de la Nouvelle-Zélande, il a obtenu son doctorat du Massachusetts Institute of Technology. Il a joué un rôle important dans le cadre de la plupart des évaluations scientifiques du Groupe d'experts intergouvernemental sur l'évolution du climat (GIEC). Il a aussi largement contribué au Programme mondial de recherche sur le climat (PMRC) et récemment en tant que président de l'Expérience mondiale sur les cycles de l'énergie et de l'eau (GEWEX) relevant du PMRC. Il a également siégé à de nombreux comités nationaux américains. Il est membre de l'American Meteorological Society, de l'American Association for Advancement of Science, de l'American Geophysical Union et membre honoraire de la Royal Society of New Zealand.

Résumé: Exploration du déséquilibre énergétique de la Terre fondée sur de multiples sources

Le déséquilibre énergétique actuel de la Terre découle principalement de l'activité humaine et influe sur le réchauffement de la planète. La valeur absolue de ce déséquilibre représente la mesure fondamentale qui définit l'état des changements climatiques planétaires. Elle s'estime le mieux à partir des modifications de la quantité de chaleur contenue dans la mer et, en complément, à partir des mesures spatiales de rayonnement. Les observations soutenues issues du réseau ARGO de flotteurs profilants autonomes et le développement à venir du système d'observation de la mer, visant à échantillonner l'océan profond, les mers marginales et les zones de glace marine, s'avèrent essentiels pour améliorer les futures estimations du déséquilibre énergétique de la Terre. La combinaison optimale de multiples mesures semble très prometteuse pour estimer le déséquilibre énergétique et donc pour évaluer l'état des changements climatiques mondiaux, améliorer les synthèses et les modèles du climat, et tester l'efficacité des mesures d'atténuation. Un effort international concerté pourra nous faire progresser. Nous présenterons de nouvelles estimations du déséquilibre énergétique planétaire et les taux correspondants de changement de la quantité de chaleur des océans, afin de mettre au jour les lacunes actuelles, qui comprennent le manque de continuité dans plusieurs estimations de la quantité de chaleur contenue dans la mer.

Monsieur Michel Jean
Directeur général
Centre de prévision météorologique et environnementale du Canada
Service météorologique du Canada – Environnement Canada

Monsieur Michel Jean a obtenu un baccalauréat en physique de l'Université du Québec à Montréal (UQAM) en 1982, ainsi qu'une maîtrise en météorologie de l'Université McGill en 1987, et ce, après avoir travaillé au sein du Service de l'environnement atmosphérique (SEA), à divers endroits au Canada, comme prévisionniste opérationnel. Tôt au cours de sa carrière au SEA, il a occupé un poste d'instructeur à la Division de la formation, puis de chercheur en météorologie dans les domaines des systèmes d'observations et de prévisions, de la prévision numérique du temps, et de la modélisation du transport et de la dispersion atmosphérique.

En 2001, il a mis sur pied le Groupe national de modélisation appliquée à la qualité de l'air. Il a été nommé directeur des opérations nationales au Centre météorologique canadien en septembre 2004. En juin 2006, monsieur Jean a assumé le poste de directeur régional des opérations météorologiques et environnementales du Service météorologique du Canada (SMC). En août 2009, il est devenu directeur général des opérations météorologiques et environnementales du SMC, une direction générale importante responsable des programmes de surveillance, de prévision, de services et de sciences pour tout le Canada.

En plus d'assumer la gestion pancanadienne de son personnel, monsieur Jean était le gestionnaire supérieur fonctionnellement responsable de tout le système de prévisions météorologiques et environnementales au Canada, de la stratégie à long terme de la superinformatique, et de la conception et de l'implantation des stations de travail de prochaine génération destinées aux prévisionnistes. Depuis le 1er avril 2014, monsieur Jean a entrepris de mettre sur pied une nouvelle organisation, le Centre canadien de prévision météorologique et environnementale, dont le but est de fournir au Canada la meilleure infrastructure humaine, scientifique et technologique visant à analyser et à prévoir les conditions atmosphériques, océaniques et glaciaires, en soutien à la prise de décision. Au fil des ans, il a mené le développement de systèmes d'interaction personne-machine, y compris les systèmes de traduction automatique.

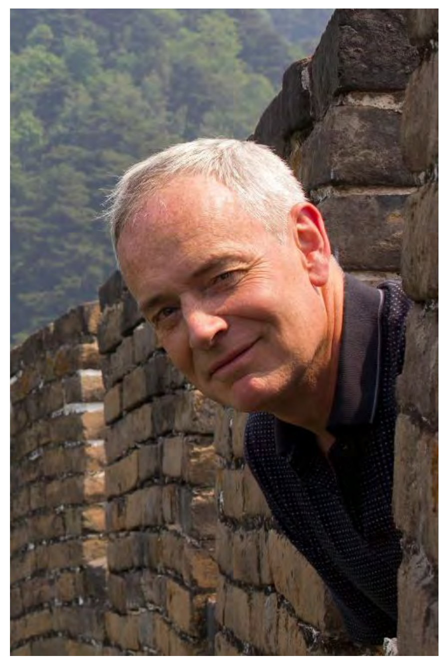
Parallèlement à ses responsabilités nationales, entre 2001 et 2006, monsieur Jean a participé aux travaux gouvernementaux sur la sécurité et le contre-terrorisme dans le cadre de l'Initiative de recherche et de technologie chimique, biologique, radiologique et nucléaire (IRTC). Il est aussi membre de l'Autorité nationale canadienne pour le Traité d'interdiction complète des essais nucléaires (TICEN) depuis 1995. Entre 1995 et 2005, il a présidé un groupe de travail international sur la modélisation atmosphérique en soutien aux vérifications du TICEN et sur les interactions avec l'Organisation météorologique mondiale (OMM), sous les auspices de la Commission préparatoire de l'Organisation du Traité d'interdiction complète des essais nucléaires. Il a contribué à la création du Centre d'avis de cendres volcaniques de l'Organisation de l'aviation civile internationale (OACI-VAAC) de Montréal et du Centre météorologique régional spécialisé (CMRS) de Montréal pour les activités d'intervention en cas d'urgence. Il a aussi participé en tant qu'expert canadien au groupe d'experts de l'OMM sur l'élargissement du mandat des centres météorologiques régionaux spécialisés relativement aux incidents chimiques et biologiques. Il a également participé au Groupe de travail sur la veille des volcans le long des voies aériennes internationales relevant de l'OACI et au Groupe de coordination des interventions en cas d'urgence. Il est membre du Groupe de gestion de la Commission des systèmes de base (CSB) depuis 2006 et rapporteur pour l'évolution du Système mondial des systèmes

Résumé: Les mégadonnées (big data), les médias sociaux, l'externalisation ouverte (crowdsourcing) et l'évolution de l'entreprise météorologique

Nous vivons à une époque de technologies géniales où le rythme d'innovation augmente à une vitesse sans précédent. Nous sommes inondés de données d'observation de la Terre et les médias sociaux nous donnent accès à de l'information contextuelle. De plus, les mécanismes de diffusion inédits et les systèmes informatiques à haut rendement nous permettent de nous attaquer à des problèmes autrefois insolubles. Ce n'est qu'une question de temps avant que la fusion de la météorologie, des applications commerciales et des technologies appliquées aux mégadonnées ne se généralise et qu'elle ne change notre façon d'aborder les données météorologiques et hydriques, en plus de nous faire ressentir les effets multiplicateurs qu'elle va produire pour améliorer la prise de décision touchant la vie et les activités commerciales sensibles aux intempéries. Non seulement cette évolution nous force à repenser nos modèles d'affaires, nos stratégies de recrutement et de formation, ainsi que nos stratégies de partenariat à l'échelon national, mais elle aura un impact fondamental sur l'entreprise météorologique

mondiale. Elle nous forcera également à réfléchir sur la fonction de facilitation qu'assumeront nos sociétés professionnelles.

Dan Hutt (Ph. D.) a commencé sa carrière au sein de Recherche et développement pour la défense Canada en 1983, quand il a intégré la division électro-optique du Centre de recherches de Valcartier près de Québec. Il y a travaillé sur la télédétection optique et a obtenu un doctorat en physique de l'Université Laval en 1994. En 1997, D. Hutt a été muté au Centre de recherches de l'Atlantique à Dartmouth (Nouvelle-Écosse), où il a travaillé sur la détection acoustique à l'aide d'un réseau d'hydrophones innovateur. Depuis 2007, il occupe le poste de chef de la section de télédétection sous-marine du Centre de recherches de l'Atlantique pour la défense. Il dirige actuellement une nouvelle initiative qui servira à démontrer des concepts de détection sous-marine destinés à l'Arctique canadien.



Résumé: Détection sous-marine au service de la défense canadienne

L'arrivée des sous-marins, et de la menace sérieuse qu'ils constituaient durant la Première Guerre mondiale, a entraîné un besoin urgent de les détecter sous l'eau. Le domaine de la détection sous-marine s'est développé à partir de cette menace et il est maintenant presque entièrement fondé sur l'acoustique. Mais la qualité de la détection acoustique que l'on peut atteindre sous l'eau est dictée par l'environnement physique marin : le profil de densité, dépendant du temps et de l'espace, et les conditions frontière. En revanche, le son a été un moyen dominant pour déterminer les caractéristiques physiques de la mer, de la bathymétrie à la structure de la densité à grande échelle. En fait, on pourrait dire que l'océanographie physique

moderne découle largement des besoins militaires liés à la lutte anti-sous-marine. Nous passerons en revue les activités du Canada relativement à la détection sous-marine au service de la défense, la situation actuelle et nos aspirations visant à appliquer nos connaissances à la détection sous-marine dans l'Arctique canadien.

Fiona Darbyshire (Ph. D.) a obtenu un doctorat en sismologie de l'Université Cambridge au Royaume-Uni, en 2000, pour ses études sur la structure crustale de l'Islande. Elle est arrivée au Canada cette même année, pour occuper le poste de boursière de recherche postdoctorale à la Commission géologique du Canada. Elle s'est jointe au département des Sciences de la Terre et de l'Atmosphère à l'Université du Québec à Montréal, en 2006. Elle est titulaire d'une chaire de recherche de niveau 2 depuis 2011. Le domaine de recherche principal de Fiona Darbyshire porte sur la sismologie structurale. Elle étudie la structure de la croûte et du manteau supérieur à l'aide de données sismiques provenant de tremblements de terre qu'enregistrent partout sur la planète des réseaux régionaux de sismographes. Elle utilise les modèles sismiques qui en découlent pour répondre aux questions fondamentales sur la formation et l'évolution continentales, de l'Archéen au présent. Elle se concentre principalement sur la partie nord du continent américain et sur le Groenland. Elle siégeait au comité directeur du projet POLARIS entre 2006 et 2013. Ces dernières années, F. Darbyshire a participé à nombre d'expériences et de groupes de travail liés au projet américain Earthscope et aux réseaux actuels de sismographes du Groenland. Elle a participé également à la mise en place d'un nouveau réseau de sismographes de longue durée couvrant le nord du Québec et le Labrador.

Résumé: Mettre au jour la structure du continent nord-américain : avancées de la sismologie large bande

Depuis le début du XXI^e siècle, la sismologie nord-américaine a accompli des progrès considérables grâce à des projets nationaux comme POLARIS au Canada et Earthscope aux États-Unis (et en partie au Canada). La mise sur pied de réseaux distribués de sismographes à large bande aux échelles locale, régionale et même continentale a permis aux sismologues en structure d'obtenir un portrait de la croûte et du manteau supérieur de l'Amérique du Nord, et ce, à des niveaux de détail sans précédent. La couverture améliorée des données nous permet de rétrécir l'écart entre la géophysique et la géologie du globe solide. Elle a contribué à émettre de nouvelles idées valables sur la formation et l'évolution de l'Amérique du Nord au fil des trois derniers milliards d'années et plus.

Nous examinons les résultats et les incidences des dernières études sismologiques du Bouclier canadien et de sa marge est, à l'aide de données provenant du projet POLARIS et de projets connexes, ainsi que des projets Earthscope Transportable Array et FlexArray. Nous passons en revue les nombreuses données existantes et la large gamme de méthodes de prise

d’image qui fournissent de nouvelles informations sur la structure de la croûte et du manteau supérieur.

Nous visons notamment la contribution des données et des modèles récents à notre compréhension de la formation et de l’évolution continentales au fil du temps, ainsi que les changements possibles qui auraient pu se manifester de l’Archéen au Phanérozoïque, en passant par le Protérozoïque. L’analyse de la fonction récepteur de la croûte laisse croire à une évolution séculaire pour laquelle chaque période montre certaines caractéristiques de formation et de composition. Nous examinons la nature de l’épaisse quille lithosphérique à l’aide de techniques tomographiques et de l’analyse de l’anisotropie sismique, qui pointent toutes vers un processus de formation de la quille en plusieurs étapes.

Tandis que de plus en plus de données sont recueillies et analysées, les modèles et leur interprétation se raffinent aussi. Il reste toutefois beaucoup de travail à effectuer et nous examinons la façon d’équilibrer le besoin de larges modèles régionaux et celui d’études locales ciblées portant sur les zones géologiques d’intérêt particulier.

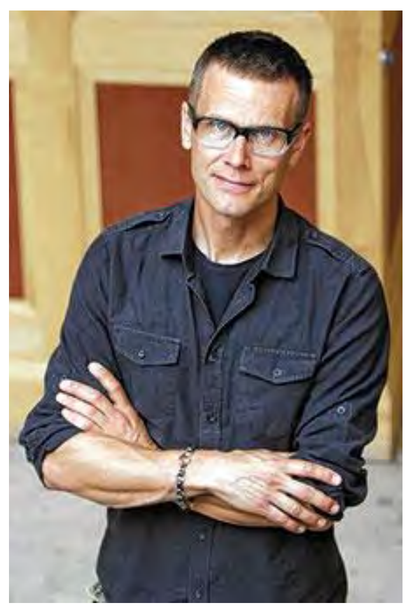
Gordon McBean (Ph. D.) est président du Conseil international pour la science (CIUS), coprésident du conseil d’administration de « Future Earth » (une initiative de recherche pour une planète durable) et professeur émérite de géographie à l’Université Western, London (Ontario). Entre 1994 et 2000, il était sous-ministre adjoint responsable des services et des sciences météorologiques, climatologiques et de la qualité de l’air, au sein d’Environnement Canada. Auparavant, il occupait les postes de professeur de sciences atmosphériques et océaniques à l’Université de la Colombie-Britannique et de chercheur scientifique au sein d’Environnement Canada. Il est membre de la Société royale du Canada, membre émérite de la SCMO et lauréat de la médaille Patterson (1989). Il a présidé la SCMO (1993-1994) et a reçu le Prix du président en 1975. Il a participé, en tant que prévisionniste, au premier Congrès de la SCM en 1967, et y participe presque tous les ans depuis. Il contribue activement à divers programmes scientifiques nationaux et internationaux : président (1988-1994), Programme mondial de recherche sur le climat; président, comité de planification/science, Programme de recherche intégrée sur les risques de catastrophes (2005-2011); président (2009-2015), Système d’analyse, de recherche et de formation - START (renforcement des capacités liées à l’environnement en Afrique et en Asie).

Résumé: Les sciences météorologiques, climatologiques et océaniques en soutien à une Terre durable

Les changements climatiques, la réduction des risques de catastrophes, l’éradication de la pauvreté, et le développement social et économique durable sont des enjeux interreliés dont nous devons tenir compte relativement à l’élaboration de politiques. La 3^{e} Conférence mondiale sur la prévention des catastrophes s’est tenue à Sendai en mars 2015. Les gouvernements ont approuvé les Objectifs de développement durable (septembre 2015) et l’Accord de Paris a été confirmé à la

Conférence des parties de la Convention-cadre des Nations unies sur les changements climatiques, à Paris, en décembre 2015. Il faut maintenant déterminer la façon dont les sciences fourniront le plus efficacement les assises à ces politiques et comment notamment elles aideront les gouvernements et le public à aborder ces enjeux. Ces questions nécessitent des résultats menant à des réalisations qui aborderont des enjeux complexes relatifs à la société, à l'économie, à la nature, à la santé, à l'ingénierie, à la philosophie et à la culture, et plus complexes encore, liés à leurs interactions.

Le programme « Future Earth », une initiative de recherche pour une planète durable, vise ce but : « Fournir les connaissances nécessaires aux sociétés du monde, afin que celles-ci puissent s'adapter aux risques que posent les changements environnementaux mondiaux et saisir chaque occasion que présente la transition vers une durabilité planétaire. » Le programme a choisi une approche inédite et a créé à la fois un comité scientifique et un comité de mobilisation, afin de concevoir et de produire conjointement le programme de recherche scientifique et d'en diffuser ensemble les résultats. Le sujet de recherche, c'est-à-dire la transformation vers la durabilité, présentera entre autres des difficultés associées aux processus de transformation et aux gouvernances mondiales et régionales, y compris les mesures incitatives et les lois internationales. « Future Earth » et le Programme mondial de recherche sur le climat sont liés, par l'entremise du Conseil international pour la science, entre autres, au programme de recherche intégrée sur les risques de catastrophes, et au programme de santé urbaine et de bien-être. Ils doivent ensemble aborder les difficultés inhérentes au regroupement interdisciplinaire et transdisciplinaire d'équipes scientifiques, afin d'entreprendre des recherches transformatrices menant à des réalisations qui améliorent la durabilité mondiale. Les enjeux transsectoriels de tous ces accords sont les tempêtes, les inondations, les sécheresses, les ondes de tempête et les dangers climatiques connexes, ainsi qu'une compréhension et des prévisions adéquates de ces phénomènes, aujourd'hui et demain, et pour plusieurs décennies. Il s'agit là d'une entreprise scientifique pour nous tous.



David Risk (Ph. D.) s'intéresse à la mesure des émissions de gaz émanant des sols, aux isotopes comme traceurs et aux techniques de détection. Son expertise s'applique entre autres aux écosystèmes naturels où les émissions de gaz servent à mesurer l'activité biologique du sol. D. Risk collabore avec des chercheurs sur des projets se déroulant d'un pôle à l'autre, notamment en ce qui a trait à la dynamique microbienne des sols dans les écosystèmes froids. Une grande portion de ses recherches vise aussi à améliorer le rendement environnemental de l'industrie énergétique, grâce à la mise sur pied de techniques relatives aux détecteurs et aux traceurs.

Résumé: Production de gaz à effet de serre dans les sols des hautes latitudes durant la saison sans croissance

Les zones de pergélisol renferment environ la moitié de la matière organique mondiale et de nombreuses fois la quantité de carbone que contient l'atmosphère. À mesure que le pergélisol fond, les matières organiques qui ont gelé jadis sont soumises à la décomposition microbienne. Ce processus génère des gaz à effet de serre, y compris du dioxyde de carbone (CO_2) et du méthane (CH_4). Nous savons que les

microbes du sol demeurent actifs dans les sols froids et que sous des conditions propices leur métabolisme peut même s'activer quand la température passe sous le point de congélation durant la saison sans croissance. Toutefois, l'ampleur de leur production reste inconnue et les modèles de cycle mondial du carbone n'en tiennent pas compte. À l'aide de diverses méthodes, y compris la mesure en continu de CO_2 (chambres de flux et gradient), nous avons étudié le sol pour déterminer son potentiel de production et de rejet de CO_2 durant la saison sans croissance en zones froides : l'Arctique, le centre du Canada et des vallées mortes de l'Antarctique. Dans certains cas, nous avons également utilisé des mesures de radiocarbone du CO_2 comme descripteur de l'utilisation du substrat. Nous avons observé des flux considérables de CO_2 durant la saison sans croissance, particulièrement dans les environnements riches en carbone où il neige. Les résultats laissent croire que plus de 50 % des rejets annuels de CO_2 relevés à nombre de ces sites pourraient se produire en hiver. Cet apport ne se retrouve actuellement pas dans les modèles ou dans les bilans créés à partir d'études portant sur la saison de croissance. Les mesures de radiocarbone du CO_2 semblent indiquer que la communauté microbienne utilise occasionnellement le vieux carbone des sols comme matière première. De nouvelles initiatives de surveillance durant la saison sans croissance permettront d'améliorer la précision des bilans de carbone, contribueront à la compréhension de l'activité microbienne dans les environnements extrêmes et amélioreront la modélisation du sol en zones froides et de pergélisol.

Workshops | Groupes de travail

Sunday Workshops and Meetings / Réunions et ateliers du dimanche

Time Heures	Sunday Dimanche								Time Heures
	Marysville A	Barkers Point A	Lincoln A&B	Silverwood	St. Mary's A	Devon	Nashwaaksis A	Marysville B	
0800-0830			Volunteer Room Reserved for Week	LAC Room Reserved for Week					0800-0830
0830-0900									0830-0900
0900-0930						Volunteer Orientation Reserved		CGU Executive Meeting Réunion de l'Exécutif UGC	0900-0930
0930-1000									0930-1000
1000-1030					SCOR AGM AGA de SCOR				1000-1030
1030-1100									1030-1100
1100-1130	PSC Meeting Réunion du CSP								1100-1130
1130-1200									1130-1200
1200-1230	CMOS Publication Committee Meeting Réunion du Comité de publication SCMO	Young Hydrologists Workshop Atelier de jeune hydrologues							1200-1230
1230-1300									1230-1300
1300-1330						Using R Language Workshop Atelier de utilisation de R Langue	Campbell Scientific Workshop Atelier de Campbell Scientific		1300-1330
1330-1400								CMOS SC Meeting Réunion du CS SCMO	1330-1400
1400-1430									1400-1430
1430-1500									1430-1500
1500-1530	CMOS Council Meeting Réunion du conseil SCMO				HYD Exec Meeting Réunion de l'Exéc HYD				1500-1530
1530-1600									1530-1600
1600-1630									1600-1630
1630-1700		EarthsCAN Information Session d'information EarthsCAN						Student Meet and Greet / Étudiant rencontrer et saluer	1630-1700
1700-1730									1700-1730
1730-1800									1730-1800
1800-1830	Icebreaker Soirée d'ouverture (Pointe Sainte-Anne C&D)								1800-1830
1830-1900									1830-1900
1900-1930									1900-1930
1930-2000									1930-2000
2000-2030									2000-2030
2030-2100									2030-2100
2100-2130									2100-2130
2130-2200									2130-2200

Workshop #1: Using R for Analysis of Ocean and Atmosphere Data
Atelier n° 1 : L'utilisation de R pour l'analyse de données océaniques et atmosphériques

Sunday, May 29 | 13:00 – 16:30 / Dimanche 29 mai | 13 h à 16 h 30
Room / Chambre: Devon
Cost / Coût: $10

The R software environment is a free and open source tool for statistical computing and graphics (see www.r-project.org). It is available for Windows, Mac, and Linux, and is rapidly gaining popularity within the scientific community. Through additional user contributed packages, the capabilities of R can be extended to cover almost any desired need. This workshop will introduce users to the R environment, with a focus on oceanographic and meteorological applications. In particular, the workshop will introduce the "oce" add-on package, which includes a wide range of specialized functions familiar to physical oceanographers (CTD and ADCP data, equation of state, TS diagrams, mapping, etc) who currently use other non-free analysis software, such as Matlab. No prior R experience is necessary, and participants are encouraged to bring a laptop to be able to work through examples.

Le logiciel R est un environnement de calcul statistique et de représentation graphique gratuit et libre (voir www.r-project.org). Il est compatible avec Windows, Mac et Linux, et gagne rapidement en popularité auprès de la communauté scientifique. Grâce aux modules supplémentaires que fournissent les utilisateurs, les capacités étendues de R comblent presque tous les besoins. Cet atelier d'introduction à l'environnement R portera particulièrement sur ses applications océanographiques et météorologiques. Notamment, l'atelier vous fera connaître le module « oce ». Celui-ci comprend un large éventail de fonctions spécialisées bien connues des spécialistes de l'océanographie physique qui utilisent d'autres logiciels d'analyse non libres comme Matlab : données de conductivité-température-profondeur et de courantomètre à effet Doppler, équations d'état, diagrammes T-S, cartographie, etc. Aucune expérience du logiciel R n'est requise. Nous encourageons les participants à apporter leur ordinateur, afin de travailler avec les exemples proposés.

Instructors / Instructeurs : Clark Richards (clark.richards@rbr-global.com), Dan Kelley (dan.kelley@dal.ca)

EarthsCAN Information Session
Séance d'information sur EarthsCAN

Sunday/Dimanche, May 29 | 16:30 – 18:00
Room/Chambre: Barkers Point A

Globally, climate change, population growth, natural hazards and the need for long term sustainability of resource supply (including materials, energy and food) demand new approaches to the Earth Sciences. Here we are intending to create new research networks that permit us to approach the challenges facing society with completely new ways of thinking. This initial EarthsCAN information session (preceding CGU/CMOS – companion to a second information session at GACMAC) will discuss this research initiative, brainstorm and design possible proof of concept projects, in preparation for upcoming workshops being coordinated for August 2016 in Ottawa (21, 22, 23) and Calgary (17, 18, 19); which now have >100 committed participants from Department of Fisheries and Oceans, Environment & Climate Change Canada, academia, Earthscope and emergency management agencies.

The purpose of the EarthsCAN research initiative is to develop a Canada-wide multi-disciplinary research initiative, expanding on the success of the US Earthscope program (http://www.earthscope.org) with the addition of atmospheric-oceanographic-climatic/weather modeling. For example, in April 2016, discussions were started to ensure that the Meteorological Research Division at Environment & Climate Change Canada gains access to real time meteorological data that will result from the installation of 17 new Earthscope instrument sites in northwestern Canada during this upcoming summer.

Information Session Goals

- Discuss science goals that can be addressed using EarthsCAN data
- Capitalize on momentum from the EarthScope 2010-2020 Science Plan (http://www.earthscope.org/information/publications/science-plan)
- Outline possible pilot project(s) for EarthsCAN, and discuss general recommendations for possible deployment of USArray Transportable Array sites in western Canada
- Explore the breadth of community providing input to EarthsCAN
- Provide an opportunity to develop cross-disciplinary personal contacts and stimulate future scientific collaborations
- Provide recommendations for planning the August (Calgary-Ottawa) workshops

Information Session Format and Agenda (draft agenda to follow)

This information session will feature invited, cross-disciplinary talks and breakout discussion sessions. We are soliciting white papers, discussing either research results or hypotheses that could be tested using EarthsCAN data. We will select several speakers to give short (5 minute) mini-talks to complement the invited speakers. These whitepapers will be available to breakout groups at the August (Ottawa-Calgary) workshops and incorporated into a final workshop report. Everyone is encouraged to submit whitepapers, regardless of whether you are able to attend this EarthsCAN information session.

Format for white papers: 2-3 powerpoint/PDF slides (with 1-2 pages word background)
Deadline for white papers: May 16, 2016
Interested? Please contact Katherine Boggs (kboggs@mtroyal.ca)

À l'échelle de la planète, les changements climatiques, la croissance de la population, les dangers naturels et l'accès durable aux ressources (y compris les matières, l'énergie et la nourriture) exigent une nouvelle approche des sciences de la Terre. Nous tentons ici de créer de nouveaux réseaux de recherche qui nous permettraient d'aborder les enjeux touchant la société, et ce, en nous appuyant sur de nouvelles façons de penser. Durant cette séance d'information préliminaire sur EarthsCAN (avant le congrès UGC-SCMO et associée à une seconde séance d'information au congrès GAC-MAC), nous discuterons de cette initiative de recherche, nous proposerons des idées et démontrerons la faisabilité de projets éventuels, et ce, en préparation pour les prochains ateliers, qui auront lieu en août 2016 à Ottawa (21, 22 et 23) et à Calgary (17, 18 et 19). Ceux-ci comptent maintenant plus de 100 participants sérieux, provenant du ministère des Pêches et des Océans, d'Environnement et Changement climatique Canada, des universités, d'Earthscope et des organismes de gestion des urgences.

L'initiative de recherche EarthsCAN vise à développer un réseau de recherche pancanadien et multidisciplinaire, reposant sur le succès du programme américain Earthscope (http://www.earthscope.org), et en y ajoutant une composante de modélisation atmosphérique-océanographique-climatique. Par exemple, en avril 2016, des discussions ont été amorcées pour que la Division de la recherche météorologique d'Environnement et Changement climatique Canada ait un accès en temps réel, au cours de l'été qui vient, aux données météorologiques issues de l'installation de 17 nouveaux sites d'instruments Earthscope dans le nord-ouest du Canada.

Objectifs de la séance d'information

- Discuter des objectifs scientifiques qui peuvent s'appuyer sur les données EarthsCAN.
- Exploiter l'intérêt que suscite le plan scientifique 2010-2020 d'Earthscope (http://www.earthscope.org/information/publications/science-plan).
- Déterminer les projets pilotes éventuels à la portée d'EarthsCAN et discuter de recommandations générales pour le déploiement prévu du réseau américain d'instruments mobiles USArray, dans l'ouest du Canada.
- Explorer l'ampleur de la communauté qui participe à EarthsCAN.
- Mettre en place des occasions de réseautage interdisciplinaire et faciliter les collaborations scientifiques à venir.
- Émettre des recommandations en vue de la planification des ateliers du mois d'août à Calgary et à Ottawa.

Format et ordre du jour de la séance d'information (ordre du jour préliminaire à venir)

Cette séance d'information comprendra des conférences interdisciplinaires et des petits groupes de discussion. Nous sollicitons des livres blancs portant soit sur des résultats ou des hypothèses de recherche qui pourraient être validés à l'aide des données d'EarthsCAN. Nous choisirons plusieurs présentateurs qui donneront de mini-exposés (5 minutes), afin de compléter les conférences des orateurs invités. Ces livres blancs seront distribués aux petits groupes de discussions aux ateliers d'Ottawa et de Calgary, en août, et inclus dans le rapport final de l'atelier. Nous vous encourageons à soumettre un livre blanc, même si vous ne pensez pas participer à la séance d'information sur EarthsCAN.

Format des livres blancs : 2 à 3 diapositives PowerPoint/PDF (avec 1 ou 2 pages d'information écrite).

Nous avons suscité votre intérêt? Veuillez communiquer avec Katherine Boggs (kboggs@mtroyal.ca)

Workshop #3: Young Hydrologic Society Workshop
Atelier n° 3 : Atelier de la Young Hydrologic Society

Sunday, May 29 | 12:00 – 16:30 / Dimanche 29 mai | 10 h à 16 h 30
Room / Chambre: Barkers Point A
Cost / Coût: $10

Challenges and opportunities in Canadian hydrology
Select speakers will give short, informal lectures on the current challenges and opportunities they see in Canadian Hydrology in the next 10-years. This will provide young hydrologists an avenue to discuss how their future careers might address these opportunities and make a greater impact with their research.

Progression of one's scientific career
A guest speaker will provide an engaging talk on how young scientists should plan for their future research career. This will span topics including publishing and growing a personal brand during grad-studies, things to look for when applying for a post-doc, and how to position one's self for a transition to a University or other research position.

Défis et perspectives du domaine de l'hydrologie au Canada
D'éminents conférenciers présenteront de courts exposés informels sur les défis et les perspectives des 10 prochaines années, dans le domaine de l'hydrologie au Canada. Ces renseignements permettront aux jeunes hydrologistes de découvrir comment profiter des occasions qui s'offrent à eux et ainsi produire des recherches dont l'impact se révélera notable, au cours de leur carrière.

La progression d'une carrière scientifique
Cet exposé interpellera les jeunes scientifiques sur les façons de planifier leur future carrière de chercheur. Il aborde la publication scientifique et la façon de se démarquer dès les études de deuxième cycle, les informations à retenir quand on pose sa candidature pour une bourse postdoctorale, et comment se positionner pour une mutation vers une université ou un autre poste de recherche.

Facilitator: Chris Marsh chrismarsh.ca University of Saskatchewan

Workshop #4: Campbell Scientific Weather and Water Resource Monitoring Best Practices
Atelier n° 4 : Les pratiques exemplaires pour la surveillance du temps et de l'eau (Campbell Scientific)

Sunday, May 29 | 13:00 – 16:30 / Dimanche 29 mai | 13 h à 16 h 30
Room / Chambre: Nashwaaksis A
Cost / Coût: $10

This interactive session will include a presentation on common weather and water monitoring best practices. Participants are encouraged to share their field work experiences (both challenges and successes) in order to tailor the content to practical applications. As this session is focused around field based experiences, we will provide hands on instructions on how to connect different sensors to dataloggers and how to write basic programs to generate and collect data for further analysis. There will be weather and water monitoring equipment on display to use and become familiar with.

Best practices of weather and water monitoring will include:

- Hardware selection
- Programming as it relates to getting the best quality data possible
- Data management
- System installation
- Ongoing maintenance and calibration
- Data QA/QC

Cette séance interactive inclura une présentation sur les meilleures pratiques à suivre pour surveiller le temps et l'eau. Nous encourageons les participants à partager leur expérience sur le terrain (les revers et les réussites) de manière à adapter la présentation à des situations concrètes. Comme cette séance porte sur des expériences de campagne sur le terrain, nous montrerons comment connecter différents capteurs aux enregistreurs de données, et écrire des programmes de base qui permettront de générer et de recueillir des données, pour analyse future. Il sera possible d'utiliser les instruments de mesure de données météorologiques et hydriques en démonstration, afin de se familiariser avec celles-ci. Les meilleures pratiques de surveillance du temps et de l'eau comprennent :

- le choix du matériel;
- la programmation en vue de recueillir les meilleures données possible;
- la gestion des données;
- l'installation des systèmes;
- l'entretien et l'étalonnage de routine;
- l'AQ/CQ des données.

Instructors / Instructeurs : DJ Snodgrass, Supervisor of Technical Support and Field Services, Campbell Scientific Canada

Special Sessions | Sessions spéciales

Special Sessions, Social Activities and Meetings / Sessions spéciales, les activités sociales et réunions

Time Heure	Monday Lundi	Tuesday Mardi	Wednesday Mercredi	Thursday Jeudi	Time Heure
0800-0830					0800-0830
0830-0900	Educator`s Day Journée des enseignants (Devon)				0830-0900
0900-0930	Fredericton Walking Tour (meet at Lord Beaverbrook Hotel) Fredericton randonnée pédestre (Répondre à Hôtel Lord Beaverbrook)				0900-0930
0930-1000					0930-1000
1000-1030					1000-1030
1030-1100	Engaging with the Private Sector La collaboration avec le secteur privé (Marysville B)				1030-1100
1100-1130					1100-1130
1130-1200					1130-1200
1200-1230		Patterson Parsons Luncheon / déjeuner (Pointe Sainte-Anne A&B) CGU-UGC Luncheon / déjeuner (Crowne Plaza, St. John Miramichi)	Student Lunch and Learn Étudiant le déjeuner-causerie (Cora's)		1200-1230
1230-1300					1230-1300
1300-1330					1300-1330
1330-1400		CMOS Panel Discussion SCMO panel de discussion (Marysville A) Arctic SIG Panel 2016 Discussion Discussion GIS de l'Arctique 2016 (Nashwaaksis B)		Hydro Dam and DND Tours Visites de barrage hydroélectrique et DDN (FCC Entrance/ entrée)	1330-1400
1400-1430					1400-1430
1430-1500					1430-1500
1500-1530					1500-1530
1530-1600			Conférence WOO Lecture (Pointe Sainte-Anne A) ECCC & the Toronto Pan Am Games ECCC & les Jeux pan am de Toronto (Marysville A) Agroclimatic Extremes Extrêmes agroclimatiques (Barkers Point A)		1530-1600
1600-1630	CGU AGM (ESP) AGA de UGC (PST) (Devon) CGU AGM (BGS) AGA de UGC (BGS) (Barkers Point A) CGU AGM (GEOD) AGA de UGC (GEOD) (Barkers Point B) CGU AGM (HYD) AGA de UGC (HYD) (Nashwaaksis A) CGU AGM SES AGA de UGC (TSS) (Nashwaaksis B)				1600-1630
1630-1700					1630-1700
1700-1730	CMOS AGM AGA de SCMO (Nashwaaksis A) CGU AGM AGA de UGC (Nashwaaksis B)	NSERC Meeting Réunion CRSNG (Barkers Point A) Arctic SIG AGM AGA de GIS de 'lArctique (Nashwaaksis A)	CCAR Networks Meeting Réunion réseau CCRA (Devon)		1700-1730
1730-1800					1730-1800
1800-1830					1800-1830
1830-1900			Cash Bar / Bar payant **(6:15 start/départ)**		1830-1900
1900-1930	Student Night Soirée étudiante (Dolan's Pub)	Public Lecture Conférence publique (Pointe Sainte-Anne A&B)	CMOS / SCMO Banquet (Pointe Sainte-Anne A&B) CGU / UGC Banquet (Crowne Plaza Ballroom)		1900-1930
1930-2000					1930-2000
2000-2030					2000-2030
2030-2100					2030-2100
2100-2130			"Maritime Kitchen Party" / "Maritime party de cuisine" (Pointe Sainte-Anne A&B)		2100-2130
2130-2200					2130-2200

Special Session: Arctic SIG Panel 2016

Tuesday, May 31 | 13:30 – 15:00
Room: Nashwaaksis B
Session Title: Two Ways of Knowing Northern Science – A Case Study on Ice

Ice has traditionally been, and continues to be, very important to Inuit communities and hunters as it represents a major means of transportation, a route to hunting grounds, as well as habitat for keystone species (e.g. polar bears, seals, and whales). With increasing environmental change and variations in ice conditions, it is becoming increasingly important that strong and meaningful dialogue takes place between Inuit and northern knowledge holders with scientists who often work in southern Canada. This Panel will examine new and innovative ways of addressing communications and community needs by examining lessons learned and opportunities for scientists and Inuit knowledge holders to work better together in Arctic science, with a focus on the changing ice conditions in the Arctic.

Each panelist will have approximately ten-fifteen minutes for opening comments, followed by discussion and interaction amongst the panelists. The session will then open for questions and discussion with audience members.

We hope that we can conclude on some recommendations on how to work more closely together in the future – which the Arctic Special Interest Group can take for action.

The creation of the Arctic Special Interest Group within CMOS will enable these efforts and interest to be sustained from this session into future work within CMOS on Arctic oceanographic and meteorological sciences.

Convenor: Helen C Joseph HCJ Consulting Helen@hcjconsulting.ca

Séance spéciale : Discussion d'experts du Groupe d'intérêt pour l'Arctique
L'adaptation aux événements extrêmes et aux variations à long terme et leur surveillance
Mardi 31 mai | 13 h 30 à 15 h
Salle: Nashwaaksis B

La glace a toujours été, et continue d'être, essentielle aux communautés inuites et aux chasseurs. Elle représente un moyen de transport majeur, une route vers les territoires de chasse, ainsi que l'habitat d'espèces clefs (p. ex. les ours polaires, les phoques et les baleines). Étant donné que l'environnement change de plus en plus et que varient les conditions de glace, il est grandement temps d'amorcer des discussions sérieuses et utiles entre les Inuits et les détenteurs de connaissances sur le Nord, et les scientifiques qui travaillent plutôt dans le sud du Canada. Ce groupe d'experts examinera des façons nouvelles et innovatrices d'aborder les communications et les besoins de la communauté, en passant en revue les enseignements passés et les occasions pour les détenteurs des savoirs scientifiques et traditionnels de travailler ensemble sur les sciences arctiques, en se penchant sur les modifications des conditions glaciaires dans l'Arctique.

Chaque panelliste disposera de dix à quinze minutes pour présenter le sujet; suivront un débat et des interactions entre les panellistes; puis la séance s'ouvrira afin de recevoir les questions du public et pour que des discussions s'amorcent avec celui-ci.

Nous espérons pouvoir conclure cette activité par des recommandations sur la façon de travailler étroitement ensemble, et que ces recommandations se transformeront en mesures concrètes, que mettra en œuvre le groupe d'intérêts spéciaux pour l'Arctique.

L'existence de ce groupe relevant de la SCMO permettra de concrétiser ces propositions et de soutenir l'intérêt suscité au cours de la séance, afin d'entreprendre au sein de la SCMO des travaux scientifiques sur l'Arctique, dans les domaines de la météorologie et de l'océanographie.

Animatrice : Helen C. Joseph, HCJ Consulting, Helen@hcjconsulting.ca

Special Session: Engaging with the Private Sector

Monday, May 30 | 10:30 – 12:00
Room: Marysville B

While CMOS continues to grow and find relevance in society, the important transfer of knowledge and science into the private sector becomes an important vehicle to operationalise or support Canadian science. This Special Session of the CMOS Congress is intended to showcase members and companies of the CMOS Private Sector. Contributors are invited to make their pitch about their companies, on the relevance of their work and science as it relates to CMOS in meteorology, oceanography with scientific applications that results in a commercial product or service.

Chair: Martin Taillefer, CMOS Vice President & President of Maritime Way Scientific Ltd.

Séance spéciale : La collaboration avec le secteur privé
Lundi 30 mai | 10 h 30 à 12 h
Salle : Marysville B

Tandis que la SCMO continue de croître et de faire valoir sa pertinence auprès de la société, l'important transfert des connaissances et de la science vers le secteur privé devient un vecteur majeur d'exploitation et de soutien des sciences au Canada. Cette séance spéciale du Congrès vise à présenter les particuliers et les entreprises du secteur privé membres de la SCMO. Nous invitons les exposants à présenter leur compagnie, la pertinence de leurs travaux et de leur domaine scientifique, en ce qui a trait à la SCMO, en météorologie et en océanographie, ainsi que les applications scientifiques qui mènent à un produit ou à un service commercial.
Présentateur : Martin Taillefer, vice-président de la SCMO et président de Maritime Way Scientific Ltd.

Special Session: Environment and Climate Change Canada and the Toronto 2015 Pan Am and Parapan American Games (TO2015 Games)

Wednesday, June 1 | 15:30 – 17:00
Room: Marysville A

Environment Canada and the Toronto 2015 Pan Am and Parapan American Games (TO2015 Games). The collaboration between Science and Technology and the Meteorological Service of Canada to showcase Environment Canada science and operational capabilities through the provision of enhanced weather monitoring, world-class research, and venue specific weather alerts to ensure the safety and protection of athletes, staff, essential federal services, volunteers and spectators. The proposal is to have an introductory 30 minute presentation by Dr. David Sills
1. David Sills - Science in support of the TO2015 Games. The following four presentations will be 12 minutes each (with 3 for questions)
2. John MacPhee - Planning, deployment, commissioning, and decommissioning of the mesonet.
3. Martin Elie - Datalogger programing Design, coding, implementation and issues
4. Joan Klaassen - Data analysis and inter-comparison from the mesonet compact stations.
5. The Ontario Storm Prediction Centre - Forecast and alerting in support of the TO2015 Games.

Chair: John MacPhee, Environment Canada Toronto

Séance spéciale : Environnement et Changement climatique Canada et les Jeux panaméricains et parapanaméricains de Toronto en 2015 (TO2015)
Mecredi 1 juin | 15 h 30 à 17 h
Salle: Marysville A

La présentation portera sur la collaboration entre le secteur des sciences et technologies et le Service météorologique du Canada. Elle montrera les capacités scientifiques et opérationnelles d'Environnement Canada, en s'appuyant sur la surveillance météorologique améliorée, la recherche de classe internationale, les alertes visant des sites précis afin de garantir la sécurité et la protection des athlètes, du personnel, des services essentiels fédéraux, des bénévoles et des spectateurs. La séance consistera en une introduction de 30 minutes par M. David Sills (Ph. D.)
1. David Sills — La science en soutien aux jeux TO2015.

Les présentations suivantes dureront 12 minutes chacune. Trois minutes seront ensuite allouées aux questions.
2. John MacPhee — Planification, déploiement, mise en service et démantèlement du mesonet.
3. Martin Élie — Conception de programmes, programmation, mise en œuvre et problèmes relatifs aux enregistreurs de données.
4. Joan Klaassen — Analyse et intercomparaison des données issues des stations compactes du mesonet.
5. Le Centre de prévision des intempéries de la Région de l'Ontario — Prévisions et alertes en soutien aux jeux TO2015.

Animateur : John MacPhee, Environnement Canada, Toronto

Special Session: Agroclimatic Extremes- Past, Present and Future

Wednesday, June 1 | 15:30 – 17:00
Room: Barkers Point A

This session focuses on understanding how extreme weather & climatic events (including disasters) affect the agriculture sector. The objective of this session is to expand our knowledge of how we can use past, present and future events to better identify and assess risks, adapt and reduce the impacts and costs associated with extreme events. Some aspects of extreme events, such as abnormal timing of precipitation or abnormal onset of frost are unique to agriculture. For example, it is documented that between 2008 and 2012, federal-provincial disaster relief payouts for climate-related extreme events totaled more than $785 million. Additionally, more than $16.7 billion in crop insurance was paid out during the same period. This session will focus on:
1. Defining. How do we quantify and define extreme weather and climate in agriculture? Do appropriate extreme weather and climatic indices exist for agriculture?
2. Monitoring and assessing. What is the baseline? How do we monitor and assess extreme weather and climate in agriculture? What is the trend? Are extreme weather and climatic events occurring with unprecedented frequency, duration and magnitude?
3. Forecasting. Are the extreme weather and climatic indices predictable with a sufficient lead time and skill to allow affected users and decision-makers to make informed choices?
4. Modeling. To what extent are extreme weather and climatic events represented in the Global Climate Models?
5. Communicating. Are extreme weather and climatic events communicated in ways that allow effective and timely use in decision support tools? and
6. Gaps. What are the uncertainties and gaps in our understanding and knowledge of extreme weather and climate that are preventing us from moving forward?

Researchers and practitioners from the following sciences and fields are encouraged to submit papers: hydrology, climatology, geography, forestry, insurance, transportation, energy, actuary and media. In addition to the aspects outlined above, paper topics on how to integrate climate extremes in biophysical ecosystem models, and gap analysis which identifies future research work on impacts of extreme weather on resources sectors, and forecasts of opportunity that show sufficient skill in climate extremes representation are also welcome.

Chair: Aston Chipanshi, Agriculture and Agri-Food Canada

Séance spéciale : Extrêmes agroclimatiques passés, présents et futurs
Mecredi 1 juin | 15 h 30 à 17 h
Salle: Barkers Point A

Cette séance se consacrera à la façon dont les événements météorologiques et climatiques extrêmes (incluant les désastres) perturbent le secteur agricole. Elle vise à approfondir nos connaissances sur la façon d'utiliser les événements passés, présents et futurs afin de déterminer et d'évaluer les risques, de s'adapter, et de réduire les impacts et les coûts associés aux conditions extrêmes. Certains aspects des événements extrêmes, comme un décalage anormal

dans l’arrivée des précipitations ou du gel, restent particuliers à l’agriculture. Par exemple, des documents confirment qu’entre 2008 et 2012, les indemnités de secours aux sinistrés distribuées en raison d’événements climatiques extrêmes se sont élevées à plus de 785 millions de dollars. En outre, les compagnies d’assurance ont payé plus de 16,7 milliards de dollars en indemnités d’assurance-récolte. Les thèmes de la séance sont :
1. La définition. Comment quantifions-nous et définissons-nous les extrêmes météorologiques et climatiques en agriculture? Des indices météorologiques et climatologiques pertinents existent-ils pour l’agriculture?
2. La surveillance et l’évaluation. Quelles sont les conditions de base? Comment surveillons-nous et analysons-nous les extrêmes météorologiques et climatiques en agriculture? Quelle est leur tendance? Les événements météorologiques et climatiques extrêmes surviennent-ils avec une fréquence, une durée et une force inhabituelles?
3. La prévision. Générons-nous les indices d’extrêmes météorologiques et climatiques en temps utile et sont-ils assez précis pour permettre aux utilisateurs et aux décideurs d’effectuer un choix éclairé?
4. La modélisation. À quel point les modèles mondiaux de climat représentent-ils les événements météorologiques et climatiques extrêmes?
5. La communication. Communiquons-nous les événements météorologiques et climatiques extrêmes avec la précision et des délais qui permettent leur intégration aux outils d’aide à la décision?
6. Les lacunes. Quelles sont les incertitudes et les lacunes qui minent notre compréhension et nos connaissances des extrêmes météorologiques et climatiques et qui nous empêchent de progresser?

Nous encourageons les chercheurs et les praticiens à soumettre des articles dans les domaines scientifiques et connexes suivants : l’hydrologie, la climatologie, la géographie, la foresterie, les assurances, le transport, l’énergie, l’actuariat et les médias. En plus des thèmes indiqués ci-dessus, nous acceptons les études sur la façon d’intégrer les extrêmes climatiques dans les modèles biophysiques d’écosystèmes, les analyses de lacunes qui révèlent les travaux futurs qui serviront à étudier les impacts des extrêmes météorologiques sur le secteur des ressources et les prévisions des possibilités qui démontrent une capacité adéquate à représenter les extrêmes climatiques.

Présentateur : Aston Chipanshi, Agriculture et Agroalimentaire Canada

Special Session: CMOS Panel Discussion

Tuesday, May 31 | 13:30 – 15:00
Room: Marysville A
Future Considerations for CMOS Congresses

As this is the 50th Congress of CMOS, the society executive is hosting this session to give the membership and Congress participants an opportunity to discuss the format of this CMOS annual event, and provide ideas on changes and improvements. The 2014 member survey showed that the CMOS Congress is the most important function that CMOS provides to members. The 50th Congress is an appropriate time to reflect on any modernization, adjustments or revisions that may be needed. New ideas from other conferences will be welcomed. Major changes will be considered by the CMOS Council, and minor adjustments will be passed to future congress organizers for consideration.The panel members will present a few ideas for discussion, such as:

- having an app to download, for easier access to congress program material
- having the congress less frequently (maybe every 2 years), and instead run a series of more focused workshops in the intervening years.

If you have a great idea or an irritant large or small in our usual programming, come let us know!

Panel Members;
Martha Anderson – Outgoing President
Marty Taillefer – Incoming President
Gordon Griffith – Executive Director

Facilitator: Martha Anderson

Séance spéciale : SCMO panel de discussion
Points à considérer concernant les futurs congrès de la SCMO
Mardi 31 mai | 13 h 30 à 15 h
Salle: Marysville A

Les dirigeants de la Société profitent du 50e Congrès de la SCMO pour organiser cette séance afin de permettre aux membres ainsi qu'aux participants de débattre du format de cette rencontre annuelle, et de proposer d'éventuels changements et améliorations. Le sondage des membres de 2014 a révélé que le Congrès de la SCMO demeure l'activité la plus importante que notre organisation puisse fournir aux membres. Le 50e Congrès s'avère donc le moment idéal pour réfléchir à la modernisation, aux rectifications ou aux révisions que nécessiterait cet événement. Les nouvelles idées émanant d'autres congrès sont les bienvenues. Le conseil d'administration de la SCMO examinera les propositions de modifications majeures, tandis que les ajustements mineurs seront simplement proposés aux organisateurs des congrès à venir. Les membres du panel présenteront quelques sujets de discussion :

- Proposer le téléchargement d'une application, pour un accès facile au programme et aux autres documents du congrès.
- Tenir le congrès à intervalle (p. ex. aux deux ans) et organiser plutôt une série de symposiums entre les congrès.

Si vous avez une bonne idée ou si un point, anodin ou important, vous irrite relativement à notre programme habituel, n'hésitez pas à nous en faire part!

Membres du panel :
Martha Anderson – présidente sortante
Marty Taillefer – président à venir
Gordon Griffith – directeur général

Special Session: WOO Lecture

Wednesday, June 1 | 15:30 – 17:00
Room: Pointe Sainte-Anne A

Recent advances in river temperature research and modeling

Daniel Caissie
Fisheries and Oceans Canada
Daniel.Caissie@dfo-mpo.gc.ca

The thermal regime of rivers plays an important role in the overall health of aquatic ecosystems. For instance, river water temperature is important when conducting environmental impact assessments as well as for the management of fisheries and aquatic resources. As such, it is important to understand and properly characterize fundamental controls influencing the thermal behaviour of rivers, the spatial and temporal heterogeneity in river temperatures as well as relevant river heat exchange processes. This study will present information related to these aspects both from a descriptive and modeling perspective. Notably, when modeling river temperatures, heat exchange processes (surface and streambed heat fluxes) need to be quantified. Quantifying these different surface heat fluxes can be a challenge, particularly in small streams where instream microclimate conditions are very different than land-based meteorological data. Therefore, data collection methods to quantify most relevant surface heat fluxes will be presented as well as the role of important parameters (e.g., solar radiation, river evaporation, etc.). The streambed heat flux plays a significant role in the overall heat budget, and this flux is particularly important in small streams. New and innovative techniques have been used to estimate this flux using streambed temperatures as a tracer. Information pertaining to the estimation of this flux will be presented when both conduction and advection (groundwater flow) components are present. Finally, the implication of using water temperature models as a tool to better understand and protect important fisheries resources under current climate as well as under future climate conditions will be discussed.

Facilitator: Daniel Peters

Séance spéciale : WOO conférence

Progrès récents en recherche et en modélisation de la température de cours d'eau

Mecredi 1 juin | 15 h 30 à 17 h
Salle: Pointe Sainte-Anne A

Le régime thermique de cours d'eau se révèle un facteur important de la santé globale des écosystèmes aquatiques. Par exemple, on doit connaître la température de l'eau afin de mener une évaluation d'impacts environnementaux ou de gérer des ressources halieutiques et aquatiques. Ainsi, il importe de comprendre et de caractériser adéquatement les facteurs fondamentaux qui influent sur le régime thermique de cours d'eau, l'hétérogénéité spatiale et temporelle des températures de cours d'eau, ainsi que les processus d'échange thermique connexes. Nous décrivons ici tous ces aspects et présentons les résultats de modélisation s'y rapportant. Notamment, quand il s'agit de modéliser la température de cours d'eau, nous devons quantifier les processus d'échange de chaleur (les flux de surface et de lit). Il peut être difficile

de quantifier les divers flux de chaleur de surface, particulièrement dans de petites rivières où les conditions microclimatiques diffèrent considérablement des conditions météorologiques terrestres. En conséquence, nous présentons également les méthodes de mesure des données servant à quantifier les flux de chaleur les plus pertinents, ainsi que la fonction d'importants paramètres (p. ex. le rayonnement solaire, l'évaporation de l'eau, etc.) Le flux de chaleur du lit joue aussi un rôle considérable dans le bilan thermique global. Il s'avère particulièrement important dans les petits cours d'eau. Des techniques nouvelles et innovatrices ont servi à estimer ce flux en utilisant la température du lit comme traceur. Nous présentons les résultats relatifs à l'estimation du flux de chaleur du lit, quand les deux composantes, conduction et advection (courants souterrains), existent simultanément. Finalement, nous discutons de l'utilisation de modèles de température de l'eau pour améliorer la compréhension et la protection des ressources halieutiques sous les climats actuel et futur.

Animateur : Daniel Peters

Guidelines for Presenters | Instructions pour les présentateurs

Abstract Guidelines

- Abstracts should be a maximum of 300 words with no graphics content. The abstract should provide a basic summary of your poster or oral presentation.

Poster Presentation Guidelines

- Posters will be displayed on the upper level of the convention center in Point Saint-Anne C & D as well as in the adjacent east atrium area.
- Posters will be on display throughout the meeting, but poster presenters should be present at their posters to answer questions during the main poster sessions scheduled Monday May 30th and 31st from 15:30-17:00. The Exhibits Floor Plan shows the poster board areas.
- The maximum poster size is 42 inches by 42 inches (107 cm x 107 cm). Poster presenters are responsible for hanging and removing their own posters. Velcro fastener supports will be provided. Please hang your poster on the assigned numbered board to allow grouping by theme.
- Posters should be up by **10:30 am on Monday May 30th for the first poster session and 10:30 am Tuesday May 31st for the second poster session.** Posters should be removed by 13:00 on Thursday June 2nd. Posters not removed by this time will be discarded.
- Prizes will be awarded by CMOS for the best student poster in Oceanography, the best student poster in Meteorology and best overall poster.

Oral Presentation Guidelines

*****Please review the CMOS Presentation Guidelines*****

- Each oral presentation has been allotted 15 minutes, including 12 minutes for presenting and 3 minutes for questions/comments. Some invited speakers have been allotted 30 minutes total and plenary speakers have been allotted 45 minutes.
- *****Please arrive well ahead of time (30 minutes is suggested)***** to your session to ensure your presentation can be loaded on to the session computer from your USB drive before the session begins.
- Please be sure to have your presentation on a standard USB Thumb drive (eg. not a partitioned drive etc.) to ensure compatibility with session computers. **Session computers will not be able to load from DVDs**
- *****Please ensure you also bring a pdf version of your presentation***** in case there are any compatibility issues with your presentation software

Naming presentation files

- All file and folder names should contain your Last Name followed by First Name then Abstract ID.
- The following file types are acceptable for oral presentations:
  - PowerPoint (.ppt, .pptx)
  - Adobe Reader (.pdf)
  - QuickTime

PowerPoint embeds image files directly into the file when you save them, while video files are not embedded. Only a link is made to the video file. Copy the video clips you want to insert into the same folder as the PowerPoint file before linking them into your presentation. This will eliminate the problem of PowerPoint losing the link to the file. Be sure you upload both the video files and the PowerPoint files to your USB drive. Video/audio can also be played independently of PowerPoint using the VLC media player, which supports various formats (e.g. .wmv, .mpg,.avi, .mov, etc.). Please prepare your files accordingly.

Computer and A/V Equipment

Using your own computer will not be possible. All meeting rooms will be equipped with a Windows 10 based PC with MS Office 2010, QuickTime, VLC media player, Windows media player, and Adobe Acrobat Reader. Please remember to verify proper performance of your presentation in advance, particularly if it includes audio, video, or animation files. Internet access will be available during your presentation. Each session room will be equipped with a screen, LCD projector, timer, laser pointer and lectern with wired microphone.

If you have any questions, please feel free to send an email to the SPC Chair: paul.yang@canada.ca

Directives abstraites
• Les résumés doivent être d'un maximum de 300 mots sans contenu graphique. Le résumé doit fournir un résumé de base de votre affiche ou une présentation orale.

Lignes directrices pour les présentations d'affiche
• Les affiches seront exposées sur le niveau supérieur de la centre de congrès à Pointe Saint-Anne C & D ainsi que dans la zone adjacente à l'est de l'atrium.
• Les affiches seront exposées tout au long de la réunion, mais les présentateurs d'affiches devraient être présents à leur affiche pour répondre aux questions au cours de la session principale prévue le lundi et mardi 30 est 31 mai entre 15h 30 et 17h 00. Le plan d'étage exposition montre les zones d'affichage.
• La taille maximale de l'affiche est de 42 pouces par 42 pouces (107 cm x 107 cm). Les présentateurs d'affiches sont responsables de suspendre et retirer leurs propres affiches. Des supports de velcro de fixation seront fournis. S'il vous plaît accrocher votre affiche sur le tableau numéroté qui vous a été assigné pour permettre le regroupement par thème.
• Les affiches doivent être jusqu'à **10h30 le lundi 30 mai pour la première séance d'affiches et de 10h30 mardi 31 mai pour la deuxième session d'affiches.** Les affiches doivent être enlevées par 13h00 le jeudi 2 Juin. Les affiches non retirées à ce moment seront jetées.
• Les prix seront décernés par la SCMO pour la meilleure affiche étudiante en océanographie, la meilleure affiche étudiante en météorologie et la meilleure affiche globale.

Lignes directrices pour les présentations orales
*****S'il vous plaît examiner les lignes directrices de présentation CMOS*****

• Chaque présentation orale a été allouée 15 minutes, dont 12 minutes pour la présentation et 3 minutes pour les questions et commentaires. Certains présentateurs invités ont été attribuées un total de 30 minutes.
Télécharger les fichiers sur le serveur de fichier de la SCMO
• ***** S'il vous plaît arriver bien à l'avance (30 minutes est proposé) ***** à votre session pour vous assurer que votre présentation peut être chargé sur l'ordinateur de session à partir de votre clé USB avant le début de la session.
• S'il vous plaît être sûr d'avoir votre présentation sur une clé USB standard (par ex. Pas un dur partitionné etc.) pour assurer la compatibilité avec les ordinateurs de session.**Ordinateurs de session ne sera pas en mesure de charger à partir de DVD**

• ***** S'il vous plaît vous assurer d'avoir aussi une version pdf de votre présentation ***** au cas où il ya des problèmes de compatibilité avec votre logiciel de présentation

Nommer les fichiers de présentation
• Tous les noms de fichiers et de dossiers doivent contenir votre nom de famille suivi de son prénom puis Résumé ID.
• Les types de fichiers suivants sont acceptés pour les présentations orales:

-PowerPoint (.ppt, .pptx)

-Adobe Reader (.pdf)

-QuickTime

PowerPoint intègre les fichiers d'image directement dans le document lorsque vous les enregistrez, tandis que les fichiers vidéo ne sont pas intégrés. Seul un lien est établi avec le fichier vidéo. Copiez les vidéos que vous voulez insérer dans le même dossier que le fichier PowerPoint avant de les relier dans votre présentation. Cela éliminera le problème de PowerPoint qui perd le lien vers le fichier. Assurez-vous de télécharger à la fois les fichiers vidéo et le fichier PowerPoint à votre clé USB. Vidéo/audio peut également être joué indépendamment de Powerpoint en utilisant le lecteur VLC media, qui supporte divers formats (par exemple, .wmv, .mpg, .avi, .mov, etc.). S'il vous plaît préparer vos fichiers en conséquence.

Ordinateur et équipement A/V
L'utilisation de votre propre ordinateur ne sera pas possible. Toutes les salles de réunion seront équipées d'un PC équipé de Windows 10 avec MS Office 2010, QuickTime, VLC media player, Windows media play, et Adobe Acrobat Reader. S'il vous plaît vérifier la bonne performance de votre présentation à l'avance, en particulier si elle inclut de l'audio, de la vidéo ou des fichiers d'animation. L'accès à Internet sera disponible lors de votre présentation. Chaque salle de présentation sera équipée d'un écran, un projecteur LCD, un minuteur, pointeur laser et un lutrin avec microphone filaire.

Si vous avez des questions, s'il vous plaît sentir libre d'envoyer un email à la présidence de la CPS:
paul.yang@canada.ca

Session Schedule | Horaire des sessions

Time	Monday May 30									Time
	Pointe Sainte- Anne A	Pointe Sainte-Anne B	Marysville A	Marysville B	Barkers Point A	Barkers Point B	Devon	Nashwaaksis A	Nashwaaksis B	
0800-0830	**Opening Ceremony (Pointe Sainte-Anne A&B)**									0800-0830
0830-0900	Plenaries (Pointe Sainte-Anne A&B) Azetsu-Scott and Hay						Educators Day			0830-0900
0900-0930										0900-0930
0930-1000										0930-1000
1000-1030	Coffee Break (Pointe Sainte-Anne C&D & Atrium)									1000-1030
1030-1100	Coastal Oceanography and Inland waters - Part 1	General Hydrology - Part 1	Clouds: Microphysics, Aerosols, and Radiation - Part 1 Microphysics and Modelling	Engaging with the Private Sector	Atmosphere, Ocean, and Climate Dynamics - Part 1	Fog or Low Visibility in Atlantic Canada - Part 1	Educators Day	Collaboration in development, evaluation and analysis of ocean models - Part 1	Use of Remote Sensing for Floodplain Characterization & Impacts of long-term variations and extreme events on winter biogeochemical processes	1030-1100
1100-1130										1100-1130
1130-1200										1130-1200
1200-1230	Lunch (on your own)									1200-1230
1230-1300										1230-1300
1300-1330										1300-1330
1330-1400	Coastal Oceanography and Inland waters - Part 2	General Hydrology - Part 2	Clouds: Microphysics, Aerosols, and Radiation - Part 2: Observations and Measurements	Sensitivity and Uncertainty Analysis of Earth and Environmental Systems Models & Prediction and Communications of Weather-Related Health Services	Atmosphere, Ocean, and Climate Dynamics - Part 2	Fog or Low Visibility in Atlantic Canada - Part 2	Educators Day	Collaboration in development, evaluation and analysis of ocean models - Part 2	Geodesy and Geodynamics	1330-1400
1400-1430										1400-1430
1430-1500										1430-1500
1500-1530	Coffee Break (Pointe Sainte-Anne C&D & Atrium)									1500-1530
1530-1600	Poster Session 1 (Pointe Sainte-Anne C&D & Atrium)									1530-1600
1600-1630										1600-1630
1630-1700										1630-1700

Time	Tuesday May 31									Time
	Pointe Sainte- Anne A	Pointe Sainte-Anne B	Marysville A	Marysville B	Barkers Point A	Barkers Point B	Devon	Nashwaaksis A	Nashwaaksis B	
0830-0900	Plenaries (Pointe Sainte-Anne A&B) Trenberth and Jean									0830-0900
0900-0930										0900-0930
0930-1000										0930-1000
1000-1030	Coffee Break (Pointe Sainte-Anne C&D & Atrium)									1000-1030
1030-1100				Coastal Oceanography and Inland waters - Part 3	Land surface modelling for GCMs and ESMs	Lithospheric Structure of Eastern North America & General Solid Earth	Cold Regions Hydrology and Hydrometeorology - Part 1	Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 1	Oil Sands Reclamation	1030-1100
1100-1130										1100-1130
1130-1200										1130-1200
1200-1230	CMOS Patterson Parsons Luncheon (Pointe Sainte-Anne A&B) CGU Luncheon (Crowne Plaza, St. John Miramichi)									1200-1230
1230-1300										1230-1300
1300-1330										1300-1330
1330-1400			CMOS Panel Discussion	Coastal Oceanography and Inland waters - Part 4	Physical Oceanography - Part 1	General Biogeosciences & Greenhouse Gas Exchange from Restored or Reclaimed Ecosystems	Cold Regions Hydrology and Hydrometeorology - Part 2	Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 2	Arctic SIG Panel 2016	1330-1400
1400-1430										1400-1430
1430-1500										1430-1500
1500-1530	Coffee Break (Pointe Sainte-Anne C&D & Atrium)									1500-1530
1530-1600	Poster Session 2 (Pointe Sainte-Anne C&D & Atrium)									1530-1600
1600-1630										1600-1630
1630-1700										1630-1700

Time	Wednesday June 1									Time
	Pointe Sainte- Anne A	Pointe Sainte-Anne B	Marysville A	Marysville B	Barkers Point A	Barkers Point B	Devon	Nashwaaksis A	Nashwaaksis B	
0830-0900	Plenaries (Pointe Sainte-Anne A&B) Hutt and Darbyshire									0830-0900
0900-0930										0900-0930
0930-1000										0930-1000
1000-1030	Coffee Break (Pointe Sainte-Anne C&D & Atrium)									1000-1030
1030-1100	Applications of L-Band Microwave Remote Sensing in hydrological monitoring	General Cryosphere - Part 1	Regional climate modelling and diagnostics - Part 1	Hydro-Climatic Extremes and Variability	Physical Oceanography - Part 2	Geophysical signatures of active subsurface processes	Cold Regions Hydrology and Hydrometeorology - Part 3	General Climate & Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 3	Military Meteorology and Oceanography	1030-1100
1100-1130										1100-1130
1130-1200										1130-1200
1200-1230	Lunch (on your own)									1200-1230
1230-1300										1230-1300
1300-1330										1300-1330
1330-1400	Acoustics in oceanography and marine Sciences	General Cryosphere - Part 2	Regional climate modelling and diagnostics - Part 2	Progress in Developing Uncertainty Estimates for Gridded Climate Data	Advances in Earth Surface Processes & Modelling Earth Surface Processes	Aquatic Transport of Nutrients and Carbon from Agricultural Landscapes - Part 1	Cold Regions Hydrology and Hydrometeorology - Part 4	General Atmosphere - Part 1	Climate Variability and Predictability - Part 1	1330-1400
1400-1430										1400-1430
1430-1500										1430-1500
1500-1530	Coffee Break (Pointe Sainte-Anne C&D & Atrium)									1500-1530
1530-1600	WOO Lecture	Coupled modelling and the Year of Polar Prediction	Environment Canada and the Toronto 2015 Pan Am and Parapan American Games (TO2015 Games)	Climate Services and Monitoring - Part 1	Agroclimatic Extremes-past, present and future	Aquatic Transport of Nutrients and Carbon from Agricultural Landscapes - Part 2	Monitoring marine ecosystems and climate	General Atmosphere - Part 2	Climate Variability and Predictability - Part 2	1530-1600
1600-1630										1600-1630
1630-1700										1630-1700

Time	Thursday June 2									Time
	Pointe Sainte- Anne A	Pointe Sainte-Anne B	Marysville A	Marysville B	Barkers Point A	Barkers Point B	Devon	Nashwaaksis A	Nashwaaksis B	
0830-0900	Plenaries (Pointe Sainte-Anne A&B McBean and Risk									0830-0900
0900-0930										0900-0930
0930-1000										0930-1000
1000-1030	Coffee Break (Pointe Sainte-Anne C&D & Atrium)									1000-1030
1030-1100	Modelling Tracers in the Ocean	Urban Water In Canada & Historical and Projected Changes in Hydroclimatological Extremes: Investigating the Roles of Teleconnection Signals and Climate Change	Unmanned air vehicles in the earth, meteorological and oceanographic sciences & Imaging in the earth, meteorological and oceanographic sciences	Climate Services and Monitoring - Part 2	The emerging Arctic Ocean and ocean-atmosphere interactions	Advances in Hydroecology in Canada	Cold Regions Hydrology and Hydrometeorology Part 5 & Hot and Hotter: Temperature as an indicator of environmental change and a tracer of hydrologic processes	Climate-carbon cycle interactions	Aviation Meteorology and Climatology	1030-1100
1100-1130										1100-1130
1130-1200										1130-1200
1200-1230	End of Congress Sessions									1200-1230
1230-1300										1230-1300
1300-1330										1300-1330
1330-1400	Mactaquac Dam and DND Tours (Buses leaving from FCC main entrance)									1330-1400
1400-1430										1400-1430
1430-1500										1430-1500
1500-1530										1500-1530
1530-1600										1530-1600
1600-1630										1600-1630

Temps	Lundi 30 mai									Temps
	Pointe Sainte- Anne A	Pointe Sainte-Anne B	Marysville A	Marysville B	Barkers Point A	Barkers Point B	Devon	Nashwaaksis A	Nashwaaksis B	
0800-0830	**Cérémonie d'ouverture (Pointe Sainte-Anne A&B)**									0800-0830
0830-0900	Plénières (Pointe Sainte-Anne A&B) Azetsu-Scott et Hay						Jour des éducateurs			0830-0900
0900-0930										0900-0930
0930-1000										0930-1000
1000-1030	Pause de café (Pointe Sainte-Anne C&D & Atrium)									1000-1030
1030-1100	Océanographie côtière et les eaux intérieures - Partie 1	Hydrologie Général - Partie 1	Nuages: Microphysique, Aérosols et Radiation - Partie 1 Microphysique et modélisation	Engager avec le secteur privé	Atmosphère, Océan et dynamique du climat - Partie 1	Brouillard ou faible visibilité au Canada Atlantique - Partie 1	Jour des éducateurs	Collaboration dans le développement, l'évaluation et l'analyse des modèles océaniques - Partie 1	L'utilisation de la télédétection pour caractérisé les plaines inondables & Les impacts des variations à long terme et des événements extrêmes sur les processus biogéochimiques	1030-1100
1100-1130										1100-1130
1130-1200										1130-1200
1200-1230	Déjeuner (par vous mêmes)									1200-1230
1230-1300										1230-1300
1300-1330										1300-1330
1330-1400	Océanographie côtière et les eaux intérieures - Partie 2	Hydrologie Général - Partie 2	Nuages: Microphysique, Aérosols et Radiation - Partie 2 Observations et mesures	Sensibilité et Analyse des incertitudes des Systèmes de Terre et de l'environnement Modèles & Prédictions et communications des services de santé à-propos de Météo	Atmosphère, Océan et dynamique du climat - Partie 2	Brouillard ou faible visibilité au Canada Atlantique - Partie 2	Jour des éducateurs	Collaboration dans le développement, l'évaluation et l'analyse des modèles océaniques - Partie 2	Géodésie et géodynamique	1330-1400
1400-1430										1400-1430
1430-1500										1430-1500
1500-1530	Pause de café (Pointe Sainte-Anne C&D & Atrium)									1500-1530
1530-1600	Session d'affiche 1 (Pointe Sainte-Anne C&D & Atrium)									1530-1600
1600-1630										1600-1630
1630-1700										1630-1700

Temps	Mardi 31 mai									Temps
	Pointe Sainte- Anne A	Pointe Sainte-Anne B	Marysville A	Marysville B	Barkers Point A	Barkers Point B	Devon	Nashwaaksis A	Nashwaaksis B	
0830-0900	Plénières (Pointe Sainte-Anne A&B) Trenberth et Jean									0830-0900
0900-0930										0900-0930
0930-1000										0930-1000
1000-1030	Pause de café (Pointe Sainte-Anne C&D & Atrium)									1000-1030
1030-1100				Océanographie côtière et les eaux intérieures - Partie 3	La modélisation de la surface pour les GCMs et ESMs	Structure Lithosphérique de l'Est de l'Amérique du Nord & Terre Solide Général	Hydrologie et hydrométéorologie des régions froides - Partie 1	Extrêmes climatiques: causes et mécanismes, aujourd'hui et dans l'avenir - Partie 1	Remise en état des sables bitumineux	1030-1100
1100-1130										1100-1130
1130-1200										1130-1200
1200-1230	Déjeuner SCMO Patterson Parsons (Pointe Sainte-Anne A&B) Déjeuner UGC (Crowne Plaza, St. John Miramichi)									1200-1230
1230-1300										1230-1300
1300-1330										1300-1330
1330-1400			Table ronde du SCMO	Océanographie côtière et les eaux intérieures - Partie 4	Océanographie physique - Partie 1	Biogeosciences Général & Échange de gaz Greenhouse des écosystèmes restauré ou régénérée	Hydrologie et hydrométéorologie des régions froides - Partie 2	Extrêmes climatiques: causes et mécanismes, aujourd'hui et dans l'avenir - Partie 2	Table ronde du SIG Arctic	1330-1400
1400-1430										1400-1430
1430-1500										1430-1500
1500-1530	Pause de café (Pointe Sainte-Anne C&D & Atrium)									1500-1530
1530-1600	Session d'affiche 2 (Pointe Sainte-Anne C&D & Atrium)									1530-1600
1600-1630										1600-1630
1630-1700										1630-1700

Temps	Pointe Sainte- Anne A	Pointe Sainte-Anne B	Marysville A	Marysville B	Barkers Point A	Barkers Point B	Devon	Nashwaaksis A	Nashwaaksis B	Temps
	Mecredi 1 juin									
0830-0900	Plénières (Pointe Sainte-Anne A&B) Hutt et Darbyshire									0830-0900
0900-0930										0900-0930
0930-1000										0930-1000
1000-1030	Pause de café (Pointe Sainte-Anne C&D & Atrium)									1000-1030
1030-1100	Applications de la télédétection L-Band dans la surveillance hydrologique	Cryosphère Général - Partie 1	La modélisation et diagnostic du climat régional - Partie 1	Les extrêmes et variabilités Hydro-climatiques	Océanographie physique - Partie 2	Signatures géophysiques des processus souterrains actifs	Hydrologie et hydrométéorologie des régions froides - Partie 3	Climat Général & Extrêmes climatiques: causes et mécanismes, aujourd'hui et dans l'avenir - Partie 3	Météorologie et océanographie militaire	1030-1100
1100-1130										1100-1130
1130-1200										1130-1200
1200-1230	Déjeuner (par vous mêmes)									1200-1230
1230-1300										1230-1300
1300-1330										1300-1330
1330-1400	Acoustique en océanographie et des sciences marin	Cryosphère Général - Partie 2	La modélisation et diagnostic du climat régional - Partie 2	Les progrès dans l'élaboration des estimations des incertitudes pour les données climatiques grillé	Les progrès dans les processus du surface de la Terre & Modélisation de processus du surface de la Terre	Transport aquatique d'éléments nutritifs et de carbone des paysages agricoles - Partie 1	Hydrologie et hydrométéorologie des régions froides - Partie 4	Atmosphère Général - Partie 1	Variabilité et prévisions climatiques - Partie 1	1330-1400
1400-1430										1400-1430
1430-1500										1430-1500
1500-1530	Pause de café (Pointe Sainte-Anne C&D & Atrium)									1500-1530
1530-1600	Conférence WOO	Modélisation couplée et l'Année de prévision polaire	Environnement Canada et les jeux parapanaméricains et panaméricains de Toronto en 2015	Services et surveillance climatologiques - Partie 1	Extrêmes agro-climatiques - passé, présent et futur	Transport aquatique d'éléments nutritifs et de carbone des paysages agricoles - Partie 2	Surveillance des écosystèmes et du climat marin	Atmosphère Général - Partie 2	Variabilité et prévisions climatiques - Partie 2	1530-1600
1600-1630										1600-1630
1630-1700										1630-1700

Temps	Jeudi 2 juin									Temps
	Pointe Sainte- Anne A	Pointe Sainte-Anne B	Marysville A	Marysville B	Barkers Point A	Barkers Point B	Devon	Nashwaaksis A	Nashwaaksis B	
0830-0900	Plénières (Pointe Sainte-Anne A&B McBean et Risk									0830-0900
0900-0930										0900-0930
0930-1000										0930-1000
1000-1030	Pause de café (Pointe Sainte-Anne C&D & Atrium)									1000-1030
1030-1100	Modélisation des traceurs dans l'océan	Eau en zone urbaine au Canada & Changements historiques et projetés dans les extrêmes hydroclimatologique: Investigation des rôles des signaux de téléconnexion et le changement climatique	Véhicules aériens sans pilote dans les sciences de la terre, météorologiques et océanographiques & Imagerie dans les sciences de la terre, météorologique et océanographiques	Services et surveillance climatologiques - Partie 2	Les interactions de l'océan Arctique émergent et l'océan-atmosphère	Les progrès de l'hydro-écologie au Canada	Hydrologie et hydrométéorologie des régions froides - Partie 5 & Chaud et plus chaud: Température comme un indicateur de changement de l'environnement et un traceur des processus hydrologiques	Interactions du cycle-carbone et la climat	Météorologie et climatologie de l'aviation	1030-1100
1100-1130										1100-1130
1130-1200										1130-1200
1200-1230	Fin due Congrès									1200-1230
1230-1300										1230-1300
1300-1330										1300-1330
1330-1400	Barrage Mactaquac et visites DND (Les autobus partant de l'entrée principale du FCC)									1330-1400
1400-1430										1400-1430
1430-1500										1430-1500
1500-1530										1500-1530
1530-1600										1530-1600
1600-1630										1600-1630

Monday May 30 Oral Presentation Schedule (Plenaries and Special Sessions in Red)						
Theme	**Session**	**Abstract Title**	**Presenter**		**Time**	**Session Room**
Plenaries	Plenary Day 1	Ocean acidification in the Arctic	Kumiko	Azetsu-Scott	**8:30**	**Pointe Sainte-Anne A&B**
Plenaries	Plenary Day 1	Dynamic adjustment of the seabed to wave-current forcing in the nearshore	Alex	Hay	**9:15**	**Pointe Sainte-Anne A&B**
Parallel Sessions 10:30-12:00						
Ocean	Collaboration in development, evaluation and analysis of ocean models	NEMO modelling with the Arctic Northern Hemisphere Atlantic Configuration	Paul	Myers	**10:30**	**Nashwaaksis A**
Ocean	Collaboration in development, evaluation and analysis of ocean models	Sea Ice Analysis using a Framework based on 3D Surfaces	Ting On	Chan	**10:45**	**Nashwaaksis A**
Ocean	Collaboration in development, evaluation and analysis of ocean models	Greenland meltwater into the Labrador Sea in numerical simulations with CORE-II and CGRF forcing	Xianmin	Hu	**11:00**	**Nashwaaksis A**
Ocean	Collaboration in development, evaluation and analysis of ocean models	Evaluation of hindcasts simulations with the CONCEPTS regional ocean and sea-ice model covering three oceans around Canada	JI	LEI	**11:15**	**Nashwaaksis A**
Ocean	Collaboration in development, evaluation and analysis of ocean models	Ocean Circulation and Marine Terminating Glaciers of the Greenland Ice Sheet	Laura	Gillard	**11:30**	**Nashwaaksis A**
Ocean	Collaboration in development, evaluation and analysis of ocean models	Schwarz-Christoffer Conformal Mapping based Grid Generation for Global Oceanic Circulation Models	Shiming	Xu	**11:45**	**Nashwaaksis A**

Hydrology	Use of Remote Sensing for Floodplain Characterization	Characterizing Floodplain Elevation, Vegetation, and Snow Depth using unmanned aerial vehicles	Sylvain	Leblanc	**10:30**	**Nashwaaksis B**
Biogeosciences	Use of Remote Sensing for Floodplain Characterization	Use of RADARSAT-2 and ALOS-PALSAR images for floodplain mapping in New Brunswick	Brigitte	Leblon	**11:00**	**Nashwaaksis B**
Hydrology	Use of Remote Sensing for Floodplain Characterization	Detection of surface water using airborne LiDAR and TerraSAR-X data	Danielle	Beaulne	**11:15**	**Nashwaaksis B**
Biogeosciences	Impacts of long-term variations and extreme events on winter biogeochemical processes	Drivers of Under-Ice Phosphorus Increases in Shallow Eutrophic Ponds	Maria	Armstrong	**11:30**	**Nashwaaksis B**
Interdiscplinary and other	Atmosphere, Ocean, and Climate Dynamics - Part 1	Understanding the hydrodynamics of strong tidal flow	Richard	Karsten	**10:30**	**Barkers Point A**
Interdiscplinary and other	Atmosphere, Ocean, and Climate Dynamics - Part 1	A Geometric Decomposition of Eddy-Mean Flow Interactions: Extension to Baroclinic Dynamics	Stephanie	Waterman	**10:45**	**Barkers Point A**
Interdiscplinary and other	Atmosphere, Ocean, and Climate Dynamics - Part 1	On Available Potential Energy and Hyperviscosity in a Spectral Collocation Method	Christopher	Subich	**11:15**	**Barkers Point A**
Interdiscplinary and other	Atmosphere, Ocean, and Climate Dynamics - Part 1	A Model for Shear Response in Swimming Plankton	Justin	Shaw	**11:30**	**Barkers Point A**
Interdiscplinary and other	Atmosphere, Ocean, and Climate Dynamics - Part 1	Schmidt and Reynolds number effects in simulations of shoaling long internal waves	Marek	Stastna	**11:45**	**Barkers Point A**
Atmosphere	Fog or Low Visibility in Atlantic Canada - Part 1	A comparison of the world's foggiest marine areas that are in the NW Pacific and the NW Atlantic based upon 58 years of ship observations.	Clive	Dorman	**10:30**	**Barkers Point B**
Atmosphere	Fog or Low Visibility in Atlantic Canada - Part 1	MARINE FOG VISIBILITY: MEASUREMENTS AND FORECASTING DURING SAR PROJECTS	Ismail	Gultepe	**11:00**	**Barkers Point B**
Atmosphere	Fog or Low Visibility in Atlantic Canada - Part 1	Characterizing summer fog events in Halifax, Nova Scotia	Rachel	Chang	**11:30**	**Barkers Point B**
Atmosphere	Fog or Low Visibility in Atlantic Canada - Part 1	Technology-Enabled Understanding of Fog and Low Visibility in the	Randy	Gillespie	**11:45**	**Barkers Point B**

		Offshore of the North Atlantic				
Atmosphere	Clouds: Microphysics, Aerosols, and Radiation - Part 1	Aerosol radiative forcing under cloudy-sky: estimations from combination of satellite observations and global modeling	Xiaoyan	Ma	**10:30**	**Marysville A**
Atmosphere	Clouds: Microphysics, Aerosols, and Radiation - Part 1	Dust aerosol size distribution and its impact on climate	Jiangnan	Li	**10:45**	**Marysville A**
Atmosphere	Clouds: Microphysics, Aerosols, and Radiation - Part 1	Modelling Uncertainty without an Assumed Distribution: Turbulent Cloud Microphysics	David	Collins	**11:00**	**Marysville A**
Atmosphere	Clouds: Microphysics, Aerosols, and Radiation - Part 1	Microphysical Processes Associated With the Formation and Evolution of Precipitation Types During the Alberta Flooding Event of June 2013	Patrick	Duplessis	**11:15**	**Marysville A**
Atmosphere	Clouds: Microphysics, Aerosols, and Radiation - Part 1	The transition from shallow-to-deep cumulus convection over an idealized mesoscale convergence zone.	Daniel	Kirshbaum	**11:30**	**Marysville A**
Atmosphere	Clouds: Microphysics, Aerosols, and Radiation - Part 1	An analytical solution to water diffusion in glassy aerosol particles	Ali	Moridnejad	**11:45**	**Marysville A**
Interdiscplinary and other	Engaging with the Private Sector	Low power/high accuracy loggers for ocean instrument platforms	Clark	Richards	**10:30**	**Marysville B**
Interdiscplinary and other	Engaging with the Private Sector	Maritime Way Scientific Ltd: Innovation Sonar Performance modelling & Seabed Mapping & Classification	Martin	Taillefer	**10:45**	**Marysville B**
Interdiscplinary and other	Engaging with the Private Sector	Quantifying Canadian Catastrophes with CatIQ	Carolyn	Rennie	**11:00**	**Marysville B**
Interdiscplinary and other	Engaging with the Private Sector	Oceanography, geomorphology and engineering services for coastal and offshore environments at Golder Associates Ltd	Alexandre	Forest	**11:15**	**Marysville B**
Interdiscplinary and other	Engaging with the Private Sector	Hoskin Scientific Ltd. – 70 Years of Service to the Canadian Market	Jennie	van der Have	**11:30**	**Marysville B**

Interdiscplinary and other	Engaging with the Private Sector	Info-Electronics Systems Inc.: Instrumentation, analysis and forecasting for hydro-meteorological and environmental monitoring applications	Harinder	Ahluwalia	**11:45**	**Marysville B**
Ocean	Coastal Oceanography and Inland waters - Part 1	Using satellite altimetry in monitoring storm surges	Guoqi	Han	**10:30**	**Pointe Sainte-Anne A**
Ocean	Coastal Oceanography and Inland waters - Part 1	Simulating three-dimensional circulation and hydrography over the central Scotian Shelf using a multi-nested ocean circulation model	Shiliang	Shan	**10:45**	**Pointe Sainte-Anne A**
Ocean	Coastal Oceanography and Inland waters - Part 1	Sea level variability along the Nova Scotia coast during 1993-2012	Li	Zhai	**11:00**	**Pointe Sainte-Anne A**
Ocean	Coastal Oceanography and Inland waters - Part 1	Tidal currents in the south coast of Newfoundland: diurnal or semi-diurnal?	Andry	Ratsimandresy	**11:15**	**Pointe Sainte-Anne A**
Ocean	Coastal Oceanography and Inland waters - Part 1	Tidal currents and intertidal sediment transport under land-fast ice	Urs	Neumeier	**11:30**	**Pointe Sainte-Anne A**
Hydrology	General Hydrology - Part 1	Land cover controls on depression-focused recharge: an example from southern Ontario	James	Buttle	**10:30**	**Pointe Sainte-Anne B**
Hydrology	General Hydrology - Part 1	Hydrological functions of an alpine talus inferred from diel signals: Linking field observations with modeling	Barret	Kurylyk	**10:45**	**Pointe Sainte-Anne B**
Hydrology	General Hydrology - Part 1	A Whole-Catchment Manipulation to Evaluate the Impact of Dry Conditions on Boreal Lakes	Christopher	Spence	**11:00**	**Pointe Sainte-Anne B**
Hydrology	General Hydrology - Part 1	Water Retention Properties of Agricultural Soils in Western Newfoundland Amended with Biochar	Lakshman	Galagedara	**11:15**	**Pointe Sainte-Anne B**
Hydrology	General Hydrology - Part 1	Landscape influences on transit times in six Precambrian Shield catchments	Carl	Mitchell	**11:30**	**Pointe Sainte-Anne B**
Hydrology	General Hydrology - Part 1	An Efficient Approach to Analyze the Behavior of Hydrological Models Using Global Sensitivity Analysis	Amin	Haghnegahdar	**11:45**	**Pointe Sainte-Anne B**

Monday May 30 Parallel Sessions 13:30-15:00						
Ocean	Collaboration in development, evaluation and analysis of ocean models - Part 2	Coastal upwelling off southwest Nova Scotia simulated with a high resolution baroclinic ocean model	C. Harold	Ritchie	**13:30**	**Nashwaaksis A**
Ocean	Collaboration in development, evaluation and analysis of ocean models - Part 2	Improving the Representation of Mixing, Transport, and Deep Water Renewal in a Numerical Model of a Sill-Basin Estuarine System	Nancy	Soontiens	**13:45**	**Nashwaaksis A**
Ocean	Collaboration in development, evaluation and analysis of ocean models - Part 2	Evaluation of the Surface Flows and Mean Currents in the Fraser River Plume in a Model	Jie	Liu	**14:00**	**Nashwaaksis A**
Ocean	Collaboration in development, evaluation and analysis of ocean models - Part 2	Semi-Lagrangian Advection in NEMO	Christopher	Subich	**14:15**	**Nashwaaksis A**
Ocean	Collaboration in development, evaluation and analysis of ocean models - Part 2	Toward a National Repository of Ocean Modeling Code and Best Practices	Doug	Latornell	**14:30**	**Nashwaaksis A**
Ocean	Collaboration in development, evaluation and analysis of ocean models - Part 2	Discussion on development, validation and application of Canadian ocean models	Youyu	Lu	**14:45**	**Nashwaaksis A**
Geodesy	Geodesy and Geodynamics	Can dedicated satellite gravity observations be used to detect subaerial and submarine landslides?	Athina	Peidou	**13:30**	**Nashwaaksis B**
Geodesy	Geodesy and Geodynamics	Impact of direct ray-tracing in PPP GNSS analysis	Thalia	Nikolaidou	**13:45**	**Nashwaaksis B**
Geodesy	Geodesy and Geodynamics	Towards a cloud-based multi-constellation precise point positioning tool for GNSS data processing and analysis	Marco	Mendonca	**14:00**	**Nashwaaksis B**
Geodesy	Geodesy and Geodynamics	Replacing NAD 83: progress and considerations	Joe	Evjen	**14:15**	**Nashwaaksis B**

Geodesy	Geodesy and Geodynamics	Spatio-temporal analysis of GRACE models using Principal Component Analysis: filtering and hydrological signal extraction	Dimitrios	Piretzidis	**14:30**	**Nashwaaksis B**
Geodesy	Geodesy and Geodynamics	Integration of geodetic monitoring techniques in order to augment hazard studies of the northern Cascadia Subduction Zone	Joseph	Henton	**14:45**	**Nashwaaksis B**
Interdiscplinary and other	Atmosphere, Ocean, and Climate Dynamics - Part 2	Rotating stratified turbulence near the tropopause	Olivier	Asselin	**13:30**	**Barkers Point A**
Interdiscplinary and other	Atmosphere, Ocean, and Climate Dynamics - Part 2	On the role of breaking African easterly waves and critical layers in hurricane genesis.	Gilbert	Brunet	**13:45**	**Barkers Point A**
Interdiscplinary and other	Atmosphere, Ocean, and Climate Dynamics - Part 2	North Atlantic atmospheric and ocean inter-annual variability over the past fifty years - dominant patterns and decadal shifts	Entcho	Demirov	**14:00**	**Barkers Point A**
Interdiscplinary and other	Atmosphere, Ocean, and Climate Dynamics - Part 2	Factors influencing the pattern of greenhouse gas-forced surface temperature change	Timothy	Merlis	**14:15**	**Barkers Point A**
Interdiscplinary and other	Atmosphere, Ocean, and Climate Dynamics - Part 2	Constructing Higher-Order Finite Volume Operators on Icosahedral Global Meshes	Christopher	Subich	**14:30**	**Barkers Point A**
Interdiscplinary and other	Atmosphere, Ocean, and Climate Dynamics - Part 2	Meteorological Influences on Dispersion Modeling – Case Study	Chris	Lyons	**14:45**	**Barkers Point A**
Atmosphere	Fog or Low Visibility in Atlantic Canada - Part 2	Improving Visibility Forecasts for the Grand Banks of Newfoundland and Labrador	Terry	Bullock	**13:30**	**Barkers Point B**
Atmosphere	Fog or Low Visibility in Atlantic Canada - Part 2	The Climatology of Advection-Type Fog at the HMDC Hibernia Platform Offshore Newfoundland	Jennifer	Beale	**14:00**	**Barkers Point B**
Atmosphere	Fog or Low Visibility in Atlantic Canada - Part 2	Grand Banks Fog: Climatology from the Hibernia Platform	Elnaz	Bodaghkhani	**14:15**	**Barkers Point B**
Atmosphere	Fog or Low Visibility in Atlantic Canada - Part 2	An Initial Conceptual Model of Fog Offshore Newfoundland	Jennifer	Beale	**14:30**	**Barkers Point B**
Atmosphere	Fog or Low Visibility in Atlantic Canada - Part 2	Machine Learning Approaches to Fog Identification and Prediction on the Grand Banks of Newfoundland	Joel	Finnis	**14:45**	**Barkers Point B**

Atmosphere	Clouds: Microphysics, Aerosols, and Radiation - Part 2	Polarimetric Retrievals of Cloud Droplet Number Concentrations	Kenneth	Sinclair	**13:30**	**Marysville A**
Atmosphere	Clouds: Microphysics, Aerosols, and Radiation - Part 2	Data assimilation of far infrared radiation in polar regions	Laurence	Coursol	**13:45**	**Marysville A**
Atmosphere	Clouds: Microphysics, Aerosols, and Radiation - Part 2	Atmospheric Measurements in the FIR at Eureka, Nunavut: Sensitivity to Thin Ice Clouds and Water Vapor	Jean-Pierre	Blanchet	**14:15**	**Marysville A**
Interdiscplinary and other	Prediction and Communications of Weather-Related Health Services	LE SACDENGUE - SYSTEME D'ALERTE CLIMATIQUE-METEOROLOGIQUE DE PREVENTION DE L'EPIDEMIE DE DENGUE	Francisco	Mendonca	**13:30**	**Marysville B**
Interdiscplinary and other	Prediction and Communications of Weather-Related Health Services	Heat Health Warning Systems in Canada: Development, Implementation and Assessment	Dave	Henderson	**13:45**	**Marysville B**
Interdiscplinary and other	Prediction and Communications of Weather-Related Health Services	Extreme Heat during the Toronto 2015 Pan Am Games – Health-related Impacts and Lessons Learned for Public Health Alerting in Canada	Melissa	MacDonald	**14:00**	**Marysville B**
Interdiscplinary and other	Prediction and Communications of Weather-Related Health Services	Emissions Inventory Preparation in Support of High-Resolution CMAQ Modelling Applications	Martin	Gauthier	**14:15**	**Marysville B**
Interdiscplinary and other	Sensitivity and Uncertainty Analysis of Earth and Environmental Systems Models	Enhanced Identification of hydrologic models using streamflow and satellite water storage data: a multi-objective calibration approach	Fuad	Yassin	**14:30**	**Marysville B**
Interdiscplinary and other	Sensitivity and Uncertainty Analysis of Earth and Environmental Systems Models	Implications of a multi-criteria sensitivity analysis for understanding model structure and selecting calibration parameters	Amin	Haghnegahdar	**14:45**	**Marysville B**
Hydrology	General Hydrology - Part 2	Development of methods to monitor peatland hydrological conditions using	Koreen	Millard	**13:30**	**Pointe Sainte-Anne B**

		RADARSAT-2 Synthetic Aperture Radar Data				
Hydrology	General Hydrology - Part 2	Competitive sorption and dispersion processes of monovalent nutrients in poorly decomposed Sphagnum peat	Colin	McCarter	**13:45**	**Pointe Sainte-Anne B**
Hydrology	General Hydrology - Part 2	Multi-objective optimization based flood frequency analysis	Jianxun (Jennifer)	He	**14:00**	**Pointe Sainte-Anne B**
Hydrology	General Hydrology - Part 2	Predicting the vertical distribution of NAPL, water and air in a hydrocarbon contaminated peat layer by measuring its two- and three-phase capillary pressure relations	Behrad	Gharedaghloo	**14:15**	**Pointe Sainte-Anne B**
Hydrology	General Hydrology - Part 2	Global fresh water ages	Scott	Jasechko	**14:30**	**Pointe Sainte-Anne B**
Hydrology	General Hydrology - Part 2	Hydrologic Controls on Trembling Aspen (Populus tremuloides) Regeneration and Succession Post-Fire	Midori	Depante	**14:45**	**Pointe Sainte-Anne B**
Ocean	Coastal Oceanography and Inland waters - Part 2	TSA – the two-scale approximate in the operational WAVEWATCHIII forecast model	Bash	Toulany	**13:30**	**Pointe Saite Anne A**
Ocean	Coastal Oceanography and Inland waters - Part 2	Assessing performance of different wave breaking parameterizations over shallow water in spectral ocean wave models	Shangfei	Lin	**13:45**	**Pointe Saite Anne A**
Ocean	Coastal Oceanography and Inland waters - Part 2	Simulation of wave-current interaction under Hurricane conditions using FVCOM	Yujuan	Sun	**14:00**	**Pointe Saite Anne A**
Ocean	Coastal Oceanography and Inland waters - Part 2	Preliminary results of applying a shallow acoustic tomography system to monitor tidal currents in Grand Passage, Nova Scotia	Mahdi	Razaz	**14:15**	**Pointe Sainte-Anne A**
Ocean	Coastal Oceanography and Inland waters - Part 2	Satellite-based study of wind and river forcing of the Fraser River plume	Mark	Halverson	**14:30**	**Pointe Saite Anne A**
Ocean	Coastal Oceanography and Inland waters - Part 2	EFFECT OF WIND FORCING ON THE OCEANOGRAPHIC CONDITIONS OF FORTUNE BAY – BELLE BAY (NL)	Sebastien	Donnet	**14:45**	**Pointe Saite Anne A**

Tuesday May 31 Oral Presentation Schedule (Plenaries and Special Sessions in Red)						
Theme	**Session**	**Abstract Title**	**Presenter**			**Session Room**
Plenaries	Plenary Day 2	Insights into Earth's energy imbalance from multiple sources	Kevin	Trenberth	**8:30**	**Pointe Sainte-Anne A&B**
Plenaries	Plenary Day 2	Big data, Social Media, Crowd Sourcing and the Evolution of the Meteorological Enterprise	Michel	Jean	**9:15**	**Pointe Sainte-Anne A&B**
Parallel Sessions 10:30-12:00						
Climate	Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 1	Attribution of extreme climate events	Kevin	Trenberth	**10:30**	**Nashwaaksis A**
Climate	Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 1	Investigation of the 2013 Alberta flood from weather and climate perspectives	Bernardo Stephan	Teufel	**11:00**	**Nashwaaksis A**
Climate	Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 1	Evaluation of the atmospheric conditions associated with freezing rain and ice pellets produced by regional climate model simulations	Julie	Theriault	**11:15**	**Nashwaaksis A**
Climate	Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 1	How does dynamical downscaling affect explosive cyclones along North America's Atlantic coast?	Christian	Seiler	**11:30**	**Nashwaaksis A**
Climate	Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 1	What were the drivers of the "Polar Vortex" winters of 2013/14 and 2014/15?	Paul	Kushner	**11:45**	**Nashwaaksis A**
Hydrology	Oil Sands Reclamation	Perched Peatland Formation and Maintenance on the Boreal Plains of Canada	Lindsay	James	**10:30**	**Nashwaaksis B**
Hydrology	Oil Sands Reclamation	Understanding the hydrochemical evolution and patterns of a constructed wetland in the Athabasca oil sands region, Canada.	Kelly	Biagi	**10:45**	**Nashwaaksis B**
Hydrology	Oil Sands Reclamation	The transport of sodium from a contaminated tailing sands upland to a constructed fen peatland in a post-mined oil sands landscape, Fort McMurray, Alberta:	Eric	Kessel	**11:15**	**Nashwaaksis B**

		Two years post-construction				
Hydrology	Oil Sands Reclamation	Controls on methane flux from a constructed fen in the Athabasca Oil Sands Region, Alberta	Kimberley	Murray	**11:30**	**Nashwaaksis B**
Hydrology	Oil Sands Reclamation	Long-term precipitation-driven salinity change in a saline peatforming wetland in the Athabasca oil sands region, Canada	Olena	Volik	**11:45**	**Nashwaaksis B**
Earth Surface Processes	Land surface modelling for GCMs and ESMs	Surface-Groundwater Interaction in Canadian Land Surface Model	arman	Ganji	**10:30**	**Barkers Point A**
Earth Surface Processes	Land surface modelling for GCMs and ESMs	Snow and ice on sub-grid scale lakes in climate models	Diana	Verseghy	**10:45**	**Barkers Point A**
Earth Surface Processes	Land surface modelling for GCMs and ESMs	Simulated Albedo in Needleleaf Forests is Highly Sensitive to The Treatment of Intercepted Snow: An examination of Canopy Snow Parameterizations in the Canadian Land Surface Scheme	Paul	Bartlett	**11:00**	**Barkers Point A**
Earth Surface Processes	Land surface modelling for GCMs and ESMs	Adding a nitrogen cycle to the Canadian Land Surface Scheme coupled with the Canadian Terrestrial Ecosystem Model: Effects on simulated global carbon exchanges	Paul	Bartlett	**11:15**	**Barkers Point A**
Earth Surface Processes	Land surface modelling for GCMs and ESMs	Impact of interactive vegetation phenology on the simulated pan-Arctic land surface state	Bernardo Stephan	Teufel	**11:30**	**Barkers Point A**
Earth Surface Processes	Land surface modelling for GCMs and ESMs	A study on radiative transfer schemes in plant canopy for land surface models	Qiudan	Dai	**11:45**	**Barkers Point A**
Solid Earth	Lithospheric Structure of Eastern North America	New Seismic Evidence for Multi-stage Lithosphere Evolution in Western Laurentia	Jeff	Gu	**10:30**	**Barkers Point B**
Solid Earth	Lithospheric Structure of Eastern North America	Seismic anisotropic fabrics in eastern and northern Canada : evidence from shear wave splitting measurements	Fiona	Darbyshire	**11:00**	**Barkers Point B**
Solid Earth	Lithospheric Structure of Eastern North America	Constraining Crustal and Lithospheric Structure via Transfer Function Analysis of	Andrew	Frederiksen	**11:15**	**Barkers Point B**

		Teleseismic Data				
Solid Earth	Lithospheric Structure of Eastern North America	Approaching the Petrophysics of deep Earth's and Earth-like Planetary Interior	Hans J.	Mueller	**11:30**	**Barkers Point B**
Hydrology	Cold Regions Hydrology and Hydrometeorology - Part 1	Sensitivity and response of cold regions hydrological regimes to climatic change: A process-based perspective using observations and conceptual understanding from the interior of western Canada	Chris	DeBeer	**10:30**	**Devon**
Hydrology	Cold Regions Hydrology and Hydrometeorology - Part 1	Changing temperature and precipitation in the western Canadian Arctic: Hydrological Implications	Philip	Marsh	**10:45**	**Devon**
Hydrology	Cold Regions Hydrology and Hydrometeorology - Part 1	Changes in snowpack from regional to global scales and implications for water resources in dry season	Mohammad Reza	Najafi	**11:00**	**Devon**
Hydrology	Cold Regions Hydrology and Hydrometeorology - Part 1	Modelling the Athabasca Watershed Snow Response to a Changing Climate	Yonas	Dibike	**11:15**	**Devon**
Hydrology	Cold Regions Hydrology and Hydrometeorology - Part 1	Hydro-climatic controls of the 2014 ice-jam flood on the Peace-Athabasca delta	Spyros	Beltaos	**11:30**	**Devon**
Hydrology	Cold Regions Hydrology and Hydrometeorology - Part 1	Future climate change may lead to greater variability in daily and seasonal streamflow in the Fraser River	Waqar	Younas	**11:45**	**Devon**
Ocean	Coastal Oceanography and Inland waters - Part 3	Effects of Model Parametrization on Lagrangian Particle Tracks in the Bay of Fundy	Fred	Page	**10:30**	**Marysville B**
Ocean	Coastal Oceanography and Inland waters - Part 3	Simulation of Atlantic salmon post-smolt movement along the north shore of the Gulf of St. Lawrence	Kyoko	Ohashi	**10:45**	**Marysville B**
Ocean	Coastal Oceanography and Inland waters - Part 3	Seasonal variability of air-sea CO2 fluxes in the Yellow and East China Seas	Youyu	Lu	**11:00**	**Marysville B**
Ocean	Coastal Oceanography and Inland waters - Part 3	A modelling study of dispersion properties in Vancouver Harbour	Yongsheng	Wu	**11:15**	**Marysville B**

Ocean	Coastal Oceanography and Inland waters - Part 3	Development and application of FVCOM off Newfoundland	Guoqi	Han	**11:30**	**Marysville B**
Ocean	Coastal Oceanography and Inland waters - Part 3	Numerical Model of Shelburne, Nova Scotia with Application to Aquaculture	Susan	Haigh	**11:45**	**Marysville B**
Tuesday May 31 Parallel Sessions 13:30-15:00						
Climate	Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 2	Event attribution – the emerging science of attributing causes to extreme events	Francis	Zwiers	**13:30**	**Nashwaaksis A**
Climate	Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 2	The role of land-atmosphere interaction on future hot-spells over North America as simulated by the Canadian Regional Climate Model (CRCM5)	Gulilat Tefera	Diro	**14:00**	**Nashwaaksis A**
Climate	Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 2	Projected changes of rain-on-snow events over North America based on two Canadian regional climate models	Dae Il	Jeong	**14:15**	**Nashwaaksis A**
Climate	Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 2	The 2015 extreme drought in western Canada: the role of anthropogenic climate change and future outlooks	Kit	Szeto	**14:30**	**Nashwaaksis A**
Climate	Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 2	Attribution of extreme events in Arctic sea ice extent	Kasia	Tokarska	**14:45**	**Nashwaaksis A**
Ocean	Physical Oceanography - Part 1	Source-sink and wind stress curl driven planetary flows in a polar basin	Andrew	Willmott	**13:30**	**Barkers Point A**
Ocean	Physical Oceanography - Part 1	Seasonal and interannual variability of the latitudinal position of the Gulf Stream	Simon	Higginson	**13:45**	**Barkers Point A**
Ocean	Physical Oceanography - Part 1	The Instability of Stratified Jets	Francis	Poulin	**14:00**	**Barkers Point A**
Ocean	Physical Oceanography - Part 1	Attenuation of surface variability by oceanic ventilation	Andrew	Shao	**14:15**	**Barkers Point A**
Ocean	Physical Oceanography - Part 1	Baroclinic topographic Rossby waves on the Northern slope of Flemish Cap	Chantelle	Layton	**14:30**	**Barkers Point A**
Ocean	Physical Oceanography - Part 1	Dependence of working range on near-surface conductivity, sea state, and tides for a 25 MHz CODAR SeaSonde	Mark	Halverson	**14:45**	**Barkers Point A**

Biogeosciences	General Biogeosciences	Controls on variability in seepage lake dissolved organic carbon concentrations across northern Wisconsin	Nora	Casson	**13:30**	**Barkers Point B**
Biogeosciences	General Biogeosciences	Peatland Mercury Cycling and Climate Change: Influence of Water Table Regime and Vegetation Communities	Kristine	Haynes	**13:45**	**Barkers Point B**
Biogeosciences	General Biogeosciences	Effects of changing rainfall frequency on net ecosystem exchange among different vegetation communities in a Southern Ontario poor fen	Danielle	Radu	**14:00**	**Barkers Point B**
Biogeosciences	Greenhouse Gas Exchange from Restored or Reclaimed Ecosystems	Greenhouse Gas Fluxes of Irrigated Sphagnum Moss in a Reclaimed Peatland	Catherine	Brown	**14:15**	**Barkers Point B**
Biogeosciences	Greenhouse Gas Exchange from Restored or Reclaimed Ecosystems	Estimating greenhouse gas fluxes from dairy manure based silage corn cropping systems in western Newfoundland	Mumtaz	Cheema	**14:30**	**Barkers Point B**
Biogeosciences	Greenhouse Gas Exchange from Restored or Reclaimed Ecosystems	Assessing initial biogeochemical characteristics of a 3-yr old forested upland following reclamation procedures in a constructed watershed, Fort McMurray, Alberta	Tristan	Gingras-Hill	**14:45**	**Barkers Point B**
Hydrology	Cold Regions Hydrology and Hydrometeorology – Part 2	Two summers of low flow in Mackenzie River: causative factors and long-term context	Ming-ko	Woo	**13:30**	**Devon**
Hydrology	Cold Regions Hydrology and Hydrometeorology – Part 2	Spatial Distribution of Snowmelt at Scotty Creek, NWT	Emily	Haughton	**13:45**	**Devon**
Hydrology	Cold Regions Hydrology and Hydrometeorology – Part 2	Wildfire Impacts on Snow Accumulation, Snow Melt and Ground Thaw on a Peat Plateau	Elyse	Mathieu	**14:00**	**Devon**
Hydrology	Cold Regions Hydrology and Hydrometeorology – Part 2	The influence of taliks on hydrologic connectivity in discontinuous permafrost terrains	Ryan	Connon	**14:15**	**Devon**
Hydrology	Cold Regions Hydrology and Hydrometeorology – Part 2	Physically based modelling of a tundra-taiga basin in the continuous permafrost region for hydrological change diagnosis	Sebastian	Krogh	**14:30**	**Devon**

Hydrology	Cold Regions Hydrology and Hydrometeorology – Part 2	Combining new observation techniques and high resolution modelling for improved quantification of snow accumulation across an arctic shrub-tundra landscape	ally	toure	**14:45**	**Devon**
Ocean	Coastal Oceanography and Inland waters - Part 4	Turbulence and the momentum balance in a deep-water renewal event	Alex	Hay	**13:30**	**Marysville B**
Ocean	Coastal Oceanography and Inland waters - Part 4	Hydrodynamic connection between the Gulf of the St. Lawrence and adjacent coastal and shelf waters of the northwest Atlantic Ocean	Yuan	Wang	**13:45**	**Marysville B**
Ocean	Coastal Oceanography and Inland waters - Part 4	The Alongshore Tilt of Mean Dynamic Topography and Implications for Nearshore Circulation and Regional Vorticity Balance	Christoph	Renkl	**14:00**	**Marysville B**
Ocean	Coastal Oceanography and Inland waters - Part 4	Measurements of the Rate of Dissipation of Turbulent Kinetic Energy in a High Reynolds Number Tidal Channel	Justine	McMillan	**14:15**	**Marysville B**
Ocean	Coastal Oceanography and Inland waters - Part 4	Effect of coastal submarine canyon dynamics on the cross-shelf exchange of nutrients and oxygen	Karina	Ramos Musalem	**14:30**	**Marysville B**
Interdiscplinary and other	CMOS Panel Discussion	Future Considerations for CMOS Congresses	Martha	Anderson	**13:30**	**Marysville A**
Interdiscplinary and other	Arctic SIG Panel 2016	Two Ways of Knowing Northern Science – A Case Study on Ice	Helen	Joseph	**13:30**	**Nashwaaksis B**

Wednesday June 1 Oral Presentation Schedule (Plenaries and Special Sessions in Red)						
Theme	**Session**	**Abstract Title**	**Presenter**			**Session Room**
Plenaries	Plenary Day 3	Underwater sensing for Canadian defence	Daniel	Hutt	**8:30**	**Pointe Sainte-Anne A&B**
Plenaries	Plenary Day 3	Illuminating the structure of the North American continent: advances in broadband seismology	Fiona	Darbyshire	**9:15**	**Pointe Sainte-Anne A&B**
Parallel Sessions 10:30-12:00						
Interdiscplinary and other	Military Meteorology and Oceanography	Optimizing forecast operations to better serve the Canadian Armed Forces	Geoffrey	Dunsworth	**10:30**	**Nashwaaksis B**
Interdiscplinary and other	Military Meteorology and Oceanography	Meteorological Impacts on Military Operations in the High Arctic	Eric	Van Lochem	**10:45**	**Nashwaaksis B**
Interdiscplinary and other	Military Meteorology and Oceanography	Supporting our Troops: A Depiction of ADS Defence's use of NinJo in an Evolving, Global, and Dynamic Environment. /// Une description de l'utilisation de NinJo dans l'environnement global et dynamique des Services à l'aviation et à la défense (SAD)	Marshall	Hawkins	**11:00**	**Nashwaaksis B**
Interdiscplinary and other	Military Meteorology and Oceanography	Prediction of weather impact on EO-IR sensors for military operations	Denis	Dion	**11:15**	**Nashwaaksis B**
Interdiscplinary and other	Military Meteorology and Oceanography	New concepts using Numerical Environmental Prediction to assist the Canadian Armed Forces, Part 1. /// Nouveau concept d'utilisation de la prévision numérique environnementale pour le soutien aux Forces armées canadiennes, partie1.	Marie-France	Turcotte	**11:30**	**Nashwaaksis B**
Interdiscplinary and other	Military Meteorology and Oceanography	New concepts using Numerical Environmental Prediction to assist the Canadian Armed Forces, Part 2. /// Nouveau concept d'utilisation de la prévision numérique environnementale pour le soutien aux Forces armées canadiennes, partie 2.	David	Degardin	**11:45**	**Nashwaaksis B**

Ocean	Physical Oceanography - Part 2	The role of the Nordic Seas in promoting Deep Water Formation in the Northern Hemisphere	Louis-Philippe	Nadeau	**10:30**	**Barkers Point A**
Ocean	Physical Oceanography - Part 2	Freshwater transport into the interior of the Labrador Sea: A modeling study	Clark	Pennelly	**10:45**	**Barkers Point A**
Ocean	Physical Oceanography - Part 2	Watermass Transformation and Lateral Fluxes in the Lofoten Basin of the Nordic Seas	Clark	Richards	**11:00**	**Barkers Point A**
Ocean	Physical Oceanography - Part 2	VITALS - Ventilation, Interactions and Transports Across the Labrador Sea	Paul	Myers	**11:15**	**Barkers Point A**
Ocean	Physical Oceanography - Part 2	Variations in freshwater pathways from the Arctic Ocean into the North Atlantic Ocean	Zeliang	Wang	**11:30**	**Barkers Point A**
Ocean	Physical Oceanography - Part 2	An abrupt shift in the Labrador Current System	Zeliang	Wang	**11:45**	**Barkers Point A**
Solid Earth	Geophysical signatures of active subsurface processes	Time-lapse cross-well seismic travel time tomography for CO2 injection monitoring	Bernard	Giroux	**10:30**	**Barkers Point B**
Solid Earth	Geophysical signatures of active subsurface processes	Petrophysical signature of carbonates generated from the carbonation of magnesium-rich mining waste at Thetford Mines, QC	Micha	Horswill	**11:00**	**Barkers Point B**
Solid Earth	Geophysical signatures of active subsurface processes	A permanent installation for monitoring CO2 sequestration in magnesium-rich mining waste at Thetford Mines, QC.	Ali	Nowamooz	**11:15**	**Barkers Point B**
Solid Earth	Geophysical signatures of active subsurface processes	Long term monitoring of self-potential fields for seepage surveillance at the Mactaquac Dam, New Brunswick	Karl	Butler	**11:30**	**Barkers Point B**
Solid Earth	Geophysical signatures of active subsurface processes	Dynamics of solute transport through the vadose zone under a potato field as assessed by a year-long tracer test and cross-hole resistivity imaging	Shuang	Wang	**11:45**	**Barkers Point B**
Hydrology	Cold Regions Hydrology and Hydrometeorology – Part 3	Hydrological impacts of climate change in cold regions of the North American Cordillera	John	Pomeroy	**10:30**	**Devon**
Hydrology	Cold Regions Hydrology	Glacier and hydrology changes in future	Laxmi	Sushama	**10:45**	**Devon**

	and Hydrometeorology – Part 3	climate over western Canada				
Hydrology	Cold Regions Hydrology and Hydrometeorology – Part 3	Responses of river flow and glacier cover to climate change in the Atlin River basin (BC, Canada)	Jos	Samuel	**11:00**	**Devon**
Hydrology	Cold Regions Hydrology and Hydrometeorology – Part 3	Modelling changes in multi-decadal streamflow contributions – Bologna Glacier, Selwyn Mountains, NWT	Emily	Anderson	**11:15**	**Devon**
Hydrology	Cold Regions Hydrology and Hydrometeorology – Part 3	Hydrological functions and energy balance of a talus rock glacier, Canadian Rockies	Jordan	Harrington	**11:30**	**Devon**
Hydrology	Cold Regions Hydrology and Hydrometeorology – Part 3	Using Remote Sensing Data to Assess Trends in Lake Ice within Ontario and Manitoba between 2001-2014	Justin	Murfitt	**11:45**	**Devon**
Climate	Regional climate modelling and diagnostics - Part 1	Daily precipitation extremes over Northern Canada estimated from Arctic and North-America CORDEX simulations and reanalysis	Alain	Mailhot	**10:30**	**Marysville A**
Climate	Regional climate modelling and diagnostics - Part 1	Lake-river and lake-atmosphere interactions in a changing climate over Northeast Canada	Oleksandr	Huziy	**10:45**	**Marysville A**
Climate	Regional climate modelling and diagnostics - Part 1	Diurnal cycle of summer precipitation east of the Rocky Mountain	Lucia	Scaff	**11:00**	**Marysville A**
Climate	Regional climate modelling and diagnostics - Part 1	Modelled response of hail over North America to climate change	Julian	Brimelow	**11:15**	**Marysville A**
Climate	Regional climate modelling and diagnostics - Part 1	Assessment of storm tracks variability in North America using various wind products from Regional Climate Models	Housseyni	Sankare	**11:30**	**Marysville A**
Climate	Regional climate modelling and diagnostics - Part 1	North America Extra-Tropical Cyclones and their relationship with precipitation extremes using Regional Climate Models	Emmanuel D.	Poan	**11:45**	**Marysville A**
Interdiscplinary and other	Hydro-Climatic Extremes and Variability	Mid-Tropospheric Circulation Patterns Associated with Summer Hydro-Climatic Variability and Extremes on the Canadian Prairies	Barrie	Bonsal	**10:30**	**Marysville B**

Interdiscplinary and other	Hydro-Climatic Extremes and Variability	Mid-winter break-up of river ice cover in western Canada and Alaska and associated hydro-climatic drivers	Brandi	Newton	**10:45**	**Marysville B**
Interdiscplinary and other	Hydro-Climatic Extremes and Variability	Analysis of projected hydrologic extremes in the Athabasca River Basin	Yonas	Dibike	**11:00**	**Marysville B**
Interdiscplinary and other	Hydro-Climatic Extremes and Variability	The remote moisture sources for precipitation over Saskatchewan River Basin	Sopan	Kurkute	**11:15**	**Marysville B**
Interdiscplinary and other	Hydro-Climatic Extremes and Variability	Simulations of hydro-climate variables on the Great Lakes basin based on future climate scenarios using a Regional Climate Model	Frank	Seglenieks	**11:30**	**Marysville B**
Interdiscplinary and other	Hydro-Climatic Extremes and Variability	8 Years of Canadian Catastrophe Trends	Carolyn	Rennie	**11:45**	**Marysville B**
Climate	General Climate & Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 3	Convening, Disseminating and Applying Evidence-Based Climate Science to Address Extreme Weather & Climate Change Threats and Opportunities	Jim Ann	Abraham McMillan	**10:30**	**Nashwaaksis A**
Climate	General Climate & Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 3	Comparing the effects of 1.5 °C and 2 °C global warming on climate extremes over Canada and the globe	Nathan	Gillett	**11:00**	**Nashwaaksis A**
Climate	General Climate & Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 3	Impact of aerosol emission controls on future Arctic sea ice cover	Marie-Eve	Gagne	**11:15**	**Nashwaaksis A**
Climate	General Climate & Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 3	Multivariate analysis of extreme Net Basin Supplies in the Great Lakes	Dorra	Hammami	**11:30**	**Nashwaaksis A**
Climate	General Climate & Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 3	A Climatological Analysis of Lake Effect Snowfall and its Processes over the Ontario Snowbelt Region of the Great Lakes Basin	Janine	Baijnath	**11:45**	**Nashwaaksis A**

Cryosphere	Applications of L-Band Microwave Remote Sensing in hydrological monitoring	NASA Aquarius and SMAP L-band observations of the cryosphere	Ludovic	Brucker	**10:30**	**Pointe Sainte-Anne A**
Hydrology	Applications of L-Band Microwave Remote Sensing in hydrological monitoring	MULTI-SCALE L-BAND BRIGHTNESS TEMPERATURE ANALYSIS FOR SOIL FREEZING AND THAWING PROCESS STUDY	Alexandre	Roy	**11:00**	**Pointe Sainte-Anne A**
Hydrology	Applications of L-Band Microwave Remote Sensing in hydrological monitoring	Capturing Soil Freeze/Thaw Processes with L-band Airborne Field Campaign and Ground Measurements	Tracy	Rowlandson	**11:15**	**Pointe Sainte-Anne A**
Hydrology	Applications of L-Band Microwave Remote Sensing in hydrological monitoring	Assessment of Soil Moisture Products from the Soil Moisture Active Passive Mission With Data From Several Validation Sites in Canada	Aaron	Berg	**11:30**	**Pointe Sainte-Anne A**
Hydrology	Applications of L-Band Microwave Remote Sensing in hydrological monitoring	Assimilation of SMOS-retrieved soil moisture and SMOS brightness temperature observations into the Canadian Land Surface Scheme for soil moisture estimation	Manoj	Nambiar	**11:45**	**Pointe Sainte-Anne A**
Hydrology	General Cryosphere - Part 1	The Validation of the Detection of the Soil Freeze-thaw Cycle using L-Band Microwave Radiometry	Matthew	Williamson	**11:00**	**Pointe Sainte-Anne B**
Cryosphere	General Cryosphere - Part 1	The Canadian Ice Island Drift, Deterioration and Detection Database: Documenting the fate of massive glacial ice hazards in the Canadian waters	Anna	Crawford	**11:15**	**Pointe Sainte-Anne B**
Cryosphere	General Cryosphere - Part 1	Direct Forcing of Regional Currents by Sea Ice.	Stefan	Jendersie	**11:30**	**Pointe Sainte-Anne B**
Cryosphere	General Cryosphere - Part 1	Potential and actual predictability of snow water equivalent in the Canadian Seasonal to Interannual Prediction System (CanSIPS)	Reinel	Sospedra-Alfonso	**11:45**	**Pointe Sainte-Anne B**
Wednesday June 1 Parallel Sessions 13:30-15:00						
Atmosphere	General Atmosphere - Part 1	The role of air masses in producing extreme precipitation events	John	Gyakum	**13:30**	**Nashwaaksis A**
Atmosphere	General Atmosphere - Part 1	Development and predictability of a continental atmospheric river coupled with a winter cyclone across North America	Ruping	Mo	**13:45**	**Nashwaaksis A**

Atmosphere	General Atmosphere - Part 1	On the relationship between North Atlantic baroclinic growth rate regimes and surface cyclogenesis	Bryn	Ronalds	**14:00**	**Nashwaaksis A**
Atmosphere	General Atmosphere - Part 1	A Rare Winter Supercell Produces an EF1 'Snownado'	David	Sills	**14:15**	**Nashwaaksis A**
Atmosphere	General Atmosphere - Part 1	Characteristics of winter precipitation types and associated atmospheric conditions in the Kananaskis valley	Paul	Vaquer	**14:30**	**Nashwaaksis A**
Atmosphere	General Atmosphere - Part 1	An intercomparison of weather-based thermal-rating methods for a 500kV transmission line in British Columbia	Maggie	Campbell	**14:45**	**Nashwaaksis A**
Climate	Progress in Developing Uncertainty Estimates for Gridded Climate Data	Development and Application of a Station Based Gridded Ensemble Precipitation and Temperature Dataset over the Contiguous United States	Andrew	Newman	**13:30**	**Marysville B**
Climate	Progress in Developing Uncertainty Estimates for Gridded Climate Data	Quantifying uncertainty in the E-OBS dataset using an ensembles approach	Richard	Cornes	**13:45**	**Marysville B**
Climate	Progress in Developing Uncertainty Estimates for Gridded Climate Data	How well do gridded datasets of observed daily precipitation compare over Australia?	Steefan	Contractor	**14:00**	**Marysville B**
Climate	Progress in Developing Uncertainty Estimates for Gridded Climate Data	Assessment of model-derived precipitation products over Canada	Jefferson	Wong	**14:15**	**Marysville B**
Climate	Progress in Developing Uncertainty Estimates for Gridded Climate Data	Quantification of uncertainties in modelling the present and projected hydrology of the Fraser River Basin, British Columbia	Siraj ul	Islam	**14:30**	**Marysville B**
Climate	Progress in Developing Uncertainty Estimates for Gridded Climate Data	Effect of varied weather data inputs on hydrological modelling of a humid continental agricultural watershed in southern Ontario	Karl	Hanke	**14:45**	**Marysville B**
Climate	Climate Variability and Predictability - Part 1	Tropical Oceanic Rainfall and Sea Surface Temperature Structure: Parsing Causation from Correlation in the MJO	Yanping	Li	**13:30**	**Nashwaaksis B**

Climate	Climate Variability and Predictability - Part 1	Linear and nonlinear statistical downscaling of surface wind vectors	Yiwen	Mao	**13:45**	**Nashwaaksis B**
Climate	Climate Variability and Predictability - Part 1	Climate Change and Extreme Wind Forecasting	James	Young	**14:00**	**Nashwaaksis B**
Climate	Climate Variability and Predictability - Part 1	Vigilance: Detecting severe weather with confidence levels in the extended forecast.	Michael	Schaffer	**14:15**	**Nashwaaksis B**
Climate	Climate Variability and Predictability - Part 1	GEM-NEMO global coupled model for subseasonal to seasonal predictions	Hai	Lin	**14:30**	**Nashwaaksis B**
Climate	Climate Variability and Predictability - Part 1	Predictability of Different Types of ENSO	Youmin	Tang	**14:45**	**Nashwaaksis B**
Earth Surface Processes	Modelling Earth Surface Processes	Flow Dynamics and Erosion in Bedrock Channels	Jeremy	Venditti	**13:30**	**Barkers Point A**
Earth Surface Processes	Advances in Earth Surface Processes	Geophysical surveys to validate a potential sinkhole collapse, Lake on the Mountain, ON.	Andrew	Gagnon-Nandram	**14:00**	**Barkers Point A**
Earth Surface Processes	Advances in Earth Surface Processes	Acoustic Measurements of Small-Scale Sand Transport in River Flow	Greg	Wilson	**14:15**	**Barkers Point A**
Earth Surface Processes	Modelling Earth Surface Processes	Bedload Transport and the Active Width in Gravel-Bed Braided Rivers	Sarah	Peirce	**14:30**	**Barkers Point A**
Earth Surface Processes	Modelling Earth Surface Processes	Assessing Differential Scaling of River Profile Smoothing on the Spatial Distribution of Specific Stream Power and Associated River Channel Adjustment	Pamela	Tetford	**14:45**	**Barkers Point A**
Biogeosciences	Aquatic Transport of Nutrients and Carbon from Agricultural Landscapes - Part 1	Phosphorus transport in subsurface flow – established science and emerging knowledge	Peter	Kleinman	**13:30**	**Barkers Point B**
Biogeosciences	Aquatic Transport of Nutrients and Carbon from Agricultural Landscapes - Part 1	Linking phosphorous export dynamics to landscape heterogeneity and climatic variability: can c-Q relations help?	Genevieve	Ali	**14:00**	**Barkers Point B**
Biogeosciences	Aquatic Transport of Nutrients and Carbon from Agricultural Landscapes - Part 1	Exploring Nitrogen Legacies and Time Lags: A 200-Year Longitudinal Study of the Mississippi and Susquehanna Watersheds	Kimberly	Van Meter	**14:30**	**Barkers Point B**

Hydrology	Cold Regions Hydrology and Hydrometeorology – Part 4	On improving cold region hydrological processes in the Canadian Regional Climate Model	arman	Ganji	**13:30**	**Devon**
Hydrology	Cold Regions Hydrology and Hydrometeorology – Part 4	Testing warranted model complexity using a multi-scale, variable-complexity hydrological modelc	Christopher	Marsh	**13:45**	**Devon**
Hydrology	Cold Regions Hydrology and Hydrometeorology – Part 4	Snow-atmosphere coupling in current and future climates over North America in the Canadian Regional Climate Model (CRCM5)	Gulilat Tefera	Diro	**14:00**	**Devon**
Hydrology	Cold Regions Hydrology and Hydrometeorology – Part 4	The incorporation of an organic soil layer in the Noah-MP Land Surface Model and its evaluation over a Boreal Aspen Forest	Yanping	Li	**14:15**	**Devon**
Hydrology	Cold Regions Hydrology and Hydrometeorology – Part 4	Spatial and Temporal Modelling of Current and Predicted Hydrologic Processes of a High Arctic Watershed, Pond Inlet (Mittimatalik), Nunavut	Alexis	Robinson	**14:30**	**Devon**
Hydrology	Cold Regions Hydrology and Hydrometeorology – Part 4	Subsurface Behaviour of a Continuous Solute Release in a Sub-Arctic Bog	Nicole	Balliston	**14:45**	**Devon**
Climate	Regional climate modelling and diagnostics - Part 2	Snow Characteristics and Snow Albedo Feedback over North America as simulated by the Canadian Regional Climate Model	Bruno	Fang	**13:30**	**Marysville A**
Climate	Regional climate modelling and diagnostics - Part 2	The Gulf of St. Lawrence future ocean climate; ensemble results of nine regional simulations	Joël	Chassé	**13:45**	**Marysville A**
Climate	Regional climate modelling and diagnostics - Part 2	Regional Climate Modelling of the Arctic Ocean ecosystem	Nadja	Steiner	**14:00**	**Marysville A**
Climate	Regional climate modelling and diagnostics - Part 2	Energy conversions in a rapid intense storm developing over mid-latitude area	Oumarou	Nikiema	**14:15**	**Marysville A**
Climate	Regional climate modelling and diagnostics - Part 2	Small-scale development in regional climate model simulations	Dominic	Matte	**14:30**	**Marysville A**
Climate	Regional climate modelling and diagnostics - Part 2	Evidence of added value in North American regional climate model simulations with increasing horizontal resolutions	J.P. René	Laprise	**14:45**	**Marysville A**

Ocean	Acoustics in oceanography and marine sciences	Swath Doppler: Multi-beam Doppler sonar for scanning water velocity sections	Len	Zedel	**13:30**	**Pointe Sainte-Anne A**
Ocean	Acoustics in oceanography and marine sciences	Sound Attenuation in Water-Saturated Sand at MHz Frequencies	Jenna	Hare	**13:45**	**Pointe Sainte-Anne A**
Ocean	Acoustics in oceanography and marine sciences	Suspended sediment profiles in a deep-water renewal event: Estimates using dual-frequency acoustic backscatter	Alex	Hay	**14:00**	**Pointe Sainte-Anne A**
Ocean	Acoustics in oceanography and marine sciences	Transmission loss variability on different time scales during the Target and Reverberation Experiment 2013	Cristina	Tollefsen	**14:15**	**Pointe Sainte-Anne A**
Ocean	Acoustics in oceanography and marine sciences	Ambient noise from turbidity currents in Howe Sound	Matthew	Hatcher	**14:30**	**Pointe Sainte-Anne A**
Ocean	Acoustics in oceanography and marine sciences	Soundscape characterization in a dynamic acoustic environment: A baseline assessment in Grand Passage, Nova Scotia	David	Barclay	**14:45**	**Pointe Sainte-Anne A**
Cryosphere	General Cryosphere - Part 2	Characterization and applications of a combined observation-based northern hemisphere snow water equivalent dataset	Paul	Kushner	**13:45**	**Pointe Sainte-Anne B**
Cryosphere	General Cryosphere - Part 2	Permafrost mapping derived from remotely-sensed ground surface temperature over Arctic during summer periods	Alain	Royer	**14:00**	**Pointe Sainte-Anne B**
Cryosphere	General Cryosphere - Part 2	Retrogressive thaw slump impacts on ecosystem structure and function in Arctic streams	Brianna	Levenstein	**14:30**	**Pointe Sainte-Anne B**
Cryosphere	General Cryosphere - Part 2	Changes to the mass balance, hypsometry, and dynamics of White Glacier, Nunavut, over the past half-century	Laura	Thomson	**14:45**	**Pointe Sainte-Anne B**
Wednesday June 1 Parallel Sessions 15:30-17:00						
Atmosphere	General Atmosphere - Part 2	A new era in monitoring weather events from geostationary satellite with GOES-R	Robert	Rabin	**15:30**	**Nashwaaksis A**
Atmosphere	General Atmosphere - Part 2	Comparison of remote air quality monitoring data with output from the GEOS-Chem global chemical transport model	Christian	Reuten	**16:00**	**Nashwaaksis A**

Atmosphere	General Atmosphere - Part 2	CMC's highlights of operational and experimental numerical products updates over the last year	Nicole	Bois	**16:15**	**Nashwaaksis A**
Atmosphere	General Atmosphere - Part 2	Performance of the new Global Deterministic Prediction System (GDPS 5.0.0) of the Canadian Meteorological Center	Sebastien	Chouinard	**16:30**	**Nashwaaksis A**
Atmosphere	General Atmosphere - Part 2	Evaluating Precipitation Forecasts from a High-Resolution Ensemble Kalman Filter (HREnKF) Over the Pacific Northwest	Phillipa	Cookson-Hills	**16:45**	**Nashwaaksis A**
Climate	Climate Variability and Predictability - Part 2	Changes in Climate over the South China Sea and Adjacent Regions: Response to and Feedback on Global Climate Change	Song	Yang	**15:30**	**Nashwaaksis B**
Climate	Climate Variability and Predictability - Part 2	Continuity of Long-Term Daily Temperature Observations with Automation	Ewa	Milewska	**15:45**	**Nashwaaksis B**
Climate	Climate Variability and Predictability - Part 2	Relationship between North American winter temperature and large-scale atmospheric circulation anomalies and its decadal variation	Bin	Yu	**16:00**	**Nashwaaksis B**
Climate	Climate Variability and Predictability - Part 2	Changes in the structures of low-frequency modes of variability before and after 1980	Nicholas	Soulard	**16:15**	**Nashwaaksis B**
Climate	Climate Variability and Predictability - Part 2	A new dipole index of the salinity anomalies of the tropical Indian Ocean	Junde	Li	**16:30**	**Nashwaaksis B**
Climate	Agroclimatic Extremes- past, present and future	Can artificial intelligence and machine-learning algorithms improve extreme weather agricultural risk assessment?	Nathaniel	Newlands	**15:30**	**Barkers Point A**
Climate	Agroclimatic Extremes- past, present and future	Extreme weather effects on Agriculture: The effect of changing weather patterns on farming operations.	Dan	MacDonald	**15:45**	**Barkers Point A**
Climate	Agroclimatic Extremes- past, present and future	Extreme weather events and agriculture: identifying and characterizing key impacts to corn and soybeans at the regional scale	Anna	Zaytseva	**16:00**	**Barkers Point A**
Climate	Agroclimatic Extremes- past, present and future	Phenological responses of dryland wheat and maize to changes in crop management	Fei	Mo	**16:15**	**Barkers Point A**

		and rising temperatures from 1992 to 2013 across the Loess Plateau				
Climate	Agroclimatic Extremes- past, present and future	Adapting to Climatic Extremes and Variations that affect Western Canadian Grain Production	Ray	Garnett	**16:30**	**Barkers Point A**
Climate	Agroclimatic Extremes- past, present and future	Examining the impact of trends and variability in effective growing degree days and precipitation patterns (1951-2010) on Land Suitability Ratings for Brome in the Whitehorse region.	Dan	MacDonald	**16:45**	**Barkers Point A**
Biogeosciences	Aquatic Transport of Nutrients and Carbon from Agricultural Landscapes - Part 2	Long-Term Effects of Anthropogenic Nutrient Inputs on Riverine Fluxes: A Statistical Approach to Quantifying Watershed Lag Times	Nandita	Basu	**15:30**	**Barkers Point B**
Biogeosciences	Aquatic Transport of Nutrients and Carbon from Agricultural Landscapes - Part 2	Seasonal phosphorus dynamics of Hopewell Creek and its tributaries within a multiple land-use sub-watershed	Cameron	Irvine	**15:45**	**Barkers Point B**
Biogeosciences	Aquatic Transport of Nutrients and Carbon from Agricultural Landscapes - Part 2	Climate drivers of runoff and phosphorus export through agricultural tile drains under sandy loams	W. Vito	Lam	**16:00**	**Barkers Point B**
Biogeosciences	Aquatic Transport of Nutrients and Carbon from Agricultural Landscapes - Part 2	Investigation of flow and solute transport in a shallow perched groundwater system beneath a potato field	Keenan	Lamb	**16:15**	**Barkers Point B**
Biogeosciences	Aquatic Transport of Nutrients and Carbon from Agricultural Landscapes - Part 2	Impact of freeze-thaw cycle magnitudes on the release of phosphorus from cover crops	James	Cober	**16:30**	**Barkers Point B**
Biogeosciences	Aquatic Transport of Nutrients and Carbon from Agricultural Landscapes - Part 2	How much data is needed to robustly detect changes in water quality in agricultural watersheds?	Christopher	Wellen	**16:45**	**Barkers Point B**

Ocean	Monitoring marine ecosystems and climate	The Atlantic Zone Monitoring Program: Observations of a Changing Ocean	Catherine	Johnson	**15:30**	**Devon**
Ocean	Monitoring marine ecosystems and climate	Autonomous monitoring systems: temperature-salinity profiling from an oceanographic buoy and from an ARGO-type profiler	Peter	Galbraith	**15:45**	**Devon**
Ocean	Monitoring marine ecosystems and climate	Multi-annual variability and trends in nutrients and phytoplankton biomass in the Gulf of St. Lawrence	Michael	Scarratt	**16:00**	**Devon**
Ocean	Monitoring marine ecosystems and climate	A time series of nitrogen speciation and nitrogen isotope fractionation over an annual cycle from Bedford Basin, Nova Scotia.	Douglas	Wallace	**16:15**	**Devon**
Ocean	Monitoring marine ecosystems and climate	Seasonal variability and degradation investigation of iodocarbonsin a coastal fjord. Qiang Shi, Douglas Wallace Oceanography Department,Dalhousie University, Halifax, Canada, Email: qshi@dal.ca,	Qiang	Shi	**16:30**	**Devon**
Ocean	Monitoring marine ecosystems and climate	The integrated Beaufort Observatory (iBO)	Alexandre	Forest	**16:45**	**Devon**
Atmosphere	Environment Canada and the Toronto 2015 Pan Am and Parapan American Games (TO2015 Games)	The ECCC Science Showcase during the Toronto 2015 Pan Am and Parapan Am Games	David	Sills	**15:30**	**Marysville A**
Atmosphere	Environment Canada and the Toronto 2015 Pan Am and Parapan American Games (TO2015 Games)	Toronto 2015 Pan Am datalogger programing Design, coding, implementation and issues	Martin	Elie	**15:45**	**Marysville A**
Atmosphere	Environment Canada and the Toronto 2015 Pan Am and Parapan American Games (TO2015 Games)	Experimental air quality forecasts for the Toronto 2015 Pan Am and Parapan Am Games	Andrew	Teakles	**16:00**	**Marysville A**
Atmosphere	Environment Canada and the Toronto 2015 Pan Am and Parapan American	Climatological Information for the Toronto 2015 Games	Joan	Klaassen	**16:15**	**Marysville A**

	Games (TO2015 Games)					
Atmosphere	Environment Canada and the Toronto 2015 Pan Am and Parapan American Games (TO2015 Games)	Application of the MetObject Approach during the 2015 Toronto Pan Am and Parapan Am Games in Support of MSC's Warning Production Renewal Project.	Norbert	Driedger	**16:30**	**Marysville A**
Atmosphere	Environment Canada and the Toronto 2015 Pan Am and Parapan American Games (TO2015 Games)	The Toronto 2015 Pan Am and Parapan Am Games Mesonet. Mission, design, build, deployment, and operation.	John	MacPhee	**16:45**	**Marysville A**
Climate	Climate Services and Monitoring - Part 1	Early Toronto Temperatures	Kenneth	Devine	**15:30**	**Marysville B**
Climate	Climate Services and Monitoring - Part 1	Assessment of Environment and Climate Change Canada's Surface Precipitation Observations	Eva	Mekis	**15:45**	**Marysville B**
Climate	Climate Services and Monitoring - Part 1	Snow Water Equivalent: Do we have the information we need for standards and risk assessment?	Jim	Abraham	**16:00**	**Marysville B**
Climate	Climate Services and Monitoring - Part 1	Constructing hourly temperature-wind scenarios for the Hudson Bay area: challenges and method.	Patrick	Grenier	**16:15**	**Marysville B**
Climate	Climate Services and Monitoring - Part 1	Probabilities for future greenhouse gases emission scenarios	David	Huard	**16:30**	**Marysville B**
Climate	Climate Services and Monitoring - Part 1	Development of "weather vigilance" tools at the Meteorological Service of Canada	Marc	Beauchemin	**16:45**	**Marysville B**
Interdiscplinary and other	Coupled modelling and the Year of Polar Prediction	Coupled wave – atmosphere – ocean modeling at NCEP	Avichal	Mehra	**15:30**	**Pointe Sainte-Anne B**
Interdiscplinary and other	Coupled modelling and the Year of Polar Prediction	Overview of Coupled Environmental Prediction Systems in CONCEPTS	C. Harold	Ritchie	**16:00**	**Pointe Sainte-Anne B**
Interdiscplinary and other	Coupled modelling and the Year of Polar Prediction	Regional atmosphere, sea-ice, wave and ocean prediction systems in the European Arctic and planned contributions to YOPP	Malte	Müller	**16:15**	**Pointe Sainte-Anne B**
Interdiscplinary and other	Coupled modelling and the Year of Polar Prediction	Examination of wave-current interactions over the eastern Canadian shelf under	Pengcheng	Wang	**16:45**	**Pointe Sainte-Anne B**

		severe weather conditions using a coupled circulation-wave model				
Hydrology	WOO Lecture	Recent advances in river temperature research and modeling	Daniel	Caissie	**15:30**	**Pointe Sainte-Anne A**

Thursday June 2 Oral Presentation Schedule

(Plenaries and Special Sessions in Red)

Theme	**Session**	**Abstract Title**	**Presenter**			**Session Room**
Plenaries	Plenary Day 4	Weather, Climate and Ocean Sciences for a Sustainable Future Earth	Gordon	McBean	**8:30**	**Pointe Sainte-Anne A&B**
Plenaries	Plenary Day 4	Non-growing season greenhouse gas production in high-latitude soils	David	Risk	**9:15**	**Pointe Sainte-Anne A&B**
		Parallel Sessions 10:30-12:00				
Climate	Climate-carbon cycle interactions	Quantifying the impact of non-CO2 forcings on cumulative carbon budgets using an Earth System Model	Katarzyna (Kasia)	Tokarska	**11:00**	**Nashwaaksis A**
Climate	Climate-carbon cycle interactions	Cumulative carbon emissions budgets consistent with 1.5°C warming	Nathan	Gillett	**11:15**	**Nashwaaksis A**
Climate	Climate-carbon cycle interactions	The effect of biogeochemical and thermal equilibration on the zero-emission warming commitment	Ines Dana	Ehlert	**11:30**	**Nashwaaksis A**
Climate	Climate-carbon cycle interactions	Symmetry of the climate-carbon cycle response to CO2 emission pulses	Kirsten	Zickfeld	**11:45**	**Nashwaaksis A**
Atmosphere	Aviation Meteorology and Climatology	Canadian Contribution to the WMO Aviation Research Demonstration Project (AvRDP)	David	Sills	**10:30**	**Nashwaaksis B**
Atmosphere	Aviation Meteorology and Climatology	Severe thunderstorms in the high arctic on 24 July 2014	Daniel	Brown	**10:45**	**Nashwaaksis B**
Atmosphere	Aviation Meteorology and Climatology	Modeling aircraft icing using the mass and size distribution of droplets.	Agnieszka	Barszcz	**11:00**	**Nashwaaksis B**
Atmosphere	Aviation Meteorology and Climatology	Surface Visibility at Hudson Bay Region Airports	Andrew	Leung	**11:15**	**Nashwaaksis B**
Atmosphere	Aviation Meteorology and Climatology	The need for better meteorological support for aviation activities	Steve	Ricketts	**11:30**	**Nashwaaksis B**

Ocean	The emerging Arctic Ocean and ocean-atmosphere interactions	The new operational 1/12th degree resolution Arctic-North Atlantic ice-ocean prediction system at Environment Canada.	Frederic	Dupont	**10:30**	**Barkers Point A**
Ocean	The emerging Arctic Ocean and ocean-atmosphere interactions	Changes in Water Temperature in the Barents Sea in the 21st Century	Zhenxia	Long	**10:45**	**Barkers Point A**
Ocean	The emerging Arctic Ocean and ocean-atmosphere interactions	Wave-ice interactions in the operational WAVEWATCHIII forecast model	Will	Perrie	**11:00**	**Barkers Point A**
Ocean	The emerging Arctic Ocean and ocean-atmosphere interactions	Modeling Sea-Ice Thermodynamics Forced by a Cabled Ocean Observatory	Ada	Loewen	**11:15**	**Barkers Point A**
Hydrology	Advances in Hydroecology in Canada	A Review of Recent Advances in Environment Flow Needs Science in Canada	Daniel	Peters	**10:30**	**Barkers Point B**
Hydrology	Advances in Hydroecology in Canada	Subarctic peatland-pond interactions in a permafrost landscape: runoff quantity and quality depend on frost table development and antecedent moisture conditions	Matthew	Morison	**10:45**	**Barkers Point B**
Hydrology	Advances in Hydroecology in Canada	DETERMINING CRITICAL HABITAT AND EMERGENCE CONDITIONS FOR AN INSECT SPECIES AT RISK IN THE SAINT JOHN RIVER, NEW BRUNSWICK	Zoe	O'Malley	**11:00**	**Barkers Point B**
Hydrology	Advances in Hydroecology in Canada	Creating river types to support the assessment of environmental flow requirements in Canada at large-scale	Camille	Ouellet Dallaire	**11:15**	**Barkers Point B**
Hydrology	Advances in Hydroecology in Canada	River water temperature in relation to local air temperature in the Yukon and Mackenzie river basins	Daqing	Yang	**11:30**	**Barkers Point B**
Hydrology	Advances in Hydroecology in Canada	Groundwater flow reversals in an abandoned vacuum-harvested bog, southeastern Manitoba	Pete	Whittington	**11:45**	**Barkers Point B**
Hydrology	Hot and Hotter: Temperature as an indicator of environmental	Miramichi River: An overview of 20 years of research in river temperature monitoring and modeling	Daniel	Caissie	**10:30**	**Devon**

	change and a tracer of hydrologic processes					
Hydrology	Hot and Hotter: Temperature as an indicator of environmental change and a tracer of hydrologic processes	Influence of Turbidity and Aeration on the Albedo of Mountain Streams	Alex	McMahon	**10:45**	**Devon**
Hydrology	Hot and Hotter: Temperature as an indicator of environmental change and a tracer of hydrologic processes	New analytical solution and open access computer program (FAST) to estimate fluid fluxes from subsurface temperature profiles	Barret	Kurylyk	**11:00**	**Devon**
Hydrology	Cold Regions Hydrology and Hydrometeorology – Part 5	Characteristics of Easterly-Induced Snowfall in the Yeongdong region of Korea	Byung-Gon	Kim	**11:15**	**Devon**
Hydrology	Cold Regions Hydrology and Hydrometeorology – Part 5	Cold region river peak flow forecasting using GRACE satellite observations	Shusen	Wang	**11:30**	**Devon**
Hydrology	Cold Regions Hydrology and Hydrometeorology – Part 6	Mapping flood risk in the Kennebecasis River Basin (NB) using the hydrogeomorphological approach	Guillaume	Fortin	**11:45**	**Devon**
Interdiscplinary and other	Imaging in the earth, meteorological and oceanographic sciences	Comparing a Miniature Structured-Light Sensor and Lidar for Imaging Rock Walls	Sara	McPeak	**10:30**	**Marysville A**
Interdiscplinary and other	Imaging in the earth, meteorological and oceanographic sciences	Towards a new method of rock mass stress calibration based on tunnel deformation captured by LiDAR imaging	Claire	Samson	**10:45**	**Marysville A**
Interdiscplinary and other	Imaging in the earth, meteorological and oceanographic sciences	Geological mapping of mining tunnels using 3D images acquired from a moving platform	Eric Ting-Kuei	Chou	**11:00**	**Marysville A**
Interdiscplinary and other	Unmanned air vehicles in the earth, meteorological and oceanographic sciences	Student-Led Project for Development of a Small Multi-mission UAV for Geophysical Surveying Applications	Claire	Samson	**11:15**	**Marysville A**

Interdiscplinary and other	Unmanned air vehicles in the earth, meteorological and oceanographic sciences	Terrain-Following and Draping for Geophysical Survey Uninhabited Aerial Vehicles	Salman	Shafi	**11:30**	**Marysville A**
Interdiscplinary and other	Unmanned air vehicles in the earth, meteorological and oceanographic sciences	Assessment of Unmanned Aerial Vehicle (UAV)-acquired imagery for creation of point clouds, Digital Elevation and Surface Models (DEM and DSM) and orthophotos: case study within vegetated peatland environments	Koreen	Millard	**11:45**	**Marysville A**
Climate	Climate Services and Monitoring - Part 2	A Brief Review of the Environment Canada Rainfall Intensity-Duration-Frequency (IDF) Package	Ka-Hing	Yau	**10:30**	**Marysville B**
Climate	Climate Services and Monitoring - Part 2	The challenges of calibrating a site-specific wind gust forecast in the built up environment with on-site observations.	Ron	Chapman	**10:45**	**Marysville B**
Climate	Climate Services and Monitoring - Part 2	Considering adaptation to climate change as a timescale problem : examples from tourism industry	Dominique	Paquin	**11:00**	**Marysville B**
Climate	Climate Services and Monitoring - Part 2	Identification of alert thresholds for heat waves in Canada from evidence-based data: historical and future climate perspectives	Philippe	Gachon	**11:15**	**Marysville B**
Climate	Climate Services and Monitoring - Part 2	A Digital Ecosystem for Climate Services	James	MacLellan	**11:30**	**Marysville B**
Climate	Climate Services and Monitoring - Part 2	Reflexive Analytics as a Precondition for Climate Services	James	MacLellan	**11:45**	**Marysville B**
Ocean	Modelling Tracers in the Ocean	The Gulf of St. Lawrence: a nutrient trap or a nutrient source?	Diane	Lavoie	**10:30**	**Pointe Sainte-Anne A**
Ocean	Modelling Tracers in the Ocean	Model Study of the Spreading Pathways and Transit Times of the Labrador Sea Water Produced in Different Convection Regimes	Entcho	Demirov	**10:45**	**Pointe Sainte-Anne A**
Ocean	Modelling Tracers in the Ocean	Dealing with Diffusivity and Running Tracers Offline	Susan	Allen	**11:00**	**Pointe Sainte-Anne A**

Ocean	Modelling Tracers in the Ocean	INTERMEDIATE AND DEEP WATER CIRCULATION IN THE ARCTIC OCEAN (2002-2013): INFERRED FROM THE DISTRIBUTION OF 231Pa/230Th IN WATER COLUMN	Xiaoxin	Yu	**11:15**	**Pointe Sainte-Anne A**
Ocean	Modelling Tracers in the Ocean	A simulation study of dissolved Barium and Oxygen isotope ratio in the Arctic	Yingkai	Sha	**11:30**	**Pointe Sainte-Anne A**
Ocean	Modelling Tracers in the Ocean	Global ocean mercury transport and biogeochemistry model	Ashu	Dastoor	**11:45**	**Pointe Sainte-Anne A**
Hydrology	Urban Water In Canada	Geospatial Estimates of Road Salt Usage Across a Gradient of Urbanizing Watersheds in Southern Ontario	Gregory	Giberson	**10:30**	**Pointe Sainte-Anne B**
Hydrology	Urban Water In Canada	Assessing the potential for best-practices in urban design to mitigate hydroecological degradation in urban streams	Christine	Ward-Paige	**10:45**	**Pointe Sainte-Anne B**
Hydrology	Historical and Projected Changes in Hydroclimatological Extremes: Investigating the Roles of Teleconnection Signals and Climate Change	Regularized non-stationary model for extreme hydro-meteorological events in New Brunswick	Nawres	Yousfi	**11:15**	**Pointe Sainte-Anne B**
Hydrology	Historical and Projected Changes in Hydroclimatological Extremes: Investigating the Roles of Teleconnection Signals and Climate Change	Variation of daily precipitation and temperature extremes over southern discontinuous permafrost terrain near Fort Simpson Northwest Territories	Bhaleka	Persaud	**11:30**	**Pointe Sainte-Anne B**
Hydrology	Historical and Projected Changes in Hydroclimatological Extremes: Investigating the Roles of Teleconnection Signals and Climate Change	MTO IDF Curve Look-Up Tool, Phase 3: Identifying and projecting recent historical time trends.	Ric	Soulis	**11:45**	**Pointe Sainte-Anne B**

Poster Session 1, May 30 15:30-17:00
Session d'affiches 1, 30 mai 15h30-17h00
Point Sainte-Anne C&D & Atrium

Poster Theme Thème de l'affiche	Session ID ID de session	Session Session	Abstract Title Titre du résumé	Presenter Présentateur		Poster Order Ordre des affiches
Atmosphere Atmosphère	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	The effect of aerosol acidity on secondary organic aerosol formation in two plumes observed from an airborne measurement campaign over the Athabasca oil sands region	Yuemei	Han	20600P01
Atmosphere Atmosphère	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Mesosphere Wind and Airglow Irradiance Observations in Eureka, Nu	Samuel	Kristoffersen	20600P02
Atmosphere Atmosphère	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Using WRF to improve roadway safety: Forecasting roadway ice in Edmonton	Clark	Pennelly	20600P03
Atmosphere Atmosphère	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Estimating Boreal Fire-generated Ozone over Canada using Ozonesonde Profiles and a Differential Back Trajectory Technique	Omid	Moeini	20600P04
Ocean Océan	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Dissolved methane in the Old Harry influence area in the Gulf of the St. Lawrence	Huixiang	Xie	50600P01
Ocean Océan	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	The Dominating Impact of Inertial Currents on Ocean Surface Waves over the Global Ocean	Will	Perrie	50600P02
Ocean Océan	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Photomethanification of dissolved organic matter in Saguenay River surface water	Huixiang	Xie	50600P03
Ocean Océan	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Validation of a high resolution model in Vancouver Harbour	Mitchell	O'Flaherty-Sproul	50600P04

Ocean Océan	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Toward an operational biogeochemical model for the Strait of Georgia and Salish Sea	Elise	Olson	50800P01
Ocean Océan	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	High-resolution modeling of the Northeast Pacific based on NEMO	Jean-Philippe	Paquin	50800P02
Ocean Océan	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Drivers of the modelled variability of subsurface oxygen and biological pump in two distinct basins: the Labrador Sea and Baffin Bay.	Laura	Castro de la Guardia	50800P03
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Validation of the Soil Moisture Active Passive (SMAP) Soil Moisture Retrieval in the Western Canadian Arctic	Tracy	Rowlandson	70300P02
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Estimation of Pothole Wetland Extent and Seasonal Variability in Kenaston, Saskatchewan using RADARSAT-2	Jenelle	White	70300P03
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	The Relationship Between Satellite Derived Soil Moisture Anomalies and Watershed Runoff Ratios	Elené	Ueckermann	70300P04
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	The impact of glacier recession on water resources: time series analysis in Huancayo, Peru	Lauren	Somers	70400P01
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Climatological influences and the effects of snow cover on lake ice in Central Ontario, Winter 2016	Sarah	Ariano	70400P02
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Lake Ice in the Northern Hemisphere: 2004 to 2015	Laura	Brown	70400P03
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Terrain modelling of snow accumulation near Iqaluit, Nunavut	Murray	Richardson	70400P04

Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Water storage dynamics in geographically isolated wetlands in the Prairie Pothole Region	Md Aminul	Haque	70400P05
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Primary water transport pathways of channel fens in the peatland-dominated zone of discontinuous permafrost	Lindsay	Stone	70400P06
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Modelling permafrost degradation under a linear disturbance in the discontinuous permafrost zone	Michael	Braverman	70400P07
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Determining permafrost-thaw-induced forest loss in the boreal peatlands of the Canadian subarctic	Aaron	Berg	70400P08
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	New Brunswick hydrometric network analysis and rationalization	Nassir	El-Jabi	70600P01
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Estimating storage properties of drainage basins on the Oak Ridges Moraine in southern Ontario: a combined hydrometric – hydrogeologic – isotopic approach	James	Buttle	70600P02
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Assessment of the relationship between near-surface soil moisture and runoff generation in a near-level Prairie watershed	Cody	Ross	70600P03
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	A study of river evaporation within different size watercourses in the Miramichi River	Daniel	Caissie	70600P04
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	A quick evaluation of water isotopic signatures and water travel times in a cold Canadian Prairie watershed	Samuel	Bansah	70600P05
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Evaluating NARR Precipitation Estimates Using a Spatially Distributed Water Balance Model	Cameron	Hunter	70600P06

Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Signals of forest cover effect on flow regime across the Appalachians using simulated soil moisture and evapotranspiration	Wafa	Chouaib	70600P07
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Predicting ecologically-relevant streamflow metrics for drainage basins on the Oak Ridges Moraine, southern Ontario	James	Buttle	70601P01
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Micro-scale characterization of peat hydraulic properties using pore network modeling and X-ray computed tomography	Behrad	Gharedaghloo	70601P02
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Linking Mining Wastewater Discharge to Methylmercury Production and Persistence in a Sub-Arctic Peatland	Lauren	Twible	70601P03
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Evaluating retrievals of soil moisture from C-Band SAR to changes in vegetation throughout a growing season	Josh	MacDougall	70601P04
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Environmental tracer based analysis of groundwater and surface water interactions in the Jock watershed, Ontario, Canada	Cassandra	Michel	70601P05
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Impacts of road construction and removal on the hydrologic and geochemical function of two peatlands within the Athabasca oil sands region, Alberta, Canada	Corey	Wells	70601P06
Hydrology Hydrologie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	HydRun: A MATLAB toolbox for rainfall-runoff and water quality calculations	Weigang	Tang	70601P07
Geodesy Géodesie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	ASSESSING LIGHTNING HAZARD BY INTEGRATED SURFACE PROPERTIES AND ACTUAL CLOUD TO GROUND (CG) LIGHTNING DATA WITH ASSOCIATION RULE	Donghwan	Cha	80100P01
Geodesy Géodesie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Analysing local deformations on a PPP-continental velocity model for the establishment of reference stations	Emerson	Cavalheri	80200P01

Geodesy Géodesie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Time Series Analysis of Daily GNSS Positions in a Volcanic Region.	peter	dare	80200P02
Geodesy Géodesie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Formulating a rigorous satellite based gravitational model	Michael	Sheng	80300P01
Geodesy Géodesie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Parametrization of radial base functions using Bi-Conjugate gradient method to local gravity field modelling	Ismael	Froughi	80300P02
Geodesy Géodesie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Harmonic downward continuation of scattered point gravity anomalies to mean anomalies on a mesh on the geoid	Ismael	Foroughi	80300P03
Geodesy Géodesie	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Heights in the Great Lakes Region Developed from GNSS and a Gravity Field Model	Daniel	Roman	80300P04
Earth Surface Processes Processus de surface de la terre	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Braiding Channel Pattern Dynamics in a Proglacial River	Lara	Middleton	100300P01
Earth Surface Processes Processus de surface de la terre	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Applying physical modelling to engineering challenges: hazards on fans	Brett	Eaton	100300P02
Interdiscplinary and other Interdisciplinaire ou autres	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Climate change in Paraná, Brazil: more humid and dry conditions in Panapanema River basin.	DEISE	ELY	110100P01
Interdiscplinary and other Interdisciplinaire ou autres	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Gravity Wave Parameters observed over Eureka, Nunavut using the PEARL All Sky Imager	Christopher	Vail	110300P01
Interdiscplinary and other Interdisciplinaire ou autres	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Representing shoaling internal waves in layered models	Matthew	Ambacher	110400P01

Interdiscplinary and other Interdisciplinaire ou autres	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Estimates of water mass transformation rate in subpolar North Atlantic using different atmospheric forcing data	Jean-Philippe	Paquin	110400P02
Interdiscplinary and other Interdisciplinaire ou autres	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Automatic Detection of Cyclonic and Anticyclonic Features from a Dense Wind Forcing Dataset	Ting On	Chan	110400P03
Interdiscplinary and other Interdisciplinaire ou autres	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Optimising resources to better serve the Canadian Armed Forces /// Vers l'optimisation des ressources pour mieux servir les Forces armées canadiennes	Kara	Pul	110500P01
Interdiscplinary and other Interdisciplinaire ou autres	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	Some Impacts of the Record Setting Year 2015 in British Columbia	Faron	Anslow	110600P01
Interdiscplinary and other Interdisciplinaire ou autres	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	The July 2015 wildfire smoke event of south coastal British Columbia: evolution and air quality impacts for the Lower Fraser Valley	Robert	Nissen	110600P02
Interdiscplinary and other Interdisciplinaire ou autres	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	The Warm Northeast Pacific Anomaly: Atmospheric Forcing - Ocean Response	Richard	Dewey	110600P03
Interdiscplinary and other Interdisciplinaire ou autres	120100	POSTER SESSION - 1 SESSION D'AFFICHES - 1	What Constitutes a “Good” Sensitivity Analysis? Elements and Tools for a Robust Sensitivity Analysis with Reduced Computational Cost	Saman	Razavi	110800P01

Poster Session 2, May 31 15:30-17:00
Session d'affiches 2, 31 mai 15h30-17h00
Point Sainte-Anne C&D & Atrium

Poster Theme	Session ID	Session	Abstract Title	Presenter		Poster Order
Thème de l'affiche	ID de session	Session	Titre du résumé	Présentateur		Ordre des affiches
Atmosphere Atmosphère	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Airborne far-infrared measurements of the Arctic atmosphere during the NETCARE 2015 campaign	Ludovick	Pelletier	20200P01
Atmosphere Atmosphère	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Analysis of ice clouds observed during the NETCARE Arctic field experiment	Ludovick	S.Pelletier	20200P02
Atmosphere Atmosphère	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	PSC detection at the poles, a TICFIRE strategic objective	Jean-Pierre	Blanchet	20200P03
Atmosphere Atmosphère	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	An innovative statistical post-processing system and its application during the 2015 Pan Am and Parapan Am Games	Andrew	Teakles	20500P01
Climate Climat	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Intraseasonal oscillation linkages to Yangtze Basin rainfall in the Meiyu season	Yonghong	Yao	30100P01
Climate Climat	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Tropical Subseasonal Variability and Its Teleconnection in Canadian EC GEM	Pei-Ning	FENG	30100P03
Climate Climat	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Roles of Remote and Local Forcings in Variation and Prediction of Regional Maritime Continent Rainfall in Wet and Dry Seasons	Tuantuan	Zhang	30100P04

Climate Climat	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Interannual change in South Chinan Sea tropical cyclone frequency related to sea surface temperature in different basin.	Teng	Wang	30100P05
Climate Climat	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Effects of snow-melt on soil moisture memory and on Land-Atmosphere interaction	Jaison	Ambadan Thomas	30100P06
Climate Climat	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Influence of Latent Heating over Southern Asia on Sahel Summer Rainfall	Shan	He	30200P1
Climate Climat	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	CRCM5 dynamical downscaling over the CORDEX Arctic domain	Oumarou	Nikiema	30200P3
Climate Climat	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Investigation of Discontinuity in Precipitation Measurements Across Canada and U.S. Border	Yiwen	Li	30300P01
Climate Climat	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	A Data System for Monitoring and Reporting Weather and Climate Conditions for Canadian Agriculture	Patrick	CHERNESKI	30300P02
Climate Climat	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Developing gridded uncertainty fields for PRISM climate data	Faron	Anslow	30500P01
Climate Climat	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	High-Latitude Transport Modelling in support of the Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE)	John	Henderson	30600P01

Climate Climat	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Relationship between Extensive and Persistent Extreme Cold Events in China and Stratospheric Circulation Anomalies	Hui	Yang	30700P01
Climate Climat	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Climate projections of the occurrences of mixed precipitation over southern Quebec	Dominic	Matte	30700P02
Climate Climat	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Impacts of Climate Change on the Ocean Wave Climate over the Northwest Atlantic Ocean	Lanli	Guo	30800P01
Cryosphere Cryosphère	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Circumpolar Assessment of Trends in Arctic Freshwater Systems	Jennifer	Lento	40100P01
Cryosphere Cryosphère	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Spatio-Temporal Patterns in Trends of Northern Hemisphere Snow Extent and Duration, 1971-2014	Michael	Allchin	40100P02
Ocean Océan	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Convection and circulation in the deep Arctic Ocean	Hayley	Dosser	50200P01
Ocean Océan	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	The physical context of seasonal and inter-annual variability in phytoplankton blooms across the Scotian Shelf: insights from gliders	Richard	Davis	50300P01
Ocean Océan	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Ocean observations on the Scotian Shelf using autonomous vehicles	Richard	Davis	50300P02

Ocean Océan	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Time series ocean observations in Bedford Basin, Nova Scotia	Richard	Davis	50300P03
Ocean Océan	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Oceanographic impact on the performance of fish tag monitoring stations on the Scotian shelf.	David	Barclay	50400P01
Ocean Océan	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Improvement of the MOHID Oil Spill Model for Prediction of the Fate/Behaviour of Oil Spills on Scotian Shelf	Shihan	Li	50500P01
Ocean Océan	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Internal Tidal Wave Propagation under the Landfast Sea Ice in the Southeast Hudson Bay.	Vladislav	Petrusevich	50900P01
Ocean Océan	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Downscaling Simulation of the Arctic Climate using the High-Resolution Regional Atmospheric Model PWRF	Will	Perrie	50900P02
Ocean Océan	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Estimating Mixing Rates and Turbulence in the Canadian Arctic from Glider-based Microstructure Measurements	Stephanie	Waterman	50900P03
Solid Earth Terre solide	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Seasonal Temperature Monitoring for Seepage Reconnaissance in an Embankment Dam	Tana	Yun	60200P01
Solid Earth Terre solide	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	On the feasibility of superconducting gravimetry to monitor surface water and groundwater extraction	Alexander	Braun	60200P02

Solid Earth Terre solide	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Linking Seismic Wave Velocity and Rock Density	Anisa	Kassam	60300P01
Solid Earth Terre solide	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	A Statistical Model for Hydraulic Fracturing-Induced Seismicity in the Western Canada Sedimentary Basin	Hadi	Ghofrani	60300P02
Solid Earth Terre solide	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Real-time ground-motion mapping based on an Automatic Response System (ARS), with applications to induced-seismicity traffic light protocols	Karen	Assatourians	60300P03
Solid Earth Terre solide	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Imaging Sediment Thickness and Stratigraphy Beneath the Mactaquac Headpond by Acoustic Sub-bottom Imaging	Mitch	Grace	60300P04
Solid Earth	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Assessment of source proportion estimates using different sampling designs for sediment source fingerprinting studies	Monica	Boudreault	90400P02
Hydrology Hydrologie	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Examining Modelled Boundary Layer Separation within Wetlands of the Western Boreal Plains	Adam	Green	30200P02
Hydrology Hydrologie	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	An assessment of water table dynamics within a constructed reclaimed fen, Fort McMurray, Alberta	Haley	Spennato	70100P01
Hydrology Hydrologie	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Evaluating the composition of dissolved organic carbon (DOC) with the use of fluorescence indices between a reclaimed and two natural wetlands, Fort McMurray, Alberta.	Jessica	Rastelli	70100P02

Hydrology Hydrologie	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	The evaluation of depressional features as recharge components within a constructed tailing sands upland and the implications for solute transport	Eric	Kessel	70100P03
Hydrology Hydrologie	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Numerical modelling of sodium transport at a constructed fen in the Athabasca Oil Sands Region (AOSR), Alberta.	Owen	Sutton	70100P04
Hydrology Hydrologie	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Examining the first three years of site-scale carbon and water fluxes over a constructed fen-upland watershed in Alberta, Canada.	George	Sutherland	70100P05
Hydrology Hydrologie	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Dissolved organic carbon dynamics in a constructed fen following oil sands extraction	Sarah	Irvine	70100P06
Hydrology Hydrologie	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Investigating lateral outflow from a raised bog in British Columbia.	Johannes	Exler	70500P01
Hydrology Hydrologie	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Plant water usage in a Canadian Prairie context: Using stable water isotopes to identify uptake sources	Janelle	Laing	70500P02
Hydrology Hydrologie	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Ionic Aluminium Levels Toxic for Aquatic Organisms in South Western Nova Scotia Rivers	Sarah	MacLeod	70500P03
Hydrology Hydrologie	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Modeling coupled hydrology-vegetation dynamics in the Boreal Plains Ecozone	Andrew	Ireson	70500P04

Hydrology Hydrologie	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Assessing Historical Changes to the Upper Peace River Flow Regime – CHIC Happens	Daniel	Peters	70500P05
Hydrology Hydrologie	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	A comparison of chloride concentration dynamics in stream, hyporheic zone and groundwater compartments of multiple urbanizing catchments in the Lake Simcoe and Nottawasaga River watersheds	Claire	Oswald	70700P01
Hydrology Hydrologie	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Impact of subdivision construction on stream water quality in a suburbanizing stream of southern Ontario, Canada	Tim	Duval	70700P02
Hydrology Hydrologie	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Future changes in precipitation and temperature extremes in western Canada	Mohammad Reza	Najafi	70800P01
Biogeosciences Biogéosciences	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	An Analysis of Methane and Carbon Dioxide Exchange in a Post-Extraction, Unrestored Peatland in Eastern Québec	Tracy	Rankin	90100P01
Biogeosciences Biogéosciences	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	High N2O and dissolved nitrogen at a restored cutover peatland in Alberta, Canada	Martin	Brummell	90100P02
Biogeosciences Biogéosciences	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Disentangling the mechanisms behind warming, nitrogen fertilization, and vegetation composition effects on greenhouse gas emissions from peatland	Jianghua	Wu	90100P03
Biogeosciences Biogéosciences	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Variability of water quality in space and time in a cold, mesoscale, heavily engineered Prairie watershed	Maliheh	Rabie	90400P01

Biogeosciences Biogéosciences	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Assessment of source proportion estimates using different sampling designs for sediment source fingerprinting studies	Monica	Boudreault	90400P02
Biogeosciences Biogéosciences	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Freeze–thaw cycle effects on phosphorus release from <i>Phleum pretense, </i> a grass buffer strip species, after multiple harvests	Kristen	Kieta	90400P03
Biogeosciences Biogéosciences	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Biofuel production using willow (Salix spp.): influence of nitrogen fertilizer on soil CO2 and N2O emissions	Katelyn	Lutes	90600P01
Biogeosciences Biogéosciences	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Impacts of possible future atmospheric concentrations of carbon dioxide on the productivity of boreal feather mosses in Newfoundland	Victoria	Nimmo	90600P02
Biogeosciences Biogéosciences	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Reconstructing Changes in Land-Cover and the Extent of a Peatland over 200 years of Recorded Anthropogenic Disturbances	R. Alexander	Foster	90600P03
Biogeosciences Biogéosciences	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Evaluating dissolved organic carbon concentration and chemistry using a hand-held colour sensor	Maria	Strack	90600P04
Biogeosciences Biogéosciences	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	Temporal and seasonal variations in permafrost pond chemical trajectories with implications for scaling to river export	Matthew	Morison	90600P05
Biogeosciences Biogéosciences	120101	POSTER SESSION - 2 SESSION D'AFFICHES - 2	The danger in the deep: internal phosphorus loading in Canadian water bodies	Nora	Casson	90600P06

51st CMOS Congress | 51e Congrès de la SCMO

Future Earth

Weather, Oceans, Climate

La Terre de l'avenir

Météo, océans, climat

Canadian Meteorological and Oceanographic Society
La Société Canadienne de Météorologie et d'Océanographie

CANADA 150

June 4 - 8th | 4 au 8 juin

2017 TORONTO

Hilton Toronto Downtown | Hilton Toronto, centre-ville

Art & Design: Alicja Parlak, Toronto, ON

2016 Joint Scientific Congress of CMOS and CGU
Congrès scientifique 2016, SCMO, UGC

Monitoring of and Adapting to Extreme Events and Long-Term Variations

L'adaptation aux événements extrêmes et aux variations à long terme et leur surveillance

Abstract Book

Recueil des résumés

Photos: City of Fredericton
Art: MCS

Fredericton, NB

29 mai – 2 juin / May 29 – June 2, 2016

http://congress.cmos.ca

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

Canadian Geophysical Union
Union Géophysique Canadienne

Introduction

The following are the accepted abstracts for oral and poster presentations for the 2016 CMOS-CGU Congress held in Fredericton New Brunswick May 29th - June 2nd 2016. Where possible, all withdrawn abstracts have been removed. Abstracts are searchable and sorted in ascending order by session number and primary author last name. The abstracts are reproduced here in the format and language in which they were submitted

Introduction

Voici les résumés acceptés pour les présentations orales et d'affiches pour 2016 Congrès SCMO-UGC tenue à Fredericton au Nouveau-Brunswick le 29 mai – 2 juin 2016. Si possible, tous les résumés retirés ont été supprimés. Les résumés sont consultables et triés par ordre croissant par numéro de session et auteur principal du nom de famille. Les résumés sont reproduits ici dans le format et la langue dans laquelle elles ont été soumises

Editors | Éditeurs – Rick Fleetwood and Erick Ouellette

ISBN 978-0-9880587-4-3

Part 1 - Oral Presentations

Session 1001 - Plenary Day 1
Ocean acidification in the Arctic
Azetsu-Scott, Kumiko
Bedford Institute of Oceanography
Kumiko.Azetsu-Scott@dfo-mpo.gc.ca
Accelerated increase of carbon dioxide concentration in the atmosphere due to human activities (anthropogenic CO_2, mainly from fossil fuel burning) affects the ocean by lowering its pH, a phenomenon known as ocean acidification. About a quarter of the anthropogenic CO_2 to the atmosphere since the start of the Industrial Revolution has been taken up by the oceans. Consequently, ocean pH has decreased by 0.1 units over the past 200 years, which is equivalent to a 30% increase in acidity. If global emissions of CO_2 continue at the present rate, ocean pH is predicted to fall an additional 0.3 units by 2100 (150% increase in acidity). Although ocean acidification is a global phenomenon, the Arctic Ocean is especially vulnerable owing to freshwater input and increasing CO_2 uptake from atmosphere as sea-ice cover decreases. Mechanisms of ocean acidification, possible effects on marine organisms and ecosystems and knowledge gaps in the Arctic will be discussed.

Session 1001 - Plenary Day 1
Dynamic adjustment of the seabed to wave-current forcing in the nearshore
Hay, Alex
Dalhousie University
alex.hay@dal.ca
During the past 20+ years, major advances have been made in our knowledge of the response of mobile sediments to the combined action of waves and currents in the nearshore zone. In the context of this presentation the nearshore zone is defined to be that strip of the coastal ocean in which shoreward-propagating surface gravity waves first shoal, then break, and then - diminished in height and energy - progress toward the beach face to dissipate in the swash zone. Associated with this cross-shore transformation of wave energy are changes in the higher-order statistical properties of the wave field: for example, third-order statistics related to wave shape, such as skewness. Consequently the resulting forces at the bed also exhibit significant cross-shore variations not only in magnitude but also in net direction - seaward or shoreward - over a wave cycle. For the O(100 um) to O(1 mm) diameter grains in sandy beach environments, the cross-shore variation in forcing conditions leads to cross-shore variations in the local response of the mobile bed which - through the development of forcing-dependent bedform types, each characterised by a different bottom roughness - feeds back to morphological evolution at larger scales, such as bar development and migration. The focus of this presentation is the local response of the bed, as revealed through the use of acoustic remote sensing technologies, developed either by adapting commercially-available systems or in-house in collaboration with colleagues. The account will be largely personal, but will draw upon the work of others. Topics will include: the occurrence of different bedform types relative to moments of the forcing; cross-shore migration; the structure of velocity and stress field above ripples in oscillatory flow; and the surprise occurrence of ripples on a steep beach. The role of acoustics in model development for these features will also be discussed.

Session 1002 - Plenary Day 2

Big data, Social Media, Crowd Sourcing and the Evolution of the Meteorological Enterprise

Michel Jean, David
Meteorological Services Canada
michel.jean2@ec.gc.ca

We live in a time of brilliant technologies and the rhythm of innovation is increasing at an unprecedented pace. We are flooded by earth observations, social media provides access to contextual information and unprecedented dissemination mechanisms and high performance computing platform allow us to tackle previously unsolvable problems. It is only a matter of time before the fusion of weather, big data technologies and business applications go mainstream and change the way people and businesses view weather and water data, and experience the force-multiplying effects it will have on improving life and weather sensitive business decisions. Not only is this forcing us to rethink our business models, our recruitment and training strategies and our partnership strategies at the national level, it will also have a fundamental impact on the global meteorological enterprise. It will also force us to reflect on how our professional societies can play a facilitating role in this.

Session 1002 - Plenary Day 2

Insights into Earths energy imbalance from multiple sources

Trenberth, Kevin
NCAR
trenbert@ucar.edu

The current Earths energy imbalance (EEI) is mostly caused by human activity, and is driving global warming. The absolute value of EEI represents the most fundamental metric defining the status of global climate change, and can best be estimated from changes in ocean heat content (OHC), complemented by radiation measurements from space. Sustained observations from the Argo array of autonomous profiling floats and further development of the ocean observing system to sample the deep ocean, marginal seas and sea ice regions are crucial to refining future estimates of EEI. Combining multiple measurements in an optimal way holds considerable promise for estimating EEI and thus assessing the status of global climate change, improving climate syntheses and models, and testing the effectiveness of mitigation actions. Progress can be achieved with a concerted international effort. New estimates of EEI and corresponding rates of change of OHC will be presented to highlight outstanding issues that include lack of sufficient continuity in many OHC estimates.

Session 1003 - Plenary Day 3

Illuminating the structure of the North American continent: advances in broadband seismology

Darbyshire, Fiona
GEOTOP, Université du Québec à Montréal
darbyshire.fiona_ann@uqam.ca

Since the beginning of the 21st century, North American seismology has seen considerable advances thanks to nationwide projects such as POLARIS in Canada and EarthScope in the USA (and parts of Canada). The establishment of distributed networks of broadband seismographs on a local, regional and even continental scale has allowed structural seismologists to image the crust and upper mantle of the North American continent in unprecedented detail. The improved data coverage allows us to begin to bridge the gap between geophysics and geology of the solid Earth, and has contributed to valuable new insights into the formation and evolution of North America over the last >3 billion years.We consider the results and implications of the latest seismological studies of the Canadian Shield and its eastern margin, using data from the POLARIS project and its offshoots, as well as EarthScope Transportable Array and FlexArray projects. We examine the wealth of data now available, and the wide range of imaging methods that provide new information on crust and upper mantle structure.Of particular interest are the contributions of the new data and models to our understanding of continental formation and evolution over time, and the way in which this may have changed from Archean to Proterozoic to Phanerozoic. Receiver function analysis of the crust suggests a secular evolution in which each time period shows certain characteristics in formation process and composition. The nature of the thick lithospheric keel is probed using tomographic techniques and analysis of seismic anisotropy, all of which show evidence for a multi-stage keel formation process.As more data are gathered and analysed, the models and their interpretation are increasingly refined. Much work remains, however, and we consider how to balance the need for broad regional-scale models with targeted local studies in areas of particular geological interest.

Session 1003 - Plenary Day 3
Underwater sensing for Canadian defence
Hutt, Daniel
DRDC
daniel.hutt@drdc-rddc.gc.ca
The advent of submarines as a serious threat during the 1st World War led to an urgent need to be able to detect them underwater. The field of underwater sensing grew from that requirement and is almost entirely based on acoustics to this day. But the performance of acoustic sensing that can be achieved underwater is dictated by the physical ocean environment - the time and space-dependant density profile and boundary conditions. Conversely, sound has been a primary means of determining the physical characteristics of the ocean from bathymetry to large scale density structure. It may in fact be argued that modern physical oceanography has been largely driven by the military requirement to conduct anti-submarine warfare. This presentation will review Canadas activities in defence-related underwater sensing, where we are today, and our aspirations to apply what we have learned to underwater sensing in the Canadian Arctic.

Session 1004 - Plenary Day 4
Weather, Climate and Ocean Sciences for a Sustainable Future Earth
McBean, Gordon
International Council for Science
gmcbean@uwo.ca
Climate change, disaster risk reduction, poverty eradication, social and economic sustainable development are interconnected issues that must be addressed in the development of policy. The 3rd World Conference on Disaster Risk Reduction was held in Sendai (March 2015), governments approved the Sustainable Development Goals (September 2015) and the Paris Agreement was confirmed at Convention on Climate Change Conference of Parties in Paris (December, 2015). A key issue is how can science best provide the inputs to these policy processes and more importantly to help governments and people address the issues? These questions require outputs leading to outcomes that address complex socio-economic, natural, health, engineering, philosophical and cultural issues and most challenging their intersections. The Program Future Earth: Research for Global Sustainability has as its goal: To provide the knowledge required for societies in the world to face risks posed by global environmental change and to seize opportunities in a transition to global sustainability. The program has adopted a unique approach of both a Science Committee and an Engagement Committee to co-design and co-produce the scientific research program and to co-deliver the results. The research theme of transformations to sustainability will be a special challenge in dealing with issues such as transformation processes and global and regional governance, including incentives and international law. Future Earth and the World Climate Research Programme are linked, through the International Council for Science and other ways, to the Integrated Research on Disaster Risk and Urban Health and Well-Being Programmes and they need to collectively address the challenges of bringing together interdisciplinary, transdisciplinary teams of scientists to undertake transformative research leading to outcomes that make a difference for global sustainability. Cross-cutting issues in all these agreements are storms, floods, droughts, storm surges and related climatic hazards and their better understanding and prediction for today and tomorrow to the next many decades. This is a scientific challenge for us all.

Session 1004 - Plenary Day 4
Non-growing season greenhouse gas production in high-latitude soils
Risk, David Egan, Jocelyn Graham, Laura MacIntyre, Chris Natali, Susan Minions, Christina McArthur, Gordon
St. Francis Xavier University
drisk@stfx.ca
Permafrost zones hold about half of the worlds organic matter, and several times more carbon than the atmosphere. As permafrost melts, previously frozen organic matter becomes subject to microbial decay, and this process generates greenhouse gases including carbon dioxide (CO_2) and methane (CH_4). We do know that soil microbes are active in cold soils, and under the right conditions their metabolism may even be active below the freezing point in the non-growing-season (NGS), however the magnitude of their production is unknown and unaccounted for in global carbon cycle models. Using a variety of methods including continuous CO_2 measurements (gradient and flux chambers), we have been investigating the potential for CO_2

production and release during the NGS within cold region soils in the Arctic, central Canada, and Antarctic Dry Valleys. In some cases we have also used radiocarbon-CO2 measurements as a descriptor of substrate utilization. We have observed substantial NGS CO2 fluxes, particularly in high-carbon environments that receive snowfall. Results suggest that over 50% of the annual CO2 release at many of these sites could come during the winter, which is not currently accounted for in models, or in budgets created from growing season studies. Radiocarbon-CO2 measurements suggest that the microbial community occasionally recruits old soil carbon as a feedstock. New NGS monitoring initiatives will help improve the accuracy of carbon budgets, contribute to our understanding of microbial activity in extreme environments, and improve soil models in cold and permafrost environments.

Session 20200 - Clouds: Microphysics, Aerosols, and Radiation - Part 1

Modelling Uncertainty without an Assumed Distribution: Turbulent Cloud Microphysics

Collins, David
University of Victoria
davidc@uvic.ca

Modelling processes which contain uncertainties typically involves assuming a probability distribution for one or more variables. In cloud microphysics, the size distribution of cloud droplets is not known, but gamma, log-normal, and Weibull distributions have been used. Assuming a distribution requires using ad-hoc parameters which may have no physical meaning.We present a method of modelling uncertainty which does not require any assumed probability distribution. We do this by systematically decomposing the evolved variables of densities (mixing ratio and number) into a mean and a set of point-wise fluctuations. Instantaneous aggregate fluctuations are considered as points in a stochastic process. Statistics on these stochastic processes become system parameters which have physical meanings that can be acquired from data.In the application to bulk models of cloud droplet collision and coalescence, the systematic decomposition of these density functions provide a novel way to represent higher moments of the kinetic collection equation and thus close the system of bulk equations. In doing so, each bulk equation is derived independently. Conservation of mass and consistency of number result instrinsically from the derivations rather than being applied externally. The independent derivation of the four autoconversion terms provides for (to the best of the authors knowledge) an unprecedented constraining of the autoconverion parameter and subsequent fine control of the evolution of the droplet size spectrum.We compare results from this (stochastic differntial equation) SDE-based stochastic model to a deterministic bulk model and use detailed results as benchmarks. We present results from comparisons using hydrodynamic and turbulent kernels.

Session 20200 - Clouds: Microphysics, Aerosols, and Radiation - Part 1
Microphysical Processes Associated With the Formation and Evolution of Precipitation Types During the Alberta Flooding Event of June 2013
Duplessis, Patrick Thériault, Julie M Stewart, Ronald Pomeroy, John
Dalhousie University
p.duplessis@dal.ca
In June 2013, an intense and persistent low-pressure system dropped locally more than 300 mm of precipitation on the lee side of the Alberta Rockies and this in turn led to the catastrophic flooding that became Canadas most expensive natural disaster. Most of the precipitation fell as rain but changed to snow in some high-elevation regions of the affected area. The transition from rain to snow allowed the precipitation to accumulate on the ground instead of flowing directly to the rivers and this had a major impact on the severity of the flooding event. Although previous analyses have been conducted on the hydrological response and meteorological conditions during the storm, this study focuses on the microphysical processes associated with the formation and evolution of the associated precipitation types. A combination of in-situ observations, operational atmospheric model outputs, and a one-dimensional cloud model coupled with a sophisticated microphysical scheme has been used in this study. The 42-hour forecast produced by the GEM-LAM model starting at 1800 UTC 20 June 2013 has been used as the initial conditions. Several types of snowflakes have been tested to investigate their impact on the timing and elevation of the transition from rain to snow in the Kananaskis area. The results suggest that heavily rimed particles such as snow pellets might have been responsible for most of the accumulation of solid precipitation. Without the production of such particles, the precipitation would have melted before reaching the surface and therefore would have fallen as rain. Overall, this research highlights the importance of accurately accounting for the key microphysical processes in atmospheric models to better predict rain-snow transitions in mountainous regions because of their importance to flood severity.

Session 20200 - Clouds: Microphysics, Aerosols, and Radiation - Part 1
Dust aerosol size distribution and its impact on climate
Li, Jiangnan
Canadian Center fort Climate Modeling and Analysis
jiangnan.li@canada.ca
The impact of size distribution of mineral dust aerosol on radiative transfer was investigated using the Aerosol Robotic Network-retrieved aerosol size distributions. In all current climate models, the aerosol optical property parameterizations are based on lognormal size distribution. However it is found that the gamma size distributions match with observations better by comparing with lognormal size distributions. The accuracies of the parameterizations based on lognormal and gamma size distributions are about 25% and 5%, respectively. The two assumed size distributions are also evaluated in a climate model. The results show that the dust radiative forcing over the desert areas determined by the scheme based on the gamma size distribution are about 1 W/m2 less than those from original model based on the lognormal size distribution, This brings the model results closer to the observations. The climate feedback due to the change of dust size distribution is also analyzed.

Session 20200 - Clouds: Microphysics, Aerosols, and Radiation - Part 1

Aerosol radiative forcing under cloudy-sky: estimations from combination of satellite observations and global modeling

Ma, Xiaoyan Yu, Fangqun Jia, Hailing Quaas, Johannes

Key Laboratory for Aerosol Cloud-Precipitation of China Meteorological Administration, Nanjing University of Information Science and Technology, China,Atmospheric Sciences Research Center, State University of New York at Albany, Albany, New York, USA

xiaoyancloud@gmail.com

Large uncertainties exist in estimations of aerosol radiative forcing, and the values derived from global modeling differ substantially with satellite-based calculations. We estimated cloudy-sky aerosol radiative forcings by employing updated satellite products from 2004 to 2011 in combination with the anthropogenic aerosol optical depth (AOD) fraction obtained from model simulations using the Goddard Earth Observing System-Chemistry-Advanced Particle Microphysics (GEOS-Chem-APM). Our derived annual mean aerosol cloudy-sky forcing (-0.34 W m-2) is higher than the corresponding results (-0.2W m-2) reported in Quaas2008. This study indicates that the derived forcings are sensitive to the anthropogenic AOD fraction and its spatial distribution but insensitive to the temporal resolution used to obtain the regression coefficients, i.e.,monthly or seasonal based. The forcing efficiency (i.e., the magnitude per anthropogenic AOD) of this study (11 W m-2) is more than a factor of 2 larger than Quaas2008s value of 4.7 W m-2. Uncertainties studies suggest that anthropogenic fraction of AOD strongly affects the computed forcings while using aerosol index instead of AOD from satellite data as aerosol proxy does not appear to cause any significant differences in regression slopes and derived forcings.

Session 20200 - Clouds: Microphysics, Aerosols, and Radiation - Part 1

An analytical solution to water diffusion in glassy aerosol particles

Moridnejad, Ali Preston, Thomas

McGill University

ali.moridnejad@mail.mcgill.ca

To better understand the influence of the atmospheric aerosol on climate and air quality, it is essential to extend our knowledge of aerosol hygroscopicity. Recent studies have shown that secondary organic aerosol particles can exist in an amorphous state at very low relative humidities or temperatures. This glassy state substantially slows down the uptake of water by particles as it impedes condensed phase diffusion. This can keep the particle out of equilibrium with its surroundings and potentially impact the ice nucleation efficiency of the aerosols. The present study will focus on water uptake of ultra-viscous secondary organic aerosols and how non-linear diffusion affects this process. The thermodynamics of the amorphous state along with the mathematical physics of particle diffusion will be presented. A recently derived analytical solution for the water uptake of a stationary spherical particle under certain ambient conditions will be discussed. These results are compared to pre-existing numerical schemes and discussed in the context of a laboratory based isotopic exchange experiment.

Session 20200 - Clouds: Microphysics, Aerosols, and Radiation - Part 1

The transition from shallow-to-deep cumulus convection over an idealized mesoscale convergence zone.

Rousseau-Rizzi, Raphael Kirshbaum, Daniel Yau, Peter
McGill University
daniel.kirshbaum@mcgill.ca

A necessary condition for deep convection within a conditionally unstable atmosphere is that air parcels reach their level of free convection, above which latent-heat release creates positive buoyancy. This condition is not sufficient, however, because mitigating factors such as entrainment of dry air and adverse perturbation vertical pressure gradients may prevent nascent shallow clouds from ascending further. Recent studies suggest that the transition from shallow-to-deep convection may additionally require the formation of evaporative cold pools, a sufficient convective available potential energy, a gradual moistening of the mid-troposphere through shallow-cumulus detrainment, and/or the fortuitous development of new cumuli through the remnants of their predecessors. This study uses cloud-resolving simulations of cumulus convection over an idealized surface-based convergence zone to investigate the mechanisms and sensitivities of deep-convection initiation forced by mesoscale ascent. The surface convergence forms in response to a localized diurnal heating anomaly over an otherwise homogenous and unheated surface, producing a sharp boundary-layer updraft with an amplitude of ~2 m/s over the center of the heat source. This convergence gives rise to a line of cumuli that gradually deepens and, in some cases, transitions into deep convection. To statistically investigate the factors controlling this transition, a new thermal-tracking algorithm is developed to follow incipient cumulus cores as they ascend through the troposphere. This tool is used to isolate the impacts of key environmental parameters (cloud-layer lapse rate, mid-level mean humidity, convergence-line strength) and initial core parameters at cloud base (horizontal area, vertical velocity, and buoyancy) on the ultimate thermal height. In general, the initial core size determines which thermals in a given cloud field will undergo the deepest ascent, and the sensitivity of cloud depth to initial core parameters increases in environments that are more hostile to deep convection.

Session 20201 - Clouds: Microphysics, Aerosols, and Radiation - Part 2

Atmospheric Measurements in the FIR at Eureka, Nunavut: Sensitivity to Thin Ice Clouds and Water Vapor

Blanchet, Jean-Pierre Libois, Quentin S. Pelletier, Ludovick Girard, Éric Coursol, Laurence Gauthier, Pierre Tran, Sophie McCullough, Emily Strong, Kimberly
ESCER Center, UQAM
blanchet.jean-pierre@uqam.ca

The Arctic climate is highly sensitive to atmospheric water vapour and clouds through the radiation balance. As a complement to satellite data from the A-Train, we have initiated ground based measurements extending from the mid thermal infrared (8 to 14µm) well into the far IR, up to 50µm from the new FIRR instrument developed by INO for the Canadian Space Agency. Given the cold and dry conditions prevailing in the High Arctic during the dark season, these observations, jointly with other instruments at Eureka, provide new insights on the role of thin ice clouds on the air mass transformation and on the sensitivity of the surface-atmosphere

radiation balance. This talk summarizes the experiment and the main results of the first winter of FIRR operation with CANDAC at Eureka. Understanding the physical processes between radiation, clouds and light precipitations during polar nights is an essential step toward improving climate model parameterisations and weather forecasting assimilation. The results of these measurements will be applied to the development of the TICFIRE satellite aimed at covering both Poles for cloud-radiation interaction and atmospheric water balance in very cold regions through spectral mid to far IR observations.

Session 20201 - Clouds: Microphysics, Aerosols, and Radiation - Part 2
Data assimilation of far infrared radiation in polar regions
Coursol, Laurence Gauthier, Pierre   Blanchet, Jean-Pierre Libois, Quentin
UQÀM
laurence.coursol@gmail.com
The Far InfraRed Radiometer (FIRR) is an instrument proposed for the future satellite mission TICFIRE (Thin Ice Clouds in Far IR Experiment). This sounder will measure atmospheric radiation in the far infrared region between 8 and 50 ?m. This project use information content to study different configurations of the instrument by varying the number of wavelengths observed in multiples atmospheric conditions. Also, it verifies that the measurements of radiances taken by this instrument have a sensibility to the temperature, which is different for each wavelength. To do so, the radiative transfer model RTTOV, used to assimilate numerous satellite instruments at many meteorological services, will be used to simulate radiances for the sounder for 6 atmospheric profiles. Evaluation of the amount of information for each configuration of the instrument has been done and thus it was possible to assess the optimal configuration from a data assimilation standpoint. Experiments will be done to evaluate the impact of the TICFIRE when its measurements are added to those of the satellite AIRS.

Session 20201 - Clouds: Microphysics, Aerosols, and Radiation - Part 2
Polarimetric Retrievals of Cloud Droplet Number Concentrations
Sinclair, Kenneth van Diedenhoven, Bastiaan Cairns, Brian Hair, John Moore, Richard Hostetler, Chris
Columbia University / NASA GISS
kas2237@columbia.edu
Cloud droplet number concentration (CDNC) is one of the most significant microphysical properties of liquid clouds and is essential for the understanding of aerosol-cloud interactions. It impacts radiative forcing, cloud evolution, precipitation and thus global climate. CDNC is a crucial parameter for monitoring the cloud albedo effect, or the first indirect effect, whereby an increase in aerosol concentration results in an increase in cloud droplet number concentration leading to changes in the radiative properties of the cloud. The IPCCs Fifth Assessment Report continues to consider aerosol-cloud interactions as one of the largest uncertainties in radiative forcing of climate. The North Atlantic and Marine Ecosystems Study (NAAMES), which was a NASA-led ship and air campaign that took place off the east coast of Newfoundland, Canada in November 2015, provided an opportunity for the Research Scanning Polarimeter (RSP) to cross-

validate a new approach of sensing CDNC with the High Spectral Resolution Lidar (HSRL) and the Langley Aerosol Research Group Experiment (LARGE) instrument. The RSP is an airborne scanning sensor that provides high-precision measurements of polarized and full-intensity radiances at multiple angles over a wide spectral range.The distinctive feature of the polarimetric technique is that it does not make any assumption of the liquid water profile within the cloud. The approach involves (1) estimating the droplet size distribution from polarized reflectance observations in the rainbow, (2) using polarized reflectance to estimate above cloud water vapor, (3) using total reflectances in a water vapor absorption band and cloud top pressure retrievals to estimate cloud physical thickness assuming a saturated mixing ratio for water vapor and (4) determining the cloud droplet number concentration from the physical thickness and droplet size distribution retrievals.An overview of the polarimetric technique will be presented along with the results of applying the approach to NAAMES campaign data. An analysis of the algorithms performance when compared with the HSRL and LARGE systems is also shown.

Session 20300 - Fog or Low Visibility in Atlantic Canada - Part 1
Characterizing summer fog events in Halifax, Nova Scotia
Chang, Rachel Hartery, Sean
Dalhousie University
rachel.chang@dal.ca
Fog acts as a significant transportation disruptor in many coastal communities, causing delays and occasional accidents in marine, aviation and road traffic. While the formation of fog is strongly tied to meteorological conditions, the resulting visibility depends on various parameters including aerosol and droplet microphysics. This study presents fog droplet size and concentration measurements conducted in Halifax during August 2015. Fog events and fog microphysics will be related to local observations of atmosphere and ocean state as well as air mass source using Lagrangian particle dispersion modelling. The overall objective of this work is to explore the effects of local conditions and air mass source on visibility.

Session 20300 - Fog or Low Visibility in Atlantic Canada - Part 1
A comparison of the worlds foggiest marine areas that are in the NW Pacific and the NW Atlantic based upon 58 years of ship observations.
Dorman, Clive Koracin, Darko
Scripps Institution of Oceanography, UCSD
cdorman@ucsd.edu
An analysis is presented of the marine fog distribution based upon the International Comprehensive Ocean-Atmosphere Data Set (ICOADS) ship observations taken during 1950-2007. The densest marine fog is in the NW Oceans, during the summer, and over shallow water. The shallow water about the Kuril Islands in the NW Pacific is the site of marine worlds most frequent fog reaching almost 60 %. There is a regional sea surface temperature minimum about the Kuril Islands.   Close by are less frequent, but high occurrence fog areas during the summer over the marginal seas of Okhotsk (maximum fog 51 %), the Japan Sea (maximum fog 28 %) and the Yellow Sea (maximum fog 23 %, 2nd highest 14 %).   The shallow water over the

Grand Bands in the NW Atlantic is site of the worlds 2nd large area of fog reaching 45 % occurrence. There does not seem to be the sharp, area wide, SST minimum over the Grand Banks as there is over the Kuril Islands. However, tidal current are stronger over the Grand Banks compared to the surrounding waters. Nearby is a small area fog maximum centered over shallow water on the SW tip of Nova Scotia that has a summer fog occurrence of 47.1 % which is coincident with an SST minimum. Lesser amounts of fog extend along the shelf to the west of the Grand Banks (higher values ~25-30 %) and to the NW over the Labrador Current (~ 7-12 %). The fog occurrence maxima were examined for climate trends over the 58 summers of 1950-2007. The Kuril Island block averaged area fog maximum occurrence linear trend increased +15.8 % and the Grand Banks block average fog maximum occurrence linear trend increased +12.8 %.

Session 20300 - Fog or Low Visibility in Atlantic Canada - Part 1

MARINE FOG VISIBILITY: MEASUREMENTS AND FORECASTING DURING SAR PROJECTS

Gultepe, Ismail Burrows, William Pavolonis, Michael Milbrandt, Jason Hansen, Bjarne Chung, Victor
Environment Canada
ismail.gultepe@canada.ca

The main objective of this work is to evaluate visibility (Vis) observations and fog forecasting over Eastern Canada. Observations used were collected during The Fog Remote Sensing and Modeling (FRAM) and Satellite Applications for Arctic Weather and SAR (Search And Rescue) Operations (SAAWSO) projects. These projects were designed to focus on development of 1)ground based instrumental platforms, 2) understanding instrument capabilities and limitations for observations, 3) microphysical parameterizations for model applications, 4) remote sensing methods for fog detection, and 5) integration of model and observation data for developing nowcasting applications for short time periods e.g. less than 3 hr. Both projects were conducted over three regions of Eastern Canada, including i) Lunenburg, Nova Scotia during summer of 2006-2007, ii) St. Johns International Airport, NFL, during winter of 2008-2009, and iii) St. Johns at the Environment Canada Upper Air Site during 2012-2013. For each project, numerous in-situ measurements were obtained, including droplet and aerosol spectra, precipitation rate, phase, and amount, and Vis characteristics. During the projects, a Fog And Precipitation Observing System for Vis (FAPOSV) was developed for fog monitoring and nowcasting applications. Satellite microphysical retrievals and Vis parameterizations have also been developed. A rule based technique was developed for fog prediction. The algorithms were used in High Resolution Deterministic Prediction System (HRDPS) for Vis predictions. The long term fog predictions are found strongly related to ocean currents, ocean surface temperature gradients, synoptic weather systems, and local weather conditions in the marine-land interfaces. Results suggest that improved scientific understanding of marine fog formation needs to be developed and that can lead to better forecasting/nowcasting skills based on NWP model runs and observations. In this presentation, the issues related to measurements of fog and its parameterization for fog simulations will be discussed and challenges will be summarized.

Session 20300 - Fog or Low Visibility in Atlantic Canada - Part 1

Technology-Enabled Understanding of Fog and Low Visibility in the Offshore of the North Atlantic

Kelly, Richard Gillespie, Randy
Centre for Applied Ocean Technology, Marine Institute of Memorial University, St. Johns, Newfoundland.
Richard.Kelly@mi.mun.ca

Technology is the application of knowledge to the practical benefit of humanity; the bridge between knowing and doing. Developments in technology are motivated by human need and rely on careful design and synthesis of inputs from many disciplines. The field of ocean observation is informed by computer science, physics, chemistry, acoustics, nautical science, engineering and materials science to generate innovative solutions. Forecasting fog and low visibility conditions in the offshore of the North Atlantic is a major concern for marine operators, including those in the oil and gas industry. Any initiative to understand and predict the formation of fog in the offshore of the North Atlantic should be technology-enabled, rather than technology-driven. The broad objective is to gather necessary data efficiently and safely, at a sufficient temporal-spatial resolution with reliable accuracy from season to season. The specific objectives, to be determined collectively by meteorological, oceanographic, policy, business and science stakeholders, will include frequency and metrics which should be employed to gather and report fog and low visibility data. Stakeholder driven objectives such as these will guide the design of a measuring/monitoring system. Also through consultation with stakeholders, clear requirements for a multiyear mission to understand fog and low visibility in the offshore of the North Atlantic will be established. These requirements, combined with a review of past relevant research will benchmark the current state of technology available to measure specified parameters. The outcome of this research is to provide recommendations on how to effectively measure required fog and visibility forecasting parameters using a technology-enabled approach.

Session 20301 - Fog or Low Visibility in Atlantic Canada - Part 2

The Climatology of Advection-Type Fog at the HMDC Hibernia Platform Offshore Newfoundland

Beale, Jennifer Bullock, Terry Isaac, George A. Allan, Shawn
Amec Foster Wheeler, Environment & Infrastructure
jennifer.beale@amecfw.com

The climatology of advection fog (visibility < 0.5 nautical miles) at the Hibernia Management & Development Company Limited offshore oil platform has been extracted from the 1997 to 2015 record of WMO FM 13-XIV Ext. SHIP observations (called MANMAR in Canada). Until recently, the only known attempt at an analysis of fog observations on the Grand Banks dates back 100 years ago to the observations taken by Taylor in 1913 aboard the iceberg scout ship, Scotia, and his subsequent Lagrangian analysis of the air parcel trajectories (1917). Beyond the general knowledge of advection fog, investigation into each mechanism and their interaction over the Grand Banks is ongoing. At the Hibernia derrick platform level (139 m), a preferred wind direction and speed is associated with the fog occurrence even when the most frequently reported wind speeds and directions are taken into account, fog or no fog. Fog probability is

highest from July 1 to July 10 (55.5%) when derrick level winds are 20 knots or greater from the southwest quadrant, and is associated with the prevailing direction of the SST gradient given by the GHRSST Level 4 G1SST Global Foundation Sea Surface Temperature Analysis (GDS Version 1). The strong dependence of advection fog on wind direction, wind speed, moisture advection, and SST gradient is also ultimately tied to the climatological averages of the air temperature and SST. Fog probability is correlated to the climatological averages of the SST and the 69 m air temperature (T_{air}), and to the difference between them (TSST=T_{air}-SST): the maximum fog probabilities occur at the end of June and beginning of July and correspond to the maximums in the TSST which is positive during this time, and to a large SST gradient in the southwest quadrant of the site. During August, as the T_{air} and SST equalise and the TSST becomes negative, the fog probability drops from 35% to 20%.

Session 20301 - Fog or Low Visibility in Atlantic Canada - Part 2

Grand Banks Fog: Climatology from the Hibernia Platform

Bodaghkhani , Elnaz   Finnis, Joel
Memorial University of Newfoundland
jfinnis@mun.ca

Frequent marine fog exerts a significant impact on the Grand Banks of Newfoundland, and this impact has increased with growth in local offshore oil developments. Improved understanding of regional fog processes, climatology, and predictability could consequently offer significant economic and safety benefits. Research in these areas requires a reliable, long-term observational record; fortunately, offshore oil platforms provide a stable platform for collecting relevant information. Operational marine (MANMAR) and aviation (METAR) weather reports from offshore oil rigs present a near-continuous record of environmental conditions, extending from 1998 to present. Using a combination of visibility data, reported weather conditions, and fog-related environmental data (air and sea surface temperatures, humidity, wind speeds etc), an 18-year fog record has been constructed for the Hibernia platform, and used to establish a detailed climatology. Annual analyses exploring seasonality and diurnal variability are presented, and (using a proposed definition for the onset and end of the peak fog season) variability in annual fog season severity is explored. By treating low visibility events as a point process, we further examine the climatology of fog event characteristics. Event duration, persistence of fog cover, and coincident weather conditions are considered, and used to identify and classify distinct event types. Results inform parallel efforts to develop fog identification and prediction tools for the Grand Banks region.

Session 20301 - Fog or Low Visibility in Atlantic Canada - Part 2

Improving Visibility Forecasts for the Grand Banks of Newfoundland and Labrador

Bullock, Terry Allan, Shawn Beale, Jennifer Isaac, George
Amec Foster Wheeler
terry.bullock@amecfw.com

A Hibernia Management Development Company Ltd. (HMDC) sponsored Workshop on Metocean Monitoring and Forecasting for the Newfoundland & Labrador Offshore, held 22-24 September 2014, identified reduced visibility in fog as being the most significant metocean issue to affect operations in this harsh environment area. This has led to an open and collaborative multi-year HMDC Metocean Research and Development Project that is presently in its third year. Some twenty government, academic and industry agencies are participating in this project. Offshore visibility affect helicopters and surface vessels supplying the oil-producing installations operating between 350 and 500 kilometers east of St. Johns, as well as fishing and other marine operations. Fog, usually formed by warm Gulf Stream air flowing over the cold Labrador current, occurs with a peak frequency of over 50% of the time (with visibility ½ nautical mile or less) at the Hibernia Platform in July and a minimum frequency of 10% in winter months. Detailed buoy and offshore platform-based scientific measurements have been collected in the vicinity of the Hibernia Field on the Grand Banks of Newfoundland and Labrador over the past two years. This monitoring program has been enhanced for 2016 and will be further augmented with flux measurements and atmospheric profiles in future campaigns.Current techniques used to forecast fog are not well established or verified. There is a definite lack of good observations and predictive models have substantial need of improvement. Fog formation and dissipation mechanisms on the Grand Banks are not well understood with very few studies related to this topic since G.I. Taylors 1913 seminal work. Forecasting techniques (e.g. numerical atmospheric and oceanic prediction models, satellite-based schemes, and rules based systems) being evaluated, are outlined.Monitoring data gathered under the project, climate analysis, literature reviews, and model validation and development are contributing to a new conceptual model about how Grand Banks fog forms, is maintained and dissipates.

Session 20301 - Fog or Low Visibility in Atlantic Canada - Part 2

Machine Learning Approaches to Fog Identification and Prediction on the Grand Banks of Newfoundland

Finnis, Joel Bodaghkhani, Elnaz Hauser, Tristan Bullock, Terry
Memorial University of Newfoundland
jfinnis@mun.ca

Using an eighteen-year environmental record established for the Hibernia oil rig from operational aviation and marine reports, various machine learning approaches to fog identification and prediction on the Grand Banks of Newfoundland are tested. The relative value of local and synoptic scale fog predictors are compared, with emphasis on variables regularly reported in operational forecast model output (temperatures, humidity, wind speed, SLP etc). Several approaches to identifying i) moderate and ii) severe fog are compared, including decision trees and neural networks. Preliminary efforts to predict the conditional likelihood of fog duration and persistence of cover are also presented, based on Conditional Density Estimation Networks (CDEN), an extension of traditional neural network regression that returns the likelihood of all potential outcomes (i.e. full probability distributions of a desired variable, conditional upon input predictors). The ultimate goal is to establish best practices for statistical post-processing of model output for fog forecasting in the Grand Banks.

Session 20400 - Aviation Meteorology and Climatology

Modeling aircraft icing using the mass and size distribution of droplets.

Barszcz, Agnieszka Chergui, Nacéra
Environment Climate Change Canada
agnieszka.barszcz@canada.ca

An accurate icing forecast greatly helps improve safety aboard aircraft and reduce operating costs of airline companies. There is an increased interest in modeling icing in recent years. Few of the currently available models cover the Canadian territory, especially northern regions. A Canadian icing model has thus been developed using the explicit double moment Milbrandt-Yau microphysics scheme with a kilometer scale atmospheric model. This original approach relies not only on the information provided by the mass distribution, but also on the size distribution of supercooled liquid water droplets in the atmosphere. In fact, it is possible to calculate the trajectories of water droplets around a standard air foil as a function of their geometrical characteristics. This allows calculation of an accretion rate of supercooled water on the wing, i.e. the icing rate. It was first shown that using the amounts of supercooled water only in order to diagnose icing gives a good indication on the location but systematically underestimates the severity. Thus icing is now diagnosed as a function of both mass content and size distribution of supercooled liquid water. Case studies have shown that this method significantly improves the icing forecast. Also, Canadian forecasters started using this tool and provided positive feedback.

Session 20400 - Aviation Meteorology and Climatology

Severe thunderstorms in the high arctic on 24 July 2014

Brown, Daniel
Environment Canada
dmbrown1@ualberta.ca

On 24 July 2014, a rare case of severe thunderstorms developed early in the morning over the Nunavut portion of Victoria Island. A strong upper ridge was breaking down over western Nunavut, while a low pressure system developed near Victoria Island and tracked northeastwards towards Resolute Bay. Limited data availability made analysis difficult because there are no radar sites, few satellite images, sparse lightning detection, and few observations in the Arctic. However, soundings at Cambridge Bay and Resolute Bay along with Surface weather station data and the GEM Regional Model suggest that the convective available potential energy (CAPE) was between 1500 and 2000 J kg-1, the vertical wind shear was between 25 and 50 knots, and there were some places with a storm relative helicity greater than 300 m-2 s-2. This environment could support strong multi-cell or even supercell thunderstorms. Most Arctic regions are too far to register lightning from the Canadian Lightning Detection Network. The GLD360 Lightning Detection Network recorded many lightning strokes from the thunderstorms during this event, but it does not separate out the cloud-to-ground lightning, nor does it group lightning flashes. About 4000 lightning strokes were detected over Victoria Island, and about 100 strokes were detected near the Resolute Bay observing site, where the observer reported thunderstorms for about 2 hours. Resolute Bay has only recorded 4 previous thunderstorms. Lightning strokes were even recorded as far north as Grise Fjord on Ellsemere Island. The Grise Fjord station has never recorded a thunderstorm. The strongest storms appear on satellite images

over Victoria Island, where satellite measurements suggested that the overshooting cloud tops were -60 °C at 40000 feet.

Session 20400 - Aviation Meteorology and Climatology

Surface Visibility at Hudson Bay Region Airports

Leung, Andrew Gough, William
University of Toronto Scarborough
andrewc.leung@mail.utoronto.ca

Low visibility is a considerable risk for flying. There has been fatal aircraft accidents in northern Canada that are attributed to poor visibility. Better understanding of visibility around the airports leads to improved safety, less flight delays and cancellations, and lower operating costs for airlines. Our previous study found different regimes for fog and freezing fog between the eastern and western sides of Hudson Bay. There was an overall decline of fog in the region but appeared to be highly dependent from one year to the next year.In this study, we seek to further analyze and the breakdown the various causes of low visibility in the region. These factors include fog, freezing fog, blowing snow, heavy rain, haze and others. The results allow us to determine how often the runway visibility is below the runway visual range (RVR) during instrument approach. Other transportation modes such as shipping, driving and snowmobiling also benefit from an enhanced understanding of local visibility which improves safety.

Session 20400 - Aviation Meteorology and Climatology

Canadian Contribution to the WMO Aviation Research Demonstration Project (AvRDP)

Reid, Janti Crawford, Robert Huang, Laura Hansen, Bjarne Joe, Paul Sills, David
Environment and Climate Change Canada
Janti.Reid@canada.ca

In 2013 the International Civil Aviation Organization (ICAO) endorsed a new 15-year Global Aviation Navigation Plan (GANP). One aspect of GANP is to enhance aviation MET services to support the concept of Trajectory Based Operations (TBO): the seamless integration of multiple scale observations, nowcasting and forecasting along distinct phases of flight trajectories (e.g. take-off, ascending, en-route, landing, etc.) into air traffic management (ATM) systems. Specific to the terminal area, collaboration between ICAO and WMO was forged to investigate meteorological-related ATM requirements within the terminal area, and with this the WMO Aviation Research Demonstration Project (AvRDP) was born. Phase 1 of AvRDP focuses on meteorological nowcasting capabilities at selected host airports with an emphasis on nowcasting system demonstration and verification. Phase 2 of the project will focus on the translation of MET information into ATM-relevant parameters and to further validate its ATM impact. The Environment and Climate Change Canada (ECCC) contribution to AvRDP is a cold-season nowcasting demonstration at a high-density, northern hemisphere airport, namely Toronto Pearson International Airport (CYYZ; 43° 40 36 N, 79° 37 50 W). During two planned intensive operation periods (IOP) in winter 2015-2016 and 2016-2017, ECCC will demonstrate a variety of point-based nowcasting methodologies including a climatology-based system, a radar-based system, and a blended NWP-observation system. These will be verified and compared against

high time resolution surface and remote sensing observational data collected at the Pearson observation site. A further ECCC contribution is a cold-season nowcasting demonstration at Iqaluit Airport (CYFB; 63°4523N, 68°3321W) in winter 2016-2017 which will provide a unique look into prediction capabilities in the Arctic. This presentation will give an overview of the AvRDP project and provide a first look at ECCCs IOP verification results from CYYZ as well as an update of the status of the observational site at CYFB.

Session 20400 - Aviation Meteorology and Climatology
The need for better meteorological support for aviation activities
Ricketts, Steve
stevericketts@telus.net
The world of aviation is evolving rapidly. New technologies, such as space-based monitoring and communication, and procedures to support both Air Traffic Control (ATC) and Air Traffic Flow Management (ATFM) are coming online and are enabling more efficient and effective flight planning, routing and management. Many of these systems have a weather angle, and theres a need for the aviation meteorology community to respond with new and better ways of predicting weather and incorporating weather information into decision-support tools. This presentation will touch on several initiatives and lay out suggestions for other approaches.

Session 20500 - Environment Canada and the Toronto 2015 Pan Am and Parapan American Games (TO2015 Games)
Application of the MetObject Approach during the 2015 Toronto Pan Am and Parapan Am Games in Support of MSCs Warning Production Renewal Project.
Driedger, Norbert Sills, David Brunet, Dominique Hung, Emma Greaves, Brian Chang, William
Environment and Climate Change Canada
Norbert.Driedger@canada.ca
During the summer of 2015, in weeks leading up to and during the Toronto Pan Am and Parapan Am Games, a special Research Support Desk (RSD) session was run collocated with the Ontario Storm Prediction Centre (OSPC). As one component of the evaluation of the Interactive Convective Analysis and Storm Tracking (iCAST) prototype, a new semi-automated approach to severe thunderstorm tracking and threat zone generation was tested at the RSD. This test provided a glimpse of how forecasters might interact with a steering flow field, and occasionally individual tracks themselves, to manage multiple storm threat zones over a large area of responsibility. Progress was also made in storm tracking for the purpose of lightning flash jump detection from the Southern Ontario Lightning Mapping Array (SOLMA).The above work was done in alignment with the Warning Production Renewal (WPR) Project of the Meteorological Service of Canada (MSC). The MSC is investing in a new approach that aims to make the best data available in the best form through all stages of warning production and dissemination. The delivery mechanism is the so-called MetObject, a formalized data structure that has been extended to include storm tracks and polygon-bounded gridded data in addition to more traditional object-oriented features. In high level terms, MetObjects are intended to facilitate

interpretation, interaction, and communication of meteorological information.What separates weather event information systems from other geospatial database systems is the massive turnover of data in the time dimension. Watches and warnings (alerts) can occur over a wide range of time scales, and limits to predictability suggest that a level of smoothing is likely required. WPR is considering these factors in discussions on weather event feature motion and time interpolation. The status of these discussions will be noted in the presentation.

Session 20500 - Environment Canada and the Toronto 2015 Pan Am and Parapan American Games (TO2015 Games)

Toronto 2015 Pan Am datalogger programing Design, coding, implementation and issues

Elie, Martin
Environnement Canada
martin.elie@ec.gc.ca

Science in Support of the Toronto 2015Pan Am and Parapan GamesThe presentation will describe the work required to provide the design, write, test, and implement the datalogger code used to provide minute-by-minute reporting from a 55 station monitoring Mesonet designed, built and deployed across southern Ontario to inform the forecast process put in place to support the Toronto Pan Am and Parapan Am Games. The Games monitoring Mesonet was designed to deliver high-frequency minute-by-minute observations. Each station reported the standard meteorological parameters of, pressure, wind speed and direction, relative humidity, temperature and precipitation amounts, in addition to two new elements, precipitation type and black globe temperature. The majority of the stations used three models of compact station; the Vaisala WXT520, the LUFFT WS600, or the LUFFT WS601. Three standard MSC auto stations using the RCS design were also configured to report minute-by-minute. All stations used one of two types the datalogger, the Campbell Sci CR1000 or CR3000. The move to minute-by-minute reporting necessitated a complete review of the data acquisition system, from sensor to archive. The high-frequency required a move to FTP transmission, a break from our existing dial-out modem banks. A central FTP server was upgraded and stress tested, while the Central Services Branch wrote new post-logger algorithms. A Network Time Protocol (NTP) was implemented to increase the accuracy of clock synchronisation between the station and other computers within the system. An absolute minimum of calculations are done within the logger with almost all calucualtions being done post logger through a modular data processing process which has replaced CODECON. All work was part of the ECCC Data Management System, making it available for use on operational networks. ECC will share this code with other monitoring networks.

Session 20500 - Environment Canada and the Toronto 2015 Pan Am and Parapan American Games (TO2015 Games)

The Toronto 2015 Pan Am and Parapan Am Games Mesonet. Mission, design, build, deployment, and operation.

Klaassen, Joan   Johnston, Diane   So, Jonathan   MacPhee, John
Environment Canada
John.Peter.MacPhee@gmail.com

Science in Support of the 2015 Toronto GamesJohn MacPhee   Joan Klaassen   Diane Johnston Jonathan So Environment and Climate Change Canada (ECCC) (formerly Environment Canada) was tasked to support the Toronto 2015 Pan Am and Parapan Am Games with enhanced weather monitoring and venue-specific weather warnings, watches and advisories, to ensure the safety and protection of athletes, staff, volunteers and spectators. The Games provided Environment and Climate Change Canada with an opportunity to showcase its innovations and technological capabilities. To fulfil its mission, Environment and Climate Change Canada designed a high-resolution state-of-the-art automated atmospheric monitoring network called the Games Mesonet. Data from the Mesonet informed forecast and numerical weather prediction systems, which produced Games-specific alerts (Advisories, Watches and Warnings), and forecasts at a fine temporal and spatial resolution.The high-resolution Games Mesonet was comprised of 55 new automated land- and marine-based weather stations, in addition to S&T experimental monitoring platforms. Most of the new stations comprised compact weather station technology, paired with solar power and cell modems. The stand-alone design permitted easy installation at temporary locations, notably where there were space constraints in the urban environment and at sports venues.While the Mesonet was designed to monitor weather at the venues it also provided close tracking of southern Ontario lake-breezes, which can be associated with severe weather initiation and high air pollutant concentrations. The Mesonet had both high-density station spacing and high-frequency minute-by-minute reporting. Standard meteorological variables were reported - pressure, wind speed and direction, relative humidity, temperature and precipitation amounts - as well as a new element, recorded by a black globe thermometer/sensor, used in the evaluation of heat stress on the human body. We will describe the build, deployment and operation of the network with a particular emphasis on data acquisition, transmission, archive and display.

Session 20500 - Environment Canada and the Toronto 2015 Pan Am and Parapan American Games (TO2015 Games)

The ECCC Science Showcase during the Toronto 2015 Pan Am and Parapan Am Games

Sills, David Joe, Paul Belair, Stéphane Brook, Jeffrey Stroud, Craig
Environment and Climate Change Canada
David.Sills@canada.ca

During July and August of 2015, two Environment and Climate Change Canada (ECCC) branches - Science and Technology and the Meteorological Service of Canada - collaborated to demonstrate cutting-edge science and operational capabilities during the Toronto 2015 Pan Am and Parapan Am Games. Several observational, numerical modelling, and nowcasting initiatives were undertaken.On the observational side, there were a number of science contributions to the surface mesonet, including network design and the addition of multiple fixed and mobile weather and air quality units. A high-resolution 3-D total lightning mapping array, two scanning Doppler lidars, and a meteorological supersite were implemented.Related to numerical modelling, high-resolution urban modelling was undertaken using the High-Resolution Deterministic Prediction System (HRDPS). Nested model runs cascaded from 2.5 km to 1 km to 250 m. Special high-resolution air quality modelling was also carried out using the GEM-MACH coupled meteorology / air chemistry model with 2.5-km horizontal grid spacing.Lastly, a next generation forecasting, nowcasting and alerting demonstration evaluated the use of a multi-scale MetObject approach. The interactive Convective Analysis and Storm Tracking (iCAST) research prototype was used to generate a number of experimental products via dual Research Support Desks in the Ontario Storm Prediction Centre operations areas. iCAST made full use of enhanced observations and HRDPS predictions, output from the Global and Regional Ensemble Prediction Systems, and post-processed NWP products related to convection initiation and severe thunderstorms. Real-time and post-Games verification was also a priority.Science showcase products were made available to forecasters at the OSPC and at Games command centres via web-based applications. Ultimately, the showcase served to accelerate scientific progress in critical areas, enhance collaboration with universities, provincial agencies and Health Canada, and create a legacy data set that will be mined by various researchers both within and outside of ECCC.

Session 20500 - Environment Canada and the Toronto 2015 Pan Am and Parapan American Games (TO2015 Games)

Experimental air quality forecasts for the Toronto 2015 Pan Am and Parapan Am Games

Teakles, Andrew Baik, Jonathan So, Rita
Environment Canada
andrew.teakles@ec.gc.ca

An experimental infrastructure for the statistical post-processing of operational forecasts was applied to support researchers and meteorologist with air quality forecasts during the Toronto 2015 Pan Am and Parapan Am Games. The event provided a useful benchmark for the real-time forecast capabilities of the system and its ability to meet ongoing air quality forecast program needs. Prototypes using three different statistical techniques (linear model, random forest, and Kalman filter) were used to deliver additional forecast guidance for both air quality monitor locations and the individual sport venues. Innovative approaches were taken to leverage output from a new experimental GEM-MACH version at 2.5km resolution and improvements to the air quality objective analysis.   The presentation will be an overview of the development efforts mentioned above while highlighting the challenges and lessons learned from this project.

Session 20600 - General Atmosphere - Part 1

An intercomparison of weather-based thermal-rating methods for a 500kV transmission line in British Columbia

Campbell, Maggie Stull, Roland
University of British Columbia
magcampb@eos.ubc.ca

To determine the amount of electricity a high voltage transmission line can safely transmit at a given time, power utilities have consistently used conservative assumptions of weather variables that affect the temperature of the transmission line conductor. This leads to transmission lines being greatly underutilized, and at risk for damage when weather conditions do meet the assumptions used in static thermal ratings. Alternatively, thermal ratings that use real-time weather conditions are more realistic. These dynamic thermal ratings allow transmission lines to be used more efficiently and safely, however they are more expensive and difficult to implement. Here, thermal ratings, ranging from static to quasi-dynamic to dynamic, will be compared in an effort to show the extent to which real-time weather conditions can improve a thermal rating. All thermal-rating methods will be applied to a span of 500kV transmission line located in British Columbia. Air temperature, wind speed, and wind direction observations from a nearby Environment Canada weather station will be averaged over different time periods for quasi-dynamic thermal ratings, and the real-time values will be used in the dynamic thermal rating. Quasi-dynamic thermal ratings will be developed that incorporate averaged and real-time values of weather conditions. Finally, a dynamic thermal rating will be computed using numerical weather model output of the same parameters at every point along the transmission line span.

Session 20600 - General Atmosphere - Part 1

The role of air masses in producing extreme precipitation events

Gyakum, John
McGill University
john.gyakum@mcgill.ca

The role of the air mass in modulating the strength of a precipitation event is addressed with an analysis of the most basic of expressions discussed by Dr. Charles Doswell in several of his works, namely P = RD, where P is the total precipitation, and R is the precipitation rate, averaged through the duration, D, of the event. Though appearing simple, this expression includes R, which incorporates thermodynamic and dynamic factors driving the airs ascent. This ascent is associated with a change of water vapor mixing ratio, as an air parcels moisture condenses following a moist adiabat. Thus, the analysis of this deceptively simple expression involves non-linear interactions between the parcels ascent and its air mass. The time scales for D range from a few minutes for an isolated thunderstorm, to hours or days for both mesoscale and synoptic-scale features, such as transient cyclones, and their attendant regions of frontogenesis. Much longer durations of several days to weeks, represent blocking regimes that anchor in place otherwise transient processes, such as frontogenesis.Our research will be focused on the pertinent aspect of an extreme precipitation event: the details of the associated air mass. The precipitation rate, R (assumed to be same as condensation, with an efficiency of 1), may be expressed as the product of vertical motion and the change of saturation mixing ratio following a moist adiabat, through the troposphere. This expression for R includes the essential ingredients of lift, air mass temperature, and static stability (implicit in vertical motion). We use this expression for precipitation rate to examine extreme precipitation events in the extratropical latitudes to document the associated air masses and their physical impacts on the strength of the precipitation rate.Implications of this air mass modulation on the precipitation rate are discussed in the context of longer-term global climate change.

Session 20600 - General Atmosphere - Part 1

Development and predictability of a continental atmospheric river coupled with a winter cyclone across North America

Mo, Ruping Lin, Hai
Environment and Climate Change Canada
ruping.mo@canada.ca

Atmospheric rivers (ARs) are long and narrow bands of enhanced water vapour transport in the atmosphere. These phenomena typically have their origins in the tropical maritime air masses and develop mainly over the oceans within the warm conveyor belt of extratropical cyclones. Most previous studies have focused on the importance of these maritime ARs in producing heavy orographic precipitation and severe flooding events on the west coasts of the continents. In this study, we investigate an AR associated with a North American winter storm during 2-5 February 2016. The storm was initiated by a trough of low pressure moving across the Rocky Mountain from the California coast. The low-level jet ahead of trough was capable of extracting water vapour from the Gulf of Mexico to feed and mobilize an associated Rocky Mountain lee low, and eventually transforming itself into a powerful AR within the warm sector of the mobile cyclone. Although the origin of this AR remained in the tropical ocean through its life cycle, its main journey and major development occurred over the North American continent. The continued supply of warm and moist air from the subtropics and tropics through this continental AR resulted in a narrow band of heavy precipitation along the AR major axis across the central and eastern United States, and produced significant freezing rain as the AR flowed over the warm front with below-freezing air trapped behind in the northeastern United States and eastern Canada. We show that the AR analysis in this case can assist operational meteorologists in understanding and conceptualizing the development of this winter storm and the associated high-impact weather pattern. We also demonstrate that the main features and evolution of this AR were well predicted by the Canadian numerical weather prediction models with a lead time of 7~10 days.

Session 20600 - General Atmosphere - Part 1

On the relationship between North Atlantic baroclinic growth rate regimes and surface cyclogenesis

Ronalds, Bryn Gyakum, John R.   Atallah, Eyad
McGill University
bryn.ronalds@mail.mcgill.ca

Baroclinic instability is the fundamental theory explaining midlatitude weather systems, particularly cyclogenesis, as discussed by Hoskins and Valdes in their 1990 work on storm-tracks. They included measurements of dry baroclinic growth rates in their analysis, though they theorized that moist baroclinic growth rates (?m) might provide a more appropriate measure. This project incorporates this metric in order to examine the relationship with surface cyclogenesis in the North Atlantic. An index of areal extent of high ?m was computed over the North Atlantic basin (25-60N and 0-80W) and over the vertical depth of 850-600hPa, using the National Centers for Environmental Prediction Reanalysis 1 data for 1950-2014. From this the

time series of standardized anomalies of the index was calculated. Concentrating solely on the cold season months (DJF) all synoptically independent events with standardized anomalies greater than two were identified. Case study analysis focusing on events lasting longer than 4 consecutive days (n=7) found that each was associated with an anomalously long duration explosive cyclogenesis event at some point throughout the event. The resulting extreme low pressure centre was located in the left exit region of an anomalously strong zonal tropopause jet, and covered most of the central and east portion of the North Atlantic. The buildup to these events involved a significantly extended and deep cold air mass over North America, with amplified ridging over the Aleutians.

Session 20600 - General Atmosphere - Part 1
A Rare Winter Supercell Produces an EF1 Snownado
Sills, David Giguère, Marie-Ève
Environment and Climate Change Canada
David.Sills@ec.gc.ca
On November 23, 2013, a lone supercell thunderstorm developed over southern Ontario, Canada, and generated a brief tornado that caused damage rated at EF1 on the Enhanced Fujita Scale. What is unique about this event is that surface air temperatures in the area were below 0C, and the tornado occurred in the presence of snow and graupel at ground level. In fact, dual-polarization data from the nearby TYX NEXRAD Doppler radar in Montague, New York, suggest that all precipitation associated with the supercell was frozen - mainly ice crystals with a graupel storm core. Despite the presence of ice crystals and graupel, no lightning was detected with this storm. The goal of the case study is to extend our understanding of the spectrum of supercell characteristics and environments in order to improve severe weather forecasting and nowcasting.

Session 20600 - General Atmosphere - Part 1
Characteristics of winter precipitation types and associated atmospheric conditions in the Kananaskis valley
Vaquer, Paul Thériault, Julie
UQAM
paul.vaquer@gmail.com
The type of precipitation can affect the snowpack in mountainous regions as well as the severity of the hydrological response of rivers. For example, the catastrophic flooding event in June 2013 in the Calgary area led to more than 300 mm of precipitation. This extreme precipitation event produced mainly rain at the surface but some snow was reported at higher elevation towards the end of the event. In this region, precipitation is generally associated with a low-pressure system located southeast Alberta that produces upslope flow on the eastern slope of the Rockies. The goal of this study is to investigate the characteristics of winter precipitation types and their associated atmospheric conditions aloft and at the surface in the eastern slope of the Alberta Rockies. To address this, the data collected during a field project held in the spring 2015 in the Kananaskis area is used. First, each event is classified based on the large-scale flow regime.

Preliminary analysis showed that snow is produced in a different large-scale flow regime than rain or mixed precipitation. Second, the types of precipitation are characterized using an optical disdrometer and were correlated with the surface temperature, dew point as well as manual observations. For example, snow was observed at the surface at a temperature up to +8°C in a sub-saturated environment. A thorough analysis of the atmospheric conditions measured by the MRR (Micro Rain Radar) will be linked to the type of precipitation reaching the surface as well as the large-scale flow field regime. Overall, this study contributes to better understand the precipitation formation processes and associated atmospheric conditions in complex terrain.

Session 20601 - General Atmosphere - Part 2

CMCs highlights of operational and experimental numerical products updates over the last year

Bois, Nicole Anselmo, David
Meteorological Service of Canada; CMC Dorval
nicole.bois@canada.ca

The Canadian Meteorological Centre (CMC) maintains a fully operational 24/7 production environment that includes data assimilation systems feeding data into various NWP weather and environment forecast models. Along with the requirements of maintaining a 24/7 operational environment, CMC also ensures it can implement a steady stream of systems improvements. These improvements require careful coordination between ECs Atmospheric and Environmental Research groups and CMCs various development groups before being installed into CMC operations. Increasingly there are additional systems and improvements delivered to CMC from a growing number of partners outside of CMC such as MSCs national labs and the Canadian Ice Centre for example. A review will be made of the main implementation highlights of the past year, including: - Update to the Global Deterministic Prediction System (GDPSv5) with its new YinYang grid - Updates to the regional deterministic Prediction System (RDPSv4 and upcoming v5)- Updates to the Global and Regional Ensemble Prediction System (GEPS and REPS)- Update to the high resolution deterministic prediction system (HRDPSv4.1)- Update to the regional precipitation analysis (CaPAv3.2)- Operational status gained by the Global ice-ocean prediction system (GIOPS) and its most recent update (IAU)- Updates to the regional air quality model using GEMv4 - update to the experimental Regional ice prediction system to include the oceanic component (RIOPS)- new upcoming experimental coupled model extension over the Great Lakes- updates to our data offerings and more...

Session 20601 - General Atmosphere - Part 2

Performance of the new Global Deterministic Prediction System (GDPS 5.0.0) of the Canadian Meteorological Center

Chouinard, Sebastien
Environnement Canada
sebastien.chouinard@canada.ca

The Canadian Meteorological Center (CMC) did, last December, an important update of its Global Deterministic Prediction System (GDPS). Among the changes, the most important were

the uniform lat-lon grid, which was replaced by a new Yin-Yang grid, the use of the trapezoidal method for trajectory calculation combined with a cubic interpolation scheme and an increase in the number of satellite data assimilated. The new GDPS verification, which was conducted over 6 months during 2015, shows a significant improvement in the verification scores when compared to the previous GDPS version. The results of the verification conducted by the operational meteorologists of the Analyses and prognoses (A&P) section at CMC will be presented.

Session 20601 - General Atmosphere - Part 2

Evaluating Precipitation Forecasts from a High-Resolution Ensemble Kalman Filter (HREnKF) Over the Pacific Northwest

Cookson-Hills, Phillipa   Kirshbaum, Daniel   Surcel, Madalina Fillion, Luc   Jacques, Dominik   Baek, Seung-Jong   Doyle, Jonathan
McGill University
phillipa.cookson-hills@mail.mcgill.ca

The Pacific Northwest endures some of the heaviest precipitation on the planet. Therefore, producing accurate precipitation forecasts for these areas is essential to warn different sectors of society of the timing and intensity of precipitation events. However, forecasting precipitation remains difficult in general, and in the Pacific Northwest in particular, due to the diversity of precipitation and cloud types in that region. In addition, observational precipitation estimation is difficult due to sparseness of rain gauge data and limitations of radar coverage in complex terrain. In an effort to improve forecast skill in this region, Environment and Climate Change Canada are developing a regional High-Resolution Ensemble Kalman Filter (HREnKF) for ensemble prediction. The HREnKF has a 2.5km resolution and assimilates surface and upper air observations every hour. This talk presents the challenges and outcomes of evaluating quantitative precipitation forecasts (QPF) from the HREnKF over the Pacific Northwest, a domain of highly complex topography and relatively sparse observations. To perform this evaluation, a gridded verification product is first created which merges radar and rain gauge data. Then, this product is used to evaluate the QPFs from both the HRENKF and a lower resolution (15km) Regional Ensemble Kalman Filter (REnKF) using a suite of evaluation methods- both deterministic and probabilistic. Uncertainties in the observational precipitation retrieval are also addressed by creating an ensemble of gridded verification products and thus simultaneously considering both observational and forecast uncertainties in performing the verification.

Session 20601 - General Atmosphere - Part 2

Comparison of remote air quality monitoring data with output from the GEOS-Chem global chemical transport model

Hosseini, Zahra Reuten, Christian Lundgren, Jeff Bizhani, Golnoosh
RWDI AIR Inc., University of Calgary
creuten@gmail.com

Output from the global chemical transport model GEOS-Chem provides a rich source of information for fields of study spanning a broad range of applications. Of particular interest is

an improved characterization of background concentrations of atmospheric pollutants. In our research collaborations, we are trying to improve the modelling of photochemical species in the absence of reliable upwind measurements of atmospheric aerosols, ozone, and their precursors. In cumulative effects assessments, predicted impacts of contaminant emissions from industrial activities are added to estimates of background concentration to assess the total impacts on humans and the environment. Large regions with industrial activities in Canada are lacking nearby representative background measurements. Workarounds tend to be conservatively high, while still possibly missing unusual episodes of high background concentrations. We compare one-year of hourly global GEOS-Chem predictions of several contaminants at 2.5 x 2.5 degree spatial resolution with background stations in Western Canada. The station elevations range from sea level to 1,400 m and their climates from maritime to continental. Characteristics of interest include seasonal and diurnal variability and elevation dependence. We use finer resolution 0.500 x 0.667 North American nested model output to shed light on shorter episodes of particular interest.

Session 20601 - General Atmosphere - Part 2

A new era in monitoring weather events from geostationary satellite with GOES-R

Rabin, Robert
NOAA/National Severe Storms Lab
Rabin@ssec.wisc.edu

A new series of geostationary satellites, beginning with the upcoming launch of GOES-R, will bring new capabilities to monitor clouds, lightning, and properties of the earth and ocean surface with enhanced temporal and spatial resolution. This presentation will highlight some of these capabilities with examples of satellite imagery observed at 1-minute intervals from a current satellite, GOES-14. This satellite collected data at 1-minute intervals in the Super Rapid Scan Operation for GOES-R (SRSOR) mode during select periods in 2013-2016. This enabled testing the value of simultaneous high temporal observations from satellite, radar, and ground-based lightning sensors in monitoring convective storms and winter weather. Examples will be shown which illustrate the evolution of clouds, air mass boundaries (fronts) from radar and visible satellite imagery, and their possible influence on storm initiation and interaction with existing convection. The analysis of winds from tracking cloud movement, in combination with other observations such as winds from radar, will also be illustrated.

Session 30100 - Climate Variability and Predictability - Part 1

Tropical Oceanic Rainfall and Sea Surface Temperature Structure: Parsing Causation from Correlation in the MJO

Li, Yanping Carbone, R. E.
University of Saskatchewan
yanping.li@usask.ca

Based upon on the findings of Li and Carbone (2012), the association of tropical rainfall with SST structure is further explored, with emphasis on the MJO passband. Analyses include the tropical Indian Ocean, Maritime Continent, and tropical Pacific regions. We examine the

anomalies of and correlations between SST structure, the frequency of rainfall events, and rainfall amount. Based on detailed examination of a 49 month timeseries, all findings are statistical inferences and interpretations consistent with established theory. The statistical inferences are broadly consistent with a pivotal role played by the convergent Laplacian of SST together with an expected, but somewhat indirect, role of SST itself. The main role of SST in the MJO passband appears limited to production of moist static energy, which is highly correlated with cumulative precipitation, yet bears a decidedly conditional relationship to the occurrence of rainfall. If rain occurs, then more rain is likely over warmer SST. The convergent Laplacian of SST is strongly associated with the onset of rainfall, apparently through its capacity to induce vertical air motion with sufficient kinetic energy to overcome convective inhibition in a conditionally unstable troposphere. The convergent Laplacian of SST is directly associated with the location and the variability of rainfall event frequency, while having a less direct relationship to cumulative rainfall. These nuanced interpretations of rainfall forcing by the Laplacian of SST, and conditional modulation of cumulative rainfall by SST, may underlie systematic errors in highly parameterized models as a consequence of variable asymmetry in the field of Laplacian anomalies.

Session 30100 - Climate Variability and Predictability - Part 1
GEM-NEMO global coupled model for subseasonal to seasonal predictions
Lin, Hai Muncaster, Ryan
Environment and Climate Change Canada
hai.lin@canada.ca
The CMC numerical weather prediction model, GEM, is coupled with the NEMO ocean model. The objective is to develop a global atmosphere-ocean-sea ice coupled model for climate study and subseasonal and seasonal predictions. In this presentation, the model configuration is introduced. A multi-decade integration is analyzed. It is found that the model can produce a reasonable SST variability that is similar to the observed ENSO in the tropical Pacific. Hindcasts of 31 years from 1980 to 2010 are performed starting from May 1 and November 1 of each year. 10 members of six-month integrations are produced. Seasonal forecast skill is assessed. Comparison is made with the operational Canadian Seasonal and Interannual Prediction System (CanSIPS).

Session 30100 - Climate Variability and Predictability - Part 1
Linear and nonlinear statistical downscaling of surface wind vectors
Mao, Yiwen Monahan, Adam
University of Victoria
ymaopanda@gmail.com
Predictability of surface wind vectors by statistical downscaling (SD) from free-tropospheric predictors and based on linear transfer functions (TF) varies with directions of projection; such anisotropy renders predictability of zonal and meridional components alone insufficient to fully reveal the characteristics of predictability of surface wind vectors by SD methods.This study considers whether predictive anisotropy is an artifact of linear regression models used as the

TF.We compare predictive characteristics of surface wind vectors by SD based on both linear TF and nonlinear TF (i.e. neural network, support vector machine and tree regression) using a large dataset of surface meteorological stations across the globe. Our results show that the predictability of surface wind vectors resulting from nonlinear SD is not necessarily better than the corresponding linear predictability. These results indicate that predictive anisotropy is not an artifact of linear SD.

Session 30100 - Climate Variability and Predictability - Part 1

Vigilance: Detecting severe weather with confidence levels in the extended forecast.

Schaffer, Michael
Environment and Climate Change Canada
michael.schaffer@canada.ca

The Analysis and Prognosis (A&P) section of the Canadian Centre for Meteorological and Environmental Prediction (CCMEP) has started using the Global Ensemble Prediction System (GEPS) to identify areas of potential severe weather; including rain, freezing rain, snow, wind, wind chill and humidex. The GEPS consists of 20 members running to 16 days, twice a day. By using the GEPS we are able to identify areas of severe weather and confidence levels up to 10 days in advance. Cases from the winter of 2015/16 will be discussed. La division danalyses et pronostics (AetP) du Centre des Prévisions Météorologiques et Environnementales Canadien (CPMEC) des opérations a commencé à utiliser le Système Global de Prévisions dEnsembles (SGPE) pour identifier les zones potentielles de temps significatif comprenant la pluie, la pluie verglaçante, la neige, le vent, le refroidissement éolien et lhumidex. Le SGPE est exécuté deux fois par jour. Il est composé de 20 membres, chacun produisant des prévisions de 16 jours. En utilisant le SGPE nous sommes en mesure didentifier les zones de temps significatif avec un niveau de confiance de 10 jours à lavance. Nous discuterons des cas de prévisions pour lhiver 2015/16.

Session 30100 - Climate Variability and Predictability - Part 1

Predictability of Different Types of ENSO

Tang, Youmin Tao, Suo
University of Northern British Columbia
ytang@unbc.ca

In this study, the retrospective forecasts of El Niño-Southern Oscillation (ENSO) were performed for the past 148yr from 1856 to 2003 using Zebiak-Cane model. By examining these retrospective forecasts, predictability of different types of ENSO was examined. Two methods are used in classifying El Nino events in this study. First, El Nino events are classified into two types: cold tongue and warm pool events, according to the location of the occurrence of the largest sea surface temperature anomalies (SSTA). Second, El Nino events are categorized into three types, extreme El Nino, warm pool El Nino and canonical El Nino, respectively, by using Fuzzy Clustering method. The predictability of La Nina events is also analyzed meanwhile.
It was found that the predictability of different types of El Nino events shows significant differences. For two types of El Nino events, the cold tongue type has better prediction skill than

the warm pool counterpart, whereas for three kinds of El Nino events, the best skill occurs at the extreme El Nino type, followed by canonical El Nino and warm pool El Nino. The predictability of all types of El Nino events also displays the significant interdecadal variation, which is strongly associated with the ENSO signal strength. At last, the possible reasons responsible for the differences of the predictability of different types of El Nino events were also discussed.

Session 30100 - Climate Variability and Predictability - Part 1
Climate Change and Extreme Wind Forecasting
Young, James Chapman, Ron
RWDI Air Inc.
Jim.Young@rwdi.com
Most climate projections suggest that the future will have fewer but more violent storms. Not only is this projected to result in increased flooding but also higher gust velocities due to the increased power in the storms. Gusts are important in the building sector as they can lift up and blow around materials, create hazardous working conditions and have led to injury and death to both workers and the public. The presentation will introduce the importance of gust winds and a unique method of forecasting them that is being successfully used in Canada today at the scale of individual buildings. An overview of the approach being used will be presented.

Session 30101 - Climate Variability and Predictability - Part 2
A new dipole index of the salinity anomalies of the tropical Indian Ocean
Li, Junde Liang, Chujin Tang, Youmin Dong, Changming Chen, Dake Liu, Xiaohui Jin, Weifang
State Key Lab of Satellite Ocean Environment Dynamics, Second Institute of Oceanography, State Oceanic Administration, Hangzhou, China
lijundesio@gmail.com
With the increased interest in studying the sea surface salinity anomaly (SSSA) of the tropical Indian Ocean during the Indian Ocean Dipole (IOD), an index describing the dipole variability of the SSSA has been pursued recently. In this study, we first use a regional ocean model with a high spatial resolution to produce a high-quality salinity simulation during the period from 1982 to 2014, from which the SSSA dipole structure is identified for boreal autumn. On this basis, by further analysing the observed data, we define a dipole index of the SSSA between the central equatorial Indian Ocean (CEIO: 70°E-90°E, 5°S-5°N) and the region off the Sumatra-Java coast (SJC: 100°E-110°E, 13°S-3°S). Compared with previous SSSA dipole indices, this index has advantages in detecting the dipole signals and in characterizing their relationship to the sea surface temperature anomaly (SSTA) dipole variability. Finally, the mechanism of the SSSA dipole is investigated by dynamical diagnosis. It is found that anomalous zonal advection dominates the SSSA in the CEIO region, whereas the SSSA in the SJC region are mainly influenced by the anomalous surface freshwater flux. This SSSA dipole provides a positive feedback to the formation of the IOD events.

Session 30101 - Climate Variability and Predictability - Part 2

Continuity of Long-Term Daily Temperature Observations with Automation

Milewska, Ewa Vincent, Lucie
Environment and Climate Change Canada
ewa.milewska@canada.ca

Continuity of long-term temperature observations needed to study climate trends can be affected by automation, which is often associated with a new instrumentation and some changes in local conditions of the new automated observing site. A new seasonal-by-wind bias (SWB) method based on the periods of overlapping daily maximum and minimum temperature observations from closely collocated stations and meteorological conditions is developed to connect observations from past staffed and new automated sites. SWB method that involves, if required, aligning stations for the same observing times using hourly observations and categorizing differences according to the wind speed ranges, is applied to a set of modernized References Climate Stations. The adjustments vary on individual days and perform well bringing the old and the new time series closer together, especially after the adjustment for the observing time. The seasonal and wind based adjustments are important for the stations and days that exhibited seasonal (many) and wind (some) dependency. The method and the results of the adjustment are discussed and compared with other statistical methods that use neighbouring but not closely collocated station data.

Session 30101 - Climate Variability and Predictability - Part 2

Changes in the structures of low-frequency modes of variability before and after 1980

Soulard, Nicholas Lin, Hai Yu, Bin
McGill University
nicholas.soulard@mail.mcgill.ca

Global temperatures are rising, and accompanying it are changes to flow variables, and thus changes to low-frequency patterns of variability. These low-frequency patterns derive part of their energy from sea-surface temperature (SST) variability (and other boundary forces), as well as from the background zonal flow, and synoptic eddies. Since around 1980 there has been a significant warming of the tropical oceans, in conjunction with an increase in the magnitude and eddy activity of the Northern Hemisphere zonal Jets. Using reanalysis data from NCEP/NCAR for the 65 winters of 1948 to 2013, we examine changes between periods of 1949-1980 (P1) and 1981-2013 (P2). Given that both the boundary forcings which affect the low-frequency patterns and the flow in which they are embedded have changed, we find that the structures of these low-frequency patterns have also changed. We find a stronger North Atlantic Oscillation (NAO) in P2, while the Pacific-North American pattern (PNA) has shifted slightly eastward, and its North American anomalies have weakened.Looking at the product of the gradient of the background wind with the extended Eliassen-Palm flux vector, we find that the NAO derives more energy from the background flow in P2 than in P1. The Pacific Jet in the vicinity of the PNA moves east and imparts more energy to the Aleutian anomaly centre; however, less energy is exchanged between this background flow and the PNA anomaly centre over North America, which contributes to the weakening of this centre in P2. Furthermore, height tendencies associated with

the convergence of transient eddy vorticity fluxes tend to reinforce the positive NAO pattern in P2, whereas they act to weaken and shift the PNA eastward.

Session 30101 - Climate Variability and Predictability - Part 2

Changes in Climate over the South China Sea and Adjacent Regions: Response to and Feedback on Global Climate Change

Yang, Song Li, Zhenning Hu, Xiaoming He, Shan He, Bian
School of Atmospheric Sciences, Sun Yat-sen University, Guangzhou, China
yangsong3@mail.sysu.edu.cn

El Niño-Southern Oscillation and the Asian monsoon have experienced significant long-term changes in the past decades. These changes, together with other factors, have in turn led to large climate change signals over the South China Sea and adjacent regions including Southeast Asia, the western Pacific, and the tropical Indian Ocean. An attribution analysis of the feedback processes of these signals indicates the predominant importance of water vapor and cloud radiative feedbacks. Experiments with multiple earth system models also show that these regional climate change signals exert significant influences on global climate. The increases in atmospheric heating over Southeast Asia and sea surface temperature in the adjacent oceans in the past decades have weakened the Indian monsoon and the African monsoon, led to a drying effect over East Asia, and generated wave-train patterns in both the northern and southern hemispheres, explaining several prominent climate features in and outside Southeast Asia.

Session 30101 - Climate Variability and Predictability - Part 2

Relationship between North American winter temperature and large-scale atmospheric circulation anomalies and its decadal variation

Yu, Bin Lin, Hai Wu, Zhiwei Merryfield, William
Environment and Climate Change Canada
bin.yu@ec.gc.ca

Recent studies suggest the importance of an improved understanding of extratropical atmospheric and oceanic variability as necessary for understanding North American climate anomalies. In this study, the NCEP reanalysis data is used to characterize and examine the dominant modes of wintertime North American temperature anomalies. The anomalies are dominated by two leading maximum covariance analysis (MCA) modes of northern winter North American surface temperature and tropical and Pacific-North American 500-hPa geopotential anomalies. A new teleconnection index, termed the Asian-Bering-North American (ABNA) pattern, is constructed from the normalized geopotential field after linearly removing the contribution of the Pacific-North American (PNA) pattern. The first MCA mode is highly correlated with the PNA and ABNA teleconnections, and the second mode with the North Atlantic Oscillation (NAO). This indicates the influence of both extratropical and tropical atmospheric variability on North American climate. The decadal variation of the temperature-circulation relationship is further assessed using the 20CR reanalysis data.

Session 30200 - Regional climate modelling and diagnostics - Part 1
Modelled response of hail over North America to climate change
Brimelow, Julian Burrows, William Hanesiak, John
Environment and Climate Change Canada
stomatalaperture@gmail.com
Hailstorms cause billions of dollars worth of damage annually. Consequently, how the occurrence and frequency of hail might change as the planet warms is of interest. However, there have been conflicting findings in the literature. While the body of research suggests that the number of days when the atmosphere is favourable for severe thunderstorms is expected to increase in the future, other research suggests that the number of days with small hail is expected to decrease. Here we present results from the first study to explicitly model the response of hail frequency and size to warming over most of N. America. In particular, we sought to determine whether hail and severe hail environments are likely to occur more or less frequently in the future, and if there will be a spatiotemporal shift in hail damage potential. To this end, we used dynamically downscaled output from three global and regional climate model pairings from the North American Regional Climate Change Assessment Program. These data were then used to run a coupled cloud and hail model (HAILCAST) on a 50-km grid, from 18 UTC to 03 UTC and from 1 March to 30 September. This was done for the present climate (1971-2000) and a future climate (2041-2070).We found that the response of hail to warming varied by region and by season. A dramatic decrease in hail potential was predicted over the eastern and southeastern portions of the study area. Although fewer hail days were expected in the future over most areas, an increase in the relative portion of severe hail days and in the median hail diameter was expected. An increase in hail damage potential was expected over most areas in the spring, and over higher latitudes and over the Rocky Mountains and Mackenzie River Basin in the summer.

Session 30200 - Regional climate modelling and diagnostics - Part 1
Lake-river and lake-atmosphere interactions in a changing climate over Northeast Canada
Huziy, Oleksandr Sushama, Laxmi
ESCER, UQÀM
guziy.sasha@gmail.com
Lakes influence the regional climate and hydrology in a number of ways and therefore they should be represented in climate models in a realistic manner. Lack of representation of lakes in models can lead to errors in simulated energy and water fluxes, for lake-rich regions. This study focuses on the assessment of the impact of climate change on lakes and hydrology as well as on the influence of lakes on projected changes to regional climate and surface hydrology, particularly streamflows, for Northeast Canada. To this end, transient climate change simulations spanning the 1950-2100 period are performed, with and without lakes, with the fifth generation of the Canadian Regional Climate Model (CRCM5), driven by the Canadian Earth System Model (CanESM2) at the lateral boundaries for Representative Concentration Pathway 8.5.Comparison of projected changes from the CRCM5 simulations with and without lakes suggest that lakes attenuate projected increases to 2-m air temperature in all seasons, almost everywhere in the study domain, with maximum decreases of the order of 2°C occurring during winter. As for streamflows, results suggest projected increases for winter and spring and

decreases during summer. Comparison of the projected changes suggests that lakes attenuate the projected increases in streamflows in spring due to the storage effect of lakes, and also attenuate the projected decreases in streamflows in summer in future climate due to the gradual release of the excess water stored in the lakes during spring. This study, thus demonstrates the impact of lakes on projected changes to the regional climate and hydrology for the study region using a single regional modelling system.

Session 30200 - Regional climate modelling and diagnostics - Part 1
Daily precipitation extremes over Northern Canada estimated from Arctic and North-America CORDEX simulations and reanalysis
Mailhot, Alain Diaconescu , Emilia Paula Chaumont, Diane Brown, Ross Grenier, Patrick
INRS-Eau, Terre et Environnement
Alain.Mailhot@ete.inrs.ca
The study provides a regional analysis and evaluation of historical simulations realized with several Regional Climate Models driven by Global Climate Models and participating in CORDEX experiment over Arctic and North America domains. The focus is on the models skill in simulating daily extremes over Northern Canada, a region with sparse observations, making difficult the evaluation against gridded observational products. In this context, the evaluation is typically realized with respect to station observations. To ensure a good representativeness of reference data at local scale, we use as reference station observations from three sources. We present results obtained for the climate mean, the 95th and 99th percentiles of wet days, the annual maximum daily precipitation and the annual maximum 5-day accumulated precipitation. These indices are also computed for four global reanalysis (ERA-Interim, JRA-55, MERRA and CFSR) and one gridded observational product (NRCan) derived from station measurements, with the primary goal to verify if these products can be used as reference in regions where no station measurements are available.

Session 30200 - Regional climate modelling and diagnostics - Part 1
North America Extra-Tropical Cyclones and their relationship with precipitation extremes using Regional Climate Models
Poan, Emmanuel D. Gachon, Philippe Aider, Rabah Dueymes, Guillaume Laprise, René
Centre ESCER - UQAM
emmanuel.poan@gmail.com
Extra-Tropical Cyclones (ETCs) account for a large amount of mid-latitude rainfall climatology as well as the majority of extreme and severe weather events - heavy precipitation - snow storm - coastal waves and flooding - which are responsible for important socio-economic and human damages. Likewise any synoptic to intraseasonal feature, storm dynamics involves an interrelation between large-scale and regional-scale physical processes. As a consequence, they are hardly captured and described by Global Climate Models (GCMs) which have a coarser resolution to correctly handle all the features of these meteorological events. Hence, the main objective of this study is to improve our understanding of the regional features of ETCs and the

links between storm activity and the evolution of key atmospheric variables using high-resolution Regional Climate Models (RCMs) driven by both reanalysis and GCM products over the recent decades. This study is part of the recent CNRCWP (Canadian Network for Regional Climate and Weather Processes) project, coordinated by UQAM/ESCER in collaboration with Environment Canada. Firstly, the performance of RCMs is evaluated against reanalysis over the recent past climate (1961-2009). The recent two Canadian RCMs (CRCM5 and CanRCM4) are analyzed through storm parameters such as occurrence, lifetime and intensity. Furthermore, the representation of extreme precipitation occurrence is assessed using different thresholds of severity. RCMs show a good representation of such events and exhibit clearly regional specificities that are hardly captured with GCMs. Links between intense rainfall and ETCs occurrence are obvious over the eastern coast as well as the Great Lakes region. However, the strongest link is occurring over the north/northeastern Quebec and the Hudson Bay region showing that the majority of precipitation is strongly connected with ETCs activity (in terms of occurrence, intensity and slow moving system).

Session 30200 - Regional climate modelling and diagnostics - Part 1

Assessment of storm tracks variability in North America using various wind products from Regional Climate Models

Sankare, Housseyni Gachon, Philippe Poan, Emmanuel D. Laprise, René
Centre ESCER (UQÀM)
sankare@sca.uqam.ca

Storms can seriously affect humans and the ecosystems via their frequencies and intensities. The changing weather storms projected over North America, especially in Canada, are expected to contribute to increase extreme weather conditions and hydro-meteorological hazards, through interactions from large-scale features (ex. planetary waves) and regional physical processes (ex. friction effects and diabatic heat and water fluxes according to surface conditions). Hence, to predict or estimate intensity and frequency of storm tracks in climate model simulations has always been a challenge. The goal of this study is to assess the impact of using various winds (gradient wind, geostrophic wind and direct model output wind at 1 000hPa) on the vorticity used to compute the storm tracking. To address this goal, a three hourly data from the North America Regional Reanalysis (NARR) and the Canadian Regional Climate Model version 5 (CRCM5) simulations are used over the recent past period (1979-2014). The differences in cyclonic activity are analyzed in terms of mean occurrence, duration and intensity, to evaluate the sensitivity in the storm tracking algorithm from the use of various wind fields. Overall, this study contributes to reduce uncertainties in the variables used for tracking. A good performance of regional climate model opens a perspective towards climate change related applications.

Session 30200 - Regional climate modelling and diagnostics - Part 1

Diurnal cycle of summer precipitation east of the Rocky Mountain

Scaff, Lucia Li, Yanping
University of Saskatchewan
lucia.scaff@usask.ca

Summer extreme events over extratropical mountainous regions have been studied for several decades all over the world. Special focus has been paid on the understanding of synoptic patterns, mesoscale features (such as convergence lines, capping lids, water vapour, waves and wind circulation dynamics), and improving the forecast focusing through intensive field experiments in several mountainous locations. However across the lee side of the Canadian Rockies an analysis of the diurnal cycle and the convection development versus that of US Rockies is still not well addressed. Using both station observations and a cloud-resolving RCM 4-km Weather Research and Forecast (WRF) model 15-year simulations, a detailed analysis of the summer storms diurnal cycle over these regions can give us an insight of the small features affecting their lifetime, strength and propagation over different mountainous environment. The main objective of this work is to show the importance of diurnal scale storms evolution in and east of the Canadian Rockies, compared with the US Rockies in Montana, Wyoming and Colorado. The summer storms in the lee side of the US Rockies are dominated by daily precipitation, which is mostly produced by convective systems, specially centred at night, as examined in detail in recent PECAN experiment. Instead the Canadian Rockies usually receive recurrent frontal systems, although with a trend of increasing contribution from convective rainfall in recent years. The main mechanisms to have these distinct diurnal rainfall cycles along the Rockies can be explained by the evolution of the boundary layer and the dominant land-surface fluxes, which also show different patterns during convective and stratiform precipitation.

Session 30201 - Regional climate modelling and diagnostics - Part 2

The Gulf of St. Lawrence future ocean climate; ensemble results of nine regional simulations

Chassé, Joël Perrie, Will Long, Zhenxia Brickman, Dave Guo, Lanli Lambert, Nicolas
DFO-GFC
joel.chasse@dfo-mpo.gc.ca

We present the latest results of a regional ocean climate dynamical downscaling system for the Gulf of St. Lawrence. The system consists of an atmospheric model, a hydrology model and the NEMO ice-ocean coupled model. The presentation will focus on the analysis of nine 130-year-long high-resolution simulations of ocean dynamics (1970-2100) under the A1B, RCP4.5 and RCP8.5 scenarios. The global simulations used as input in the downscaling system were obtained from the Canadian Centre for Climate Modelling and Analysis, the National Center for Atmospheric Research, the Hadley Centre and the Max Planck Institute for Meteorology. A finding of the downscaling system is the significant spatial variability of the projected changes at the scale of the Gulf of St. Lawrence with some areas warming up at a faster than others. Ice volume and extend will continuously decrease until 2100, but some ice will still be formed in winter in coastal areas. Due to increased river runoff and a re-distribution of its annual cycle, surface salinities will be decreasing in the Gulf except in summer in the short term. The decrease in salinity will be particularly marked in the St. Lawrence estuary in winter. The stratification (0-50m) will be increasing for the four seasons with maximum change in summer and minimum change in fall.

Session 30201 - Regional climate modelling and diagnostics - Part 2

Snow Characteristics and Snow Albedo Feedback over North America as simulated by the Canadian Regional Climate Model

Fang, Bruno Sushama, Laxmi Tefera Diro, Gulilat
UniversitÃ© du QuÃ©bec Ã MontrÃ©al
bruno_fang@hotmail.com

Snow albedo feedback (SAF) has shown to increase climate sensitivity over the Northern Hemisphere land area and also to exhibit large intermodel variation. This study therefore focuses on the assessment of snow characteristics and SAF over North America in the fifth-generation Canadian Regional Climate Model (CRCM5) simulations. SAF strength is controlled by an atmospheric component and a surface component. The latter is determined as the sum of a snow cover feedback term and a term representing the temperature dependence of snow albedo. In this study, snow characteristics and the surface component of SAF in the seasonal cycle context are validated by comparing CRCM5 simulation driven by the European Centre for Medium-range Weather Forecasting (ECMWF) ERA-40 and ERA-Interim Reanalysis with available observations. SAF is also assessed in the climate change context for the 2071-2100 period with respect to the 1976-2005 period from CRCM5 transient climate change simulations driven by CanESM2 and MPI-ESM, for RCPs 4.5 and 8.5. Validation suggests that the model is able to represent the main spatial and temporal distribution of snow depth and snow water equivalent over the midlatitude regions, but some overestimation is noted over the Canadian Arctic Archipelago. CRCM5 snow albedo is overestimated over forests and mountains of the midlatitude regions, in comparison with observed data. It must be noted though that there could also be considerable uncertainties in the observations. Results indicate that the surface component of SAF in CRCM5 is overestimated compared to that of the Moderate-Resolution Imaging Spectroradiometer (MODIS). This overestimation appears to be linked to the snow cover feedback, which is directly linked to the snow albedo, suggesting improvements to the representation of snow albedo are required in the model.

Session 30201 - Regional climate modelling and diagnostics - Part 2

Evidence of added value in North American regional climate model simulations with increasing horizontal resolutions

Laprise, J.P. René Lucas-Picher, Philippe
Centre ESCER - UQAM
laprise.rene@gmail.com

Commonly termed added value, the additional regional details gained by high-resolution regional climate models (RCMs) over the coarser resolution driving data have not been fully explored and efforts in determining this added value are too few. In an attempt to correct this situation, this work studies how five North American weather phenomena are affected with increasing resolution, comparing three RCM simulations using grid meshes of 0.44°, 0.22° and 0.11° with available observations. The analysis shows that the orographic precipitation on the west coast of North America is enhanced and more realistic, with two rainy bands in the finer resolution simulation. The spatial distribution of precipitation in August and the high frequency of summer precipitation extremes over southwestern United States reveal that the North American monsoon is improved with increasing resolution. Only the finer RCM simulation shows skill at producing

snowbelts around the Great Lakes, as a result of an adequate simulation of lake-effect snow. A comparison of wind roses in the St. Lawrence River Valley indicates that only the finer RCM simulation is able to reproduce wind channeling due to a proper representation of complex orography. Finally, the simulation of the summer land-sea breezes by the RCM simulations lead to added value in the diurnal cycle of precipitation over the Florida peninsula and the Caribbean islands. Overall, almost systematic improvements is found in the finer resolution simulations.

Session 30201 - Regional climate modelling and diagnostics - Part 2
Small-scale development in regional climate model simulations
Matte, Dominic Laprise, René M. Thériault, Julie   Lucas-Picher, Philppe
UQAM
mattedominic3@gmail.com
In regional climate modelling, it is well known that domains should be neither too large to avoid large departure from the driving data nor too small to provide sufficient distance from the lateral inflow boundary to allow a full development of the small-scale features resolved by the finer resolution. Although practitioners of dynamical downscaling are well aware that the jump of resolution between the driving data and the nested regional climate model impacts the simulated climate, this issue has never been properly studied. In principle, the bigger is the jump in resolution, the larger is the distance from the lateral inflow boundary to fully develop the small-scale features permitted by the increased resolution. Misplaced domain lateral boundaries might result in an inefficient use of the full potential of finer resolutions to develop fine-scale features.In our study with a regional model grid mesh of 0.15°, we compare results with driving data at 3.6°, 1.8°, 0.45° using the perfect-prognostic Big-Brother protocol. The results show that the small-scale transient eddies struggle to completely develop with coarser resolutions of the driving data. Overall, this study suggests that domain location must be chosen according to the jump of resolution to allow the optimal development of small-scale features allowed by the increased resolution of the nested model.

Session 30201 - Regional climate modelling and diagnostics - Part 2
Energy conversions in a rapid intense storm developing over mid-latitude area
Nikiema, Oumarou Laprise, René
UQÀM / CMOS
oumarou.nikiema@uqam.ca
In a changing climate, extreme weather and climate events will change in their frequency, duration, spatial extent and intensity (IPCC). The scientific community seems to agree that we are already living the effects of climate changes. It is, therefore, important to pay a particular attention on atmospheric energy conversions taking place during a rapid development of intense storms. Regional Climate Models (RCM) are known to be a good tool that can be used to study the impacts of climate changes at regional scales. Using data from a simulation performed with the fifth-generation Canadian RCM over the east part of North America, we analyse the energy conversion associated with the formation and development of an intense storm that occurred during the winter season. Our results reveal that the storm intensification is linked to baroclinic

conversion processes. Our study reveals that the rapid growth of an intense storm is associated to simultaneous growth of the total potential energy and perturbation kinetic energies, according to the thermal wind balance prevailing at synoptic scale. For different climate change scenarios, such studies can be done to better understand the baroclinic energy conversions in intense storms at regional and synoptic scales.

Session 30201 - Regional climate modelling and diagnostics - Part 2
Regional Climate Modelling of the Arctic Ocean ecosystem
Steiner, Nadja Sou, Tessa
Institute of Ocean Sciences (DFO) and CCCma (EC)
Nadja.Steiner@canada.ca
The presentation will describe the development and results of a higher resolution biogeochemical model based on NEMO-LIM for ocean climate projections in the Arctic. The model is forced with output from the Canadian Regional Climate Model (CanRCM4) for the CORDEX Arctic domain. Results highlight potential climate change impacts on Arctic marine ecosystems, such as changes in primary production and ocean acidification.

Session 30300 - Climate Services and Monitoring - Part 1
Snow Water Equivalent: Do we have the information we need for standards and risk assessment?
Abraham, Jim Auld, Heather
Climaction Services
abraham.jd@hotmail.com
The Maritime Provinces experienced a severe winter in 2015, with over 300cm of snow in just the months of February and March. During these two months, there were also several winter storms with mixed precipitation. The outcome was a snow load with very high snow water that resulted in significant roof damage, likely in the tens of millions of dollars.This presentation will examine the events and examples of significant roof damage. Snow water equivalent data from the volunteer Cocorahs network will be compared with the building codes for snow load. Discussion will examine the need for good snow water equivalent data to: enable updated building codes; and to alert property owners, the insurance industry and emergency managers of excessive snow loads and associated risk of roof collapse.

Session 30300 - Climate Services and Monitoring - Part 1
Development of weather vigilance tools at the Meteorological Service of Canada
Beauchemin, Marc
Meteorological Service of Canada
marc.beauchemin@canada.ca
In order to better prevent the population of the risks related to weather, the MSC is testing an approach called weather vigilance. This approach integrates observations with forecasts,

integrates physical variables between them and integrates time scales. Indeed, the risks linked to forecasted events depend not only on characteristics of these events, but also on the present state of the environment which, in turn, depends on past conditions, recent and less recent. Further, risks can result of the combination, or synergy, of many minor conditions which, taken separately, do not present any risk. Finally, risks can occur from the superimposition of different time scales. It is, thus, important to integrate past, present and future conditions, as well as the synergy of variables, in order to assess future risks. This talk/poster will present some of the tools developed to support this approach.

Session 30300 - Climate Services and Monitoring - Part 1
Early Toronto Temperatures
Devine, Kenneth
consultant
ken.devine@sympatico.ca
While the longest continuous temperature record in Canada began in 1840, a total of almost seven thousand temperature readings were taken in Toronto during the prior decade of the 1830s by Reverend Dade of Upper Canada College. These observations were taken at the center of the city, in an environment which was almost rural at that time. The validity of these reading will be discussed as will the major problems concerning early temperature readings before national networks were established.

Session 30300 - Climate Services and Monitoring - Part 1
Constructing hourly temperature-wind scenarios for the Hudson Bay area: challenges and method.
Grenier, Patrick
Ouranos
grenier.patrick@ouranos.ca
A climate scenario is typically constructed by merging information from an observation-based product and a numerical climate model simulation. The former sets some of the statistical properties of the climate scenario over a recent-past reference period, while the latter dictates long-term trends of the same or other statistical properties. Such procedure also often addresses the mismatch in spatial or temporal resolution between available products and needed scenarios. Moreover, users often need several variables, which raises the issue of physical coherence. Here a specific case study is used to illustrate some of the challenges faced by providers of climate services when connecting user needs with scientific data. The objective here is to build plausible scenarios for surface temperature (T_2m) and wind components (u_10m, v_10m) at an hourly resolution and over the Hudson Bay area during 1979-2100. CFSR reanalysis are used as the observation-based reference product (1979-2010). This is a defensible choice, but as the region is poorly covered with in situ data, there is no guarantee of a perfect match with the climatology really experienced. Moreover, hourly resolution of the product is appealing, but the diurnal structure is found to present non-realistic climatic peaks near 0, 6, 12, and 18 UTC, suggesting assimilation-based artifacts. The challenge of designing a meaningful method for constructing

climate scenarios also includes obtaining plausible spatial and inter-variable correlations, and covering the uncertainty in the long-term change.

Session 30300 - Climate Services and Monitoring - Part 1
Probabilities for future greenhouse gases emission scenarios
Huard, David
Ouranos
david.huard@gmail.com
Users of climate projections are increasingly asking about the likelihood of the different greenhouse gases (GHG) emission scenarios driving climate model simulations. For example, CMIP5 simulations use one of four scenarios called Radiative Concentration Pathways (RCP), RCP2.6, RCP4.5, RCP6.0 or RCP8.5, and a recurring question is Which one is more likely? Although the answer to this question is well outside climate science, climate service providers should have a better answer than a bland we dont know. Here we use emission trajectories generated by a simple global socio-economic model to estimate time-dependent posterior probabilities for the four RCPs. This analysis suggests that until 2040, RCPs are, within uncertainties, nearly equiprobable. Further out into the future, the socio-economic model assigns the highest probability to RCP6.0, followed by RCP4.5, 8.5 and 2.6.

Session 30300 - Climate Services and Monitoring - Part 1
Assessment of Environment and Climate Change Canadas Surface Precipitation Observations
Mekis, Eva Donaldson, Norman Hoover, Jeffery Reid, Janti Zucconi, Alex Nitu, Rodica Melo, Stella
Environment and Climate Change Canada
eva.mekis@canada.ca
The objective of the presentation is to provide a brief summary of the present state of precipitation observations on the ground (2-D precipitation) within Environment and Climate Change Canada (ECCC). The focus of the presentation is precipitation intensity, accumulation, snowfall and radar reflectivity. Each observational field is described by spatial (horizontal) resolution, frequency of observation, data timeliness, accuracy and data format.First, the applications and user requirements are identified for the studied variables using the WMO Observing Systems Capability Analysis and Review Tool (OSCAR) tool and with requirement summaries by the Storm Prediction Centres concerning severe weather, NWP, Climate Research and Services and the Weather Radar user community. The precipitation monitoring networks are summarized including ECCC Automatic Stations, Aviation Monitoring Stations, Partner Stations, Volunteer Climate Stations and the Canadian Weather Radar Network. In order to understand possible gaps, the period of observational records and the frequency of reporting of the existing networks are also reviewed. Existing precipitation-related data and quality control processing is cataloged. A detailed summary of the data processing path of surface and radar observations, from data collection to data archive, is also given. After processing, all surface data are sent to the Digital Archive within an hour. For radar, observations arrive within about 1

minute of the end of collection and then data products are completed to be distributed for display or as numerical products. Existing gaps from the point of view of previously defined user requirements are considered. The presentation concludes with recommendations concerning the surface precipitation observations and the impact of potential future increases and/or improvements to the measurement and data quality of these observed fields.

Session 30301 - Climate Services and Monitoring - Part 2

The challenges of calibrating a site-specific wind gust forecast in the built up environment with on-site observations.

Chapman, Ron Young, Jim Gibbons, Mike
RWDI
ron.chapman@rwdi.com

An automatic computer modeling system has been developed that provides site and height specific wind gust forecasts for construction sites and structures. The wind gust system combines the output from numerical weather models with the science of wind engineering and complex aerodynamics. Wind gusts are important to the construction industry as downtime due to winds can lead to project delays and create site safety issues once construction material becomes wind borne. Predicting the intensity and timing of wind gusts accurately in a urban, built up environment is challenging and there is a desire to have predictions calibrated with onsite instrumentation. This presentation will focus on work that has been done to date on calibrating predicted wind gusts that are based on model output with on-site observations.

Session 30301 - Climate Services and Monitoring - Part 2

Identification of alert thresholds for heat waves in Canada from evidence-based data: historical and future climate perspectives

Gachon, Philippe Bussières, Louise   Gosselin, Pierre Raphoz, Marie Bustinza, Ray Martin, Philippe Dueymes, Guillaume Gosselin, Denis Labrecque, Sylvain Jeffers, Sharon Yagouti, Abderrahmane
Centre ESCER, Université du Québec à Montréal
gachon.philippe@uqam.ca

There is no universal definition of heat wave or extreme heat. Most definitions refer to a period of time (usually several consecutive days) of exceptionally warm weather conditions that can potentially cause harm to human health. In practice, the term heat wave applies to a wide range of weather conditions, especially in terms of daytime temperatures or other jointly occurring factors such as temperature at night, humidity thresholds or episodes of air pollution. In order to be useful and relevant, these alert thresholds cannot be uniform and must be able to adapt to the local climate and human context. By using various combined criteria of maximum and minimum temperatures, as well as air humidity values for three consecutive days (from thresholds used in mortality/morbidity study), we evaluate with historical observed data the extent and magnitude of such heat waves across Canada. Such series are rarely observed in the actual climate in Canada. However, the frequency of heat waves of this type will increase, especially in the second half of the 21st century in southern Québec, Ontario, Manitoba and Saskatchewan, according to

available regional projections (based on ensemble simulations of different regional climate models). We can expect the number of occurrences of these events to double by the end of the 21st century, that is, one or two events a year on average in the future climate with respect to current conditions. The negative effects on health caused by these extreme heat events in Canada will then be potentially intensified in the context of increases in the aging population and urbanization with the associated urban heat island effects. In this context, the inclusion of appropriate thresholds and criteria, including meteorological and health data, in existing and future warning systems can be crucial to deal with these new climate and socio-demographic realities.

Session 30301 - Climate Services and Monitoring - Part 2

A Digital Ecosystem for Climate Services

MacLellan, James Gachon, Philippe Chiotti, Quentin Edwards, Jason Sparling, Erik
University of Toronto Scarborough Campus
jim.maclellan@utoronto.ca

Improving the adaptive capacity of Canadians to climate change is inherently challenging given the vast range of potential impacts, the scientific uncertainties involved, the heterogeneous nature of how impacts are experienced, the extensive array of adaptation options, the difficulties in fostering adaptive innovations, and the long planning horizons involved. This challenge is further complicated by the dynamic nature of knowledge, and the gaps that exist between researchers and the intended users of knowledge. To meet these challenges, we seek to create conditions that facilitate the production and the utilization of actionable knowledge. This broad mandate requires the integration of numerous system components that have the potential to interact in complex and unpredictable ways. Under such requirements, the development of a definitive planning system seems unlikely to succeed; instead, a dynamic, emergent, opportunistic, and reflexive approach appears warranted. The challenge is how to develop it.We adopt the digital ecosystem concept popularized by Steve Jobs (Businessweek 2007) to examine the information needs associated with climate services (MacLellan 2012). The general idea is that content emerges through the reinforcing interaction of system components to create an open and flexible architecture. A digital ecosystem transcends the traditional, rigorously defined, collaborative environments from centralised, distributed or hybrid models into an open, flexible ? demand-driven, interactive environment of ? collaborative environments(Boley and Chang 2007). The challenge then, is not simply the provision of online data and tools but the creation of a knowledge environment that evolves to meet users needs. To explore this challenge we have gathered a range of experts associated with the development, delivery and utilization of climate change vulnerability tools. Adopting Hendryxs (2005) framework we explore conditions within Canada that support the utilization of these assessment tools. Nascent examples are provided which could provide the foundations of a climate knowledge ecosystem.

Session 30301 - Climate Services and Monitoring - Part 2

Considering adaptation to climate change as a timescale problem : examples from tourism industry

Paquin, Dominique Logan, Travis de Elia, Ramon Bleau, Stéphanie
Ouranos
paquin.dominique@ouranos.ca

As climate change adaptation is increasingly discussed and becoming a mainstream concept, different kinds of users are asking themselves if and when they should develop an adaptation strategy, often not knowing where to begin. Climate experts, on the other hand, have access to an enormous amount of data that could be useful to users but often do not know how to translate it into something practical. Both users and experts can be connected through two timescales, the system lifespan and climate vulnerability. While the system lifespan relies on the users estimation of planning timeframe, the climate vulnerability is estimated from climate model projections and observations. We propose a simple tool to relate user and climate expert knowledge by combining the two timescales. To be reliable, the interconnection implies a dialogue to identify sensitive climate variables that will impact the system and provide a measure of the impact. Climate data can then be used to locate the system on a simple graph nd help the users to position themselves about the urgency of adaptation. The concept has been presented to the tourism industry, and applied for ski resorts in Québec, which will be showcased in this presentation.

Session 30301 - Climate Services and Monitoring - Part 2

A Brief Review of the Environment Canada Rainfall Intensity-Duration-Frequency (IDF) Package

Yau, Ka-Hing Shephard, Mark Kilcup, Karen
Environment Canada
kahing.yau@canada.ca

Environment Canada provides short-duration rainfall intensity statistics for supporting infrastructure design and water management. The basic IDF information is provided in files containing the IDF tables and graphs. It includes the frequency of extreme short-duration (5 minutes to 24 hours) rainfall rates and amounts for various return periods ranging from 2 to 100 years. Diagnostic statistical plots are included for assessing the goodness of the extreme value analysis. An IDF locator application is offered in the package for conveniently retrieving the IDF information for any location. In this presentation, we will elucidate the EC method of producing IDF information. The quality control process of Tipping Bucket Rain Gauge data will be illustrated with examples. The use and interpretation of the IDF tables and curves will be demonstrated. EC has undertaken steps in rescuing stranded TBRG data. Potential for improving the IDF quality and expanding the dataset will be discussed

Session 30400 - Agroclimatic Extremes- past, present and future

Adapting to Climatic Extremes and Variations that affect Western Canadian Grain Production

Garnett, Ray Khandekar, madhav
Agro Climatic Consulting
edmgar1@mymts.net

The economic benefit of Canadian prairie grain is conservatively estimated at 25-40 billion dollars a year. Severe droughts have affected the prairie and national economy. The droughts of 2001 and 2002 reduced Canadas national GNP by $5.8 billion. In 2010 waterlogged farmers received $450 in aid when the May-July growing season brought the biggest rains in 60 years reducing the spring wheat area to the lowest since 1971. The 2009 growing season was the coldest in 65 years coinciding with lowest the solar activity in 95 years (2 sunspots/month). A 1.5ºC. a cooling trend is seen in mean summer temperatures between 1985 and 2015. Preliminary research shows that the cooling is greatest in May and that extremely cool Mays have reduced the prairie canola area by 10% (0.8 mln ha). A certain soil temperature threshold at this time is required to promote germination and early growth. With a short growing season of about 96 calendar days (1080 growing degree-days are required to bring spring wheat to maturity) late and early growing season frosts are often problematic. This research identifies several climatic drivers as posing a risk to future agricultural production on the Canadian prairies. An effort is made detect their recent effects at the level of sub regions or zones. A cursory look is also taken of trends in seasons other than the summer growing months. Finally a suggestion is made as to how these drivers can be expected to behave in the next 5-10 years.

Session 30400 - Agroclimatic Extremes- past, present and future

Examining the impact of trends and variability in effective growing degree days and precipitation patterns (1951-2010) on Land Suitability Ratings for Brome in the Whitehorse region.

Gasser, Pierre-Yves
Agriculture and Agri-Food Canada
pierre-yves.gasser@agr.gc.ca

The Land Suitability Rating System (LSRS) is a spatial modeling tool that generates a class rating for individual parcels of land for specific agricultural field crops based on a soil-climate-landscape interactions. LSRS draws information from the Canadian Soil Information Service (CANSIS) soil name and layer tables, a crop parameter table and monthly normal temperature and precipitation values to generate a land rating from class 1 (fully suitable) to class 7 (unsuitable). The system has traditionally been used to evaluate land suitability under current climate conditions using 30 year climate normals for max / min temperatures and precipitation. Using climate data as the input into the Climate Indices Tool (CIT),a series of value added climate indices such as growing season start (GSS), growing season end (GSE) and effective growing degree days (EGDD) are calculated. These in turn are used to generate a climate rating, alongside two other factors (soils and landscape) to determine crop suitability. Recent development work at Agriculture and Agri-Food Canada allows the CIT to run on a daily time step instead of monthly, thus allowing the assessment of detailed year to year climatic variability. Sixty years of gridded daily climate data were used to show how EGDD have changed over this time period. Statistical tests were used to examine year to year GSS, GSE and EGDD variability. Maps showing EGDD class boundaries indicated a gradual improvement over time. Finally suitability maps for brome showed a gradual improvement due to increased accumulation of EGDD values.

Session 30400 - Agroclimatic Extremes- past, present and future

Extreme weather effects on Agriculture: The effect of changing weather patterns on farming operations.

MacDonald, Dan Waldick, Ruth Mitchell, Scott
Agriculture and Agri-Food Canada
Dan.MacDonald@agr.gc.ca

Climate dictates the types of agriculture that takes place in a given landscape. Precipitation patterns and amount and timing of heat units are key to what types of crops are grown and their relative productivity. Farmers have developed operational patterns over time to best take advantage of weather patterns in their regions. Climate change impacts those patterns and changes the frequency and severity of weather events. These extremes affect farming operations. This research looks at the effects of weather extremes on agricultural systems in Eastern Ontario. Daily precipitation and temperature data is inputted into a farm model that tracks daily farming operations as well as crop development on 22 farm types. This presentation will discuss the resulting effects on agricultural production on those farms.

Session 30400 - Agroclimatic Extremes- past, present and future

Phenological responses of dryland wheat and maize to changes in crop management and rising temperatures from 1992 to 2013 across the Loess Plateau

Mo, Fei Ma, Baoluo Xiong, Youcai
Lanzhou University; Ottawa Research and Development Centre, AAFC
Fei.Mo@AGR.GC.CA

The observed historical changes in crop phenological events are not only as a reaction to temperature variations but also the consequence of crop management such as adjustment of sowing date, cultivar selection and innovative farming practices. Clarifying how these factors influence crop phenology is of paramount importance in understanding/implementing adaptation strategies to future climate change. Changes in phenophases of dryland wheat and maize were investigated using the observed phenological data from 1992 to 2013 across the Loess Plateau. Along with significant temperature increases of 0.67 and 0.15 ?C decade-1 for wheat and maize growing season, respectively, the observed dates of sowing, heading and maturity were delayed by 3.0, 0.3 and 1.6 days decade-1 in wheat, while advanced by 1.3, 4.1 and 2.7 days decade-1 in maize. The reproductive growth phase was prolonged by 1.3 days decade-1 for wheat and 1.4 days decade-1 for maize, despite of the shortened vegetative growth phase and the whole growing season length for both crops. Using a series of phenological growth models, we illustrated that once the varietal effect was fixed, rising temperature alone produced a general advancement on dates of heading and maturity, leading to a significant shortening of the vegetative phase (5.2 days decade-1 in wheat and 1.1 days decade-1 in maize), and a shortened

duration of the reproductive phase (0.9 and 2.0 days decade-1 respectively) and the whole growing season length (6.1 days decade-1 in wheat and 3.0 days decade -1 in maize). Cultivar shifts prolonged the reproductive duration and the growing season length by 2.2 and 4.7 days decade-1 for wheat, and 3.3 and 1.5 days decade-1 for maize, respectively. The continuous change of cultivars during the past two decades has offset 63.5% of the shortening effect of growing season length caused by rising temperature for both crops. Our data indicate that adjusting sowing date and shifts to longer season cultivars are the critical management strategies for coping with temperature increases in dryland wheat and maize in the Loess Plateau or regions with similar environments.

Session 30400 - Agroclimatic Extremes- past, present and future

Can artificial intelligence and machine-learning algorithms improve extreme weather agricultural risk assessment?

Newlands, Nathaniel Chipanshi, Aston
Environmental Health, Agriculture and Agri-Food Canada
nathaniel.newlands@agr.gc.ca

The agricultural sector is highly vulnerable to a wide range of weather-related risks/threats/hazards having both transient and lasting, cumulative impacts on crop and livestock production (e.g., hail, spring frosts, excessive rain, flooding, drought and heat waves). Risk response decision-making and actions, in the future, are anticipated to become more complex and diverse, as new threats emerge. This will increasingly challenge our ability to respond to weather-related risks in an informed, effective and timely way. In particular, greater consistency, and complementarity in the use of indicators and application of operational modeling frameworks may help strengthen and promote broader coordination in risk assessment and regional disaster response. Currently, extreme indicators vary in their suitability and accuracy, so there is a need to better understand the relative impacts and changing types and levels of risk within different geographic areas and farming systems. This talk will provide an overview of modeling that is focused on advancing our understanding of the potential integrated impacts of extreme events within the context of different farming systems (e.g., horticultural, semi-arid/dryland rain fed, irrigated, continental, livestock grazing/rangeland, mixed crop-livestock enterprises). I will discuss how machine-learning embedded within an index-based modeling framework may significantly reduce model complexity; help to better identify nonlinear causally-linked patterns in data, thereby reducing uncertainty in geospatial risk prediction. This work, over the longer term, aims to inform field-level decision making/precision agriculture, regional-scale weather index-based insurance design, and enhance national-scale, bio-economic modeling that supports agricultural disaster relief and policy response to agricultural commodity market fluctuations.

Session 30400 - Agroclimatic Extremes- past, present and future

Extreme weather events and agriculture: identifying and characterizing key impacts to corn and soybeans at the regional scale

Zaytseva, Anna Mitchell, Scott Waldick, Ruth MacDonald, Dan
Carleton University
anna.zaytseva@glel.carleton.ca

Climate change is having an impact on the frequency and severity of extreme weather events such as heat waves, droughts, high intensity storms and flash floods. As their frequency increases, extreme events are expected to adversely affect crop yields and increase the vulnerability of agricultural producers to climate change. This research characterizes climate extremes in eastern Ontario in relation to corn and soybean productivity and examines how the frequency and spatial distribution of these events are expected to change in the future. Eleven locations in eastern Ontario have been selected to represent distinct ecological districts within the region. Daily temperature and precipitation data are used to calculate extreme weather indices as well as production effect indices related to specific crop growth stages. Climate data include daily infilled weather station records as well as high resolution statistically downscaled projections for a subset of general circulation models used in fifth phase of the Climate Model Intercomparison Project (CMIP5). This presentation will focus on discussing crop vulnerabilities to extreme events and provide data on past and projected changes in the frequency, duration and magnitude of these events in eastern Ontario.

Session 30500 - Progress in Developing Uncertainty Estimates for Gridded Climate Data

How well do gridded datasets of observed daily precipitation compare over Australia?

Contractor, Steefan
UNSW Australia
stefan.contractor@gmail.com

Daily gridded precipitation data are needed for investigating spatiotemporal variability of precipitation, including extremes; however, uncertainties related to daily precipitation products are large. Here, we compare a range of precipitation grids for Australia. These datasets include products derived solely from in situ observations (interpolated datasets) and two products that combine both remote sensed data and in situ observations. We show that all datasets have similar climatologies and similar spatial patterns on a broad scale, albeit regional differences exist. Our results, however, point to distinct structural uncertainties between those datasets gridding in situ observations and those datasets deriving precipitation estimates primarily from satellite measurements. We also show a large spread in the upper quantiles between the various datasets compared, indicating that substantial uncertainty exists in gridded precipitation extremes over Australia.In order to account for the above uncertainties in the future, we plan on using multiple data sets of gridded daily rainfall to account for structural uncertainties from varying interpolation methods. Other uncertainty estimates such as Kriging error, the Yamamoto standard deviation and estimates of station density at each grid cell will also be included.

Session 30500 - Progress in Developing Uncertainty Estimates for Gridded Climate Data
Quantifying uncertainty in the E-OBS dataset using an ensembles approach
Cornes, Richard van den Besselaar, Else Jones, Phil van der Schrier, Gerard Verver, Ge
KNMI
cornes@knmi.nl
E-OBS is a widely used gridded dataset that provides high-resolution, daily data from 1950 to present-day across Europe and is constructed by interpolating the station data contained in the ECA&D database. A measure of error is included in the gridded dataset that aims to provide an estimate of the uncertainty of the daily interpolated values at each grid-box. This uncertainty estimate is mainly a function of the density of the input station data and is particularly important since the quantity of these data vary spatially and temporally; this has a large effect on the reliability of the gridded data. However, the uncertainty measure currently provided in E-OBS remains one of the least-used components of the dataset by end-users. The uncertainty estimate currently provided in E-OBS is based on a combination of standard errors derived from the climatological thin-plate splines and standard errors calculated for each daily value from kriging variance. In this paper we present an alternative way of quantifying uncertainty in the E-OBS dataset for the three temperature variables (maximum, minimum and mean daily temperature) and precipitation using a multiple realization (ensemble) approach. The established E-OBS gridding method is retained but an ensemble of grids is produced using conditional stochastic simulation. This approach fits well within the existing E-OBS gridding framework and produces a measure of uncertainty that should be of more use to data users than the existing estimate.

Session 30500 - Progress in Developing Uncertainty Estimates for Gridded Climate Data
Effect of varied weather data inputs on hydrological modelling of a humid continental agricultural watershed in southern Ontario
Hanke, Karl Macrae, Merrin Michaud, Aubert Merkley, Craig   McKague, Kevin
University of Waterloo, Department of Geography and Environmental Management
khanke@uwaterloo.ca
The Soil Water Assessment Tool (SWAT) is a basin-scale, mixed (process and empirical) model that relies heavily on quality data inputs to simulate hydrological and biogeochemical processes. This study evaluates the performance of the SWAT model in the Medway Creek Watershed (200 km2), a subwatershed within the Thames River Watershed in Ontario, Canada, which discharges into Lake St. Clair and eventually Lake Erie. The objectives of the study were to (1) parameterize and calibrate the SWAT model for the Medway Creek Watershed, and (2) evaluate the sensitivity of the model hydrologic output to differences in climate data source. The Medway Creek watershed is heavily farmed (83%) and tiles drains make up a large portion of the farmed area (65%). The climate data is especially important in the simulations because it drives all of the other processes that occur within the model. Of the 4 different simulations, all had a daily time-step and used: 1) Generated 40 km resolution climate data created by National Centers for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR), 2) SWATs weather data generator based off Environment Canadas weather data from their London International Airport, Ontario site (81°0904.000 W, 43°0159.000 N), 3) Natural Resource Canada (NRCAN) 10 km resolution data interpolated using trivariate thin-plate spline smoothing algorithms. 4) Ontario Ministry of Natural Resources (MNR) climate station data, temporally

gap filled by Schroeter and Associates. The 4 simulations were evaluated using the Nash-Sutcliffe coefficient (NSE), the coefficient of determination (R2), the ratio of the root mean square to the standard deviation of the observed data (RSR), and the percent bias (PBIAS). The purpose of this study was to provide insight into the best weather dataset to use for reducing uncertainties in model parameters when modelling the impacts of climate and land use on watersheds within southern Ontario.

Session 30500 - Progress in Developing Uncertainty Estimates for Gridded Climate Data

Quantification of uncertainties in modelling the present and projected hydrology of the Fraser River Basin, British Columbia

Islam, Siraj ul Déry, Stephen J.
University of Northern British Columbia
sirajul.islam@unbc.ca

While the advance in computational power and the ongoing developments in hydrological modelling have increased the significance and accuracy of hydrologic simulations, the issue of adequately addressing the associated uncertainty remains challenging. This study focuses on the quantification of predictive uncertainties in the hydrology of the Fraser River Basin (FRB) of British Columbia (BC), using the Variable Infiltration Capacity (VIC) model forced with four different gridded climate data sets covering 1979-2006 time period. Uncertainties are quantified at different stages starting with the driving datasets and model parameters. Furthermore, uncertainties are investigated in the projected hydrological response of the FRB using VIC simulations forced by statistically downscaled forcing datasets of Global Climate Model (GCM) runs. Systematic differences in the simulated runoff are identified by comparing VIC simulations driven with different input datasets. High uncertainty corresponding to selection of forcing data is seen for the datasets with greater precipitation difference especially in mountainous sub-regions of the FRB. Parametric uncertainty in the VIC calibration process, reflecting the inability to specify exact values of model parameters due to finite length, are evaluated with two different models setups. Choice of the initial parameter range during the calibration process is found to play a crucial role in defining the model hydrological response for the FRB. Varying the spatial resolution in the VIC simulations reveals more refined spatial patterns of mountainous snowpacks and associated runoff in high versus low-resolution simulations whereas the streamflow response remains more of less similar in both model integrations. Wide ranges of projected changes in FRB hydrograph are seen for different sets of driving GCMs owing to their internal variability in temperature and precipitation.

Session 30500 - Progress in Developing Uncertainty Estimates for Gridded Climate Data

Development and Application of a Station Based Gridded Ensemble Precipitation and Temperature Dataset over the Contiguous United States

Newman, Andrew Clark, Martyn Huang, Chengcheng Prein, Andreas Craig, Jason Nijssen, Bart Wood, Andrew Gutmann, Ethan Mizukami, Naoki Brekke, Levi Arnold, Jeff NCAR
anewman@ucar.edu

Gridded precipitation and temperature products are inherently uncertain due to myriad factors. These include interpolation from a sparse observation network, measurement representativeness, and measurement errors. Generally, uncertainty is not included in gridded products of precipitation or temperature; if it is present, it may be included in an ad-hoc manner. A lack of quantitative uncertainty estimates for such hydrometeorological forcing fields limits their utility to support land surface and hydrologic modeling techniques such as data assimilation, probabilistic forecasting and verification.To address this gap, we have developed a first of its kind gridded, observation-based ensemble of precipitation and temperature at a daily increment for the period 1980-2012. Statistical verification of the ensemble indicates it provides generally good reliability and discrimination of events of various magnitudes, but has a small dry bias for high probability events. The ensemble mean is similar to other widely used hydrometeorological datasets (e.g. Maurer et al. 2002) but with some important differences. The ensemble product is able to produce an improved probability-of-precipitation field, which impacts the empirical derivation of other fields (e.g. surface shortwave radiation) used in land-surface and hydrologic modeling.Example applications of the ensemble will also be presented. The ensemble and the underlying techniques can be used for snow water equivalent (SWE) data assimilation via the Ensemble Kalman Filter (EnKF) for seasonal streamflow prediction. Additionally, the ensemble is being used to verify dynamically downscaled regional climate simulations using the Weather Research and Forecasting (WRF) model. Use of the observation ensemble allows for identification of regions where WRF lies within observational uncertainty, or conversely, identifies regions where WRF is highly likely to be performing poorly.

Session 30500 - Progress in Developing Uncertainty Estimates for Gridded Climate Data
Assessment of model-derived precipitation products over Canada
Wong, Jefferson Razavi, Saman Wheater, Howard
University of Saskatchewan
jefferson.wong@usask.ca
Model-derived precipitation products with a reasonably fine spatio-temporal resolution are becoming increasingly more available, and given the challenges in Canada of sparse ground-based networks and solid phase precipitation measurement, these may play an important role in helping to meet the needs of climate scientists, hydrologists, and other decision-makers. Many of these model-derived products have recently been developed based on a composite of different sources including satellite estimates, radar, reanalysis data, and model simulations but their error characteristics have not yet been fully examined and understood. Thus, a comprehensive evaluation is undertaken in this study in which several high-resolution, model-derived precipitation datasets are compared and assessed over Canada from 1979 to 2012 against a gauge-based precipitation product. An error component analysis is conducted to decompose the errors into three independent components, namely the hit bias, miss precipitation, and false precipitation, to better track the error sources associated with the methods of combing different information. The errors components are investigated over different seasons, temporal accumulations, and drainage basins. This study aims to provide potential users of these precipitation products with information on the accuracy of such estimates, and to contribute to the characterization of satellite precipitation errors which is fundamental to applications in uncertainty analysis and environmental modeling.

Session 30600 - Climate-carbon cycle interactions

The effect of biogeochemical and thermal equilibration on the zero-emission warming commitment

Ehlert, Ines Dana Zickfeld, Kirsten
Simon Fraser Univeristy
dehlert@sfu.ca

It has been shown in previous studies that warming persists for several centuries and even continues to increase in some climate models after emissions are set to zero. The question of what determines the magnitude of the residual climate change once emissions cease arises. In this study we focus on the timing of zeroed emissions, which means the effect of equilibration of the climate system on residual climate change is investigated. The University of Victoria Earth System Climate Model (Uvic ESCM 2.9) is forced with idealized scenarios of 1% annual increase in atmospheric CO2 until doubling and quadrupling of the preindustrial CO2 concentration and with the Representative Concentration Pathways (RCPs). After year 2300 in the RCPs or reaching doubling and quadrupling of atmospheric CO2 in the idealized scenarios, the CO2 concentrations are held constant and emissions are zeroed in 100 year intervals. Generally, heat and carbon fluxes decline while atmospheric CO2 concentrations are constant and decline further once CO2 emissions cease, i.e. the system equilibrates. In all simulations we find that the rate of decline of ocean heat flux diminishes less strongly than the rate of decline of land and ocean carbon fluxes the later emissions cease. This implies that the thermal part of the climate system equilibrates more slowly than the biogeochemical part. The residual temperature change is always positive but declines the later CO2 emissions are set to zero. This indicates that the effect of declining ocean heat flux, which leads to an increase in temperature, dominates over decline in atmospheric CO2, which leads to a decrease in temperature, once CO2 emissions cease.

Session 30600 - Climate-carbon cycle interactions

Cumulative carbon emissions budgets consistent with 1.5°C warming

Gillett, Nathan Tokarska, Kasia
Canadian Centre for Climate Modelling and Analysis, ECCC
nathan.gillett@ec.gc.ca

The recently-signed Paris Agreement mandates signatories to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels. Is limiting global warming to 1.5°C possible, given what we know about the physical climate system and plausible emissions scenarios? The median simulated cumulative CO2 emissions budget consistent with 1.5°C warming of 620 GtC reported in the IPCC Fifth Assessment Report is only 50 GtC above the best estimate of emissions to date of approximately 570 GtC. However, this emissions budget was derived from the RCP 8.5 scenario which has higher non-CO2 forcings as a function of cumulative emissions than the RCP 2.6 scenario which is more consistent with a 1.5°C warming target. Deriving this budget from RCP 2.6 and weighting of models using an observational constraint on the Transient Climate Response to Emissions increases this budget significantly.

Overall we conclude that while limiting warming to 1.5°C would be challenging, it remains possible.

Session 30600 - Climate-carbon cycle interactions

Quantifying the impact of non-CO2 forcings on cumulative carbon budgets using an Earth System Model

Tokarska, Katarzyna B Gillett, Nathan P Lee, Warren G Zickfeld, Kirsten
University of Victoria
tokarska@uvic.ca

Carbon emission budgets for particular warming thresholds were reported in the IPCC Fifth Assessment Report based firstly on the climate effects of carbon dioxide alone, and secondly under the assumption that non-CO2 forcings evolve as in RCP 8.5. The non-CO2 forcings have a net warming effect in RCP 8.5 and the cumulative emissions budgets consistent with particular warming thresholds are hence lower. It is typically assumed that the effect of the non-CO2 forcings on cumulative carbon budgets in the prescribed-concentration RCP 8.5 simulations is simply to increase the warming in a given year, but these non-CO2 forcings are also expected to reduce the carbon uptake by sinks through their climate effect. Here we quantify these effects by comparing warming, carbon uptake by the ocean and terrestrial carbon sinks, and diagnosed cumulative emissions in prescribed-concentration RCP 8.5 simulations of CanESM2, with that in a similar set of simulations in which only CO2 varies. Based on this analysis we discuss the relative importance of the direct temperature effect and carbon cycle effect of the non-CO¬2 forcings on cumulative emissions budgets.

Session 30600 - Climate-carbon cycle interactions

Symmetry of the climate-carbon cycle response to CO2 emission pulses

Zickfeld, Kirsten Azevedo, Deven
Simon Fraser University
kzickfel@sfu.ca

It is often assumed that the climate-carbon cycle response to a CO2 emission reduction is equal in magnitude and opposite in sign to the response to a CO2 emission increase. Deviations from this symmetry, however, could arise due to dependence of the carbon cycle and climate response on the background atmospheric CO2 concentration. Here we use the University of Victoria Earth System Climate Model (UVic ESCM) to explore the symmetry of the climate-carbon cycle response to positive and negative CO2 emissions. To this end, the UVic ESCM is forced with positive and negative CO2 emissions pulses of varying size (100 PgC, 500 PgC, 1000 PgC) and applied from different climate states (2x and 4x the pre-industrial atmospheric CO2 concentration). Our results suggest that for pulses applied from a climate state in equilibrium with 2xCO2 the change in atmospheric CO2 is larger and rebounds more quickly for negative than for positive pulses. This asymmetry is largely due to asymmetry in land CO2 uptake. For pulses applied from a climate state in equilibrium with 4xCO2, the asymmetry in the atmospheric CO2 response is less pronounced. The reason is that the land carbon sink is saturated, and its response to positive and negative CO2 emission pulses is muted. Despite the faster rebound of the atmospheric CO_2 concentration for negative emission pulses, the cooling following a negative emission pulse is larger than the warming following a positive emission pulse. This asymmetry in the temperature response is likely due to the logarithmic dependence of temperature on atmospheric CO_2.

Session 30700 - Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 1

What were the drivers of the Polar Vortex winters of 2013/14 and 2014/15?

Kushner, Paul Watt-Meyer, Oliver
University of Toronto, Department of Physics
paul.kushner@utoronto.ca

A key challenge of event attribution is to elucidate physical factors that control extreme climate events. In this context, we analyze the cold Polar Vortex winters of North America of 2013/14 and 2014/15. We find that these winters featured distinctive fast (weekly timescale) and slow (multiple week timescale) dynamical drivers. Ridge-trough circulation patterns that are strongly linked to wintertime temperature extremes in eastern North America can be decomposed into standing and travelling wave components. The standing component is connected to the deep subtropics in the eastern Pacific while the travelling component is connected to eastward propagating synoptic waves. In the winter of 2013/14, the record breaking cold air outbreak of January 2014 in eastern North America was driven by a travelling synoptic wave of extreme large amplitude intensifying an anomalous seasonal-timesale amplification of the standing ridge-trough structure. In 2014/2015 persistent cold was linked to a strong standing wave but extreme synoptic events did not play a reinforcing role. Cold events of this kind have been proposed to be linked to Arctic sea ice loss and climate change; this analysis identifies specific questions to ask to determine whether they exhibit a discernable anthropogenic influence. As a starting point, we find that no statistically significant long-term trend is seen in either the standing or travelling wave components of the ridge-trough structure over eastern North America. It is thus unlikely that the recent anomalous winters are associated with anthropogenically forced climate change in either the standing or the travelling waves associated with North American cold extremes.

Session 30700 - Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 1

How does dynamical downscaling affect explosive cyclones along North Americas Atlantic coast?

Seiler, Christian Zwiers, Francis
Pacific Climate Impacts Consortium
cseiler@uvic.ca

Explosive extratropical cyclones (EECs) are rapidly intensifying low pressure systems which generate severe weather along North Americas East coast. Global climate models (GCMs) significantly underestimate the frequency of EECs, which may be related to their coarse spatial resolution. This study explores if the negative frequency bias can be reduced through dynamical downscaling, and how this affects EEC climate change projections. A regional climate model

(CanRCM4) is forced with lateral boundary conditions from reanalysis (ERA-Interim) and a global climate model (CanESM2) for the North American domain for the recent past (1981-1999) and future (2081-2099). EECs are tracked with an objective-feature tracking algorithm (TRACK) from vorticity or mean sea level pressure (MSLP) at lower (T42) and higher (T61, T106) spatial resolutions. Results focus on MSLP-based tracks, since this method ensures a more accurate computation of deepening rates, and allows for a higher tracking resolution. Deepening rates of EECs are simulated to increase for ERA-Interim (8%, T42; 15%, T106) and CanESM2 (18%, T42; 21% T106) as a consequence of dynamical downscaling. Consistently, downscaling CanESM2 increases EEC frequency by up to 58% (T106) mainly along the coast line, eliminating a negative frequency bias of 44%. Climate change does not affect EEC significantly, unless a higher tracking resolution is chosen (-14%, T106). The reduction found for T106 is consistent with a projected decrease in the lower-tropospheric Eady growth rate by 0.3 day-1. EEC precipitation is projected to increase by 39% (T106) to 49% (T42, global).

Session 30700 - Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 1

Investigation of the 2013 Alberta flood from weather and climate perspectives

Teufel, Bernardo Stephan Diro, Gulilat Tefera Whan, Kirien Milrad, Shawn Jeong, Dae Il Ganji, Arman Huziy, Oleksandr Winger, Katja John, Gyakum de Elia, Ramon Zwiers, Francis Sushama, Laxmi
University of Quebec at Montreal (UQAM)
teufelbernardo@gmail.com

During 19-21 June 2013 a heavy precipitation event affected southern Alberta and adjoining regions, leading to severe flood damage in numerous communities and resulting in the costliest natural disaster in Canadian history. This flood was caused by a combination of meteorological and hydrological factors, which are here investigated from weather and climate perspectives, through specific experiments with the fifth generation Canadian Regional Climate Model (CRCM5). The CRCM5 experiments show that the contribution of orographic ascent to precipitation was important, exceeding 30% over the foothills of the Rocky Mountains. Another contributing factor was evapotranspiration from the land surface, which is found to have acted as an important moisture source and was likely enhanced by antecedent rainfall that increased soil moisture over the northern Great Plains. In addition, event attribution analysis suggests that human induced greenhouse gas increases may have led to higher evapotranspiration rates than would have likely occurred under pre-industrial conditions. Frozen and snow-covered soils at high elevations are likely to have played an important role in generating record streamflows. Results point to a doubling of surface runoff due to the frozen condition, while 25% of the modelled runoff originated from snowmelt. The estimated return time of the 3-day precipitation event exceeds 50 years over a large region, and an increase in the occurrence of similar extreme precipitation events is projected by the end of the 21st century. It is also found, through event attribution analysis, that greenhouse gas increases may have increased 1-day and 3-day return levels of May-June precipitation with respect to pre-industrial climate. However, no anthropogenic influence can be detected for 1-day and 3-day surface runoff, as increases in extreme precipitation in industrial climate are countered by decreased snow cover and less frozen water content in soils during the May-June transition months, compared to pre-industrial climate.

Session 30700 - Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 1

Evaluation of the atmospheric conditions associated with freezing rain and ice pellets produced by regional climate model simulations

Theriault, Julie Mcfadden, Vanessa   Paquin, Dominique
Université du Québec à Montréal
theriault.julie@uqam.ca

The production of precipitation types when the temperature is near 0°C can have catastrophic consequences on power networks and ground transportation. The amount of freezing rain and ice pellets obtained during a storm influence the total accumulations during a season and, in turn, the regional climatology. Even if the surface temperature is often used to diagnose rain versus snow, the occurrence of freezing rain and ice pellets requires the knowledge of the atmospheric conditions aloft. The goal of this study is to evaluate the atmospheric conditions leading to freezing rain and ice pellets diagnosed using regional climate model simulations. The study is conducted with the different Canadian Regional Climate Model 5 (CRCM5) simulations over North America. The types of precipitation are diagnosed using empirical methods based on partial thickness of lower atmospheric layers. This allows approximating the mean temperature of the melting layer aloft and refreezing layer below it. The study focuses over the Montreal area. The results showed that the median number of hours of freezing precipitation is similar to observations. The parameters of the vertical temperature such as the depth and temperature of the melting layer as well as the depth and temperature of the refreezing layer will be analyzed and compared with previous studies. Series of single event analysis will be analysed to identify the reason why freezing rain and ice pellets have been diagnosed. Threshold parameter values in current climate will be studied with respect to a warmer climate scenario. Overall, this study will contribute to assess how well regional climate model simulations can reproduce the atmospheric conditions leading to freezing precipitation.

Session 30700 - Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 1

Attribution of extreme climate events

Trenberth, Kevin
NCAR
trenbert@ucar.edu

There is a tremendous desire to attribute causes to weather and climate events that is often baseless from a physical standpoint. Indeed headlines in newspapers and other media are frequently misleading in attributing an event solely to either human-induced climate change or to natural variability when it is always a combination of both. Many attribution statements are merely a more complete description of the event. It is argued that instead a different framing is required to ask sensible questions about influences external to the atmosphere and why such extremes unfold the way they do. Specifically, it is more useful to regard the extreme circulation regime or weather event as being largely unaffected by climate change, and ask the question of

whether the impact of the particular event was affected by known changes in the climate systems thermodynamic state in which there is more confidence. Some examples to be used to briefly illustrate the new way to frame these questions, include super storm Sandy in October 2012; super typhoon Haiyan in November 2013 that devastated the Philippine Islands and, in more detail, the Boulder floods of September 2013, all of which were influenced by high sea surface temperatures that had a discernible human component. Some discussion of the 2015-16 El Niño effects will also be included.

Session 30701 - Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 2

The role of land-atmosphere interaction on future hot-spells over North America as simulated by the Canadian Regional Climate Model (CRCM5)

Diro, Gulilat Tefera Sushama, Laxmi
ESCER Centre, UQAM
diro@sca.uqam.ca

Land-atmosphere interactions play a key role in modulating climate variability and extremes. In this study, we investigate how land-atmosphere coupling may affect future extreme events, particularly the role of projected soil moisture in modulating the frequency and duration of hot-spells over North America, using the fifth generation Canadian Regional Climate Model (CRCM5). With this objective, CRCM5 simulations, driven by two coupled general circulation models (CGCMs, MPI-ESM and CanESM2), are performed with and without land-atmosphere interactions for current (1981-2010) and future (2071-2100) climates, for Representative Concentration Pathways (RCPs) 4.5 and 8.5. Analysis suggests that, in future summer climate, the soil moisture-temperature coupling regions, located over the U.S. Great Plains in current climate, extend to cover a wider region, including large parts of central Canada. Results also indicate that land-atmosphere interactions amplify temperature extremes in future by contributing more than 50% to the projected changes in hot-spell days over the southern Great Plains and parts of central Canada, especially when the model is driven by MPI-ESM for RCP4.5 scenario. For the Prairies, land atmosphere coupling in future affects more the change in variability compared to the change in mean. Therefore, the change in land atmosphere coupling and interactions is more likely to increase the future intense hot spell events. For parts of southern U.S., on the other hand, land-atmosphere interactions contribute to an increase in hot-spell days only under RCP4.5 scenario. The soil moisture-temperature coupling for RCP8.5 scenario appears to be weaker for this region due to the extreme dry soil conditions and therefore reduced evaporative fraction to affect climate.

Session 30701 - Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 2

Attribution of extreme events in Arctic sea ice extent

Gillett, Nathan Kirchmeier-Young, Megan Zwiers, Francis
Canadian Centre for Climate Modelling and Analysis, ECCC
nathan.gillett@ec.gc.ca

Extreme minima in Actic sea ice extent (SIE) have widespread implications, impacting sectors from ecosystems to commerce. Hence the quantification of the anthropogenic influence on extreme Arctic SIE events, like those in 2007 and 2012, is of considerable interest. This may be accomplished by comparing the probabilities of a specific SIE value under forcing scenarios with and without anthropogenic forcings through metrics such as the Fraction of Attributable Risk (FAR) and the Risk Ratio. We utilize two large-ensembles for this analysis. CanESM2 and CESM1 both provide ensembles of a size (50 and 30, respectively) large enough to realize a wide range of internal variability and to provide robust estimates of the event probabilities. Using several different metrics to define the events in question, it will be shown robustly that an extreme SIE minimum of the magnitude seen in 2012 is consistent with a scenario including anthropogenic influence, but is extremely unlikely in a scenario excluding anthropogenic influence. Hence, the 2012 Arctic sea ice minimum provides a counterexample to the often-quoted idea that individual extreme events cannot be attributed to human influence.

Session 30701 - Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 2

Projected changes of rain-on-snow events over North America based on two Canadian regional climate models

Jeong, Dae Il Sushama, Laxmi
Université du Québec à Montréal
jeong@sca.uqam.ca

Rain-on-snow (ROS) events have significant impacts on cold region ecosystems and water-related natural hazards, and therefore it is very important to assess how this hydro-meteorological phenomenon will evolve in a changing climate. This study evaluates the changes in ROS characteristics (i.e., frequency, amounts, and runoff) for the future 2041-2070 period with respect to the current 1976-2005 period over North America using six simulations, based on two Canadian RCMs, driven by two driving GCMs for RCP4.5 and 8.5 emission pathways. Projected changes to extreme runoff caused by the changes of the ROS characteristics are also evaluated. All simulations suggest general increases in ROS days in late autumn, winter, and early spring periods for most Canadian regions and northwestern USA for the future period, due to an increase in rain days in a warmer climate. Increases in the future ROS amounts are projected mainly due to an increase in ROS days, although increases in precipitation intensity also contributes to the future increases. Future ROS runoff is expected to increase more than future ROS amounts during snowmelt months as ROS events usually enhance runoff, given the land state and associated reduced soil infiltration rate and also due to the faster snowmelt rate occurring during these events. The simulations also show that ROS events usually lead to extreme runoff over most of Canada and north-western and -central USA in the January-May snowmelt months for the current period and these show no significant changes in the future climate. However, the future ROS to total runoff ratio will significantly decrease for western and eastern Canada as well as north-western USA for these months, due to an overall increase of the fraction of direct snowmelt and rainfall generated runoff in a warmer climate. These results indicate the difficulties of flood risk and water resource managements in the future, particularly in Canada and north-western and -central USA, requiring more in depth studies for these regions to facilitate appropriate adaptation measures.

Session 30701 - Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 2

The 2015 extreme drought in western Canada: the role of anthropogenic climate change and future outlooks

Szeto, Kit Zhang, Xuebin White, Robert Brimelow, Julian
Environment and Climate Change Canada
kit.szeto@ec.gc.ca

According to Agriculture and Agri-Food Canada, extreme drought affected most areas of southwestern Canada extending from southern British Columbia to Alberta during the spring and summer of 2015. In particular, southern B.C. experienced the driest and hottest April-July period of the last half century. Apart from significantly affecting social and agricultural activities, the drought also caused an extraordinarily long and active wildfire season in western Canada. The analysis in this study focuses on southern B.C., which was amongst the regions most affected by the drought. Analysis based on the NCEP reanalysis and CANGRD precipitation and temperature datasets shows that the hot and dry conditions were associated with an extensive and resilient upper-level ridge near the west coast of Canada. Further analysis shows that there are strong correlations between the variability of the upper-level height field near the coast and precipitation and temperatures in southern B.C. during the warm season. Trends in the strength and occurrence frequency of the identified upper-level circulation feature will be examined by using NCEP reanalysis. Changes in the upper-level circulation will also be examined by using CMIP5 historical simulations with and without anthropogenic forcings to assess if anthropogenic climate change has had played a role in the development of the extreme drought. In addition, CMIP5 projection results will be examined to assess if the circulation feature will strengthen and increase the risk of future extreme droughts in the area under different emission scenarios.

Session 30701 - Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 2

Event attribution - the emerging science of attributing causes to extreme events

Zwiers, Francis
UVic
fwzwiers@uvic.ca

Climate change detection and attribution (D&A) studies consistently indicate that human influence is responsible for changes in the intensity and/or frequency of temperature extremes that have been observed over the past several decades, and also increasingly often, in precipitation extremes. A recent further development is a gathering interest in event attribution, which is loosely defined as the identification of external factors that may have contributed to the intensity or likelihood of specific events, such as the 2013 Calgary floods. Event attribution is challenging because of selection bias, the need for timeliness, the difficulty in identifying relevant controlling factors, and because results and their utility are sensitive to the framing of event attribution questions - that is, how questions are posed. For example, questions that ask whether an external factor such human influence on the climate had a discernable impact on a

given event tend to lead to less useful results than questions that ask about how much influence the external factor had on the events likelihood or intensity. Utility is also increased if questions can be posed in a way that is prospective (i.e., providing information about the likelihood or intensity of future events) rather than in only a retrospective manner (i.e., concerning only the event that has just occurred). This talk will discuss the emerging science of event attribution and will place it the context of ongoing detection and attribution research on long-term changes in the frequency and/or intensity of extreme events.

Session 30800 - General Climate & Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 3

Convening, Disseminating and Applying Evidence-Based Climate Science to Address Extreme Weather & Climate Change Threats and Opportunities

Abraham, Jim McMillan, Ann   Laframboise, Deirdre
Canadian Climate Forum
abraham.jd@hotmail.com

The Canadian Climate Forum (the Forum), which emerged phoenix-like in 2013 from the ashes of the Canadian Foundation for Climate and Atmospheric Sciences (CFCAS), is the only national organization in Canada today addressing climate change across all issues and sectors. The Forums mission is based upon years of evidence and feedback from climate scientists and climate stakeholders across sectors: To disseminate and apply evidence-based climate knowledge to advance decision-making for a safer and more sustainable Canada.In support of this mission the Forum has been very active in the science to policy interface with focus on the translation and application of the climate change science, much produced by CFCAS researchers (including many members of CMOS) and others. The Forum does this by convening multi-sector stakeholders from private and public sectors, disseminating relevant climate science knowledge, and facilitating decision making that will produce best practices in climate adaptation and mitigation strategies. The Forum main activities and services include:-   Annual Symposium - This years theme is Moving Towards Sustainable Energy (Oct, Ottawa)-   Theme-based issue papers and other publications such as Op-Eds, -   Convening and climate science knowledge mobilization services. In 2016 the Forum is launching two national initiatives that address significant gaps in Canada specific to the need to coordinate knowledge sharing on climate science, and particularly its application to best policy practices across sectors:-   The Canadian Climate Council (CCC). The CCC model would be a national, independent, think and do tank including top experts from across a broad multidisciplinary spectrum including scientist, engineers, economists, health professionals, entrepreneurs, industry leaders, human behavioral psychologists, senior government representatives and national associations including nongovernmental organizations (NGOs). This agency would work to develop, deliver and communicate policy recommendations designed to address the complex matrix of climate obligations. - The Business Roundtable on Climate Resilience (BRCR) The BRCR will include key industry sectors, those with exposure to climate change impacts including: insurance and reinsurance; banking; telecommunications; energy sector; and emergency organizations such as the Red Cross. It will be linked to international initiatives that support the Hyogo and Sendai Agreements and will focus on risk assessment and improving disaster resilience. BRCR will produce at least one major national research study annually on priority topics such as monetization of risk.This presentation will describe these roles and plans for the Canadian Climate Forum; and provide an opportunity for some feedback and suggestions from Congress participants.

Session 30800 - General Climate & Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 3

A Climatological Analysis of Lake Effect Snowfall and its Processes over the Ontario Snowbelt Region of the Great Lakes Basin

Baijnath, Janine Duguay, Claude   LeDrew, Ellsworth
University of Waterloo
janineannb@gmail.com

The leeward shores of the Great Lakes Basin (GLB) in North America are highly susceptible to lake effect snow (LES) during the cold season. LES occurs when cold and dry continental air mass advects over the relatively warm lakes. This advection induces instability in the lower atmospheric boundary layer that facilitates the exchange of moisture and energy fluxes into the atmosphere, fuelling the development of LES. These snowfall events can have disastrous impacts on local communities such as the November 2014 Buffalo LES storm that caused 13 fatalities. Thus, the need to improve the understanding and forecasting of such events in LES zones is required. However, there has been limited LES climatological research conducted for Ontarios snowbelt region. Climatological averages and trends are computed over a 32 year study period (1982 to 2013) for snowfall, snow water equivalent (SWE), precipitation, air temperature, lake surface temperature (LST), ice cover concentration, 850 mb wind direction, and the vertical temperature gradients which are taken between the 1000 mb and 850 mb level (VTG1000-850) and the LST and 850 mb level (VTGLST-850). Results show a significant decrease in SWE and precipitation along the eastern shores of Lake Superior, while there is a localized increase in SWE and precipitation in Southern Ontario. There is no uniform spatial increase or decrease in snowfall trend over the selected time interval. While there are no significant climatological trends in VTGLST-850, results indicate a robust and significant increase in VTG1000-850 over the Great Lakes, with the dominant warming occurring at the 1000 mb level. VTG1000-850 at this level helps to determine snow probability and maximum daily temperature. Furthermore, there is a significant 2 ? warming in LST and a decrease in ice cover of 2% over the time interval studied. These processes can both develop and inhibit the production of LES.

Session 30800 - General Climate & Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 3

Impact of aerosol emission controls on future Arctic sea ice cover

Gagné, Marie-Ève Gillett, Nathan Fyfe, John
Canadian Centre for Climate Modelling and Analysis
Marie-Eve.Gagne@ec.gc.ca

The anthropogenic radiative forcing from the direct effect of aerosols and aerosol precursors is dominated by sulphate and black carbon, which have opposite effects, and is influenced by a smaller contribution from organic carbon. Sulphate and organic carbon scatter solar radiation

and thus result in a net cooling of the climate system while black carbon is an absorbing aerosol hence causing warming. Globally, sulphur dioxide emissions, which lead to the formation of sulphate aerosols, caused a sharp increase in the burden of sulphate between 1950 and 1970; since 1980, the burden has dropped. In contrast, black carbon emissions have increased throughout the 20th century with a greater rate of increase between 1970 and 1990; the global atmospheric burden of black carbon almost doubled during that time frame but there is an indication of a decrease over the last decade.We here examine the response of Arctic sea ice to projected aerosol and aerosol precursor emissions changes during the 21st century under the Representative Concentration Pathway (RCP) scenarios in climate model simulations. The overall projected decrease in aerosol loading causes a warming, largest over the Arctic, which leads to an annual mean reduction in sea ice extent of approximately 1 million square kilometres over the 21st century in all projected scenarios, as well as projected ice-free summers as early as the mid-20th century with current aerosol emissions mitigation strategies. In a separate experiment with one specific scenario, the Arctic ocean is projected to become ice-free during summertime in 2045, but it does not become ice-free until 2057 in simulations with the same scenario but with aerosol precursor emissions held fixed at 2000 values. Thus, while reductions in aerosol emissions have significant health and environmental benefits, their substantial contribution to projected Arctic climate change should not be overlooked.

Session 30800 - General Climate & Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 3

Multivariate analysis of extreme Net Basin Supplies in the Great Lakes

Hammami, Dorra St-Hilaire, André
nstitut National de la Recherche Scientifique
hammamidorra2@gmail.com

This study focuses on Net Basin Supply Residuals (NBSR), which are defined as the difference of monthly values and the interannual mean. In this study, NBSR of all five Great Lakes from June to October were modelled statistically in relation with a suite of 29 hydro-climatic indices. Moreover, the effect of some teleconnections has been tested.Non stationary frequency analysis was the main tool used for this analysis. The non-stationary Generalized Extreme Value (GEV) was fitted to NBSR with the shape and scale parameters allowed to vary as a function of the most correlated hydro-climatic variables or low frequency teleconnections such as AMO, AO, NAO, PDO, PNA, SOI and WHWP. The results are promising since they allow selecting appropriate hydro-meteorological variables and teleconnection patterns to model NBSR in the Great Lakes. Non-stationary quantiles were compared to stationary values, which allowed to highlight some important differences for a number of lakes and covariates. For instance, total precipitations from December to April have a significant impact on NBSR quantiles for Lake Superior in June. The stationary 0.5 quantile (2 year return period) was -30,79 m3/s and varied between -740,10 m3/s for low total precipitations and 825,74 m3/s for high total precipitations.

Session 30800 - General Climate & Climate Extremes: Drivers and Mechanisms, Today and in the Future - Part 3

Comparing the effects of 1.5 °C and 2 °C global warming on climate extremes over Canada and the globe

Kharin, Slava Flato, Greg Anderson, Kevin Zhang, Xuebin Gillett, Nathan
CCCma, CRD, ECCC
nathan.gillett@ec.gc.ca

The Paris Agreement aims to keep the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change. Climate extremes are a key driver of risks and impacts of climate change. How much would 1.5 °C global warming reduce changes in temperature and precipitation extremes, compared to 2 °C global warming? Here we present projected changes in means and extremes in temperature and precipitation across the globe based on the CMIP5 multi-model ensemble, quantifying the magnitude of departures from linear scaling, and characterizing uncertainties based on the spread across the ensemble. To a good approximation changes in means and extremes of temperature and precipitation scale linearly with global mean temperature and are independent of scenario, hence absolute changes in extremes relative to pre-industrial are approximately 25% smaller for 1.5 °C global warming than 2 °C. When referenced against present-day conditions, which are approximately 1 °C warmer than pre-industrial, changes in extremes are approximately 50% smaller for 1.5 °C global warming than 2 °C. Over Canada 1.5 °C global warming corresponds to a mean precipitation increase of 2-20% and a local warming of 1.5-5°C. A once in 20-yr maximum daily precipitation event in the pre-industrial climate is projected to occur every 7-15 years, a once in 20-yr maximum temperature event is projected to occur every 2-10 years, while a once in 20-yr minimum temperature event is projected to occur less than once every 1000 years over most of Canada. Hence, while significantly less than those projected for 2 °C global warming, projected changes in extremes over Canada are substantial even at 1.5 °C global warming.

Session 40100 - General Cryosphere - Part 1

The Canadian Ice Island Drift, Deterioration and Detection Database: Documenting the fate of massive glacial ice hazards in the Canadian waters

Crawford, Anna Saper, Ron Mueller, Derek Desjardins, Luc Shepherd, Jeff Carrieres, Tom
Carleton University
anna.crawford@carleton.ca

Ice islands are large, tabular icebergs which calve from ice shelves and floating glacial tongues. Our ability to identify, monitor and predict the drift and deterioration of these immense ice hazards is crucial for mitigating the associated risks to marine navigation and offshore infrastructure in their vicinity. A joint initiative between the Canadian Ice Service (Environment Canada) and the Water and Ice Research Lab (Carleton University) was established in 2014 to extract pertinent information from available satellite imagery and build a geospatial database for future drift and deterioration analyses, remote-sensing detection and modeling calibration and validation. Implementation of the Canadian Ice Island Drift, Deterioration and Detection

Database (CI2D3; wirl.carleton.ca/CI2D3) is well-underway, starting with the influx of ice islands through eastern Canadian waters after massive calving events at the Petermann Glacier in 2008 and 2010. Thousands of archived RADARSAT-1 and -2 (Canadian Space Agency/MacDonald Dettweiler and Associates) and Envisat (European Space Agency) synthetic aperture radar images are now being exploited to track ice islands until they are too small to delineate (~< 0.25 km2). More than four thousand ice island polygons pertaining to the 2008 and 2010 events have so far been delineated in ArcGIS by two operators using custom productivity tools. The relationship between each ice island and its daughter fragments is captured to permit longitudinal studies of fracturing. The geodatabase will be expanded by digitizing ice islands generated from the Petermann Glacier calving in 2012 with funding from Polar Knowledge Canada. Preliminary results and future plans are presented and discussed. We expect this database to be an extremely valuable resource for offshore stakeholders, researchers and Arctic communities. For the first time we shall have an account of the drift, fragmentation, and decay of major Arctic ice islands from their formation to near disintegration, at unprecedented spatial and temporal resolution.

Session 40100 - General Cryosphere - Part 1

Direct Forcing of Regional Currents by Sea Ice.

Jendersie, Stefan
University of Otago, Dunedin, NZ & NIWA, Wellington, NZ
stefan.jendersie@niwa.co.nz

The stability of ice shelves and floating glacier outlets is critical to grounded inland ice sheets in both polar regions. Results from a climatological ice shelf-ocean coupled numerical model (Regional Ocean Modeling System) suggest a new circulation mechanism associated with High Salinity Shelf Water (HSSW) production in the Ross Sea Polynya (RSP, Antarctica) that controls oceanic heat access to the Ross Ice Shelf cavity. Within the RSP the dense water-saturated water column contracts during winter and causes a seasonal drop in sea surface height (SSH) localised to a convection chimney under the RSP. The SSH gradients of up to 1.5 mm per km are sufficient to generate a barotropic pressure gradient that can counteract the wide scale horizontal baroclinic force and reverse the geostrophic circulation. The effect causes the seasonal occurrence of a strong cyclonic barotropic circulation cell with transports greater than 1Sv. Appearing with the beginning of winter sea ice formation in the RSP it significantly changes the dynamics at the ice shelf front and dominates the regional currents.This is the first reported direct forcing effect of a polynya on the ventilation of an ice shelf cavity. It is yet to be determined whether this is a Ross Sea specific mechanism, or if polynyas have a wider role in protecting ice shelves and glacier outlets and the ice sheets they buttress from future ocean warming.

Session 40100 - General Cryosphere - Part 1

Potential and actual predictability of snow water equivalent in the Canadian Seasonal to Interannual Prediction System (CanSIPS)

Sospedra-Alfonso, Reinel Merryfield, William
Canadian Centre for Climate Modelling and Analysis
sospedra@uvic.ca

We examine potential and actual predictability of snow water equivalent (SWE) in the Canadian Seasonal to Interannual Prediction System (CanSIPS). CanSIPS is based on two global climate models developed at the Canadian Centre for Climate Modelling and Analysis (CCCma), CanCM3 and CanCM4, and has provided Environment Canadas operational seasonal forecasts since late 2011. We employ one-way ANOVA on the 10 CanCM3 and 10 CanCM4 ensemble members to estimate potential predictability (PP) of SWE in the 1981-2010 hindcast period. The essence of this approach is to discriminate between variability of interannual SWE due to chaotic fluctuations or noise, and a potentially predictable variability due to internal climate modes and/or external forcing. We find significant PP of SWE, with potentially predictable variance over 50% of the total variance at up to 5-month lead in mid-to-high latitudes in forecast initialized after snow onset. Much of this PP stems from a tendency for SWE anomalies to persist through the snow season. Although the spring melt acts as a PP barrier regardless of initialization date, in some regions significant PP reemerges in the following snow season, associated primarily to ENSO teleconnections that are modelled realistically by CanSIPS. We assess CanSIPS actual skill in forecasting SWE using several verification datasets. Highest skills are obtained using a blend of five such datasets. These skills are comparable to, though generally lower than, that implied by PP. This is due in part to the similar autocorrelation properties of the forecast and observed SWE anomalies, which provide skill through anomaly persistence, combined with a reasonably accurate initialization of SWE by CanSIPS. Long-lead skill across snow seasons is found to be linked to ENSO, particularly in western North America, much as for PP.

Session 40100 - General Cryosphere - Part 1

The Validation of the Detection of the Soil Freeze-thaw Cycle using L-Band Microwave Radiometry

Williamson , Matthew   Rowlandson, Tracy Berg, Aaron Derksen, Chris Toose, Peter Roy, Alexandre Arnold, Lauren
University of Guelph
trowland@uoguelph.ca

The soil freeze-thaw cycle has been shown to have a major control on land- atmosphere energy transfer, hydrology and carbon cycling over cold regions. Passive microwave remote sensing offers an encouraging means to monitor large and regional scale changes in the global soil freeze-thaw cycle. Passive microwave satellites, like Soil Moisture Active/Passive (SMAP) and Soil Moisture and Ocean Salinity (SMOS) offer the ability to capture the landscape soil freeze-thaw state at a relatively course spatial resolution of ~40 km. Due to the relatively course scale of current passive space-borne satellites, it is often problematic to isolate variables contributing changes to brightness temperature during the winter period. In order to more closely monitor the controls on brightness temperature emission during freeze-thaw transitions and winter

conditions, a plot-scale ground-based radiometry study was conducted in Saskatchewan, Canada during the 2014-2015 winter. The study continually monitored brightness temperature using a dual-polarized L-band (1.4 GHz, incidence angle: 40°) radiometer over an undisturbed 2.0m by 2.7m footprint. Within the study site soil permittivity, soil/snow/air temperature and snow depth were monitored coincident with the radiometer measurements. Weekly snow pits were also conducted to in order to monitor changes in snow pack conditions. Results of study indicate that the radiometer was able to detect the soil freeze-thaw transitions, though challenges occurred during snow melt conditions. Overall, it is hoped that the results of this study may be useful for improving validation procedures for future freeze-thaw studies using L-band radiometry.

Session 40101 - General Cryosphere - Part 2

Retrogressive thaw slump impacts on ecosystem structure and function in Arctic streams

Levenstein, Brianna Lento, Jennifer Culp, Joseph   Chin, Krista Kokelj, Steve
Canadian Rivers Institute; University of New Brunswick - Fredericton
brianna.levenstein@unb.ca

The northwestern Canadian Arctic is rapidly warming and with increasing air temperatures and precipitation, thermokarst features are becoming more common. Retrogressive thaw slumps are large areas of exposed permafrost that are increasing in size and frequency across the Peel Plateau, NWT, Canada. Megaslumps, which are thaw slumps greater than 5 ha in area and with headwalls higher than 4 m in height, have become common in this area. Thaw slumps form along the gentle slopes of fluvial valleys and drain into nearby stream systems, greatly changing their physico-chemical properties. This study focuses on the impacts of thaw slumping on algal growth and benthic macroinvertebrate (BMI) composition in streams. Sites were sampled upstream and downstream of thaw slumps. Regressions were used to assess the impacts of thaw-slump-associated water quality variables on algal growth, and ordinations were used to assess the impacts of thaw slumping on BMI community metrics. Total suspended solids (TSS) showed a strong negative relationship with algal growth and BMI abundance. Specific conductivity, pH, TSS and dissolved phosphorus were strong drivers of separation among sites and BMI metrics in the ordinations. The results of this study indicate that thaw slumps have the ability to change the biological structure and function of stream communities by altering food web structures.

Session 40101 - General Cryosphere - Part 2

Characterization and applications of a combined observation-based northern hemisphere snow water equivalent dataset

Mudryk, Lawrence Kushner, Paul Derksen, Chris Brown, Ross
University of Toronto
mudryk@atmosp.physics.utoronto.ca

Evaluation of past and projected SWE trends and initialization of seasonal to decadal forecasts requires a gridded observational SWE product with estimates of dataset uncertainty or spread. Towards this end, we have combined five daily, gridded Northern Hemisphere snow water equivalent (SWE) datasets over the 1981-2010 period in order to quantify their spatial and temporal spread. All of the component datasets include observations (e.g. satellite

measurements, observed inputs to reanalysis) as at least a component of the data generation, but otherwise draw from a variety of sources including remote sensing, station data, land surface assimilation systems, and reanalysis-driven snow models of varying complexity. Taken together they represent current state-of-the-art reconstructions of the Northern Hemisphere SWE record. While the climatologies of total Northern Hemisphere snow water mass (SWM) vary among the datasets by as much as 50%, their interannual variability and daily anomalies are comparable, showing moderate to good temporal correlations (between 60% and 85%) on both interannual and intraseasonal time scales. The datasets are more consistent with one another over boreal forest regions than over Arctic and alpine regions. Datasets derived using relatively recent reanalyses are strongly correlated with one another and show better correlations with the satellite-based product than do those using older reanalyses.This dataset has proven to be very useful for analyzing historical SWE trends, estimation of bias in Northern Hemisphere snow cover and snow cover trends and in both seasonal and decadal forecasting.This work was supported through the Canadian Sea Ice and Snow Evolution Network (CanSISE).

Session 40101 - General Cryosphere - Part 2

Permafrost mapping derived from remotely-sensed ground surface temperature over Arctic during summer periods

Royer, Alain Lanoix, Roxane Roy, Alexandre Ottlé, Catherine Maignan, Fabienne Krinner, Gerhard Fily, Michel
Université de Sherbrooke
Alain.Royer@Usherbrooke.ca

Projected future warming is particularly strong in northern high latitudes. Permafrost present in those areas contains high quantities of frozen carbon that could be released in the atmosphere. This communication will present an improved approach to monitor the permafrost areas from the land-surface temperature (LST) variations in summer (without snow) using microwave brightness temperatures. The method combines 37 GHz passive microwave and thermal infrared data to estimate LST during summer snow-free periods calibrated at a pixel-based scale, leading to a new LST dataset provided at 25 km scale and at an hourly time step during a ten-year analysis period (2000-2010). This product was locally evaluated at five experimental sites of the EU-PAGE21 project against air temperature measurements and meteorological model reanalysis, and compared to the MODIS LST product at both local and circumpolar scale. The results giving a mean RMSE of the order of 2.2 K demonstrate the usefulness of the microwave product, which is unaffected by clouds as opposed to thermal infrared products and offers a better resolution compared to model reanalysis.The Thawing Degree-Days Index (TDDI) from this new database was used to create permafrost maps with 5 classes (continuous, discontinuous, sporadic, isolated and no-permafrost areas). A thresholding approach on TDDI was developed based on the comparison with the International Permafrost Association (IPA) map. The accuracy of this classification was assessed and the new permafrost map was also compared with the Global Permafrost Zonation index Map (Gruber et al., 2012). Results show the differences of using continuous microwave-derived TDDI compared to MODIS and ERA-Interim. Interannual variations and anomalies on LST and permafrost areas are presented and discussed.

Session 40101 - General Cryosphere - Part 2

Changes to the mass balance, hypsometry, and dynamics of White Glacier, Nunavut, over the past half-century

Copland, Luke
lthom021@uottawa.ca

Glaciological studies at White Glacier, Axel Heiberg Island, began in 1959 with the establishment of a mass balance monitoring program and detailed early studies of ice dynamics and hydrology, ice hypsometry and thicknesses, and local climate variability. Recent observations at White Glacier, including (1) remapping of the glacier hypsometry and extent using Structure from Motion software, (2) surface ice velocity measurements at the locations of historic observation profiles, and (3) ice thickness measurements using ice-penetrating radar, provide information concerning both long-term trends in mass balance and ice dynamics, and impact of short-term hydrological events on ice motion. Overall, annual ice velocities have decreased compared to the 1960-1970s, although the differences vary depending on location on the glacier and range from decreases of 5-45%. Trends in seasonal velocities, as well as the contribution of short-term speed up events to annual ice displacement, are connected to the development and degradation of the subglacial hydrological system. The results of a recent reanalysis of the mass balance program, validated against a volume-change derived measure of mass balance over a 54 year period, indicate that the two methods are statistically consistent. This provides confidence that the traditional mass balance stake monitoring method used in the Canadian high Arctic provides an effective measure of long-term mass change. Together, these results provide insight into the long-term sensitivity and stability of Arctic alpine glaciers under the influences of enhanced Arctic warming.

Session 50200 - Physical Oceanography - Part 1

Dependence of working range on near-surface conductivity, sea state, and tides for a 25 MHz CODAR SeaSonde

Halverson, Mark Pawlowicz, Rich
University of British Columbia
mhalvers@eos.ubc.ca

A 1.6 year time series of radial current velocity from a 25 MHz highfrequency radar system in the Strait of Georgia is analyzed todetermine how working range varies in response to changingnear-surface conductivity, sea state, and tidal height. The intentionis to provide a practical guide to the range expected under naturalenvironmental conditions. We extract radial velocities from a singlebearing, and define working range as the distance to the furthestradial velocity solution. Comparison to spatially-resolvednear-surface conductivity measurements from an instrumented ferry showthat conductivity has a large impact on working range. Range wasfound to increase linearly with increasing conductivity, from 22 km atC = 1.3 S/m, to 35 km at C = 3.5 S/m, which yields a slope of 5.6 kmper S/m. In terms of salinity at T = 15 C, this is equivalent to anincrease from 22 km at SR = 9 g/kg to 35 km at SR = 28 g/kg (0.72 kmper g/kg). Sea state, which is proxied here by wind speed, also has alarge effect. Range increases by 1 km per meter per second of windspeed over the range of 0.5 to 6.5 m/s, but decreases weakly at higherwind speeds. This behaviour contradicts two previous studies fromother regions, which

both showed a reduction in range with increasingwave height. Finally, a power spectra of the range revealedvariability at tidal frequencies. We estimate that the rangeincreases by a total of 3 km over a 5 m increase of sea surfaceheight, with the lowest ranges observed at low water. We also notethat the range leads sea surface elevation by about two hours, whichsuggests that the tidal range variations might have some dependence onthe tidal currents.

Session 50200 - Physical Oceanography - Part 1
Seasonal and interannual variability of the latitudinal position of the Gulf Stream
Higginson, Simon Lu, Youyu
Bedford Institute of Oceanography
simon.higginson@yahoo.ca
The Gulf Stream is the dominant feature of the North Atlantic Ocean circulation. It plays an important role in transporting heat polewards, and influences the properties of the shelf and slope waters of Eastern Canada. The current varies on many spatial and temporal scales, making it difficult to observe the position of the current. Here we present new estimates of the seasonal and interannual variability of the latitudinal position of the Gulf Stream, based on satellite altimeter measurements of sea surface height. We examine relationships between the Gulf Stream position, the North Atlantic Oscillation and the variability of the Atlantic Meridional Overturning Circulation.

Session 50200 - Physical Oceanography - Part 1
Baroclinic topographic Rossby waves on the Northern slope of Flemish Cap
Layton, Chantelle Kelley, Dan E. Greenan, Blair Hebert, Dave
Dalhousie University
chantelle.layton@dal.ca
The Flemish Cap region is an area of high biodiversity, intense fishing pressure and active hydrocarbon exploration. Substantial concentrations of deep-water corals and sponges have been observed from in situ benthic camera surveys, and this resulted in closure to bottom trawling activity in areas defined as vulnerable marine ecosystems. These closures presented an opportunity to deploy oceanographic moorings on the northern slope of Flemish Cap. We will present results from the moored measurements which indicate significant variability in currents at a period of about 20 days and show evidence that this is caused by bottom-trapped topographic waves on the slope of Flemish Cap.

Session 50200 - Physical Oceanography - Part 1
The Instability of Stratified Jets
Poulin, Francis Yawney, John
University of Waterloo
fpoulin@uwaterloo.ca

In this talk I will share some recent advances in studying the dynamics of stratified jets with and without topography. One of the underlying themes of this research is to investigate how energy cascades to smaller vertical scales. First, we present the results of a linear stability analysis that enables us to explore a wide range of range of stratifications and topographies. This yields some insights into what vertical scales we should expect as a result of the linear processes themselves. Second, we discuss the nonlinear evolution of the 3D primitive equation model to learn how the generation vertical variations can be due to nonlinear equilibration of the instability. Throughout this work we consider both barotropic and surface intensified jets.

Session 50200 - Physical Oceanography - Part 1
Attenuation of surface variability by oceanic ventilation
Shao, Andrew Mecking, Sabine Thompson, LuAnne Sonnerup, Rolf
Princeton University, Program in Atmospheric and Oceanic Sciences
ashao@uw.edu
A water parcel in the oceanic interior has a distribution of timescales due to the presence of oceanic mixing. These so-called transit time distributions (TTDs) are the Greens function solutions to the scalar transport equation and thus can be used to propagate a time-varying boundary condition into the oceanic interior. The Fourier transform of the two-parameter Inverse Gaussian, the TTD for the 1d transport equation, is used to demonstrate how subduction and large-scale transport act as an effective low-pass filter with nonlinear phase on surface variability. Estimates of age from both an offline tracer model and inferred from tracer observations are used to demonstrate that variability at the surface boundary will be significantly reddened with attenuation of frequencies higher than 0.2 yr^{<small>-1</small>} in most of the thermocline. The relatively high-frequency Southern Annular Mode is shown to be insignificantly correlated to variability in modeled Indian Ocean mode waters whereas the low-frequency Pacific Decadal Oscillation is strongly correlated to changes in North Pacific Mode Water.

Session 50200 - Physical Oceanography - Part 1
Source-sink and wind stress curl driven planetary flows in a polar basin
Willmott, Andrew Gavilan, Estanislao   Morales Maqueda, Miguel   Luneva, Maria
Newcastle University UK
andrew.willmott@ncl.ac.uk
Analytical process models are developed to study linear, steady-state, source-sink and wind stress curl driven barotropic planetary flows in a circular polar basin on the sphere with two open boundaries and simple shelf topography. The leading order dynamical balance is geostrophic except near the boundary of the basin and the shelf edge, where dissipation in the form of either linear bottom friction or eddy diffusion becomes significant. Full spherical geometry is retained in the derivation of the barotropic vorticity equation. Subsequently, an overlooked approximation in the refereed literature of the sixties is adopted whereby the latitudinal dependence in the coefficients of the vorticity equation are suppressed, hence allowing analytical solutions to be obtained. The approximation is justified a posteriori and the study compares the analytical

solutions with numerical solutions obtained from the NEMO Ocean modelling system configured for the same spherical cap domain. The NEMO model is then used to investigate the impact of a shelf and simple representation of the Lomonosov Ridge on the structure of both wind and source-sink driven flows, where analytical solutions cannot be obtained. The study concludes with a discussion about how these experiments shed light on the subtle interplay between the complex Arctic basin topography and the wind and boundary driven sea ice-ocean circulation.

Session 50201 - Physical Oceanography - Part 2

VITALS - Ventilation, Interactions and Transports Across the Labrador Sea

Myers, Paul
University of Alberta
pmyers@ualberta.ca

The VITALS (Ventilation, Interactions and Transports Across the Labrador Sea) research network is a newly funded NSERC CCAR project. Our goal is to answer fundamental questions about how the deep ocean exchanges carbon dioxide, oxygen, and heat with the atmosphere through the Labrador Sea. Our working hypothesis is that deep convection in the Labrador Sea, which allows for exchange of oxygen and natural and anthropogenic carbon to the deep ocean, is sensitive to the warming that is taking place at high latitudes. Validating and quantifying this sensitivity is central to our research network and also the broader community of climate change researchers and policy makers interested in characterizing, and possibly minimizing, the effects of global climate change. New observations, including biogeochemical, will include those collected from a SeaCycler moored in the interior of the Labrador Sea, additional moorings, gliders and floats as well as ship-board measurements and remote sensing). Combined with numerical modelling at a variety of scales and resolutions, we will determine what controls these exchanges and how they interact with varying climate, in order to resolve the role of deep convection regions in the Carbon Cyle and Earth System. VITALs is a pan-Canadian initiative involving scientists from 11 Canadian universities as well as multiple federal government laboratories (Fisheries and Oceans Canada, as well as Environment Canada), industrial and foreign partners. This presentation will provide an update on the status of the project, as well as highlight some of the more interesting preliminary findings.

Session 50201 - Physical Oceanography - Part 2

The role of the Nordic Seas in promoting Deep Water Formation in the Northern Hemisphere

Nadeau, Louis-Philippe Ferrari, Raffaele
ISMER
lpnadeau@gmail.com

An ocean general circulation model is used in an idealized setting to examine the role of the basin latitudinal extent on promoting deep water formation in the northern Atlantic. Most of the debate over what causes this deep water formation has focused on the role of different salinity concentrations in the Atlantic and the Pacific. Here, it is emphasized that temperature differences

are another important aspect of the problem using simulations of an ocean with two basins with areas equal to those of the Atlantic and Pacific Oceans. The simulations are forced with somewhat realistic winds and are restored to a latitudinally symmetric atmospheric temperature. Deep water formation through convection in the northern hemisphere is localized in the basin that extends further north, be it the small Atlantic-like basin or the Pacific-like basin. We interpret these results as evidence that deep water formation in the Atlantic Ocean is favored not only by its higher salinities, but also by its connection to the Nordic Seas which are exposed to colder temperatures than the North Pacific.

Session 50201 - Physical Oceanography - Part 2
Freshwater transport into the interior of the Labrador Sea: A modeling study
Pennelly, Clark Myers, Paul G. Hu, Xianmin
University of Alberta
pennelly@ualberta.ca
The Labrador Sea is one of the worlds sources of deep convection; a link between the atmosphere at the Earths surface and the deep ocean. The deep water formed via wintertime convection is a component of the southward flow of the Atlantic Meridional Overturning Circulation. The strength of convection, and the subsequent southern AMOC flow, may be reduced if the Labrador Sea stratification increases such to dominate over winter buoyancy loss. An input of freshwater can strengthen the stratification. We examine the transport of freshwater into the interior of the Labrador Sea, consider where this exchange occurs, and by which processes.   We used the Arctic Northern Hemisphere Atlantic (ANHA) configuration of the Nucleus for European Modelling of the Ocean (NEMO) framework to perform four simulations. Two simulations were performed at eddy-resolving resolutions (1/12°), but with different initial conditions. Each had a lower resolution (1/4°), eddy-permitting, twin simulation. We examine the transport of freshwater across isobaths separating the interior of the Labrador Sea from the fresh shelf and slope boundary currents. Analysis includes the total, mean, and eddy freshwater transport. We use two salinity references: 34.8 and 35.2 g/kg. We discuss the location and timescales of freshwater transport across the isobaths, as well as differences between the eddy-permitting and eddy-resolving model configurations.

Session 50201 - Physical Oceanography - Part 2
Watermass Transformation and Lateral Fluxes in the Lofoten Basin of the Nordic Seas
Richards, Clark Straneo, Fiamma
RBR Ltd.
clark.richards@gmail.com
Recent work to understand the Meridional Overturning Circulation has focused on the role of watermass transformation in high latitude marginal seas. Despite increased understanding, observations of the relevant processes are sparse, and there remain many unanswered questions. In the Nordic Seas, the Lofoten Basin has been increasingly recognized as a region of significant watermass transformation, owing to the large wintertime surface buoyancy loss. Climatologically, the Lofoten Basin accounts for approximately 1/3rd of the total surface

buoyancy loss over the Nordic Seas despite only covering about 1/5th of the total area. Here we compare two years of high temporal resolution mooring data (2010-2012) with properties derived from Argo profiles (between 2001 and present) within the basin. We highlight the spatial and temporal variability of basin water properties (including mixed layer depths, springtime restratification, and upper ocean heat content budgets), and extrapolate the results of the mooring observations over longer periods.

Session 50201 - Physical Oceanography - Part 2

Variations in freshwater pathways from the Arctic Ocean into the North Atlantic Ocean

Wang, Zeliang Hamilton, Jim
Bedford Institute of Oceanography
zeliang.wang@dfo-mpo.gc.ca

The freshwater pathways from the Arctic Ocean into the North Atlantic Ocean are investigated using a 1 degree global model. Results suggest that the freshwater (liquid) transport through the Canadian Arctic Archipelago and those through Fram Strait have an out of phase relationship. EOF analyses of sea surface height (SSH) and GRACE data (Gravity Recovery and Climate Experiment) show that the 2nd modes from both of them can represent the freshwater exports to the North Atlantic Ocean. The geostrophic flows associated with the 2nd mode of SSH can well explain the freshwater (liquid) transports from the Arctic Ocean to the North Atlantic Ocean, and this mode appears to be linked to the current variations at top layers. Both of the Arctic Oscillation and Arctic Di-pole are found to correlate with the PC2 of sea surface height. Our study further suggests that the Arctic Di-pole appears to be more important than the Arctic Oscillation for the freshwater export through the Canadian Arctic Archipelago in the 21st century. The tidal gauge data at Prudhoe Bay along the Beaufort Sea coast are found to be strongly correlated with the freshwater transport through Barrow Strait which is the major freshwater route to the North Atlantic Ocean in the Canadian Arctic Archipelago.

Session 50300 - Monitoring marine ecosystems and climate

The integrated Beaufort Observatory (iBO)

Forest, Alexandre Melling, Humfrey Lévesque, Keith Lalande, Catherine Meredyk, Shawn Osborne, Philip D. Fortier, Martin
Golder Associates Ltd.
Alexandre_Forest@golder.com

The integrated Beaufort Observatory (iBO) is a new mooring-based program (2015-2018) targeting the shelf and slope environment of the Canadian Beaufort Sea and co-led by ArcticNet, the Institute of Ocean Sciences (Department of Fisheries and Oceans Canada, DFO), Université Laval, and Golder Associates Ltd. The program is supported by the Environmental Studies Research Funds (ESRF) and Imperial Oil Limited and aims to extend existing time-series and regional coverage and contribute key information required for decisions on development and regulations in the offshore Beaufort Sea. iBO builds upon extensive time-series acquired by DFO since the 1970s and through ArcticNet and related projects (e.g. Canadian Arctic Shelf Exchange Study, ArcticNet-Industry partnership, Beaufort Regional Environmental Assessment) from 2002

to 2015. Through the collection of multi-year observations and the integration of existing time series, the iBO program will contribute to the further development of regional syntheses of ocean circulation, sea ice observations and biogeochemical fluxes that will include: (1) information on the magnitude, duration and return period of extreme ice features and ocean currents, comprising those associated with abrupt current surges and storms; (2) ice and ocean datasets to assess the inter-annual variability of ice dynamics, seawater circulation and particulate matter fluxes in relation to various environmental forcing factors, such as upwelling- and downwelling-favorable wind conditions; and (3) data to support accurate predictive capability of operational models and the validation/verification of regional circulation models, ice drift models, and oil spill trajectories. The main iBO sampling platform is composed of 7 tautline moorings located in waters ranging from 20 to 750 m depth at key locations from the Mackenzie Canyon, to the mid- and outer central shelf and slope, up to the remote northwestern area off Banks Island. The moorings are equipped with state-of-the-art instrumentation, including acoustic Doppler current profilers from 75 to 2000 MHz to measure current velocity, current direction, ice drift and plankton/particulates backscattering; ice-profiling sonar for the measurement of sea ice thickness, under-ice topography and for assessing waves and storm surges; water quality sensors for salinity, temperature, turbidity, chlorophyll and dissolved oxygen; and automated sediment traps that collect sinking particles for the measurement of biogeochemical fluxes. Data from the iBO program will be available to all stakeholders and interested end-users, including industry, regulators, northern communities, federal departments and the public through the Polar Data Catalogue.

Session 50300 - Monitoring marine ecosystems and climate

Autonomous monitoring systems: temperature-salinity profiling from an oceanographic buoy and from an ARGO-type profiler

Galbraith, Peter Gilbert, Denis
DFO-Maurice Lamontagne Institute
Peter.Galbraith@dfo-mpo.gc.ca

There has been pressure for some time on monitoring programs to adopt automatic systems as part of their tools and methods in other to lower costs and increase sampling resolution. In the summer of 2015, an automatic temperature-salinity profiler (CTD) was deployed from an oceanography buoy in the St. Lawrence Estuary as part of AZMP activities, and an ARGO-type NOVA profiler was deployed in the Gulf of St. Lawrence in a Government of Canada (DND, EC and DFO) and University (UQAR-ISMER) collaboration. Results obtained from these two examples are shown and compared to those obtained using more traditional methods. Difficulties and limitations are discussed.

Session 50300 - Monitoring marine ecosystems and climate

The Atlantic Zone Monitoring Program: Observations of a Changing Ocean

Johnson, Catherine Brickman, David Chassé, Joël Colbourne, Eugene Galbraith, Peter Hebert, Dave Lavoie, Diane Pepin, Pierre Plourde, Stéphane Scarratt, Michael
Fisheries and Oceans Canada, Bedford Institute of Oceanography
Catherine.Johnson@dfo-mpo.gc.ca

The Atlantic Zone Monitoring Program (AZMP) was implemented in 1999 to collect and analyze the data required to characterize and understand the causes of ocean variability at seasonal, interannual, and decadal scales and to establish relationships among physical, chemical, and biological variability in the Canadian northwest Atlantic continental shelf system. Although the program is still relatively young, its design, built to complement and coordinate with existing monitoring efforts, has allowed it to make substantial contributions to understanding interdecadal ocean variability and shelf ecosystem interactions in the northwest Atlantic. As the program approaches its twentieth year, it is increasingly called on to support assessment of climate change impacts on the shelf ecosystem, consideration of environmental variability in ocean stewardship and management of commercial species, and ocean and ecosystem modeling efforts. This presentation will provide an overview of the program and review its strengths and challenges. It aims to stimulate discussion among ocean monitoring practitioners and information users about actions and directions that would increase the value and impact of the program in coordination with other ocean observing efforts.

Session 50300 - Monitoring marine ecosystems and climate

A time series of nitrogen speciation and nitrogen isotope fractionation over an annual cycle from Bedford Basin, Nova Scotia.

Kalvelage, Tim Li, William Normandeau, Claire Haas, Sebastien Wallace, Douglas
ETH Zurich
douglas.wallace@dal.ca

The cycling of nitrogen (N) in the marine environment is complex and highly variable in both space and time. Multiple microbially-mediated pathways are involved, and observations and experiment regularly reveal unexpected processes and capacities. The natural abundance of stable isotopes of N and O are useful tracers of the microbial processes operating on different pools of nitrogen. However data sets which characterize variations in the isotopic composition of multiple N-pools over time, and allow testing of hypotheses concerning N-cycling, are very rare. Here, we present results from a comprehensive time-series of measurements of a wide range of nitrogen pools and their stable isotope composition which were obtained from the Bedford Basin Time Series, a coastal monitoring program in the Northwestern Atlantic near Halifax, Canada. The time-series has weekly resolution and allows detailed examination of the linkage between changing physical and biogeochemical conditions and nitrogen cycling, including stable isotope fractionation, over seasonal and event-driven timescales. During spring and early summer, high export production and remineralization of phytoplankton-derived organic matter resulted in increasing levels of particulate N and accumulation of ammonium in the basin bottom waters (60 m). In mid-summer, inflow of more saline Scotian Shelf water into the basin was observed, whereupon nitrifying activity markedly increased. Decreasing surface productivity in autumn was followed by a decline in subsurface ammonium concentrations and a complete oxidation of

the ammonium pool to nitrate. The variations of the N isotopic compositions of ammonium, nitrite, and nitrate are being modelled in order to estimate bulk fractionation factors and environmental controls for a number of nitrogen transformation pathways.

Session 50300 - Monitoring marine ecosystems and climate

Multi-annual variability and trends in nutrients and phytoplankton biomass in the Gulf of St. Lawrence

Scarratt, Michael Starr, Michel Michaud, Sonia St-Amand, Liliane Devine, Laure Galbraith, Peter
Fisheries and Oceans Canada - Maurice Lamontagne Institute
michael.scarratt@dfo-mpo.gc.ca

Since 1998, monitoring of oceanographic properties of the Gulf of St. Lawrence has been conducted on seven regular seasonal transects and selected higher-frequency stations as part of the Atlantic Zonal Monitoring Program of DFO. Vertical profiles of physical properties, oxygen, dissolved nutrients and chlorophyll-a are collected throughout the Gulf, as well as phytoplankton taxonomic data. This detailed time series spanning nearly two decades provides a good description of the spatiotemporal distribution of these properties, although long-term trends are still difficult to distinguish from natural variability. Nutrient distributions follow a typical seasonal pattern, with a maximum in late winter, followed by seasonal drawdown as the spring bloom progresses. The highest winter nutrient concentrations, and greatest seasonal drawdown occur in the western Gulf near the Gaspé Peninsula. Deep water (>50 m) nutrients have been increasing progressively in recent years, concomitant with increases in deep water temperature and salinity. However, surface (<50 m) nutrient concentrations remain quite variable, and the magnitude of the seasonal drawdown has been decreasing in many parts of the Gulf since 2008, resulting in spring chlorophyll levels near or below the long-term mean. Two high-frequency stations are sampled at monthly (Shediac Valley) to weekly (Rimouski) intervals and provide higher-resolution data. At Rimouski, the relative abundances of dinoflagellates and flagellates have been low in recent years, contrary to the longer-term trend, while at Shediac Valley, diatoms have been relatively less abundant recently. The description of nutrient and phytoplankton distributions provided by this survey constitutes important information on the organisms forming the base of the marine food web, their variability and the annual cycle of primary production. This understanding forms an essential element of an ecosystem approach to marine resource management.

Session 50300 - Monitoring marine ecosystems and climate

Seasonal variability and degradation investigation of iodocarbonsin a coastal fjord.Qiang Shi, Douglas WallaceOceanography Department,Dalhousie University, Halifax, Canada, Email: qshi@dal.ca,

Shi, Qiang
dalhousie university
qshi@dal.ca

Methyl iodide (CH_3I) is considered an important carrier of iodine atoms from sea to air. The importance of other volatile iodinated compounds, such as very short-lived iodocarbons (e.g. CH_2ClI, CH_2I_2), has also been demonstrated [McFiggans, 2005; ODowd and Hoffmann, 2005; Carpenter et al., 2013]. The production pathways of iodocarbons, and controls on their sea-to-air flux can be investigated by in-situ studies (e.g. surface layer mass balance from time-series studies) and by incubation experiments. Shi et al., [2014] reported previously unrecognised large, night-time losses of CH_3I observed during incubation experiments with coastal waters. These losses were significant for controlling the sea-to-air flux but are not yet understood. As part of a study to further investigate sources and sinks of CH_3I and other iodocarbons in coastal waters, samples have beenanalysed weeklysince April 2015 at 4 depths (1 to 60 m) in the Bedford Basin, Halifax, Canada. The time-series study was part of a broader study that included measurement of other, potentially relatedparameters (temperature, salinity, Chlorophyll a etc.). A set of repeated degradation experiments was conducted, in the context of this time-series, including incubations within a solar simulatorusing 13C labelled CH_3I. Results of the time-series sampling and incubation experiments will be presented.

Session 50400 - Acoustics in oceanography and marine sciences

Sound Attenuation in Water-Saturated Sand at MHz Frequencies

Hare, Jenna Hay, Alex E
Dalhousie University
jenna.hare@dal.ca

During the past 20 years, significant advances have been made using acoustic remote sensing for the study of sediment dynamics in the ocean. Under energetic waves, sheet flow is thought to be the dominant sediment transport process, but there has yet been no measurement of the thickness of this thin, high-concentration moving layer in the nearshore environment. High (MHz) frequencies are needed to resolve the moving layer, but sound attenuation at these frequencies may limit penetration through the layer and thus, prevent the measurement. In order to explore the range of frequencies which might be suitable, we measured sound attenuation in water-saturated sand with median diameters of 0.22 mm, 0.4 mm and 0.5 mm. A wide-bandwidth sonar was used to obtain backscatter amplitude profiles for frequencies between 1.0 and 2.1 MHz as a function of range. Attenuation coefficients were determined based on the change in amplitude of the return signal travelling through different thicknesses of sand resting on a reflective surface. Our estimates are compared to model predictions as well as to previous experimental results reported in the literature. As acoustic frequency and/or sediment size increases, the scattering contribution to attenuation dominates the viscous loss. In this frequency range, our measurements agree with multiple scattering theory.

Session 50400 - Acoustics in oceanography and marine sciences

Ambient noise from turbidity currents in Howe Sound

Hatcher, Matthew Hay, Alex   Hughes Clarke, John
Dalhousie University
mhatcher@dal.ca

The Squamish River enters Howe Sound near Squamish, British Columbia. Due to the sediment carried by the river the interface between the fjord and river is characterized by a fan delta and delta front descending into the several 100 m deep fjord. Sediment mass transport from the delta into the fjord is dominated by discrete turbidity current events which have incised semi-permanent channels on the delta front and out onto the prodelta. Subsequent turbidity currents flow through these channels modifying them and the bedforms within them. Acoustic Data was collected here in the spring of 2013. Broadband (10 kHz to 200 kHz) noise generated by these discrete turbidity currents is present in the data and shows some features with much variability and other features which are relatively constant among events. This presentation focuses on modelling efforts, in both the sound production mechanism and sound transmission, aimed at explaining certain features observed in the data and thereby gaining insight into these seldom measured physical phenomena. The potential future goal of work of this type could be quantitative passive acoustic monitoring of sediment transport events similar to those measured here.

Session 50400 - Acoustics in oceanography and marine sciences

Suspended sediment profiles in a deep-water renewal event: Estimates using dual-frequency acoustic backscatter

Hay, Alex Dewey, Richard
Dalhousie University
alex.hay@dal.ca

Multiple deep-water renewal events in the Strait of Georgia have been captured with a heavily instrumented bottom lander, the BBLpod, connected to the VENUS cabled underwater ocean observing system in the Strait of Georgia, British Columbia at XX m depth. The inflows are bottom-trapped, ca. 50 m thick, with (non-tidal) ca. 0.5 m/s flow speeds. They are driven by the excess density associated with the higher salinity of the inflow water and -- possibly also -- the high concentrations of suspended sediment entrained from the seabed as the current flows down- and along-slope. Among the sensor systems mounted on the BBLpod are two acoustic Doppler current profilers (ADCPs) operating at 300 and 600 kHz. A two-frequency inversion of the backscatter amplitude profiles from these instruments is used to obtain profiles of suspended concentration extending through the full thickness of the density inflow. The inversion utilizes the differential attenuation as a function of acoustic frequency and range arising from scattering and viscous attenuation losses due to the interaction of sound with the particles in suspension. The concentration estimates from the inversion are then used to address the question as to whether this contribution to the excess density from suspended sediment is sufficient to be dynamically significant.

Session 50400 - Acoustics in oceanography and marine sciences
Soundscape characterization in a dynamic acoustic environment: A baseline assessment in Grand Passage, Nova Scotia
Lombardi, Anne Hay, Alex
Dalhousie University
dbarclay@dal.ca
The marine environment in the Bay of Fundy hosts a dynamic and diverse soundscape that is a fundamental component of the local ecosystem. The emergence of new anthropogenic marine activities and infrastructure, such as tidal turbine installations, introduces new sound sources that change or disrupt the existing acoustic environment, but the full extent of these changes is not well understood and is not predictable. To better evaluate the effects of future tidal energy development on the local soundscape in Grand Passage, Nova Scotia, a thorough understanding of the pre-development characteristics must be established. This research quantifies and analyzes the acoustic environment as a dynamic compilation of various discrete and semi-continuous sound sources, to characterize the soundscape as a function of its governing biological and physical processes and conditions. Passive acoustic measurements have been conducted using long-term moored omnidirectional hydrophones, a moored 5-channel array, and drifting hydrophone arrays, enabling identification of dominant signals and source direction, estimation of pseudonoise masking effects due to turbulent flow, and analysis of diurnal, daily, seasonal, and annual variability as well as spatial variability within the study area. The results provide a comprehensive baseline assessment that will support accurate evaluation of anthropogenic acoustic impacts.

Session 50400 - Acoustics in oceanography and marine sciences
Swath Doppler: Multi-beam Doppler sonar for scanning water velocity sections
Razaz, Mahdi Zedel, Len Hay, Alex
Memorial University, Department of Physical Oceanography
mrazaz@mun.ca
We report on the development of a swath Doppler system operating at a frequency of 500 kHz that provides velocity profiles in multiple directions simultaneously. Sound is projected with two single-element transducers with a fan-shaped beam pattern (30 degrees, by 3.8 degrees). An 8-element receiving transducer is used to steer the received signal into (in this case) 8 distinct beams (each 3.8 degrees wide). Velocity estimates out to a range of order 1 m are generated using the pulse-to-pulse coherent signal processing technique. By pairing two transmitting beams in a bistatic geometry the system can generate 2-component velocity sections. We present results from a computer model of the system which establishes the operating limitations. Experimental trials of the system were undertaken in a 1-m deep flume tank over a mobile bed with mean horizontal velocities of 1-2 m/s. Preliminary results from the experimental trial will be presented.

Session 50400 - Acoustics in oceanography and marine sciences

Transmission loss variability on different time scales during the Target and Reverberation Experiment 2013

Tollefsen, Cristina Pecknold, Sean
Defence Research and Development Canada
cristina.tollefsen@gmail.com

Variability in underwater acoustic propagation caused by environmental fluctuations and uncertainty in the position of sources, targets, and receivers is a significant driver of uncertainty in sonar performance. A set of echo-repeat experiments was conducted during the Target and Reverberation Experiment 2013, a sea trial that took place in very shallow water (20 m depth) in April-May 2013 in the Gulf of Mexico near Panama City, Florida. Both one-way and two-way transmission loss results were analyzed to investigate the transmission loss variability at timescales ranging from less than one second to several days. The main oceanographic forcings in the area that affected acoustic propagation were the diurnal pattern of solar heating and evaporation (the afternoon effect) and wind-driven vertical mixing. The results of statistical tests suggest that when appropriately modelled, the transmission loss variability can be treated as Gaussian fluctuations about a mean transmission loss obtained from a propagation model with appropriate environmental inputs. Furthermore, the magnitude of the variability about the mean was consistently 3-7 dB at all the time scales studied, suggesting that the acoustic propagation fluctuates stochastically on time scales from 10⁻¹ to 10⁶ s. This seven-decade range is consistent with the time scales of oceanic turbulent processes that range from the dissipation scale (on the order of the Kolmogorov time) to large-scale fluctuations in heat flux and mixing (over the course of days).

Session 50500 - Modelling Tracers in the Ocean

Dealing with Diffusivity and Running Tracers Offline

Allen, Susan Ramos Musalem, Karina Sha, Yingkai Yu, Xiaoxin
University of British Columbia
sallen@eos.ubc.ca

Passive, or nearly passive tracers are great integrators of ocean flow and inform us about long time scale physics that is difficult to directly measure. However implementing tracers in physical models takes care. The transport of tracers in a numerical model is determined by advection and mixing processes. This first part of this talk will deal with best practices for implementing tracer diffusivity and for evaluating the strength of inherent numerical diffusivity. The importance of the resolution scale on the appropriate the model choices for the turbulence scheme will be discussed. The second part of the talk will focus on running tracers offline, including the benefits (such as speed) and some of the pitfalls (such as boundary conditions). Tracers can also amplify numerical problems. How to get around some of these, without re-running the base physical model, will be presented.Examples will be taken from two different numerical models (MITgcm and NEMO) and from coastal systems to full ocean systems.

Session 50500 - Modelling Tracers in the Ocean

Model Study of the Spreading Pathways and Transit Times of the Labrador Sea Water Produced in Different Convection Regimes

Demirov, Entcho Zhu, Jieshun Yashayaev, Igor
Memorial University of Newfoundland
entcho@mun.ca

The transit time of the Labrador Sea Water (LSW) spreading is a characteristic which is commonly used to quantify the rate of the LSW propagation. An ocean general circulation model (OGCM) is used to investigate the transient time of LSW and its relation to the interannual variations in the LSW properties and circulation intensity. The simulated LSW is much colder, fresher and deeper and the circulation is more intense in 1993 (hereafter LSW1993) than that in 2000 (hereafter LSW2000). The derived residence time for LSW1993 in the Labrador basin is longer than that for LSW2000. The transit times of the LSW in the Irminger Sea, subtropical North Atlantic and the Eastern Basin show a strong interannual variability. The mechanism of this variability and more specifically the impact of the variations of the circulation intensity and water mass properties on the TTD are discussed based on the results from the model experiments.

Session 50500 - Modelling Tracers in the Ocean

The Gulf of St. Lawrence: a nutrient trap or a nutrient source?

Lavoie, Diane Starr, Michel Chassé, Joël Lambert, Nicolas Brickman, David
Institut Maurice-Lamontagne
diane.lavoie@dfo-mpo.gc.ca

The Gulf of St. Lawrence (GSL) has been characterised as a nutrient trap in the late 1970s, as nutrient concentrations in the deep layers of the GSL are greater than seaward of Cabot Strait at similar or greater depths. The trapping of nutrient would result from the interaction of biological regeneration of organic matter sinking from the surface with the estuarine-like circulation that brings the intermediate and deep waters towards the head of the GSL channels. These deep nutrient-rich waters are then upwelled at the head of the Laurentian Channel and mix with surface water. This source of nutrient can sustain the primary production found in the Lower St. Lawrence Estuary and Northwest Gulf of St. Lawrence. However, views differ on the role of this nutrient source for the primary production of the Magdalen Shallows. The GSL was also reported to be a source of nutrient for the Scotian Shelf. Some sources of nutrient could thus remain unaccounted for. We use a 3D biogeochemical model to investigate the sources and processes that could reconcile these observations. Model results highlight the importance of the microbial loop, notably in the recycling and transport of organic matter, which is sensitive to the parameterisation of grazing, PON sinking and remineralisation rates.

Session 50500 - Modelling Tracers in the Ocean

Global ocean mercury transport and biogeochemistry model

Semeniuk, Kirill Dastoor, Ashu
Environment and Climate Change Canada
ashu.dastoor@ec.gc.ca

The consumption of food harvested from the oceans is a primary pathway for human exposure to neurotoxic methylmercury. A significant portion of mercury entering oceans via atmospheric deposition and riverine discharge is re-emitted back to the atmosphere accounting for one-third of total global emission of mercury. Transport and biogeochemistry in oceans, and air-sea interactions of mercury are integral processes of the environmental mercury cycle; therefore, a coupled atmosphere-ocean mercury model is required to assess impacts of changing anthropogenic mercury emissions and climate on mercury levels in terrestrial and aquatic systems. This study presents a new 3-dimensional global ocean mercury transport and biogeochemistry model which includes for the first time an explicit methyl mercury cycle. The ocean mercury model (NEMO-Hg) is developed by extending Environment Canadas operational ocean model - the Nucleus for European Modeling of the Ocean (NEMO). There are five transported tracers in NEMO-Hg: dissolved elemental mercury (Hg0), dissolved divalent mercury (HgII), dissolved methylmercury (MMHg), dissolved dimethylmercury (DMHg), and particle-sorbed divalent and methyl mercury (HgP). We conducted equilibrium ocean mercury simulations for the pre-anthropogenic period which is before 3500 BC by running the model from zero mercury initial conditions for 5,000 years with atmospheric deposition of Hg to the ocean surface and riverine Hg fluxes as inputs of mercury to the ocean. Pathways for mercury distribution in oceans are explained; pre-anthropogenic mercury concentrations in ocean waters are determined; model results are compared to observations of deep water not yet dominated by the anthropogenic signal and to younger waters contaminated by anthropogenic emissions; mercury life time in the global ocean and anthropogenic enrichment in modern times are determined; and knowledge gaps are identified. The model description, model results, knowledge gaps in biogeochemistry of Hg in ocean and issues with modeling tracers in NEMO will be presented.

Session 50500 - Modelling Tracers in the Ocean

A simulation study of dissolved Barium and Oxygen isotope ratio in the Arctic

Sha, Yingkai Allen, Susan Hu, Xianmin Myers, Paul
Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia, Vancouver, British Columbia V6T 1Z4
yingkai@eos.ubc.ca

Dissolved Barium (Ba) and oxygen isotope ratio (d18O) are widely recognized as tracers for river runoff and sea-ice melt water. Ba is highly enriched in North American rivers and less so in Eurasian rivers but in both sets of rivers exceeds that of background Atlantic seawater. d18Os end-member value for sea ice meltwater is higher than other freshwater components. The spatial and temporal variation of Ba and d18O give useful information on the Arctic freshwater budget and pathways. However, sparse field measurements can be difficult to interpret.A 3-dimensional dynamic ocean model with initial condition, boundary conditions, prescribed end-member values and parameterized tracer scheme is applied to simulate the regional distribution of Ba-like and

d180-like tracers in the Arctic. The tracer scheme includes explicit sources and dilution of tracer concentration from runoff, net precipitation and sea-ice melt. The initial and boundary conditions are estimated from various field observations.We will present the details of the model configuration, the parameterization of the two tracers and the simulation results from 2002 to 2013. We will compare the model results with field observations, provide and discuss the spatial and temporal variations of the two tracers and show our plan for sensitivity studies and potential uses of the tracers for future climate research.

Session 50500 - Modelling Tracers in the Ocean

INTERMEDIATE AND DEEP WATER CIRCULATION IN THE ARCTIC OCEAN (2002-2013): INFERRED FROM THE DISTRIBUTION OF 231Pa/230Th IN WATER COLUMN

Yu, Xiaoxin Allen, Susan Hu, Xianmin Myers, Paul
University of British Columbia
xiaoxiny@eos.ubc.ca

The ratio of 231Pa/230Th has been used as an indicator of ocean circulation in the Pacific and Atlantic Oceans. Here we investigate this ratio in the Arctic using a numerical model, illustrating circulation pattern changes from a geo-tracer perspective.To simulate changes in the ratio, we coupled a scavenging model, which describes the exchange of 231Pa (and 230Th) between the dissolved and particulate phases, to an offline NEMO model (the Nucleus for European Modelling of the Ocean) that provides the advection and mixing processes that redistribute the tracers within the ocean.The parameterization of scavenging rates is based on the ice condition in the Arctic. Since the scavenging strengths of such tracer elements are strongly affected by particle concentrations in the ocean, we investigate the relationship between scavenging rates and ice concentration, which, to a great extent, influences the biological processes in the water. We also trace the change of ice condition in the water column to ensure this approximation is reasonable. The initial tracer fields are generated from all available water column data of dissolved and particulate 230Th and 231Pa.Model output shows how the distributions of 231Pa and 230Th change within our research period. These results are evaluated by observation. We also use our simulation results to examine how the ratio of 231Pa/230Th responds to the circulation and infer pathways of how intermediate and deep water flow through the system.

Session 50600 - Coastal Oceanography and Inland waters - Part 1

Using satellite altimetry in monitoring storm surges

Han, Guoqi Ma, Zhimin Chen, Nancy
Fisheries and Oceans Canada
Guoqi.Han@dfo-mpo.gc.ca

Storm surges are the main factor that causes coastal flooding, resulting in catastrophic damage to properties and loss of life in coastal communities. Thus it is important to enhance our capabilities of observing and forecasting storm surges for mitigating damage and loss. In this talk we provide examples of storm surges observed by nadir satellite altimetry, during Hurricane Sandy, Igor, and Isaac, as well as other cyclone events. The satellite results are evaluated against tide-gauge

data. The storm surges are discussed for dynamic mechanisms. We also discuss the potential of a wide-swath altimetry mission to be launched in 2020, the Surface Water and Ocean Topography (SWOT), for observing storm surges.

Session 50600 - Coastal Oceanography and Inland waters - Part 1
Tidal currents and intertidal sediment transport under land-fast ice
Neumeier, Urs Cheng, Colette
Institut des sciences de la mer de Rimouski
urs_neumeier@uqar.ca
The presence of sea-ice influences currents and turbulence, especially in the intertidal zone, where water flow is constrained between land-fast ice and a tidal flat. As a consequence, intertidal sediment dynamics under ice are likely to be modified compared to ice-free seasons. Currents and turbulence were measured on a tidal flat near Rimouski (lower St. Lawrence Estuary, Québec) with several current-meters and current profilers across an 800-m transect from outer sandflat to low salt marsh. Sediment transport was monitored by measuring suspended sediment concentration (SSC) with optical backscatter sensors (OBS). Current and turbulence were strongest when the rising tide started to lift the land-fast ice from the ground and water flow was constrained in a narrow space. Afterwards, current variations in time and space were similar to the usual intertidal pattern. Velocity profiles were characterized by two logarithmic boundary layers, at the bed and at the ice bottom. The upper boundary layer pushed the velocity maximum toward the bed, which increased the bed shear stress compared to ice-free flow. SSC was maximal at the beginning of flood and decreased afterwards. SSC was higher in the low marsh than on the tidal flat, probably because finer low-marsh sediments are more easily be resuspended and were no longer shielded by vegetation in winter. Overall SSC was also controlled by storms resuspending sediments in ice-free waters, as illustrated by differences between experiment days.The results provide the first insights on sediment transport processes under ice in winter, which have rarely been studied so far, but are essential for establishing full-year sediment budgets.

Session 50600 - Coastal Oceanography and Inland waters - Part 1
Tidal currents in the south coast of Newfoundland: diurnal or semi-diurnal?
Ratsimandresy, Andry Donnet, Sebastien Lazure, Pascal
Fisheries and Oceans Canada
andry.ratsimandresy@dfo-mpo.gc.ca
In an effort to further understand the role of the different forcing fields on the sea level and on the water circulation in the South Coast of Newfoundland, data from Acoustic Doppler Current Profilers (ADCP) moored at various locations in thesouth coast of Newfoundland were analyzed and compared with the output of the unstructured grid Finite Volume Community Ocean Model (FVCOM) implemented for the region. The tides were found to explain more than 85% of the variance of the sea level and were relatively well reproduced by the model. This makes the circulation model a suitable tool for sea level study in the region. In contrast, the contribution of the tides to the total currents depends on the location andrepresent only 5 to ~30% of the

variance of the currents. In addition, although the sea surface elevation shows a strong semi-diurnal variation in the whole region of interest, the ratio between semi-diurnal tidal currents and the diurnal onesvaries depending on the location. Interestingly, observation data from numerous locations show a relatively larger diurnal components of the currents. This higher diurnal tidal current variability is not reproduced by the circulation model (runin barotropic mode). It suggests other important coastal processes occurring in the region. These other processes seem to play an important role on the water circulation in the region. The analysis of the observation from the ADCP and the output of the circulation model will be presented. We will also look into the possible physics which might explain the change in the contribution of the tidal currents in the area. This study contributes in the understanding of the circulation in the area for aquaculture purposes.

Session 50600 - Coastal Oceanography and Inland waters - Part 1

Simulating three-dimensional circulation and hydrography over the central Scotian Shelf using a multi-nested ocean circulation model

Shan, Shiliang Sheng, Jinyu Ohashi, Kyoko Dever, Mathieu
Department of Oceanography, Dalhousie University
sshan@Dal.Ca

A multi-nested coastal ocean circulation model was developed recently for the central Scotian Shelf. The model consists of four submodels downscaling from the eastern Canadian Shelf to the central Scotian Shelf. The model is driven by tides, river discharges, and atmospheric forcing. The model results are validated against observations, including satellite remote sensing data from GHRSST and Aquarius and in-situ measurements taken by tide gauges, a marine buoy, ADCPs and CTDs. The ocean circulation model is able to capture variations of sea levels, hydrography and the Nova Scotia Current on timescales of days to seasons over the central Scotian Shelf. Model results are also used in examining the effect of tidal mixing and wind-driven coastal upwelling in the formation of cold surface waters along the coast of Nova Scotia.

Session 50600 - Coastal Oceanography and Inland waters - Part 1

Sea level variability along the Nova Scotia coast during 1993-2012

Zhai, Li Lu, Youyu Higginson, Simon Greenan, Blair
Bedford Institute of Oceanography
Li.Zhai@dfo-mpo.gc.ca

The tide gauge and altimeter data during 1993-2012 are analyzed to describe characteristics of sea level variations along the coast of Nova Scotia and adjacent shelf seas. Seasonal cycle of sea level variations at Halifax corresponds with that of steric height at a hydrography survey station (HL2) located nearby. Seasonally-averaged sea level anomalies (SLA) at Halifax are correlated with that in the southern Gulf of St. Lawrence and along the coast of Nova Scotia for all seasons, and in the Gulf of Maine except in summer. In winter and fall, the regression to surface wind stress and the steric change at HL2 together account for 62% and 76% of the Halifax SLA variance respectively. In spring (summer), the steric effect alone can explain 42% (50%) of the Halifax SLA variance. Halo-steric effect dominates interannual variations of the total steric

change at HL2 for all seasons. Regarding a significant sea level rise from the fall of 2009 to early 2010 (Goddard et al, 2015), the response to inverse barometer (IB), regression to wind stress and thermo-steric change account for 36%, 37% and 17%, respectively, of the Halifax sea level after removing the linear trend and seasonal cycle. The contributions of the IB-response and surface winds are correlated with the index the North Atlantic Oscillation (NAO). While the NAO index is also correlated with changes in the Atlantic Meridional Overturning Circulation (AMOC), the direct influence of the AMOC on the 2009-2010 sea level rise along the coast of Nova Scotia cannot be established.

Session 50601 - Coastal Oceanography and Inland waters - Part 2

EFFECT OF WIND FORCING ON THE OCEANOGRAPHIC CONDITIONS OF FORTUNE BAY - BELLE BAY (NL)

Donnet, Sebastien Ratsimandresy, Andry W. Han, Guoqi Lazure, Pascal
Fisheries and Oceans Canada
sebastien.donnet@dfo-mpo.gc.ca

Recent studies show that while the tide is responsible for 80-90% of the sea-level variation, it accounts for less than 10% of the ocean currents variability in most of the Fortune Bay - Belle Bay region (NL). Wind, however, appears to be a major driver of the surface and sub-surface currents. A recent assessment of the Belle Bay region shows a significant change of its oceanographic conditions when exposed to strong winds (e.g., storms and hurricanes) with storm surge of the order of 1.6 m, vertical displacement of the thermocline of the order of 10 meters or more and ocean currents of about 0.9 m/s. Similarly, what appears like strong wind-induced currents affecting the whole water column and lasting for periods of the order of a week to 10 days have been observed recently on the coastal shelf of the neighboring archipelago of Saint Pierre and Miquelon. Subsequent to those findings, the Department of Fisheries and Oceans is currently implementing an oceanographic program in partnership with Ifremer (France). The program consists of the collection of ocean currents and water column temperature time series, complemented by data collected by the aquaculture industry. Design, objectives and preliminary results of this program will be presented.

Session 50601 - Coastal Oceanography and Inland waters - Part 2

Satellite-based study of wind and river forcing of the Fraser River plume

Halverson, Mark Pawlowicz, Rich Di Costanzo, Romain Rehm, Eric Devred, Emmanuel
University of British Columbia
mhalvers@eos.ubc.ca

The Fraser River is the largest source of inorganic particles to theStrait of Georgia (SoG). Most of the particles escape the Fraserestuary and mudflats, and enter the SoG in a buoyant plume. The fateof these particles now depends on how the plume responds to forcing bywind, river flow, and tides. The distribution of inorganic particlesaffects important processes such as light attenuation in the watercolumn and adsorption of contaminants.Previous studies of particle dispersal in the SoG were based on lighttransmission profiles or sediment traps, and they lacked sufficientresolution in time and space to adequately address how the large andfickle Fraser River plume responds to forcing. Satellite imagery canovercome some of these sampling limitations. In this talk we presentearly results from an analysis of 13 years of satellite imagery of theSoG. Maps of suspended particulate material were derived from theapplication of a single-band algorithm utilizing MODIS HiRes band 1(620 - 670 nm), which has a nominal resolution of 250 m.After validating the images with in situ optical and hydrographicdata, we conditionally average the images to determine how the plumevaries in response to river flow and wind speed and direction. Undercalm winds, the plume occupies an increasingly larger surface area asriver flow increases. Surprisingly, it undertakes a southward setunder calm winds, contrary to the influence of rotation. Undernorthwesterly winds, the plume is advected southward, even reaching asfar south as the San Juan Islands under strong winds. Undersoutheasterly winds the plume is advected to the northwest. However,it is important to point out that these are just average tendencies,and they are only somewhat representative of the myriad of shapes andsizes displayed by the plume.

Session 50601 - Coastal Oceanography and Inland waters - Part 2

Assessing performance of different wave breaking parameterizations over shallow water in spectral ocean wave models

Lin, Shangfei Sheng, Jinyu
Department of Oceanography,Dalhousie University
Shangfei.Lin@dal.ca

Depth-induced wave breaking is one of important dissipation mechanisms for ocean surface gravity waves in shallow waters. Various parametric energy dissipation schemes were suggested for parameterizing this process in ocean wave models. In this study the performance of five parametric schemes for depth-induced wave breaking specified in the third generation spectral wave models is assessed. The main differences between these five schemes are different representations of breaker index and fraction of breakers. The parameterization suggested by Battjes and Janssen (1978, BJ78) considers a constant value of breaker index and uses a truncated Rayleigh distribution to estimate the fraction of breakers in random wave field. The other four schemes are those suggested respectively by Nelson (1987, NE87), Thornton and Guza(1983, TG83), Ruessink et al.(2003, RU03) and Salmon et al. (2015, SA15). These five schemes are implemented in a triply-nested ocean wave model for the Gulf of Mexico based on SWAN for assessing their performance. The wave model results are compared with observational data over different types of bottom profiles under different wave breaking conditions. The simulated significant wave heights using both the BJ78 and SA15 schemes agree better with the observational data with the averaged error of less than 9%, in comparison with other three schemes. The significant wave heights using TG83and RU03 are under-predicted due to its overestimation of fraction of breakers, resulting in the equivalent error of about 15%. An additional energy dissipation is needed for plunging breakers, however, since the current parametric schemes overestimate the significant wave heights with the equivalent errors between 9%~79%. In terms of the spectral evolution of waves, nonlinear energy transfers become evident with the development of sub and super harmonics during the shoaling, and the dissipation of super-harmonic frequency energy due to wave breaking can be approximated better by the BJ78 scheme than others.

Session 50601 - Coastal Oceanography and Inland waters - Part 2

Preliminary results of applying a shallow acoustic tomography system to monitor tidal currents in Grand Passage, Nova Scotia

Razaz, Mahdi Zedel, Len   Hay, Alex Kawanisi, Kiyosi
Memorial University of Newfoundland
mrazaz@mun.ca

A trial experiment with the Fluvial Acoustic Tomography (FAT) system was carried out in Grand Passage, Nova Scotia, through 4 days of Aug 2014. Using two broadband FAT transceivers with a central frequency of 7.0 kHz and bandwidth of 2.5 kHz reciprocal transmissions every 30 sec. The results indicate the potential of the system for continuous measurements of channel-wide transport in tidal passages. In total, up to three stable arrivals could be identified in the acoustic receptions recorded by FAT. By computing the time delay between each two consecutive arrivals and comparing the corresponding data from opposite sound propagation paths, it was concluded that current shear has a trivial influence on sound propagation pattern. To examine the effect of bathymetry and sound-speed perturbations in inducing multiple arrivals BELLHOP ray-propagation model was used to generated arrival times. The model results indicated only two arrivals. It is hypothesized that the tertiary arrivals might be attributed to the presence of a near-surface bubble-dominant layer, which delays the arrival of a minor part of the total rays and attenuates the sound. The tomographically-derived flow velocities from all the three arrivals compare favorably with direct current measurements obtained using a moving-boat ADCP.

Session 50601 - Coastal Oceanography and Inland waters - Part 2

Simulation of wave-current interaction under Hurricane conditions using FVCOM

Sun, Yujuan Perrie, Will
Bedford Institute of Oceanography
perriew@dfo-mpo.gc.ca

Hurricanes not only could generate large waves up to tens of meters in the deep ocean, but also play a significant role through the effects of wave-current interactions on the storm surge and coastal inundation in the shallow water area. Understanding the processes of wave-current interaction is an essential part of investigating the ocean dynamics and the possible effects of climate change under extreme weather events. In this study, Hurricane Juan (2003) and Hurricane Bill (2009) are both simulated by the unstructured-grid ocean model FVCOM coupled to a surface wave model, SWAVE (which is a modification of the well-known SWAN wave model) in North Atlantic Ocean. The simulation results are validated through buoy observations and satellite altimeter data.We show that the coupled model is generally able to provide good simulations of these storms. For Hurricane Juan, the overall correlation coefficients between the simulated significant wave height and buoy 44137, 44142, and 44258 in-situ observations are 0.97, 0.93 and 0.94, while the root mean errors are 0.65m, 0.61m, and 0.55m separately. The comparison with the altimeter satellite track observed through 21:01UTC to 21:06UTC on September 26, 2003 are also shown to match well. The correlation coefficient of wind speed and wave height is 0.94 and 0.90, and the bias is 1.61m/s and 0.38m, respectively. For Hurricane

Bill, the simulated wave heights agreed well with the buoy 44141, 41048, 44008 and 44066, with the bias of 0.55m, 0.55m, 0.50m, and 0.49m, respectively. The effect of the wave-current interactions is most notable in the coastal regions. For Hurricane Juan, the average difference of significant wave heights between the SWAVE simulation and altimeter observation is about 0.71m. The average improvement in accuracy when wave-current interactions are included is 7%, and the maximum improvement in accuracy is as high as 24%.

Session 50601 - Coastal Oceanography and Inland waters - Part 2

TSA - the two-scale approximate in the operational WAVEWATCHIII forecast model

Toulany, Bash Perrie, Will
Bedford Institute of Oceanography
perriew@dfo-mpo.gc.ca

TSA is implemented in WAVEWATCHIII (WW3), and is available to WW3 developers group as SNL4 branch, in early 2016, and to be available for general WW3 users with the next release version of WW3, namely version 5.xx. Whats new with TSA? The operational version of TSA has been redeveloped, and has the following features: a) alternate loop integration over wave angle bins, and wavenumber bins, for enhanced speed, b) careful selection of integration area in wavenumber space, for enhanced speed, c) multiple broad-scale terms for complex seas, e.g. turning winds, windsea-swell interactions, etc., with multiple swell components, d) use of MPI and OMP optimization / parallelization available in WW3. The final composite efficiency for WW3 using ST4 source terms is just about 10X slower that running WW3 with DIA code. Tests are presented using simple academic cases, like fetch limited growth and turning winds cases, showing that the new TSA generally works well in these situations, and also describes its limitations, and biases. Additional tests cases include actual storms where wave observations have been collected: hurricane Juan from 2003, and three noreaster storms in the NW Atlantic.

Session 50602 - Coastal Oceanography and Inland waters - Part 3

Numerical Model of Shelburne, Nova Scotia with Application to Aquaculture

Haigh, Susan Page, Fred Law, Brent Pratomo, Danar Losier, Randy Change, Blythe Greenberg, David
St Andrews Biological Station, Fisheries and Oceans Canada
susan.haigh@dfo-mpo.gc.ca

Shelburne, Nova Scotia is an area with an active aquaculture industry. With the presence of fish farms comes the need to map the transport and deposition of organic waste and the transport of pesticides, both of which require knowledge of the water circulation in the area. To this end, the Finite Volume Community Model (FVCOM) has been implemented for Shelburne, Nova Scotia with the goal of providing improved predictions of environmental impacts of fish farms in this area. The model is run in barotropic mode and is forced with tides on the open boundaries and surface winds. The model is validated against moored ADCP data. The usefulness of the model to acquaculture regulators is explored.

Session 50602 - Coastal Oceanography and Inland waters - Part 3

Development and application of FVCOM off Newfoundland

Han, Guoqi Ma, Zhimin   deYoung, Brad Pepin, Pierre Xie, Yingda Chen, Nancy Ratsimandresy, Andry Donnet, Sabastien
Fisheries and Oceans Canada
Guoqi.Han@dfo-mpo.gc.ca

In the past several years Fisheries and Oceans Canada and Memorial University collaboratively developed and applied the finite volume coastal ocean model (FVCOM) to address oceanographic and ecosystem issues off Newfoundland. The model domains vary from the Newfoundland and Labrador Shelves, Eastern Newfoundland Coast, Placentia Bay, Fortune Bay to Arnolds Cove. The model results are validated against in situ and satellite observations. We examine circulation variations at tidal, storm, seasonal, and interannual time scales. The model results are used to under circulation dynamics and to examine implications for particle transport and larval dispersion. In this talk we summarize the FVCOM applications in Newfoundland waters from shelf to harbour scales and from tidal to interannual scales.

Session 50602 - Coastal Oceanography and Inland waters - Part 3

Seasonal variability of air-sea CO2 fluxes in the Yellow and East China Seas

Lu, Youyu Wei, Hao   Zhao, Liang Lu, Youyu
Fisheries and Oceans Canada
Youyu.Lu@dfo-mpo.gc.ca

An inorganic carbon system module is developed and coupled with a physical-ecological model based on the concept of continental shelf sea carbon cycle. Seasonal air-sea CO_2 flux (FDIC) distribution in the Yellow Sea (YS) and East China Seas (ECS) are simulated and compared with available observations. Model results suggest that the whole region serves as a significant sink (-7.1 ± 3.6 mmol m-2 day-1) of atmospheric CO_2 in winter, and a moderate sink (-1.6 ± 0.8 mmol m-2 day-1) in spring. In summer, the YS and the Changjiang Estuary are sink areas, while the middle and outer shelves of the ECS provide moderate sources. In autumn, the Changjiang Bank and the Subei Shoal are areas with significant sources. The factors contributing to seasonal and regional variations of carbon sink/source are analyzed, with a supplementing model sensitivity experiment that excludes biological activities. In winter and spring, the low ambient temperature causes lower pCO_2 in the surface water relative to the atmospheric pCO_2, making the YS and ECS to be carbon sinks. In summer, photosynthesis plays a dominant role in causing the central YS and the Changjiang Bank to be carbon sinks. Without biological activities, these areas would become carbon sources. In autumn, the phytoplankton growth and the biological cumulative effect make the central YS to be a carbon sink, and vertical mixing makes the Changjiang Bank as a carbon source through bringing mounting DIC into the euphotic layer. In the middle shelf, seasonal cycle of the FDIC is mainly controlled by that of the SST. The Kuroshio Subsurface Water intrusion serves as a net DIC source for the euphotic layer in the shelf. Overall, the dynamic phytoplankton production and various ocean circulation branches induce seasonal and regional changes of FDIC in the YS and ECS.

Session 50602 - Coastal Oceanography and Inland waters - Part 3

Simulation of Atlantic salmon post-smolt movement along the north shore of the Gulf of St. Lawrence

Ohashi, Kyoko Sheng, Jinyu
Dalhousie University
kyokoohashi@gmail.com

We simulate the movement of Atlantic salmon (<i>Salmo salar</i>) post-smolts (juveniles that have left their natal rivers and entered a saltwater environment) using a combination of circulation fields simulated by a numerical ocean circulation model and a numerical particle-tracking scheme. Particles representing post-smolts are released near a river mouth on the north shore of the Gulf of St. Lawrence (GSL), and their movement due to both the ambient currents and active swimming behaviour are tracked with a time step of one hour. We conduct experiments with various swimming behaviours specified for the particles, with the aim of matching an observational study in which a post-smolt released from a river on the north shore of the GSL was observed at the Strait of Belle Isle (northeastern exit of the GSL) after 44 days. Our results suggest that post-smolts need to adjust their swimming behaviour according to the direction of ambient currents, and that variations in the circulation fields on the scale of <i>O</i>(weeks) have a significant effect on the eastward movement of post-smolts against the prevailing westward currents in this area.

Session 50602 - Coastal Oceanography and Inland waters - Part 3

Effects of Model Parametrization on Lagrangian Particle Tracks in the Bay of Fundy

Page, Fred Haigh, Susan Losier, Tristan Shija, Neema Scouten, Sarah Corrigan, Sean Losier, Randy MacAulay, Phillip
St Andrews Biological Station, Fisheries and Oceans Canada
susan.haigh@dfo-mpo.gc.ca

A real-time operational hydrodynamic model of the Saint John Harbour, New Brunswick and the Bay of Fundy is being developed as part of the Government of Canada World Class Tanker Safety E-Nav initiative. The model is based on the Finite Volume Community Ocean Model (FVCOM). The open boundaries are forced with output from a NEMO model as well as tides. Observed river levels are used to force the Saint John River. At the surface, the model is driven using output from an Environment Canada weather model. Model validation includes comparison with stationary current meter data and Lagrangian drifter tracks. The effect of model parametrization on the predicted Lagrangian drift tracks is presented and their implications for potential uses of the model are discussed.

Session 50602 - Coastal Oceanography and Inland waters - Part 3

A modelling study of dispersion properties in Vancouver Harbour

Wu, Yongsheng OFlaherty-Sproul, Mitchell   Hannah, Charles
Bedford Institute of Oceanography
Yongsheng.Wu@dfo-mpo.gc.ca

In the present study, the dispersion properties in the Vancouver Harbour have been investigated using a hydrodynamic model with a high horizontal resolution (~ 10m) based on the Finite Volume Community Ocean Model (FVCOM). The model was evaluated against the surface drifter data and good agreement was obtained. The model results (surface currents) were then used to drive a particle tracking model for a series of modelling experiments by releasing tracers at different places and times. The results showed that the spreading rate of particles was controlled by the two Narrows, the First Narrows and the Second Narrows, where tidal currents are strong and tidal jets are formed. The spreading rate and the trajectory of particles are strongly sensitive to the time and place, when and where the particles are released.

Session 50603 - Coastal Oceanography and Inland waters - Part 4

Turbulence and the momentum balance in a deep-water renewal event

Hay, Alex Dewey, Richard
Dalhousie University
alex.hay@dal.ca

Multiple deep-water renewal events in the Strait of Georgia have been captured with a heavily instrumented bottom lander, the BBLpod, connected to the VENUS cabled ocean observing system in the Strait of Georgia, British Columbia at 50 m depth. The inflows are bottom-trapped, ca. 50 m thick, with (non-tidal) ca. 0.5 m/s flow speeds. They are driven by the excess density associated with the higher salinity of the inflow water and possibly also the high concentrations of suspended sediment entrained from the seabed as the current flows down- and along-slope. Using the high-sampling rate beam-coordinate velocities from the two upward-looking ADCPs mounted on the BBLpod, vertical profiles of second-order turbulence quantities - Reynolds stress, dissipation rate and turbulent kinetic energy - are obtained. The Reynolds stress estimates are used to determine the bed shear stress and interfacial shear stress at the top of the flow, and compared to values determined from the mean flow profile via - for example - the law-of-wall. The implications of the results for the vertically-integrated momentum balance are discussed.

Session 50603 - Coastal Oceanography and Inland waters - Part 4

Measurements of the Rate of Dissipation of Turbulent Kinetic Energy in a High Reynolds Number Tidal Channel

McMillan, Justine Hay, Alex Lueck, Rolf Wolk, Fabian
Dalhousie University
justine.mcmillan@dal.ca

The rate of dissipation (?) of turbulent kinetic energy at mid-depth in a high speed tidal channel is estimated using measurements from both a standard acoustic Doppler current profiler (ADCP) and shear probes mounted on an underwater, streamlined buoy. The investigation was carried out in Grand Passage, Nova Scotia where the depth-averaged flow speed reached 2 m/s and the Reynolds number was 4x10⁷. The dissipation rates estimated from the ADCP data agree with the shear probe data to within a factor of two, with some of the discrepancy attributed to the 40 m separation of the instrument platforms. Both the ADCP and the shear probe measurements indicate a linear dependence of ? on the cube of the flow speed during flood tide with maximum values reaching 5x10⁻⁵ W/kg. Much lower dissipation rates were observed on the ebb tide when the convergence of the flow in the narrowing channel suppresses the turbulent fluctuations.

Session 50603 - Coastal Oceanography and Inland waters - Part 4

Effect of coastal submarine canyon dynamics on the cross-shelf exchange of nutrients and oxygen

Ramos Musalem, Karina Allen, Susan Elizabeth
Department of Earth, Ocean and Atmospheric Sciences, UBC
kramosmu@eos.ubc.ca

The exchange of water and solutes between the coastal area and the open ocean is of great importance to biogeochemical fluxes, nutrient budgets and their response to climate change and human activities. On a regional scale, submarine canyons are known to enhance physical processes such as shelf-slope mass exchange and mixing. There is good understanding of the flow around upwelling submarine canyons; however, the flux of biologically relevant tracers such as oxygen and nitrate is less understood. The objective of this work is to characterize the impact that upwelling dynamics within a submarine canyon has on the spatial and temporal distribution, and cross-shelf exchange of nutrients having different initial concentration profiles. For that purpose, numerical experiments simulating an upwelling event near an idealized canyon were performed using realistic nutrient and tracer profiles from Barkley Canyon, BC taken during the Pathways Cruise 2013.This work presents results from numerical experiments using the community model MITgcm when varying the initial concentration profiles for six different tracers; it also suggests a physical mechanism through which each final distribution is reached. We find that for all tracers, the depth of strong gradients is key to the exchange process, allowing more tracer transport when located deeper than the shelf break. Added to this, enhanced mixing within the canyon drives a higher diffusive transport, while the lower background diffusivity allows relatively unmixed ocean water onto the shelf, near the bottom. Thus, the regime that leads to the lowest, deep oxygen concentration on the shelf, is not the same as that which leads to the highest shelf nitrate inventory. Taken together, our work shows that the tracer pathways developed by the canyon dynamics, locally enhanced mixing and initial tracer profile have significant implications for the final tracer distribution on the shelf.

Session 50603 - Coastal Oceanography and Inland waters - Part 4

The Alongshore Tilt of Mean Dynamic Topography and Implications for Nearshore Circulation and Regional Vorticity Balance

Renkl, Christoph Thompson, Keith R.
Department of Oceanography, Dalhousie University
christoph.renkl@dal.ca

Coastal tide gauge observations in combination with the latest generation of geoid models are providing observations of the alongshore tilt of mean dynamic topography (MDT) with unprecedented accuracy. Additionally, high-resolution ocean models are providing better representations of nearshore circulation and the associated tilt of MDT along their coastal boundaries. The alongshore tilt of MDT is an important component of the alongshore momentum balance. As shown by Stewart (1989), it can also be related to the stress gradient at the coastal boundary and vorticity transport to the ocean interior. In this study, we explore how different boundary conditions and stress parameterizations affect the alongshore tilt of MDT and, conversely, what the observed tilts of MDT can tell us about nearshore circulation and regional distributions of vorticity.Using a regional-scale configuration of the NEMO ocean model with a grid spacing of 1/36°, the tilt of MDT along the coast of Nova Scotia and Gulf of Maine is predicted, using different lateral boundary conditions and stress parameterizations. These predictions are then compared to independent estimates of MDT based on tide gauge observations referenced to the Canadian Gravimetric Geoid model (CGG2013). We first show that the observed and predicted tilts are in good agreement. It is next shown that the nearshore circulation depends on the form of the coastal boundary condition, but, somewhat counterintuitively, the associated alongshore tilt of MDT does not. Reasons for this are given. Furthermore, we relate the alongshore tilt to regional distributions of vorticity and discuss the possibility of using observed alongshore tilts of MDT to validate ocean models, and monitor shelf circulation.

Session 50603 - Coastal Oceanography and Inland waters - Part 4

Hydrodynamic connection between the Gulf of the St. Lawrence and adjacent coastal and shelf waters of the northwest Atlantic Ocean

Wang, Yuan Sheng, Jinyu
Dalhousie University
yuan.wang@dal.ca

Distributions of circulation and tracers in the Gulf of the St. Lawrence (GSL) are affected by many physical processes such as tidal mixing, estuarine plume and atmospheric forcing at the sea surface. The GSL is also affected by the large-scale ocean circulation over the eastern Canadian Shelf and adjacent deep waters of the northwest Atlantic (NWA) through Cabot Strait and the Strait of Belle Ile. The main objective of this study is to have better understanding of dynamic connections of circulation and hydrography in the GSL with those outside of the GSL through Cabot Strait. The coupled circulation-ice model based on the NEMO is used this study. The coupled model is applied to the northwest Atlantic Ocean (NWA) with a 1/12o horizontal resolution and 50 vertical z-levels. The model is driven by a suite of external forcing including tides, atmospheric forcing, tides and river runoff. The atmospheric forcing at the sea surface is taken/derived from the 6-hourly fields of Climate Forecast System Reanalysis (CFSR). The model is also driven by the monthly climatology of freshwater runoff from fifteen major rivers in the study region. The model is integrated for the 15-year period 1996-2010. A comparison between model results and oceanographic observations demonstrates that the coupled circulation-ice model performs well in simulating tides, density-driven circulation, ice cover, and temperature and salinity distributions in the GSL and adjacent coastal and shelf waters. The analysis of model results confirms previous findings that circulation and variability inside the GSL are affected significantly by those outside the Gulf due to the major hydrodynamic connection through Cabot Strait. It also shows that the inflow (northward) over the eastern part of Cabot Strait is highly dynamic and has significant impact on the temperature and salinity variability within the GSL.

Session 50800 - Collaboration in development, evaluation and analysis of ocean models

Sea Ice Analysis using a Framework based on 3D Surfaces

Chan, Ting On Myers, Paul G. Hu, Xianmin

Department of Earth & Atmospheric Sciences, University of Alberta

ting.chan@ualberta.ca

Sea ice in the Arctic Ocean plays a very important role in the global climate system. Its coverage and thickness have been monitored over decades by sensors equipped on satellites, and by other instruments. Sea ice is also widely studied using numerical ocean circulation and sea-ice models such as the NEMO (Nucleus for European Modeling of the Ocean) - LIM (Louvain-la-Neuve Sea Ice Model). More often, the sea ice observation and the estimates produced by the models are compared and analyzed simultaneously in a study. Other than locally interpolating the observations for comparisons, 3D (three-dimensional) surfaces can be constructed using the observations over a region. We present a framework for sea ice observation-model comparison and analysis using 3D trend surfaces (based on polynomial fitting) and the NURBS (nonuniform rational B-splines) surfaces. We focus on the comparison between the sea ice thickness derived from the ICESat (Ice, Cloud, and the Land Elevation Satellite) and those estimated by our coupled ocean and sea-ice models based on the NEMO. The analysis is conducted for the winter of 2003 - 2007 over the entire Arctic Ocean and several ice-rich sub-regions such as the Beaufort Sea. Also, along-track sea ice observations from airborne survey is analyzed along with our model outputs.

Session 50800 - Collaboration in development, evaluation and analysis of ocean models

Ocean Circulation and Marine Terminating Glaciers of the Greenland Ice Sheet

Gillard, Laura   Hu, Xianmin   Myers, Paul

University of Alberta

gillard2@ualberta.ca

The Greenland Ice Sheet (GrIS) stores the largest amount of freshwater in the northern hemisphere, and in recent years, has been losing mass at an increasing rate. This lost mass is added to the surrounding oceans as freshwater. Based on estimates from a glacial mass balance model, an eddy-permitting ocean/sea-ice general circulation model (Arctic and Northern Hemisphere Atlantic configuration of NEMO) is forced with realistic estimates of meltwater runoff from the GrIS. Using two approaches to track the meltwater (a passive tracer and offline Lagrangian technique), we examine where this discharge is taken up in the high-latitude ocean. Here we show freshwater from western and eastern Greenland have very different fates, at least on a decadal timescale. Freshwater from west Greenland mainly ends up in Baffin Bay, before being exported south down the Labrador shelf. Meanwhile, freshwater entering the interior of the Labrador Sea, where deep convection occurs, comes mainly (~80%) from east Greenland. Our results suggest the need to understand the regional aspects of changes in the GrIS if we wish to understand how its evolution in a warming climate may affect the ocean. It has been shown that relatively warm ocean waters may accelerate melt production of marine terminating glaciers. We explore and classify the pathways for the warmer Atlantic waters that reach the fjords along the

coasts of Greenland. Preliminary work will be shown of a high resolution Baffin Bay NEMO model configuration, to examine the role of ocean bottom topography in impacting shelf-basin exchange.

Session 50800 - Collaboration in development, evaluation and analysis of ocean models

Greenland meltwater into the Labrador Sea in numerical simulations with CORE-II and CGRF forcing

Hu, Xianmin Myers, Paul G.
Department of Earth and Atmospheric Sciences, University of Alberta
xianmin.hu@gmail.com

Increasing meltwater from Greenland is an important freshwater source into the ocean. This is true not only regionally but also for the whole Arctic and subarctic. In recent years, studies have focused on the impact on neighbouring seas and ocean dynamics while early studies examined questions of global sea level and meridional overturning circulation changes. This study will focus on the meltwater transported into the Labrador Sea in response to the surface atmospheric forcing.To study the potential impacts of surface atmospheric forcings on Greenland meltwater into Labrador Sea, we set up twin experiments using a 1/4 degree resolution NEMO regional configuration (ANHA4, Arctic and North Hemisphere Atlantic), with inter-annual CORE-II and CGRF atmospheric forcings. Inter-annual runoff, including realistic Greenland meltwater (icebergs excluded), is utilized in the simulations. Online passive tracers are enabled to trace the meltwater from Greenland. The basic simulated ocean physical properties will be shown first. Then we will present the pathway and time scale of Greenland meltwater into the Labrador Sea. Taking advantage of passive tracers, we will also estimate the lateral exchange of Greenland meltwater into Labrador Sea, particularly the northern region.

Session 50800 - Collaboration in development, evaluation and analysis of ocean models

Evaluation of hindcasts simulations with the CONCEPTS regional ocean and sea-ice model covering three oceans around Canada

LEI, JI Roy, François Dupont, Frédéric Smith, Gregory Lu, Youyu Higginson, Simon Lemieux, Jean-François
ECCC and DFO
ji.lei@canada.ca

A new regional ocean model domain that includes the North Atlantic Ocean, the Arctic Ocean and the North Pacific Ocean has been established under the NEMO-CICE frame of Canadian Operational Network of Coupled Environmental Prediction Systems (CONCEPTS). With a space resolution of ¼ degree, the model can run fast on Environment and Climate Change Canada (ECCC) super computers. A series of hindcasts (2004-2010) simulations has then been carried out to test the models sensitivity to various physical factors. The results are evaluated against in-situ observation, reanalysis data, and products from other models. The results of these runs will guide the future development of the operational Regional Ice-Ocean Prediction System (RIOPS) run at ECCC.

Session 50800 - Collaboration in development, evaluation and analysis of ocean models

NEMO modelling with the Arctic Northern Hemisphere Atlantic Configuration

Myers, Paul Hu, Xianmin Pennelly, Clark Castro de la Guardia, Laura Chan, Ting On Garcia, Yarisbel   Gillard, Laura Grivault, Nathan Holdsworth, Amber Marson, Juliana Ridenour, Natasha   Courtois, Peggy
University of Alberta
pmyers@ualberta.ca

Here we examine a suite of NEMO model simulations using the Arctic Northern Hemisphere Atlantic (ANHA) configuration run at 1/4 and 1/12 degree resolution. The 1/12 degree simulations include those with the AGRIF grid refinement package. Questions examined include how NEMO represents the mixed layer depth in regions of deep convection (and how it can be improved), Labrador Sea Water formation rates, gateway transports between the Arctic and the North Atlantic and freshwater exchange processes between the boundary currents and the interior. The use of the TOP package for passive tracers and coupling to the biogeochemical model BLING will be discussed. Finally, planned future developments and studies will be highlighted.

Session 50800 - Collaboration in development, evaluation and analysis of ocean models

Schwarz-Christoffer Conformal Mapping based Grid Generation for Global Oceanic Circulation Models

Xu, Shiming
Tsinghua University
xusm@tsinghua.edu.cn

Grid generation methods based on Schwarz-Christoffer conformal mappings are proposed for ocean general circulation models. By mapping user prescribed, irregular boundaries to those with regular boundaries (i.e., disks, slits, etc.), we generate OGCM grids for the high-resolution and multi-scale ocean modeling. The generated grids could potentially achieve the alignment of grid lines to the large scale coastlines, enhanced spatial resolution in coastal regions, and easier computational load balance. Since the grids are orthogonal curvilinear, they can be easily utilized by the majority of OGCMs that require grid orthogonality. The proposed grid generation methods can also be applied to the regional ocean modeling where complex land-sea distribution is present.

Session 50801 - Collaboration in development, evaluation and analysis of ocean models - Part 2

Coastal upwelling off southwest Nova Scotia simulated with a high resolution baroclinic ocean model

Chegini, Fatemeh Lu, Youyu Ritchie, Hal Thompson, Keith Katavouta, Anna
Department of Oceanography, Dalhousie University
hal.ritchie@canada.ca

This study is part of a larger effort to develop relocatable high resolution ocean forecasting systems by downscaling from global and regional systems. The present model is developed to study circulation off southwest of Nova Scotia (SWNS) and is downscaled from a regional model of the Gulf of Maine and Scotian Shelf (GOMSS). This three dimensional baroclinic model is based on NEMO (Nucleus for European Modelling of the Ocean), has a horizontal resolution of approximately 700 m and uses 40 vertical z-levels with a variable spacing of 0.5 m at the surface to 12 m at the deepest level. The maximum water depth is 305 m. The model is forced with realistic meteorological forcing. The initial and boundary conditions are derived from a larger-scale model covering the GOMSS region. The objective of this study is to investigate the seasonal variability of SWNS dynamics using improved representation of circulation. The transport pathway of upwelled water and the role of physical processes on particle movements are also studied. In this presentation, details of the model development will be discussed. The model performance will also be evaluated by comparing the numerical results with observations. Analysis of the influence of tidal, wind and density induced currents on the upwelling process off Cape Sable, southwest of Nova Scotia will be presented. It is shown that the dominant forcing is different in summer and winter, with near bottom cross-isobath currents being strong in summer throughout the whole region, but weaker and only in deeper regions in winter. It is confirmed that shoreward currents are due to tides. This study is funded by the Marine Environmental Observation, Prediction and Response (MEOPAR) Network of Centers of Excellence.

Session 50801 - Collaboration in development, evaluation and analysis of ocean models - Part 2

Toward a National Repository of Ocean Modeling Code and Best Practices

Latornell, Doug Allen, Susan Dumont, Dany Lapointe, Stéphane Lu, Youyu
University of British Columbia
dlatornell@eos.ubc.ca

Sharing of code and documentation of best practices for modeling reduces repetition of work, increases the quality of the code, and boosts research productivity. MEOPAR, in collaboration with CONCEPTS, and research groups across Canada are implementing a collection of on-line resources. The resources will facilitate sharing code and documentation for models, tools to prepare and execute model runs, and tools and techniques to analyze model results. The focus will be on the core ocean models, NEMO and FVCOM, the coupled wave and ice models, WAVEWATCH III (TM) and CICE, and processing and application of AIS ship movement data. The intent is to create a national community resource that will help sustain long-term Canadian leadership in ocean and environmental modeling.This talk will survey existing resources that may be integrated into the planned framework, or serve as patterns or inspiration for the resources that we are developing. One example is the mechanisms for sharing model configurations and region/research-specific code changes in ways that preserve the provenance of the code model. Another is automated web publication of practical documentation. The goal is to facilitate sharing by hands-on users of up-to-date instructions on how to set up the models on various computing platforms, prepare boundary conditions and forcing inputs for model runs, and how to use a variety of software tools to analyze model run results. Such instructions are

invaluable to new and experienced researchers alike.The development status and roadmap for the repository will also be discussed.

Session 50801 - Collaboration in development, evaluation and analysis of ocean models - Part 2

Evaluation of the Surface Flows and Mean Currents in the Fraser River Plume in a Model

Liu, Jie Allen, Susan Soontiens, Nancy   Halverson, Mark
University of British Columbia
jieliu@eos.ubc.ca

The Fraser River plume is the brackish surface layer formed by discharge of the Fraser River into the Strait of Georgia. The Salish Sea MEOPAR team has developed a three-dimensional baroclinic model of the Salish Sea, including the Strait of Georgia, which produces daily nowcasts and forecasts for salinity, temperature,currents and sea surface height. One of the goals of the project is to accurately model the Fraser River plume. The model was initially configured with a crude representation of the Fraser River, and comparison of the modelled surface currents to observations revealed significant errors. For example, cross-strait flows were weaker in the model than in the observations. By adding an extended and deepened river channel in the model, cross-strait surface flows in the plume are improved when compared to ferry-based observational data. Meanwhile, reducing both the minimum vertical eddy viscosity and the diffusivity help minimize the discrepancy between modelled and observed particle trajectories. However, mean surface currents do not match well with the surface currents observed by HF radar. Finally, we will discuss how mean currents in the model are influenced by tides, winds and freshwater flow.

Session 50801 - Collaboration in development, evaluation and analysis of ocean models - Part 2

Discussion on development, validation and application of Canadian ocean models

Lu, Youyu Greenberg, David   Allen, Susan Dupont, Frederic
Fisheries and Oceans Canada
Youyu.Lu@dfo-mpo.gc.ca

Ocean models based on NEMO (The Nucleus for European Modelling of the Ocean) and FVCOM (Finite Volume Community Ocean Model) are being used and developed for major Canadian projects such as CONCEPTS, MEOPAR, VITALS, GEOTRACES and WCTSS. The development has benefited greatly from sharing expertise, code, software and data among various groups from government laboratories and universities. This presentation reviews progress and challenges, major model configurations, linking of the two models,code versions, metrics for model evaluation, and highlights of scientific and operational applications. The presentation aims to inspire discussions on how to improve collaboration in model development and research.

Session 50801 - Collaboration in development, evaluation and analysis of ocean models - Part 2

Improving the Representation of Mixing, Transport, and Deep Water Renewal in a Numerical Model of a Sill-Basin Estuarine System

Soontiens, Nancy Allen, Susan
University of British Columbia
nsoontie@eos.ubc.ca

The Straits of Juan de Fuca and Georgia make up a semi-enclosed, sill-basin, estuarine-like system between Vancouver Island and the mainland of British Columbia and Washington State. Fresh water enters the system by way of many rivers and exits towards the Pacific Ocean through the Strait of Juan de Fuca at the west and Johnstone Strait at the north. The largest volume of water exits through the Strait of Juan de Fuca, where it first passes over complicated bathymetry and endures strong tidal mixing with the inflowing dense waters from the Pacific Ocean. This mixing modulates the renewal of dense water into the Strait of Georgia basin and is very difficulty to accurately diagnose in numerical ocean models, especially in operational settings where demands on computational resources are high. The Strait of Georgia is well-instrumented with an extensive array of observational equipment making it a useful domain for testing and improving ocean model mixing parametrizations. In this talk, we will present a three-dimensional, baroclinic model of this system and will outline strategies for improving how the model represents the deep water renewal process. We will discuss the role of advective and mixing processes on the freshwater transport and will outline model sensitivities to several mixing parametrizations. Finally, we will discuss a numerical instability that strongly impacts the estuarine exchange in this system.

Session 50801 - Collaboration in development, evaluation and analysis of ocean models - Part 2

Semi-Lagrangian Advection in NEMO

Subich, Christopher Pellerin, Pierre Smith, Greg
Environment Canada
Christopher.Subich@ec.gc.ca

At one-quarter degree resolution, ocean simulations based on the NEMO framework are partially eddy-resolving, and their ultimate effective resolution is limited by both explicit numerical diffusion and implicit stabilization properties of the advection schemes. The semi-Lagrangian method permits the use of higher-order, less-diffusive interpolation for the advection of both tracer and momentum quantities, improving the models ability to capture rapidly-varying features.This presentation discusses the implementation details of the semi-Lagrangian advection scheme, its impacts on conservation and effective resolution of eddies in a multi-year simulation, results from select theoretical test-cases, and the potential for relaxing strict Courant number limitations in regions of fine grid resolution such as the Canadian Arctic Archipelago.

Session 50900 - The emerging Arctic Ocean and ocean-atmosphere interactions

Modeling Sea-Ice Thermodynamics Forced by a Cabled Ocean Observatory

Dewey, Richard Loewen, Ada
Ocean Networks Canada
rdewey@uvic.ca

In 2012, Ocean Networks Canada installed a cabled ocean observatory in Cambridge Bay, Nunavut. The shallow water system includes a shore-based weather station and in-water sensors to monitor the coastal marine conditions in 6-8m of water. Servicing of the observatory each summer has resulted in a near continuous record of the marine conditions over 4 years. The data include standard meteorological measurements (air temperature, wind speed and direction, and solar radiation), and near bottom measurements of seawater temperature, salinity, dissolved Oxygen, and ice draft thickness. A simple thermodynamic model has been developed to test various sea-ice thermodynamic formulations. The goals are to enhance the models skill using real-time observations to better predict the dates of both freeze-up and break-up. These critical periods often limit safe transportation on the ice and in the marine environment and are likely to evolve dramatically under the influence of climate change.

Session 50900 - The emerging Arctic Ocean and ocean-atmosphere interactions

The new operational 1/12th degree resolution Arctic-North Atlantic ice-ocean prediction system at Environment Canada.

Dupont, Frederic Lemieux, Jean-François Lei, Ji Roy, François Smith, Gregory Caya, Alain Lu, Youyu Higginson, Simon Xu, Jinshan Davidson, Fraser Garric, Gilles Bourdalle-Badie, Romain
MSC, Environnement et Changements Climatiques Canada
frederic.dupont@canada.ca

The Canadian Operational Network of Coupled Environmental Prediction Systems (CONCEPTS) has developed a 5km Regional Ice-Ocean Prediction System (RIOPS) based on NEMO-CICE. The domain covers the Arctic and North Atlantic regions. The objective is to provide Canada with short-term ice-ocean predictions and hazard warnings in ice-infested regions. RIOPS includes in particular explicit tides and a landfast ice parametrization based on the effect of grounded ice ridges (for improved representation over shallow waters) and on an increased resistance to tension and shear in the ice rheology (for improved representation in land-locked areas). The analysis component of the system is for the moment based on a simple approach where the simulated large scales are spectrally nudged towards the coarser analysis provided by the operational global ice-ocean system (1/4th degree resolution). The system produces four 48h forecasts a day of future ice and ocean conditions with an output frequency of three hours for all fields. The system is evaluated using satellite products and in situ data and compares favourably to the existing global ice-ocean system and the regional ice only prediction system.

Session 50900 - The emerging Arctic Ocean and ocean-atmosphere interactions
Changes in Water Temperature in the Barents Sea in the 21st Century
Long , Zhenxia   Perrie, Will
Bedford Institute of Oceanography
perriew@dfo-mpo.gc.ca
We explore possible modifications to the water temperature in the Barents Sea induced by climate change, performing simulations for 1970 to 2099 with a coupled ice-ocean Arctic model (CIOM). The surface fields to drive CIOM are provided by the Canadian Regional Climate Model (CRCM), driven by the third-generation Canadian Global Climate Model (CGCM3) outputs following the A1B climate change scenario. Compared to observations, CIOM can reproduce the basic patterns of the water temperature and sea ice. While the CIOM simulations show the observed magnitudes of water volume inflow and heat flux through the Barents Sea Opening, both the CIOM simulation and the observations suggest a positive trend in the Atlantic water volume inflow and associated heat flux into the Barents Sea, due to enhanced storm activity in the region. Under the A1B climate change scenario, the loss in sea ice significantly increases both the solar radiation, and the ocean surface heat loss in the Barents Sea. Moreover, there is an increasing trend in the lateral heat flux into the Barents Sea. Therefore, in this region, the changes in the water temperature depend on the heat balance among the solar radiation, surface turbulence heat flux and lateral heat flux. During this period, the average water temperature tends to increase from 0oc to 1oC, in the southwestern Barents Sea, mostly due to the increased lateral heat flux and solar radiation. However, in the northeastern Barents Sea, the average water temperature shows a decreasing trend from ~ -0.2oC in the 2010s to ~ -0.6oC in the 2040s, suggesting that the increased surface heat flux are the dominant impacts.

Session 50900 - The emerging Arctic Ocean and ocean-atmosphere interactions
Wave-ice interactions in the operational WAVEWATCHIII forecast model
Perrie, Will Hu, Yongcun Toulany, Bash
Bedford Institute of Oceanography
perriew@dfo-mpo.gc.ca
WAVEWATCHIII (WW3) is adapted for wave scattering in the marginal ice zone (MIZ) following earlier development by Masson and LeBlond (1989, JFM), Perrie and Hu (1996, JPO) and Meylan and Masson (2006), and correcting errors in earlier formulations. Presently, no practical methodology has been developed to directly incorporate a reliable wave attenuation scattering model for the MIZ, into a model like WW3. As part of a recent ONR initiative, Squire et al. (2014) developed a phase resolved scattering model which is capable of simulating hundreds of elastic ice floes. However, the latter model cannot be incorporated into WW3 directly. By comparison, the theory of how to include scattering into ocean wave models was developed by Masson and LeBlond (1989), Meylan et al. (1997), and Meylan and Masson (2006) ; but Perrie and Hu (1996) were the only ones to make such an implementation in an earlier 2nd generation wave model. One limitation on their methodology is that they used rigid floes, whereas ice floe flexure can be expected to dominate for large floes, (Meylan and Squire, 1994; 1996). However Perrie and Hu (1996) were able to predict many of the features observed in measurements such as the roll over effect and the strong dependence of wave scattering on wave period. Moreover, the change from rigid to flexural ice floes is quite feasible to implement. We

propose to update and optimize this model approach for wave-ice attenuation and scattering, with implementation in WW3. The resulting model system will be validated with in situ and satellite remotely sensed MIZ data, and from field conditions during the ONR field experiments in the Beaufort Sea during October 2015.

Session 60100 - Lithospheric Structure of Eastern North America

Seismic anisotropic fabrics in eastern and northern Canada : evidence from shear wave splitting measurements

Darbyshire, Fiona Bastow, Ian Gilligan, Amy Dubé, Jean-Michel Forte, Alessandro
GEOTOP, Université du Québec à Montréal
darbyshire.fiona_ann@uqam.ca

Shear wave splitting measurements are used to determine the orientations and strength of anisotropic fabric in the upper mantle. Whether this anisotropy is caused primarily by fossil fabrics preserved in the continental lithosphere or by present-day sublithospheric flow, or some combination thereof, has been the subject of debate for several decades. With the increase in seismograph station coverage in eastern and northern Canada, new data sets are able to contribute to the evidence for lithospheric vs sublithospheric anisotropy.We examine the variation in fast-polarisation orientations and splitting delay times across eastern and northern Canada in the context of geological and geophysical constraints such as major tectonic boundaries, potential-field anomalies, absolute plate motion and geodynamic models of sublithospheric mantle flow.In some regions, notably the Canadian Maritimes and northernmost Canada, fast-polarisation orientations exhibit a strong correspondence with tectonic boundaries. In these areas, plate-scale lithospheric deformation related to past tectonic processes such as the Appalachian and Eurekan orogenies, respectively, appear to dominate the anisotropic fabric. Splitting measurements at long-term Arctic Canadian seismograph stations, though incomplete in back-azimuthal coverage, suggest systematic variations that likely indicate multiple anisotropic layers. Across much of central-eastern Canada, we observe partial correlation both with tectonic structures and with present-day mantle flow directions. Variations in splitting parameters between closely-spaced stations indicate the presence of lithospheric fabrics via Fresnel-zone considerations, but it is also likely that sublithospheric mantle flow plays a significant role. Given the thickness of the lithosphere beneath the Canadian Shield, it is reasonable to expect that our measurements would record contributions from multiple sources of seismic anisotropy.

Session 60100 - Lithospheric Structure of Eastern North America

Constraining Crustal and Lithospheric Structure via Transfer Function Analysis of Teleseismic Data

Frederiksen, Andrew
University of Manitoba
andrew.frederiksen@umanitoba.ca

Seismograms from distant (teleseismic) earthquakes represent a combination of source-side and receiver-side effects. Various approaches have been used to separate out receiver-side structural information, including traditional receiver function deconvolution for the teleseismic P coda, and

grid searches for one-layer splitting parameters for the SKS pulse. These approaches yield new observables (receiver functions and single-event splitting parameters) that are then examined or inverted in various ways to recover more complex structure.The common flaw in these approaches is that they are based on inverting the result of a previous non-unique inversion. Receiver functions are prone to deconvolution artifacts, particularly in the presence of sedimentary basins; single-event splitting parameters are not robust observables, and multi-layer interpretations of parameters derived assuming a single layer are inherently contradictory. I propose an alternative methodology applicable in principle to any teleseismic phase: the generation of transfer functions relating data components. For the teleseismic P wave, the transfer function between vertical and radial ground motion depends only on the receiver-side structure, and may be used to predict the radial component from the vertical; for an SKS pulse, the radial-to-transverse transfer function may be used in a similar way. In either case, we can evaluate how well a particular subsurface model predicts the actual observed waveform, and directly derive a meaningful misfit; inversion may be performed through Monte Carlo or grid search approaches. I will present examples of applications to crustal and basinal thickness measurement from the P coda, shear-wave splitting analysis, and a possible layer-stripping technique for removing basinal artifacts from receiver functions.

Session 60100 - Lithospheric Structure of Eastern North America
New Seismic Evidence for Multi-stage Lithosphere Evolution in Western Laurentia
Gu, Yu Chen, Yunfeng Hung, Shu-Huei
University of Alberta
ygu@ualberta.ca
The crystalline basement beneath the Western Canada Sedimentary Basin (WCSB) exemplifies a complex tectonic assembly of welded Precambrian lithospheric fragments. Earlier studies have suggested extensive subduction, magmatism and accretion, especially along the boundaries of major tectonic domains such as Hearne and Rae provinces, and the Trans-Hudson orogen. The existence and the state of the lithosphere beneath southern WCSB remain largely speculative, however, due to the thick Phanerozoic sedimentary cover and relatively few regional broadband seismic stations prior to mid-2006. This study combines data from USArray and four regional networks and inverts both P and S wave velocity model of the mantle lithosphere beneath the Cordillera-craton transition region. The result of our finite-frequency tomography shows vertically continuous high velocities (>0.5%) at depths above 200 km beneath the Archean Rae and Hearne cratons as well as Medicine Hat Block, a potential Archean micro-continent between the colliding Hearne and Wyoming cratons. A high velocity anomaly (~2%) is observable at ~300 km depth at the base of the Hearne province, which provides compelling seismic evidence for the preservation of the lithospheric root. These intact lithosphere keels are largely responsible for a sharp mantle seismic velocity gradient along the foothills of the Rocky Mountains. Furthermore, distinctive seismic signatures of Rae and Hearne cratons potentially delineate the subsurface extension of the Snowbird Tectonic Zone. The anomalously thick lithosphere of Hearne and a low-velocity crust/shallow upper mantle under Vulcan, an Archean suture zone, suggests a two-stage formation of the lithosphere of the western Laurentia.

Session 60100 - Lithospheric Structure of Eastern North America
Approaching the Petrophysics of deep Earths and Earth-like Planetary Interior
Mueller, Hans J. Lathe, Christian Lauterjung, Joern
GFZ
hjmuel@gfz-potsdam.de
The Earths deep interior is only accessible by indirect methods, first and foremost seismologicalstudies. The interpretation of these seismic data and the corresponding numerical modelling requiremeasurements of the elastic and inelastic properties of representative Earth materials underexperimental simulated in-situ pressure-temperature conditions. Seismic tomography studies andcorresponding numerical models have demonstrated that under certain conditions subducting slabscan even reach the core mantle boundary. That means former crustal rocks became heavilyoverprinted by increasing pressure, temperature, deformation and partial material exchange. Becausethere is no known geodynamic mechanism able to bring them back to the surface as a whole, wecannot sample them. But there is no indication to assume they are simpler than their parental rocks -quite the contrary. I think the first-order future challenge for large volume geophysical high pressureresearch is to measure data for an understanding of the relation between structural and physicalproperties of these complex polymineral rock-like assemblages. The paper presents the results ofpetrophysical transient experiments with natural rocks under uppermost mantle conditions and firststeps to perform in-situ experiments under deep mantle conditions.

Session 60200 - Geophysical signatures of active subsurface processes
Long term monitoring of self-potential fields for seepage surveillance at the Mactaquac Dam, New Brunswick
Butler, Karl E. Ringeri, Andrew McLean, D. Bruce
University of New Brunswick, Dept. of Earth Sciences
kbutler@unb.ca
The development of surveillance techniques for early detection of concentrated seepage is important to dam operators. Long term monitoring of electrical self-potentials (SP) is of interest because of their direct dependence on subsurface fluid flow, and their expected sensitivity to seepage within the interior of an embankment. However, the viability of such long term SP monitoring has yet to be demonstrated through field trials.   A multichannel SP monitoring system has been operating since April, 2013 at the 660 MW Mactaquac hydroelectric generating station located on the Saint John River near Fredericton, New Brunswick, Canada. The region of interest is a steeply inclined interface between a large zoned embankment dam and a concrete diversion spillway. Electrode locations were guided by modelling which indicated advantages to measuring SP both on the downstream slope of the embankment and in a sub-vertical 50 m long borehole drilled into the concrete at an offset of 0.5 m from the clay/till core. Surface instrumentation includes 30 Pb/PbCl2 non-polarizing electrodes emplaced on the embankment, and two remote orthogonal telluric monitoring dipoles. An additional 32 electrodes are deployed in 16 pairs along the borehole. Surface installations allow for the determination and removal of long term electrode drift. Electric potentials from each electrode are currently lowpass filtered at ~0.03 Hz and sampled at 1 min intervals.Electric potential variations appear to be dominated by

bulk seepage, telluric fields, and hydrologically-driven effects including rainfall, ground-freezing, and the annual freshet. No anomalies suggestive of concentrated seepage have been recognized to date. Finite element modelling of bulk seepage through the foundation of a 2D dam model is able to reproduce the amplitude, though not the steep gradient of a prominent positive SP effect observed along the toe of the embankment. The spatial coherence and repeatability of SP data acquired over three years is encouraging for the development of SP monitoring in long term seepage surveillance.

Session 60200 - Geophysical signatures of active subsurface processes

Time-lapse cross-well seismic travel time tomography for CO2 injection monitoring

Giroux, Bernard Bouchedda, Abderrezak

INRS

bernard.giroux@ete.inrs.ca

Time-lapse geophysical monitoring has been used for about two or three decades to track the behaviour of underground fluids. Inverted difference images reveal changes that vary over space and time and that can be related to fluid movement. Seismic methods are predominantly used to monitor oil and gas reservoirs, while in hydrogeology, electric resistance tomography (ERT) is commonly used, although ground-penetrating radar is also sometimes used. Common practice relies on surface measurements mainly for economical reasons, although down-hole methods are also used. Until very recently, ray-based time-lapse travel time tomography algorithms were scarce and limited, in opposition to ERT where multiple approaches have been developed over the last two decades. In this contribution, three time-lapse ERT schemes are adapted for travel time tomography. The first algorithm, called difference inversion, seeks to minimize the misfit between the difference in two datasets and the difference between two model responses. In the second, called temporally constrained inversion, all datasets are inverted simultaneously while using regularization constraints to ensure that the changes from one time to another are smooth. With the third, named simultaneous inversion, constraints of smoothness and closeness to a reference model are applied to the inverted image while all travel time data are inverted simultaneously. We show using synthetic cross-well data that the time-lapse algorithms allow reducing artifacts compared to independent inversions. Moreover, schemes relying on a reference model to regularize the inversion (difference inversion and simultaneous inversion) provide the best results. If time-lapse data are co-localized, difference inversion appears suitable because it is faster that simultaneous inversion. On the other hand, simultaneous inversion is more flexible as sources and sensors need not be co-localized. Finally, cross-well seismic data collected before and after a CO2 injection experiment are used as a test case for the algorithms.

Session 60200 - Geophysical signatures of active subsurface processes

Petrophysical signature of carbonates generated from the carbonation of magnesium-rich mining waste at Thetford Mines, QC

Horswill, Micha Dupuis, J. Christian   Nowamooz, Ali Lemieux, Jean-Michel   Fortier, Richard Molson, John Beaudoin, Georges Constantin, Marc

Université Laval

micha.horswill.1@ulaval.ca
The natural process of mineral carbonation occurring within Mg-rich mining waste represents a novel solution to reduce the carbon footprint of our industrial society. Unlike geological storage within saline aquifers which requires CO2 separation from industrial flue gas, often at great eff_x000B_ort and expense, mineral carbonation captures atmospheric CO2 from di_x000B_ffuse sources and generates heat that may be harnessed through geothermal heat-exchangers. In Quebec, di_x000B_ffuse CO2 sources contribute to over 2/3 of all emissions.We present geophysical and petrophysical measurements acquired at a 300 Mt chrysotile mining waste pile located in Thetford Mines, QC. Airborne hyper-spectral infrared imaging, resistivity soundings and ground penetrating radar profi_x000C_les have allowed us to identify resistive structures that could be related to active carbonation processes. Petrophysical measurements were made on core samples recovered from a 90 m-deep sonic borehole that was drilled within the waste pile. Resistivity and magnetic anomalies were identi_x000C_ed from measurements on core and from wireline logs. These anomalies have been correlated to an increase in carbonate concentration (up to 0.5 wt % CO2) in the core.The interpretation of the geophysical and petrophysical measurements allows us to outline methods that can be used to identify carbonate-rich horizons within magnesium-rich mining waste. These results are the fi_x000C_rst step towards quanti_x000C_cation of the carbonation process within the mine waste pile at a scale which is of industrial signifi_x000C_cance. In turn, these methods will help to guide the development of future optimization schemes to enhance the e_x000E_cfficiency of carbon sequestration and heat recovery in mining operations.

Session 60200 - Geophysical signatures of active subsurface processes

A permanent installation for monitoring CO2 sequestration in magnesium-rich mining waste at Thetford Mines, QC.

Nowamooz, Ali Dupuis, J. Christian Lemieux, Jean-Michel Fortier, Richard Beaudoin, Georges Molson, John Constantin, Marc
Université LAVAL
ali.nowamooz.1@ulaval.ca
Mineral carbonation of Mg-rich mining waste has been known for about ten years, although the processes of CO2 sequestration and heat generation at the scale of an industrial waste pile had never been investigated. In order to characterize these reactions in-situ, a 92 m-deep sonic borehole was drilled within a 300 Mt waste pile of chrysotile mining waste at the Black Lake mine, Thetford Mines (QC). The six-inch diameter well was instrumented with 22 thermistors and nine pneumatic ports for monitoring temperature, differential pressure and interstitial air composition, including the concentration and carbon isotope composition of CO2, within the waste pile. A weather station, installed at the top of the mining waste pile, provides local environmental conditions in order to investigate correlations between the meteorological conditions and in-situ measurements.The design of this unique CO2 sequestration observatory posed significant challenges in terms of automating and protecting the monitoring system and in providing an off-grid power supply. This presentation will showcase the solutions developed in order to meet these challenges and presents results for the first eight months of operation.Early results show two distinct geothermal regimes in the waste pile; geothermal gradients of 18 and 45°C/km, respectively, within the top and bottom 40 m of the waste pile. Significant pressure

variations with depth and time have also been observed in the well which have been correlated to wind speed and direction, as well as to barometric pressure and snow accumulation on the surface of the pile. These transient pressures are also linked to variations in temperature and CO2 concentrations of interstitial air within the mining waste pile. Measured CO2 concentrations vary between 18 and 200 ppm within the pile while the atmospheric concentration is close to 400 ppm, consistent with CO2-depleted warm air venting at the surface of the waste pile. These unique results will provide needed ground-truthing for numerical modeling of CO2 sequestration and heat generation and for optimizing these processes within the context of greenhouse gas reduction and clean energy generation in mining operations.

Session 60200 - Geophysical signatures of active subsurface processes

Dynamics of solute transport through the vadose zone under a potato field as assessed by a year-long tracer test and cross-hole resistivity imaging

WANG, SHUANG Butler, Karl Danielescu, Serban   Petersen, Brent   Grimmett, Mark
Dept. of Electrical and Computer Engineering, University of New Brunswick, Fredericton
swang6@unb.ca

Nitrate is a necessary nutrient for crops, but high nitrate concentrations in water can negatively affect aquatic ecosystem and human health. At AAFC-AAC Harrington Research Farm (PEI), 3D cross-hole electrical resistivity imaging (ERI) is being used to investigate the transport of conductive tracer through a vadose zone as a proxy for the transport of nitrate under natural recharge conditions. The objectives are to investigate the effect of heterogeneity on transport pathways and infer how long it would take changes in farming practices at the surface to affect nitrate loading to the underlying aquifer.Borehole geological logs, and pre-tracer resistivity surveys indicate the 17 m deep vadose zone can be divided into five layers including ~ 6 m of soil and glacial till overlying interbedded sandstone and shaley sandstone. On March 27th, 2015, 1.1 m of snow was removed from a 15.2 m2 area positioned symmetrically inside the triangular cross-hole resistivity array and 100 kg of granular KCl was evenly distributed on the ground surface. The removed snow was replaced to await the spring thaw. Post-tracer surveys indicate tracer had percolated to depths of 1 m, 1.2 m, 3.0 m and 3.5 m by the 4th, 26th, 30th, and 46th days after tracer application. Its movement slowed significantly by early May with the end of snow melt. The most recent data from February 4th, 2016 yielded a resistivity model very similar to that obtained in mid-May, 2015. The stalling of tracer is thought to be caused by a low permeability layer. Preferential percolation of tracer towards west was observed, indicating heterogeneity within overburden. Tracer movement will be monitored through the spring thaw of 2016, and results will be used to improve infiltration and percolation models. Forward modelling and volume of investigation studies are ongoing to determine the sensitivity and resolution of this ERI array.

Session 70100 - Oil Sands Reclamation

Understanding the hydrochemical evolution and patterns of a constructed wetland in the Athabasca oil sands region, Canada.

Biagi, Kelly Carey, Sean Oswald, Claire Nicholls, Erin

McMaster University
biagikm@mcmaster.ca
Bitumen extraction in the Athabasca oil sands causes significant landscape disturbance of wetland-forest ecosystems, which now require reclamation as required by Albert legislation. Although wetlands dominated the pre-disturbance landscape, reclamation has largely focused on upland-forested ecosystems. Syncrude Canada Ltd. has constructed a unique 52 hectare upland-wetland system, the Sandhill Fen Watershed (SFW), which is a highly managed system. A pump/drain system was installed during construction to provide freshwater and inhibit salinization from the underlying waste materials, characterized by elevated electrical conductivity (EC) and Na^+ concentrations. The objective of this research is to understand the evolution and hydrochemical responses of the SFW three years post construction by examining variations in the sources, flow pathways and major chemical transformations of water within the SFW. EC, major ions and stable isotopes were collected using a combination of high frequency and discrete surface and pore water sampling from 2013-2015. Results indicate that the high activity of both inflow and outflow pumps in 2013 kept the overall EC relatively low, with most wetland sites <1000 µS/cm. Most water classified as Ca-HCO3 or Ca-SO4 in 2013 with Na^+ concentrations <250 mg/L. With limited pump activity in 2014, the overall EC and ion concentrations increased considerably with many sites in the wetland exceeding 1000 µS/cm. Although most sites classified as Ca-SO4, the most notable change in 2014 was the presence of several Na^+ hotspots in SFW, where water classified as Na-SO4 and Na^+ concentrations reached as high as 886 mg/L. These results provide evidence of upward movement of Na^+ from the underlying waste materials and subsequent seepage into these hotspots. Pumps remained inactive throughout 2015 and preliminary data show a continued increase in EC (850-5500 µS/cm). It is anticipated that ion concentrations have consequently increased and Na^+ hotspots have continued to develop.

Session 70100 - Oil Sands Reclamation

Perched Peatland Formation and Maintenance on the Boreal Plains of Canada

James, Lindsay Devito, Kevin Alessi, Daniel   Mendoza, Carl Leonard, Rhoswen Kettridge, Nick
University of Alberta
lmjames@ualberta.ca
Perched wetlands on the Boreal Plain of north central Alberta may have key implications for watershed construction in the Athabasca Oil Sands, as they could be important water sources for headwater streams and surrounding forest vegetation. Many of these systems are peatlands isolated from local and regional groundwater, and occur where a low permeability (clogging) layer is proximal to the surface. Due to the sub humid climate of the Boreal Plains, isolated peatlands exist in a delicate water balance. They are found in depressions as well as topographic highs, and are surrounded by treed margin swamps. The role of margin swamps as buffers of water loss, or as generators of perched groundwater to adjacent peatlands, and the influence of shading, wind protection, and peatland negative feedbacks on perched wetland maintenance is not well known. This study examines formation and maintenance of perched, isolated wetland complexes on topographic highs, with the objective of quantifying the relative roles of peatland and margin swamp within this unique hydrogeologic setting. A water budget is developed to

evaluate the relative role of autogenic wetland feedbacks and allogenic controls; employing hydrometric, geochemical (DOC, pH, tracer cations and anions), and isotopic (D/H, ¹⁸O/¹⁶O) techniques. Contrasts in water storage due to the morphology of the clogging layer appear to determine peatland and swamp form and function. Soil texture and layering exerts control on the generation and conservation of water. Understanding of hydrological interactions between perched peatlands and surrounding swamps gained from this study can serve as a proxy for reclaiming similar features on topographic highs within mining environments. The construction of perched peatlands could contribute to reclaiming biodiversity in watersheds, as they are fresh water sources, and isolated from potential groundwater contaminants.

Session 70100 - Oil Sands Reclamation

The transport of sodium from a contaminated tailing sands upland to a constructed fen peatland in a post-mined oil sands landscape, Fort McMurray, Alberta: Two years post-construction

Kessel, Eric Ketcheson, Scott Price, Jonathan
University of Waterloo
e2kessel@uwaterloo.ca

As a result of recent energy demands, vast amounts of land within the Athabasca Oil Sands Region has been disturbed through surface strip mining to recover the near surface bitumen oil sands. Oils sands extraction results in large amounts of tailing sands, a sodium contaminated waste material. In an attempt to reclaim the post-mined landscape, a constructed tailing sands upland was designed to supply water of adequate quantity and quality to an adjacent constructed fen peatland, hydrologically connected by a petroleum coke underdrain. It is anticipated that within the first several years post-construction, sodium will flush from the upland tailing sands and into the petroleum coke underdrain, effectively dispersing under and into the fen peatland. As such, the purpose of this study was to determine the sodium generated within the tailing sands upland and to evaluate the transport of sodium plumes as they flush into the highly permeable petroleum coke underdrain, and ultimately towards the fen peatland. Results have determined that high sodium concentrations (~400 mg/L to 700 mg/L) were representative within the tailing sands upland immediately prior to snow melt post-construction (May 2013). A large precipitation event in June 2013 resulted in the generation of a sodium plume that began to migrate from the tailings sand upland into the petroleum coke underdrain. By October 2013, the sodium plume reached a maximum extent, with concentration breakthrough (0.5Co) of 200 mg/L, reaching the most northern end of the system. In 2014, sodium concentrations diminished dramatically (~150 mg/L), especially along the east side of the upland which received preferential recharge due to larger contributing hill slopes. The sodium plume within the petroleum coke layer was less apparent in 2014 as the upland was capable of transmitting relatively low sodium water within 2 years post construction.

Session 70100 - Oil Sands Reclamation

Controls on methane flux from a constructed fen in the Athabasca Oil Sands Region, Alberta

Murray, Kimberley Strack, Maria
University of Waterloo
k7murray@uwaterloo.ca

Fen construction in a post-mined landscape near Fort McMurray, Alberta has recently been attempted with an aim to return a disturbed landscape to an ecosystem that may retain water and sequester carbon. Ongoing monitoring to understand the ability of the fen design to return ecosystem function should consider carbon dynamics, comparing results to fluxes measured in undisturbed reference ecosystems. Methane (CH4) flux was monitored over the 2015 growing season at a constructed fen, as well as saline and poor fen reference sites near Fort McMurray, to determine controls on CH4 dynamics within the constructed fen. As vegetation is known to influence CH4 flux to the atmosphere, this study focused on two dominant graminoid species at the constructed fen, Carex aquatilis and Juncus balticus, and moss. Fluxes from these communities were compared to similar plant communities at the reference sites. Controls on CH4 flux at these sites, including water table depth, soil temperature, geochemistry, and vegetation productivity and biomass were evaluated. Methane flux across all constructed fen treatments (Carex, Juncus, moss, mixed graminoid and moss, and bare) averaged 3.95 mg/m2/day (±0.31 standard error) over the 2015 growing season. While the Juncus treatment had significantly higher CH4 flux compared to the bare and moss treatments across the constructed fen, all graminoid treatments had similar flux. Comparing seasonal CH4 emissions from the saline fen and poor fen to the constructed fen revealed that the poor fen had the highest mean flux of 23.90 mg/m2/day (±3.94). Seasonal CH4 release from the saline fen was lower and similar to the constructed fen (4.40 mg/m2/day ± 0.81). Environmental controls influenced CH4 flux differently from each site. Geochemistry was an important control on flux across all sites, with higher sulfur availability measured at the constructed fen and saline fen corresponding to lower CH4 flux.

Session 70100 - Oil Sands Reclamation

Long-term precipitation-driven salinity change in a saline peatforming wetland in the Athabasca oil sands region, Canada

Volik, Olena Petrone, Richard Wells, Corey Hall, Roland Price, Jonathan
University of Waterloo
volik.olena@gmail.com

Saline boreal peatforming wetlands are rare and unique ecosystems that can be considered potential models for wetland reclamation in Oil Sands Region where construction of sustainable wetland ecosystems is greatly challenged by salinization. Better understanding the drivers and trends of salinity change in natural saline wetlands should help to gain a broader perspective for interpreting processes of increasing salt content in man-made wetlands. A paleoecological study carried out in a natural saline peatforming wetland (56°3428.84 N, 111°1638.39 W) situated in close proximity (~ 10 km) to Fort McMurray (Alberta) suggests that precipitation is one of the main drivers of long-term salinity variation. Fluctuations in salinity and water level recorded by diatom assemblages in pond sediment cores correlate well with historical precipitation data in the Fort McMurray region and the cumulative departure from long-term mean (CDLM). During

1944-1975 decrease in CDLM coincided with the decline in salinity and water level, and this direct correlation combined with the synchronous character of the response suggests that the wetland has been fed by shallow saline groundwater recharged by precipitation. In 1980 CDLM exceeded certain level, and an inverse correlation between salinity and CDLM becomes evident. This negative feedback likely resulted from the dilution of near-surface water by precipitation that began to constitute a more significant portion of the water balance. The non-linear character of the correlation between salinity, precipitation and water level reveals the existence of precipitation threshold values that specify the amount of precipitation required for shifts in salinity and water level. Determining actual levels of these thresholds under various local conditions (e.g, location, topography, substrate) can be useful for determining the potential sustainability of saline wetlands under climate change as well as for the development of new approaches (e.g., artificial irrigation) to control salinity at constructed wetlands.

Session 70200 - Hot and Hotter: Temperature as an indicator of environmental change and a tracer of hydrologic processes

Miramichi River: An overview of 20 years of research in river temperature monitoring and modeling

Caissie, Daniel
Fisheries and Oceans
Daniel.Caissie@dfo-mpo.gc.ca

The thermal regime of rivers plays an important role in the overall health of aquatic ecosystems. River water temperature is important when conducting environmental impact assessments as well as when developing effective fisheries management strategies, such as the closing and subsequent reopening of angling fisheries during high temperature events. As such, it is important to understand the thermal behaviour of rivers, river heat exchange processes as well as the different modeling approaches. This study looks at over 20 years of research pertaining to river temperature modeling in the Miramchi River. Different heat exchange processes responsible for water temperature variability will be described including important surface and streambed heat fluxes. Surface heat flux was quantified using data from land-based and instream microclimate stations whereas streambed heat flux was quantified using measured temperatures within the streambed. As such, streambed temperatures were measured at different depths and temperatures were used as a tracer to predict the magnitude and direction of groundwater flow using an inverse solution to the advection-conduction heat transport equation. Modeling examples will be presented, including the implication of using water temperature models as a tool to better understand and protect important fisheries resources under current climate as well as under future climate conditions.

Session 70200 - Hot and Hotter: Temperature as an indicator of environmental change and a tracer of hydrologic processes

New analytical solution and open access computer program (FAST) to estimate fluid fluxes from subsurface temperature profiles

Kurylyk, Barret Irvine, Dylan
University of Calgary
barret.kurylyk@ucalgary.ca

This study presents a new analytical solution to the one-dimensional, transient conduction-advection equation that is applied to trace vertical subsurface fluid fluxes. The solution employs a flexible initial condition that allows for non-linear temperature-depth profiles, providing a key improvement over most previous solutions. The boundary condition is made up of any number of superimposed step changes in surface temperature, and thus it accommodates intermittent warming and cooling periods due to long term changes in climate or land cover. A new computer program FAST (Flexible Analytical Solution using Temperature) is also presented to facilitate the inversion of this analytical solution to estimate vertical groundwater flow. The program requires surface temperature history (which can be estimated from historic climate data), subsurface thermal properties, a present-day temperature-depth profile, and reasonable initial conditions. FAST is written in the Python computing language and can be run using a free graphical user interface. Herein, we demonstrate the utility of the analytical solution and FAST using measured subsurface temperature and climate data from the Sendia Plain, Japan. Results from these illustrative examples highlight the influence of the chosen initial and boundary conditions on estimated vertical flow rates.

Session 70200 - Hot and Hotter: Temperature as an indicator of environmental change and a tracer of hydrologic processes

Influence of Turbidity and Aeration on the Albedo of Mountain Streams

McMahon, Alex Moore, Robert
University of British Columbia
mcmahonad@geog.ubc.ca

Stream surface albedo plays a key role in the energy balance of rivers and streams that are exposed to direct solar radiation. Most physically based models assume that stream albedo lies between 0.03 and 0.05, based primarily on measurements from low-gradient streams with low suspended sediment concentrations. Stream surface albedo was measured at nine sites with a variety of gradients and suspended sediment characteristics in the southern Coast Mountains of British Columbia, Canada. As expected, albedo of low-gradient, non-whitewater (flatwater) streams increased with solar zenith angle, suspended sediment concentration, and proportion of diffuse to direct solar radiation, ranging between 0.025 during cloudy periods in clear water to 0.25 for turbid water at zenith angles of less than 20 degrees. Albedo varied with discharge in steep reaches or at channel steps and cascades where flow was visibly aerated, with a range of 0.09 to 0.33. In clear weather, albedo exhibited notable diurnal variability at flatwater sampling sites. For example, during late summer, surface albedo typically fluctuated between 0.08 and 0.15 on a diurnal basis at a flatwater site on the highly turbid, glacier-fed Lillooet River. Physically based representations of albedo should be incorporated into energy balance models in order to improve predictions of stream temperature, especially for future scenarios.

Session 70300 - Applications of L-Band Microwave Remote Sensing in hydrological monitoring

Assessment of Soil Moisture Products from the Soil Moisture Active Passive Mission With Data From Several Validation Sites in Canada

Berg, Aaron Rowlandson, Tracy Wrona, Elizabeth Woodley, William MacDougall, Josh Ueckermann, Elené Tetlock, Erica
University of Guelph
aberg@uoguelph.ca

The Soil Moisture Active Passive (SMAP) mission was successfully launched January 31st, 2015. The satellite platform is currently monitoring global soil moisture patterns using a passive L-band (~21cm wavelength) radiometer. At this wavelength, the satellite measurements are sensitive to approximately the first 5cm of the soil surface. Post-launch, the availability of soil moisture data began at the end of April and continues to be available with a latency period of less than 24 hours. Work has been conducted to validate the SMAP soil moisture products globally over a range of soil textures and vegetation types to understand both the accuracy and potential limitations of the products. Within Canada, several networks have been developed suitable for the evaluation of SMAP retrievals of soil moisture in several environments. In this presentation description of soil moisture validation networks established at sites near Trail Valley Creek, NT, Kenaston Saskatchewan, and Guelph Ontario will be described including issues of network calibration. Early assessment at the agricultural sites at in Saskatchewan and Ontario show high and significant correlation (0.67 and 0.93 respectively) and relatively low unbiased root mean square errors (0.037 and 0.038 respectively in volumetric percent soil moisture) when compared to ground-based observations. Relationships between the SMAP soil moisture products and observed soil moisture at the northern site are observed however numerous challenges for retrieval and use of SMAP products at high latitudes will be discussed including interpolation and interpretation of the products, presence of organic soils and the role of permafrost.

Session 70300 - Applications of L-Band Microwave Remote Sensing in hydrological monitoring

NASA Aquarius and SMAP L-band observations of the cryosphere

Brucker, Ludovic Dinnat, Emmanuel
NASA GSFC / USRA GESTAR
ludovic.brucker@nasa.gov

NASAs Aquarius and Soil Moisture Active/Passive (SMAP) missions offer passive microwave observations of the Earths polar regions and the cryosphere at ~1.4 GHz (L-band). These satellite observations extend the range of frequencies traditionally used for studying the cryosphere. Despite the fact that Aquarius and SMAP have been designed for the monitoring of ocean salinity and soil moisture, innovative investigations were lately carried out at L-band over ice sheets, sea ice, snow covered land, and frozen soil. To facilitate the use of these L-band observations over the polar regions, and to move forward our understanding of L-band measurements at high latitudes, weekly polar-gridded products were produced. They are

distributed by the US National Snow and Ice Data Center (http://nsidc.org/data/aquarius/data-sets.html#L3-weekly-polar-grid) on the version 2.0 of the Equal-Area Scalable Earth (EASE2.0) grid, with a resolution of 36 km. We will present these Aquarius products, and highlight recent investigations over the cryosphere regarding for instance influence of snow density variation, effect of sea ice concentration, and monitoring of freeze-thaw cycles. We will also show that despite L-band radiation emanating from deep into the Antarctic ice sheet, observation varies with time, even at Dome C on the Antarctic plateau. During the Aquarius mission (2011-2015) brightness temperatures revealed a seasonal amplitude of 0.8 K at vertical polarization, and a 4.5-K dynamic range at horizontal polarization (with a variation of 2.5 K in 2015). Understanding of these variations will require modeling activities. A succinct summary of existing state-of-the-art radiative transfer models will be also given.

Session 70300 - Applications of L-Band Microwave Remote Sensing in hydrological monitoring

Assimilation of SMOS-retrieved soil moisture and SMOS brightness temperature observations into the Canadian Land Surface Scheme for soil moisture estimation

Nambiar, Manoj Thomas Ambadan, Jaison Rowlandson, Tracy   Berg, Aaron Bartlett, Paul
University of Guelph
aberg@uoguelph.ca

There is widespread interest in the use of soil moisture retrievals from passive microwave satellites. A difficulty in the application of these soil moisture estimates is the typically shallow depth at which the soil moisture is retrieved (top few centimetres) and the accuracy of the retrieval. Over the past decade significant advancements for both of these issues have been realized using data assimilation systems where the soil moisture estimate or brightness temperature retrieval are assimilated into a land surface model. In the assimilation of satellite soil moisture data into land surface models, two approaches are commonly used. In the first approach brightness temperature data are assimilated, while in the second approach retrieved soil moisture data from the satellite are assimilated. However, there is not a significant body of literature comparing the differences between these two approaches, and it is not known whether there is any advantage in using a particular approach over the other. This study focuses on this issue and employs an Ensemble Kalman Filter (EnKF) to investigate the effect of assimilating (i) near surface soil moisture retrieved from the Soil Moisture and Ocean Salinity (SMOS) satellite into the Canadian Land Surface Scheme (CLASS) and, (ii) brightness temperature from SMOS into CLASS using the Community Microwave Emission Model (CMEM) as the forward model. The soil moisture estimates from both schemes are analysed and compared with each other and also with observational data from in-situ monitoring networks over an agricultural site in southern Saskatchewan. We have also designed numerous assimilation experiments to determine (1) if any additional estimation accuracy can be achieved by adding additional layers with varying thicknesses to the standard 3 layer CLASS, (2) the efficacy of surface soil moisture assimilation to improve soil moisture estimates for deeper layers.

Session 70300 - Applications of L-Band Microwave Remote Sensing in hydrological monitoring

Capturing Soil Freeze/Thaw Processes with L-band Airborne Field Campaign and Ground Measurements

Rowlandson, Tracy Berg, Aaron Kim, Edward Powers, Jarrett Roy, Alexandre   Toose, Peter   Houser, Paul McDonald, Kyle Lewis, Kristin   Entin, Jared
University of Guelph
trowland@uoguelph.ca

A field campaign was conducted over a two week period, beginning October 30th, 2015, south-west of Winnipeg, Manitoba. This campaign consisted of both airborne and ground based measurements in an effort to capture diurnal freeze/thaw signals. The Scanning L-band Active/Passive (SLAP) instrumentation, which consists of a radiometer and a scatterometer was flown twice daily, once prior to sunrise to capture frozen conditions and again around noon local time to capture thawed conditions. In addition to the airborne L-band instrumentation, two ground-based L-band radiometers (one owned by Environment Canada and the other by the Univ. de Sherbrooke) were deployed and measured continuously throughout the campaign. During the airborne measurements, sampling teams measured the soil and residue temperatures and soil relative permittivity across two transects in 17 fields. Additionally, continuous in situ measurements of soil temperature and soil permittivity were measured in 18 fields. Results examining the freeze/thaw state as measured by the airborne L-band instrumentation, ground-based L-band radiometers and the field sampled measurements will be presented, in addition to SMAP measurements. Ground based measurements of soil relative permittivity indicate significant difference between early morning and afternoon measurements. A freeze/thaw signal was also observed with the L-band instrumentation.

Session 70300 - Applications of L-Band Microwave Remote Sensing in hydrological monitoring

MULTI-SCALE L-BAND BRIGHTNESS TEMPERATURE ANALYSIS FOR SOIL FREEZING AND THAWING PROCESS STUDY

Royer, Alain Derksen, Chris Toose, Peter Brucker, Ludovic Mialon, Arnaud Berg, Aaron Rowlandson, Tracy Williamson, Matthew   Langlois, Alexandre Kerr, Yann
Université de Sherbrooke
alexandre.r.roy@usherbrooke.ca

Snow and frozen ground play a crucial role in climatological and hydrological processes, and are key factors in modulating energy, water, and carbon budgets. L-band space-borne missions such as Soil Moisture Active Passive (SMAP), Soil Moisture and Ocean Salinity (SMOS), and Aquarius have the potential to provide enhanced information on the surface freeze/thaw (F/T) state over northern regions where it is a key parameter for studies of terrestrial hydroclimatology and ecosystem processes.In this presentation, we first present an analysis over Canadian sites of the L-band brightness temperature (TB) variations from SMOS, Aquarius and first SMAP data in order to characterize the freeze/thaw (FT) soil state, including in winter when a dry snow cover exists. The analysis show that because of the strong permittivity difference between ice and water, the signal at L-band is very sensitive to the F/T state. However for forested sites it was shown that the signal is much more subtle during transitional periods, suggesting that the boreal

F/T signal is more ambiguously influenced by the vertical soil-vegetation continuum and its developmental stages following vegetation phenology. Despite the strong sensitivity of the L-Band passive microwave signal to soil F/T, the intensity can vary because of spatially and temporally varying contributions from vegetation, soil, and snow, and their physical properties. Hence, a second analysis was conducted from surface-based L-band radiometer measurements conducted in Saskatchewan, Canada during the 2014-2015 fall, winter, and spring. This dataset was used to analyse the effects of soil and snow. The results show that the snow and wet snow has a non-negligible effect on TB at L-Band.The study brings important information for the development and improvement of F/T algorithm from SMAP and SMOS observations. The work confirms that space-born L-Band data can also leads to retrieve other important cryosphere variables such as snow density.

Session 70400 - Cold Regions Hydrology and Hydrometeorology - Part 1

Hydro-climatic controls of the 2014 ice-jam flood on the Peace-Athabasca delta

Beltaos, Spyros Peters, Daniel Carter, Tom
Watershed Hydrology and Ecology Research Division National Water Research Institute, Environment Canada, 867 Lakeshore Rd., Burlington, ON L7S 1A1
spyros.beltaos@canada.ca

Extreme ice jams forming in the lower reaches of Peace River during the spring breakup of the ice cover have been identified as the main agents of flooding and replenishment of the Peace-Athabasca delta (PAD), one of the worlds largest inland freshwater deltas and home to large populations of waterfowl, muskrat, beaver, and free-ranging wood bison. The paucity of ice jamming in the lower Peace River following construction of the Bennett Dam (1968) and the potential impacts of climate change have raised concerns regarding habitat degradation. The most recent ice-jam flood occurred in 2014, ending a 17-year period of minor, if any, spring jamming. Relative to previous occasions (1972, 74, 96, 97), the 2014 flood event was monitored in considerable detail. The progression of breakup was documented by various agencies over the entire regulated reach, including the evolving configuration of the final ice jam that caused the flooding of the delta. Unusually complete water level recordings at key delta hydrometric stations provide essential quantitative evidence. Following ice clearance, numerous high water marks were established along the lower 120 km of the river and their geodetic elevations surveyed later in the same year. A synthesis of this information, along with antecedent hydro-climatic conditions, is presented herein. The 2014 data confirm that breakup processes occurring hundreds of kilometers upstream can play an important role in PAD flooding, as had been indirectly deduced in a past study. Comparison to previous extreme events furnishes new insights on the factors that promote or inhibit the occurrence of extreme ice jams. Climate-related temporal trends in associated hydrologic variables are examined and implications to potential adaptation measures discussed.

Session 70400 - Cold Regions Hydrology and Hydrometeorology - Part 1

Sensitivity and response of cold regions hydrological regimes to climatic change: A process-based perspective using observations and conceptual understanding from the interior of western Canada

DeBeer, Chris Wheater, Howard Carey, Sean Spence, Chris Hayashi, Masaki Marsh, Phil
University of Saskatchewan
chris.debeer@usask.ca

Hydrological regimes in northern and high elevation cold regions are particularly sensitive to changes in climate due to alterations in cryospheric regime, especially at temperatures near 0 °C. However, the responses are not easily generalizable and depend on multiple interacting and often confounding processes, occurring over various spatial and temporal scales. There has been much speculation on the future trajectory of hydrological change in these regions in relation to climate projections, but this has not often been grounded on proper conceptual understanding and process-based representation of the underlying response mechanisms. Given the complexities involved, this is required to develop plausible scenarios of change for the 21st century, especially considering that while certain processes and their interaction are inherently accounted for in some physically-based models, other factors are likely not (e.g., landcover changes such as deglaciation, permafrost degradation, and changing vegetation and ecological assemblages, and their influence on hydrology). The Changing Cold Regions Network (CCRN) is a Canadian research network that aims to understand, diagnose, and predict the interactions amongst the cryospheric, ecological, hydrological, and climatic components of the changing Earth system in western Canada. Here we bring together insights from a regional analysis and interpretation of recent hydro-climatic trends, and from CCRN process studies at a variety of intensively instrumented, long-term, and well-studied research basins across the cold interior of western Canada to shed light on trajectories of hydrological change. This helps to show how climate change confounds hydrological response and how some simple projections of change may be misleading. We recommend several priority research areas that will be a focus of continued work in CCRN.

Session 70400 - Cold Regions Hydrology and Hydrometeorology - Part 1

Modelling the Athabasca Watershed Snow Response to a Changing Climate

Dibike, Yonas Eum, Hyung-Il   Prowse, Terry
Environment and Climate Change Canada
yonas.dibike@canada.ca

Snow response to projected temperature and precipitation in northern and alpine dominated watersheds is complex, with the magnitude and sign of changes varying with local climate regime and elevation. In this study, the hydro-climatic response of the Athabasca River Basin (ARB) in Alberta is simulated using the Variable Infiltration Capacity (VIC) process-based and distributed hydrologic model. The monthly and annual maximum Snow Water Equivalent (SWE) values over the ARB derived from the hydrological model are compared with observation-based gridded snow product for the baseline period of 1980-2010. The projected changes in the SWE and duration of snow cover over the ARB are also simulated based on future climate data derived from a selected set of CMIP5 GCMs. The simulated SWE values for the baseline period show a

very good agreement with the observation-based data except at the very high elevation alpine regions. Hydrologic model projections till 2100 also show an overall decreasing trend in the mean monthly and annual maximum SWE, with the biggest decreases being in the high elevation alpine regions of the basin. The implication of such changes on the hydrologic regime of the Athabasca River is a subject of ongoing investigation.

Session 70400 - Cold Regions Hydrology and Hydrometeorology - Part 1
Changing temperature and precipitation in the western Canadian Arctic: Hydrological Implications
Marsh, Philip Walker, Branden de Jong, Tyler
Wilfrid Laurier University
pmarsh@wlu.ca
The landscape of the western Canadian arctic has been changing over the last 5 decades in response to warming air temperatures and decreasing precipitation. In order to understand the implications of this on hydrology, permafrost and vegetation, there is a need to better understand the details of the changes in air temperature and precipitation, and these changes over both the region and at the local research watershed scale. Analysis of temperature records since the 1930s and precipitation records since the 1950s, have shown warming in all seasons, and drying in all seasons. Warming has included dramatic changes in extremes, with the number of days per year with temperatures below -40c decreasing dramatically and above 20C increasing dramatically. These will have significant impacts on permafrost features that have hydrologic implications and likely increase summer evaporation for example. Although the nations of the world agreed to keep global warming below 2C in the coming decades, the Western Canadian Arctic has already seen much greater warming in annual, seasonal, and extreme temperatures, and the region will continue to warm dramatically. Future changes in precipitation are likely, but the direction and magnitude of change is not well known.

Session 70400 - Cold Regions Hydrology and Hydrometeorology - Part 1
Changes in snowpack from regional to global scales and implications for water resources in dry season
Najafi, Mohammad Reza Zwiers, Francis Gillett, Nathan
Pacific Climate Impacts Consortium, University of Victoria
rnajafi@uvic.ca
Water stored in the form of snow in cold seasons, when the temperature stays below freezing, is a critical component of water resource management in nival river basins. The increasing global temperature has reduced the spatial extent of snow cover (SCE) and snow mass, measured as water equivalent (SWE), in months when the maximum snowpack is expected to occur. In this study, we quantify the contribution of anthropogenic factors to this reducing trend and the subsequent changes in summer streamflow. Using various observed datasets and a suite of climate model simulations provided by the Coupled Model Intercomparison Project Phase 5 (CMIP5), we evaluate the historical changes of the Northern Hemispheric SCE during spring. Although there are considerable uncertainties from different sources of observations as well as

simulations, we find substantial evidence that the anthropogenic forcing factors including greenhouse gas increases have contributed to the declining SCE trends. Secondly, by conducting an exhaustive hydrologic modeling over British Columbia, we show that climate change is also responsible for the observed decrease in April-1st SWE. Consequently, this has resulted in reduced summer streamflow in this region. Hydrologic modeling was based on the Variable Infiltration Capacity (VIC) model that was forced with observed climate data and with CMIP5 climate simulations that were downscaled with the Bias Correction and Spatial Disaggregation (BCSD) approach. Detection and attribution was performed based on the optimal fingerprinting method.

Session 70400 - Cold Regions Hydrology and Hydrometeorology - Part 1

Future climate change may lead to greater variability in daily and seasonal streamflow in the Fraser River

Younas, Waqar Islam, Siraj Ul Déry, Stephen
University of Northern British Columbia
vickyqau@gmail.com

Twenty-first century climate projections of Coupled Models Inter-Comparison Project Phases 3 and 5 (CMIP3 and CMIP5) are used to drive the Variable Infiltration Capacity (VIC) hydrological model to simulate potential future changes in Fraser River streamflow. The VIC model is used to estimate the mean, standard deviation, and coefficient of variation in simulated daily streamflow data for 30-year base (1980-2009) and future (2070-2099) time periods. Analyses are performed using projected data of the A2 scenario and RCP 8.5 pathway for CMIP3 and CMIP5 models, respectively.There is considerably large variability in future winter streamflow for CMIP3 and CMIP5 as compared to the base period, which is consistent in most of the models. For this reason, the Multi Model Mean (MMM) is presented instead of individual models. The large variability in winter season in future projections as compared to the baseline period shows that future water management may be more challenging owing to increased uncertainty in day-to-day and seasonal flows. This is tied to a regime change for the Fraser River from snow dominant to either hybrid or even rain dominant regime in the 21st century.

Session 70401 - Cold Regions Hydrology and Hydrometeorology - Part 2

The influence of taliks on hydrologic connectivity in discontinuous permafrost terrains

Connon, Ryan Quinton, William
Wilfrid Laurier University
rfconnon@gmail.com

In the wetland-dominated basins that characterise the southern margin of permafrost, permafrost thaw and disappearance and resulting land-cover change, are occurring at an unprecedented rate. Permafrost thaw has the potential to fundamentally alter the processes giving rise to streamflow in this region by altering the physical structure, type and relative proportions of biophysical terrains. Field studies were conducted at the Scotty Creek Research Basin, a 152 km2 watershed, located near Fort Simpson, Northwest Territories, Canada. Scotty Creek is typical of other basins in the region and is underlain by discontinuous permafrost. There are three major land-cover

types in the basin, each exhibiting a distinct hydrological function. Channel fens convey water to the basin outlet, flat bogs can either store or transmit water to a fen via ephemeral channels, and permafrost plateaus are runoff generators. As permafrost in this region thaws, the wetlands (fens and bogs) grow at the expense of the plateaus and are increasing hydrological connectivity and runoff contributing area. At the study site, the annual ground heat flux (QG) is positive, indicating a net loss of permafrost, a condition allowing for the development of taliks. The formation of a talik serves two purposes: 1) it allows for the year-round lateral advection of water and energy between wetlands on either side of a plateau; and 2) it creates unstable thermal conditions for the underlying permafrost, as the temperature of the talik is perennially unfrozen. Extensive frost table mapping was conducted in 2011 and 2015 to determine the depth to the frost table and the date when the active layer thawed through to a talik. The increased presence of taliks provides new routes for the transmission of moisture from bogs to fens; this moisture would have been previously unavailable to the fen network and retained as storage in the bog.

Session 70401 - Cold Regions Hydrology and Hydrometeorology - Part 2
Spatial Distribution of Snowmelt at Scotty Creek, NWT
Haughton, Emily Quinton, William Sonnentag, Oliver
Wilfrid Laurier University
haug6220@mylaurier.ca
At high latitudes, snow has a significant influence on hydrological, biogeochemical and atmospheric processes. Coniferous forests dominate large portions of these regions, which affect energy and mass exchanges between the atmosphere and the land surface. Beneath a forest canopy, the large spatial variability of radiative and turbulent fluxes strongly influence energy dynamics. The spatial variation of shortwave irradiance to snow surface is important to quantify, as it is often the primary control on the spatial pattern and rate of snowmelt. In current scientific literature, there is sparse quantification of the variation of melt rates and snow cover depletion in the peatland-dominated zone of discontinuous permafrost by field measurements during melt. This limits the physical basis with which to develop and evaluate the performance of numerical melt models for this region. This study was conducted in the high-Boreal zone of discontinuous permafrost at Scotty Creek, 50 km south of Fort Simpson, Northwest Territories, Canada. The specific objectives were to: 1) compute the snowmelt energy balance in a high-latitude peatland with varying canopy characteristics (e.g., dense, sparse, and open), and 2) for each environment, determine the relative importance of the radiative and turbulent energy fluxes with respect to snowmelt. Point measurements of snowmelt were used in combination with aerial remote sensing, including high-resolution LiDAR, to examine the spatial distribution of snowmelt. Calculation of 2014 and 2015 energy balances suggests that under clear-sky stable atmospheric conditions-typical of the study site-incoming shortwave radiation provides the majority of melt energy.

Session 70401 - Cold Regions Hydrology and Hydrometeorology - Part 2

Physically based modelling of a tundra-taiga basin in the continuous permafrost region for hydrological change diagnosis

Krogh, Sebastian Pomeroy, John
Centre for Hydrology, University of Saskatchewan
seba.krogh@usask.ca

Physically based models that couple mass and energy in the surface and subsurface, and include detailed snow physics and vegetation interactions as well as rainfall-runoff processes are necessary to successfully represent Arctic hydrology. In order to characterise the hydrological cycle of a tundra-taiga transition basin, a physically based hydrological model suitable for the Arctic was created using the Cold Regions Hydrological Model platform (CRHM). The model was applied to Havikpak Creek, a small basin near Inuvik, NWT, to reconstruct and diagnose changes in its past hydrology. The model represents the most relevant physical processes of this environment, such as permafrost thaw/freeze, snow redistribution by wind and vegetation, sublimation, snowmelt, evapotranspiration and subsurface flow through organic terrain. Parameterization was challenging due to sparse and uncertain information on the basin biophysical and pedological characteristics. Model structure and parameters were set from the results of remote sensing analysis, digital elevation models, information from site visits and calibration. Calibration was restricted to subsurface hydraulic and storage parameters. The model was run for 30 years at an hourly interval to represent the variability associated with snowmelt peak flows and quick rainfall-runoff events generated by convective storms during the summer. Multi-objective evaluation of the model against streamflow and snow water equivalent surveys showed adequate representation of both. The evolution of the spatial distribution of active layer thickness, snow water equivalent, surface and subsurface runoff, and mass and energy balances over the hydrological year is presented and discussed. Results show the dominance of snowmelt in controlling runoff, the strong coupling between rainfall and evapotranspiration, and the importance of severe summer rainstorms in generating peak flows. Changes in hydrology over 30 years associated with climate changes, such as 12 days earlier spring runoff and a decrease of approximately 35 [mm] for the end-of-the-winter SWE, are also discussed.

Session 70401 - Cold Regions Hydrology and Hydrometeorology - Part 2

Wildfire Impacts on Snow Accumulation, Snow Melt and Ground Thaw on a Peat Plateau

Mathieu, Elyse Quinton, William
Wilfird Laurier University
math8590@mylaurier.ca

Permafrost is a vital component of northern ecosystems. The southern fringe of the discontinuous permafrost, the permafrost is relatively warm and thin, and as a consequence, its thaw often leads to its local disappearance. Climate warming-induced permafrost thaw has increased in recent decades throughout the southern fringe, as has the frequency and severity of wildfires. The influence of wildfire on the rates and patterns of ground thaw is not well understood. This study investigated the impact of a wildfire on the patterns of snow accumulation, as well as the rates and patterns of snowmelt and ground thaw. This study was conducted at Scotty Creek, 50 km south of Fort Simpson, Northwest Territories, Canada. Following a 2.7ha wildfire at Scotty

Creek in July 2014, burned and non-burned sections of a peat plateau were instrumented with tripods with instruments such as a 4-component net radiometer, SR50 and an anemometer, to measure differences in meteorological variables and ground temperatures. A field campaign from March to August 2015 allowed for the measurement of depth and density of the snowpack, snowmelt rates and ground thaw depth needed for estimating the impacts of a wildfire on a northern permafrost plateau. Preliminary results demonstrated the net solar radiation at the surface of the unburned plateau, from April to June, was 23% higher and the cumulative incoming shortwave radiation was 11% lower. Prior to snowmelt, this plateaus snowpack was 10% shallower and 27% less dense. Its snowpack began showing snow free patches four days earlier than the burned plateau; yet, the burned plateaus snowpack disappeared seven days earlier. At the end of August, the average frost table depths on the burned plateau was 30% deeper than the unburned plateau. Initial, results indicate that wildfires have an adverse effect on rates and patterns of snowmelt and ground thaw depth.

Session 70401 - Cold Regions Hydrology and Hydrometeorology - Part 2

Two summers of low flow in Mackenzie River: causative factors and long-term context

Woo, Ming-ko Thorne, Robin Faria, Derek Kokelj, Shawne
McMaster University
woo@mcmaster.ca

The Mackenzie River experienced intense low flows in the summers of 2014 and 2015. Differences in meteorological and hydrological conditions led to spatial and between-year variations in flow within the basin. The summer of 2014 was warmer than usual to heighten evaporation. Precipitation in the western mountains was below normal and failed to compensate for the increase of evaporation loss, resulting in widespread low flows in the river system as summer progressed. The following summer was less hot but low winter snowfall and early spring melt in 2015 gave rise to early summer drought, notably in the southern Basin though not as severe in the north. After mid-summer, sufficient runoff from northern mountains further raised the flow in lower Mackenzie.To place the two summers in the context of the range of daily flows likely to be experienced in the long run, simulations were performed for two stations located at the upper and lower Mackenzie Basin as examples (Athabasca below Fort McMurray and Mackenzie at Norman Wells). Discharge is classified into five states according to several non-exceedance probabilities (0.1, 0.2, 0.3 and 0.4). Simulations made use of the Markovian behaviour of streamflow to generate multiple time series of the states of daily discharge, from which were derived their recurrence probabilities for every calendar day of the summer. Set against the simulated results, the flows of the recent summers fell within the low range of the long-term conditions during parts of the season. Understanding the causative elements and deriving information on the probabilities of daily low flow can assist in the planning of river-related activities and the assessment of impacts on aquatic ecology.

Session 70401 - Cold Regions Hydrology and Hydrometeorology - Part 2

Combining new observation techniques and high resolution modelling for improved quantification of snow accumulation across an arctic shrub-tundra landscape

toure, ally de Jong, Tyler   Mann, Phil Walker, Branden Marsh, Phil Wilcox, Evan
Wilfrid Laurier University
allytoure@gmail.com

Multi-decade hydrologic studies in the western Canadian Arctic have demonstrated a dramatically warming and drying climate. These changes are resulting in other hydrologically important landscape changes, including: 1) a deepening active layer across the tundra with greater soil water storage capacity, 2) shrub patches that are undergoing both infilling and expansion, with deeper end of winter snow cover within the patches, and changes in snowmelt rate and active layer depth when compared to tundra (in each case, the changes are very sensitive to shrub patch characteristics), and 3) possibly smaller slope drifts (due to increasing catch of blowing snow by shrub patches). Surprisingly, and for poorly understood reasons, the associated changes in streamflow and lake levels have been subtle and given the large errors in estimating all aspects of the snow system - snowfall, snow cover accumulation and melt, and streamflow, it is currently difficult to understand the ongoing changes or to validate predictive models or to provide robust scenarios for future changes in streamflow and lake level that are of direct interest to northern Canadians. This paper will outline preliminary results from a study focussed on greatly improving observations of snow cover accumulation, melt and runoff at the Trail Valley Creek research watershed south of Tuktoyaktuk, NWT, in the western Arctic. Here we will focus on snow accumulation and end of winter snow cover, and consider the utility of a combination of new instruments [cosmic ray sensors providing snow water equivalent (SWE) accumulation estimates across both a broad tundra area and a transect across a shrub drift, and an Unmanned Aerial System (UAS) to map snow depth and SWE across a drainage basin] and high-resolution modelling to provide greatly improved estimates of snow accumulation and end of winter snow cover. Such an improved data set is a key requirement for considering the complex factors controlling snow runoff over the past few decades and under a rapidly changing climate.

Session 70402 - Cold Regions Hydrology and Hydrometeorology - Part 3

Modelling changes in multi-decadal streamflow contributions - Bologna Glacier, Selwyn Mountains, NWT

Anderson, Emily Pomeroy, John Demuth, Michael   Pradhananga, Dhiraj Atkinson, David Courtin, Eric
Centre for Hydrology, University of Saskatchewan
emily.anderson@usask.ca

Climate warming results in glacier contraction and changes in the coverage of snow, firn, and glacier ice that impact the energy balance and affect the timing and magnitude of streamflow generation. The impact of glacier-climate co-variability on streamflow in Canadas northern continental regions, however, has remained undocumented. This study evaluates changes in glacier snow accumulation, energy balance, ablation, and hydrological regime with changing climate for the Bologna Glacier in the Ragged Range (Selwyn Mountains) headwaters of the South Nahanni River, NWT. The Bologna Glacier Basin was instrumented with two meteorological stations in 2014, which measured air temperature, relative humidity,

precipitation, wind speed, and radiation on and off the glacier surface. These short-term observations were subsequently used to spatially and temporally downscale ECMWF Interim Re-Analysis (ERA-Interim) atmospheric reanalyses for the meteorological parameters and thereby construct a meteorological record from 1979 to 2015. The Cold Regions Hydrological Model Platform (CRHM) was used to construct a physically-based glacier hydrology model that incorporated a new glacier module: an energy balance snow and ice ablation model coupled with a blowing snow and avalanche model to characterize the mass balance of glacier snow and ice. To set up the model, the Bologna Glacier Basin was discretized into Hydrological Response Units (HRUs) representing the spatial distribution of hydrological processes, parameters, and driving meteorology. HRUs were delineated by metrics including elevation, slope, aspect, equilibrium line, and land cover type, using a digital elevation model and Landsat satellite imagery from 1982 and 2014. Reconstructed meteorological data were used to force the model to run continuously over three decades with the former (1982) and contemporary (2014) glacier geometry and equilibrium line configuration to determine the impact of climate warming, reduced glacier cover, and increased ice exposure on headwater streamflow generation.

Session 70402 - Cold Regions Hydrology and Hydrometeorology - Part 3
Hydrological functions and energy balance of a talus rock glacier, Canadian Rockies
Harrington, Jordan Hayashi, Masaki
University of Calgary
jordie.harrington@gmail.com
Mountains are considered to be the water towers of the world, notably providing the majority of streamflow to arid and semi-arid regions such as the Canadian Prairies. In these mountainous environments, hydrological functions of glaciers and their responses to the changing climate have received much attention. Rock glaciers are ubiquitous in many alpine catchments where glaciers do not exist under the current climate, yet their hydrological functions remain poorly understood. They represent important aquifers, as they sustain baseflow in critical alpine stream habitats and dry season water resource availability in downstream communities. The Helen Creek rock glacier is a small (90,000m^2) inactive rock glacier located in a headwater region of the Bow River in the Canadian Rockies. Previous geophysical investigations indicated that groundwater flow and storage processes are controlled by the internal geological structure. Sporadic ground ice is present, as determined from geophysical imaging and bottom temperature of snow (BTS) measurements. Ground temperature simulations confirm the applicability of the BTS method for the site conditions. The Helen Creek rock glacier contributes 30-50% of summer streamflow and ~100% of winter baseflow, even though it occupies only 10% of the catchment area. Preliminary end-member mixing analysis indicates that June-November outflow from the rock glacier is sourced from 55% groundwater storage, 35% snowmelt, and 10% rainfall. A kinematic wave approximation of the Boussinesq equation yields a bulk hillslope hydraulic conductivity on the order of 10^-2 - 10^-3 m/s. Analysis of dissolved Radon-222 indicates significantly longer residence time for rock glacier outflow compared to reference streamflow. The low temperature (< 2C) of groundwater discharging at the rock glacier toe plays a significant role in regulating the temperature of Helen Creek, which is designated as critical habitat for a population of trout that is listed as threatened by the Species at Risk Act.

Session 70402 - Cold Regions Hydrology and Hydrometeorology - Part 3

Using Remote Sensing Data to Assess Trends in Lake Ice within Ontario and Manitoba between 2001-2014

Murfitt, Justin Brown, Laura
University of Toronto Mississauga
lc.brown@utoronto.ca

Lakes are a major geographic feature in northern landscapes and play an important role in understanding the regional climate systems. In order to better model changes within climate systems it is important to study lake ice processes. Although the study of lake ice through ground measurements has declined in recent years, the increased use of remote sensing provides an alternative to this. In order to study the trends in lake ice phenology dates and trends in temperature across Ontario and Manitoba, the MOD10A1 global 500 metre snow and ice product (2001 - 2014) as well as the ERA-Interim reanalysis data was used. The MOD10A1 product is based on images acquired by the Terra sensor on the Moderate Resolution Imaging Spectroradiometer (MODIS), the product successfully delineates between different land cover classes with a 93% accuracy including lake water and lake ice. In order to validate the data, the IceWatch dataset was used for the MODIS product and Environment Canadas Adjusted and Homogenized Surface Air Temperature dataset was used to validate the ERA-Interim dataset. The validation of the MODIS product showed that the in situ data and satellite data was significantly correlated and the mean bias error for freeze up and break up dates was less than 6 day in both cases. The ERA dataset was strongly correlated with the in situ data ($R2 > 0.94$). Results showed that although the trends in fall temperature and trends in freeze up dates were not significantly correlated, there was a significant correlation between trends in spring temperature and trends in break up dates ($p < 0.01$).

Session 70402 - Cold Regions Hydrology and Hydrometeorology - Part 3

Hydrological impacts of climate change in cold regions of the North American Cordillera

Rasouli, Kabir Pomeroy, John Marks, Danny Janowicz, Richard   Carey, Sean Fang, Xing
University of Saskatchewan
john.pomeroy@usask.ca

In this study, the response of mountain hydrology to changing climate is investigated within a climate uncertainty framework. Mid-21st century cordilleran climate was estimated based on statistical downscaling of 11 regional climate models from the NARCAPP for three snowmelt-dominated headwater basins along the cordillera with different climate and biophysical characteristics: Wolf Creek, Yukon; Marmot Creek, Alberta; and Reynolds Mountain East, Idaho. Statistical downscaling was trained using multi-elevational mountain meteorological observations at each site. Future hydrology was estimated by driving models derived from the Cold Regions Hydrological Modelling platform (CRHM) with the downscaled climate data. Results show that higher rates of warming at higher latitudes and altitudes cause precipitation phase to shift from solid to liquid to a greater degree in these regions. This leads to greater vertical and north-ward homogeneity in precipitation phase. By mid-21st century, all three

basins become rainfall-dominated with the greatest decline in peak snow accumulation for low elevation forests. Snowpack and sublimation from the blowing snow in Idaho, and snow transport and sublimation from the intercepted canopy snow in Idaho and Yukon are very sensitive to climate change, whilst snowpack and sublimation from the blowing snow in the Canadian Rockies and snowmelt in Yukon are resilient to projected climate change. Interannual variability of peak SWE in Yukon and peak streamflow in all three basins increases with a changed climate. The date of peak streamflow advances 35 days in the Yukon and Idaho basins but remains unchanged in Canadian Rockies - suggesting the persistence of observed hydrological resiliency at Marmot Creek. Runoff ratios currently decrease from north to south; under climate change the runoff ratio decreases in the north and increases in mid-latitudes. Given the substantial process changes, all basins show remarkable resiliency in peak and annual discharge which respectively decline moderately and increase slightly with changing climate.

Session 70402 - Cold Regions Hydrology and Hydrometeorology - Part 3

Responses of river flow and glacier cover to climate change in the Atlin River basin (BC, Canada)

Samuel, Jos Kavanaugh, Jeffrey Pomeroy, John FANG, XING PRADHANANGA, DHIRAJ Brown, Tom
Yukon Research Centre, Yukon College
jsamuel@yukoncollege.yk.ca

The focus of this study is to investigate the future surface mass balance changes and their contributions to river flow at the outlet of the Atlin River basin (British Columbia, Canada), which is necessary for improved water management and planning in this region. We applied the physically based Cold Region Hydrological Model (CHRM) to simulate flow observation and snow-water equivalent surveys. Model outputs were also validated in the glacierized areas with remote sensing data, snow and ice melt temperature index model outputs, former regional studies, and velocity stake measurements. The model captures the flow, snow and glacier field observations with relatively good accuracy. Outputs from the GFDL (Geophysical Fluid Dynamics Laboratory) and IPSL (Institut Pierre Simon Laplace) Global Climate Models (GCMs) under RCP4.5 and RCP8.5 (Representative Concentration Pathways) scenarios were bias corrected and then used to force the CRHM model to project future glacier cover and flow changes. The model estimated losses of surface area and volume of Llewellyn and Willison Glaciers, the two largest glaciers in the study basin, varying from 90 to 110km2 and from 50,000 to 70,000km3, respectively at the end of 2045 relative to at the end of 2013 (assuming no dynamical response in ice flow). These model simulations indicate that by in 2045, the contribution of discharge from these glaciers to the Altin River outlet would increase to about three times larger than modern (2006-2013 average) flow. Our sensitivity analysis shows that ice melt and river discharge at the basin outlet are significantly more sensitive to changes in air temperature than precipitation, relative humidity or wind speed.

Session 70402 - Cold Regions Hydrology and Hydrometeorology - Part 3

Glacier and hydrology changes in future climate over western Canada

Winger, Katja Sushama, Laxmi Marshall, Shawn
Centre ESCER, Université du Québec à Montréal, Montréal, Québec, Canada
winger.katja@uqam.ca

Glaciers are frozen fresh water reservoirs that respond to changes in temperature and snowfall. Concern is growingabout the impact that changes in glaciers may have on water resources in regions such as western Canada thatderive a lot of their summer streamflow from glacier melt. Given that RCM projections are an important tool andare increasingly being used in assessing projected changes to water resources, particularly due to its high resolutioncompared with GCMs, realistic representation of glaciers in RCMs is very important. Currently, glaciers are onlyrepresented in an extremely simplified way in the fifth generation Canadian Regional Climate Model (CRCM5).This simple approach of representing glaciers as static glacier masks is appropriate for short-term integrations,where the response of glacier to changing atmospheric conditions might still be small due to glacier responsetimes and therefore the feedback of changing glacier extent on large-scale atmospheric flow conditions might benegligible. A new dynamic glacier scheme has been developed for use within CRCM5, based on volume-arearelationships. Simulations have been performed with this glacier model and Land Surface Scheme CLASS forthe 2000-2100 period over a domain covering western Canada. These simulations were driven by outputs froma CRCM5 transient climate change simulation driven by CanESM2 at the lateral boundaries, for RCPs 4.5 and8.5. Preliminary results suggest significant decreases to glacier fractions in future climate. Though the glaciercontribution to streamflows is found to dramatically decrease in future climate, the total streamflows did not showany dramatic decreases due to the increase in precipitation for these regions.

Session 70403 - Cold Regions Hydrology and Hydrometeorology - Part 4

Subsurface Behaviour of a Continuous Solute Release in a Sub-Arctic Bog

Balliston, Nicole Price, Jonathan
University of Waterloo
nballiston@gmail.com

Resource extraction and transportation activities in subarctic Canada can result in unintentional release of contaminants in subarctic peatlands. In the event of a release, a thorough understanding of solute transport within peatlands is necessary to predict the fate of the plume; however, there is limited information on solute transport in peatlands. To better understand contaminant transport in these systems, approximately 14 000 L/day of sodium chloride (200 mg/L) was continuously released over 45 days onto the slope of a bog peatland in the James Bay Lowlands, through a 1.25 m injection well. Hydraulic head and electrical conductivity (EC) of the saturated zone were measured to determine the hydrological impacts and plume development. Vadose zone plume movement was measured using EC derived from Time Domain Reflectrometry probes installed at -5, -10 and -15 cm bgs. Over the spill period the bulk of the plume travelled a lateral distance of 90 m in the direction of the bogs slope. Microtopography (i.e., hummocks and hollows) caused an irregular plume shape and saturated solute transport occurred primarily within 20 cm of the water table. Patterns of solute transport were confounded by a heavy rains (535 mm total over the study period) which enhanced lateral

convection, and diluted the tracer in the highly permeable upper peat layer. Elevated EC values were observed in the unsaturated zone, increasing on average from ~25 to ~50 µs/cm in the shallowest (5 cm) probes, indicative of capillary rise, and EC measured in lower probes mimicked that below the water table. This research clearly indicates that solute transport in bog peatlands is subject to variations due to microtopgraphy, thus information on the topography, vegetation community distribution and basic hydrology of the system are necessary to predict the behaviour of real world spills.

Session 70403 - Cold Regions Hydrology and Hydrometeorology - Part 4
Snow-atmosphere coupling in current and future climates over North America in the Canadian Regional Climate Model (CRCM5)
Diro, Gulilat Tefera Sushama, Laxmi
ESCER Centre, UQAM
diro@sca.uqam.ca
The influence of snow variation on climate variability over North America is assessed using the fifth generation of Canadian Regional Climate Model (CRCM5). For this, we first carried out a suite of CRCM5 simulations driven by ERA-Interim reanalysis, whereby the snow was either prescribed (uncoupled) or allowed to evolve interactively (coupled) during the model integration. Results indicate a systematic influence of snow on the inter-annual variability of air and surface temperature throughout winter and spring seasons. In the coupled simulations, where the snow depth and snow cover were allowed to evolve freely, the inter-annual variability of surface and near surface air temperatures were found to be larger and explains up to 70% of the surface temperature variation over northern Great Plains and Canadian Prairies. The impact of snow is found to be stronger in spring than in winter, since in spring season both albedo and hydrological effects contribute to the variability in temperature. To study projected changes to snow-atmosphere coupling in future climate, coupled and uncoupled CRCM5 simulations, driven by coupled GCMs, were performed, for current (1981-2010) and future (2071-2100) climates. Coupling regions in the GCM-driven current climate simulations are similar to those obtained with ERA-Interim driven CRCM5 simulations discussed above. In future climate, snow-temperature coupling shows some change in spatial structures and in magnitudes. These results suggest that accurate initialization of snow condition could potentially be helpful to improve seasonal prediction skill over these snow-atmosphere coupling hotspot regions.

Session 70403 - Cold Regions Hydrology and Hydrometeorology - Part 4
On improving cold region hydrological processes in the Canadian Regional Climate Model
Ganji, arman Sushama, Laxmi
Département des Sciences de la Terre et de lAtmosphère, Université du Québec à Montréal
aganji@sca.uqam.ca
Regional and global climate model simulated streamflows for high-latitude regions show systematic biases, particularly in the timing and magnitude of spring peak flows. Though these biases could be related to the snow water equivalent and spring temperature biases in models, a good part of these biases is due to the unaccounted effects of non-uniform infiltration capacity of

the frozen ground and other related processes. In this paper, the treatment of frozen water in the Canadian Land Surface Scheme (CLASS), which is used in the Canadian regional and global climate models, is modified to include fractional permeable area, supercooled liquid water and a new formulation for hydraulic conductivity. The impact of these modifications on the regional hydrology, particularly streamflow, is assessed by comparing three simulations, performed with the original and two modified versions of CLASS, driven by atmospheric forcing data from the European Centre for Medium-Range Weather Forecasts (ECMWF) reanalysis (ERA-Interim), for the 1990-2001 period, over a northeast Canadian domain. The two modified versions of CLASS differ in the soil hydraulic conductivity and matric potential formulations, with one version being based on formulations from a previous study and the other one is newly proposed. Results suggest statistically significant decreases in infiltration, and therefore soil moisture, during the snowmelt season, for the simulation with the new hydraulic conductivity and matric potential formulations and fractional permeable area concept, compared to the original version of CLASS, which is also reflected in the increased spring surface runoff and streamflows in this simulation with modified CLASS, over most of the study domain. The simulated spring peaks and their timing in this simulation is also in better agreement to those observed. This study thus demonstrates the importance of treatment of frozen water for realistic simulation of streamflows. To study the impact of these modifications on the surface climate, 10-year Canadian Regional Climate model simulation with and without the modifications are compared. Results from this comparison will also be presented at this talk.

Session 70403 - Cold Regions Hydrology and Hydrometeorology - Part 4

The incorporation of an organic soil layer in the Noah-MP Land Surface Model and its evaluation over a Boreal Aspen Forest

Li, Yanping   Chen, Liang Chen, Fei Barr, Alan Barlage, Michael   Wan, Bingcheng
University of Saskatchewan
yanping.li@usask.ca

A thick top layer of organic matter is a dominant feature in boreal forests and can impact land-atmosphere interactions. In this study, the multi-parameterization version of the Noah land-surface model (Noah-MP) was used to investigate the impact of incorporating a forest-floor organic soil layer on the simulated surface energy and water cycle components at the BERMS Old Aspen Flux (OAS) field station in central Saskatchewan, Canada. Compared to a simulation without an organic soil parameterization (CTL), the Noah-MP simulation with an organic soil (OGN) improved Noah-MP simulated soil temperature profiles and soil moisture at 40-100cm, especially the phase and amplitude of soil temperature below 10 cm. OGN also enhanced the simulation of sensible and latent heat fluxes in spring, especially in wet years, which is mostly related to the timing of spring soil thaw and warming. Simulated top-layer soil moisture is better in OGN than that in CTL in summer but worse in winter. The effects of including an organic soil layer on soil temperature are not uniform throughout the soil depth and are more prominent in summer. For drought years, the OGN simulation substantially modified the partitioning of water between direct soil evaporation and vegetation transpiration. For wet years, the OGN simulated latent heat fluxes are similar to CTL except for spring season where OGN produced less evaporation, which was closer to observations. Including organic soil produced more sub-surface runoff and resulted in much higher runoff throughout the season in wet years.

Session 70403 - Cold Regions Hydrology and Hydrometeorology - Part 4

Testing warranted model complexity using a multi-scale, variable-complexity hydrological modelc

Marsh, Christopher Pomeroy, John Wheater, Howard
Centre for Hydrology & GIWS, University of Saskatchewan
chris.marsh@usask.ca

Modeling of hydrological processes at any scale is hampered by large uncertainties in parameters and forcing data, incomplete process representations (the scientific conceptualization of a phenomena codified numerically), and arbitrary process representation selections and linkages (collectively model structure). There is also consistent difficulty and/or an inability to easily test and estimate the uncertainty due to variations in model structure, parameter values, number of parameters, forcing data requirements, and spatial discretization requirements (collectively model complexity). In this work, a new model framework is presented that can examine a variety of process representations, process linkages and levels of model complexity. Algorithms can be easily interchanged, removed, and decoupled while preserving the underlying model framework. Thus uncertainty propagation and subsequent feedbacks within the model structure can be quantified. Unstructured meshes represent the spatial heterogeneity of surface and sub-surface features in a computationally efficient manner and also decreases number of parameters and initial conditions. The parallel architecture allows for efficient uncertainty testing of parameter ranges.A case study is presented using this framework to quantify the topographic and alpine snowpack conditions under which compensatory feedbacks in the energy balance dampen input perturbations due to errors in driving meteorology. Such feedbacks can introduce robustness, characterized by persistent behaviours despite perturbations, to snow model behaviour in the face of uncertainty. By maintaining a consistent model framework and only varying snowmelt model complexity, it is possible to isolate the impact of model complexity on these dampening mechanisms. The uncertainty due to snowpack process representations is quantified by an uncertainty index allowing for a direct evaluation of the benefit of reduced parameter and data requirements. Understanding these compensatory responses is necessary when to designing hydrological models of appropriate complexity to adequately capture the process of interest in the face of uncertainty.

Session 70403 - Cold Regions Hydrology and Hydrometeorology - Part 4

Spatial and Temporal Modelling of Current and Predicted Hydrologic Processes of a High Arctic Watershed, Pond Inlet (Mittimatalik), Nunavut

Robinson, Alexis Atkinson, David M. Oswald, Claire J.
Ryerson University
alexis.robinson@ryerson.ca

High Arctic watersheds fluxes of water, sediment, and nutrients are traditionally dominated by snowmelt. Projected climate changes are anticipated to impact winter snowpack and melt season conditions, which in turn will affect water quality and quantity. The water within these watersheds is both a key source of freshwater for northern communities, as well as a crucial

component for local ecosystems. Understanding the current watershed dynamics and potential future trajectories are crucial to protecting source water. The goal of this study is to model current and predicted streamflow of an ungauged High Arctic watershed, using a combination of meteorological and remotely sensed data as inputs to the Cold Regions Hydrological Model (CRHM). Preliminary research identified the Salmon River watershed as an important source of freshwater to the town of Pond Inlet (Mittimatalik), Nunavut. Remote sensing data (e.g. digital elevation model, Landsat 8 OLI/TIRS, NDVI, and statistically downscaled climate scenarios) were used to derive meteorological data, and topographic indices which were used to delineate and classify hydrological response units (HRUs) and spatial parameters related to landscape characteristics. The HRUs were used to model current and predicted hydrologic processes in the watershed. The models were forced using current climate data collected by Environment Canada (e.g. precipitation, temperature, wind speed and relative humidity) and statistically downscaled air temperature and precipitation from the Representative Concentration Pathways (RCP) 2.6, RCP 4.5 and RCP 8.5 scenarios developed by the International Panel on Climate Change (IPCC). The preliminary findings can be used to assess the both the potential for CRHM and remotely sensed data to model ungauged High Arctic watersheds. The results of the research provide a framework for Pond Inlet (Mittimatalik), Nunavut to determine potential source water catchment areas and for developing a source water protection plan.

Session 70404 - Cold Regions Hydrology and Hydrometeorology - Part 5

Mapping flood risk in the Kennebecasis River Basin (NB) using the hydrogeomorphological approach

Fortin, Guillaume Thériault, Francis   Albuquerque, Allan Goudard, Gabriela
Université de Moncton
guillaume.fortin@umoncton.ca

In fluvial environments in New Brunswick (NB) floods are a natural risk that threatens the integrity of infrastructure and the safety of surrounding communities. In 2014, two major floods occurred whose damages exceeded $26 million.Sussex and Sussex Corner, two communities within the watershed of the Kennebecasis River (total area of about 1346 km2) are among the areas in the province that are most often and hardest hit by flooding. This area, like other parts of the provinces southeast, is experiencing a growth in population, particularly in the areas at risk. This entails significant changes that are not reflected in existing maps delineating flood areas, which date back more than thirty years.In 2015 we started a project to use different flood risk mapping approaches to highlight the main advantages and disadvantages of each approach. In this work we present our first results: a mapping of flood zones based on an hydrogeomorphological approach. The goal is to define the main morphological units of the alluvial plain (streambed, streambank and floodplain) corresponding to the frequency of the hazard in order to identify the limits of frequent, rare or exceptional floods.We present hydrogeomorphological maps of two of the main tributaries of the Kennebecasis River (Trout Creek and Millstream) and discuss the advantages, disadvantages and limitations of this approach. We also focus on the major changes experienced by these watercourses since the early 1980s and their impact on flooding.

Session 70404 - Cold Regions Hydrology and Hydrometeorology - Part 5

Characteristics of Easterly-Induced Snowfall in the Yeongdong region of Korea

Kim, Byung-Gon Eun, Seung-Hee Seong, Dae-Kyeong Choi, Byeong-Cheol Chang, Ki-Ho

Gangneung-Wonju National University

bgk@gwnu.ac.kr

In general, Yeongdong in Korea has heavy snowfall in late winter because of high Taeback Mountains and an adjacent East Sea to the east. The synoptic setting for the heavy snowfall in winter are the Siberian High extended to East Sea and further northern Japan along with the Low system passing by the southern Korean peninsula, which eventually results in the northeasterly or easterly flows in the Yeongdong region. The basic mechanism to initiate snowfall around Yeongdong seems to be similar to that of lake-effect snowstorms around Great Lakes in Canada, and the United States, and also western Japan across the East Sea. Interestingly, snowfall appeared to begin in case of an air-sea temperature difference exceeding over 15?. We also attempted to investigate temporal variations of water vapor, liquid water and snowfall using ground-based Global Navigation Satellite System measurements, Microwave radiometer, and radiosonde systems. The results show that low-level clouds exist below 2~3km thickness with cloud base less than 1km, where northeasterly and northerly winds are consistent. The analysis has been made along with the classification of 3 dominant synoptic patterns such as Low Crossing, Low Passing, and Stagnation types. The snowfall intensity of the largely easterly-induced Stagnation type is highest in spite of lower available water vapor. Late-winter snowfall is likely to have mixed precipitation, and also relatively heavier wet-snow. Rimed habits were frequently observed with various kinds of dendrites dominant by using both an i-phone and a digital camera.

Session 70404 - Cold Regions Hydrology and Hydrometeorology - Part 5

Cold region river peak flow forecasting using GRACE satellite observations

Wang, Shusen

Canada Centre for Remote Sensing

shusen.wang@NRCan.gc.ca

Flood from snowmelt during the spring break-up is a widespread hydrological phenomena for cold-region river basins. Forecasting peak river flow from snowmelt remains a challenge due to scarce of observations and lack of knowledge for cold region hydrological processes. This study developed a flood forecast model using the observations from the Gravity Recovery and Climate Experiment (GRACE) satellite mission. The model forecasts peak river flow by simulating peak surface runoff from snowmelt and the corresponding baseflow from groundwater discharge. Peak surface runoff from snowmelt is predicted using a temperature index model. Baseflow is predicted using a first order differential equation model. The model also quantifies the hysteresis between the peak snowmelt date and the peak streamflow occurring time. Applications of the model to several Canadian river basins will be demonstrated. The model is relatively simple and only needs GRACE and temperature inputs for flood forecast. It can be readily applied to other cold-region basins after simple calibration, and could be particularly useful in regions with minimal data.

Session 70500 - Advances in Hydroecology in Canada

Groundwater flow reversals in an abandoned vacuum-harvested bog, southeastern Manitoba

Hawes, Melanie Whittington, Pete
Brandon University
whittington.pete@gmail.com

Canada is the worlds largest producer of horticultural peat and Manitoba contributes ~13% of this total. Peat harvesting requires drainage of the peatland and the removal of the surficial vegetation, which makes restoration of these sites challenging as the vegetation does not typically grow back on its own after harvesting ends. Peat mining began at the Moss Spur peatland in 1940 and was abandoned in 1993. Amazingly, the majority (~95%) of Moss Spur has vegetation regeneration. The objective is to determine the hydrology of the Moss Spur peatland and how it relates to the spontaneous regeneration. Wells and piezometers were installed in nests at 6 locations (A, M, X, J, P, I) across Moss Spur and measurements were taken every ~2-3 days from May to August. Hydraulic conductivity (K) tests were performed 1-4 times at each nest.Darcys law was used to calculate specific discharge of groundwater at each nest. Nests A, M, and X have poor bog vegetation regeneration, and the specific discharge shows groundwater recharge of 0.06, 0.04, and 0.2 mm/day, respectively. Nests J, P, and I exhibit greater amounts of bog vegetation, with the specific discharge supporting groundwater discharge of 10, 1 and 0.2 mm/day, respectively. The results suggest groundwater flow reversals may play an important role in the upwelling (discharge) of groundwater, stimulating vegetation regeneration at Moss Spur.

Session 70500 - Advances in Hydroecology in Canada

Subarctic peatland-pond interactions in a permafrost landscape: runoff quantity and quality depend on frost table development and antecedent moisture conditions

Morison, Matthew Macrae, Merrin Petrone, Richard Fishback, LeeAnn
University of Waterloo
mmorison@uwaterloo.ca

In subarctic permafrost environments, ecological productivity is often nutrient-limited, both in terrestrial and aquatic vegetation. The subarctic is experiencing significant climatic change, including rapid warming and changing precipitation patterns, which may result in changes in nutrient dynamics within terrestrial and aquatic systems and hydrologic transport between them. It is unclear if changes in hydrologic connectivity throughout the ice-free season will also result in enhanced nutrient mobilization in the landscape. The objective of this research was to characterize changes in runoff pathways, quantity and quality between peatlands and ponds over the snow-free summer season. Twenty-two ponds and five transects of piezometer nests along moisture gradients were instrumented to measure changes in hydrologic storage, frost table position, and water quality over three snow-free seasons in Churchill, Manitoba, within the Hudson Bay Lowlands. Differences in antecedent moisture conditions across landscape units, combined with frost table position (inhibiting infiltration and storage) produced non-linear,

threshold responses in runoff generation. Greater inputs were required to exceed storage (fill and spill) when a lower frost table permitted deeper infiltration. Seasonal variations in groundwater chemistry were reflective of different layers of peat and mineral soil accessed at different times throughout the season. Varying thaw rates across landscape units (controlled by moisture and vegetation) resulted in changing groundwater pathways throughout the season. This work has implications for how nutrient dynamics and exchange between terrestrial and aquatic systems in cold regions may evolve under a changing climate. Although shallow permafrost thaw might have a different character of soil chemistry, this may not be reflected in future runoff chemistry due to low conductivity at those depths. Instead, hydrochemical contributions to ponds may be more reflective increased frequency and intensity of storms during a period of lesser evaporative demand with flow primarily through highly-conductive surficial peat layers.

Session 70500 - Advances in Hydroecology in Canada

Creating river types to support the assessment of environmental flow requirements in Canada at large-scale

Ouellet Dallaire, Camille Lehner, Bernhard
McGill University
camille.ouelletdallaire@mail.mcgill.ca

Environmental flow requirements (EFR) can be defined as the water regime provided within a river to maintain ecosystems and their benefits. Because of the nature of river systems and the socio-ecological relevance of this concept, large-scale approaches can be a key component of a successful application. In Canada, more than three million kilometres of rivers flow through the landscape and provide a wide spectrum of vital services and goods to the Canadian communities. Most of these rivers flow through currently undeveloped landscapes and few remote locations are currently monitored.Most approaches to assess EFR rely on hydrological indices at the daily time step to identify critical components of river regimes that maintain a specific ecological status. However, daily discharge data is not available for all Canadian rivers. River classifications are used in EFR assessments to define groups of rivers that have similar hydrological characteristics. This study proposes a new river type classification for Canada facilitated by at 500m pixel resolution based a suite of hydrologically relevant datasets including a river network and monthly discharge data at the Canadian scale. This project is based on the Global River Classification framework relying on the creation of multiple sub-classifications based on different disciplines; in this case, integrating hydrology, physiography, climate, and geomorphology. High-quality records of HYDAT (National Water data archive from Environment Canada) stations were attributed a river type. This association allowed the exploration intra-groups variability among daily discharge indices defined by Indicator of Hydrological Alteration (IHA, Richter et al., 1996). This information could be used as a baseline of EFR in remote regions and for rivers that currently do not have gauged stations.

Session 70500 - Advances in Hydroecology in Canada

A Review of Recent Advances in Environment Flow Needs Science in Canada

Peters, Daniel Baird, Donald Curry, Allen Linnansaari, Tommi Monk, Wendy
Environment and Climate Change Canada
daniel.peters@canada.ca

The natural flow regime (e.g., magnitude & timing) of many streams in Canada has been altered with the introduction of dams, diversions, and water withdrawals (e.g., irrigation, hydroelectric power production, and municipal/industrial uses), as well as via landscape alterations (e.g., agriculture and urbanization). Associated with changes to the flow regime are potential impacts to the structure and functioning of riverine and associated floodplain ecosystems (e.g., deltaic environment). Internationally, there has been a significant scientific effort invested in the last three decades in improving our understanding of the relationship between streamflow, geomorphology and aquatic ecology. Emanating from the hydroecological research are numerous simple to sophisticated environmental flow needs methodologies developed to estimate the quantity of water through time required to maintain the health of a river in a particular state. The purpose of this paper is three-fold: 1) review the state of knowledge of environmental flow needs in Canada, 2) compare and contrast the environmental flow needs methodologies currently proposed and/or applied in the Provinces and Territories of Canada, and 3) discuss recent advances in first level environmental flow needs assessment methodology that can be applied to watersheds across Canada, taking into account the regionally variability in hydroclimatology and ecology.

Session 70500 - Advances in Hydroecology in Canada

River water temperature in relation to local air temperature in the Yukon and Mackenzie river basins

Yang, Daqing Peterson, Amber
Environment Canada
daqing.yang@ec.gc.ca

Water temperature has an important impact on many aspects of stream ecology. In northern regions, the investigation of river thermal regimes and their changes over space and time is a challenge due to data limitations. In this study, water temperature regimes of several rivers within the Mackenzie and Yukon river basins were examined. The association between water temperature and local air temperature and flow rate was explored; and linear regression and s-shaped water temperature models were tested. In most cases, the s-shaped models gave the best results. Estimates of water temperature from air temperature were slightly improved by the inclusion of discharge data. Overall, the spatial variability of mean monthly water temperatures across the regions was found to be strongly related to local climate.

Session 70600 - General Hydrology - Part 1

Water Retention Properties of Agricultural Soils in Western Newfoundland Amended with Biochar

Galagedara, Lakshman Diamond, Nicholas Unc, Adrian Cheema, Mumtaz Altdorff, Daniel Nadeem, Muhammad
Grenfell Campus, Memorial University of Newfoundland
lgalagedara@grenfell.mun.ca

The predominant Podzolic soils (sandy and stony) of western Newfoundland have water holding capacity issues that may affect crop growth. Bio char (BC) can alter water retention characteristics given its high specific surface area and charge densities. An initial laboratory experiment evaluated the water retention properties on BC amended sandy loam agricultural soils collected from the 0-15 cm depth at Pynns Brook research station. Treatments carried out in triplicate, included, soil (T1), soil+1% BC (T2) and soil+4% BC (T3), (on mass basis). Soils were repacked at 1.25 g cm-3 bulk density in plastic containers (3.1 L) designed as small weighing lysimeters and were saturated from the bottom and then drained under gravity over 48 h. Evaporative daily water losses under constant temperatures (22oC, 25oC and 28oC) were estimated. Measured and calculated water losses were evaluated for 24 h intervals. The initial and at saturation, volumetric soil moisture contents were 31.6%, 28.9% and 12.5% and 53.4%, 54.4% and 48.9% for T1, T2 and T3, respectively. Results show the following trends; (i) relative total water absorbed during saturation were 35.3%, 36.5% and 37.4% and lost due to free drainage and drying were 67.4%, 68.1% and 66.8% for for T1, T2 and T3, respectively (non-significant); (ii) water absorbed due to capillarity was significantly higher in T3 versus T1 (P=0.0095), but not significantly increased in T2 versus T1; (iii) during the entire experiment, free drainage and drying at 28oC losses were 3.96, 4.02 and 3.53 mm/day for T1, T2 and T3, respectively; (iv) water loss was significantly lower in T3 versus T1 (P=0.042) and T2 (P=0.033). These short-term preliminary results indicate water retention properties to be directly linked to biochar amendment ratio. Understanding of long-term retention properties for a wetting-drying soil under natural conditions, at field scale, is an obvious follow-up question.

Session 70600 - General Hydrology - Part 1

Land cover controls on depression-focused recharge: an example from southern Ontario

Greenwood, Wesley Buttle, James
Trent University
jbuttle@trentu.ca

The Oak Ridges Moraine (ORM) is a critical hydrogeologic feature in southern Ontario. Although previous research has highlighted the implications of spatially-focused recharge in closed topographic depressions for regional groundwater resources, such depression-focused recharge (DFR) has not been empirically demonstrated on the ORM. Permeable surficial sands and gravels mantling much of the ORM imply that water fluxes will largely be vertical recharge rather than lateral downslope transfer into depressions. Nevertheless, lateral fluxes may occur in winter and spring, when concrete frost development encourages surface runoff of rainfall and snowmelt. The potential for DFR was examined under forest and agricultural land cover with similar soils and surficial geology. Soil water contents, soil temperatures and ground frost thickness were measured at the crest and base of closed depressions in two agricultural fields and

two forest stands on permeable ORM outcrops. Recharge from late-fall to the end of spring snowmelt was estimated via 1-d water balances and surface-applied bromide tracing. Both forest and agricultural sites experienced soil freezing; however, greater soil water contents prior to freeze-up at the latter led to concrete soil frost development. This resulted in lateral movement of snowmelt and rainfall into topographic depressions and surface ponding, which did not occur in forest depressions. Both the water balance and bromide tracer approaches indicated DRF exceeded recharge at the depression crest in agricultural areas with little difference in forest areas. Water balance estimates suggest winter-spring DFR (1300 - 2000 mm) is 3-5× recharge on level agricultural sites. Differences in the potential for DFR between agricultural and forest land covers have important implications for the spatial variability of recharge fluxes and the quality of recharging water on the ORM.

Session 70600 - General Hydrology - Part 1

An Efficient Approach to Analyze the Behavior of Hydrological Models Using Global Sensitivity Analysis

Haghnegahdar, Amin Razavi, Saman
Global Institute for Water Security, University of Saskatchewan, Canada
amin.haghnegahdar@usask.ca

Complex hydrological models are being increasingly used in a variety of water and environmental resources management due to advances in computational capabilities and data availability. Sensitivity analysis (SA) is an essential tool for analyzing the behavior of these complex models and providing insight into its underlying processes. Existing Global SA (GSA) methods are often very computationally intensive to generate reliable sensitivity metrics, especially for complex hydrological models with a large number of parameters. In order to identify important hydrological processes we conducted a comprehensive sensitivity analysis using a novel and efficient technique, Variogram Analysis of Response Surfaces (VARS). VARS is designed based on the Variogram concept to efficiently provide reliable global sensitivity metrics across a range of scales within the parameter space. The sensitivity of model response (streamflow) to underlying model processes (represented through parameters) was analyzed using various metrics selected based on various hydrograph characteristics including high flows, low flows, and volume. In addition, we present innovative ideas to demonstrate the efficiency of a sensitivity analysis and the level of confidence we can assign to its results.

Session 70600 - General Hydrology - Part 1

Hydrological functions of an alpine talus inferred from diel signals: Linking field observations with modeling

Kurylyk, Barret Hayashi, Masaki
University of Calgary
barret.kurylyk@ucalgary.ca

Alpine watersheds source major rivers in many regions of the world and thereby supply essential water for irrigation, human consumption, and hydroelectricity. Coarse depositional units in alpine catchments, such as taluses and proglacial moraines, are thought to store and transmit

significant volumes of groundwater and thus attenuate flooding during snowmelt and augment stream discharge during the dry season when water supply is critical. This study focuses on the hydrologic functions of an alpine talus unit within the Lake OHara watershed in the Canadian Rockies of British Columbia. Previous field investigations indicate that the talus exhibits very high hydraulic conductivity, low storage capacity, and a fast hydrograph recession with an exponential decay of approximately 1 d-1. Despite the low storage and flashy response to snowmelt input, the isotopic signature of the stream fed by the talus indicates that the discharging water is predominantly pre-event water. We investigate internal processes controlling the bulk hydrologic functioning of this talus unit using a finite element model of coupled subsurface water flow and transport. The hydrologic parameters of the model are calibrated to achieve congruence between the simulated and observed response (lag time) to the snowmelt input. The transport equation is employed to simulate the age of discharging water and investigate how the mean transit time is influenced by hydraulic conductivity, boundary conditions, and talus geometry (e.g., step features in the bedrock plane beneath the talus). The hydraulic properties and talus boundaries are adjusted within the model to see how other talus units with differing geologic composition and geometry may store and transmit water and thus attenuate flood stage or enhance baseflow in other alpine catchments. The results illustrate the importance of alpine landforms for storing groundwater and providing baseflow in the context of a changing climate.

Session 70600 - General Hydrology - Part 1

Landscape influences on transit times in six Precambrian Shield catchments

Mitchell, Carl Lane-Coplen, Daniel Richardson, Murray McConnell, Christopher Yao, Huaxia
University of Toronto Scarborough
carl.mitchell@utoronto.ca

Transit time analysis can be a powerful catchment-level descriptor since it provides broad information about flow and storage processes. In this study, we investigated transit time distributions and mean transit times across six small (22 to 191 hectare), southern Precambrian Shield catchments in central Ontario using convolution lumped modeling that incorporated 3.5 years of precipitation and streamflow water isotope signatures. The main objective was to explore the dominant physical controls on catchment-scale transit times by investigating relationships between geomorphic and physiographic variables such as catchment area, soil depths, surficial geology, wetland area, and a suite of LiDAR derived flowpath metrics. Mean transit times across the catchments ranged from 7 to 13 months and were best correlated to topographic metrics such as flow path gradient and the ratio of flow path length to gradient. These findings support the notion that within shallow-soil catchments in this region, topography, especially gradient-driven metrics, largely dictate catchment-scale water storage and movement.

Session 70600 - General Hydrology - Part 1

A Whole-Catchment Manipulation to Evaluate the Impact of Dry Conditions on Boreal Lakes

Spence, Christopher Beaty, Ken   Blanchfield, Paul   Mackay, Murray
Environment and Climate Change Canada
chris.spence@canada.ca

Hydrologists typically induce the nature of processes and causal relationships by observing hydrological and biogeochemical terms over a specified period under a range of conditions. A deductive experiment to test hypotheses on the effect of drought, water diversion or removal on boreal lakes would represent a rare attempt to integrate scientific study of the interaction of hydrometeorological and biogeochemical processes in boreal lakes in the context of physical habitat alteration, water management and climate change and in turn improve resource management decisions by improving understanding of cumulative impacts on these lakes. After two years of background study, we commenced such an experiment in November 2010 by diverting the natural incoming streamflow around a 26 ha lake, subsequently reducing lake catchment area 5-fold (from 347 to 69 ha). This reduction in basin area, and associated reduction in inflow, was meant to simulate drier conditions. The hypothesis was that there would be a reduction in dissolved organic carbon flux into the lake, and this would change light extinction properties of the water column. Simulations with the Canadian Small Lake Model (CSLM) suggested this change would permit more energy to reach deeper waters, sink the thermocline depth, and lower surface water temperatures. Observations suggested that after four years of manipulation, a drop in surface water temperatures suppressed evaporation rates from the experimental lake relative to a control lake. These results are the first to highlight how biogeochemical and hydrometeorological processes are coupled in boreal lakes. It has now been shown that low streamflow conditions impact evaporation rates from lakes that occupy close to one quarter of the boreal landscape. How this feedback mechanism manifests at larger scales could have serious repercussions for regional energy and streamflow budgets under climate change.

Session 70601 - General Hydrology - Part 2

Hydrologic Controls on Trembling Aspen (Populus tremuloides) Regeneration and Succession Post-Fire

Depante, Midori Devito, Kevin Kettridge, Nicholas Waddington , J. Michael Petrone, Richard
University of Waterloo
mdepante@uwaterloo.ca

The Western Boreal Plains (WBP) is characterized by a sub-humid climate where evapotranspiration often exceeds precipitation, resulting in moisture deficits in most years. This highlights the hydrologic importance of peatlands to uplands via hydraulic redistribution (HR). While HR been previously studied in the WBP, it is uncertain if this process continues post-fire disturbance, and if so, if it will facilitate upland regeneration. The purpose of this study was to monitor trembling aspen (Populus tremuloides Michx.) regeneration across a burned hillslope in north central Alberta during the summers of 2013 and 2014, two and three years post-fire. The aim of this study was also to understand the controls that have allowed P. tremuloides, a

dominant upland species, to regenerate in peatlands and if they contribute to forest recovery. To determine how well aspen thrive along a burned forest-peatland gradient, plot transpiration (Eplot) was taken during both growing seasons, where midslope (0.42 mm hr-1) > hilltops (0.29 mm hr-1) > riparian (0.23 mm hr-1) > peatlands (0.095 mm hr-1). While soil moisture was limited in forests where volumetric water content (VWC) was <0.25 m3m-3, upland transpiration was likely sustained through aspen roots present in peatlands and peatland margins that participated in hydraulic redistribution. Evidence for this was observed in oxygen (?18O) and hydrogen (?2H) isotopes (per-mille, ?), where upland xylem and peat core signatures were -10.0 ?, -117.8 ? and -9.2 ?, -114.0 ?, respectively. This study demonstrated that aspen seedling germination was dependent on soil substrates and moisture, and that peatlands were unsuitable for the continued growth of P. tremuloides. Instead, the amount of water that was hydraulically redistributed to moisture-limited uplands was sufficient for aspen regeneration post-fire.

Session 70601 - General Hydrology - Part 2

Predicting the vertical distribution of NAPL, water and air in a hydrocarbon contaminated peat layer by measuring its two- and three-phase capillary pressure relations

Gharedaghloo, Behrad Price, Jonathan
Ph.D. candidate, University of Waterloo
bghareda@uwaterloo.ca

The accidental release of Non Aqueous Phase Liquids (NAPL) on peatlands is threatening peatlands located in the vicinity of the hydrocarbon production and transport. The current action plan after a hydrocarbon release on a peatland is to physically remove the peat layer, which also seriously damages the hydrological regimes of the peatland. Better knowledge of flow and transport processes of hydrocarbons will allow a better assessment of the potential threat of a spill to downstream aquatic ecosystems, and the potential for natural processes to attenuate the contaminant; this has not been properly evaluated for peatlands. Our approach is to measure multiphase flow parameters for peat, including surface contact angle, two-phase and three-phase capillary pressure and relative permeability relations. In this study, contact angle, two-phase and three-phase capillary pressure data of water-air, diesel-air and diesel-water-air systems were measured for peat samples. Contact angle data showed strong variation of peat surface chemistry during drainage and imbibition of water and diesel into peat pore space. Two-phase results of diesel-air and water-air systems were matched successfully using measured contact angle data verifying the accuracy of contact angles and two-phase capillary pressure data. The three-phase data provide a fundamental understanding on the effects of peat bulk density on hydrocarbon infiltration rate, and the vertical distribution of water, diesel and air in the vadose zone of the contaminated peatlands. The results are also a required input for the multiphase flow simulators; these simulators predict the migration of NAPL in peatlands and are able to evaluate the applicability of other remediation scenarios in hydrocarbon contaminated peatlands.

Session 70601 - General Hydrology - Part 2
Global fresh water ages
Jasechko, Scott Kirchner, James W.
University of Calgary
sjasechk@ucalgary.ca
The age of fresh water - defined as the time that precipitation takes to move to a location on the continents - impacts geologic weathering, nutrient cycling, contaminant degradation and regional geotherms. Both groundwater and river water contain a mixture of young and old precipitation inputs. However, the global proportions of young and older waters is not known. Here we analyze isotope compositions of rain, snow, groundwater and streamflow across in 260 rivers and 202 aquifers across the globe. First, we show that precipitation that enters a river in less than 1.5-3 months comprises ~1/3 of global river flows and present in the great majority of rivers. Our finding highlights that, although the average catchment transit times may be years or longer, most catchments can rapidly transmit water and solutes to their outlets with little time for dispersion, degradation or detection. Second, we show that a finite fraction of groundwaters are replenished over a ~50 year timespan, and that most (>50%) groundwaters recharged more than ~10,000 years ago. Our study exploring ground- and surface-water ages shows that much of global streamflow is at least four orders of magnitude younger than most groundwaters, demonstrating that waters leaving watersheds are far younger than the water stored underground in these same catchments.

Session 70601 - General Hydrology - Part 2
Multi-objective optimization based flood frequency analysis
Kasiviswanathan, K.S.   He, Jianxun (Jennifer)
University of Calgary
jianhe@ucalgary.ca
Uncertainty, which in nature is always embedded into developed models, should not be ignored when evaluating model prediction. Flood frequency analysis (FFA) is subjected to various levels of uncertainty originated from different sources. In hydrological modeling and analysis, the uncertainty has often been quantified given the variation ranges of inputs and model parameters, and then the variations are propagated to the model outputs. In such an approach, there is no statistical justification for the selected ranges. From management perspective, model results with large uncertainty bounds would impede their implementation in decision making. This work illustrates an alternative approach for conventional FFA, in which the uncertainty level of estimated flood quantiles is quantified and constrained using the combination of the ensemble simulation technique and the multi-objective optimization. Two uncertainty measures, percentage of coverage (POC) and average width (AW), are used in the optimization. The use of the proposed approach is demonstrated through analyzing the annual maximum daily flow data collected from two flow gauge stations on the Bow River, Alberta, Canada. The results show that the proposed approach can capture and optimize the uncertainty bounds, since the POC is approximately maximized while the AW, namely the prediction interval of flood quantile, is minimized.

Session 70601 - General Hydrology - Part 2

Competitive sorption and dispersion processes of monovalent nutrients in poorly decomposed Sphagnum peat

McCarter, Colin Weber, Tobias Price, Jonathan
University of Waterloo
cmccarte@uwaterloo.ca

Unlike in many mineral soils, sorption and transport processes of nutrients are relatively unknown in Sphagnum peat and monovalent ions, such as sodium, potassium, and ammonium, have not been investigated. To understand their movement and retardation within peatlands, a combination of equilibrium adsorption batch and breakthrough reactor experiments on these nutrients were completed to better understand mobility within undecomposed Sphagnum peat. Effective porosity, representing mobile-water fraction, was determined as the drainable porosity at -100 mb and ranged from 0.46-0.60. Single, pairwise, and triplicate (i.e., sodium, sodium & potassium, and sodium & potassium & ammonium, respectively) adsorption batch experiments were completed (n=3) using chloride as their anion pair. Single and triplicate breakthrough reactor experiments were run to determine the dispersion coefficient at a Darcy Flux (1.3 m/day) similar to those found in field conditions. The partitioning coefficients were ~1.5 L/kg (chloride), ~2.7 L/kg (potassium), 8.0 L/kg (sodium), and ~10.6 L/kg (ammonium); additionally, both potassium and sodium showed little competitive exchange, while ammonium decreased sequentially in the presence of potassium (9.9 L/kg) or sodium (9.4 L/kg) and further decreased to 8.6 L/kg in the presence of potassium and sodium. Chloride sorption caused a retardation coefficient of ~1.2, potentially indicating an overestimation of the measured active porosity. Chloride dispersion coefficients ranged from 27 cm/hr to 57 cm/hr with retardation factors varying between 1 - 1.4. Notwithstanding diffusion into inactive pores, chloride sorption is likely the primary chloride retardation mechanism in undecomposed Sphagnum peat.

Session 70601 - General Hydrology - Part 2

Development of methods to monitor peatland hydrological conditions using RADARSAT-2 Synthetic Aperture Radar Data

Millard, Koreen Richardson, Murray
Carleton University
koreen_millard@carleton.ca

Soil moisture and water table depth are important variables in many peatland hydrological and biophysical models but measurement technologies and field site access often limit the spatial extent and representativeness of hydrologic observations. Remote sensing provides the much needed synoptic view of remote, inaccessible peatland areas, and Synthetic Aperture Radar (SAR) is particularly promising for hydrologic data retrieval due to its sensitivity to the dielectric constant of its targets. However, the high degree of variability in both soil and vegetation parameters is widely cited as the fundamental barrier to the development of reliable retrieval of hydrologic information with SAR.This presentation will discuss the results of soil moisture retrieval and water table depth estimation from SAR. Throughout the summer of 2014, in-situ soil moisture measurements were acquired during the same day as RADARSAT-2 (FQW) acquisitions in an Eastern Ontario peatland. Water table depth measurements were recorded on

an hourly basis during 2014 and 2015. Several polarimetric parameters were found to be highly related to peatland soil moisture and water table variability over time at the peatland class scale, but soil moisture retrieval models for single locations (pixels) were not as strong. The specific peatland class and the microtopographic position of measurements explained most of the variability in the models. While peatland class information can be obtained from image classifications and incorporated into models, microtopographic variability at the site or pixel level needs to be accounted for but is difficult to measure over large areas.

Session 70700 - Urban Water In Canada

Geospatial Estimates of Road Salt Usage Across a Gradient of Urbanizing Watersheds in Southern Ontario

Giberson, Gregory Oswald, Claire
Ryerson University
ggiberso@ryerson.ca

Chloride (Cl) salts, while an effective de-icing agent, have significant environmental consequences to local aquatic ecosystems. Chloride has been recognized as a pollutant of concern in Canada by the Canadian Council of Ministers of the Environment, especially in urban areas. In many waterways, Cl concentrations have been increasing since the early 1990s, often exceeding national water quality guidelines, resulting in negative ecological effects for many aquatic organisms. Assessments of the factors that control Cl storage in urban and urbanizing watersheds require accurate estimates of road salt application rates. Complex jurisdictional control over salt applications requires a geospatial approach for calculating Cl inputs at the watershed-scale. The goal of this study was to develop a geospatial protocol for combining information on road salt applications and road network areas to improve the accuracy of watershed-scale Cl storage estimates. Our study focuses on 12 watersheds that span a gradient of urbanization, and varying degrees of chloride contamination (7 in the Lake Simcoe watershed, 3 in the Toronto region, and 2 that flow into Hamilton Harbour). First, geospatial shapefiles were used to calculate total lane-lengths for each study watershed and lane-lengths managed by each governmental jurisdiction. Second, road salt application data from Environment Canada (for multiple upper- and lower-tier municipalities) and the Ontario Ministry of Transportation (for provincial patrol areas), was reviewed in order to determine and validate salt quantities and application rates to be applied to each jurisdictions roads; gaps in the data were populated by using rates from geographically similar jurisdictions. Third, the resulting cleaned jurisdictional rates were uniformly allocated across the calculated lane-lengths for each jurisdictions roads and then summed to the watershed of concern, as well as to the various jurisdictional tiers within each watershed. Lastly, statistical analyses of the relationships between salts/solids (e.g. sand-salt mixture) inputs and various predictive factors (e.g. daily snowfall (cm), snow on ground (cm), and daily total precipitation (mm)), was carried out to explore intra- and inter-watershed spatiotemporal salting patterns as they relate to climatic patterns, road conditions, and winter road maintenance guidelines. The results of this study will be used for a chloride mass balance analysis to assess watershed-scale Cl storage and will help inform regional initiatives to balance road salt usage for public safety and environmental concerns related to elevated Cl concentrations in aquatic ecosystems.

Session 70700 - Urban Water In Canada

Assessing the potential for best-practices in urban design to mitigate hydroecological degradation in urban streams

Ward-Paige, Christine Lynch, Alex Henderson, Caila
eOceans
wardpaca@hotmail.com

Urbanization has historically destroyed freshwater ecosystems at alarming speed. However, recent efforts to balance hydrology and ecology within urban design and retrofits have gained traction. Our objective was to rapidly assess the ecological health of a stream within an industrial park on a land reclamation site in Dartmouth, Nova Scotia. The site previously contained an asphalt plant with buried streams and contaminated soils, where contaminants remained on-site following reclamation. The industrial park was built following best-practices to restore the local hydroecology, with on-site enhancements that include stream daylighting, restoring stream connectivity and shape, mimic natural hydrologic release rates and temperature patterns, etc. Physical, chemical and biological measures were made along this stream, following adapted version of the Canadian Aquatic Biomonitoring Network (CABIN), and compared to other adjacent and nearby streams of varying urbanization (i.e., ranging from <5% developed land in the watershed to >90% impermeable surfaces). We found that the flashiness of the stream, which reflects the range of flow (low where the surrounding release is slow or natural) to be similar to the reference sites with low urbanization. As well, the macroinvertebrate diversity of pollution intolerant species, a measure of long-term stream health, were found to be higher than even the cleanest sites that were surrounded by intact forest and downstream of a large wetland. Although still preliminary, our initial results show there may be potential for engineering to mitigate factors that cause physical and biological degradation in urban streams when best-practices are implemented.

Session 70800 - Historical and Projected Changes in Hydroclimatological Extremes: Investigating the Roles of Teleconnection Signals and Climate Change

Variation of daily precipitation and temperature extremes over southern discontinuous permafrost terrai near Fort Simpson Northwest Territories

Persaud, Bhaleka Quinton , William   Whitfield, Paul
Wilfrid Laurier University
pers3479@mylaurier.ca

While changes in climate may have an impact on ecosystems directly or indirectly, how changes in extreme weather events will affect permafrost regions is not fully understood. The ability to scale from the global scale to regional and local impacts presents a major challenge. In this work, we focus on comparing quantitative analysis of extreme events using both observational and reanalysis datasets for Fort Simpson domain in the Northwest Territories. Preliminary results for both scales show significant warming trends for minimum and maximum temperature and warm days and nights. Significant increasing trends were found in warm extremes and night-time based temperature indices. Precipitation extremes are occurring significantly more frequently

and intense precipitation events have significantly increased in frequency during winter and summer at Fort Simpson since 1898.

Session 70800 - Historical and Projected Changes in Hydroclimatological Extremes: Investigating the Roles of Teleconnection Signals and Climate Change

MTO IDF Curve Look-Up Tool, Phase 3: Identifying and projecting recent historical time trends.

Soulis, Ric Suthar, Megh Tinel, Mateusz
University of Waterloo
rsoulis@uwaterloo.ca

The Ontario Ministry of Transportation (MTO) is reviewing IDF curves in Ontario. The project, commissioned by the MTO, began in 2005, to improve the quality and consistency of the IDF data available in Ontario. This led to the development of the MTO IDF Look-up Tool. Phase 2 has been available online since February 2013. Phase 3, to be released in March 2016, is presented here. This project combined datasets across national borders by combining NOAA data from bordering states with the Meteorological Service of Canada (MSC) data for Ontario. This project also added MSC data recorded from neighbouring provinces as well as from non-MSC Canadian data networks. Together, this dataset improved extreme rainfall estimates. We had the luxury of a large, high-quality dataset with over 10,000 station years. This dataset drew from the period 1960 to 2010. The use of the spatial and temporal interpolation methods allowed simultaneous treatment of all of the stations. Much of the uncertainty in the records can be accounted for by a slight trend in the increase of intensity with time which provided the basis to provide non-stationarity. We were able to introduce non-stationarity and provide estimates in both space and time. There was a general trend of a 1 per cent per decade increase in intensity for short-duration events which is consistent with other studies.The detection of historical time trends lays the foundation for the assessment of climate change projections. Based on the projections from this study, Phase 3 provides adjustments of the design storm that reflect these trends.

Session 70800 - Historical and Projected Changes in Hydroclimatological Extremes: Investigating the Roles of Teleconnection Signals and Climate Change

Regularized non-stationary model for extreme hydro-meteorological events in New Brunswick

Yousfi, Nawres El Adlouni, Salah Laroche, Anne-Marie
Université de Moncton
eny2893@umoncton.ca

Climatic variations have important effects on the frequency and / or the intensity of extreme weather events such as high temperatures (heat waves) and heavy precipitations (snow storms and heavy rains). These events can cause natural disasters affecting agronomy, ecology, biodiversity, civil security and economy. Therefore, it is essential to take account of these variations in the risk assessment of extreme events for management and prevention.The purpose of this study is to develop new risk assessment methods for extreme events to take account of

climatic variations. The proposed approach considers the risk as a function of explanatory variables characterizing climate variability. Such approaches require the development of mathematical algorithms for solving complex equations. We focused on the resolution of these systems in a Bayesian framework by integrating constraints as penalties. Five penalties (Lasso, Ridge, SCAD1, SCAD2 and SCAD3) were considered and each of them have been compared to the generalized maximum likelihood (GML) method, based on simulated data.The simulation results show a great improvement, by adding the penalties, in terms of estimated relative bias and the root mean square error, especially in the case of SCAD1 penalty. The approach with SCAD1 was applied to series of annual maximum flows of watersheds in New Brunswick to estimate the risk associated to extreme flows with the total annual precipitations as covariate. Results show a significant change in the conditional quantile curves for almost all watersheds. The proposed approach can be considered for conditional risk estimation in the case of large set of covariates and the parsimony of the model will be guaranteed by the penalty constraint.

Session 80200 - Geodesy and Geodynamics

Replacing NAD 83: progress and considerations

Evjen, Joe
National Geodetic Survey, USA
joe.evjen@noaa.gov

The official U.S. horizontal mapping datum, the North American Datum of 1983 (NAD 83)-in both its definition, as well as the services the U.S. National Geodetic Survey provides for its access-is in need of improvement. As defined, it is non-geocentric by over two meters and has non-zero, residual plate velocities. Since 1983, increasingly accurate International Terrestrial Reference Frames (ITRF) have become available and have been adopted by many groups, including Mexicos INEGI and the U.S. National Geospatial-Intelligence Agency. The U.S. National Geodetic Survey is planning a replacement of NAD 83 with a new ITRF-aligned geometric datum, to be released with a new GNSS-accessible geopotential datum replacing the North American Vertical Datum of 1988. We will discuss the importance of a modern national datum, how its definition will be aided by and differ from international frames, the tools (Real-Time GNSS, Online Processing User Service, passive monuments) expected to provide datum access, and the anticipated benefits and challenges recognized by our Federal, state, private sector partners.

Session 80200 - Geodesy and Geodynamics

Integration of geodetic monitoring techniques in order to augment hazard studies of the northern Cascadia Subduction Zone

Henton, Joseph Dragert, Herb Lambert, Tony
Natural Resources Canada
jhenton@NRCan.gc.ca

To better assess and report earthquake hazards near Vancouver Island and the adjacent mainland, geodetic methods are used to explore the time-varying components of crustal deformation in southwestern Canada. Our work primarily uses Global Navigation Satellite System (GNSS), absolute gravity (AG), and borehole strainmeter (BSM) data sets to study both long-term (interseismic) and shorter-term (transient) deformation processes in the forearc of the northern Cascadia Subduction Zone. A tentative correlation between long-term gravity rates and GPS-determined interseismic strain rates is observed, possibly related to deformation with density increasing due to loading from the subduction fault. Also, preliminary analyses of regional AG observations during transient Episodic Tremor and Slip (ETS) events indicate gravity decreases larger than expected from the observed collocated GPS height change associated with thrust faulting. However the reliability of deformation results may be partially diminished by signals on non-tectonic origin. The impact and mitigation of these key environmental signals present in the time-series will be discussed.

Session 80200 - Geodesy and Geodynamics

Towards a cloud-based multi-constellation precise point positioning tool for GNSS data processing and analysis

Mendonca, Marco Santos, Marcelo
University of New Brunswick
marco.mendonca@unb.ca

The UNB GNSS Analysis and Positioning Software (GAPS) is an in-house software being developed since 2007 at the Geodesy and Geomatics Engineering Department. Its primary goal is to provide to researchers of different fields a cloud-based environment to perform GNSS precise point positioning (PPP) followed by data transform and analysis. The recently released version of GAPS utilizes data from ten different centers around the world to provide the user an accurate and complete report of the submitted data. A novelty among this kind of platform is the GAPS advanced submission page, where the file submitter can choose between forty-five options to enhance the processing or to test a new approach for the data set processing, such as precise products provider, GNSS signals to be utilized, several neutral atmosphere parameters to be assessed including precipitable water estimation, antenna calibration, among others. From the atmospheric sciences perspective, GAPS provides an overview of the effects of the electrically-neutral and ionized portions of Earths atmosphere over GNSS signals. Without the need for further processing, the user can retrieve, as mentioned, the precipitable water estimation, latitudinal and longitudinal gradients of neutral atmospheric delay and the vertical ionospheric delay for as many stations as submitted. During recent benchmark tests, GAPS results were found compatible with those provided by the International GNSS Service (IGS), confirming that the online platform can be used by the scientific community to achieve an accurate analysis of GNSS data from several different points of view.

Session 80200 - Geodesy and Geodynamics

Impact of direct ray-tracing in PPP GNSS analysis

Nikolaidou, Thalia Santos, Marcelo
University of New Brunswick
tnikolai@unb.ca

It has been shown recently that GPS derived zenith wet delays (ZWD) are in good agreement (1-2 cm rms) with numerical weather prediction (NWP) model derived ZWD. Integrating a NWP into GNSS processing through tropospheric mapping functions is the state-of-art technique to achieve geodetic level accuracy. However, mapping functions derived from NWP models are subject to parameterization during their creation which can lead to systematic errors in the results. Moreover, errors that are hard to control are introduced into the adjustment and can result into erroneous interpretation of the state of the neutral atmosphere. These errors include the limited ability of the tropospheric model to represent the hydrostatic component of the delay, when in situ pressure measurements are unavailable, multipath, and random errors. We approach the problem of accounting for the tropospheric delay in GNSS processing by applying tropospheric delays directly, obtained from a high precision 3D ray-tracing procedure, for every station-satellite link and at every elevation angle. The tropospheric delays are then subtracted from the GNSS observations, liberating the adjustment from the troposphere term and reapplied later to obtain the position along the other products of the processing. Using precise point positon (PPP) technique, we examine the improvement in station coordinates stability, for 4 stations globally distributed, employing 3 scenarios: a) applying the NWM mapping functions UNB-VMF1 to the modelled and estimated GNSS observations b) using the previous scenario along with gradients, and c) injecting the ray-traced delays to the GNSS processing at every epoch. Moreover, we assess the accuracy of the obtained tropospheric delays from every scenario by comparing them with the IGS tropospheric product.

Session 80200 - Geodesy and Geodynamics

Can dedicated satellite gravity observations be used to detect subaerial and submarine landslides?

Peidou, Athina Fotopoulos, Georgia
Department of Geological Sciences and Geological Engineering, Queens University,
athina.peidou@queensu.ca

The utility of satellite-based gravity observations for detecting and monitoring geodynamic processes such as earthquakes and landslides depends on the spatial scale/extent of individual events and the resolution/noise level of the satellite mission. In this study, two past subaerial and submarine mass transfer events, namely the Agulhas slump (a post-Pliocene age submarine landslide located in SE Africa with a spatial extent of 750 x 106 km) and the Heart Mountain landslide (an Eocene age subaerial landslide, located in NW Wyoming with a spatial extent of 70 x 50 km) were simulated. Using the geodetic and geological characteristics of each event (spatial extent, thickness and density), three-dimensional forward modeling and two-dimensional discrete wavelet transforms were incorporated to determine the impact of each landslide on the gravity field. Taking into account the Gravity Recovery and Climate Experiment (GRACE) resolution and noise levels, results indicate that both the Agulhas slump and the Heart Mountain landslide had a noticeable impact on the gravity field, resulting in ~0.4 mGal and ~0.2 mGal

change, respectively. The developed methodology could be considered useful in planning for the next generation gravity missions should the detection of such hazards be deemed an advantageous endeavor in our overall understanding of the Earths gravity field and its changes.

Session 80200 - Geodesy and Geodynamics

Spatio-temporal analysis of GRACE models using Principal Component Analysis: filtering and hydrological signal extraction

Piretzidis, Dimitrios Rangelova, Elena Sideris, Michael
University of Calgary
dimitrios.piretzidis@ucalgary.ca

This study investigates the capabilities of Principal Component Analysis (PCA) to successfully filter GRACE data and derive mass changes that correspond to hydrological processes. CSR GRACE Release 05 monthly solutions are used from April 2002 to August 2015. The GRACE C(2,0) coefficients are replaced by SLR-derived ones. The GLDAS land hydrology model with the Noah land surface model is also used for comparison purposes.The study focuses on the area of North America. Mass changes in the form of Equivalent Water Height (EWH) are calculated for every monthly solution. The Empirical Orthogonal Functions (EOFs) and their respective Principal Components (PCs) are derived for GRACE and GLDAS EWH fields. The compression properties of PCA are examined in order to choose the minimum number of PCs that can reconstruct the original signal. Also, each GRACE EOF spatial pattern is studied and compared to the GLDAS results through correlation analysis. PCs strongly related to noise and non-hydrological signal are isolated and removed. From the reconstructed GRACE signal, the annual, semi-annual and long-term variations are studied.Early results on a global scale show that the PCs associated with the secular trend and the annual amplitude produce the strongest signal that corresponds to 64% and 20% of the original signal, respectively. By selecting the first 5 and 14 PCs we are able to reconstruct 90% and 95% of the original signal, respectively. As the secular trend does not always correspond to hydrological processes (e.g., water accumulation/depletion), especially in near-polar areas, further investigation is required to derive the PCs connected to the hydrology signal.

Session 90100 - Greenhouse Gas Exchange from Restored or Reclaimed Ecosystems

Greenhouse Gas Fluxes of Irrigated Sphagnum Moss in a Reclaimed Peatland

Brown, Catherine Strack, Maria Price, Jonathan
University of Waterloo
c5brown@uwaterloo.ca

Sphagnum farming is a recent reclamation effort implemented in extracted peatlands. Extracted peatlands are a source of greenhouse gases, and Sphagnum farming can assist in mitigating this while producing Sphagnum fibers for use in horticultural peat products and alleviating extraction in natural peatlands; however, there is a limited understanding concerning which water management technique is most effective for increasing CO2 uptake, while minimizing CH4 emissions. An experimental Sphagnum farming site measuring approximately 1.2 ha in Shippagan, NB, was created in 2014 within a block-cut peatland. The site has 7 different water

management treatments that were monitored to evaluate the hydrological controls on CO_2, CH_4, N_2O and DOC fluxes. In 2014 and 2015 seasonal average CO_2 uptake across the plots and under full light conditions ranged from 0.40 to 5.48 $gCO_2/m^2/day$ and 2.77 to 12.61 $gCO_2/m^2/day$, respectively. Average CO_2 uptake at the site increased from 3.25 $gCO_2/m^2/day$ (±1.91) in 2014 to 6.24 $gCO_2/m^2/day$ (±3.7) in 2015. In 2014, all plots sequestered CO_2 after the first month of establishment, and in 2015 all plots were CO_2 sinks under full light conditions. The most productive plots had a WT range (maximum - minimum WT position) <10 cm in 2014, and <15 cm in 2015. The average seasonal CH_4 flux across the site was 9.4 $mg/m^2/day$ (± 11.5) in 2014 and 7.8 $mg/m^2/day$ (± 11.4) in 2015, which is below reported values for natural bogs. CH_4 flux was controlled by WT in 2015, but not in 2014. DOC concentration was correlated to discharge, and ranged from 25.89 to 37.01 mg/L. The carbon balance of the various irrigation treatments will be discussed

Session 90100 - Greenhouse Gas Exchange from Restored or Reclaimed Ecosystems

Estimating greenhouse gas fluxes from dairy manure based silage corn cropping systems in western Newfoundland

Cheema, Mumtaz Nadeem, Muhammad   Wu, Jianghua Galagedara, Lakshman Unc, Adrian   Kavanagh, Vanessa

Grenfell Campus Memorial University of Newfoundland / BERI

mcheema@grenfell.mun.ca

Application of a large volume of dairy manure in silage corn cropping systems could lead to adverse environmental effects such as excessive nutrients loads and gaseous losses into the atmosphere. However, emission of greenhouse gases (GHGs), i-e., carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) in silage corn cropping systems under climatic and soil conditions of western Newfoundland has not yet been estimated. A field experiment with three dairy manure treatments: manure with high nitrogen (N)[(1.5 kg/1000L) (DM1)], manure with low N [(0.5 kg/1000L) (DM2)], and control [without dairy manure (DM0)] was conducted at Pynns Brook Research Station in western Newfoundland. Manure was applied at 30,000 L ha^{-1} according to the practice by local farmers. We monitored the GHG fluxes, using the closed chamber method, at around two weeks interval during August - October 2015. Soil moisture, temperature and electric conductivity (EC) were also measured at the same time when the GHGs samples were taken. Dairy manure treatments had non-significant effect on GHGs fluxes. However, cumulative CO_2, CH_4 and N_2O fluxes were 1580 g m^{-2}, 0.69529 g m^{-2}, 0.05098 g m^{-2} and 1610 g m^{-2}, -0.45757 g m^{-2}, 0.01302 g m^{-2} and 1430 g m^{-2}, -0.12498 g m^{-2}, and -0.00034 g m^{-2} in DM1, DM2, and DM0 treatments, respectively. Significant temporal effects were recorded on the CO_2 flux ($P < 0.001$) and were high at initial measurements and decreased thereafter. There was also a strong positive exponential relationship ($R = 0.97$) between soil temperature and CO_2 emission but no positive relationship between soil moisture and GHG fluxes were noticed. Preliminary results indicate that manure treatments had non-significant effect on GHGs flux, contrary to significant temporal effect on CO_2 flux through the entire growing season. However, non-significant temporal fluxes of CH_4 or N_2O were noted.

Session 90100 - Greenhouse Gas Exchange from Restored or Reclaimed Ecosystems

Assessing initial biogeochemical characteristics of a 3-yr old forested upland following reclamation procedures in a constructed watershed, Fort McMurray, Alberta

Gingras-Hill, Tristan Petrone, Richard Nwaishi, Felix   Macrae, Merrin
University of Waterloo
Tgingras@Uwaterloo.ca

The Western Boreal Plains (WBP) are currently undergoing landscape scale disturbances, attributed to industrial development and natural resource extraction, the most significant of which is oil sands development. In this landscape, wetlands and forested uplands interact with one another to ensure resilience during periodic moisture stresses. Approximately half of the natural areas disturbed during mining activities are wetlands, the majority of which are peatlands. Complete watershed re-construction projects are currently taking place throughout the Athabasca Oil Sands Region (AOSR) in an attempt to reproduce the natural functioning of the various hydrological units (i.e. peatlands and forested uplands). The aim of this study was to assess both the spatial and temporal biogeochemical characteristics of a 3-year-old reclaimed upland in relation to the reclamation practices used (LFH placement, fertilizer usage & plantation). These parameters will aid in understanding the current health of the upland and help predict future vegetation community establishment. The study location was divided among topographic locations (High, Mid, Low) and monitored throughout the research season (Early, Mid, Late). Plant Root Simulators (PRS) were used to estimate nutrient availability and fertilizer use efficiency (FUE). Storm runoff collectors and groundwater samples quantified the losses of essential plant nutrients (N-P-K). Multivariate statistics were used to measure soil physical properties to dictate both spatial and temporal changes throughout the upland. The findings demonstrated that LFH placement led to heterogeneity throughout the upland and fertilizer application led to temporal changes in nutrient abundance and might have created a N limited environment. Although preliminary results demonstrate that fertilizer is likely being assimilated by the vegetation, fertilizer usage in upland reclamation must be applied with caution and in relation to the novel ecosystems requirements in order to limit the colonization of undesired species, which could lead to changes in the communities naturally found in the WBP.

Session 90300 - Use of Remote Sensing for Floodplain Characterization

Detection of surface water using airborne LiDAR and TerraSAR-X data

Beaulne, Danielle Irwin, Katie Fotopoulos, Georgia Braun, Alexander Lougheed, Stephen
Queens University
danielle.beaulne@queensu.ca

Identifying the presence and extent of surface water bodies (wetlands, estuaries, lakes, ponds, rivers and creeks) is critical for determining potential habitats and dispersal corridors for numerous species, including those that are at risk or economically important. At the Queens University Biological Station, airborne LiDAR data with a spatial resolution of one point/m2 are used in conjunction with TerraSAR-X staring spotlight mode radar data with a spatial resolution of 0.25m to identify likely habitats, barriers, and corridors in wetlands and along edges of water bodies. This is accomplished through the classification of water, vegetation, agricultural and urban land cover based on three parameter sets; i) the backscatter signature of SAR data, ii)

intensity of LiDAR data, and iii) LiDAR-derived elevation models for morphological constraints. The integration of topography, hydrology, geology, infrastructure, drainage paths and water extent/volume allows for the development of habitat/landscape models to shed light on the distribution and habitats of targeted species. The synergies between optical and radar based remote sensing will be exploited and an application for habitat mapping of Pseudacris crucifer will be presented.

Session 90300 - Use of Remote Sensing for Floodplain Characterization

Characterizing Floodplain Elevation, Vegetation, and Snow Depth using unmanned aerial vehicles

Leblanc, Sylvain Fernandes, Richard Maloley, Matthew Canisius, Francis Prévost, Christian
Natural Resources Canada
sylvain.leblanc@canada.ca

Digital Elevation Models (DEMs) are crucial for developing timely information about vegetation canopies and ground layers. These DEMs can be extracted from point clouds, which are three dimensional information points traditionally extracted using costly airborne LiDAR surveys. However, these point clouds can now be generated using optical data from unmanned aerial vehicles (UAVs) using Structure from Motion (SfM) techniques. In addition to generating DEMs, point clouds can also be used for characterizing the 3D structure of vegetation and for surveys of snow depth and cover that can be used for validating and calibrating larger-area snow and vegetation products derived using satellite methods that are required for hydrologic flood models. The Canada Centre for Mapping and Earth Observation of Natural Resources Canada, with funding from Public Safety Canada, is studying the use of off-the-shelf UAVs to characterise areas prone to flooding. Moreover, a UAV photograph simulator was also developed to allow DEM retrieval with different know conditions, such as crown closure, Leaf Area Index (LAI) and variable topography, to be assessed. Technical challenges and preliminary results from two experimental sites, one in Gatineau Park near Ottawa with 2 sub-sites and one in the Acadia Forest near Fredericton with 3 subsites, along with simulated data sets, will be presented. Each experimental site has ground truth measurements of snow depth for comparison with the UAV based estimates from several dates during the 2015-2016 winter season, and sub-site containing coniferous trees have up-looking hemispherical photographs for canopy cover and LAI ground truth.

Session 90300 - Use of Remote Sensing for Floodplain Characterization

Use of RADARSAT-2 and ALOS-PALSAR images for floodplain mapping in New Brunswick

Leblon, Brigitte LaRocque, Armand Woodward, Renata   Bourgeau-Chavez, Laura French, Nancy
UNB Forestry and Environmental Management
bleblon@unb.ca

This study used different combinations of LANDSAT-5 TM images with RADARSAT-2 C-band and ALOS-PALSAR L-band SAR images for mapping wetland areas in the St-John river watershed (New Brunswick). The resulting maps were compared to GPS field data as well as the two wetland maps currently in use by the Province of New Brunswick, namely the Department of Natural Resources (DNR) wetland and forested wetland maps. Whatever the image combination we used (LANDSAT + RADARSAT-2 and/or ALOS-PALSAR), the overall accuracy for the image classification is always higher than 90%, with a maximum of 93.9%. In addition, the number of correctly identified sites is higher with the ALOS-PALSAR-based classified image (91.1%) or the RADARSAT-2-based classified image (88.4%) than with the DNR maps (44.5%). From the classified images, the few misclassifications are due to wetland sites classified in another wetland class. For the DNR maps, about half of them are associated to wetland sites that not being mapped, the remaining half being wetland sites that are not classified in the right wetland class. The classified images show that the RADARSAT-2 C band better detects marshes than the ALOS-PALSAR L band, but this is the opposite for the detection of the shrub wetlands. Therefore, all the SAR images are complementary and their combination gives the best ground-truth identification accuracy (98.6%). The study was funded by two NB Environmental Trust Fund grants and supported by a NASA Interdisciplinary Science Program grant. The RADARSAT-2 images were provided under a Canadian Space Agency SOAR grant awarded to the Province of New Brunswick.

Session 90400 - Aquatic Transport of Nutrients and Carbon from Agricultural Landscapes - Part 1

Linking phosphorous export dynamics to landscape heterogeneity and climatic variability: can c-Q relations help?

Ali, Genevieve Wilson, Henry Penner, Amber Ross, Cody Rabie, Maliheh Haque, Aminul Elliott, Jane

Dept. of Geological Sciences, University of Manitoba, Winnipeg, Manitoba

genevieve.ali@umanitoba.ca

Concentration-discharge (c-Q) plots are routinely used to infer solute sources and travel pathways and as an integrated signal of watershed response. However, the interpretation of c-Q data can be difficult unless these data are fitted using numerical models. Such models are frequently applied to c-Q data for geogenic solutes but it is still unclear to what extent they might aid in the investigation of nutrient export patterns, particularly for dissolved phosphorous (DP) which is a critical driver of downstream eutrophication problems. The goal of the present study was therefore to model DP-Q relations in a set of contrasting Prairie agricultural watersheds - ranging in size from 0.2 to 1000+ km2 - in order to assess the relative controls of climate drivers and landscape properties on DP fluxes. Four models were fitted to DP-Q data, notably (i) one empirical model, (ii) one model assuming that c-Q relations are driven by the mixing of end-member waters from different landscape locations (i.e., power law), (iii) one model hypothesizing that c-Q relations change as a function of the solute subsurface contact time (i.e., hyperbolic model), and (iv) one model assuming that solute fluxes are mostly dependent on reaction rates (i.e., chemical model). The stability of DP-Q relations over time was also assessed. Preliminary results reveal a lot of spatiotemporal variability in the fitted model parameters. The power law model notably revealed that some watersheds act as a chemostat in all seasons but the

late freshet, thus suggesting season-specific hydrological and biogeochemical controls on DP export. A conceptual framework will be suggested to explain how fitted model parameters related to biogeochemical processing efficiency, mean water residence time and reaction rate vary according to watershed area, effective flowpath length, average relief, dominant crop type, wetland presence and other characteristics peculiar to Prairie systems.

Session 90400 - Aquatic Transport of Nutrients and Carbon from Agricultural Landscapes - Part 1

Phosphorus transport in subsurface flow - established science and emerging knowledge

Kleinman, Peter King, Kevin Buda, Tony Lamba, Jasmeet Macrae, Merrin Bryant, Ray
United States Department of Agriculture - ARS, University Park, PA, USA
peter.kleinman@ars.usda.gov

Even with over four decades of scientific documentation, the transport of phosphorus in subsurface flow continues to surprise conservationists, watershed managers, and even scientists. From New Zealand to Sweden to Canada to the U.S., there are long histories of documenting phosphorus transfers in shallow groundwater and drainage effluent of agricultural systems. This presentation seeks to provide an overview of P transport in shallow subsurface flow, emphasizing factors affecting P losses from agriculture, opportunities for improved management, and trade-offs in management options. In addition to highlighting research related to artificially drained systems in the Lake Erie and Chesapeake Bay watersheds, the presentation explores new areas of research that point to a potentially important role of subsurface P transport in sloping landscapes where variable source area hydrology predominates.

Session 90400 - Aquatic Transport of Nutrients and Carbon from Agricultural Landscapes - Part 1

Exploring Nitrogen Legacies and Time Lags: A 200-Year Longitudinal Study of the Mississippi and Susquehanna Watersheds

Van Meter, Kimberly Basu, Nandita Van Cappellen, Philippe
University of Waterloo
vanmeterk4@gmail.com

Global flows of reactive nitrogen (N) have increased significantly over the last century in response to land-use change, agricultural intensification and elevated levels of atmospheric N. Despite widespread implementation of a range of conservation measures, N concentrations in surface waters are in many cases remaining steady or continuing to increase. Such time lags to the recovery of surface water quality are increasingly being attributed to the presence of legacy N stores in subsurface reservoirs. It has remained unclear, however, what the magnitudes of such stores might be, and how they are partitioned between soil and groundwater reservoirs. In the present work, we have developed a comprehensive, 200-year dataset of N inputs to the land surface of the continental United States. We have concurrently developed a parsimonious, process-based model utilizing this N input trajectory to simulate biogeochemical transformations of N along subsurface pathways. Model results allow us predict the magnitudes of legacy N in soil and groundwater pools and to predict long-term N-loading trajectories over the last century

and into the future. We have applied this modeling approach to two major U.S. watersheds, the Mississippi River and Susquehanna River Basins, which are the sources of significant nutrient contamination to the Gulf of Mexico and Chesapeake Bay, respectively. Using the model, we estimate spatiotemporal patterns of N accumulation in both groundwater and soil organic matter in response to increases in N inputs to agricultural soil as well as changes in N residence times across the terrestrial system.

Session 90401 - Aquatic Transport of Nutrients and Carbon from Agricultural Landscapes - Part 2

Long-Term Effects of Anthropogenic Nutrient Inputs on Riverine Fluxes: A Statistical Approach to Quantifying Watershed Lag Times

Basu, Nandita Zhang, Xiaoyi Van Meter, Kimberly Schiff, Sherry Van Cappellen, Philippe
University of Waterloo
kvanmeter@uwaterloo.ca

The Grand River, the largest Canadian river feeding Lake Erie, is greatly impacted by agricultural intensification and urbanization, leading to high riverine fluxes of nutrients. In order to understand and mitigate the problem, it is critical to quantify the legacies of these nutrients that develop in agroecosystems, and lag times in their transport. Here, we have developed a 70-year dataset of nutrient inputs and outputs in the Grand River Watershed, and use them to quantify spatial and temporal patterns in legacy accumulation within the catchment. We then compare these spatial maps to riverine nitrogen and phosphorus fluxes at multiple scales. Results demonstrate a clear decoupling between nutrient inputs and outputs that is suggestive of watershed lag times. A statistical approach is used to quantify the lag times as a function of climate and land use change controls over time. Such quantification of legacies and lag times is critical for watershed managers that implement various best management practices to reduce stream nutrient concentrations.

Session 90401 - Aquatic Transport of Nutrients and Carbon from Agricultural Landscapes - Part 2

Impact of freeze-thaw cycle magnitudes on the release of phosphorus from cover crops

Cober, James Macrae, Merrin Van Eerd, Laura OHallorn, Ivan
University of Waterloo
jrcober@uwaterloo.ca

The use of cover crops is a best management practice (BMP) that has been employed to reduce nutrient losses in agricultural runoff. However, there is potential for cover crops to enhance losses of dissolved reactive phosphorus (DRP) following freeze-thaw cycles (FTC). We examined (1) the impact of FTC magnitude on water extractable phosphorus (WEP) pools; (2) if DRP release varied with crop type; (3) if DRP release varied between vegetation that was living or dead at the time of freezing. Five species (cereal rye, red clover, oilseed radish, hairy vetch, and oat) were exposed to five days of FTC at a range of magnitudes (4 °C, -4 to 4 °C, -18 to 4 °C, and -18 to 10 °C). WEP concentrations from vegetation were significantly higher when exposed to -18 °C temperature and were not affected at -4 °C. The magnitude of P loss under very cold temperatures was larger for radish and oats, but not for clover or vetch. Termination (by spraying) increased WEP pools in all five species, and did not differ across the FTC magnitude treatments. Thus, cover crop selection and management, as well as temperature greatly influenced WEP, which may have implications for cover crop use in southern Ontario.

Session 90401 - Aquatic Transport of Nutrients and Carbon from Agricultural Landscapes - Part 2

Seasonal phosphorus dynamics of Hopewell Creek and its tributaries within a multiple land-use sub-watershed

Irvine, Cameron Macrae, Merrin
University of Waterloo, Department of Geography and Environmental Management
cirvine@uwaterloo.ca

The transport and speciation of phosphorus (P) to receiving water bodies has been widely studied at the field scale to better understand the complex transport dynamics of P to surface water bodies. To evaluate the temporal dynamics of seasonality and storm response related to P export via streams, a larger watershed scale approach was used to monitor and collect stream water samples within the Hopewell Creek watershed which serves as a tributary to the Grand River. Sample collection sites were established with one located at the outlet of the watershed, two which have predominately agricultural land use and one with a forested headwater contributing area. Water samples were collected at high-frequency during storm flow events over the course of one year throughout the watershed. Event response magnitude and timing varied spatially between the headwaters and watershed outlet. Seasonally, the highest P concentrations were exported during the snowmelt period. At this time, flow-weighted mean P concentrations and loads were greater in the area dominated by livestock in comparison to other sites within the watershed. Spatial and temporal patterns in P loss throughout the watershed will be discussed.

Session 90401 - Aquatic Transport of Nutrients and Carbon from Agricultural Landscapes - Part 2

Climate drivers of runoff and phosphorus export through agricultural tile drains under sandy loams

Lam, WV Macrae, ML English, MC OHalloran, IP Wang, YT
University of Waterloo
vito.lam@uwaterloo.ca

Tile drains beneath agricultural fields have been identified as a key pathway for phosphorus (P) transfer. Two tile drains in an agricultural field with sandy loam soil in southern Ontario, Canada were monitored over a 28-month period to quantify discharge and concentrations and loads of dissolved reactive P (DRP) and total P (TP) in effluent. This study characterizes seasonal differences in runoff generation and P export in tile drainage and relates hydrologic and biogeochemical responses to precipitation and antecedent soil moisture conditions. Runoff in tiles was only observed above a clear threshold soil moisture content (near saturation), indicating that tile discharge responses to precipitation inputs are governed by the soil water storage

capacity. Soil moisture content remained close to this threshold throughout the non-growing season (October - April), resulting in runoff responses to most precipitation inputs. Instantaneous and flow weighted mean concentrations of P in effluent were variable throughout the study but not correlated with discharge. However, there were strong relationships between discharge volume and DRP and TP loads. This research has implications for improving scientific ability to predict and model tile hydrobiogeochemical responses.

Session 90401 - Aquatic Transport of Nutrients and Carbon from Agricultural Landscapes - Part 2

Investigation of flow and solute transport in a shallow perched groundwater system beneath a potato field

Lamb, Keenan MacQuarrie, Kerry Butler, Karl Danielescu, Serban Grimmett, Mark Mott, Eric
University of New Brunswick
keenan.lamb@unb.ca

Intensive potato production in the Canadian province of Prince Edward Island (PEI) has contributed to the leaching of nitrate to groundwater and increased nutrient loadings to surface waters. The presence of a compact till layer at roughly one metre depth is known to cause temporary perched water table conditions, which may result in lateral subsurface flow that may effectively reduce the migration of nitrate to groundwater. The primary objective of this work was to determine the importance of this compact layer to vertical and lateral subsurface flow of water and nitrate. A surface applied tracer test was conducted at the Harrington Research Farm in central PEI. A shallow drain-tile pipe system, with a tipping bucket gauge, was installed down gradient of the tracer application to monitor lateral subsurface flow. A three-dimensional electrical resistivity imaging (ERI) array was employed on surface to monitor the spatial and temporal distribution of the applied tracer. A small scale, transient flow and transport model was constructed to simulate the tracer test. Results from the tracer test monitoring and numerical modelling show that the occurrence of lateral flow is dependent on the antecedent moisture conditions in the subsurface. The water balance yielded a total vertical flow of 94 % of the infiltration for the period beginning October 25, 2014 and ending January 1, 2015. The cumulative observed tracer mass in the tipping bucket as of May 12, 2015 (10.5 months after tracer application) was 0.125 % of the applied mass. The preference for vertical over lateral flow was further evidenced by the electrical resistivity images for the same time period. These results show a strong preference for vertical flow of water and nitrate through the compact layer as opposed to lateral subsurface flow.

Session 90401 - Aquatic Transport of Nutrients and Carbon from Agricultural Landscapes - Part 2

How much data is needed to robustly detect changes in water quality in agricultural watersheds?

Wellen, Christopher Van Cappellen, Philippe Mohamed, Mohamed
University of Waterloo
christopher.wellen@uwaterloo.ca

Despite the investment of significant resources in agricultural beneficial management practices (BMPs) designed to reduce the export of nutrients to the environment, there is little consensus on their watershed-scale effectiveness. Modelling studies often conclude that significant water quality benefits are achievable from BMP implementation, yet empirical work struggles to detect significant changes in water quality. This work adapts statistical power analysis methodologies to the case of change detection in stream water quality. Using data from a number of watersheds in the Great Lakes ranging in size from 1000 to 1,800,000 ha, this talk will show that detecting changes in average watershed scale annual nutrient loads requires decades of data, even for effect sizes as large as 40%. Detecting changes in flow-weighted concentrations still requires significant amounts of data (>10 years). Subsampling approaches were used to reproduce common sampling regimes. Over long time scales, monthly sampling regimes required about 50% more time than daily sampling regimes to arrive at similar levels of statistical power, while weekly sampling required only about 25% longer than daily sampling regimes. Concrete guidelines for the design of sampling programs to detect watershed scale changes will be presented.

Session 90500 - Impacts of long-term variations and extreme events on winter biogeochemical processes

Drivers of Under-Ice Phosphorus Increases in Shallow Eutrophic Ponds

Armstrong, Maria Baulch, Helen Westbrook, Cherie
University of Saskatchewan
marmalily@gmail.com

Across the temperate regions of North America periods of lake ice cover are decreasing with a warming climate. Ice cover impacts conditions of light, temperature, pH and oxygen with some shallow lakes and ponds becoming anoxic during winter due to isolation from the atmosphere. Modelling of climate scenarios for shallow eutrophic lakes indicate that the duration of winter anoxia may be significantly reduced or eliminated due to decreased ice cover. These changes in lake conditions during winter have the potential for strong impacts on biogeochemistry. In particular, phosphorus (P) release and retention in lake sediments are known to be closely linked to oxygen conditions during the ice-free season. Yet, there is little research on the biogeochemistry of lakes and wetlands during winter to help predict how changes ice cover would impact chemistry and biota. The shallow eutrophic ponds of the Canadian prairies have displayed large increases in P following the onset of winter anoxia. A shorter duration of ice-cover may result in lower P concentrations at ice-break up by reducing the duration of anoxic release and could impact the nutrient balance of these ponds in spring. This research aims to determine the drivers of winter increases in P concentrations through under-ice monitoring of water chemistry and laboratory experiments. Preliminary analysis of sediment P release

experiments indicate that sediment release plays an important role in the winter P increases seen in the study ponds. However, redox conditions are only a partial driver with the difference between anoxic and oxic experimental P release rates being limited. Further analysis is needed to understand drivers of winter changes in P concentrations, and assess the role of pH, salinity, sulfate and Fe concentrations, as well as the exclusion of P from ice.

Session 90600 - General Biogeosciences

Controls on variability in seepage lake dissolved organic carbon concentrations across northern Wisconsin

Casson, Nora Corman, Jessica Sebestyen, Steve Kolka, Randy Stanley, Emily
University of Winnipeg
n.casson@uwinnipeg.ca

Dissolved organic carbon (DOC) is not only an important component of aquatic carbon budgets, but it also mediates transport and processing of associated nutrients, metals and pollutants. Delivery of DOC to lakes is shaped by catchment properties, and in many northern forested systems, wetland coverage is a good predictor of DOC concentrations. This relationship, however, may not hold in flat, groundwater-rich areas, such as northern Wisconsin, where flowpaths of water vary with landscape position. The objective of this study was to investigate controls on the spatial variability in seepage lake DOC concentrations across the forested area of northern Wisconsin. We present data from synoptic surveys of more than 90 seepage lakes across the Chequamegon-Nicolet National Forest that ranged in size from 1.6 to 75 ha, conducted in the summers of 2013 and 2014. Seasonal groundwater and soil leachate sampling and precipitation chemistry were used to construct mixing models to quantify hydrological inputs to the lakes. The catchments of these lakes are difficult to delineate, as they are relatively small and at times have significant groundwater input, so we calculated landscape characteristics for fixed buffer zones around the lake. The chemical composition of the lakes varied widely across the landscape; for instance, dissolved organic carbon concentrations ranged from 2.9 to 39 mg/L. The results of this study have implications for how we understand carbon inputs to these small lakes that are vulnerable to droughts and air pollution.

Session 90600 - General Biogeosciences

Peatland Mercury Cycling and Climate Change: Influence of Water Table Regime and Vegetation Communities

Haynes, Kristine Kane, Evan Potvin, Lynette Lilleskov, Erik Kolka, Randy Mitchell, Carl P.J.
Department of Geography, University of Toronto
k.haynes@utoronto.ca

Peatlands act as significant stores of mercury in the landscape and sources of methylmercury to downstream aquatic ecosystems. Climate change has the potential to significantly affect the hydrology, ecology and ecosystem function of peatlands, which may have subsequent implications for the cycling and mobility of mercury. Using a full factorial mesocosm approach, we investigated the potential impacts of water table regime changes and vegetation community

shifts on mercury cycling and mobility in sub-boreal peatlands. This study was conducted at the PEATcosm Mesocosm Facility, United States Department of Agriculture Forest Service Northern Research Station in Houghton, Michigan. Over three years, pore water, snowmelt runoff and peat samples were collected at regular intervals from twenty-four 1 m3 peat mesocosms, which had manipulated water table positions (Control or Low) and different overstory plant functional groups (Sedge only, Ericaceae only or Unmanipulated Control) above the Sphagnum moss layer. Due to differences in redox conditions, lower mean water table levels promoted peak peat methylmercury loads to approach the mean water table position, while the Control water table resulted in a deepening of the depth at which peak methylmercury was observed. However, no significant differences in peat methylmercury loads among the vegetation treatments were observed. The greatest accumulation of total mercury and methylmercury in pore waters, and the largest concentrations in spring runoff, were observed in the Low Water Table -Sedge Only mesocosms. Pore water and snowmelt mercury concentrations were positively correlated with dissolved organic carbon and phenolic concentrations. The increased mobility of mercury may be due to enhanced oxidation and decomposition of the peat. With the potential for climate-induced water table lowering and fluctuation resulting in a subsequent shift in vegetation toward sedge-dominated overstory, methylmercury production in peat and accumulation of mercury in the mobile pore water phase may be significantly impacted.

Session 90600 - General Biogeosciences

Effects of changing rainfall frequency on net ecosystem exchange among different vegetation communities in a Southern Ontario poor fen

Radu, Danielle Duval, Tim
University of Toronto Mississauga
danielle.radu@mail.utoronto.ca

Climate change projections for the Northern Hemisphere show an increase in the intensity of rainfall events, but at a lower frequency that may lead to lower water tables and drier surface conditions. These changes could potentially threaten Sphagnum moss-dominated peatlands, which depend on moist surface conditions to continue to function as carbon sinks. Recent research has linked lower water tables to increased CO2 emissions, but minimal attention has been paid to the influence of the temporal distribution of rainfall on water table position. Thus, the objective for this project was to investigate the effects of varying rainfall frequencies on CO2 exchange through integrated field and laboratory experiments. In a poor fen located in Southern Ontario, and in a growth chamber setting, we manipulated rainfall over 3 groups of different plant community types: (1) Sphagnum-moss only, (2) Sphagnum moss with ericaceous shrubs, and (3) Sphagnum moss with sedges. Simulated rainfall treatments over each of the plant community types varied in frequency but the total amount of water applied to all treatments remained the same. Over a 4-month period, net ecosystem exchange (NEE), ecosystem respiration (ER), and gross ecosystem photosynthesis (GEP) were monitored using the static chamber method. Our results show that throughout the growing season, NEE is highest in the sedge community and lowest in the shrub community. As the water table drops, larger but less frequent events resulted in lower NEE in all three vegetation communities. Furthermore, while the presence of sedges increased water table decline relative to other vegetation types, increasing ER, the frequent small rainfall treatment minimized this response. These results, linked to

changes in hydrology including soil moisture, water table position, evapotranspiration (ET), and soil water tension will be discussed in the context of climate-change induced changes to rainfall regimes and peatland CO2 balance.

Session 100100 - Land surface modelling for GCMs and ESMs

Simulated Albedo in Needleleaf Forests is Highly Sensitive to The Treatment of Intercepted Snow: An examination of Canopy Snow Parameterizations in the Canadian Land Surface Scheme

Bartlett, Paul Verseghy, Diana
Environment and Climate Change Canada
paul.bartlett@canada.ca

The winter albedo of boreal evergreen needleleaf forest (ENF) has been poorly simulated in climate models, with a reported range among CMIP5 models exceeding 0.25 in April, and a strong positive bias in areas with high canopy cover. Such errors have been attributed to unrealistic representation of leaf area index, snow interception and unloading, and are associated with biases in the simulated snow albedo feedback. The Canadian Atmospheric Global Climate Model has been shown to underestimate the winter albedo in boreal ENF. We present changes to the parameterization of the albedo of ENF with intercepted snow; a new relationship between interception and the fractional coverage of the canopy by snow (fsnow); and unloading based on weather conditions. The new algorithms are employed in version 3.6 of the Canadian Land Surface Scheme (CLASS) in off-line mode and the simulated daily albedo compared with observations at four ENF sites.Default values for the visible and near-infrared albedo of snow-covered canopy were increased from 0.17 and 0.23, respectively, to 0.27 and 0.38. fsnow increased too slowly with interception, producing a damped albedo response. A new model for fsnow is based on zI* = 3 cm, the effective depth of newly intercepted snow required to raise the canopy albedo to its maximum (corresponding to fsnow = 1). Snow unloading rates were derived from visual assessments of photographs and modeled based on relationships with meteorological variables. A model based on wind speed at the canopy top produced the best result, replacing the time-based method employed in CLASS. Model configurations were assessed based on the index of agreement, d, and the root mean squared error (RMSE). The mean d and RMSE over four sites were 0.58 and 0.058 for the default configuration of CLASS 3.6, and 0.86 and 0.038 for the best model configuration.

Session 100100 - Land surface modelling for GCMs and ESMs

A study on radiative transfer schemes in plant canopy for land surface models

Dai, Qiudan
Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China.
dqd@mail.iap.ac.cn

This work develops methods for estimating radiative transfer within plant canopy in land surface modes (LSMs). By using the basic estimate for canopy reflectance and transmittance of a radiative transfer model under the condition of assumed zero soil reflectance, a sets of explicit analytical solutions of radiative transfer within the canopy with any soil reflectance magnitude

are given. Also a set of explicit analytical solutions for two kinds of vegetations are derived. For two different kinds of vegetations in the same model grids, the radiative transfer models dont have to treat them separately every time. Using the explicit analytical solutions, the fractions of any kind of incident solar radiation reflected from (defined as surface albedo, or canopy reflectance), transmitted through (defined as canopy transmittance), and absorbed by (defined as canopy absorptance) the canopy and other properties pertinent to the radiative transfer within the canopy can be estimated easily on the ground surface below the canopy (soil or snow surface) with any reflectance magnitudes. This new transfer model scheme is very efficient computing.

Session 100100 - Land surface modelling for GCMs and ESMs
Surface-Groundwater Interaction in Canadian Land Surface Model
Ganji, arman Sushama, Laxmi
Département des Sciences de la Terre et de lAtmosphère, Université du Québec à Montréal
aganji@sca.uqam.ca
Surface-groundwater interactions are important and determine the evolution of hydrologic variables such as soilmoisture, evapotranspiration and surface runoff. Despite its importance, groundwater is not explicitly representedin many land surface schemes, used in climate models. In this study, the Canadian Land Surface Scheme (CLASS),which is used in the Canadian regional and global climate models, is modified to include groundwater dynamics.The impact of these modifications on the regional hydrology is assessed by comparing three simulations, performedwith the original and modified versions of CLASS, driven by atmospheric forcing data from the European Centrefor Medium-Range Weather Forecasts (ECMWF) reanalysis (ERA-Interim), for the 1980-2011 period, over anortheast Canadian domain. The modified and original versions of CLASS differ in the underlying boundarycondition for soil layer hydrology, with one version being based on gravitational drainage from an original versionof CLASS and the other one is newly proposed unconfined groundwater at the depth of bedrock layer. Resultssuggest statistically significant increases in soil moisture, during the spring and summer seasons, for the simulationwith the new groundwater scheme, compared to the original version of CLASS, which is also reflected in theincreased summer surface runoff and streamflows in this simulation with modified CLASS, over most of the studydomain. The streamflows in this simulation is in better agreement to those observed. This study thus demonstratesthe importance of groundwater scheme in land surface models for realistic simulation of hydrological processes.

Session 100100 - Land surface modelling for GCMs and ESMs
Adding a nitrogen cycle to the Canadian Land Surface Scheme coupled with the Canadian Terrestrial Ecosystem Model: Effects on simulated global carbon exchanges
Huang, Suo Bartlett, Paul Arain, Altaf
Agriculture and Agri-Food Canada, McMaster University
paul.bartlett@canada.ca
Terrestrial biosphere models (TBMs) represent the role of vegetation in regulating climate though cycling and sequestering carbon (C). There is growing evidence that nutrient limitations, primarily nitrogen (N), will suppress the so-called CO2 fertilization effect caused by increasing

atmospheric CO2. Conversely, increasing N deposition and enhanced N mineralization in warmer and wetter soils may increase the availability of N to plants. The net effect of N limitation with enhanced deposition under a changing climate is not yet clear, but TBMs are beginning to include a N cycle to represent these important processes.A C-only TBM, Version 2.7 of the Canadian Land Surface Scheme coupled with version 1.2 of the Canadian Terrestrial Ecosystem Model, and a C-N coupled version were used to simulate global terrestrial carbon cycles from 1901-2010. The C-N version simulated slightly smaller (by less than 5%) gross ecosystem productivity (GEP) and ecosystem respiration (Re), which caused small decreases in soil organic carbon and total vegetation biomass over 1980-2010. The aggregated results suggest that the N cycle has not had a large effect on terrestrial C sequestration, but the temporal evolution and spatial distribution of simulated C budgets show important influences of the N cycle.The response to evolving climate, CO2 concentration and N deposition over 1901-2010 shows similar increasing trends in global GEP, Re and net ecosystem productivity (NEP = GEP - Re) until about 1970, after which increases were suppressed in the C-N model version. Spatial plots for 1980-2010 show that GEP and Re were reduced in the C-N model version in temperate regions and in boreal forests and high latitude regions, where N limitation is well documented. NEP in the boreal forests of North America, Northern Europe and Northwestern Asia, showed significant decreases in response to the inclusion of a N cycle. These results have important implications for future climate change scenarios because the response to increasing CO2, N deposition, and climate patterns shows diverging model behavior with respect to the C-only model version when a N cycle is incorporated, including a relative slowing of C sequestration, as well as differing responses with respect to ecoregion.

Session 100100 - Land surface modelling for GCMs and ESMs

Impact of interactive vegetation phenology on the simulated pan-Arctic land surface state

Teufel, Bernardo Stephan Sushama, Laxmi Arora, Vivek Verseghy, Diana
University of Quebec at Montreal (UQAM)
teufelbernardo@gmail.com

The pan-Arctic land surface is undergoing rapid changes in a warming climate, with near-surface permafrost projected to degrade significantly during the 21st century. This can have important impacts on the regional climate and hydrology through various feedbacks, including vegetation-related feedbacks. In this study, the impact of interactive phenology on the land surface state, including near-surface permafrost, is assessed by comparing two simulations of the Canadian Land Surface Scheme (CLASS) - one with interactive phenology, modelled using the Canadian Terrestrial Ecosystem Model (CTEM), and the other with prescribed phenology. These simulations are performed for the 1979-2012 period, using atmospheric forcing from ECMWFs ERA-Interim reanalysis. The impact of interactive phenology on projected changes to the land surface state are also assessed by comparing two simulations of CLASS (with and without interactive phenology), spanning the 1961-2100 period, driven by atmospheric forcing from a transient climate change simulation of the 5th generation Canadian Regional Climate Model (CRCM5) for the Representative Concentration Pathway 8.5 (RCP8.5). Comparison of the CLASS coupled to CTEM simulation with available observational estimates of plant area index, primary productivity, spatial distribution of permafrost and active layer thickness suggests that the model captures reasonably well the general distribution of vegetation and permafrost.

Significant differences in evapotranspiration, leading to differences in runoff, soil temperature and active layer thickness are noted when comparing CLASS simulations with and without interactive phenology. Furthermore, the CLASS simulations with and without interactive phenology for RCP8.5 show extensive near-surface permafrost degradation by the end of the 21st century, with slightly accelerated degradation of permafrost in the simulation with interactive phenology, pointing towards a positive feedback of changes in vegetation structure and phenology on soil temperatures.

Session 100100 - Land surface modelling for GCMs and ESMs
Snow and ice on sub-grid scale lakes in climate models
Verseghy, Diana Mackay, Murray
Environment and Climate Change Canada
diana.verseghy@canada.ca
The presence of small sub-grid scale lakes on the land surface, generally neglected in climate models, can have important local effects on surface fluxes where the lake fractional coverage is fairly large. The presence of lakes has a cooling effect in the summer, when lakes store available solar energy at greater depths than the surrounding land surface. This leads to a large pulse of evaporation in the fall, when lakes remain warmer than the surrounding land, until surface cooling leads to overturning and isothermal conditions. In the winter and spring, frozen snow-covered lakes have a much higher albedo than vegetated land, resulting in a cooling effect.A one-dimensional small lake model is under development for use with the Canadian atmospheric global climate model (CanAGCM) and regional climate model (CanRCM). Testing against field datasets has shown that the model performs well, realistically simulating the development of the mixed layer through the summer and the formation of ice cover in the winter. Most recently, the capability of simulating snow cover on the lake ice has been added, using the snow model from the Canadian Land Surface Scheme (CLASS). Regional-scale tests have been carried out over a domain centring on eastern Canada, where the lake coverage can reach as much as 40%. Forcing data were obtained from downscaled ERA-Interim data over a 20-year time period. The tests demonstrate the importance of properly accounting for the presence of lakes on the model domain, and the strong effect of the snow cover on the lake thermal regime and the surface energy fluxes.

Session 100200 - Modelling Earth Surface Processes
Bedload Transport and the Active Width in Gravel-Bed Braided Rivers
Peirce, Sarah Ashmore, Peter
University of Western Ontario
speirce@uwo.ca
Spatially and temporally variable bedload transport is directly linked to the complex and dynamic morphology of gravel-bed braided rivers. For instance, braided rivers have multiple channels conveying water but relatively few of channels actively conveying sediment at any given time. Even within an active channel the total width of bed transporting sediment (active width) is restricted to a relatively small area that is intimately linked to morphology and is a

major control of bedload transport rate. Understanding these linkages will lead to improved predictions of bedload transport rate in braided rivers and a more complete understanding of braided river morpho-dynamics. To investigate the variation in active width and bedload with changing discharge a 1:30 physical-scale model of a gravel-bed river (D50 = 1.3mm) with adjustable discharge (0.7-2.1l/s) was used to simulate a series of experimental hydrographs. The model is the approximate full-scale equivalent of a braided river with medium gravel and discharges of 4-13 m3s-1. High-resolution DEMs (±1mm) were generated every 15 minutes on a dry bed using digital photogrammetry and the SfM-based software program Agisoft. The active width was measured by differencing successive DEMs, which quantifies areas and volumes of erosion and deposition over the entire length of the model. Bedload transport rate was independently measured at the downstream end of the flume using five mesh sediment baskets spanning the width of the flume. The results show that at very low discharges both morphological change and sediment transport are largely undetectable and that active width and flux increase with increasing discharge. Results also indicate that antecedent morphological state plays an important role at all discharges producing considerable spatio-temporal variability. These results will contribute to the overall understanding of morpho-dynamics in complex gravel-bed rivers by linking changes in discharge to changes in morphology and bedload transport.

Session 100200 - Modelling Earth Surface Processes

Assessing Differential Scaling of River Profile Smoothing on the Spatial Distribution of Specific Stream Power and Associated River Channel Adjustment

Tetford, Pamela Phillips, Roger Desloges, Joseph
University of Toronto
pam.tetford@mail.utoronto.ca

Quaternary glaciations are reflected in the landforms and surficial geology of the southern Laurentian Great Lakes region. Glacial deposits impact the post-glacial adjustment of fluvial processes and are an important determinant of the type and availability of sediment in a watershed. Therefore, rivers in glacially conditioned regions, with varied downstream channel form, are subject to spatial variation of stream energy, sediment transport and lateral and vertical stability.This study assesses differential scaling of slope generalisation lengths on modelling the spatial variation in stream power and associated channel responses. A single-pass moving window is used to smooth a Digital Elevation Model (DEM) derived slope. The key objective of slope generalisation is to establish a longitudinal profile that reveals localized variation, while maintaining generalised channel characteristics that are representative of fluvial processes. Combining field and laboratory data, this study uses a detailed slope-area analysis to model specific stream power for the Duffins Creek basin in southern Ontario. Discharge and width proxies, based on empirical data, provide further input for determining stream energy. Duffins Creek is a small, low relief, watershed that exemplifies landforms and geology of multiple glacial and interglacial periods, and thus is subject to significant variations in stream energy. Results show that a 2.00 km moving average of the extracted DEM slope provides the most useful channel slope for representing reach-averaged channel adjustments in the watershed. Modelled specific stream power and associated channel morphologies at the reach-scale are assessed, with respect to prevailing flow and boundary conditions. Most reaches are adjusted as

predicted, however, glacial materials that influence bedload composition and bank strength yield more variable morphologies. At the watershed scale, the longitudinal profile shows a fluvial system that is still adjusting to post-glacial regimes significantly conditioned by the spatial arrangement of glacial sediments.

Session 100200 - Modelling Earth Surface Processes
Flow Dynamics and Erosion in Bedrock Channels
Venditti, Jeremy Rennie, Colin Church, Mike
Simon Fraser University
jeremy_venditti@sfu.ca
Bedrock erosion in rivers sets the pace of landscape evolution, influences the evolution of orogens and determines the size, shape and relief of mountains. A variety of models link fluid flow and sediment transport processes to bedrock incision in canyons. The model components that represent sediment transport processes are increasingly well developed. In contrast, the model components that are being used to represent fluid flow are rudimentary because there are no observations of the flow structure in bedrock canyons. Here we show that the flow structure in a bedrock canyon is more complex than assumed in the flow models currently employed. Observations of three-dimensional (3D) flow structure reveal that, as flow enters a canyon, a high velocity core follows the bed surface, causing a velocity inversion (high velocities near the bed and low velocities at the surface). The plunging flow then upwells along the canyon walls, resulting in counter-rotating, along-stream coherent flow structures that diverge near the bed. The resulting flow structure promotes deep scour in the bedrock channel floor and promotes undercutting of the canyon walls. This provides a mechanism for channel widening and ensures the base of the canyon walls are swept clear of debris that otherwise may be deposited due to lower shear stresses abutting the walls, keeping them near vertical. These observations reveal the complexity of flow in a bedrock canyon. Fluid flow models that capture the essence of the 3D flow field, using simple phenomenological rules that are computationally tractable, are required to capture the dynamic coupling between flow, bedrock erosion and solid earth dynamics.

Session 100300 - Advances in Earth Surface Processes
Geophysical surveys to validate a potential sinkhole collapse, Lake on the Mountain, ON.
Gagnon-Nandram, Andrew Braun, Alexander
Queens University
9arg1@queensu.ca
Lake on the Mountain, located in Prince Edward County, Ontario, has been a mystery to researchers and locals alike for decades. The 35 m deep lake is located precipitously close to the edge of a 62 m cliff overlooking the Bay of Quinte. How the lake has existed at this elevation without draining into the bay below is unknown, nor is it completely understood how the lake was originally formed. The accepted hypothesis is that it was formed by a Quaternary sinkhole collapse, though significant evidence to support this claim does not exist. The objective of this project is to provide validation to support a hypothesis of the lakes formation, through the

collection and analysis of geophysical data, as well as water temperature and conductivity measurements. A Ground Penetrating Radar (GPR) survey was performed from the frozen lake surface using a MALA ProEx 100 MHz instrument. An acoustic survey was also performed from a canoe platform, using a Knudsen Pinger Echosounder. The GPR and acoustic surveys were performed to acquire a more detailed bathymetric image of the lake bottom surface. This improved characterization of the bathymetric surface will help to understand the mechanism of formation of the lake. Additional Max-Min and EM-31 horizontal loop electromagnetic surveys were conducted around the perimeter of the lake to identify inflow channels.Temperature and conductivity measurements were collected using a YSI multimeter probe. This data indicates that the lake is strongly stratified in temperature and chemistry with the strongest interface contrast at approximately 7 m depth. This suggests that there is no significant groundwater flux occurring at depth in the lake. The final bathymetric model will be presented, and the details of the lakes shape and bedrock characteristics will be used to discuss how this data supports or discredits the present sinkhole collapse hypothesis.

Session 100300 - Advances in Earth Surface Processes
Acoustic Measurements of Small-Scale Sand Transport in River Flow
Wilson, Greg Hay, Alex
Dalhousie University, Oceanography
greg.wilson@dal.ca
In May 2015, an experiment was conducted in the main channel flume at the St. Anthony Falls Laboratory, to measure sediment transport using a multi-frequency acoustic Doppler instrument (MFDop). The flume was operated with ~1 m water depth over a ~50 cm thick bed of naturally-sourced medium sand, and ~1 m/s free stream velocity, resulting in a bed state comprised of ripples and quasi-2D dunes.The MFDop measures instantaneous (20 Hz) sediment size, concentration, and 3-component velocity, within discrete sampling volumes of ~1 cm^3, spanning a vertical profile from bed level to ~15 cm above bed. Measurements were collected as dunes migrated past the fixed instrument frame, hence the data spans the full range of spatial/temporal scales relevant to sediment transport: from the fluid-bed interface to the mean large-scale flow over the dunes. This data set provided a unique opportunity to test two recent stochastic theories for sediment activity and flux. The results show that these theories, previously validated for flat beds and low sediment activity, are in excellent agreement with sand transport under field-scale flow and bed conditions.

Session 110100 - Hydro-Climatic Extremes and Variability
Mid-Tropospheric Circulation Patterns Associated with Summer Hydro-Climatic Variability and Extremes on the Canadian Prairies
Bonsal, Barrie Cuell, Charles
Environment and Climate Change Canada
barrie.bonsal@canada.ca
Within Canada, the Canadian Prairies are a region of high natural hydro-climatic variability with the periodic occurrence of severe droughts and excess moisture conditions that often have severe

impacts on the environment and economy. Although previous studies examined the occurrence and atmospheric causes of Canadian Prairie droughts during the instrumental period, none have focused on the spatial characteristics of both extreme dry and wet periods. Using the Standardized Precipitation Evapotranspiration Index (SPEI) as a hydro-climatic extreme indicator and an atmospheric synoptic typing procedure, this investigation evaluates the dominant mid-tropospheric atmospheric circulation patterns associated with the spatial characteristics of extreme dry and excessive wet conditions over the southern Canadian Prairies from 1950 to 2011. Results reveal the prevalence of three distinct summer moisture patterns over the study area including same sign anomalies centred over the entire region, and an east-west and north-south dipole pattern. Examination of the daily 500 hPa circulation during summers associated with extremes in these three patterns shows significant increases/decreases in the frequency of key synoptic types in which the locations of mid-tropospheric ridges/troughs and zonal flow impact surface temperature and precipitation. In addition, trends in these key types indicate an increased occurrence of atmospheric circulation patterns associated with both extreme dry and excessive wet summers. Results from this investigation aid in the better understanding of the atmospheric causes associated with the temporal and spatial features of hydro-climatic extremes on the Canadian Prairies. They can also be used to anticipate future changes to these extremes that will benefit society in its ability to anticipate and adapt to future occurrences of these events.

Session 110100 - Hydro-Climatic Extremes and Variability

Analysis of projected hydrologic extremes in the Athabasca River Basin

Dibike, Yonas Eum, Hyung-Il   Prowse, Terry
Environment and Climate Change Canada
yonas.dibike@canada.ca

Projected changes in the global climate, such as an overall increase in temperature and variations in precipitation patterns and extremes, will have significant impacts on the various components of watershed hydrology, such as snow accumulation and melt, soil moisture and runoff affecting local hydrological regimes. Besides the potential changes in the total volume of flow in rivers and streams, there may also be a significant change in the frequency and severity of extremely high and low flow events. This study examines the potential changes in those hydrologic extremes over the Athabasca watershed based on the Variable Infiltration Capacity (VIC) processed based and spatially distributed hydrologic model projections under two greenhouse gas emission scenarios. Statistically downscaled high resolution climate data generated by select set of GCMs from the latest Coupled Model Intercomparison Project (CMIP5) were used as climatic forcings for the hydrologic model. Potential changes in hydrological extremes over seven hydrometric stations were examined in terms of exceedance probabilities as well as the frequency of high and low flow events. The main finding of this study is that, while there is an overall decreasing tendency in the frequency of low flows under the projected wetter and warmer climate, the potential changes in this and the other extreme hydrologic events are not uniform. Instead, the direction and magnitude of those changes depend on the emission scenario, the future time horizon and the location of each hydrometric station considered for analysis.

Session 110100 - Hydro-Climatic Extremes and Variability

The remote moisture sources for precipitation over Saskatchewan River Basin

Kurkute, Sopan Li, Yanping
University of Saskatchewan
kurkute.sopan@gmail.com

The Saskatchewan is the agriculturally dominant province for Canada and agriculture is heavily dependent on the natural weather system and Saskatchewan River network. It is important to detect the moisture sources that contribute to the precipitation over Saskatchewan River Basin (SRB). Based on ANUSPLINE precipitation data the locations of the daily maximum precipitation areas has been identified in SRB for warm seasons between 2001-2013. The Lagrangian approach has been used to identify the sources of moisture for each precipitation day happened in the SRB for the 12-year period. The Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model has been used to trace back the moisture transport and to identify the remote moisture source outside the SRB. The methodology employed in the study computes the moisture uptake through the calculation of the evaporation minus precipitation as well as the changes in the specific humidity along 10-day backward trajectories. The results indicate that the moisture released in the SRB region in warm season is substantially originated from the east or the south especially US Great Plains and Midwest. The moisture uptake from the western Pacific Ocean also made considerable contribution. Special attention has been paid to extreme drought/wet years over SRB.

Session 110100 - Hydro-Climatic Extremes and Variability

Mid-winter break-up of river ice cover in western Canada and Alaska and associated hydro-climatic drivers

Newton, Brandi Prowse, Terry de Rham, Laurent
University of Victoria
bwnewton@uvic.ca

Mid-winter break-up of a competent river ice cover, triggered by mild temperatures and/or rain on snow, can cause severe flooding and have profound impacts on subsequent spring break-up. This research identifies 46 mid-winter break-up events in western Canada from 1950-2008, and 6 events in Alaska from 1950-2014, and evaluates the hydro-climatic conditions that precede these events. Additionally, dominant 5-day sequences of mid-tropospheric circulation leading up to the mid-winter break-up events are classified using Self-Organizing Maps. Results indicate that the majority of events are located within a temperate region, defined as the area between 400 and 1000 winter (Dec-Feb) freezing degree-days; however, several recent events occurred north of this zone. Further classification of mid-winter break-up events by terrestrial biome reveal considerable variability in hydro-climatic triggers. In particular, 3 days of above-freezing mean daily temperature and/or rain on snow is sufficient to trigger a mid-winter break-up in Temperate Coniferous Forests and Temperate Grasslands, Savannas, and Shrublands biomes. Conversely, mean daily temperature is a poor predictor of mid-winter break-up events in Tundra and Boreal Forest/Taiga biomes where diurnal temperature range is high. Instead, events in these biomes were preceded by rain on snow (Tundra only) and/or several days of freeze-thaw ($T_{max} > 0°C$ and $T_{min} < 0°C$). The classification of 5-day sequences of mid-tropospheric circulation reveals

three dominant sequences, all depicting a persistent trough of low-pressure over the North Pacific. Mid-winter break-up events in BC and Alberta are preceded by a series of days with a strong trough of low-pressure, while events in Alaska and the Yukon are preceded by a weaker, more subdued trough. The results of this research improve our understanding of the hydro-climatic variables associated with the generation of mid-winter break-up of river ice in western Canada and Alaska and will aid in the prediction and mitigation of future events.

Session 110100 - Hydro-Climatic Extremes and Variability
8 Years of Canadian Catastrophe Trends
Rennie, Carolyn
Catastrophe Indices and Quantification Inc. (CatIQ)
carolyn.rennie@catiq.com
Managing risk in a changing climate requires observational data on extreme weather events. Recent natural and man-made disasters which cause significant insured property losses, called catastrophes by the insurance industry, are catalogued in CatIQs platform including over 130 events since 2008. Catastrophes in Canada have caused insured losses of over $11 billion over the last 8 years, averaging $1.4 billion a year. This presentation will provide an analysis of meteorological and geographic data associated with catastrophes. Trends will be identified such as where events occur, what type of events are most frequent and provide insight into mitigating damage in high-risk areas.

Session 110100 - Hydro-Climatic Extremes and Variability
Simulations of hydro-climate variables on the Great Lakes basin based on future climate scenarios using a Regional Climate Model
Seglenieks, Frank
Environment and Climate Change Canada
frank.seglenieks@gmail.com
Changes in the future hydro-climate regime of the Great Lakes are an important area of study at Environment and Climate Change Canada (EC3) as these changes will have significant impact on the environment, economy, and overall quality of life of the region.Unfortunately, the current resolution of Global Circulation Models (GCMs) generally result in the Great Lakes not being modelled as water bodies. Thus, regional climate model (RCM) results are crucial in properly simulating the unique nature of the area given the large percentage of lake area in the basin. Although simulations from GCMs using the CMIP5 series of future climate scenarios have been produced for a few years, only recently have results been available from RCMs based on the CMIP5 scenarios.For this study, current and future climate simulations of temperature and precipitation are used to run the hydrological model WATFLOOD, which has a long history of simulations in the Great Lakes basin. The climate simulations are provided by the Canadian Centre for Climate Modelling and Analysis using their CanRCM4 model based on the RCP4.5 scenario driven by the CCCma-CanESM2 GCM.The results of the hydrological model are examined on a monthly basis in terms of differences between the current climate and future climate simulations. The hydro-climate variables examined are streamflow (both in terms of

overall total as well as both higher extremes and extended low flow), snow water equivalent, evaporation, and soil moisture.This next steps of this project will be to include other RCMS that are part of the CORDEX project, use of more sophisticated hydrological models (for example the standalone MESH model being developed by EC3), and determination of changes in future lake levels based on these future climate simulations.

Session 110200 - Unmanned air vehicles in the earth, meteorological and oceanographic sciences

Assessment of Unmanned Aerial Vehicle (UAV)-acquired imagery for creation of point clouds, Digital Elevation and Surface Models (DEM and DSM) and orthophotos: case study within vegetated peatland environments

Millard, Koreen Armstrong, Lindsay Moreira Amaral, Fernanda Stiff, Doug Richardson, Murray
Carleton
koreen_millard@carleton.ca

Over the past few years the cost of obtaining a UAV system has decreased rapidly, making the use of UAVs for hobbies and small-footprint aerial photography very popular. However there are barriers in moving beyond simply capturing images to using the data for mapping and analysis of landscapes as can done with traditional photogrammetric techniques. Traditional photogrammetry used specialized cameras that are too heavy for inexpensive UAV systems to carry. As well, photogrammetric methods are not optimal for UAV imagery due to the often random orientation of the acquired images. A technique called Structure from Motion (SfM) has been developed that is similar to traditional photogrammetry, in that it requires images to be acquired from multiple viewpoints in order to determine the 3D geometry of a surface, but it uses more recently developed image matching techniques (Lowe, 1999) allowing the use of images from various orientations (Fonstad et al, 2013).   This technique has been recently integrated into user-friendly graphical user interfaces, creating an automated process that requires much less user intervention than traditional methods. These software have demonstrated the ability to create 3D point clouds and DEMs from UAV imagery that are often compared to LiDAR point clouds, but due to the low altitude of the UAV data collection can be orders of magnitude more dense.   In this presentation we will discuss how to move from simply collecting imagery to mapping physical features such as vegetation and topography. The implications of the use of ground control targets and target placement, issues in performing accuracy assessments, effects of vegetation on point clouds and the ability to create both DEM and DSMs (similar to LiDAR) will also be discussed.

Session 110200 - Unmanned air vehicles in the earth, meteorological and oceanographic sciences

Student-Led Project for Development of a Small Multi-mission UAV for Geophysical Surveying Applications

Penley, Darren Laliberte, Jeremy Samson, Claire
Carleton University
claire.samson@carleton.ca

Carleton Universitys fixed wing Uninhabited Aerial Vehicle (UAV) heritage began in 1991 with a paper-design forest-fire UAV. In 1998, undergraduate students worked on Hammerhead the universitys first flying, in-house designed and manufactured UAV, to detect bilge-oil dumping. Its retirement launched GeoSurv in 2000 - a purpose built, Cessna-Caravan sized UAV in partnership with Sander Geophysics, instrumented with magnetometers for geophysical surveying. In 2004, GeoSurv II took over from its predecessor and remains as Carletons flagship aircraft. In 2009, a medium-sized (25 kg) test and training UAV was needed to bridge the gap between GeoSurv II (100 kg) and the small, off-the-shelf Avionics Test Beds (1-2 kg). The Corvus Demonstrators commenced to serve this role.The Corvus Demonstrators are two modular, full-scale, fixed-wing UAVs for multi-mission sensor and flight control testing. Carletons fifth UAV design, Corvus was realized by undergraduate students participating in the 4th-year Capstone project with support from Masters students. The design process included simulation using computational fluid dynamics, finite element modelling, and hardware-in-the-loop testing to refine the aircraft before materials were cut. Constructed from aluminum and composites, Corvus will serve as a magnetic survey testbed. With a tail-dragger configuration, the power-plant is on a cantilever behind the fuselage in a pusher configuration. Corvus-1 flew in October 2013, featuring an electric motor and lithium batteries offering 45 minutes endurance. Flight controls are through the 3DR Pixhawk autopilot and an Independent-Flight-Termination-Switch (IFTS) disables the motor to prevent flyaway. The primary mission sensors are survey-grade magnetometers.Corvus-2, currently under construction, will include improvements addressing aerodynamics, modular capabilities, avionics, and power distribution. Use of a gas power-plant is being considered to test the effects of engine vibrations on avionics and sensors. Modular capabilities will be improved by designing interchangeable nose cones to accommodate various avionics.

Session 110200 - Unmanned air vehicles in the earth, meteorological and oceanographic sciences

Terrain-Following and Draping for Geophysical Survey Uninhabited Aerial Vehicles

Shafi, Salman Laliberte, Jeremy
Carleton University
salmanshafi@cmail.carleton.ca

There are organizations that perform manned aircraft surveillance missions to assess crop health, measure global warming effects, study animal migration habits, collect airborne geomagnetic data, and the like. These missions tend to take place in remote and sometimes dangerous areas with minimal infrastructure. Collecting high-resolution airborne geomagnetic data require sensors that need to be active at lower above ground level (AGL) altitudes. To combat this problem, operators have been considering uninhabited aerial vehicles (UAVs) to complement manned aircraft surveillance missions. For UAVs to provide accurate magnetometry, the aircraft must fly at a constant AGL at low altitudes and therefore requires a built-in terrain-following system.In partnership with Sander Geophysics Ltd., a low-cost UAV terrain-following and draping system is being developed, which measures ground altitude, flies at specified AGL altitudes, and follows preloaded flight paths with terrain draping to maximize data quality. Using predefined digital terrain models, a smooth flight path is predetermined so that an aircraft can follow the terrain without exceeding its flight envelope; this process is known as terrain draping. The drape profile is loaded onto an autopilot system used in conjunction with a terrain-following system to follow the ground at the desired altitude while monitoring for unforeseen changes. This system features a LiDAR (Light Detection and Ranging) unit connected to the autopilot through a microcontroller board. The altitude recorded by the LiDAR is compared with a preloaded draped profile; any deviation between expected and actual terrain will cause the aircraft to adjust its flight path to maintain the desired AGL. Before flight tests, the terrain-following and draping system will be tested in the lab for its ability to measure and record distance, interpret terrain draped data, and cause control surfaces to react appropriately to the information being received by the flight management system.

Session 110300 - Imaging in the earth, meteorological and oceanographic sciences

Geological mapping of mining tunnels using 3D images acquired from a moving platform

Chou , Eric Ting-Kuei Samson, Claire Watson, Curtis Chapman, Andrew
Carleton University
claire.samson@carleton.ca

This contribution features the uGPS Rapid Mapper, a laser scanner mounted on a mining vehicle which acquires 3D images (point clouds with X, Y, Z spatial coordinates and intensity I) of tunnels in underground mines with a 270? field-of-view. The instrument was originally developed to provide the instantaneous location of individual mining vehicles within a fleet of mobile machines working in an active underground mine. As the mining vehicle equipped with the instrument travels through the different tunnels, however, a detailed map of the mine is gradually constructed. The objective of our project was to process the 3D images to derive geological information, thereby extending the applicability of the instrument. On 21-22 October, 2015 we imaged three tunnels at the Hoyle Pond gold mine in Timmins, Ontario. The instrument was mounted on a trolley moving at walking speed (~1km/h) to achieve a point cloud density of ~1000point/m2. The strike and dip of 24 features of interest, such as ore veins and graphite-filled faults, were measured with a compass. The image data was draped with a triangular mesh in post-processing. The strike and dip of individual triangles within the mesh were computed and compared with the compass measurements. While angular measurements were in agreement at several locations, there were also significant discrepancies at other locations which are attributed to limitations in range accuracy of the laser. More sophisticated processing techniques will be tested in the future to further stabilize results. The intensity data was sensitive to changes in reflectivity associated with different types of rock. In particular, a quartz ore vein and a contact between graphite and ultramafic rock could be traced clearly on the images.

Session 110300 - Imaging in the earth, meteorological and oceanographic sciences
Towards a new method of rock mass stress calibration based on tunnel deformation captured by LiDAR imaging
McAnuff , Connor McKinnon , Steve Samson, Claire
Queens University
claire.samson@carleton.ca
Far-field stresses are the stresses present in a rock mass prior to any excavations being created. Estimates of the orientation and magnitude of far-field stresses are used in mine layout, schedule and ground support design. Currently, many mines rely upon estimating far-field stresses based on regional, large-scale trends. Other mines employ costly point stress measurements, which often do not accurately describe far-field stress conditions as they can be influenced by surrounding excavations and geological structures such as dykes and faults. Thus, far-field stress estimates can be loosely constrained, and therefore associated with a high degree of uncertainty.This contribution concerns the development of a method in which far-field stress estimates are calibrated through inversion of tunnel deformation measurements, and will feature a case study from the Nickel Rim South mine in Sudbury, Ontario. The proposed method makes extensive use of both 2D and 3D numerical models for stress calculations.Tunnel deformation is measured through the use of LiDAR, a high-resolution imaging technology that outputs a set of points in 3D Cartesian space, essentially creating a 3D model of the tunnel. If two sets of LiDAR scans are performed over a time interval involving increments of mining and subsequent changes in the local stress field, the difference between two images of the same scene can be used to calculate tunnel deformation. The proposed method would be a new and economical technique to accurately and efficiently improve the estimates of the orientation and magnitude of far-field stresses in a rock mass surrounding a mine. LiDAR has been previously demonstrated in geotechnical applications such as the determination of shotcrete thickness, the identification of regions of potential leaks, as well as discontinuity and large-scale roughness mapping. The data collected for far-field stress calibration could therefore have multiple additional applications.

Session 110300 - Imaging in the earth, meteorological and oceanographic sciences
Comparing a Miniature Structured-Light Sensor and Lidar for Imaging Rock Walls
McPeak, Sara Lai, Po Mezzino, Davide Bethell, Erin Samson, Claire Bose, Prosenjit
Carleton University
sara.mcpeak@carleton.ca
We report on a comparison study between a structured-light sensor and a Lidar for imaging rock walls for the purpose of facilitating geological interpretation. The structured-light sensor chosen for the study is a miniature (119.2mm x 27.9mm x 29mm; mass: 95g) and inexpensive (~$500) instrument that attaches to a computer tablet and captures the reflection pattern of projected infrared laser light as a point cloud. The sensor software processes the raw data points internally and outputs a 3D image as a triangular mesh. The Lidar used was a portable high-resolution Faro Laser Scanner Focus3D, capable of capturing up to 976,000 points/second with an accuracy of ± 2mm. The different scans were combined using a target-based registration approach. The Reflectorless Electronic Distance Meter (REDM) technique was used to survey targets placed on the rock wall to orient and geo-reference the point cloud. The surveying tool employed was a Leica Total Station TS11. On December 8th, 2015 both the structured-light sensor and the Lidar

were taken to the Canadian Wollastonite mine located in Seeleys Bay, Ontario to image two freshly blasted gneiss rock walls (one facing northeast that was approximately 6m long and 3m high, and another facing southwest that was approximately 10m long and 3m high). A total of 95 scans were taken using the structured-light-sensor, which included duplicate scans acquired to fill in gaps in coverage due to occlusion effects.The Lidar has an operational range of 0.6-30m and images were taken less than 10m away from the rock walls. The meshes generated from the structured-light sensor and the Lidar data were color-coded to highlight features of interest. The orientation of the main fractures on the rock walls was estimated using stereonets where the strike and dip of each triangle in the meshes is reported.

Session 110400 - Atmosphere, Ocean, and Climate Dynamics - Part 1

Understanding the hydrodynamics of strong tidal flow

Karsten, Richard Roc, Thomas Culina, Joel OFlaherty-Sproul, Mitchell
Acadia University
rkarsten@acadiau.ca

Tidal channels suitable for the deployment of in-stream tidal turbines have flows that generally exceed 3 m/s and may reach 6m/s. Such strong flows are often well mixed, adn so can be treated as barotropic. The strong flow also creates a boundary layer which often extends through the entire water column. These two features make the leading order flow easy to model and understand -- the flow is a balance between pressure gradients and bottom friction, with variations in speed governed by bathymetry. However, such a basic understanding of the flow is insufficient for turbine site assessment, since the forces acting on a turbine and the power generated are proportional to u^2 and u^3. Relatively small variations or shear in the flow can greatly affect turbine performance. Such variations in the flow are generally not produced locally but advected from upstream bathymetry. In this talk, we examine the dynamics of strong tidal flow in the Bay of Fundy using a high resolution coastal ocean model, and observations from ADCPs, drifters, and X-Band radar. We illustrate how micro and macro scale turbulence affect the hydrodynamics of a particular site, potentially creating high levels of shear that make the site unsuitable for the development of tidal energy.

Session 110400 - Atmosphere, Ocean, and Climate Dynamics - Part 1

A Model for Shear Response in Swimming Plankton

Shaw, Justin Stastna, Marek
Masters Student
justin_shaw@outlook.com

While their small size ensures that plankton are primarily advected by ambient fluid currents, many are also capable of swimming. We examine stochastic swimming models of the run and tumble type for plankton moving in a velocity field induced by internal waves in a channel. The swimming of individual plankton is modelled as a type of random walk, modified to include a shear response and a biased swimming towards a preferred light level. Several different types of particle models for the motion of the plankton under advection and their own propulsion are considered. It is shown that the most rational model can produce aggregation of plankton

populations along the bottom boundary of high shear regions, and that all models considered can produce vertical patches.

Session 110400 - Atmosphere, Ocean, and Climate Dynamics - Part 1
Schmidt and Reynolds number effects in simulations of shoaling long internal waves
Stastna, Marek Deepwell, David Ambacher, Matt
University of Waterloo
mmstastn@uwaterloo.ca
In many lakes, the summer time density stratification intersects the lake bottom over a significant portion of the lakes areal extent. At the same time, winds induce a variety of motions in the lake interior. I will focus on the long, or basin scale motions which may be well represented by idealized, often linear, theories over the majority of the lake. However, in the regions where the stratification intersects the bottom strongly nonlinear effects are observed. I will review some of the published literature on the topic, use weakly nonlinear theory to explain why nonlinearity matters in particular regions, and discuss the effects of changes in Reynolds and Schmidt number on direct numerical simulations of the project. Changes in Reynolds and Schmidt numbers have different implications. The former are important when scaling up laboratory scale simulations to the field scale, while the latter are important when comparing and contrasting a temperature stratified fluid with Sc=7 and a salt stratified fluid with Sc two orders of magnitude larger. In particular, I will focus on the way that short length scale bottom undulations are expressed in the evolution of the longer scale wave.

Session 110400 - Atmosphere, Ocean, and Climate Dynamics - Part 1
On Available Potential Energy and Hyperviscosity in a Spectral Collocation Method
Subich, Christopher Stastna, Marek
Environment Canada
Christopher.Subich@ec.gc.ca
The available potential energy (APE) of a fluid flow is the portion of its potential energy available for work, the remainder existing as the background potential energy (BPE) consistent with the flow at rest and adiabatically rearranged into its minimal-energy configuration. Computing these quantities in mixing flows requires an online sorting of fluid density, a difficult task for large-scale models.This work presents a computational algorithm for efficiently sorting these flows in the context of a parallel pseudospectral model, along with preliminary results of investigations into optimal hyperviscosity operators that preserve model stability while minimizing erroneous ``unmixing and growth of APE.

Session 110400 - Atmosphere, Ocean, and Climate Dynamics - Part 1
A Geometric Decomposition of Eddy-Mean Flow Interactions: Extension to Baroclinic Dynamics
Waterman, Stephanie Lilly , Jonathan
University of British Columbia
swaterman@eos.ubc.ca
Understanding eddy-mean flow interactions is a long-standing problem in geophysical fluid dynamics, with modern relevance to the task of representing eddy effects in coarse resolution models while preserving their dependence on the underlying dynamics of the flow field. A promising approach is to express the eddy forcing of the mean flow in the form of gradient operators applied to an eddy stress tensor. Such a formulation yields the so-called geometric decomposition of eddy feedbacks, a framework in which eddy-mean flow interactions are expressed in terms of the eddy energy together with geometric parameters describing average eddy shape and orientation. This framework has the potential to offer new insights into eddy-mean flow interactions in a number of ways: 1. it identifies the ingredients of the eddy motion that have a mean flow forcing effect; 2. it links eddy effects to spatial patterns of eddy geometry that can suggest the mechanisms underpinning these effects; and 3. it illustrates the importance of resolving the characteristic shape and orientation of eddy fluctuations, and not just the eddy energy, to accurately represent eddy feedback effects. Here we present an extension to the geometric decomposition for barotropic (2D) systems presented at this meeting last year, to baroclinic (3D) flows. In doing so, the geometric decomposition is extended to encompass the eddy forcing from both the eddy Reynolds stresses associated with lateral momentum transfer, as well as the eddy buoyancy fluxes associated with vertical momentum transfer. We show how these fluxes can be combined to describe a 3-dimensional ellipsoid, whose geometry encodes various pieces of useful information about eddy-mean flow feedbacks such as 1. the relative magnitudes of eddy fluxes to eddy energies; 2. the dominant orientation of the eddy momentum and buoyancy fluxes; and 3. the partitioning of eddy energy between kinetic and potential forms. Further, as in the barotropic case, we illustrate how spatial patterns in ellipsoid geometry can be linked directly to the eddy forcing, thus offering insights into eddy forcing mechanisms and model resolution requirements.

Session 110401 - Atmosphere, Ocean, and Climate Dynamics - Part 2
Rotating stratified turbulence near the tropopause
Asselin, Olivier Bartello, Peter N. Straub, David
McGill University
olivier.asselin@mail.mcgill.ca
Quasigeostrophic (QG) dynamics have been used extensively to model near-tropopause flows at mid-latitudes. Many features of the synoptic-scale tropospheric dynamics appear to be well described by considering only QG motion at the tropopause and at the ground (Hoskins et al. 1978, Juckes 1994). This closely relates to the Eady model, whereby the tropopause and ground anomalies interact to produce baroclinic instability. It was further suggested that the near-tropopause energy spectrum can be explained within a QG framework (Tulloch and Smith 2006). More recently, QG dynamics have been studied in the presence of rapid yet continuous transition in stratification in an attempt to model the tropopause better (Plougonven and Vanneste 2010,

Smith and Bernard 2013). We recently showed that under QG dynamics, the presence of a sharp transition in the stratification profile leads to the formation of comparably sharp vertical gradients of buoyancy. For typical atmospheric values, this violates the small Froude number assumption underlying QG and may even lead to statically unstable conditions. Therefore, a more general dynamical framework is necessary to provide a dynamically consistent picture of near-tropopause flows.In this talk, we present numerical simulations of rotating stratified turbulence in the presence of a sharp but continuous transition in background stratification. Boussinesq and QG dynamics will be compared. Preliminary results suggest that the production of sharp vertical buoyancy gradients --- and thus statically unstable conditions --- is reduced in Boussinesq runs. Implications for the relevance of QG tropopause dynamics will be discussed.

Session 110401 - Atmosphere, Ocean, and Climate Dynamics - Part 2
On the role of breaking African easterly waves and critical layers in hurricane genesis.
Brunet, Gilbert Asaadi, Ali Yau, Peter
Environnement et changement climatique Canada
gilbert.brunet@canada.ca
This study bring new understanding on the decades-old hurricane genesis problem that starts with westward travelling African easterly waves that can evolve into coherent cyclonic vortices depending on their strength and other nonlinear wave breaking processes.To better understand the dynamics involved in hurricane genesis, the flow characteristics and the physical and dynamical mechanisms by which easterly waves form cats eyes are investigated with the help of atmospheric reanalyzes and numerical simulations. We perform a climatological study of developing easterly waves covering the 1998-2001 hurricane seasons using ERA-Interim 6-hourly reanalysis data. Composite analyses for all named storms show a monotonic potential vorticity (PV) profile with weak meridional PV gradient and a cyclonic (i.e. south of the easterly jet axis) critical line for time periods of several days preceding the cats eye formation. In addition, the developing PV anomaly composite shows a statistically significant companion wave-packet of non-developing easterly waves. The latter permit to develop a geometrical criteria to distinguish developing versus non-developing easterly waves (EWs) suggesting that only developing waves (~25% of the total) are associated with a nonlinear critical layer adjacent to a region of weak meridional PV gradient. A shallow water model is used to study the initial value and forced problems of disturbances. The results highlight the synergy of the dynamical mechanisms and the thermodynamical mechanisms. These findings are consistent with the analytical theory of free and forced disturbances to an easterly parabolic jet (Brunet and Warn, 1990; Brunet and Haynes, 1995; Choboter et al., 2000).

Session 110401 - Atmosphere, Ocean, and Climate Dynamics - Part 2
North Atlantic atmospheric and ocean inter-annual variability over the past fifty years - dominant patterns and decadal shifts
Demirov, Entcho Hauser, Tristan
Memorial University of Newfoundland
entcho@mun.ca

The talk presents results from a study of dominant patterns of decadal ocean and atmospheric variability over the North Atlantic. Cluster analysis is used to identify the typical weather regimes of the North Atlantic. The long-term impact of the weather regimes on the regional climate is characterized by their distribution; i.e. the frequency of occurrence and persistence in time of each of them. Four typical distributions of the weather regimes are identified in this study associated with four dominant spatial interannual patterns representing the phases of two asymmetrical modes. The decadal shift in atmospheric circulation in the 1980s is explained by a change in the distribution of membership probabilities for the interannual patterns.

Session 110401 - Atmosphere, Ocean, and Climate Dynamics - Part 2
Meteorological Influences on Dispersion Modeling - Case Study
Lyons, Chris Corning, Vicki Murphy, Mike
Stantec Consulting Ltd.
clyons@stantec.com
Meteorology is a key element in modeling of atmospheric transport of exhaust plumes originating from sources such as stacks at power plants or petroleum refineries. Winds drive the dispersion of exhaust plumes containing air contaminants in the downwind direction from the stack. This is the primary mechanism behind dispersion of air contaminant releases to the atmosphere. Dispersion models are used as a tool to assess the ground-level impacts of air contaminants released from a source or group of sources. Dispersion modeling is conducted for environmental impact assessments (EIA) and regulatory permitting purposes. This session will consist of a review of a case study on the influence of meteorology and terrain on dispersion modeling of emissions. The modeling was conducted for an industrial facility in the Saint John River Valley, New Brunswick and was done using the California Puff model (CALPUFF). CALPUFF is a non-steady state meteorological and integrated Lagrangian puff modeling system. CALMET is the meteorological model for CALPUFF, which consists of a diagnostic wind field module and micro-meteorological modules for over water and over land boundary layers. The focus of the case study is on the CALMET meteorological modeling within the study area and the influence of the terrain in the river valley on long-range transport of exhaust plumes. A 3-dimensional model of the atmosphere covering the study area was developed using CALMET. Surface and upper air radiosonde data covering a five year period from 5 stations (1 upper air and 4 surface stations) in the region were used as inputs to the model. Geophysical data including land-use and terrain elevations within the study area are also used as inputs. The results of the meteorological and dispersion modeling analyses illustrate a significant influence of the terrain in the valley on the long-range transport of exhaust plumes from the facility.

Session 110401 - Atmosphere, Ocean, and Climate Dynamics - Part 2
Factors influencing the pattern of greenhouse gas-forced surface temperature change
Merlis, Timothy Henry, Matthew
McGill University
timothy.merlis@mcgill.ca

The pattern of regional surface temperature change is a key aspect of the climates response to greenhouse gas forcing. Local feedback analyses assess the surface temperature response needed to balance the spatial distribution of the top-of-atmosphere (TOA) energy balance and attribute changes in surface temperature to the spatial distribution of radiative forcing, ocean-atmosphere energy transport, and radiative feedbacks. However, changes in one component of the TOA energy balance affect others. The interaction between the energy transport, which is not a local function of surface temperature, and spatially confined radiative feedbacks, such as that of the surface albedo, is a fundamental challenge to this approach. We will show simulations in diffusive energy balance models and general circulation models in which we disable processes that affect the spatial structure of radiative feedbacks to assess their importance in determining the pattern of greenhouse gas-forced surface temperature change.

Session 110500 - Military Meteorology and Oceanography

New concepts using Numerical Environmental Prediction to assist the Canadian Armed Forces, Part 2. /// Nouveau concept dutilisation de la prévision numérique environnementale pour le soutien aux Forces armées canadiennes, partie 2.

Degardin, David
Services Ã laviation et Ã la dÃ©fense
david.degardin@canada.ca

Within the frame of its mandate, the Applied Development Cell of the Joint Meteorological Centre has defined a project to meet the needs of the Canadian Armed Forces, for environmental forecasting (meteorological and oceanographic) and related impacts on their operations. These operations are often multidisciplinary and cover large geographical areas with variable duration (combat missions, reconnaissance, intelligence, rescue, humanitarian, etc.). This constitutes a challenge for the development of a decision-support tool which meets the various requirements associated with many types of missions. A post-processing step using both deterministic and probabilistic models outputs in their respective fields of excellence will provide homogenous, consistent and relevant information with respect to both time and space while remaining adjustable to operations specificities. At this early stage of the project, the concepts behind The British Met Office Global and Regional Ensemble Prediction System (MOGREP-S) and the European extreme forecast index (EFI), are considered for this post-processing phase with respect to the probabilistic systems. Among other concepts, they will be the first to be assessed. The developments of scenarios by clustering techniques are also considered. This presentation is the first step of the project, inspired by the Meteorological Service of Canada transformation program and also aligned with the data centric approach promoted by the Canadian Force Weather and Oceanographic Service. It will be used to facilitate discussions and exchanges of ideas with research groups in other institutions and universities. /// Dans le cadre de son mandat, la cellule de développement appliqué du Centre météorologique interarmées a défini les lignes directrices dun projet destiné à répondre aux nécessités des Forces armées canadiennes relatives à la prévision environnementale (météorologie et océanographie) et de ses impacts sur leurs opérations. Ces dernières sont souvent multidisciplinaires (missions de combat, reconnaissance, renseignement, sauvetage, humanitaire, etc.) et couvrent un large spectre spatio-temporel ce qui constitue un défi pour le développement dun outil daide à la décision permettant de répondre aux différentes exigences associées aux nombreux types de missions. Une étape de post-traitement qui utilisera les sorties des modèles déterministes et ensemblistes dans leurs domaines dexcellence respectifs fournira une information homogène, consistante et pertinente dans le temps et dans lespace tout en restant ajustable aux spécificités des missions. À ce stade préliminaire du projet et pour le volet ensembliste de cette phase de post-traitement, les concepts britannique et européen sur lesquels reposent respectivement MOGREP-S et lindice de prévision extrême (IPE) sont considérés et feront lobjet dévaluations, sans toutefois sy restreindre. Les méthodes délaboration de scénarii par partitionnement des membres des SPE sont également considérées. Cette présentation constitue le démarrage de ce projet, qui sinscrit dans la philosophie du programme de transformation du Service météorologique du Canada et de lapproche centrée sur les données choisie par le Service météorologique et océanographique des Forces canadiennes. Elle servira également de support de discussions et déchanges avec les centres de recherche institutionnels et universitaires.

Session 110500 - Military Meteorology and Oceanography

Prediction of weather impact on EO-IR sensors for military operations

Dion, Denis
DRDC Valcartier
denis.dion@drdc-rddc.gc.ca

The performances of Electro-Optical and Infrared (EO-IR) sensors highly depend on the prevailing meteorological conditions. Further to knowing about the general capability of sensor systems, for efficient military mission planning, it is highly desirable to get reliable estimates of performances for the planned sorties. An EO-IR sensor performance Tactical Decision Aid (EO-IR TDA), called WISE-IR (for Weather Impact Sensor Efficiency - IR), is being developed at the Defense R&D Canada in partnership with the Joint Meteorology Center (Aviation and Defence Services) and the Environment Canada Science & Technology Branch. In the presentation, meteorological effects on sensor performance will be briefly recalled and a general description of the system under development will be given. A main output for the military users will be the anticipated variation of the Detection, Reconnaissance and Identification (DRI) ranges during the day.

Session 110500 - Military Meteorology and Oceanography

Optimizing forecast operations to better serve the Canadian Armed Forces

Dunsworth, Geoffrey Pettipas, Nicole Zwicker, Nathan
MSC
geoffdunsworth@yahoo.ca

The Meteorological Service of Canada (MSC) provides Meteorological products to the Canadian Armed Forces (CAF) through the Canadian Forces Weather and Oceanographic Service (CFWOS). The CFWOS will become a Data as a Service enterprise in the future and MSC forecasters must adapt to this concept in order to be able to provide the best possible service to the CAF and to remain relevant within CFWOS. The Meteorological Operations department of the Joint Meteorological Centre has identified the need to evolve its forecast production strategy to meet these new needs. This evolution in strategy will be done by shifting resources toward

high impact based meteorological support and by improving the meteorologists ability to provide added value to high-level weather briefings through in depth pre-briefing consultations between Meteorological Technicians and MSC meteorologists. The Joint Meteorological Centre will increase its engagement with ongoing MSC signature projects and continue its collaboration with the Applied Development Cell and Defence Weather Informatics and their global scale military forecast product development in order to develop the operational efficiencies needed to focus more on high impact weather. This presentation summarizes the first stage of this transformation project which is inspired by the Meteorological Service of Canadas transformation signature projects and is also aligned with the Data as a Service framework of the Canadian Forces Weather and Oceanographic Service.

Session 110500 - Military Meteorology and Oceanography
Supporting our Troops: A Depiction of ADS Defences use of NinJo in an Evolving, Global, and Dynamic Environment. /// Une description de lutilisation de NinJo dans lenvironnement global et dynamique des Services à laviation et à la défense (SAD)
Hawkins, Marshall
Services Ã laviation et Ã la dÃ©fense
marshall.hawkins@canada.ca
Within the MSC there is a subset of meteorologists whose forecast area of responsibility is not bounded by sovereign Canadian borders. For meteorologists within ADS Defence, NinJo has increasingly become a global tool capable of servicing the needs of a dynamic client in a broad forecast environment. In this presentation we will explore how the integration of NinJo within ADS Defence complements the primary forecast cycle, how the versatility of NinJo assists our special missions, and how new tools like NinJo Batch help drive innovation as business strategies evolve. This presentation is inspired by the Meteorological Service of Canadas transformation program and is aligned with the data centric approach promoted by the Canadian Force Weather and Oceanographic Service. /// Au sein des Services à laviation et à la défense (SAD) les zones de responsabilités des météorologues au service de la Défense ne sont pas limitées aux frontières canadiennes. Pour les météorologues de la Défense, NinJo est devenu un outil de prévision qui offre la capacité requise pour soutenir des opérations globales et multi disciplinaires. Cette présentation illustre lutilisation de NinJo pour la production routinière des prévisions, son application aux opérations spéciales, et son potentiel pour linnovation en utilisant le mode Batch. Cette présentation sinscrit dans la philosophie du programme de transformation du Service météorologique du Canada et de lapproche centrée sur les données choisie par le Service météorologique et océanographique des Forces canadiennes.

Session 110500 - Military Meteorology and Oceanography

New concepts using Numerical Environmental Prediction to assist the Canadian Armed Forces, Part 1. /// Nouveau concept dutilisation de la prévision numérique environnementale pour le soutien aux Forces armées canadiennes, partie1.

Turcotte, Marie-France
Environnement Canada
marie-france.turcotte@canada.ca

Within the frame of its mandate, the Applied Development Cell of the Joint Meteorological Centre has defined a project to meet the needs of the Canadian Armed Forces for environmental forecasting (meteorological and oceanographic) and related impacts on their operations. These operations are often multidisciplinary and cover large geographical areas with variable duration (combat missions, reconnaissance, intelligence, rescue, humanitarian, etc.). This constitutes a challenge for the development of a decision-support tool which meets the various requirements associated with many types of missions. A post-processing step using both deterministic and probabilistic model outputs in their respective fields of excellence will provide homogenous, consistent and relevant information with respect to both time and space while remaining adjustable to operations specificities. Some data or products derived from the deterministic systems are already in use by the Canadian Armed Forces, either in operational mode or during exercises with the use of experimental data. Some examples will be presented. The next steps are to make new data available in the space-time spectrum of the overall deterministic forecasting system, in order to obtain a seamless suite of products up to the ensemble forecasts timescale (see Part 2). This presentation is the first step of the project which is inspired by the Meteorological Service of Canada transformation program and also aligned with the data centric approach promoted by the Canadian Force Weather and Oceanographic Service. It will be used to facilitate discussions and exchanges of ideas with research groups in other institutions and universities. /// Dans le cadre de son mandat, la cellule de développement appliqué du Centre météorologique interarmées a défini les lignes directrices dun projet destiné à répondre aux nécessités des Forces armées canadiennes relatives à la prévision environnementale (météorologie et océanographie) et de ses impacts sur leurs opérations. Ces dernières sont souvent multidisciplinaires (missions de combat, reconnaissance, renseignement, sauvetage, humanitaire, etc.) et couvrent un large spectre spatio-temporel ce qui constitue un défi pour le développement dun outil daide à la décision permettant de répondre aux différentes exigences associées aux nombreux types de missions. Une étape de post-traitement qui utilisera les sorties des modèles déterministes et ensemblistes dans leurs domaines dexcellence respectifs fournira une information homogène, consistante et pertinente dans le temps et dans lespace tout en restant ajustable aux spécificités des missions. Certaines données ou produits dérivés des systèmes déterministes sont déjà en utilisation par les Forces armées canadiennes, que ce soit en mode opérationnel ou encore lors dexercices avec lutilisation de données expérimentales. Quelques exemples seront présentés. Les prochaines étapes consistent à rendre de nouvelles données disponibles, dans le domaine spatio-temporel du système global de prévision déterministe, de façon à obtenir une suite continue de produits pour rejoindre léchéance des prévisions densemble (voir partie 2). Cette présentation constitue le démarrage de ce projet, qui sinscrit dans la philosophie du programme de transformation du Service météorologique du Canada et de lapproche centrée sur les données choisie par le Service météorologique et océanographique des Forces canadiennes. Elle servira également de support de discussions et déchanges avec les centres de recherche institutionnels et universitaires.

Session 110500 - Military Meteorology and Oceanography

Meteorological Impacts on Military Operations in the High Arctic

Van Lochem, Eric
Joint Meteorological Centre
eric_vanlochem@msn.com

During recent years, there has been a proliferating focus in Canada on the Arctic from both a scientific and political perspective. Two of the Canadian Armed Forces annual sovereignty missions, Operation Nunalivut and Operation Nanook, focus primarily on the militarys ability to effectively conduct a multi-faceted mission in one of the worlds harshest climates. Under these circumstances, and notwithstanding the lack of permanent infrastructure, deployed units must operate as a self-sustaining entity with a minimal margin for error. Severe winter weather has derailed a myriad of pivotal missions throughout history, from the American Revolution to the Korean War. Winter warfare training courses are just one example of how the Canadian Armed Forces prepares its members for extreme environments such as the Canadian Arctic. However, the regions remote location and climate still pose a major logistical challenge to even the most experienced personnel. Based on the operations of yesteryear, this presentation will expand on significant meteorological impacts and the importance of weather support to the various aspects of this type of mission.

Session 110700 - Coupled modelling and the Year of Polar Prediction

Coupled wave - atmosphere - ocean modeling at NCEP

Mehra, Avichal Chawla, Arun Kim, Hyun-Sook Tolman, Hendrik Saha, Suranjana Tallapragada, Vijay Liu, Bin Sheinin, Dmitri
NOAA/NWS/NCEP/EMC
Avichal.Mehra@noaa.gov

Studies in recent years have shown that to properly account for physical processes, different components of earth system modeling - land, atmosphere, waves, sea-ice and oceans - have to be modeled simultaneously to accurately simulate the transfer of mass, momentum and heat fluxes across different components. NCEP is currently transitioning from a stand alone modeling framework, with different components only interacting through boundary conditions, to fully coupled systems with two-way interactions. Development is currently occurring for two different systems - a global coupled system (including coupled data assimilation) for seasonal applications and a regional coupled hurricane model. The coupled systems account for wind stress modified by surface waves, impact of surface fluxes due to mixing processes in the ocean mixed layer, wave driven Stokes Drift interacting with ocean models (Coriolis Stokes circulation as well as Langmuir mixing), impact of ocean currents on wave transport and transfer of momentum and heat from atmosphere to ocean and vice versa. The development paths of these two systems and their associated coupling frameworks will be reported upon here, with some initial results.

Session 110700 - Coupled modelling and the Year of Polar Prediction
Regional atmosphere, sea-ice, wave and ocean prediction systems in the European Arctic and planned contributions to YOPP
MÃ_ller, Malte Batrak, Yurii   Christensen, Kai Hakon   Fritzner, Sindre Graversen, Rune   Homleid, Mariken   Kristensen, Nils Melsom Randriamampianina, Roger Sperrevik, Ann Kristin Süld, Jakob Valkonen, Teresa
Norwegian Meteorological Institute
maltem@met.no
The Norwegian Meteorological Institute is operating atmosphere, sea-ice, wave, and ocean models in the European Arctic, in order to support and safeguard people working and living in the High North and to fulfill Norways WMO METAREA IXX responsibilities. The models are not fully coupled yet but a coupling strategy has been developed recently. In this Arctic model system the atmosphere is simulated by a convective-scale (2.5 km resolution) numerical weather prediction model coupled to a simplified 1-D thermodynamic sea-ice model. A 3D-Var data assimilation system incorporates synoptic, radiosonde, and satellite (AMSU-A, AMSU-B, IASI, and ASCAT) observations. The coupled ocean - sea-ice model components are ROMS and CICE, while the wave prediction model is WAM. The sea ice data assimilation will be based on ensemble methods and a 4D-Var data assimilation will be used for the ocean component.In this presentation we will demonstrate our current prediction capabilities in the European Arctic, e.g. forecasting of extreme weather events such as polar lows, and we will discuss our plans and projects to couple the different system components. Furthermore, we will inform about intended contributions to YOPP, which are for example the real-time distribution of high-resolution forecasts and the assimilation of observations of the YOPP Intensive Observation Periods.

Session 110700 - Coupled modelling and the Year of Polar Prediction
Overview of Coupled Environmental Prediction Systems in CONCEPTS
Ritchie, Harold Smith, Gregory
Environment and Climate Change Canada
hal.ritchie@canada.ca
As numerical weather prediction (NWP) systems become further refined, the interactions across the Air-Ice-Ocean (AIO) interface are becoming increasingly important. This is giving rise to the development of a new generation of fully-integrated environmental prediction systems composed of atmosphere, ice, ocean, and wave modeling and analysis systems. Within the Canadian Operational Network of Coupled Environmental PredicTion Systems (CONCEPTS), a fully-coupled AIO forecasting system for the Gulf of St. Lawrence (GSL) has been developed and has been running operationally at the Canadian Centre for Meteorological and Environmental Prediction (CCMEP) since June 2011.   Here we present an overview of recent system developments in CONCEPTS. We investigate the impacts of interactive coupling between the ocean and sea ice with the Global Deterministic NWP Prediction System at CCMEP. The approach optimizes the information content in respective modelling components by calculating fluxes in the ocean and sea ice models and coupling to the atmosphere at every timestep, followed by aggregation that allows an accurate estimate of heat fluxes. Moreover, the benefits from coupling are found to depend sensitively on a careful treatment of both ocean and sea ice initialization. Using this coupling framework, statistically significant improvements to global

verification scores are obtained. In particular, a strong sensitivity to coupling for tropical cyclones is found with large-scale impacts on weather prediction. The GSL system is also being tested at higher resolution over the Laurentian Great Lakes, with the same objective of improving forecasts both for the atmosphere and the water bodies. The system was run at even higher resolution to provide real-time support for the recent Pan Am Games held in Toronto ON. Illustrations of the high resolution modelling capabilities from both of these applications will be shown.This presentation will be made on behalf of our many colleagues in CONCEPTS.

Session 110700 - Coupled modelling and the Year of Polar Prediction
Examination of wave-current interactions over the eastern Canadian shelf under severe weather conditions using a coupled circulation-wave model
Wang, Pengcheng Sheng, Jinyu
Dalhousie University
wpc302@gmail.com
This paper presents a numerical investigation on interactions between surface gravity waves and currents over the eastern Canadian shelf and adjacent deep waters of the northwest Atlantic Ocean under severe weather events. A coupled ocean circulation-wave model based on the third generation wave model and three-dimensional (3D) circulation model is applied to the study region with a horizontal resolution of 1/16o. The circulation model uses the vortex-force formalism and wave-induced vertical mixing to account for effects of surface gravity waves on the 3D currents. The wave model uses the sea surface elevations and 3D currents generated by the circulation model to account for the effect of the circulation on the surface gravity waves. An external coupler is used to exchange information between the circulation and wave models. Analysis of model results demonstrates that the simulated significant wave heights (SWHs) and peak periods are significantly affected by the wave-current interaction (WCI) during and after the storm. For fast-moving hurricane cases, major contributions to the WCI include the current-induced modification of wind energy input to the wave generation, current-induced wave advection and refraction. In the slow-moving winter storm case, the effect of the current-induced advection differs significantly from that in fast-moving hurricane cases. The effect of the 3D wave forcing on the vertical mixing is significant over the Scotian Shelf. By comparison, the effect of wave-enhanced vertical mixing due to breaking waves is mainly significant in the fast-moving hurricane cases.

Session 110800 - Sensitivity and Uncertainty Analysis of Earth and Environmental Systems Models
Implications of a multi-criteria sensitivity analysis for understanding model structure and selecting calibration parameters
Haghnegahdar, Amin Razavi, Saman Wheater, Howard Gupta, Hoshin
Global Institute for Water Security, University of Saskatchewan, Canada
amin.haghnegahdar@usask.ca
Sensitivity analysis (SA) is an important tool for understanding model behavior, characterizing uncertainty, improving model calibration, etc. One of the applications of SA is to reduce the

dimensionality of the calibration process by eliminating insensitive parameters. This will significantly reduce the computational cost of calibration especially for complex environmental models. However, it is often overlooked that the metric choice can significantly change the assessment of model sensitivity and must be aligned with study (and calibration) objectives. Accordingly, multi-criteria sensitivity analysis can be used in this context. In this study, we use multiple criteria to assess the sensitivity of a physically-based hydrological model. Sensitivity metrics are selected based on various hydrograph characteristics including high flows, low flows, and volume. It is demonstrated that metric choice has a significant influence on SA results. Moreover, implications of the multi-criteria SA approach for understanding model structure and also selecting calibration parameters are discussed.

Session 110800 - Sensitivity and Uncertainty Analysis of Earth and Environmental Systems Models

Enhanced Identification of hydrologic models using streamflow and satellite water storage data: a multi-objective calibration approach

Yassin, Fuad Razavi, Saman Wheater, Howard
Global Institute for Water Security, University of Saskatcewan
fuad.yassin@usask.ca

The conventional procedure for parameter identification of hydrological processes through conditioning only to streamflow data is challenging in physically based distributed hydrologic modelling due to high parameter uncertainty. The challenge increases for modeling the landscapes where vertical processes dominate horizontal processes, leading to high uncertainties in modelled state variables, vertical fluxes and hence parameter estimates. Such behavior is common in modeling the prairie region of the Saskatchewan River Basin (SaskRB, our case study), Canada, where hydrologic connectivity and vertical fluxes are mainly controlled by surface and sub-surface water storage.To address this challenge, we used an effective and efficient multi-criteria framework to compare two approaches to model constraint. The first constrains model parameters to streamflows based on multiple performance metrics (i.e., volume bias, Nash-Sutcliffe Efficiency for flows and logarithm of flows) and the second utilizes total column water storage derived from the Gravity Recovery and Climate Experiments (GRACE) satellite to constrain model storage as an additional criterion. We used a multi-objective optimization algorithm (Borg) and a recently-developed global sensitivity analysis approach VARS (Variogram Analysis of Response Surfaces) to effectively identify the model parameters and characterize their significance in model performance. We applied this framework in the calibration of a Land Surface Scheme-Hydrology model, MESH (Modélisation Environmentale Communautaire - Surface and Hydrology) to a prairie region sub-watershed of SaskRB. Results showed that the multi-criteria framework under the second approach is superior than the conventional calibration to streamflows (the first approach). The multi-criteria framework allowed us to find optimal solutions that effectively constrain the posterior parameter space and are representative of storage and streamflow performance criteria, yielding more credible prediction with reduced uncertainty of model parameters and modeled storage output.

Session 110900 - Prediction and Communications of Weather-Related Health Services

Emissions Inventory Preparation in Support of High-Resolution CMAQ Modelling Applications

Gauthier, Martin Boulton, Wayne Lundgren, Jeff Conley, Greg McClellan, Carol Moran, Mike Zhang, Junhua Zheng, Quiong Aubin, Louise McAdam, Kim Adelman, Zac Omary, Mohammad
RWDI AIR Inc.
martin.gauthier@rwdi.com

Over the past several years regulations and public policies have been promulgated and developed to ease air pollution and particularly photochemical smog afflicting many urban areas across the country. There are many local, upwind and trans-boundary sources of primary and secondary pollutants that contribute to air quality in the Region of Peel (Peel). Understanding how these sources influence air quality at both region-wide and local scales is important to developing public policies for managing growth in a healthy and sustainable manner.In response to Official Plan Policy 2.2.3.3.8, the Region of Peel Public Health (PPH) commissioned a study to develop an air quality modelling system (AQMS) to assist in evaluating public policy decisions and how these decisions may affect air quality in Peel. The US Environmental Protection Agencys (EPA) Community Multiscale Air Quality (CMAQ) modelling system was selected for the AQMS. The first year of the study focused on compiling meteorological and emission data, and setting up and testing the AQMS for selected time periods in 2012. In the second year, improve emission information related to rail, marine and airport were assessed and the AQMS was run for the full 2012 calendar year.The presentation will be discussing the methodology used to improve those emissions and will present modelling results of healths contaminants of primary concern (ozone and PM2.5) as well as model evaluation results.

Session 110900 - Prediction and Communications of Weather-Related Health Services

Heat Health Warning Systems in Canada: Development, Implementation and Assessment

MacDonald, Melissa Yagouti, Abderrahmane
dave.henderson@ec.gc.ca

The World Health Organization and World Meteorological Organization recently issued joint guidance on warning system development to reduce heat health risk, warning that these events will increase in the future due to climate change. In Canada, the Federal Government, led by Environment Canada and Health Canada, has been collaborating with provincial and municipal health agencies to develop coherent risk communication strategies around the issuance of public heat warnings. The purpose of this abstract is to report on the emerging picture in Canada and provide the status information on a few of these initiatives. For example, such collaborations have demonstrated the necessity for heat warnings to be driven by health evidence complemented by multi-tiered prescriptive messaging while considering regional climatology. Another example is the value of systematic, timely notification provided by the Meteorological Service of Canada (MSC) to municipal health units of impending heat events. This notification is used to support mobilization around reducing public heat risk, specifically early action for those most vulnerable to heat. Assessment of the collaboration around issuing warnings and the public health response to reduce the risk is underway. Furthermore, the MSC will align its

public warning thresholds to coincide with the health evidence thresholds which key response action to those heat-health risks.

Session 110900 - Prediction and Communications of Weather-Related Health Services
LE SACDENGUE - SYSTEME DALERTE CLIMATIQUE-METEOROLOGIQUE DE PREVENTION DE LEPIDEMIE DE DENGUE
MENDONÇA, FRANCISCO
Université Federale du Paraná - LABOCLIMA / Brésil
chico@ufpr.br
La dengue est une maladie virale transmise par des moustiques du genre Aedes (Aedes aegypti et Aedes albopictus) dans le monde tropical et sous-tropical. Selon lOMS elle affecte annuellement plus de 100 000 personnes dans le monde, dont environ 20 000 en meurent. Le fait quil nexiste pas de mesures médicales capables de contrôler la maladie incite la mise en place dune série dautres actions visant à arrêter la progression de la maladie.Deux conditions sont indispensables à la prolifération de la maladie: les conditions sociales et les conditions climatiques. Une grande partie du Brésil présente des conditions climatiques et urbaines optimales pour le vecteur.Visant la surveillance et le contrôle de la maladie au Brésil nous avons construit le SACDENGUE. Ce système résulte dun travail conjoint entre le Laboratoire de Climatologie, le Système Météorologique et le Service de Santé Publique du Paraná, et il est publié chaque semaine par le biais de bulletins spécifiques. Le bulletin contribue à des campagnes de lutte contre la dengue en indiquant le risque dinfestation du vecteur et la possibilité de transmission de la maladie.Le SACDENGUE ne concerne que la surveillance des conditions météorologiques dans lÉtat du Paraná et il identifie la formation de conditions favorables à la reproduction et lactivité de lAedes aegypti. Lanalyse des données météorologiques permet lidentification dun profil météorologique journalier des différentes régions de lEtat en ce qui concerne la formation des conditions climatiques favorables ou non à linfestation des moustiques.Dans de nombreux pays les préoccupations concernant la propagation de la dengue se sont intensifiées récemment (2015 et 2016) avec la hausse des cas de zyka et de chikungunha. Pour les moustiques, la concentration des précipitations couplée à un environnement avec des températures plus élevées et des vents légers crée une situation optimale pour lampleur de la maladie.

Session 110900 - Prediction and Communications of Weather-Related Health Services
Extreme Heat during the Toronto 2015 Pan Am Games - Health-related Impacts and Lessons Learned for Public Health Alerting in Canada
MacDonald , Melissa Farrell, C.T. Henderson, Dave
Health and Air Quality Services/MSC/ECCC
melissa.macdonald@canada.ca
A new harmonized Heat Alert Response System (HARS) was piloted in Southern Ontario in the summer of 2015. Are these new public health heat warning protocols sufficient to respond to the needs of mass gathering organizers, spectators, athletes and public health agencies? Health-related impacts of extreme heat and humidity on select days during the Toronto 2015 Pan Am Games will be examined to improve how the Meteorological Service of Canada supports public

health alerting for mass gatherings such as large outdoor sporting events. On the days when the 2015 Pan Am Womens Marathon and Mens Bronze Medal Soccer match were held, higher than normal temperatures and relative humidity were experienced. This case study will explore the effectiveness of various heat-health related initiatives in Canada during these events. An observational Mesonet put in place for increased resolution forecasting and service capabilities for the 2015 Pan Am and Parapan Am Games provided additional data for this analysis. Temperature observations and various calculated heat indices (Canadian Humidex, UTCI, Apparent Temperatures, and WBGT) will be shown and compared for their value for public health alerting and planning of mass gatherings.

Session 111000 - Engaging with the Private Sector

Info-Electronics Systems Inc.: Instrumentation, analysis and forecasting for hydro-meteorological and environmental monitoring applications

Ahluwalia, Harinder
Info-Electronics Systems Inc.
wendy@info-electronics.com

Incorporated in 1981, Info-Electronics Systems Inc. (IES) is a Montreal-based engineering, systems integration and project management services company with strong experience in developing software solutions, providing instrumentation, and supplying end-to-end systems for hydro-meteorological and environmental monitoring applications. In this presentation, we will provide an overview of our expertise and project experience which we have gained over the last 35 years in Canada and around the world. We will also introduce some of our state-of-the-art partner manufacturers who help us bring to Canada the latest in instrumentation, remote sensing, analysis and forecasting. In addition, we will present some of our in-house developed products which we have marketed and sold internationally. Our presentation will also include a summary of our professional and value-added services which we offer our customers.

Session 111000 - Engaging with the Private Sector

Oceanography, geomorphology and engineering services for coastal and offshore environments at Golder Associates Ltd

Forest, Alexandre Osborne, Philip D.
Golder Associates Ltd.
Alexandre_Forest@golder.com

Golder Associates is a global, employee-owned consulting company driven by the purpose of engineering earths development while preserving earths integrity. Founded in Canada more than 55 years ago, Golder has considerable experience and knowledge of environmental conditions in Canadian waters including the north Atlantic, the Arctic and the Pacific Oceans and the Great Lakes. Golder is a specialist provider of coastal and offshore services including engineering, geomorphology and oceanography that bridge across engineering and environmental sciences. We have conducted many environmental and social impact assessments and baseline studies for a broad range of clients in oil & gas, mining, infrastructure, and government sectors. Our coastal team includes more than 20 specialists and registered professionals skilled in integrated data collection and numerical modelling of coastal processes for a wide range of applications including climate change and sea level rise adaptation, water quality modelling for wastewater treatment, industrial / municipal discharges and contaminated site remediation, dredging and disposal, shore protection and restoration design and addressing the unique challenges that arising from the impacts of ice and circulation on the environment, structures and operations associated with natural resource development. Golder uses established quality assurance / quality control procedures, data collection protocols, modelling capacity, and in-house quality management system compliant with internationally recognized standards. In this presentation we will provide an overview of key coastal and offshore services provided by Golder by showcasing recent project experience including the deployment of oceanographic moorings associated with deep water leases on the continental shelf and slope of the Canadian Beaufort Sea; as well as nearshore oceanographic investigations and modelling studies for projects related to project development along the eastern and western coasts of Canada.

Session 111000 - Engaging with the Private Sector
Quantifying Canadian Catastrophes with CatIQ

Rennie, Carolyn
Catastrophe Indices and Quantification Inc. (CatIQ)
carolyn.rennie@catiq.com

Catastrophe Indices and Quantification Inc. (CatIQ) reports detailed analytical, GIS & meteorological information in addition to insured loss estimates on Canadian natural and man-made catastrophes. CatIQ serves as connection between scientific data and impact-based damage and loss information that can be used by the insurance & reinsurance industries, risk managers, and the emergency management community to benchmark, quantify, and evaluate vulnerabilities. CatIQs Canadian annual Catastrophe Conference (C4), which ran in February, was created to foster collaboration before, during and after catastrophic events between industry, academia and governments. Join CatIQs Managing Director Carolyn Rennie to learn about CatIQ, the insurance industry and how everyone can work together to become resilient to catastrophes.

Session 111000 - Engaging with the Private Sector
Low power/high accuracy loggers for ocean instrument platforms

Richards, Clark Schillinger, Doug
RBR Ltd.
clark.richards@gmail.com

High quality measurements of ocean properties are crucial to a complete understanding of the state of the ocean, and for informing predictions of future climate. Recent advances in the development of autonomous measurement platforms have highlighted a need for robust and low power sensor technologies, without compromising accuracy or storage capabilities. RBR sensors are particularly well suited to such platforms, and in this talk we give a broad overview of integration into two such platforms: Argo floats and the wire-walker profiler. In the case of Argo floats, power savings from utilizing an RBR CTD are expected to increase the autonomy of an

individual float by as many as 50% more profiles. For a wire-walker, complete integration of the sensors, data controller, and telemetry is accomplished through an end-to-end integration of low power components, again increasing autonomy and permitting more data collection.

Session 111000 - Engaging with the Private Sector
Hoskin Scientific Ltd. - 70 Years of Service to the Canadian Market
van der Have, Jennie Brown, Scott
Hoskin Scientific Limited
salesv@hoskin.ca
For over seventy years, Hoskin Scientific has been a supplier of testing and monitoring instrumentation to the Canadian market. With offices in Vancouver, Burlington, and Montreal our customers are able to receive local sales and technical support in our three major departments. Our Environmental Department provides solutions for monitoring and sampling biological and chemical parameters in the environment. Our team of environmental sales representatives and diverse product range guarantee that you will find the right products for your application. Hoskin Scientific has significant experience both in the fields of meteorology and oceanography within Canada and on an international scale. Specific areas of focus include water quality, water quantity, meteorology, soil moisture, plant science, indoor air quality, aquatic sampling, and oceanographic monitoring. At Hoskin Scientific we can also provide our customers with complete turnkey environmental monitoring solutions. Our integrated systems division works with our diverse customer base to create customized monitoring platforms tailored to the needs of our clients. Whatever the area of specialty, Hoskin Scientifics environmental department can equip you to collect the data you need for your project whether through a purchase or rental.Visit us at www.hoskin.ca for more information.

Part 2 – Poster Presentations

Session 120100 - POSTER SESSION - PART 1

Time Series Analysis of Daily GNSS Positions in a Volcanic Region.

Akay, Gozde Dare, Peter Langley, Richard
UNB
dare@unb.ca

In this study, we estimate seasonal variations that exist in daily GNSS positions for a set of sites on the island of Monteserrat. The sites were around the islands Soufriere Hills Volcano and we used LSSA (Least Squares Spectral Analysis) on GNSS data from 2012-2015 during the volcanos post-eruptive stages. As a first step, time series of the position solutions were cleaned of outliers by using a sliding two-sided-kth neighbour windows approach. Then, the linear trend was estimated and subtracted. LSSA was then applied to the data in order to detect significant periodic peaks. We do this as it is recognized that if seasonal variations present in data are not removed from a time series, they will cause a bias in any subsequent deformation analysis. Annual and semi-annual variations are found to be most significant in our study. Estimated amplitudes, their formal error, and other significant peaks seen during the analysis will be presented.

Session 120100 - POSTER SESSION - PART 1

Representing shoaling internal waves in layered models

Ambacher, Matthew Stastna, Marek Deepwell, David
University of Waterloo
matt.ambacher@uwaterloo.ca

The vast majority of basin scale lake models are hydrostatic, layered models. In order to maintain the stability of the water column as the fluid evolves these models make use of a variety of parametrization for mixing (eddy diffusivity) and dissipation (eddy viscosity). Over the past decade an understanding of processes which systematically violate the assumption of hydrostatic balance has developed (e.g. large amplitude solitary-like waves in Lake Constance). We applied a diagnostic method to direct numerical simulations (DNS) of shoaling, long internal waves. This technique allowed us to choose a number of layers, and then compare locations of peaks in quantities like the spanwise averaged viscous dissipation to locations of overturns in one or more of the layers. This in turn, allowed for an assessment of parametrizations based on local overturning.

Session 120100 - POSTER SESSION - PART 1

Some Impacts of the Record Setting Year 2015 in British Columbia

Anslow, Faron Schnorbus, Markus Menounos, Brian
Pacific Climate Impacts Consortium
fanslow@uvic.ca

The province of British Columbia lies just west of the record-setting ocean surface temperature anomaly in the northeast Pacific Ocean. The conditions that lead to the formation of the ocean anomaly also promoted much warmer than normal conditions in the province with associated hydrological and cryospheric impacts. This culminated in 2015 in which a developing El Niño combined with the warm ocean temperature anomalies and the combined impacts on the atmospheric circulation to produce a record-setting year in many aspects. Using the combined Environment Canada, BC Ministries and BC Hydro observational data we detail the surface conditions over the province during the year and through cryospheric measurements and hydrometric data, investigate some of the impacts of the year on water supplies. Comparison may be drawn with climate projections and indicate that 2015 may have been a suitable analogue for future climate and surface water resources in British Columbia.

Session 120100 - POSTER SESSION - PART 1

Climatological influences and the effects of snow cover on lake ice in Central Ontario, Winter 2016

Ariano, Sarah Brown, Laura
University of Toronto Mississauga
lc.brown@utoronto.ca

Considering the importance lakes have on regional climate and weather-related events, it is essential to examine the sensitivity of lakes to changing climate conditions. To do this, changes in lake ice phenological records are used to provide insight on lake-climate interactions. Monitoring lake ice phenology is important because of the impacts on freshwater ecosystems (including evaporation, lake stratification and aquatic productivity) as well as economic benefits through recreation and transportation. In Central Ontario, the presence (or absence) of snow cover leads to ice-on/off dates that differ from current model simulations, largely due to the impact of snow cover on both ice thickness and composition. This study focuses on quantifying the effects of snow cover on the lake ice for three lakes in Central Ontario for the 2016 ice season. Twelve outdoor digital cameras were used to capture a visual record of the snow redistribution patterns and show the range of ice-on/off dates occurring across the study lakes. A Shallow Water Ice Profiler was placed at the bottom of one of the study lakes to investigate the full seasonal evolution of the ice cover. Field measurements of snow depth, snow density, ice thickness and ice composition were used to quantify the snow and ice conditions on the lakes. Snow ice formation occurred during initial ice growth as a precipitation event occurred during ice freeze up (Jan. 4 2016). Later in the season (Jan. 26 2016), a slushing event occurred when air temperature increased to +2°C leading to melt of the snowpack on the ice surface. The slush layer then froze a day later resulting an ice cover comprised almost entirely of snow/slush ice - which is unusual for these lakes. The seasonal evolution of the ice and snow, as well as the influencing climate factors, are presented for the three study lakes.

Session 120100 - POSTER SESSION - PART 1

A quick evaluation of water isotopic signatures and water travel times in a cold Canadian Prairie watershed

Bansah, Samuel Ali, Genevieve Haque, Aminul   Laing, Janelle   Schmall, Adrienne
Dept. of Geological Sciences, University of Manitoba, Winnipeg, Manitoba, R3T 2N2; Manitobas Watershed Systems Research Program; Center for Earth Observation Science, University of Manitoba
bansahs@myumanitoba.ca

Stable water isotopes are critical tools for the study of how precipitation water is partitioned into surface runoff, shallow subsurface runoff and slow groundwater flow. Comparing ?18O and ?2H values of water to a meteoric water line (MWL) can aid in the evaluation of sources of groundwater recharge, surface water-groundwater interactions, and water-mineral exchange. The goals of this study were to 1) compare the isotopic signatures of different water types across the Manitoba escarpment, and 2) use an empirical method to infer how fast groundwater travels above, across and below the escarpment. 1137 precipitation (snow, meltwater and rain), streamwater, shallow and deeper soil and groundwater samples (from depths of 0.6 m, 1.5 m and 8 m) were collected in 2014-15 from eight outlets in the 74 km2 South Tobacco Creek Watershed (STCW), located in South Central Manitoba. Six of the outlets are located above the escarpment, one on the escarpment itself, and the last one below the escarpment. All the water samples were analysed for ?18O and ?2H and plotted with respect to the local MWL. A qualitative assessment of site-specific water travel times was also made using the damping ratio method. Preliminary results show that the isotopic composition of water in the watershed follows expected trends since most samples plotted on the local MWL, thus needing no accounting for errors before its use in water partitioning and water travel time studies. The damping ratio method showed that travel times are correlated with topography only for the sites located above the escarpment, suggesting that the geological control exerted by the fractured shale making up the Manitoba escarpment is more important than topography as we move downstream. Future work will focus on using convolution integral methods to obtain more accurate estimations of water travel times for all sites.

Session 120100 - POSTER SESSION - PART 1

Determining permafrost-thaw-induced forest loss in the boreal peatlands of the Canadian subarctic

Berg, Aaron Berg, Aaron Adams, Justin Quinton, William
University of Guelph
aberg@uoguelph.ca

Permafrost distribution is not particularly well understood due to a combination of the remoteness and size of the region, spatial and temporal heterogeneity, limited data availability, and incomplete monitoring networks across the Canadian arctic and subarctic. These factors not only highlight the need to better define the changing distribution of permafrost under the impacts of climate change, but also further emphasize the need to improve techniques of remotely evaluating permafrost condition. An emerging method of achieving this in subarctic boreal peatland environments is based on solidifying the relationship between landcover and permafrost; where forest cover is often indicative of permafrost plateaus while wetlands are

underlain by permafrost-free ground. Recent decades have shown a significant decrease in permafrost cover in this area, which has also corresponded with widespread forest loss as wetlands expand due to increased water on the landscape. Research was conducted at two subarctic sites: Scotty Creek Basin, NWT (61°18N, 121°18W) and the Cordova region, BC (59°46N, 120°42W), both of which are characterized by a boreal peatland landscape. Each forest patch throughout the study area was delineated using an object-oriented model for landcover-mapping, which was developed using eCognition. The result of this model not only provided an assessment of this new technique over manual digitizing, but also extracted forests and any associated fragments for a change detection analysis that was run at each site between historical aerial photographs and present-day satellite imagery. This analysis provided the amount and rate of forest loss observed as well as quantified forest fragmentation over the study period at both sites. Results of this study suggest that forest loss, and thus permafrost-thaw-induced landcover change, is occurring at different rates over the Cordova region site compared to Scotty Creek Basin further north.

Session 120100 - POSTER SESSION - PART 1

Modelling permafrost degradation under a linear disturbance in the discontinuous permafrost zone

Braverman, Michael Quinton, William L. (Bill)
Wilfrid Laurier University
michael.braverman@ghd.com

The relatively thin and warm permafrost below subarctic peatlands is highly sensitive to ground surface disturbance. Seismic lines are one of the most common types of linear disturbance in the Northwest Territories, Canada, yet their impact is poorly understood. Based on temperature and water level observations and on the results of geophysical surveys, we modelled permafrost thaw from the time the seismic line was cut in 1985 to the present. The modelled results indicate that permafrost thaw under a linear disturbance is an irreversible process resulting in a permafrost-free corridor within 250 years at the study site. However, the model does not account for heat transfer by advection, which can accelerate permafrost degradation and reduce the time of disappearance. It was also found that once the permafrost table descends below the elevation of the water table in adjacent wetlands, the linear disturbance forms a hydrological connection wetlands a link between them. Subsurface flow continues throughout the year through the talik (i.e. perennially-thawed) layer, with approximate equal volumes discharging during the summer (49%) and winter (51%) periods. This study also suggests that ice loss from within thawing permafrost has enabled such bodies to conduct water thereby providing another subsurface flowpath connecting wetlands separated by permafrost.

Session 120100 - POSTER SESSION - PART 1

Lake Ice in the Northern Hemisphere: 2004 to 2015

Brown, Laura Xiong, Dingyi
University of Toronto Mississauga
lc.brown@utoronto.ca

Lakes comprise a large portion of the surface cover in the Northern Hemisphere, forming an important part of the cryosphere. The timing of lake ice phenological events (e.g. break-up/freeze-up) can be useful indicators of climate variability and change. Recent studies have demonstrated that ice break-up dates, in particular, have been occurring earlier in many parts of the Northern Hemisphere over the last 50 years in response to warmer climatic conditions in the winter and spring seasons. The 4km Interactive Multisensor Snow and Ice Mapping System (IMS) has been available since 2004 and been used successfully to examine lake ice phenology. Lake ice break-up and freeze-up dates as well as ice cover duration were extracted from the 4km IMS dataset for the last 10 years and examined for recent trends and spatial patterns. Lake ice break-up trends show a mix of earlier break-up (primarily in northern regions) and later break-up (primarily in the southern regions), with some significant trends ($p < 0.1$) identified both near the southern limits of the ice cover and the High Arctic regions. Freeze-up dates also show earlier and later trends with spatial clustering but less latitudinal tendencies then the trends identified in the ice break-up dates. The combined ice cover duration shows some significant trends, primarily clustered in southern Alberta and the Arctic coastal regions. While most long-term trends are tending towards earlier ice break-up dates and in some regions later ice freeze-up dates, the 10-year record now available from the IMS dataset provides an overview of the variability observed in the lake ice record of the last decade.

Session 120100 - POSTER SESSION - PART 1

Estimating storage properties of drainage basins on the Oak Ridges Moraine in southern Ontario: a combined hydrometric - hydrogeologic - isotopic approach

Buttle, James
Trent University
jbuttle@trentu.ca

The role of basin storage is one of the least-understood functions in hydrology; nevertheless, increasing attention is being paid to the role of storage in accounting for basin hydrological behaviour and in explaining hydrological response to basin perturbation. This study employed multiple approaches to estimate storage for basins draining the Oak Ridges Moraine (ORM) in southern Ontario. Daily streamflows for 2007-2013 for 22 basins gauged by Water Survey of Canada were used to estimate dynamic storage (DS) for each basin following the approach of Kirchner (Water Resources Research 45, W02429, doi:10.1029/2008WR006912). A 3-d hydrogeologic model of the ORM was used to estimate aquifer and aquitard extent and thickness for each basin, supplemented by measures of basin topography and land cover. A subset of five basins was monitored for stable isotopic signature of precipitation and streamflow for 2015, and data were used to estimate the mean residence time (MRT) of water in each basin assuming exponential and gamma distributions of water residence times. Estimates of MRT ranged from 1 - 1.7 years, and there was a significant positive relationship between MRT and DS for the five basins. Results suggest that DS may serve as a useful and easily-derived storage metric that can assist in explaining inter-basin differences in hydrologic response to changes in climate and land cover on the ORM.

Session 120100 - POSTER SESSION - PART 1

A study of river evaporation within different size watercourses in the Miramichi River

Caissie, Daniel Maheu, Audrey El-Jabi, Nassir St-Hilaire, André
Fisheries and Oceans
Daniel.Caissie@dfo-mpo.gc.ca

River water temperature is a very important variable in ecological studies, especially for the management of fisheries and aquatic resources. River evaporation has been identified as an important heat loss and a key process in the thermal regime of rivers. However, very few studies have measured river evaporation (condensation), and subsequently calculated corresponding heat fluxes in different stream environments, mainly because microclimate data (data collected within the stream environment) are essential and rarely available. The objectives of this study were to characterize the evaporative heat flux at different scales and to improve the estimation of the evaporative heat flux. Using a mass balance approach with floating evaporation minipans, we measured river evaporation at an hourly timescale in three rivers of different size, a medium-sized river (Little Southwest Miramichi), a brook (Catamaran Brook) and in a small tributary stream (Tributary 1 of Catamaran Brook). Results showed contrasting results in river evaporation between small stream and medium-size rivers. Evaporation was the main heat loss mechanism in Little Southwest Miramichi River and Catamaran Brook whereas the long-wave radiation was the main heat loss in Tributary 1. Solar radiation dominated the heat gains in all the studied systems.

Session 120100 - POSTER SESSION - PART 1

Drivers of the modelled variability of subsurface oxygen and biological pump in two distinct basins: the Labrador Sea and Baffin Bay.

Castro de la Guardia, Laura Claret, Mariona Hu, Xianmin Myers, Paul G Galbraith, Eric D
Department of Earth and Atmospheric Sciences, University of Alberta
castrode@ualberta.ca

Using a regional configuration of a fully coupled biogeochemical-ocean-sea ice model, on the framework of BLING-NEMO-LIM2 at ¼ degree resolution, we identify dominant parameters governing the modelled fluctuations in subsurface oxygen concentrations and biological pump in the Labrador Sea and Baffin Bay from 1963-2008. In the Labrador Sea, winter cooling of the surface water leads to deep convection, which acts as a window for a large exchange of gas between the atmosphere and deep ocean. When deep convection ceases in late spring, the gases exchanged remain trapped within the ocean interior, contributing to the storage of carbon at depth and the oxygenation of the deep waters in the subpolar north Atlantic. At the same time, the seasonal deepening of the mixed layer replenishes the surface waters with nutrients, which preconditions the phytoplankton productivity in the following summer. Thus, in the Labrador Sea, we expect to have a strong relation between the depth of mixing and the interannual variability of subsurface oxygen concentrations and biological pump. In Baffin Bay, however, little is known about how the deep waters are ventilated and the magnitude or relative importance of the biological pump. The winter sea ice cover in Baffin Bay acts as a barrier for the exchange of gas between atmosphere and ocean, and prevents a deep convection. Therefore processes controlling fluctuations in subsurface oxygen and biological pump are expected to be

different from those governing the variability in the Labrador Sea. We first asses model biases simulating chlorophyll, nutrient, and sea ice using available observations from the World Ocean Database, and satellite remote sensing. Using multiple regression analysis we then determine the role of sea ice concentration, sea ice thickness, mixed layer depth, and spring nutrient concentration on the interannual and decadal variability of ventilation and biological pump in each basin.

Session 120100 - POSTER SESSION - PART 1

Analysing local deformations on a PPP-continental velocity model for the establishment of reference stations

Cavalheri, Emerson Santos, Marcelo Chaves, Joao
University of New Brunswick
e.cavalheri@unb.ca

Geodetic applications in the area of crustal or plate monitoring make use of reference stations to determine the current state and, over time, the movement of these bodies. These reference stations usually are chosen depending on the history of collection and its site of monumentation. For precise applications relying on these choices may not be a good option since the station may be in a dynamic area, in other words its site may be moving due to local deformations. When coordinate time series are analysed, it is possible to realize a tendency or systematic effect caused by the continental movement. To consider only local deformations these continental deformations should be removed from the time series. Therefore, a plate or velocity model of the station is required to take this effect into account. This work will present a methodology for detecting systematic errors based on a mathematical model which considers only local deformation of points on the surface of the Earth. To evaluate this model post-adjustment analysis is carried out using a statistical and geometrical technique, called Robustness Analysis. This technique identifies deformations caused by small systematic or gross errors in the observations that can interfere the parameter estimation in networks models. This study proposes a procedure that will enable the detection of systematic and gross errors in the model resulting in a tool for classification and establishment of reference networks. A case study was performed using a precise point positioning and a model to represent the continental effects of a set of continuously operating GNSS stations. The results suggest the possibility to detect errors that would not be detectable under a common statistical analysis.

Session 120100 - POSTER SESSION - PART 1

ASSESSING LIGHTNING HAZARD BY INTEGRATED SURFACE PROPERTIES AND ACTUAL CLOUD TO GROUND (CG) LIGHTNING DATA WITH ASSOCIATION RULE

Cha, Donghwan Baek, Jin Xin, Wang Kim, JeongWoo
University of Calgary
donghwan.cha@ucalgary.ca

In Canada, fire season runs from late April through August with most of the area burnt occurring in June and July primarily due to the lightning fire activity. According to the Canadian forest fire

database, more than 70% of fires were caused by lightning strikes, resulting in about 85% of the burnt area, mostly in the northern Canada where the population is sparse. It has been also reported that about 9 to 10 deaths and 92 to 164 injuries were attributable to the lightning strikes each year in Canada. In addition, the lightning-induced fire often causes damages to the properties, forestry, power generation, agriculture, transportation infrastructure and telecommunications. Therefore, assessing lightning hazard by analysing locations of lightning-induced fire is very important for development plans, such as constructing infrastructures and residential area. The lightning strike potentials based on the physical surface properties and actual cloud to ground (CG) lightning record will be utilized in conjunction with the Data Mining method (Association rule mining) for finding a specific lightning hazard patterns or trends through Alberta province. Our studies could help better understanding of lightning patterns on the ground so that we could utilize those patterns to prevent hazards from lightning strikes. The lightning strike potentials based on the physical surface properties and actual cloud to ground (CG) lightning record will be utilized in conjunction with the Data Mining method (Association rule mining) to present the combinations of frequent itemsets and its supports. This allows determination of the association rules highlighting the general trends. Item factors extracted from satellite measurement data (Aster Global digital elevation model, surface slope), land use data, soil type data and cloud to ground (CG) lightning data are different variables for finding a specific lightning hazard pattern or trend on a site.

Session 120100 - POSTER SESSION - PART 1

Automatic Detection of Cyclonic and Anticyclonic Features from a Dense Wind Forcing Dataset

Chan, Ting On Myers, Paul G.
Department of Earth & Atmospheric Sciences, University of Alberta
ting.chan@ualberta.ca

High-resolution wind forcing datasets are essential as input to ocean numerical modelling. They are also important for model output analysis related to atmosphere-ocean interaction. Such analysis can be facilitated if temporal and spatial information of cyclonic and anticyclonic circulations are automatically and accurately extracted from wind forcing datasets. An automatic detection algorithm has been developed primarily based on analyzing the curl of the circulations using various image processing techniques such as the Shannon entropy estimation. Potential centres of the circulation are first identified by examining the gradients of the wind directions of the entire wind vector field. It is followed by a series of curl distribution analysis around those centre candidates. The method was applied to the daily 30-hour forecasted CGRF (CMC GDPS reforecasts) datasets produced by the Canadian Meteorological Centres global deterministic prediction system. The detection results obtained from the hourly varying CGRF wind vector fields over the western North Atlantic Ocean for some randomly selected dates during the winters of 2007 - 2010 were verified against corresponding manual selection. A circulation recognition rate of over 80% is achieved.

Session 120100 - POSTER SESSION - PART 1

Signals of forest cover effect on flow regime across the Appalachians using simulated soil moisture and evapotranspiration

Chouaib, Wafa Alila, Younes
PhD candidate
chouaiebwafa@gmail.com

An observational study the objective of which is to investigate the interplay between evapotranspiration (ET), soil moisture (SM) and the flow regime in an attempt to tease out possible signals of forest cover effects on flow regime across the Appalachians. Long term measured streamflows and model simulated SM and ET, revealed that favorable energy conditions for a predominantly coniferous cover helped to smooth the flow response year around. Forested catchments of steep slopes and high elevations (18%-34% and 1000 -1900 m respectively) in Center Appalachian, showed lower ET rates, higher extreme and mean monthly flows than flat agricultural catchments (20 % - 30 % Agriculture). The extreme flow response was exponential for forested catchments of fine soil structure (high HGC 90% -70%). The potential ET was decreasing with the elevation. However, when the soil disturbance is high (50% agriculture) and the catchments have equal SM rates, the forested catchment (10 % coniforous) yet it is energy limited sustained higher ET in winter, early spring and late fall that kept smaller response all over the year. In North Appalachian, a flat topography (5% slope) of forested catchment allowed for higher potential and actual ET along with equal seasonal distribution of storm intensity resulted in smaller flow response. The catchments flow elasticity to ET and SM was proportional to forest distribution. The SM storage capacity and deficit were smaller for forested catchments of steep slopes and high elevations. The flow variability assessed from the flow duration curves was higher for the least forested catchments and for those with steep slope and small SM deficit. Overall, forested catchments flow response is conditioned by the compound effect of climate, topography, soil characteristics and energy conditions that deemed to be correlated with elevation. Each of those factors intervene in the process of soil moisture storage opportunity and cumulative ET effect on flow response. .

Session 120100 - POSTER SESSION - PART 1

The Warm Northeast Pacific Anomaly: Atmospheric Forcing - Ocean Response

Dewey, Richard Ross, Tetjana
Ocean Networks Canada
rdewey@uvic.ca

In 2013 there were major shifts starting to develop in the northeast Pacific atmosphere-ocean system. By late 2013, the Aleutian Low had diminished and a ridge of high pressure had developed over western North America. The Jet Stream had also shifted and developed into a large meandering mode that would be a reoccurring feature of the winters of both 2013-14 and 2014-15. Weather throughout the entire western North America and much of the central continent felt the effects. The northeast Pacific Ocean responded in several dramatic ways. Reduced winter storms and Ekman transport across the Gulf of Alaska resulted in a lack of heat transport and deep water mixing, which usually cools the surface waters and replenishes vital nutrients from below. By January 2014, the surface temperatures in the entire Gulf of Alaska were more than 3 degrees warmer than usual, and when plotted as the sea surface temperature

anomaly field, revealed itself to be a massive blob of warm water. The Blob, as coined by Nick Bond (University of Washington), has persisted for over two years and has had dramatic influence on the marine environment. A review of the governing dynamics, measured patterns, and consequences of the extraordinary atmosphere-ocean conditions will be presented.

Session 120100 - POSTER SESSION - PART 1

Climate change in Paraná, Brazil: more humid and dry conditions in Panapanema River basin.

ELY, DEISE
Universidade Estadual de Londrina
deise.ely@gmail.com

This paper analyses the evolution of total annual rainfall at the south of Paranapanema River hydrographic basin, located in the state of Paraná, Brazil, trying to identify possible climate changes in a regional scale. The analyses is based on the chronological graphic method of information processing - MGCTI - of Bertin Matrix type (NOUACEUR; LAIGNEL; TURKI, 2014). The research verifies an extreme variability of precipitations on regional scale, showing existence of both drought and humid periods. The research observed very well defined trends: an humid period between 1980 and 1998, in which annual precipitations shows an increasing trend. During this period, most of index are positive, and above +1 in 6 years; A drought period is also observed during 1999 and 2008, in which for all years index are negatives, and below -1 for at least 2 years (1999 and 2006). A third period shows a change in the decreasing trend of precipitations of the previous period, once it was observed index above +1, and a pluviometric surplus was observed during 2009 and 2013. The analyses of these periods indicates a correlation with El Niño Southern Oscillation (ENSO). During positive ENSO phase humid years are more frequent, and during negative ENSO phase more dry years are observed.

Session 120100 - POSTER SESSION - PART 1

Applying physical modelling to engineering challenges: hazards on fans

Eaton, Brett MacKenzie, Lucy
Geography, The University of British Columbia
brett.eaton@ubc.ca

Infrastructure on fans is at risk to damage from a range of geomorphic processes. While the hazards associated with depositional events like debris flows and debris floods are widely recognized, floods with lower sediment concentrations can produce significant channel scour and lateral migration, posing significant hazards to infrastructure buried beneath the stream, such as telecommunication lines, pipelines and municipal sewers. A series of experiments using a 1:30 scale model of a gravel-cobble fan channel were conducted to assess the magnitude and distribution of scour during floods with return periods up to about 100 years. A Monte Carlo simulation approach was used to translate the observed geomorphic changes into exposure probabilities for infrastructure buried beneath the stream. The simulation results were used to develop recommended minimum depths of cover above the buried infrastructure and minimum

lateral setbacks of the infrastructure from the channel banks for a design flood twice the formative flow.

Session 120100 - POSTER SESSION - PART 1

New Brunswick hydrometric network analysis and rationalization

El-Jabi, Nassir Caissie, Daniel Boisvert, Jasmin Turkkan, Noyan
Université de Moncton
nassir.el-jabi@umoncton.ca

The availability and quality of hydrometric data is of great importance to the management of water resources, as well as the prediction of flood and drought events. The spatial distribution and density of hydrometric gauging stations are important for precision when estimating design flows, both for gauged and ungauged locations. The lengths of records are also important. Many examples can be found in scientific literature that show that an overly dense (redundant) network as well as an under developed (sparse) network can cause inaccurate simulations of hydrological phenomena. The objective of this study is to propose a methodology for the rationalization of the New Brunswick Hydrometric Network. A Hierarchical Clustering was first used to divide the province into two sections (North and South) based on latitude and high flow timing. After which a Principal Component Analysis was used in an attempt to identify important hydrological attributes that explain a significant amount of the variance found in flows, but was ultimately deemed inconclusive. Instead, the GEV shape parameter, fitted to the annual maximum flow series of each gauging station, was used to split each group into three homogenous subgroups, based on each stations value of the GEV shape parameter. Lastly, an Entropy method was used to rank the importance of each station in their group (North or South), by computing the amount of information that is shared between stations. A station with a lot of shared information is redundant, and therefore less important, whereas a station with very little to no shared information is unique, and thus very important. The ranking of stations by importance can be a useful decisional tool when deciding which stations can be discontinued or displaced, particularly in a budget reduction scenario

Session 120100 - POSTER SESSION - PART 1

Harmonic downward continuation of scattered point gravity anomalies to mean anomalies on a mesh on the geoid

Foroughi, Ismael Vaní?ek, Petr Novák, Pavel William Kingdon, Robert Goli, Mehdi Sheng, Michael Santos, Marcelo
Department of Geodesy and Geomatics, University of New Brunswick, Fredericton, Canada
i.foroughi@unb.ca

Harmonic downward continuation (DC) of ground gravity anomalies to produce input values required in the geodetic boundary-value problem, is perhaps the most challenging step in geoid determination. An inverse of discretized Poissons integral has typically been used to continue point Helmerts gravity anomalies from the surface of the Earth down to their mean values on a regular coordinate mesh on the geoid. The matrix of a system of linear equations, resulting from

discretized Poissons integral, is badly numerically conditioned if either the discretization step on the geoid is too small or the surface points have high elevations. The numerical conditionality of the problem is measured by the condition number of the matrix of the resulting linear equations. Different discretization and rastering techniques, such as mean to mean or point to point, as well as different iterative processes for inverting the Poisson matrix have been applied to improve conditionality of the problem. A point to mean transform has been more of interest as such a set up would be the most physically meaningful of all possible options. Inherently, the DC is a high pass filtering technique, yet, we should be really interested in the mean gravity values on the geoid. In the ideal case the DC of scattered observations at the Earth surface should be combined with the prediction process, whereby the resulting downward continued values would be produced on a regular coordinate mesh, ready for numerical integration. It is the purpose of this study, to discuss the combination of the DC with the prediction on a regular mesh on the geoid. We wish to transfer the scattered points from topography down to mean points on a raster on the geoid, to deteriorate the frequency information contained in the observation data as little as possible.The least-squares technique (LST) was tested for continuing scattered Helmerts gravity anomalies in the Auvergne area down to 1*1 arc-min mesh on the geoid. Results show that due the poor conditionality of the 3-D matrix of normal equations, the desired accuracy cannot be obtained without some regularization. For evaluation of this approach, EGM2008 up to full degree/order of 2190 was used to generate both synthetic scattered gravity anomalies on topography and mesh mean gravity anomalies on the geoid. Numerical results of the evaluation will be provided.

Session 120100 - POSTER SESSION - PART 1

Micro-scale characterization of peat hydraulic properties using pore network modeling and X-ray computed tomography

Gharedaghloo, Behrad Rezanezhad, Fereidoun Price, Jonathan
Ph.D. candidate, University of Waterloo
bghareda@uwaterloo.ca

Peat soils have complex pore structures that contain open, dead-end pores and pores that are closed or partially closed. This unique physical property influences the hydraulic properties (i.e., flow and transport) in peat. In peat soils, the advective flux occurs through the hydrologically-active fraction of the total porosity (e.g., open and connected pores). Despite widespread interest in micro-pore scale modeling of fluid flow in different type of porous media, there are no studies on pore scale modeling of organic soils such as peat. In this study, we extracted the pore network structure using the pore space geometry information obtained from 3D X-ray computed tomography images of peat soil. The extracted pore network information was used to simulate the saturated and unsaturated hydraulic conductivity properties using POREFLOW, a pore-network modeling tool. The peat pore-throat radius size and frequency distribution in the depth profile were calculated. Horizontal and vertical hydraulic conductivity of peat were calculated, and the anisotropy ratio was obtained. Furthermore, the measured water-air contact angle of peat soil was used as an input in the pore network simulations to obtain the peat hydraulic conductivity and water retention characteristics. The model simulations agreed well with measured hydraulic conductivity, which indicates that our micro-scale pore characterization of

the peat using pore network modeling is realistic. This study suggests that hydraulic conductivity of peat soils is essentially controlled by its pore size distribution and network structure.

Session 120100 - POSTER SESSION - PART 1

The effect of aerosol acidity on secondary organic aerosol formation in two plumes observed from an airborne measurement campaign over the Athabasca oil sands region

Han, Yuemei Liggio, John Li, Shao-Meng Akingunola, Ayodeji Makar, Paul A. Stroud, Craig A.
Air Quality Research Division, Science and Technology Directorate, Environment and Climate Change Canada, Toronto, Canada
yuemeihan@hotmail.com

Oxidation of anthropogenic emissions such as SO2 and NOx contributes to the formation of acidic aerosols in the atmosphere. The role of aerosol acidity in promoting secondary organic aerosol (SOA) formation in the ambient atmosphere remains unclear, because few studies have provided evidence of acid-catalyzed SOA formation from field measurements and the existing results tend to be inconsistent. In this study, the effect of aerosol acidity on SOA formation was investigated using data from an airborne measurement campaign over the Athabasca oil sands region of Alberta, Canada in the summer of 2013. An organic rich plume and an SO2 rich plume were observed during the measurement period, with the chemical composition of VOC precursors nearly identical in the two plumes but more VOCs in organic rich plume. The molar ratios of NH4/SO4 (a proxy of particle acidity) in the SO2 and organic plumes were 1.18-1.21 and 1.36-1.45, respectively; the lower ratio in the SO2 plume suggests that aerosols were more acidic than those in the organic plume. Aerosol acidity correlated positively with a freshly formed oxygenated organic aerosol component, suggesting acidic conditions can facilitate SOA formation. In addition, the SOA production rate in the SO2 plume was slightly higher than that in the organic plume, despite much lower VOC precursor concentrations compared to the VOC rich plume. The relative signal intensities in the high mass range of the organic aerosol mass spectra for organic and SO2 plumes were higher than those in the background airmass, indicating that oligomers were possibly formed via acid-catalyzed reactions. On average approximately 57 ± 17% of the measured OA was predicted by the GEM-MACH model, with slightly better model performance for the airmass with less acidic aerosols, indicating the potential importance of incorporating an acidity effect in air quality models.

Session 120100 - POSTER SESSION - PART 1

Water storage dynamics in geographically isolated wetlands in the Prairie Pothole Region

Haque, Md Aminul Ali, Genevieve Ross, Cody Schmall, Adrienne Bansah, Sam
Department of Geological Sciences, University of Manitoba; Watershed Systems Research Program, University of Manitoba; Center for Earth Observation Science, University of Manitoba
haquema@myumanitoba.ca

The loss or alteration of the pothole wetlands, often called geographically isolated wetlands (GIWs), has significantly affected the overall watershed-level hydrologic responses in the Prairie

Pothole Region (PPR). Although the literature does discuss the role of GIWs in determining overall watershed hydrologic behavior, very little is known about the water storage dynamics prevailing in individual Prairie potholes and the landscape and climatic drivers that influence those dynamics. The water storage capacity of GIWs in the PPR is the key element that controls their function of reducing flood intensity. Hence, to understand water storage and discharge dynamics further in GIWs, 10 intact, 3 consolidated and 7 drained potholes were selected for study in Broughtons Creek Watershed (Manitoba, Canada) on both sides of a 5 km creek reach. Capacitance water level loggers were placed in intact and consolidated wetlands to monitor surface water level fluctuations while perched water table wells were drilled below the drainage ditches associated with drained potholes to a depth of 1m to monitor shallow groundwater fluctuations every 15 minutes in 2013 and 2014. Initial data analysis shows a considerable variation of wetlands water storage characteristics in all types of wetlands between 2013 and 2014. In 2014, all wetlands had higher water level and less dry periods compared to 2013. Spilling of water from one site to another was common for most of the sites in 2014 whereas there was no spilling in 2013. Seasonal and spatial variations in water level and spilling episodes were also observed, indicating climatic and topographic control on wetland hydrology. Future analysis will be carried out to understand the influence of wetland characteristics (e.g., wetland surface area, contributing area, and volume) and alteration status (e.g., intact, consolidated, fully drained) on wetland water storage dynamics.

Session 120100 - POSTER SESSION - PART 1

Evaluating NARR Precipitation Estimates Using a Spatially Distributed Water Balance Model

Hunter, Cameron Moore, Dan McKendry, Ian
University of British Columbia
cameron.hunter@geog.ubc.ca

Obtaining reliable precipitation estimates over mountainous regions is a challenge due to the typically sparse network of climate stations, especially at higher elevations. The objective of this study was to evaluate the accuracy of the North American Regional Reanalysis (NARR) gridded precipitation fields over British Columbia, Canada, a geographically diverse region with marked spatial variability in precipitation. The NARR precipitation fields were spatially integrated within 52 basins across BC that are gauged by Water Survey of Canada (WSC), selected to have natural flow regimes and minimal glacier coverage, the latter criterion to minimize influences of changes in water storage. Apparent evapotranspiration was calculated by subtracting WSC streamflow from the integrated NARR precipitation for each basin and water year. Small basins (< 750 km2) located in the Coast Mountains were associated with large negative apparent ET, indicating that NARR severely underestimated precipitation in these areas. Relatively small positive ET values were observed in the larger basins located in the Interior, suggesting a more accurate representation of actual precipitation patterns. Examination of the topographic data for the NARR grid points revealed a large amount of smoothing compared to higher-resolution digital elevation models, which was most apparent in the Coast Mountains. This topographic smoothing is likely the cause of the underestimation of catchment-mean precipitation by NARR. To complement the catchment-scale analysis, seasonal and interannual variation of observed

precipitation at selected weather stations was compared to NARR precipitation at the nearest grid point.

Session 120100 - POSTER SESSION - PART 1

Mesosphere Wind and Airglow Irradiance Observations in Eureka, Nu

Kristoffersen, Samuel Ward, William Meek, Chris Manson, Alan
Department of Physics, University of New Brunswick
y6qk7@unb.ca

The E-Region Wind Interferometer (ERWIN-II) is a Michelson interferometer that measures airglow (green line, O2, and OH) and winds in the mesosphere (~90 km) region of the atmosphere. It is located at the Polar Environment Atmospheric Research Laboratory (PEARL) in Eureka, Nu (80N 86W). As the ERWIN has a high temporal cadence (~3 min) for all three atmospheric emissions, atmospheric waves of both low (e.g. tides) and high (e.g. gravity waves) frequency are observed and characterized. Comparisons with the SkiYMET VHF Meteor Radar, which is co-located at PEARL, provides validation of wind measurements, in addition to information about the airglow layer height and shape.

Session 120100 - POSTER SESSION - PART 1

Evaluating retrievals of soil moisture from C-Band SAR to changes in vegetation throughout a growing season

MacDougall, Josh Ueckermann, Elené   Rowlandson, Tracy Berg, Aaron
University of Guelph
aberg@uoguelph.ca

Soil moisture estimates can have a significant role in monitoring and predicting extreme events such as floods and droughts. Ground-based observations are useful but typically lack the spatial distribution necessary for many applications. Numerous studies have demonstrated relationships of C-Band SAR for retrieval of soil moisture based on backscatter intensity at different polarizations. At C-Band, the retrieval of soil moisture is highly impacted by vegetation growth throughout the growing season, therefore limiting its applications. To understand the applicability of soil moisture retrievals during the growing season it is useful to demonstrate the accuracy of soil moisture estimates relative to vegetation parameters. In this study the leaf area index, vegetation water content and crop height were monitored over several agricultural fields during the 2015-growing season. In addition to the vegetation measurements, soil moisture was monitored using an in-situ network across the same fields. The RADARSAT-2 toolbox was used to process several RADARASAT-2 acquisitions obtained during the 2015 growing season to derive a soil moisture estimate at the field scale; these estimates were compared to the network sites. The estimated soil moisture product from RADARSAT-2 did not show a discernible relationship with the observed soil moisture. However, many of the RADARSAT-2 acquisitions occurred after significant canopy development, where it has been well documented that retrieval errors increase. To assess sensitivity of RADAR backscatter to vegetation growth, HV, HH, VV backscatter was compared to the vegetation parameters obtained from each field. The strongest relationships between the vegetation parameters were observed with HV. However, saturation of the backscatter signal occurred at approximately 2.5 kg /m^2 VWC and 2.3 m^2m^-2 LAI. This highlights the need to establish a relationship between the backscatter and vegetation to determine when during the growing season RADARSAT-2 can be utilized for soil moisture retrieval

Session 120100 - POSTER SESSION - PART 1

Environmental tracer based analysis of groundwater and surface water interactions in the Jock watershed, Ontario, Canada

Michel, Cassandra Richardson, Murray
Carleton University
cassandra.a.michel@gmail.com

There has been an increasing interest in hydrologic research to determine methods for understanding groundwater-surface water interactions at spatial scales relevant to water resource management. The use of stable water isotopes (SWI) and geochemical parameters with end-member mixing analysis (EMMA) provides the ability to analyze these processes at convergent scales. Synoptic surveys of headwater streams were conducted in the Jock sub-watershed located within the City of Ottawa. This region is used as a case study to examine the variability in groundwater-surface water interactions across a spatially and temporally geologically complex, heterogeneous landscape with a combination of natural and anthropogenic land cover types. The ability to employ SWI and geochemical parameters in EMMA is examined using samples collected from spring and summer headwater synoptic surveys as well as those collected bi-weekly from the main tributaries. The results are examined geospatially in combination with ancillary GIS datasets to determine features which have a dominant role in groundwater and surface water interactions within the sub-watershed. The results are also compared against baseflow discharge measurements conducted throughout the watershed. The aim is to determine a methodology that can be implemented by researchers and managers for rapid and cost effective characterization of groundwater-surface water interactions at the sub-watershed scale.

Session 120100 - POSTER SESSION - PART 1

Braiding Channel Pattern Dynamics in a Proglacial River

Middleton, Lara Ashmore, Peter Leduc, Pauline
University of Western Ontario
lmiddle7@uwo.ca

The planform geometry of braided rivers is determined by the morphology of the multiple unstable channels and ephemeral bars within the river bed. Previous research has found that morphological changes occur rapidly during high flow periods when increased rates of bedload transport occur indicating a channel forming flow at which morphological development of the channel is seen. We expect that the rate of bedload transport and the critical discharge needed for morphological change is linked to the planform development of the river, but this relationship is unknown. Channel planform change in relation to discharge was analyzed during summer melt-water periods from June to October in 2012 and 2013 from the Sunwapta River, a proglacial gravel-bed river. Extended high flow periods during the melt-water season guaranteed

morphological change while the daily variation allowed us to see variations in rates of planform change over the full range of discharges. Oblique time lapse images were taken at an interval of 30 minutes and then were rectified to vertical view for measurement. Planform change was measured as the proportion of a fixed area of the river bed which underwent detectable planform change during the daily meltwater hydrograph on successive days. These observations of continuous planform changes over long periods and at high frequency made it possible to establish the discharge conditions under which planform change occurred and the correlation between planform change and discharge. A critical discharge was found below which no planform change occurred. Above the critical discharge of 11 m3s-1 area of daily planform change increased at higher discharges but with considerable variation related to the contingencies of flow sequences and intrinsic variability in braiding processes. The next step in this research is to tie rates and styles of planform change to known rates of bedload transport using a Froude-scale physical model.

Session 120100 - POSTER SESSION - PART 1

Estimating Boreal Fire-generated Ozone over Canada using Ozonesonde Profiles and a Differential Back Trajectory Technique

Moeini, Omid Tarasick, David   McElroy, Tom Liu, Jane Osman, Mohammed
York University, Department of Earth and Space Science and Engineering, Toronto, ON, Canada
omidmns@yorku.ca

Tropospheric ozone (O_3) is an important short-lived climate pollutant, in addition to its well-known effects on crop production and human respiratory health. Wildfires generate large amounts of O_3 photochemical precursors. The frequency and intensity of boreal forest fires is likely to increase over Canada and the US as a result of climate change. A number of studies suggest that boreal fires can contribute to exceedances of the O_3 air quality threshold concentrations via production and long-range transport of O_3 and its precursors. However, different approaches and datasets used to study ozone production from boreal fires appear to give conflicting results. While dozens of studies suggest some degree of ozone production by wildfires, a number of observations, mainly in boreal regions, show that O_3 is minimally enhanced or even depleted downwind of some biomass burning plumes. In this study, a Differential Back Trajectory (DBT) method was developed, employing HYSPLIT back-trajectories and MODIS fire data to calculate the average difference between ozone concentrations associated with fire-affected and fire-unaffected parcels at 19 ozone sounding sites in North America. The DBT method was applied to more than 900 ozonesonde profiles collected from these sites during campaigns from June to August 2006, 2008, 2010 and 2011. The ozone enhancement for stations nearer large fires such as Trinidad Head, Bratts Lake, Kelowna and Stony Plain was up to 1.9±0.5% of the TTOC (Total Tropospheric Ozone Column). Fire ozone accounted for up to 3.9±1.3% of TTOC at downwind sites such as Yarmouth, Narragansett, and Walsingham. On average, fire ozone accounted for 1.1±0.7% of the TTOC at sites nearer large fire activity, while a 2.5±0.7% ozone enhancement was detected at sites further downwind. The results are consistent with other studies that have reported an increase in O_3 production with the age of the smoke plume.

Session 120100 - POSTER SESSION - PART 1

The July 2015 wildfire smoke event of south coastal British Columbia: evolution and air quality impacts for the Lower Fraser Valley

Nissen, Robert Ainslie, Bruce Brugman, Melinda M. Vingarzan, Roxanne
Environment Canada, Meteorological Services of Canada, Prediction and Operations West, Vancouver, BC
robert.nissen@canada.ca

Throughout much of southern British Columbia extremely low snow packs in the winter of 2014-15 and a very dry spring provided highly favorable conditions for an early start to an active summer wildfire season. By early July significant wildfires were burning in the mountainous backcountry near Pemberton north of Whistler. During the overnight hours of July 4-5, a strong and gusty outflow front caused an explosive flare-up of the Boulder Creek Wildfire complex including the Elaho Valley wildfire. The resultant plume extended above the mountaintops. Northeasterly winds aloft rapidly transported thick smoke across the Strait of Georgia and even beyond the west coast of Vancouver Island, where wildfire smoke plumes are a very rare occurrence. At low levels, smoke followed the Elaho Valley and Howe Sound to the Strait of Georgia. During the daylight hours, developing marine inflow winds transported smoke across the heavily populated greater Vancouver area. Some monitoring stations reported PM2.5 concentrations unequaled in the observation history. On the afternoon of July 5 the championship match of the FIFA Womens World Cup soccer final was held in downtown Vancouver, garnering higher than usual media attention to this extraordinary smoke event.This presentation will examine the meteorological factors involved in this event including the 3-dimensional wind fields and vertical stability. High resolution meteorological models are employed to diagnose the pathways for smoke transport from the wildfires ultimately to the many impacted receptors in the Lower Fraser Valley. Various observation tools including satellite, LIDAR, wind profiler, weather radar imagery, webcams, and air quality monitors are used to track and verify the magnitude and extent of this event. Implications of the events predictability will be discussed.

Session 120100 - POSTER SESSION - PART 1

Validation of a high resolution model in Vancouver Harbour

OFlaherty-Sproul, Mitchell Wu, Yongsheng Wang, Zeliang Boom, Bodo de Lange
Bedford Institute of Oceanography
Mitchell.OFlaherty-Sproul@dfo-mpo.gc.ca

Fisheries and Oceans Canada is developing a national network of operational systems based on state-of-the-art hydrographic data, prediction, and forecast methods. The system will provide timely information and warning to marine traffic navigating in and around selected ports. The aim is to mitigate the risks associated with existing and changing hydrographic conditions. A hydrodynamic model using FVCOM in Vancouver Harbour is presented in this poster. The modelled region contains narrows and complex coastal structures. These features significantly increase the difficulty of accurately modelling the area. The spatial resolution of the model ranges from tens meters in the narrows to 2.5 km in Strait of Georgia. In this poster, the model is compared to available observations and hydrodynamic feature of the region are discussed.

Session 120100 - POSTER SESSION - PART 1

Toward an operational biogeochemical model for the Strait of Georgia and Salish Sea

Olson, Elise Allen, Susan Moore-Maley, Ben Soontiens, Nancy Latornell, Doug
UBC
eolson@eos.ubc.ca

The Strait of Georgia, located between Vancouver Island and mainland British Columbia, is a 28 km wide fjord-like estuary that is home to a vibrant marine ecosystem. An NPZD-type model for the region was developed based on available biomass time series. Data showed that after diatoms, the mixotroph, Myrionecta rubra was the next most abundant primary producer by biomass. Therefore, in addition to diatoms, M. rubra and its cryptophyte prey are represented as functional groups in the model. This model has now been extended to three dimensions through coupling with a NEMO-based physical model of the Salish Sea. We will discuss challenges and successes in the extension of the biological model to three dimensions and the outlook for production of daily operational predictions of biological and chemical fields. In addition, we will present preliminary findings on the spatial variability and controls of primary productivity in the Salish Sea, including a model-based analysis of the impacts of river outflow, wind and tidal mixing, and exchange with continental shelf waters.

Session 120100 - POSTER SESSION - PART 1

High-resolution modeling of the Northeast Pacific based on NEMO

Paquin, Jean-Philippe Lu, Youyu Li, Jiaxing Lei, Ji Dyck, Sarah Hannah, Charles
Bedford Institute of Oceanography, DFO
paquin.jeanphilippe@gmail.com

Hindcast simulations for the Northeast Pacific Ocean in 2014 are carried out using the ocean forecasting model based on the Nucleus for European Modelling of the Ocean (NEMO), developed for the World Class Tanker Safety System. The model has a nominal horizontal resolution at 1/36th degree in longitude/latitude. It includes tides, and is forced at surface by a blending of the high frequency output of Environment Canadas numerical weather forecasting models at 2.5 km and 10 km horizontal resolutions. Spectral analysis show that the model resolves small-scale variations of ocean currents and T-S gradients. The model results are compared with observations at tidal gauges, and from ship-board, moorings, and satellite remote sensing.

Session 120100 - POSTER SESSION - PART 1

Using WRF to improve roadway safety: Forecasting roadway ice in Edmonton

Pennelly, Clark Reuter, Gerhard Tjandra, Stevanus
University of Alberta
pennelly@ualberta.ca

The City of Edmontons Office of Traffic Safety currently uses a numerical weather prediction model to forecast the occurrence of ice on roadways. Roadway ice, commonly called black ice, poses a significant danger to roadway users due to low friction values and difficult detection. The City of Edmonton plans to use an operational numerical weather prediction model to predict, and then, alert the citizens of Edmonton to hazardous roadway conditions, to prevent fatalities, injuries or property damage due to traffic collisions. We run the Weather Research and Forecasting model 4 times per day, producing forecasts which are 7 days in length. Each forecast contains three processes which can produce roadway ice: freezing rain, frost deposition, and thaw/freeze cycling. We present the method of ice prediction as well as some case studies which contained ice events. Furthermore, we evaluated the risk of roadway ice on traffic collisions based these cases, and put it into context with our previous findings regarding other forms of adverse weather.

Session 120100 - POSTER SESSION - PART 1

The Dominating Impact of Inertial Currents on Ocean Surface Waves over the Global Ocean

Perrie, Will Perrie, Will Hughes, Colin
Bedford Institute of Oceanography
perriew@dfo-mpo.gc.ca

Currents can significantly modulate surface waves: (i) the development of wind-generated waves, where the effective wind is relative to the surface current, (ii) wave propagation is dependent on the spatial variation of the currents, and (iii) Doppler shift. Regions with persistent strong tidal currents, such as the North Sea can have wave-height modulations up to 50%. In the open ocean, inertial currents can reach speeds of up to 0.5 m/s. Although ambient currents can change the amplitudes, directions, and frequencies of surface waves on all time scales, their interactions with waves have not been reported, except by Gemmrich and Garrett (2012, JPO), using records of surface wave heights (SWH) from buoy data. They show that wave heights can be modulated by up to 20% by local inertial currents. In this study, several high-resolution numerical experiments, using the global WAVEWATCHIII wave model, with and without the total inertial current (within 0.7~1.3f) and with no surface current inputs from a global ocean model, were conducted to explore the effects of surface inertial currents on the evolution of ocean surface waves. We find: (1) the surface currents significantly modulate the ocean surface waves, e.g. over the mid-latitude storm track region and Southern Ocean, causing up to 25% variation in SWH; (2) the inertial current dominates the impacts of the total surface currents on the ocean surface waves, with very similar spatial patterns, for the variation of the SWH field, caused by total currents; (3) the inertial currents also cause up to 25% variations in SWH, by as much as 1 meter over some selected regions. The present study indicates that to improve the surface wave simulations, it is necessary to include the surface current effects, especially for inertial currents over the storm track regions.

Session 120100 - POSTER SESSION - PART 1

Optimising resources to better serve the Canadian Armed Forces /// Vers loptimisation des ressources pour mieux servir les Forces armées canadiennes

Pul, Kara Ouellet, Erick

Services Ã laviation et Ã la dÃ©fense

kara.pul@canada.ca

In order to adjust to changing business realities and to better serve the Canadian Armed Forces, Aviation and Defence Services (ADS) has embarked on an initiative to rationalise, automate, standardise, and prioritise (RASP) operational products. The RASP initiative began by identifying and analysing different specialised products in order to determine the feasibility of their automation. One of the product that was identified as a potential candidate for automation is the Fire Weather Forecast. Over the course of the 2015 forest fire season (April to October), an automated program was developed and ran in parallel with the expert predictions by Joint Meteorological Centre (JMC) Meteorologists. A description of the two production methods will be presented as well as preliminary validation results. This presentation highlights one aspect of the RASP initiative and is inspired by the Meteorological Service of Canada transformation program and also aligned with the data centric approach promoted by the Canadian Force Weather and Oceanographic Service. /// Les Services météorologiques à la défense ont entrepris une initiative pour rationaliser, automatiser, standardiser et prioriser (RASP) le travail opérationnel afin doptimiser leur soutien aux Forces armées canadiennes. Cette initiative a débuté par une analyse des différents produits spécialisés et une étude de faisabilité de la production automatisée pour certains dentre eux. Parmi ceux-ci, la prévision des éléments du temps pour lindice Foret-Météo sest révélée être la plus simple pour la mise en place de linitiative. Pendant la saison des feux de forêt (avril-octobre) 2015, et parallèlement à la production expertisée par les météorologues, une production automatisée, basée sur la prévision numérique des éléments du temps a été développée comme première approche. Une description des méthodes de production ainsi quune validation préliminaire entre les 2 méthodes de production seront présentées. Cette présentation met en évidence un des aspects de linitiative RASP qui sinscrit dans la philosophie du programme de transformation du Service météorologique du Canada et de lapproche centrée sur les données choisie par le Service météorologique et océanographique des Forces canadiennes.

Session 120100 - POSTER SESSION - PART 1

What Constitutes a Good Sensitivity Analysis? Elements and Tools for a Robust Sensitivity Analysis with Reduced Computational Cost

Razavi, Saman Haghnegahdar, Amin Gupta, Hoshin Wheater, Howard

Global Institute for Water Security, University of Saskatchewan

saman.razavi@usask.ca

Global sensitivity analysis (GSA) is a systems theoretic approach to characterizing the overall (average) sensitivity of one or more model responses across the factor space, by attributing the variability of those responses to different controlling (but uncertain) factors (e.g., model parameters, forcings, and boundary and initial conditions). GSA can be very helpful to improve the credibility and utility of Earth and Environmental System Models (EESMs), as these models are continually growing in complexity and dimensionality with continuous advances in understanding and computing power. However, conventional approaches to GSA suffer from (1) an ambiguous characterization of sensitivity, and (2) poor computational efficiency, particularly as the problem dimension grows. Here, we identify several important sensitivity-related characteristics of response surfaces that must be considered when investigating and interpreting the global sensitivity of a model response (e.g., a metric of model performance) to its parameters/factors. Accordingly, we present a new and general sensitivity and uncertainty analysis framework, Variogram Analysis of Response Surfaces (VARS), based on an analogy to variogram analysis, that characterizes a comprehensive spectrum of information on sensitivity. We prove, theoretically, that Morris (derivative-based) and Sobol (variance-based) methods and their extensions are special cases of VARS, and that their SA indices are contained within the VARS framework. We also present a practical strategy for the application of VARS to real-world problems, called STAR-VARS, including a new sampling strategy, called star-based sampling. Our results across several case studies show the STAR-VARS approach to provide reliable and stable assessments of global sensitivity, while being at least 1-2 orders of magnitude more efficient than the benchmark Morris and Sobol approaches.

Session 120100 - POSTER SESSION - PART 1

Heights in the Great Lakes Region Developed from GNSS and a Gravity Field Model

Roman, Daniel Li, Xiaopeng
NOAAs National Geodetic Survey
dan.roman@noaa.gov

This paper focuses on the determining dynamic heights from reference field geopotential models and geodetic positions determined using GNSS technology. Only GPS data were used and all coordinates are in the IGS08 reference frame. GPS collection campaigns have been conducted on a periodic basis on the majority of the 53 Water Level Stations (WLS) maintained by NOAA on the U.S. side with similar efforts also made on the Canadian side by the Canadian Geodetic Survey (CGS) and NRCan. Twelve of the U.S. WLS are collocated with CORS stations. Three on Lake Superior and three on Lake Erie were selected for this study. Offsets from the GPS phase center to the Electric tape Gauge (ETG), and from the ETG to the water surface were determined. The geometric coordinates were transferred to the water surface and these values were used to estimate the geopotential value from the EGM2008, EIGEN6C4, and the xGEOID15B_Ref. The last model was developed using satellite, airborne and terrestrial gravity and serves as the reference field for development of the latest experimental gravimetric geoid model (xGEOID) that will eventually lead to the underlying physical height model in GRD 22. In particular, the aerogravity data derive from the Gravity for the Redefinition of the American vertical Datum (GRAVD) project, which is intended to refine the geopotential model between 4-200 km wavelengths. Comparison of orthometric heights (i.e., using geoid undulations) revealed trends from West to East across Lakes Superior and Erie of -0.06 m and +0.04 m, respectively. For Erie, that would indicate that Buffalo had a higher water level than Sandusky. Comparing dynamic heights in the same manner resulted in -0.03 m for Lake Erie and +0.01 m for Lake Superior. Both will be investigated further to refine these dynamic heights for a future Datum.

Session 120100 - POSTER SESSION - PART 1

Assessment of the relationship between near-surface soil moisture and runoff generation in a near-level Prairie watershed

Ross, Cody Ali, Genevieve Belanger, Jonathon Schmall, Adrienne Walker, Matthew Laing, Janelle
University of Manitoba
umross59@myumanitoba.ca

Runoff generation in the Canadian Prairies is dependent on flow pathways that are spatially and temporally variable. Flat terrain and soils with variable permeability make it especially difficult to assess the relative importance of surface and subsurface runoff in specific Prairie areas. One way to identify dominant runoff generation mechanisms is to focus on spatial patterns of hydrological state variables (e.g., near-surface soil moisture). Riparian zones are also appropriate areas for studying runoff generation due to their importance for water transmission and solute transport. The main objective of this study was therefore to determine whether riparian soil moisture patterns can help identify the controls on runoff generation in Prairie landscapes. Focus was on the near-level Catfish Creek Watershed (south-eastern Manitoba) that has a highly seasonal hydrological regime. Two naturally vegetated riparian sites were chosen: a grassland site and a headwater, wooded forest site. Twelve soil moisture surveys were completed at each site throughout 2015 using a 75-point grid: they were matched with water level data from adjacent drains and data on the average depth to the water table in the riparian areas. Several statistics were computed for each spatial pattern, e.g., min, max and mean soil moisture as well as omnidirectional and directional variogram ranges. Those statistics were then correlated to stream and subsurface water level data to establish the link between soil moisture and runoff generation. Preliminary results show significant relationships between pattern statistics and water levels, but also significant inter-site and seasonal variability. At the forested site, survey statistics are strongly correlated to subsurface water levels with moderate seasonal variability in correlation strength, while a strong relationship with stream water level at the grassland site exists regardless of season. Future analysis will include additional state variables and runoff generation indicators, including measures of antecedent moisture conditions.

Session 120100 - POSTER SESSION - PART 1

Validation of the Soil Moisture Active Passive (SMAP) Soil Moisture Retrieval in the Western Canadian Arctic

Rowlandson, Tracy Rowlandson, Tracy Berg, Aaron Marsh, Philip
University of Guelph
trowland@uoguelph.ca

Permafrost degradation in the Canadian Arctic is a primary indicator of the effects of variations in temperature and precipitation regimes associated with climate change in this region. Soil moisture is responsible for controlling the rate of permafrost thaw within the soil, and is a key variable to aid in our understanding of permafrost degradation. Consequently, establishing reliable methods to monitor active layer soil moisture is increasingly important. The Soil Moisture Active Passive (SMAP) mission has shown promise for use in agricultural mineral soils; however, investigation into the performance of this technology over porous organic peat found in the Arctic tundra is not well understood. The objective of this study is to evaluate the

current SMAP soil moisture retrieval algorithm in soils dominated by peat. Research was conducted at Trail Valley Creek, NWT, from June through August, 2015. Ten in situ soil moisture monitoring sites were installed within a 36x36km SMAP radiometer pixel. Stevens Hydra Probe soil moisture sensors were installed at each in situ station measuring soil moisture, temperature and dielectric permittivity at 5 cm and 20 cm depths. Additionally, measurements of vegetation water content and frost table depth were collected throughout the campaign to assess potential influences of variability in these measurements on SMAP retrieval accuracy. Results indicate a dry bias of the SMAP soil moisture product, which has been noted by many monitoring sites, globally. The RMSE between the SMAP soil moisture and the network derived soil moisture is >0.08 m3m-3, with virtually no correlation. Further investigation is required into improving the SMAP soil moisture retrieval algorithm for successful application in Arctic regions.

Session 120100 - POSTER SESSION - PART 1

Formulating a rigorous satellite based gravitational model

Sheng, Michael Vanicek, Petr Foroughi, Ismael
University of New Brunswick
michaelsheng1@gmail.com

This paper provides a formulation of a gravitational model that accounts for topographical density above the geoid using the ESA-produced Release 5 gravitational models based on GRACE, GOCE, and Lageos observations. Due to the limited spectral content of the observations, the resulting model is truncated to degree and order 250, sufficient for providing a satellite-only reference field for computing regional high-precision geoids. The spherical harmonic coefficients are evaluated on the Brillouin sphere, a sphere of the smallest radius R encapsulating all the masses of the Earth. For various applications, we need to know the potential field on the geoid; this complicates matters as the field cannot be simply continued downward to the geoid, topographical masses located in that space make it non-harmonic yet we can only downward continue the field in a harmonic space. By making use of Helmerts second condensation method, it is possible to, more or less rigorously, account for the effects of topographical masses and make the space harmonic. The difference between the topographical and the condensed topographical potentials - the direct topographical effect (DTE) - is expressed in spectral form derived by Vanicek et al. (1996). Its addition transforms the gravity potential from the real to Helmerts space. Once we get Helmerts gravity potential, the normal potential GRS80 is subtracted from it to get Helmerts disturbing potential. This potential is then downward continued simply by using the spherical harmonic series. There is a problem with this approach however: the series below the Brillouin sphere appears to be divergent because the radial functions R/r are everywhere larger than 1 and the sequence of radial functions (R/r)n grows beyond all limits with growing n. We thus make the following assumption: the series does in fact converge for all r above the geoid because the Helmert disturbing potential coefficient sequence converges to 0 with increasing n faster than the sequence (R/r)n diverges. It seems to be clear that this condition must be always satisfied as gravity above the geoid has been always observed to be finite; a formal proof will be presented later on.Helmerts disturbing potential on the geoid will be used to get the Helmert co-geoid (the geoid in Helmert space). It will be also transformed back into real potential harmonic coefficients. The Helmert co-geoid will be

transformed to the real space by accounting for the difference between topographical and the condensation layers effects. Numerical values of the real potential coefficients will be compared to EGM2008, GGM05G, and SPW-r4; the resulting geoid will be compared to GPS-levelling benchmarks over North America and central Europe after estimating the omission error.

Session 120100 - POSTER SESSION - PART 1

Terrain modelling of snow accumulation near Iqaluit, Nunavut

Smith, Keegan Richardson, Murray
Carleton University
keegan.smith@carleton.ca

Snow is the dominant input to Arctic hydrologic systems, making snowmelt the most significant hydrologic event of the year. Accurate estimation of snow accumulation is important for predicting surface water availability, but estimation is challenged by the complexity of winter wind-redistribution of snow. This research aims to identify relationships between end-of-winter (EOW) snow distribution and terrain for the Apex River watershed (ARW) near Iqaluit, Nunavut. Digital terrain modeling shows promise for modeling on southern Baffin Island, where rugged terrain and lack of intercepting vegetation enhance the wind effect. Systematic field surveys conducted in the spring of 2015 were used to determine the EOW snow distribution for the ARW at a broad scale (n=88) and at a finer scale in a lake sub-watershed (n=190). Terrain analysis was then performed on a 1 m digital elevation model of the ARW using open-source geographic information software. Linear, decision-tree, and cluster-based models were all employed to assess relationships between terrain form and snow depth. Cluster-based models have shown the greatest promise, indicating that there are two major terrain classes, with differing snow accumulation regimes. The landscape is dominated by shallow snow overlying subdued, wind-exposed topography, while a small fraction of the landscape contains very deep drifts in wind-sheltered depressions. This agrees with work from the western and high Arctic, though no models have been developed for southern Baffin Island. Preferential sampling of these drift areas should yield the best information on seasonal accumulation in the ARW, since they act as catchments for wind-blown snow from other areas. Since these areas coincide with stream valleys and hillslope flow-accumulation zones, deep drifts may also slow the delivery of meltwater contributions to streamflow.

Session 120100 - POSTER SESSION - PART 1

The impact of glacier recession on water resources: time series analysis in Huancayo, Peru

Somers, Lauren McKenzie, Jeffrey   Mark, Bryan Lagos, Pablo Crumley, Ryan Wigmore, Oliver   Baraer, Michel
McGill University
lauren.somers@mail.mcgill.ca

Communities and industries in the Peruvian Andes rely on proglacial alpine watersheds for water resources. Glacial meltwater supplies continual stream discharge, even during the dry season when precipitation is minimal. As air temperatures rise due to climate change, glacial mass is quickly being lost, with many glaciers expected to disappear completely in the coming decades.

The city of Huancayo, central Peru (Lattitude ~12°S; elevation ~3000 masl), receives the majority of its water directly from the Shullcas River Watershed, a high altitude proglacial watershed within the Huaytapallana Conservation Area in the Cordillera Central. Aerial photography and satellite imagery have shown a 59 % decrease in glacial area from 1976 to 2006 within the 173 km2 watershed. A preliminary estimate, based on a chemical mass balance approach, indicates that between 9-17% of the Shullcas River outflow is glacial meltwater. We analysed over 20 years of hydrograph data from the Shullcas River and identified trends in hydrograph parameters including average dry season discharge, average rainy season discharge, timing of maximum and minimum flows. These trends were compared to the timing and rate of glacial recession, land cover change and infrastructure projects in the watershed. Furthermore, we have installed a network of seven stream gauges in the Shullcas River watershed. From this discharge data, we estimated the stream discharge that originates as glacier meltwater, precipitation, and groundwater throughout the year.

Session 120100 - POSTER SESSION - PART 1

Primary water transport pathways of channel fens in the peatland-dominated zone of discontinuous permafrost

Stone, Lindsay Quinton, Bill
Wilfrid Laurier University
ston5270@mylaurier.ca

The disproportionate warming of subarctic climates in northwestern Canada is resulting in rapid permafrost degradation, especially in the southern fringe of discontinuous permafrost. This degradation leads to dramatic land cover changes, potentially affecting the timing and volume of water movement through peat plateau-bog complexes. The combination of permafrost degradation and linear disturbance features from seismic exploration threaten our ability to understand and accurately predict basin output. This study was conducted in the southern fringe of thawing, discontinuous permafrost, at Scotty Creek, 50 km south of Fort Simpson in the Northwest Territories, Canada. The purpose of this study is to investigate the flux and storage of water through a channel fen in order to increase the understanding of and ability to predict water conveyance through these wetland types. The main hydrological function of channel fens is to convey to the basin outlet the water that has drained into them from peat plateau-bog complexes. As such, understanding the hydrological behavior of these features is critical to model simulation of basin runoff in this region. Channel fens are hydrologically complex as they contain multiple peat layers, an adjustable ground surface, diffuse surface pathways, and spatially heterogeneous ground surface characteristics. The preliminary results of this project are presented. This includes a conceptual model that describes the pathways that transport water through fens. This conceptual model is being tested using the Raven Hydrological Model supported with high-resolution LiDAR as well as detailed meteorological and hydrological data collection from the 2015 snowmelt and summer season. This research is establishing key details on the transport of water in a changing cold regions environment, with the goal of providing researchers with an improved understanding of the primary mechanisms which determine the timing and volume of flow in order to better model and predict output from these rapidly degrading basins on a larger scale.

Session 120100 - POSTER SESSION - PART 1

HydRun: A MATLAB toolbox for rainfall-runoff and water quality calculations

Tang, Weigang Carey, Sean Macrae, Merrin
McMaster University
tangw5@mcmaster.ca

Rainfall-runoff process plays an important role in the mobilization of both soluble and particulate chemicals following the application of fertilization and herbicides to agricultural lands. Measuring water quality during runoff events provides valuable information on the dynamics of transport processes and source areas of contaminants. Often, measurement is implemented during runoff events to calculate metrics such as nutrient loads, and, to determine whether concentrations exceed water quality guidelines. Blending water quality data with hydrometric information (precipitation and runoff) remains a challenge, and methods of matching, event extraction and key water quality calculations are often done manually. This limits the number of events typically studied, and can create considerable bias. HydRun, a MATLAB based toolbox, is a rapid and flexible solution for event-based rainfall-runoff analysis. It includes a sequence of nested functions to automatically extract rainfall-runoff events from long-term precipitation and streamflow data and calculate the event hydrological metrics. Here, we present recently developed supplementary functions added to the toolbox to calculate event-based hydrochemical parameters such as nutrient loads and Flow-Weighted Mean Concentrations (FWMC) with additional inputs of the time series of concentrations of nutrient in runoff water. Examples from agricultural catchments in Southern Ontario are provided and compared with traditional manual extraction methods.

Session 120100 - POSTER SESSION - PART 1

Linking Mining Wastewater Discharge to Methylmercury Production and Persistence in a Sub-Arctic Peatland

Twible, Lauren Price, Jonathan McCarter, Colin Branfireun, Brian
University of Western Ontario
ltwible@uwo.ca

Mines in remote northern regions have limited options for handling their wastewater produced through industrial and processing activities due to geographic isolation, cost, and energy requirements. Peatlands have a recognized capacity to assimilate nutrients and particulate matter, and thus are an appealing primary and/or tertiary wastewater treatment option. To test the impacts of wastewater discharges on northern peatlands, an experiment that continuously adds simulated wastewater to a string fen in the James Bay Lowlands was initiated in 2014. Previous research on temperate peatlands has shown that the addition of sulphate leads to increased methylmercury concentrations in peatland pore waters through enhancing methylation by sulphate-reducing bacteria. Initial sampling from the summer of 2014 has shown an increase in total and methyl mercury, coupled with the increased sulphate concentration, as nutrient additions continued. Continued data collection in the summer of 2015 will allow us to assess the persistence of methylmercury generation throughout the fen during nutrient addition. This will also allow me to determine if there are legacy effects on methylmercury generation between

summer 2014 and summer 2015 as the nutrient additions continue. Through the analyses of both the short-term (first year) and long-term (multi-year) methylmercury dynamics we can evaluate the potential risks associated with using peatlands in the treatment of mine wastewater that contains sulphate.

Session 120100 - POSTER SESSION - PART 1

The Relationship Between Satellite Derived Soil Moisture Anomalies and Watershed Runoff Ratios

Ueckermann, Elené Berg, Aaron   Champagne, Catherine Bonnycastle, Adam
University of Guelph
aberg@uoguelph.ca

Soil moisture plays an integral role in the hydrological cycle by controlling the partitioning of rainfall into infiltration or overland flow. With improved access to remotely sensed data, it is possible to establish the strength of the relationship between remotely sensed soil moisture and the runoff ratio over watersheds to improve predictions of peak runoff. This has many applications for improved flood forecasting - a particular concern in Canada - and will also lead to a better understanding of the physical controls on the basins hydrologic response. The objective of this research is to develop an approach for extracting soil moisture data over several Canadian watersheds, and establishing the strength of its relationship to the basins runoff ratio. A preliminary case study was conducted over the Brightwater Creek watershed in Saskatchewan using the soil moisture product from the Soil Moisture and Ocean Salinity Mission (SMOS) L-band radar, which is able to estimate volumetric soil moisture data within the top <5cm of soil. Using warm season data (April-October) from 2010 to 2013, a GIS tool was developed to extract a time series of the soil moisture anomaly (difference from 5 yea average), which was compared to the calculated to runoff ratio from local discharge and precipitation data through a regression analysis at 1-4 week lag times. The results show a significant but weak positive correlation between soil moisture and runoff ratio at short lag times, and a weakly negative correlation thereafter. These results are partly explained by examining the complex prairie hydrology this basin is part of, and the possibility of soil moisture thresholds in the basin. This method has shown promise as a tool to examine this relationship, and further research will be conducted over different watersheds to extend the reach of its conclusions.

Session 120100 - POSTER SESSION - PART 1

Gravity Wave Parameters observed over Eureka, Nunavut using the PEARL All Sky Imager

Vail, Christopher Ward, William Kristoffersen, Sam Das, Uma
University of New Brunswick
c.w.vail@unb.ca

This paper will present the analysis approach developed to detect of gravity waves and their parameters from airglow images taken by the Polar Environmental Atmospheric Research Laboratory (PEARL) All Sky Imager (PASI) and results from this analysis. PASI has been in operation since November 2007 at PEARL in Eureka, Nunavut with images being taken on

average every 45 seconds during the winter seasons. An automated data analysis approach has been developed to diagnose the gravity wave parameters in a time efficient manner. PASI is a CCD imaging system with six different spectral band filters. The filter of primary interest in this research isolates the hydroxyl airglow emission (at 720-910nm notched at 865nm to eliminate the molecular oxygen emission). PASI cycles through the different filters with the hydroxyl filter interleaved between the other filters in the sequence so it provides the highest temporal observation cadence. The diagnosed gravity wave parameters include the horizontal and vertical wavelengths, intrinsic period and propagation direction. In each image, occurrences of these waves are identified using two dimensional Fourier transforms and described in terms of horizontal spatial wavenumber and phase. Temporal phase information is deduced from consecutive images which contain wave signatures with similar horizontal wavenumbers. The vertical wavelength is determined from the horizontal wavelength, the Brunt-Väisälä frequency determined from the Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) data or extended Canadian Middle Atmosphere Model (CMAM) data and the background wind speed using the co-located E-Region Wind Interferometer (ERWIN) instrument. Monthly variations of these parameters for several seasons will be presented. In particular, the variation in gravity wave occurrence during stratospheric warmings will be highlighted.

Session 120100 - POSTER SESSION - PART 1

Impacts of road construction and removal on the hydrologic and geochemical function of two peatlands within the Athabasca oil sands region, Alberta, Canada

Wells, Corey Sutherland, George   Petrone, Richard Weber, Tobias
University of Waterloo
c2wells@uwaterloo.ca

Linear disturbances such as roads cover vast swaths of northeastern Alberta, the majority of which are wetlands. Thus, the effects of road construction can have significant implications on water movement within the region and by extension the productivity of vegetation communities and carbon sequestration. However, little is known about the effect that roads have on wetland hydrology. Two fen peatlands, one where the road was removed in 2013 (Firebag) and one where portions of the road were experimentally removed in 2011 (JACOS), were investigated to quantify the effects of linear infrastructure on peatland hydrogeochemical function and system rebound post restoration. Both sites experienced a significant increase in bulk density (pb) for the peat column within the footprint of the removed road (RR) as compared to unimpacted peat (UP). The lack of an acrotelm in the RR resulted in low specific yields (Sy) within the near surface, which has lead to temporary, but inconsistent, hydrologic connections. Along sections where the road was removed, an increase in nutrients and most major ions was observed in ground and surface water for both sites, leading to spatial changes in vegetation communities and carbon sequestration. Peat subsidence in this area has also enhanced the potential for surface flooding under both wet and dry conditions. A marked change in hydrophysical properties and ground and surface water flow patterns along with increases in nutrient and major ion content post road removal has implications for plant reestablishment and restoration and will form the basis of further study.

Session 120100 - POSTER SESSION - PART 1

Estimation of Pothole Wetland Extent and Seasonal Variability in Kenaston, Saskatchewan using RADARSAT-2

White, Jenelle Rowlandson, Tracy Berg, Aaron
University of Guelph
aberg@uoguelph.ca

Wetland monitoring is of extreme importance as wetlands worldwide face growing pressures from human activities and climate change. The extent of inundated area is also an important consideration for the retrieval of soil moisture from passive microwave observations of brightness temperatures from the Soil Moisture Active/Passive and the Soil Moisture and Ocean Salinity Mission. However, accurate detection can limited by the pixel size of the satellite utilized. This is a major concern for monitoring the pothole wetlands of the Prairie Pothole Region, as the majority of the wetlands are smaller than the pixel size of many optical satellites such as LANDSAT resulting in misclassification and error in the retrieval of wetland area. A study was conducted to investigate the potential for estimating inundated wetland extents within the Prairie Pothole Region using a multi-date backscatter retrievals from RADARSAT-2. Factors influencing seasonal wetland variations in the Prairie Pothole Region were also considered. RADARSAT-2 imagery was acquired for each month from April-September 2015 near Kenaston, Saskatchewan. The raw RADAR images were preprocessed using the RADARSAT-2 Polarimetric Toolbox and the wetlands were identified based on their backscatter signature. Over the 572km2 study region the inundated wetlands ranged considerably from 12.78 km2 (2.2% of total area) in May to 2.83 km2 (.05% of total are) in July. Wetland extent was highly correlated to accumulated precipitation during the period.   Relationships between differences observed between the retrieval of soil moisture from L-Band brightness temperatures observed from the Soil Moisture Active Passive mission and soil moisture observed using a ground-based validation network did not show significant correlation to the changes in inundated area. Although a preliminary result, this suggests that changes in inundated area over this region do not have a significant impact on the validation of soil moisture products over this region.

Session 120100 - POSTER SESSION - PART 1

Dissolved methane in the Old Harry influence area in the Gulf of the St. Lawrence

Xie, Huixiang Xie, Huixiang St-Onge, Guillaume Bourgault, Daniel   Galbraith, Peter Scarratt, Michael
UniversitÃ© du QuÃ©bec Ã Rimouski
Huixiang_Xie@uqar.ca

Methane is among the most abundant volatile hydrocarbons in offshore oil reservoirs. The Old Harry prospect in the Gulf of St. Lawrence is currently under consideration for oil exploitation, yet there are no baseline dissolved methane concentrations in the surrounding area to assess the environmental impacts of potential oil spills at the Old Harry. During a cruise on board the R/V Coriolis II in June 2015, vertical profiles of methane were collected in the Old Harry influence area, where the bathymetric survey detected an extensive number of pockmarks on the seafloor. The methane profiles from different sampling stations showed markedly consistent patterns

throughout the water column, characterized by a pronounced peak at ~100 m, a minimum at ~300 m, and a secondary maximum at ~400 m close to the seabed. Methane concentrations in bottom waters were higher than those in immediate overlying waters. Potential methane sources and relationships between methane distributions and water-column physical and biological structures are discussed.

Session 120100 - POSTER SESSION - PART 1

Parametrization of radial base functions using Bi-Conjugate gradient method to local gravity field modelling

Yusefi, Mahboobeh Safari, Abdolreza   Foroughi, Ismael
School of Surveying and Geospatial Engineering, University of Tehran, Tehran, Iran
mmyusefi@ut.ac.ir

Gravity field can be explored locally and globally. The research aims at an investigation of the optimal choice of local base functions, to derive a regional solution of the gravity field. Thus, the representation of the gravity field is separated into a global and a residual signal, which includes the regional details. To detect these details, a superposition of localizing Radial Base Functions (RBFs) is used. Number of base functions, their horizontal positions on the Bjerhammer sphere, bandwidths and coefficients are desired to find a model to predict gravity field locally by RBFs. Although the matrix of system of equations in sense of RBFs is badly conditioned, this can be solved easily by employing regularization. Tikhonov regularization parameter has typically been used in this area, not only these parameters deteriorate the physics, but also need to be defined manually. Bi-Conjugate Gradient method (BICG) deals with ill-posed linearized system of equations by estimating the inverse of design matrix in well-condition space. The functionality of BICG, as physically meaningful regularization, in local gravity field modelling using RBFs is intended in this study. Free air gravity anomalies, synthetized by EGM08 up to degree/order 2160, in the territory of Iran is considered as our input test data, available GPS/Leveling points in the area, is used as evaluation criteria. Initial results showed a compatible fast solution of RBFs using BICG.

Session 120100 - POSTER SESSION - PART 1

Photomethanification of dissolved organic matter in Saguenay River surface water

Zhang, Yong   Xie, Huixiang
Institute of Coastal Zone Research, Chinese Academy of Sciences
Huixiang_Xie@uqar.ca

Rates and apparent quantum yields of photomethanification (AQY-CH4) of chromophoric dissolved organic matter (CDOM) in Saguenay River surface water were determined at three widely differing dissolved oxygen concentrations ([O2]) (suboxic, air-saturation, and oxygenated) using simulated-solar radiation. Photoproduction of CH4 occurred under both suboxic and oxic conditions and increased with decreasing [O2], with the rate under suboxic conditions ~7-8 times that under oxic conditions. Photoproduction of CH4 under oxic conditions increased linearly with photomineralization and photobleaching. Under air-saturation, 0.00057% of the photochemical dissolved organic carbon loss was diverted to CH4, giving a photochemical

CH_4 production rate of 4.36 × 10^(-6) mol m^(-2) yr^(-1) in the Saguenay River and, by extrapolation, of (1.9-8.1) × 10^8 mol yr^(-1) in the global ocean. AQY-CH4 changed little with photobleaching under air-saturation but increased exponentially under suboxic conditions. Spectrally, AQY-CH4 decreased sequentially from UVB to UVA to VIS, with UVB being more efficient under suboxic conditions than under oxic conditions. On a depth-integrated basis, VIS prevailed over UVB in controlling CH4 photoproduction under air-saturation while the opposite held true under O2-deficiency. An addition of micromolar levels of dissolved dimethyl sulfide (DMS) substantially increased CH4 photoproduction, particularly under O2-deficiency; DMS at nanomolar ambient concentrations in surface oceans is, however, unlikely a significant CH4 precursor. Results from this study suggest that CDOM-based CH4 photoproduction only marginally contributes to the CH4 supersaturation in modern surface oceans and to both the modern and Archean atmospheric CH4 budgets, but that the photochemical term can be comparable to microbial CH4 oxidation in modern oxic oceans. Our results also suggest that anoxic microniches in particulate organic matter and phytoplankton cells containing elevated concentrations of precursors of the methyl radical such as DMS may provide potential hotspots for CH4 photoproduction.

Session 120101 - POSTER SESSION - PART 2

Spatio-Temporal Patterns in Trends of Northern Hemisphere Snow Extent and Duration, 1971-2014

Allchin, Michael Dery, Stephen
University of Northern British Columbia
sdery@unbc.ca

Seasonal snow-cover is an essential component of climatological, hydrological, ecological and anthropological processes over large areas of the terrestrial mid-to-polar latitudes of the Northern Hemisphere (NH). Recognition of these key influences, and of the potential for shifts from historical distribution patterns as a consequence of anthropogenic climate change, has prompted a series of investigations into inter-annual trends in its extent (SE) and duration (SD). These studies have consistently found that snow-cover has been declining rapidly across the NH in spring and summer, although there have been some signs of increases in other seasons in particular spatial contexts.However, none to date have described in detail both temporal and spatial patterns in the occurrence of negative and positive trends in SE. This presentation will describe an investigation into the distribution of these trajectories of snowpack losses and gains at monthly intervals within 5° grid-cells across the NH, and of both SE and SD in its major biomes (which provide a proxy for regional climatologies of multi-millenial scales). Details will thus be presented of the spatial and temporal contexts in which snow-cover is likely to be most vulnerable under continuing anthropogenic climate change.As well as identifying contexts experiencing major shifts in snow climatology, this will also help to identify areas in which such changes may signify increasing stress on summer water resources required by both the natural and human environments, provide a foundation on which to base continuing analyses of attribution, support the ongoing improvement of climate models, and contribute to the assessment of potential hydroclimatological regime transitions.

Session 120101 - POSTER SESSION - PART 2

Effects of snow-melt on soil moisture memory and on Land-Atmosphere interaction

Ambadan Thomas, Jaison Berg, Aaron Merryfield, William
University of Guelph
aberg@uoguelph.ca

This study examines snowmelt-soil moisture relationship, in particular, the influence of snowmelt on soil moisture memory and on near surface air temperature over extra-tropical northern hemisphere (ENH) using three state-of-the-art reanalysis products: ERA-Interim, MERRA-Land, and GLDAS, as well as initialized predictions from the Canadian Climate Model versions 3 and 4 (CanCM3 and CanCM4), over a 20 year period (1986-2005). The influence of snowmelt on soil moisture memory was evaluated using correlation based metrics along with a simple classification based on the timing when the top layer soil temperature became above the freezing point during annual freeze-thaw season. Our results show considerable differences across reanalyses as well as CanCM3 and CanCM4 regarding timing of maximum SWE (SWEmax) occurrences as well as onset of thawing of the frozen soil. Temporal autocorrelations between SWEmax and soil moisture indicate majority of gridcells over ENH have e-folding frequencies below 45 days with some consistency across reanalyses as well as CanCM3 and CanCM4 models. However, the intra-seasonal autocorrelation of MERRA-Land soil moisture shows anomalous sudden decline of soil moisture memory compared to rest, likely due to the offline forcing of atmospheric variables which block the atmosphere response to land feedback. CanCM4 also shows a sudden decline of intra-seasonal autocorrelation over Central Asia which is most likely due to weak land- atmosphere coupling over the region. Intra-seasonal cross-correlation between near surface air temperature and soil moisture, with respect to lag days, during the melt-thaw season show a transition from negative to positive correlations. However, in CanCM3 and CanCM4, as the lag day increases, the correlation strengths get weaker compared to reanalyses, which may indicate weaker land-atmosphere coupling in the models.

Session 120101 - POSTER SESSION - PART 2

Developing gridded uncertainty fields for PRISM climate data

Anslow, Faron
Pacific Climate Impacts Consortium
fanslow@uvic.ca

Gridded climate data at fine (sub-kilometre) and coarse (tens of kilometres) are used throughout climate and process science for as targets for downscaling to generating forcing for process models. As yet, the majority of datasets of this type are not accompanied by estimates of uncertainty as it may vary in space with the result being that the data are treated as gospel when used for further computations. While many products do provide some indication of uncertainty derived from cross-validation, a more thorough treatment is needed to maximize the utility of these data for the eventual end-users. In this talk, development of such a product for PRISM (Parameter Regression on Independent Slopes Model) climatological and timeseries data is described. We analyze several approaches and discuss some implications for including these estimates in down-stream studies.

Session 120101 - POSTER SESSION - PART 2

Real-time ground-motion mapping based on an Automatic Response System (ARS), with applications to induced-seismicity traffic light protocols

Assatourians, Karen Atkinson, Gail
Western University
kassatou@uwo.ca

We describe an Automatic Response System (ARS) that accesses and processes seismographic network data in real time. The program continuously checks an email account, which receives notifications concerning earthquake occurrence, allowing the ARS to respond to either an automated earthquake notification email, or a manual request concerning a specified time window. Upon earthquake occurrence, ARS uses ground-motion data to calculate the moment magnitude and stress drop of the event. The system tabulates response spectral ordinates at all recording stations (PSA, 5%-damped pseudo-acceleration), prepares and posts ground-motion and intensity maps online, and emails a link to the information products to a list of recipients. The ARS program can be configured to access a network database, or alternatively to draw data from a data center such as IRIS. After fetching the raw time series ARS applies routine signal processing procedures to obtain instrument-corrected ground motion time series and PSAs. The moment magnitude is obtained by fitting the low-frequency PSA amplitudes to the attenuation shape given by a regional ground-motion prediction equation (GMPE). Then the high-frequency PSA and moment are used to find the best-fitting stress drop. The derived magnitude and stress drop are used to generate an event-specific GMPE. In the final stage, ground motions are calculated for a grid of points using the event-specific GMPE, earthquake coordinates, and grid of site amplification factors. The information products are automatically posted to a website where they are displayed interactively within google maps that allow products to be zoomed, queried and downloaded. The information products are tailored to allow rapid decisions to be made for induced-seismicity applications. In particular, the ARS can be used to develop more effective traffic-light protocols that consider both the magnitude of events and the potential of the ground motions to reach damaging levels.

Session 120101 - POSTER SESSION - PART 2

Assessment of source proportion estimates using different sampling designs for sediment source fingerprinting studies

Boudreault, Monica Lobb, David   Sheng, Li Liu, Kui Zisheng, Xing Benoy, Glenn Danielescu, Serban
University of Manitoba, Agriculture and Agri-Food Canada
monicaboudreault@gmail.com

In Atlantic Canada, many cultivated fields are prone to serious water erosion due to the intensive management associated with the potato cropping systems. As a result, elevated levels of suspended sediments are observed in the surface water. In order to better control the adverse effects of suspended sediment, it is necessary to quantify the contribution from each source. The objectives of the study are: (I) to determine the main sources of sediments and the contributions from each source at the watershed scale. (II) To examine the spatial variation and explore more effective approaches for sediment fingerprinting studies in a dynamic system. The study was carried out in Black Brook Watershed (BBW), a small watershed in the potato belt of the province of New Brunswick in Atlantic Canada. Soil samples were taken from different sediment sources, including cultivated fields, forested areas, and stream banks. Suspended sediment was collected seasonally at five locations in the watershed for six years. All samples were measured for a set of chemical and biophysical properties, such as Cs-137 radioactivity, trace elements and spectral reflectance which were used as fingerprints to distinguish the different sources. Our results showed that cultivated topsoil accounted for the highest sediment source contribution with an average of approximately 46.6% followed by cultivated streambanks, upstream, forest streambanks and forest topsoil which accounted for approximately 30.3%, 15.8%, 6.2% and 1.3% of sediments respectively at the watershed outlet. However, there appear to be a substantial variation in sediment source contributions across the watershed with trends suggesting strong influence from scale and land use. Therefore, sampling solely a watersheds main outlet was not adequate in capturing the change. Advances to sediment fingerprinting, especially with regards to the sampling approach, is necessary for the proper identification of sediment sources.

Session 120101 - POSTER SESSION - PART 2
PSC detection at the poles, a TICFIRE strategic objective
Bouzid, Yacine Blanchet, Jean-Pierre Châteauneuf, François
Institut des sciences de lenvironnement, UQAM
blanchet.jean-pierre@uqam.ca
The polar stratospheric clouds (PSC) are not fully understood and remain a challenge for satellite observations. The importance of PSC detection and analysis is due to their crucial role in the ozone layer depletion. Due to their high altitude, it is difficult to observe them from a ground-base. The deployment of CALIOP on a polar orbit with its detection capability of thin ice cloud allowed to gather data on PSC, but only along the satellite orbit. In view of achieving a wide swath detection of polar thin ice clouds, the prospective TICFIRE satellite mission is under review at the Canadian Space Agency. It aims to cover the still unexplored far-infrared (FIR) spectral region with a wider field of view then the lidar. Taking advantage of the sensitivity of the FIR bands to water vapor, liquid and ice phases, we investigated the application of TICFIRE measurements to the properties of polar PSC. The new measurements will provide a wide field of view with a focus close to the poles. The results are highly relevant for the assessment of heterogeneous ozone chemistry in the context of stratospheric cooling due to increasing greenhouse gases. In this paper, we will present our first results on simulations of thermal radiation in presence of PSC events observed in September 2009 above Antarctica.

Session 120101 - POSTER SESSION - PART 2
On the feasibility of superconducting gravimetry to monitor surface water and groundwater extraction
Braun, Alexander Elliott, E. Judith Fotopoulos, Georgia
Queens University
braun@queensu.ca

The feasibility of monitoring water extraction processes using time-lapse superconducting gravimetry is investigated. Many industrial processes are water-intensive, and utilizing sustainably-extracted proximate groundwater resources is preferable. Water extraction operations are regulated and rely on groundwater replenishment by rivers or aquifers, and it is important to monitor the following parameters: depletion rate, water source, and extraction rate for each source. Gravity and gravity gradient signals are forward modeled for surface fed and aquifer fed water extraction models, to estimate signal strength and directional dependency of water flow. The required sensitivity of the gravimeters, the time scales between measurements, and the precision to which the regulatory limits can be quantified must be evaluated. This requires the incorporation of the following sub-surface parameters: permeability, conductivity and replenishing rate. If a water extraction site is fed by a combination of groundwater and surface water, the spatial resolvability of their gravity signals is investigated. Time-lapse gravimetry on small-scale reservoirs exhibits two obstacles, i) a microgal sensitivity requirement, and ii) high noise levels. In this modeling study, both limitations are overcome by proposing i) the use of a portable superconducting gravimeter, and ii) a pair of instruments under various baseline geometries. This results in improved spatial resolution for locating groundwater depletion, as well as the cancellation of noise common in both instruments. Finally, the optimal survey geometry can be determined to assess and monitor groundwater depletion processes in surface water, groundwater, or multi-source extraction processes.

Session 120101 - POSTER SESSION - PART 2

High N2O and dissolved nitrogen at a restored cutover peatland in Alberta, Canada

Brummell, Martin Strack, Maria
University of Waterloo
martinbrummell@gmail.com

N2O is a biogenic greenhouse gas (GHG) with a climate-forcing potential approximately 300 times that of CO2, and accounts for an important fraction of the total GHG budget of many ecosystems and land-use types. However, N2O has not been widely measured in wetlands, partly because reactive nitrogen availability has often found to be low or limiting in wetlands, suggesting efficient utilization of nitrogen that reduces N2O emissions. Drained peatlands may have higher rates of organic matter oxidation due to increased oxygen availability, and this oxidation may release nitrogen from organic matter, making it available to autotrophic microorganisms. Restoration of cutover peatlands includes efforts to return to conditions of hydrology and biodiversity similar to that prior to the disturbance; typically drainage ditches are filled to raise the water table, and material to promote growth of wetland plants is applied, especially Sphagnum mosses. Water table, and water table fluctuations, play a key role in N2O production and consumption by soil microorganisms that respond to changing substrate and oxygen availability. In 2015, we discovered high and variable production of N2O at a cutover peatland in Alberta where restoration efforts began in late 2012. We also found unexpectedly high concentrations of total nitrogen (i.e. Total Kjeldahl N, TKN) in the pore water collected across both the restored and unrestored areas at the study site. TKN concentration in pore water at 75cm below ground surface was positively correlated (Pearsons $r = 0.28$; $p < 0.05$) with water table depth, but not with net N2O production.This study is exploring the factors driving N2O

production in extracted peatlands, with the goal of improving restoration efforts that account for nitrogen as well as carbon cycles in these disturbed ecosystems.

Session 120101 - POSTER SESSION - PART 2

A Data System for Monitoring and Reporting Weather and Climate Conditions for Canadian Agriculture

CHERNESKI, Patrick CHERNESKI, Patrick
AAFC
patrick.cherneski@agr.gc.ca

Monitoring weather and climate conditions for agriculture in Canada is challenging due to multiple factors, including geography, dispersed data networks, and variable data availability and quality. Agriculture & Agri-Food Canadas Near Real-Time (NRT) data system, processes data daily from more than 2000 stations from federal, provincial and private networks, improves data quality, and ultimately produces hundreds of maps daily which are accessible online at www.agr.gc.ca/drought.The NRT system has been operational since 2006 and has been improved over the years. It currently utilizes information such as weather radar images, relative cloud heights, weather bulletins, independent weather observations, and reports from regional contacts on significant weather events to conduct specific data quality control on the daily raw data. Incoming weather observations are compared with historic values to identify trends and against neighbouring stations to identify any regional inconsistencies. The resultant maps show the extent and intensity of near-current conditions and can be compared against historic averages, putting current weather conditions in context. Maps are generated within 12 hours of data collection.The most recent upgrade to the NRT system are tools which analyze the short term history of each station for abnormalities, a step which has proven to be very valuable for assessing the health of a climate station/network. Indeed many observations which have been flagged for operator inspection can quickly be assessed based on this factor.A National Drought Model and Climate Index Application are additional, complementary tools that provide relevant modeled output and value-added variables for additional assessment and analyses.This presentation will provide an overview of the AAFC NRT system, will highlight selected aspects of the quality control process, and the relevance and use of the resultant products. The online products are popular with a wide variety of decision-makers.

Session 120101 - POSTER SESSION - PART 2

The danger in the deep: internal phosphorus loading in Canadian water bodies

Casson, Nora Orihel, Diane Parsons, Chris Baulch, Helen Venkiteswaran, Jason Seckar, Dalila North, Rebecca
University of Winnipeg
n.casson@uwinnipeg.ca

Eutrophication, driven by anthropogenic loading of nutrients from watersheds to lakes and reservoirs, can be enhanced by internal recycling of phosphorus (P) from sediments. The importance of this mechanism varies among water bodies, and thus understanding the controls on and patterns of internal P loading is important for predicting how lakes respond to changes in

external P loading. This study used existing literature to synthesize rates of internal P loading from Canadian water bodies, map the geographical patterns across the country, and examine the environmental drivers. We compiled 618 measurements of sediment P flux from 70 water bodies across Canada, with rates from 8 of the 10 provinces. Fluxes ranged from -24 to 48 mg/m2/d, with a median flux of 0.71 mg/m/d. Low oxygen, pH, geology, and trophic state were all factors that associated with variation in rates of P release from sediments. The relative importance of internal and external loads varied widely across the country. Very low rates of internal loading in Precambrian Shield lakes suggest a more rapid recovery from eutrophication. Higher rates of internal loading in prairie lakes likely reflect a naturally higher trophic state, and suggest that there may be longer lag times before substantive reductions in P concentrations are observed. There were several important data gaps, including a lack of observations from water bodies above 55 degrees of latitude, only one estimate of internal P loading from a reservoir (Lake Diefenbaker) and few measurements taken under ice.

Session 120101 - POSTER SESSION - PART 2

Ocean observations on the Scotian Shelf using autonomous vehicles

Davis, Richard Comeau, Adam LOrsa, Sue Covey, Brad Ross, Tetjana
Dalhousie University
richard.davis@dal.ca

Autonomous vehicles, such as ocean gliders, are rapidly becoming important tools for ocean observation due to their relative low cost of operation compared to shipboard measurements and their ability to stay on mission for extended periods ranging from several weeks to months. The Ocean Tracking Network (OTN) and the Marine Environmental Observation, Prediction and Response Network (MEOPAR) fund the largest operational glider group in Canada, housed at Dalhousie University. This group operates a fleet of gliders that survey the Scotian Shelf on a regular basis, having logged >32,000km to date. A variety of missions are conducted to support a wide range of research interests measuring a variety of bio-geochemical, bio-optical and acoustic parameters. The AZMP time-series line off of Halifax is occupied by the gliders on a much more continuous basis than the semi-annual cruises conducted by DFO, strongly augmenting their important data set. At the same time environmental context is provided for the movements of tagged marine animals passing over one of OTNs acoustic receiver lines that stretch from near Halifax Harbour to the shelf break. During summer and fall, gliders equipped with passive acoustic hydrophones are deployed to listen for marine mammals and then report the positions of some key species directly to automated aid-to-navigation systems to avoid ship strikes. Gliders can also be used to offload data from bottom-mounted instruments and then sent back to shore via satellite, reducing the costs associated with collecting the data. Critical to the success of these operations is proper data management. The Dalhousie glider group uses internationally recognized data quality control and analysis procedures and makes all data available via the internet. Glider data are also submitted to international organizations for use by the general research community.

Session 120101 - POSTER SESSION - PART 2

Convection and circulation in the deep Arctic Ocean

Dosser, Hayley Timmermans, Mary-Louise
Yale University
hdosser@uw.edu

The isolated bottom waters in the Arctic Oceans Canada Basin provide a connection with past sea-ice and upper-ocean stratification regimes during the last ~500 years. The fundamental physical processes driving the formation and evolution of the deepest waters in the Canada Basin are investigated from the perspective of geophysical fluid dynamics constrained by observations. It is determined that the ~1000m thick homogeneous bottom layer is actively mixed by rotationally controlled thermal convection forced by geothermal heating. Thermal plumes take the form of geostrophically balanced cyclonic vortices. Interactions between the frictional Ekman bottom boundary layer and vortices in the interior are poorly understood, but may be particularly important near the basin margins where there is evidence for stronger turbulent mixing. Connections to the large-scale lateral flow and Beaufort Gyre vorticity balance are discussed.

Session 120101 - POSTER SESSION - PART 2

Impact of subdivision construction on stream water quality in a suburbanizing stream of southern Ontario, Canada

Duval, Tim
University of Toronto Mississauga
tim.duval@utoronto.ca

While it is well known that urban streams are subject to impaired water quality relative to natural analogues, far less research has been directed at stream water quality during the process of (sub-) urbanization. This study determines the role of housing construction activities in Brampton, Ontario on the water quality of East Huttonville Creek, a second-order tributary of the Credit River. Prior to development the stream was engineered with a riffle-pool sequence, occasional marsh-like structures, riparian plantings, and floodplain corridor that was lined with sediment fencing, all features that should limit water quality degradation. A nearby urban stream site was developed ten years prior to this study and selected as a reference between developed and developing. The streams sites were sampled daily over the winter and spring of 2016 at three locations representing varying stages of subdivision completion. The three sampling sites were selected based on their stages of construction activity (upper site - predominantly active construction; middle site - split between finished construction and planned construction; lower site - split between finished construction and active construction). Water quality measures included pH, specific conductivity, total suspended solids, nutrients (nitrate, SRP, TN, TP), and heavy metals. Preliminary analysis suggests water quality was better in the urbanized stream and the middle sampling site than the upper or lower reaches of East Huttonville Creek. Analysis of two mid-winter rain-on-snow events revealed that TSS concentrations and fluxes in all sites increased by an order of magnitude relative to baseflow. Further analysis will investigate source origin partitioning of the stream water and relate water quality data to landscape attributes. Results of this study will inform land managers of the impact of construction activities on stream

water quality and provide recommendations to improve stream integrity during catchment suburbanization.

Session 120101 - POSTER SESSION - PART 2
Investigating lateral outflow from a raised bog in British Columbia.
Exler, Johannes Moore, R.D. (Dan) Merkens, Markus
University of British Columbia
j.exler@alumni.ubc.ca
Past peat mining activities and the resulting lowered water table change the hydrology and ecology of peatlands. Whereas drainage ditch blocking is a common restoration practice, outflow at the boundaries has been little studied. This study investigated lateral outflow from Burns Bog, a radially draining raised bog in British Columbia with an area of 3000 ha. This study focused on a 200 m section of the bogs southern boundary, in order to identify governing controls on the lateral outflow behaviour. The study spanned the period from October 21 to December 8, 2014. Water table elevations were monitored using 27 wells arranged in a grid extending from the edge to 35 m upslope of the ditch. Throughflow was monitored using 20 troughs inserted into the ditch face, and 10 seepage meters were used to measure upward discharge across the ditch bed. Throughflow began once the water table rose to within 36 to 41 cm of the soil surface and exhibited a nonlinear relation with water table elevation. Although there are uncertainties associated with the scaling of the trough measurements to the entire ditch length, throughflow dominated discharge into the ditch, representing 81 to 92.5% of total outflow. Pipeflow initiated when the water table rose to within about 40 cm of the soil surface, displayed a nonlinear relation with water table elevation, and contributed 5 to 13% of total discharge. Seepage was found to contribute only 2.5 to 6% of total outflow and showed no relation to the water table depth in close proximity to the bogs boundary.

Session 120101 - POSTER SESSION - PART 2
Tropical Subseasonal Variability and Its Teleconnection in Canadian EC GEM
FENG, Pei-Ning LIN, Hai MERLIS, Timothy   DEROME, Jacques
Dept. of Atmospheric and Oceanic Sciences, McGill University
pei-ning.feng@mail.mcgill.ca
The output of a 23-year simulation of the Global Environmental Multiscale (GEM) model of Environment Canada is analyzed to assess the tropical subseasonal variability and its winter teleconnections. The simulation is performed with specified observed monthly mean sea surface temperature and sea ice, consistent with the Atmospheric Model Intercomparison Project (AMIP) protocol. Improvement in models ability in capturing the tropical subseasonal variability and teleconnections is likely crucial for subseasonal predictions.   In general, the significant convective features of the Madden-Julian Oscillation (MJO) are reproduced by GEM though the signal is more intense than the observation. In the 23 model years, the outgoing longwave radiation (OLR) and precipitation anomalies in the tropics associated with each phase of the MJO represent an eastward propagation of the tropical convection. Based on the MJO index defined by Wheeler and Hendon, lagged composite analyses are conducted for atmospheric

variables in the extratropical Northern Hemisphere. Following MJO phase 3, when the convection occurs in the Indian Ocean, the 500hPa geopotential height anomaly evolves into a positive-North Atlantic Oscillation (NAO) like pattern. The results are in general consistent with the observations.

Session 120101 - POSTER SESSION - PART 2

Reconstructing Changes in Land-Cover and the Extent of a Peatland over 200 years of Recorded Anthropogenic Disturbances

Foster, R. Alexander Richardson, Murray Brklacich, Michael
Carleton University
alex.foster@carleton.ca

Reconstructing the historical extents of peatlands and their responses to human-induced disturbances is of multi-disciplinary interest. Peatlands occupy 3% of the Earths terrestrial surface yet provide globally significant regulating functions; storing roughly 33% of the worlds soil carbon and 10% of its freshwater resources. However, extracted peat has many commercial applications and peatlands are frequently disturbed for more socially and economically productive land-uses. An ecosystem service analysis framework can be used to quantify these land-use pressures and associated perturbations to peatlands with potential to support landscape planning and resource management practices in Canada. In this case-study, the historical land-use dynamics and changing areal extent of southern Ontarios largest remaining peatland, Alfred Bog, was quantified over eleven periods between 1800 and 2015. The main challenge was in interpreting, evaluating and amalgamating multiple existing data sources into common formats for consistently delineating changes in land cover and peatland extent. Data derived from these maps was used in estimating the dynamics of three ecosystem services: food production, carbon storage and commercial peat extraction. Digital elevation models (DEMs) extracted from aerial photography captured 3D landscape changes after 1947. They were used in combination with information from government reports, to estimate variations in the volume of peat extracted and carbon released at Alfred Bog over time. The DEMs also facilitated analysis of the peatlands responses to disturbances; providing indicators of peatland condition, such as highlighting vegetation changes and subsidence along drainage ditches. Overall, the approaches presented in this study can be used to quantitatively reconstruct historical impacts to peatland ecosystems, identify common responses to disturbances, and develop conservation plans.

Session 120101 - POSTER SESSION - PART 2

A Statistical Model for Hydraulic Fracturing-Induced Seismicity in the Western Canada Sedimentary Basin

Ghofrani, Hadi Atkinson, Gail
Western University
ghofrani_hadi@yahoo.com

In many parts of North America that have been historically quiet seismically, the rate of significant earthquakes (M>3) has increased nearly ten-fold over the last decade (Ellsworth, 2013). Most of the increase in the rate of activity has occurred in areas of oil and gas development, specifically in relation to new resource extraction technologies that have enabled the development of previously-uneconomic tight reservoirs. Recent evidence suggests that hydraulic fracturing plays a significant role in triggering seismicity in the WCSB (B.C. Oil and Gas Commission 2012, 2014; Eaton and Mahani, 2015; Schultz et al, 2015a,b; Atkinson et al, 2015a & b; Farahbod et al, 2015). This contrasts with the central U.S., where most induced seismicity has been attributed to large-scale wastewater injection into deep disposal wells. In this study, we examine the statistical relationship between hydraulic fracturing and seismicity in the WCSB from 1985-2015, using a compiled database of seismicity and a compiled database of hydraulically-fractured wells. We focus on the wells that have significant lateral extent (i.e. horizontally-drilled wells with multi-stage frack treatments), as these have a greater potential for induced seismicity. We introduced a statistical metric as an estimate of the regionally-averaged probability that operations in a 10-km cell may induce seismicity; this provides an upper bound on the prior probability of inducing seismicity by commencing HF operations in a small area (in a Bayesian sense). Since 2010, most of the regional earthquakes of M?3 are correlated in both time and space with hydraulic fracturing. Monte Carlo simulations confirm that the observed correlations are extremely unlikely (<<1%) to have been obtained by chance. Improved understanding of regional variability in fault activation processes, accounting for operational and geological factors, will aid in the development and validation of predictive models for the time-dependent hazards from induced earthquakes.

Session 120101 - POSTER SESSION - PART 2

Imaging Sediment Thickness and Stratigraphy Beneath the Mactaquac Headpond by Acoustic Sub-bottom Imaging

Grace, Mitch Butler, Karl Simpkin, Peter Yamazaki, Gordon
Department of Earth Sciences, University of New Brunswick, Fredericton, NB
mitch.grace@unb.ca

The Mactaquac Hydroelectric Generating Station, located on the Saint John River in New Brunswick, Canada, is reaching the end of its life due to deterioration of the concrete structures. As part of the Mactaquac Aquatic Ecosystem Study, designed to inform a decision on the future of the dam, sediment in the headpond is being examined. The focus of this sub-study lies in (i) mapping the thickness of sediments that have accumulated since inundation in 1968, and (ii) imaging the deeper glacial and post-glacial stratigraphy.Acoustic sub-bottom profiling surveys were completed during the summers of 2014 and 2015. The initial 3.5 kHz chirp sonar survey proved ineffective, lacking in both resolution and depth of the penetration. A follow-up survey employing a surface towed catamaran supporting a boomer based Seistec high resolution sediment profiler provided better results, resolving sediment layers as thin as about 15 cm, and yielding coherent reflections from the deeper Holocene sediments.Post-inundation sediments in the lowermost 25 km of the headpond, between the dam and Bear Island, are interpreted to be less than 40 cm thick, except in a few areas. They appear to be thickest in deep water areas overlying the pre-inundation riverbed. In the ~15 km stretch from north of Bear Island to Nackawic, the presence of gas in the uppermost sediments severely limits sub-bottom penetration and our ability to interpret sediment thicknesses. Profiles acquired in the ~40 km reach from just north of Nackawic to Woodstock show a strong, positive water bottom reflection and little to no sub-bottom penetration, indication the absence of soft post-inundation sediment.

A recently completed coring program will aid in constraining sediment thickness estimates.Deeper reflections in profiles acquired between the dam and Bear Island reveal a buried channel extending up to 20 m below the water bottom with infill consisting of glacial to post-glacial sediments; these include a finely laminated unit interpreted to be clay-silt and a possible esker - similar to stratigraphy found 20 - 40 km downriver at Fredericton.

Session 120101 - POSTER SESSION - PART 2

Examining Modelled Boundary Layer Separation within Wetlands of the Western Boreal Plains

Green, Adam Bohrer, Gil Petrone, Richard
University of Waterloo
a9green@uwaterloo.ca

The landscape of the Western Boreal Plains (WBP) of Alberta has experienced extensive destruction over the past century, due to the expansion of the oil and gas industry. Natural resource development in this region is impacting the wetlands, which dominate this landscape, whereby the reclamation of these areas is required following resource extraction. However, this is complex because of the persistent water deficit condition faced by the region, which has the ecohydrological functioning of these systems strongly controlled by evapotranspiration (ET). One of the dominant drivers of ET is wind and its ability to control the boundary layer, which has the potential to reduce wind turbulence within a wetland. Previous research has been conducted on the formation of the boundary layer around a block (frontward facing step (FFS) followed by a backward facing step (BFS)). However, minimal consideration has been directed at how the boundary layer reacts to the space between a BFS and FFS sequence, which is theoretically representative of a wetland in the WBP. Moreover, no research has been conducted assessing the impact of vegetation (surface roughness) and thermal stratifications impact on boundary layer around a step sequence. The complexity of the WBP (patches of forest, wetland and surface water bodies) has the potential to change how the boundary layer interacts with the wetlands; surrounding wetlands have the potential to modify the initial boundary layer conditions assumed in previous research. Simulations ran in the Regional Atmospheric Forest Large Eddy Simulation (RAFLES) will give insight into the small scale interactions within the space between a BSF and FFS sequence, the impact of surface roughness and thermal stratification on boundary layer separation around these features. Additionally, landscape scale interactions between surrounding wetlands and forest will be assessed to determine if the boundary layers within wetlands are influenced by surrounding wetlands.

Session 120101 - POSTER SESSION - PART 2

Impacts of Climate Change on the Ocean Wave Climate over the Northwest Atlantic Ocean

Guo, Lanli Sheng, Jinyu
Department of Oceanography, Dalhousie University
ln274995@dal.ca

A numerical study is conducted to investigate the impact of global warming induced by possible climate change on ocean surface gravity waves over the northwest Atlantic (NWA) Ocean. The

climate scenario known as RCP8.5 is considered in this study. This scenario corresponds to the pathway with the highest greenhouse gas emissions. Changes in the ocean wave climate over the study region are quantified based on 6 hourly ocean wave simulations for the 120-year period 1980-2100 produced by the third-generation ocean wave model known as WAVEWATCHIII. This wave model is driven by surface winds produced by the Canadian Regional Climate Model (CanRCM4). The study period is divided into the present (1980-2009) and future (2070-2099) periods. In comparison with the present wave climate, the significant wave heights will increase in the future climate over the northeast part of the model domain and will decrease over other areas such as the mid-latitude region between 30-50N, due mainly to the changes in winds in the future climate. It shows that the 10 m winds (U10) and significant wave heights (Hs) increase over Davis Strait and Labrador Sea during boreal winter are associated with the sea ice changes in the future climate. The future changes of the 95th percentile of U10 and Hs are twice as strong as changes in the seasonal means, and the maximum changes of the 95th percentile of U10 are mainly dominated by the changes in storm densities. An analysis of inverse wave ages suggests that wind-driven ocean wave regimes occur more frequently over the subtropical area and Labrador Sea. The dominant North Atlantic storm-track region is found to shift northward, which is the precursor to changes in the winds and ocean waves.

Session 120101 - POSTER SESSION - PART 2

High-Latitude Transport Modelling in support of the Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE)

Henderson, John Nehrkorn, Thomas Mountain, Marikate Commane, Roisin Wofsy, Steven MIller, Charles
AER
jmh@aer.com

We describe high-resolution modelling that underlies the Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE) science analysis. The NASA CARVE mission is an on-going, sub-orbital, multi-year (airborne field study period is 2012-2015), research campaign funded by NASA whose goal is to quantify correlations between atmospheric and surface state variables for the Alaskan terrestrial ecosystems through intensive seasonal aircraft campaigns, ground-based observations, and analysis sustained over a 5-year mission. CARVE-CAN began in May 2014 and extends the airborne observations to the Mackenzie Delta of the Northwest Territories (NWT). The atmospheric modelling provides high-resolution meteorological fields to drive an atmospheric transport model whose source-receptor (footprint) fields are subsequently used in carbon budget analysis studies.Here we provide an overview of the numerical weather prediction and atmospheric transport components of the modelling system used in Alaska and the Mackenzie Delta. The Polar variant of the Weather Research and Forecasting (WRF) was used to drive the Stochastic Time Inverted Lagrangian Transport (STILT) model. For CARVE a triply nested computational domain for WRF was chosen so that the innermost domain with 3.3-km grid spacing encompasses the entire mainland of Alaska and enables the substantial orography of the state to be represented by the underlying high-resolution topographic input field. A similar domain configuration was centred over the NWT for CARVE-CAN. Summary statistics of the WRF model performance indicate good overall agreement with surface and radiosonde observations. The high quality of these fine-resolution WRF meteorological fields inspires

confidence in their use to drive STILT for the purpose of computing surface-influence relationships (footprints) at commensurably increased resolution that will support accurate estimates of CO2 and CH4 surface-atmosphere fluxes using CARVE observations. Examples of three-dimensional flow fields and footprints will be shown.

Session 120101 - POSTER SESSION - PART 2

Modeling coupled hydrology-vegetation dynamics in the Boreal Plains Ecozone

Ireson, Andrew Yetemen, Omer Barr, Alan Melton, Joe Black, Andy
Global Institute of Water Security
andrew.ireson@usask.ca

Hydrological processes in the Boreal Plains Ecozone (BPE) are strongly dominated by vegetation - specifically forested uplands interspersed between wetlands and lakes. It is necessary to model these systems to understand regional and global climate, as well as regional hydrology and vegetation succession. In doing so, certain simplifying assumptions are needed, to do with spatial patterns of geology and landcover, the vegetation characteristics that dominate hydrological responses, and the functional classes of vegetation that are considered. Transpiration is critical, and the different tree species have markedly different transpiration rates and seasonal patterns. In this research, we compare a conventional land-surface scheme (CLASS) with a dynamic vegetation land surface scheme (CTEM). Field sites established ~20 years ago, and continuously monitored since, have relatively uniform vegetation cover, making them ideal to test these models. We explore which vegetation characteristics dominate the hydrological response, with a particular focus on characteristics that may vary significantly within a single plant functional type (e.g. needleleaf trees). We also explore the impact of hydrological variability within the forest and grasslands to the south on the productivity of different plant functional types.

Session 120101 - POSTER SESSION - PART 2

Dissolved organic carbon dynamics in a constructed fen following oil sands extraction

Irvine, Sarah Strack, Maria Price, Jonathan
University of Waterloo
s2irvine@uwaterloo.ca

In the Western Boreal Plain (WBP) fens comprise 50% of the landscape, however much of this area has been disturbed through bitumen extraction in the Athabasca Oil Sands. Since there is a legal requirement to return equivalent land capability, the Nikanotee Fen was constructed. Within the fen, two metres of peat is colonized by moss, planted sedge species and spontaneously occurring vegetation. As the system develops dissolved organic carbon (DOC) will likely no longer be sourced solely from the peat, but additionally from seasonal inputs of vegetation. This source of DOC may have strong implications for its carbon balance and downstream water quality since export of DOC is facilitated by system hydrology. Yet, there is limited information on DOC dynamics in constructed peatlands, with none focusing on site-specific vegetation controls or DOC transport. We report on changes in DOC concentrations through the peat profile, inputs through groundwater and losses from discharge between June and

August 2015. Preliminary results indicate that DOC concentrations increase through the peat profile over time within the Nikanotee Fen, with this effect being most dominant near-surface. Concentrations remain consistent temporally and spatially within mineral substrates which supply the fen with water. Limited discharge through this period is attributed to the small amount of precipitation received (135.8 mm) compared to the climate normal (228.8 mm) for these months. The amount of DOC within the system increased through the summer of 2015 due to greater net production within the fen and consistent inputs through groundwater, while losses of DOC were limited due to low outflow from this system. Therefore, the DOC budget of this constructed fen is primarily controlled by groundwater inputs and within-site production. This is likely a function of minimal precipitation received within this system, and this balance is likely to change under greater precipitation inputs.

Session 120101 - POSTER SESSION - PART 2

Linking Seismic Wave Velocity and Rock Density

Kassam, Anisa Milkereit, Bernd
University of Toronto
anisa.kassam@mail.utoronto.ca

A new unique velocity-density relationship of common silicates, iron-oxides, and massive sulfides has been discovered in a previous study using a database of elastic parameters based on widespread compilation of lab samples. Lab measurements were taken from core samples of isotropic, non-porous metamorphic rocks. In this study, the goal is to use real measurements from borehole logging to link seismic and geotechnical parameters by using a theoretical three-dimensional surface and comparing it to the lab measurements and a seismic Earth model. An approximation of density and elastic moduli based on compressional wave (Vp) and shear wave (Vs) velocities is developed using a three-parameter cross plot of density (d), seismic parameter (sp), and bulk modulus (k). Birchs seismic parameter (sp) is defined assp = Vp^2 - (4/3)Vs^2 and elastic parameters: Youngs modulus (E), incompressibility (k), and shear modulus (u) can be derived from P- and S- velocities:u/d = Vs^2 k/d = Vp^2 - (4/3)Vs^2E=d Vs^2 (3Vs^2 - Vs^2)/(Vs^2 -(1/3)Vs^2)The d-sp-k surface could be derived into parametric equations to then be used for obtaining elastic moduli from Vp and Vs borehole seismic data and as a result provides a link to calculate density. This correlation has far reaching implications for geotechnical applications because borehole seismic data acquisition techniques can can be used to calculate elastic moduli.

Session 120101 - POSTER SESSION - PART 2

The evaluation of depressional features as recharge components within a constructed tailing sands upland and the implications for solute transport

Kessel, Eric Price, Jonathan
University of Waterloo
e2kessel@uwaterloo.ca

The Boreal Forest of the Athabasca Oil Sands Region (AOSR) has been disturbed through surface mining in which the oil companies responsible are required to reclaim the land to the

equivalent land class prior to disturbance. Due to the natural abundance of wetlands prior to disturbance, fen peatland construction has been incorporated in post-mine landscape reclamation. However, the AOSR climate is semi-arid with the annual precipitation less than evaporation, on average, resulting in a serious concern for water quantity when attempting to reconstruct fen peatlands. Depressional features can be designed to optimize the infiltration of precipitation to effectively promote recharge to groundwater storage. By strategically placing these depression features at the toe of slopes or in areas expected to receive high volumes of surface runoff within a watershed, we can maximize the recharge rates to an aquifer. In this study, several small depressional features (recharge basins) were included in the design and construction of a tailing sands upland hydrologically connected to an adjacent fen peatland. Results have shown the importance of these recharge basins on fresh water recharge when compared to base infiltration through the surrounding upland surface. Recharge basins positioned at the toes of slopes were found to be most effective in retaining and infiltrating water. This preferential recharge of fresh water through recharge basins ultimately controlled the trajectory of solute transportation within the upland.

Session 120101 - POSTER SESSION - PART 2

Freeze-thaw cycle effects on phosphorus release from <i>Phleum pretense, </i> a grass buffer strip species, after multiple harvests

Kieta, Kristen Owens, Phil
University of Northern British Columbia
kieta@unbc.ca

Vegetated buffer strips are a common best management practice used in agricultural landscapes because of their proven effectiveness to reduce loading of sediments and nutrients, including phosphorus, to adjacent surface waters. In northern climates, these landscapes are prone to numerous freeze-thaw cycles (FTCs) throughout winter and spring which causes plant cells to lyse. During the freshet, lysed cells release phosphorus and the buffer vegetation can become a source of phosphorus to surface waters. Greenhouse experiments were conducted to understand if the number of FTCs and soil phosphorus concentrations impact the type and concentrations of phosphorus released. Timothy grass <i> (Phleum pretense) </i> was grown under controlled greenhouse conditions in 19 L containers in soil treated with either 80 kg/ha of mono-ammonium phosphate fertilizer (MAP) (12:61:0) or in soil un-amended with MAP. Shoots were harvested twice: after 65 days of growth and again 36 days later to mimic conventional agricultural practices. Biomass samples were subjected to 0, 3, or 6 FTCs consisting of 8 hrs. duration at +4°C and 16 hrs. at -20°C. After completion of respective FTCs, samples were shaken in 100 mL of deionized water. Water samples were filtered and analysed colorimetrically for water extractable phosphorus (WEP) and, after an alkaline persulfate digestion, total dissolved phosphorus (TDP). Results from the both harvests found that there was no significant difference between plants grown in soils amended with phosphorus fertilizer and those in un-amended soil, but that there was a significant difference in WEP and TDP concentrations with increased FTCs. However, concentrations of both WEP and TDP plateau after 3 FTCs. These experiments and comparisons to ongoing field studies at the AAFC research station in Morden, Manitoba will help inform landowners on how to manage buffers to reduce phosphorus loading to surface waters.

Session 120101 - POSTER SESSION - PART 2

Plant water usage in a Canadian Prairie context: Using stable water isotopes to identify uptake sources

Laing, Janelle Ali, Genevieve Casson, Nora Moore, Dana Hanson, Mark Belanger, Jonathon Bansah, Samuel Walker, Matthew Blunden, Laura Ross, Cody
Dept. of Environmental Studies and Sciences, University of Winnipeg; Manitobas Watershed Systems Research Program
janelle.rlaing@gmail.com

This study aimed to test the two water-worlds hypothesis in a Prairie semi-arid environment, which suggests that plants preferentially access tightly-bound soil water over mobile soil water. If true under a range of climates and land uses, this hypothesis could have significant implications for hydrologic process understanding as well as vegetation management. To test this hypothesis, two sites were used in south central Manitoba: a terrestrial hillslope site adjacent to the Red River as well as an aquatic mesocosm site. Rainwater, stream or tank water, mobile soil water (from tension lysimeters), tightly-bound soil water (extracted from bulk soil samples) as well as plant water (extracted from stems) were collected from both sites. ?18O and ?2H signatures were measured for all samples. Scatter plots of ?18O versus ?2H were visually inspected to compare the isotopic signature of the different water types, assuming that clustered water types originate from the same source. At the terrestrial site, vegetation type did not have a significant effect on the water type being used, as shrub water and tree water were isotopically similar. Mobile and tightly-bound soil water isotopic signatures were also shown to be more depleted with depth. At the aquatic site, the isotopic signatures associated with the different water types were overlapping, thus hinting at a significant mixing of all water types. In the terrestrial environment, however, it was found that trees and shrubs take up water which is isotopically different from both mobile and tightly bound soil water. Three distinct water pools were observed in samples collected from the terrestrial site: (1) tightly-bound soil water; (2) rain, stream, and mobile soil water; and (3) vegetation water. This suggests a three water-worlds hypothesis for our Prairie site that can be explained by frozen soil dynamics as well as plant adaptive mechanisms in water-scarce regions.

Session 120101 - POSTER SESSION - PART 2

Circumpolar Assessment of Trends in Arctic Freshwater Systems

Lento, Jennifer Culp, Joseph Goedkoop, Willem
Canadian Rivers Institute, University of New Brunswick
jlento@gmail.com

The freshwater group of the Circumpolar Biodiversity Monitoring Plan (Arctic Council: Conservation of Arctic Flora and Fauna) has begun circumpolar assessments to determine the state of Arctic freshwaters. Assessments are focused on status and trends in abiotic and biotic components of these freshwater systems. This evaluation includes examination of data from both historical (1850-1950) and contemporary time scales (post-1950), as well as traditional ecological knowledge of Arctic peoples. We highlight multiple-stressor scenarios that act on the

biodiversity and biogeochemistry of Arctic freshwaters, and cause change in biological communities of lakes and streams. Assessments compare and contrast the regional state of Arctic freshwater ecosystems in North America, Iceland, Greenland and Fenno-Scandia. In addition, circumpolar assessments for specific focal ecosystem components, namely water quality, hydrology, fish, benthic invertebrates, benthic algae, macrophytes and plankton, provide novel analyses of how climate change affects environmental drivers and biological components of freshwaters. For example, we explore driver-response relationships across latitudinal and longitudinal spatial scales to determine whether similar patterns are evident throughout the sub-, low-, and high-Arctic. This study represents the first circumpolar assessment of trends in Arctic freshwater biodiversity.

Session 120101 - POSTER SESSION - PART 2

Improvement of the MOHID Oil Spill Model for Prediction of the Fate/Behaviour of Oil Spills on Scotian Shelf

Li, Shihan Niu, Haibo
Dalhousie University
sh987503@dal.ca

MOHID water modelling system is a 3-dimensional water modelling system, consists of hydrodynamic, wave, sediments transport, sand, water quality, turbulence, Lagrangian transport, and oil spill modules. The oil spill module is a three-dimensional model that uses the Lagrangian tracers to simulate the oil fate and transport processes. To improve the performance and accuracy of MOHID, a new oil natural dispersion algorithm and a biodegradation module have been implemented into the model. The dispersion algorithm is based on SINTEFs latest semi-empirical model. The model introduces a non-dimensional number, Modified Weber Number, to calculate the oil droplet size distribution resulting from the actions of breaking waves. The biodegradation module uses a first order biodegradation equation to calculate the removal of oil by microbial-biodegradation process. The biodegradation coefficients for different oil components were obtained from laboratory experiments. A case study of a hypothetical oil spill has been conducted to evaluate the effects of this new development on the overall oil mass balances and fate and transport process. The selected study area was the Scotian Shelf where the hourly currents from a high resolution (1/36°) NEMO model and winds from NCEPs Climate Forecast System Reanalysis (CFSR) dataset were used to force the oil spill model. Results from the MOHID model were compared with a state-of-the-art oil spill model, Oil Spill Contingency and Response (OSCAR), for model cross-validation.

Session 120101 - POSTER SESSION - PART 2

Airborne far-infrared measurements of the Arctic atmosphere during the NETCARE 2015 campaign

Libois, Quentin Ivanescu, Liviu Blanchet, Jean-Pierre Pelletier, Ludovick Coursol, Laurence Barbero, Francesco Bouzid, Yacine Proulx, Christian
Centre ESCER, Université du Québec à Montréal, 201 avenue Président-Kennedy, Montréal, QC H2X3Y7
libois.quentin@uqam.ca

The water cycle in the Arctic is not well understood. In particular, ice clouds, which play a significant role in the radiative budget of this region, remain poorly known. The deployment of CALIPSO and CloudSat satellites highlighted the ubiquity of optically thin ice clouds during the polar night in the Arctic. These clouds can significantly alter the amount of far-infrared radiation escaping the Earth, hence the wintertime energy budget. Since their signature in the far-infrared is very sensitive to their microphysical properties (crystals size and shape) and optical depth, these quantities can be retrieved from satellite observations in this spectral range. Such measurements were until recently constrained by technological limitations, but recent advancements in microbolometers technology have allowed to study this under-explored spectral region. In this context, a satellite mission dedicated to studying thin ice clouds in the Arctic (TICFIRE) is under review at the Canadian Space Agency. In support of this mission, a breadboard far-infrared radiometer (FIRR) was developed and operated during the Pan-arctic NETCARE 2015 campaign. Here we present the measurements performed during this one-month airborne campaign.On board the instrumented aircraft Polar 6, the FIRR was looking downward to mimic satellite observations. Simultaneously, atmospheric profiles and clouds microphysical properties were measured by probes mounted on the same aircraft. A variety of atmospheric conditions were encountered during the campaign, allowing to investigate the radiative properties of clear atmospheres, ice clouds, mixed-phase and liquid clouds in the far-infrared. Measured radiances are compared to radiative transfer simulations to highlight the sensitivity of the radiative properties of the atmosphere to water vapor amount and clouds microphysical properties. In particular, measured vertical profiles of radiance are successfully simulated, providing consistent radiative closure experiments. This study is a first step toward the retrieval of water vapor and clouds properties using far-infrared satellite observations.

Session 120101 - POSTER SESSION - PART 2

Disentangling the mechanisms behind warming, nitrogen fertilization, and vegetation composition effects on greenhouse gas emissions from peatland

Luan, Junwei Wu, Jianghua   Wang, Mei
Grenfell Campus, Memorial University
jwu@grenfell.mun.ca

Peatlands play an important role in global carbon cycling. However, our understanding on how the future warming, atmospheric nitrogen (N) deposition, changes in vegetation composition and their interactions will impact the greenhouse gas (GHG) emissions from peatlands are still limited. We employed a unique field manipulative experiment on temperature (warmed, control), N level (N added, control), and vegetation composition (Graminoids presence/absence, shrubs presence/absence) in a boreal peatland. Our data provided direct evidences on the interactive

effects of warming, nitrogen addition, and vegetation composition on GHG emissions. A delayed response of ecosystem respiration to the manipulation may exist. Methane and N2O fluxes responded quickly to the manipulation. Warming doubled the CH4 emissions. However, the N addition counteracted most (77%) of the warming-induced CH4 emissions, which may be attributed to the interactive effect of temperature on C-N coupling. Further, the effect of warming on CH4 emission was modulated by vegetation composition. Methane flux responded more intensely to warming with the absence of graminoids than with the presence of gramnioids. The removal of shrubs had a less impact on CH4 emission in response to warming than graminoids removal, suggesting that the predicted shift in species composition will lead to a more pronounced response to climate warming than expected. For the N2O flux, warming alone did not accelerate the N2O emission while it interactively accelerated N2O emission with N addition, suggesting that the response of N cycling to atmospheric N deposition will be accelerated by warming. Also, the projected shift in species composition, such as from graminoids to shrubs dominated, will lead to tremendous positive responses of N2O emission between peatland ecosystem and the atmosphere to the expected warming and the increasing atmospheric N inputs. Our research reveals complex interactive effects between climate, N addition, and plant functional group composition on ecosystem-atmosphere GHG exchanges.

Session 120101 - POSTER SESSION - PART 2

Biofuel production using willow (Salix spp.): influence of nitrogen fertilizer on soil CO2 and N2O emissions

Lutes, Katelyn Oelbermann, Maren Thevathasan, Naresh V. Gordon, Andrew M.
University of Waterloo
klutes01@gmail.com

Willow (Salix spp.) grown in short-rotation coppice systems on marginal lands, are an effective biofuel option to provide ecosystem services, including carbon (C) sequestration. Nitrogen (N) fertilizer application is a common management practice in these systems as it increases aboveground woody biomass production and maintains soil productivity. However, it also affects soil C and N transformations, which can lead to greater soil-derived CO2 and N2O emissions. The objective of this study was to examine the effect of N fertilizer addition on greenhouse gas emissions in short-rotation willow biomass plantations, and relate these findings to soil temperature, moisture and NH4+ and NO3- concentrations.Two willow clones [S. miyabeana (SX67), S. dasyclados (SV1)] were evaluated for CO2-C and N2O-N emissions, and soil chemical characteristics in a split-plot design with fertilized and unfertilized treatments in Guelph, Ontario. Mean CO2-C emissions from SV1 and SX67 ranged from 72 to 91 mg CO2-C m-2 h-1 in fertilized treatments, and from 63 to 105 mg CO2-C m-2 h-1 in unfertilized treatments, respectively. Carbon dioxide emissions were strongly affected by seasonal temperature and moisture variability and availability of soil organic C. Nitrous oxide emissions, and NO3- and NH4+ soil concentrations increased immediately following fertilizer application. Elevated N2O-N emissions persisted for approximately month. Mean N2O-N emissions from SV1 and SX67 from fertilized treatments ranged from 22 to 26 ?g N2O-N m-2 h-1 and was significantly higher than emissions from unfertilized treatments, which ranged from 16 to 17 ?g N2O-N m-2 h-1. There was no significant difference between N2O-N emissions from clones SV1 and SX67, and N2O-N emissions were weakly correlated to soil temperature and moisture.

Results indicated that N2O emissions were more strongly affected by inorganic N fertilizer application than fluctuations in soil moisture and temperature associated with seasonal changes.

Session 120101 - POSTER SESSION - PART 2

Ionic Aluminium Levels Toxic for Aquatic Organisms in South Western Nova Scotia Rivers

MacLeod, Sarah Sterling, Shannon Clair, Thomas Jamieson, Rob Jamieson, Rob
Dalhousie University
sarah.macleod@dal.ca

Ionic aluminium (Ali) is highly toxic to aquatic organisms, and has been responsible for the decline in several Atlantic salmon populations. Most areas that have been recovering from acidification have decreasing aluminium levels; however, total Al levels have been increasing in Nova Scotia, and the trends of Ali are unknown. For this study, we sampled stream chemistry weekly speciating for Ali, in South Western Nova Scotia (SWNS). Results reveal Ali concentrations exceed the European Inland Fisheries and Aquaculture Advisory Commission threshold for Atlantic salmon of 15 ug/L for 74% of the samples. We found the highest Ali concentrations during winter months. We developed an empirical model to predict concentrations from standard water quality, as speciating Ali is difficult and expensive in the field. By monitoring and assessing the concentrations of Ali in acidified rivers, we can formulate solutions, which restore aquatic habitat and help stop the extirpation of the Atlantic salmon.

Session 120101 - POSTER SESSION - PART 2

Climate projections of the occurrences of mixed precipitation over southern Quebec

Matte, Dominic M. Thériault, Julie   Laprise, René
UQAM
mattedominic3@gmail.com

Freezing precipitation events can have major impacts on the society by causing power outages and disruptions to the transportation networks. These types of precipitation such as freezing rain and ice pellets are formed through complete or partially melting of snow as it falls through the atmosphere. Despite the catastrophic consequences associated with these precipitation types, very few studies have investigated how the occurrences will evolve under warmer climate scenarios. The goal of this study is to investigate the evolution of the mixed precipitation region over southern Quebec with climate change.This study used 4 methods (Bourgouin, Ramer, Czys and Baldwin) to diagnose freezing rain, ice pellets and their combination based on the fifth-generation Canadian Regional Climate Model with climate scenario RCP 8.5 at 0.15° grid-mesh. The analysis of the diagnosed precipitations is studied in past climate (1980-2009) and compared with future climate scenarios (2070-2099). Preliminary analysis suggested that the accumulated of freezing precipitation of some regions of southern Quebec increases for the months of January and February with small changes during the other winter months. The results also show the uncertainty associated with the different used to diagnose the type of precipitation. Overall, this study contributes to better understand how the distribution of precipitation types will change in a

warmer climate and highlight the sensitivity of atmospheric conditions to the type of precipitation reaching the surface.

Session 120101 - POSTER SESSION - PART 2

Oceanographic impact on the performance of fish tag monitoring stations on the Scotian shelf.

Moore, Danielle Barclay, David
Dalhousie University
dbarclay@dal.ca

The Ocean Tracking Network operates and maintains a continental shelf scale array of 256 bottom mounted fish-tag monitoring stations, spanning from the entrance of Halifax harbour to the Scotian shelf break. These stations detect tagged keystone, commercially important, and endangered species as they migrate across this acoustic curtain, known as the Halifax line. The detection performance of each station is dependent on the local bathymetry, oceanography (sound speed profile variability), ambient noise level, and source depth distribution. At each station, local sound speed profiles from archived glider data were collected and sorted into representative groups. An Nx2D ray-trace model was used to calculate the transmission loss at fish tag frequencies (69 kHz) for each of the representative sound speed profiles at a number of stations across the array. Geophysical uncertainty and an empirically derived computational shallow water noise model are used to predict the performance variability at each station and make inter-station comparisons.

Session 120101 - POSTER SESSION - PART 2

Temporal and seasonal variations in permafrost pond chemical trajectories with implications for scaling to river export

Morison, Matthew Macrae, Merrin Petrone, Richard Fishback, LeeAnn
University of Waterloo
mmorison@uwaterloo.ca

In permafrost peatland systems, shallow freshwater bodies have been the subject of interest due to their ubiquity in the landscape and capacity to store and exchange carbon. The intake of carbon is driven by primary productivity, which is frequently limited by bioavailable forms of phosphorus and nitrogen, although conditions of limitation may vary greatly over short spatial scales. This research set to out determine if temporal variability (seasonal, weather-driven) exceeds spatial variability in pond biogeochemical processes in tundra landscapes. Further, this research aimed to determine if it is possible to scale temporal/seasonal dynamics in pond hydrochemistry from small inland freshwater bodies to larger tributaries that contribute to freshwater fluxes towards the Hudson Bay. A suite of twenty ponds and their catchment areas located across three larger subwatersheds were selected for analyses. The ponds span a range of biophysical properties including pond area, perimeter, basin morphology, hydrological connectedness, sediment composition (mineral/organic), and depth. In addition, three major tributaries flowing directly to the Hudson Bay were selected to determine how inland pond-peatland processes relate to hydrochemical export from larger rivers. Samples were analysed for

isotopic signatures (hydrogen and oxygen), nutrient speciation (nitrogen and phosphorus), and major ions. Evapoconcentration of conservative major ions (chloride, sodium) over the growing season indicates linkages between terrestrial catchment processes and export regimes (either lentic or lotic) operate similarly, although biological processes vary, with pond chemistry driven by benthic bioassimilation. Further, this work demonstrates the importance of high temporal resolution in sampling design. Variation in pond chemistry of nutrient species during a single precipitation-runoff event can exceed the variability of the rest of the snow-free season. Singular water column samples taken to represent the entirety of a growing season do not capture this variability, with important implications for temporal and spatial scaling of singular water sample chemistry data.

Session 120101 - POSTER SESSION - PART 2

Future changes in precipitation and temperature extremes in western Canada

Najafi, Mohammad Reza Cannon, Alex Werner, Arelia Schnorbus, Markus Zwiers, Francis
Pacific Climate Impacts Consortium, University of Victoria
rnajafi@uvic.ca

Water resources management in western Canada is challenging because of the complex topography of this region and its large spatio-temporal hydroclimate variability. Although there is substantial evidence for rising global and regional temperature due to climate change, the assessment of the subsequent changes in future temperature and precipitation extremes is difficult because of data limitations. In this study, a set of simulations from the Coupled Model Intercomparison Project Phase 5 are downscaled to daily temporal and 1/16° spatial resolution using a hybrid method that combines results from Bias Correction/Constructed Analogues with Quantile mapping reordering (BCCAQ). Separate analyses of the annual and seasonal maximum precipitation and temperature are conducted based on the extreme value theory for the historical and future periods. We compare the conventional extreme analysis results, obtained by fitting a parametric distribution to records at each grid cell, to estimates from two regional frequency analysis methods including hierarchical Bayesian and index flood. Bayesian model averaging is then applied to find the multi-model ensemble averages and the corresponding uncertainties. Preliminary results show an overall projected increase in both precipitation and temperature extremes. These changes are more pronounced in higher elevations.

Session 120101 - POSTER SESSION - PART 2

Impacts of possible future atmospheric concentrations of carbon dioxide on the productivity of boreal feather mosses in Newfoundland

Nimmo, Victoria Zhu, Xinbiao Wu, Jianghua
Memorial University of Newfoundland
victoria.nimmo@gmail.com

The harvesting of the boreal forest within Canada is a large scale activity, and the effects it may have on the forest floor bryophyte species ability to respond to future atmospheric carbon dioxide (CO_2) levels is relatively unknown. This study took place in a black spruce forest in

Western Newfoundland, which was harvested 8 years prior to our study. Four moss species (Sphagnum spp, Hylocomium splendens, Ptilium crista-castrensis and Pleurozium schreberi), which are all widespread on the forest floors, were harvested bi-monthly from both harvested and unharvested control sites over the course of summer and fall 2015. Their instantaneous photosynthesis rates were measured in a chamber with increasing CO2 concentrations ranging from 390 ppm to 590 ppm in 50 ppm increments. In August, we extended the CO2 level to 1050 ppm to follow along with the IPCC climate change scenarios, and photosynthesis was measured at the CO2 concentrations of 390, 490, 650, 850, and 1050 ppm. Our results showed a clear and consistent pattern of increasing instantaneous photosynthesis for both clearcut and control samples. In the case of P. crista-castrensis, large variation in tissue moisture content impeded the response of photosynthesis to CO2 treatments. This study suggests that increased atmospheric carbon could potentially lead to more productive forest floor bryophytes, though only if moisture conditions were not limiting. More studies should be completed to better comprehend whether these increases in photosynthesis would be maintained over a longer term.

Session 120101 - POSTER SESSION - PART 2

A comparison of chloride concentration dynamics in stream, hyporheic zone and groundwater compartments of multiple urbanizing catchments in the Lake Simcoe and Nottawasaga River watersheds

Oswald, Claire Nicholls, Erin Oni, Stephen Wellen, Christopher
Ryerson University
coswald@ryerson.ca

In seasonally frozen environments, de-icers (chloride salts) are widely used to maintain safe driving conditions on roads and other impervious surfaces. In urbanizing catchments of the Lake Simcoe watershed, stream chloride (Cl) concentrations often exceed environmental protection guidelines during winter high flows and summer baseflow. In this study, we are investigating the size and dynamics of the Cl storage pool which feeds summer baseflow Cl concentrations. Our field monitoring program focuses on determining the lag time between applications of road salt and rising in-stream, hyporheic zone and groundwater Cl concentrations. We are studying whether or not these potential Cl storage pools are in equilibrium with road salt applications, or if they have been increasing over time. Using a nested catchment approach, we have instrumented four catchments located in the Lake Simcoe and Nottawasaga River watersheds with in-stream, hyporheic zone and shallow groundwater continuous electrical conductivity sensors. Relationships between continuous conductivity measurements and discrete, manually sampled Cl concentrations will allow us to estimate continuous Cl concentration records. The instrumented catchments span a range of land uses, from dominantly agricultural to urbanizing. The spatial configuration of our conductivity monitoring sites in each catchment allows us to examine the downstream evolution of Cl concentrations in each potential storage pool in relation to changes in land use and road maintenance protocols. The results of our study will allow us to determine whether or not the delayed summertime release of Cl reported in many urbanizing streams is a function of water transit time. These findings will be used to inform a conceptual and hydrological-based model of Cl transport for the study catchments. Our results will ultimately help regional and municipal environmental stakeholders understand and manage the relationship between urban development and elevated Cl concentrations in aquatic ecosystems.

Session 120101 - POSTER SESSION - PART 2

Assessing Historical Changes to the Upper Peace River Flow Regime - CHIC Happens

Peters, Daniel Baird, Donald Monke, Wendy Schrorbus, Markus Shrestha, Rajesh
Environment and Climate Change Canada
daniel.peters@canada.ca

Environmental flow needs and climate change assessments frameworks incorporate a range of ecologically-relevant hydrological variables. However, when applied in cold regions, these approaches have largely ignored the influence of winter ice cover and the spring freshet on hydrological regimes - key components of river systems in cold regions with direct effects on water quality, aquatic habitat and ecology. We identified several ecologically-relevant hydrological measures, pairing these with established metrics for incorporation into an enhanced suite of indicators specifically designed for cold regions. The goal of this paper is two-fold: 1) Present the Cold-regions Hydrological Indicators of Change (CHIC), which can provide the basis for the assessment of ecological flow needs and climate change assessments in cold-region river ecosystems; 2) Apply the CHIC approach to assess historical climate change and flow regulation changes to the upper Peace River flow regime.

Session 120101 - POSTER SESSION - PART 2

Internal Tidal Wave Propagation under the Landfast Sea Ice in the Southeast Hudson Bay.

Petrusevich, Vladislav Dmitrenko, Igor Kirillov, Sergei Kuzyk, Zou Zou Heath, Joel Eastwood, Rosemary Barber, David Ehn, Jens
University of Manitoba, CEOS
vlad.petrusevich@umanitoba.ca

Hudson Bay (HB) is a second largest saltwater bay in the world. It is relatively shallow with average depth of 100m and high tidal amplitudes (up to about 4m). Several major rivers are discharging into HB currently being regulated due to hydro dam development causing freshwater discharge to increase in winter months. All these factors makes HB a unique oceanographic system for study atmospheric-oceanographic coupling and freshwater impact.During January-March 2014 the CTD survey was conducted around Belcher islands in the southeastern HB. An ice-tethered mooring consisting of 9 conductivity and temperature (CT) sensors and acoustic Doppler current profiler (ADCP) was deployed in a narrow channel between Broomfield and OLeary islands located in the south east tip of Belcher islands group in HB as a part of an oceanographic monitoring program in that region. The CTD profiles show the surface freshened layer caused by cyclonic circulation of river runoff water in Hudson Bay. In the bottom layer, warm and saline water was recorded increasing meridionally towards the south. Such layer preserved in the south due to presence of salinity/density vertical stratification that prevents vertical mixing. The mooring recorded semidiurnal oscillations of temperature and salinity through the whole water column. Our objective was to examine the origin of this temperature and salinity variability. The tidal analysis was performed for M2 as main tidal constitutes. The tidal ellipses were computed for horizontal velocity at various depths with overlay of corresponding salinity and temperature values. From the mooring time series the M2 temperature

and salinity amplitudes were calculate for each depth. Tidal ellipses showed dominance of the baroclinic tidal pattern through the water column. The generation of internal waves normally corresponds to a baroclinic wave drag over bathymetry features which leads to barotropic tide energy transfer into internal baroclinic waves. Based on velocity, temperature and salinity data and tidal analysis we came to conclusion that our mooring recorded internal tidal waves produced from interaction of tides with bathymetry of the narrow channel between Broomfield and OLeary islands.

Session 120101 - POSTER SESSION - PART 2

Variability of water quality in space and time in a cold, mesoscale, heavily engineered Prairie watershed

Rabie, Maliheh Ali, Genevieve Spence, Christopher Schmall, Adrienne Ross, Cody Hague, Md Aminul Bansah, Samuel

Department of Geological Sciences, University of Manitoba, Winnipeg, Manitoba, R3T 2N2. Manitobas Watershed Systems Research Program. Center for Earth Observation Science, University of Manitoba

rabiem@myumanitoba.ca

While the relationship between hydrology and nutrient export has been investigated around the world, there is still a lack of understanding when it comes to cold, mesoscale, flat and heavily engineered Prairie watersheds. Two research questions were therefore the focus of this study: 1) How do spatial and temporal patterns of water quality vary in an agricultural watershed in the absence of significant topographic relief?, and 2) What is the role of engineered drain tributaries in conveying nutrients downstream and ensuring longitudinal connectivity? Ten sampling stations were selected within the 589 km2 Elm Creek watershed located in Manitoba, Canada. EC (Electrical Conductivity) and SRP (Soluble Reactive Phosphorus) concentrations were measured for surface water samples collected at the outlet of the watershed and in drain channels on 15 occasions throughout spring and summer 2014. The 30 survey-specific maps of EC and SRP concentrations were compared in light of seasonal differences and short-term antecedent moisture conditions, and the relationships between EC and SRP concentrations at the outlet versus the drain tributaries were investigated. The range of EC and SRP concentrations was 212-2250 ?S/cm and 0-4.54 ppm, respectively. Some upstream-downstream patterns were illustrative of increasing longitudinal connectivity downstream as concentrations recorded in upstream drain channels were always lower than those recorded at the watershed outlet. However, on some dates, some upstream drains had higher EC and SRP concentrations than the outlet, thus showing that some of the water or phosphorous was lost or stored upstream and never reached the outlet or that dilution effects occured. This preliminary assessment provides a broad picture of EC-rich groundwater movement and phosphorous-rich surface water movement across the watershed. Future analyses will involve integrating other meteorological and hydrological data to describe those water quality dynamics in more detail.

Session 120101 - POSTER SESSION - PART 2

An Analysis of Methane and Carbon Dioxide Exchange in a Post-Extraction, Unrestored Peatland in Eastern Québec

Rankin, Tracy Strachan, Ian   Strack, Maria Pelletier, Luc Nugent, Kelly
McGill University
tracy.rankin@mail.mcgill.ca

Peatlands are significant long-term sinks of carbon. The extraction of peat (e.g. for agricultural purposes) leads to a shift in the natural carbon dynamics. Additionally, the change in environmental conditions after extraction could allow invasive species to establish and spread across the peatland. Many studies have shown the benefits and advantages of various restoration management practices, but the carbon exchange from unrestored peatlands has yet to be examined. We measured methane and carbon dioxide fluxes from a post-extraction, unrestored peatland in Eastern Québec at both the plant community scale (using static chamber measurements) and at the ecosystem scale (using tower flux measurements). Results at both scales indicate that the site is, as expected, an overall source of carbon to the atmosphere. Phragmites and Typha, both invasive species, have established themselves in the ditches, and are sources of methane; partially explaining why the peatlands net carbon flux to the atmosphere has changed. A vegetation survey provided insight into the relative contributions of each plant community to the total methane and carbon dioxide fluxes at the peatland site. The eddy covariance tower measures higher methane fluxes from the direction of the ditches and from where the invasive species are located. The net uptake of carbon dioxide from the peatland does not compensate for the total amount of methane released. Therefore, should the invasive species continue to spread, the peatland will become an even greater net carbon flux to the atmosphere. Ultimately, this study will help managers assess the importance of post-extraction peatland restoration.

Session 120101 - POSTER SESSION - PART 2

Evaluating the composition of dissolved organic carbon (DOC) with the use of fluorescence indices between a reclaimed and two natural wetlands, Fort McMurray, Alberta.

Rastelli, Jessica Carey, Sean Oswald, Claire
McMaster University
rasteljs@mcmaster.ca

The oil sands extraction process in Northern Alberta is very extensive, as it requires the removal of vegetation and overburden materials from the landscape surface. By law, mining companies are required to restore the land to its previous capability once operations have ceased. To achieve this, reclamation practices have been initiated; however, limited research has focused on upland-wetland systems in the oil sands region. In 2012, Syncrude Canada Ltd. constructed a 52-hectare wetland, known as Sandhill Fen Watershed (SFW). SFW is a highly managed system that is composed of water storage and outlet pond, underdrains, hummocks and perched and lowland fens. DOC is a major source of carbon and plays an important role in wetland biogeochemical and ecological functions. In disturbed landscapes, it is unclear as to how the quantity and quality of DOC compare with natural analogies. The objective of this research is to determine the spatial and temporal patterns of dissolved organic carbon (DOC) quality and quantity of SFW and compare these findings with those from two natural wetlands near Fort

McMurray, AB. In 2014 and 2015, water samples were collected and analyzed for DOC concentration and optical properties. To assess DOC composition, four fluorescence indices were used: Fluorescence Index (FI), Freshness Index (?/?), Humification Index (HIX) and Specific Ultraviolet Absorbance at 254nm (SUVA254). Results indicate that there is significant difference between SFW and the natural fens for all fluorescence indices and DOC concentration. The natural wetlands exhibit high humification and decomposition from plant-derived sources, in contrast to the variability observed at SFW for all indices. Within SFW, evidence suggests a transition from lowland to transitional-upland areas of older, terrestrially-derived to recently produced, microbially-derived carbon. Additionally, overall humification and aromaticity decreases in the transitional-uplands areas. Future analysis will include further characterization of DOC using a PARAFAC model.

Session 120101 - POSTER SESSION - PART 2

The physical context of seasonal and inter-annual variability in phytoplankton blooms across the Scotian Shelf: insights from gliders

Ross, Tetjana Craig, Susanne Dever, Mathieu Beck, Matthew Comeau, Adam Davis, Richard
DFO
richard.davis@dal.ca

Understanding how phytoplankon blooms respond to their physical environment is key to predicting how bloom dynamics might change under future climate change scenarios. Phytoplankton are at the base of most marine food webs and play an important role in drawing CO_2 out of the atmosphere. We use 4 years of CTD, irradiance and Wetlabs ECOpuck equipped Slocum glider deployments across the Scotian Shelf, near Halifax, Nova Scotia, Canada, to examine the seasonal and inter-annual variability in phytoplankton blooms and their physical context. Consistent with previous studies, we find that the main spring bloom occurs before the onset set of the seasonal stratified layer. In fact, the largest chlorophyll observations consistently occurred when there was very little stratification in the upper 60 meters. This bloom, which appears to be diatom dominated in the spring, was followed by a non-diatom-dominated second phytoplankton community, located below the mixed layer. The strength and persistence of this subsurface layer suggests that there is significant primary productivity on the Scotian Shelf that is not visible from satellite.

Session 120101 - POSTER SESSION - PART 2

Analysis of ice clouds observed during the NETCARE Arctic field experiment

S.Pelletier, Ludovick Girard, Éric Blanchet, Jean-Pierre
UQÀM
ludovick.s.pelletier@gmail.com

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. It is hypothesized 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 and early spring. Recent laboratory experiments have shown that sulphuric acid coating can alter the efficiency of ice nuclei (IN) to nucleate ice crystals. The resulting lower IN concentration found in polluted air masses leads to the decrease of the ice crystal concentration. Since there is less competition for the available moisture, ice crystals reach precipitating sizes leading to the formation of TIC-2.During the NETCARE arctic campaign that took place in April 2015, In-situ measurements of ice cloud (Infrared emission, ice crystal size, chemical composition, IN, etc.) have been performed using the Polar 6 aircraft in several locations in Arctic. These data, in association with satellite products and model backward trajectories, will be used to better understand the formation processes and physical characteristics of these two types of TIC.

Session 120101 - POSTER SESSION - PART 2

Estimating Mixing Rates and Turbulence in the Canadian Arctic from Glider-based Microstructure Measurements

Scheifele, Benjamin Waterman, Stephanie Carpenter, Jeff Merckelbach, Lucas
University of British Columbia
bscheife@eos.ubc.ca

Understanding mixing rates in the Arctic Ocean allows us to estimate vertical heat fluxes through the watercolumn which have the potential to significantly impact heat budgets as well as ocean-sea ice and ocean-atmosphere interactions. We present new observations consisting of 340 quasi-vertical microstructure profiles of shear and temperature variance alongside profiles of finescale temperature and salinity in the Amundsen Gulf region of the Canadian Arctic. We use these to characterize the variability of turbulent mixing rates in both space and time, and to begin identifying the dominant physical processes responsible for mixing in this region. The measurements were collected over two weeks by an autonomous glider in August 2015, and they represent one of the most dense microstructure sampling schemes in the Arctic to date. Profiles encompass the most prominent features of the Arctic water-column, including the warm Atlantic water layer at depths below 250 m, the halocline between the Pacific and Atlantic water layers, and the surface mixed layer which exhibits a strongly stratified base. From the microstructure measurements, we calculate ? and ?, the dissipation rates of turbulent kinetic energy and thermal variance, and using these, estimate the distribution of mixing rates (i.e. the turbulent diffusivity). We relate this distribution to the background environment, the presence of topographic features, and the proximity to the shelf-slope in order to gain insight into the dominant mixing mechanisms.

Session 120101 - POSTER SESSION - PART 2

An assessment of water table dynamics within a constructed reclaimed fen, Fort McMurray, Alberta

Spennato, Haley Nicholls, Erin   Carey, Sean
McMaster University
haleyspennato@gmail.com

Oil sands surface mining in northern Alberta is a process that involves stripping the land of its natural boreal landscape, making reclamation of this disturbed land essential. With the prior success in forest reclamation of upland sites, research focus has shifted to wetland reclamation. In 2012, Syncrude Canada Limited (SCL) finished construction of the Sandhill Fen Watershed (SFW), a 52-ha system that includes an upland area, a fen wetland, hills (classified as hummocks), a freshwater storage pond, underdrain system, and artificial pumps. The aim of this study is to evaluate the spatial patterns of water tables occurring within the system to understand the evolution of flow pathways and hydrological gradients within SFW. Evaluation of these trends can support conceptual theories that uplands will begin to supply lowlands with water, and that water tables can be maintained near the surface in the wetland system. The data collection was from May 2014 through October 2015. Fluctuations in the water table were measured with a network of 28 near surface wells. Results indicate similar trends in the water table in both years, with a steady decline in water table position over the summer, and a response to larger precipitation events in the fall. Lateral gradients within the fen are being established, indicating flow from the upland areas and hummocks towards the lowland, helping to sustain the wetland portion of the system. Future research is necessary to monitor these trends in water tables to ensure water supply is sufficient to allow for peat accumulation, vegetation growth, and reduced salinity levels. Understanding relationships within SFW can then be applied to the design of future reclamation projects.

Session 120101 - POSTER SESSION - PART 2

Evaluating dissolved organic carbon concentration and chemistry using a hand-held colour sensor

Strack, Maria Strack, James Bot, Michael Lazcano, Cristina
University of Waterloo
mstrack@uwaterloo.ca

Inexpensive sensors are becoming increasing available and may reduce the cost of sample processing for environmental studies. We tested an off-the-shelf colour sensor, Nix Pro, for determination of dissolved organic carbon (DOC) concentration and spectrophotometric ratios in filtered peatland pore water samples. The Nix Pro, which includes both a light source and optical sensor, was used to illuminate the filtered water sample against a white background in a dark enclosure. The sensor recorded raw data and calibrated data related to CIE 1931 XYZ and RGB colour space. Water samples were also analyzed for organic carbon content and absorbance at 250, 254, 365, 400, 465 and 665 nm using a spectrophotometer.Differences between repeated measurements with the Nix Pro on the same water sample were less than 2%. We found excellent agreement between the raw Z reading (peak signal at ~450 nm) with spectrophotometric absorbance at 400 and 465 nm (R2 = 0.97, 0.98). Good agreement was also found between these wavelengths and the B channel of the RGB output. The ratio of the raw Z to

raw X data was also well correlated to the ratio of absorbance at 465 and 665 nm (R2 = 0.76). This spectrophotometric ratio, commonly called E4:E6, is indicative of the humic nature of DOC. Ultraviolet wavelengths were outside the range of the Nix sensor. The raw Z data was significantly correlated with DOC concentration (R2 = 0.47, p<0.01), but explained less variation than absorbance at 400 nm as measured by the spectrophotometer (R2 = 0.63). Variation between Nix Pro sensors suggests that individual calibrations are needed for each sensor. Nevertheless, the strong correlation of the Nix Pro readings with absorbance across several wavelengths suggests that it offers an inexpensive and quick alternative for DOC characterization in water samples.

Session 120101 - POSTER SESSION - PART 2

Examining the first three years of site-scale carbon and water fluxes over a constructed fen-upland watershed in Alberta, Canada.

Sutherland, George Ketcheson, Scott   Price, Jon   Petrone, Richard
University of Waterloo
george.sutherland@uwaterloo.ca

Oil sands development in the Western Boreal Plains of northern Alberta (AB) includes widespread surface mining. More than 50% of the land cover impacted by this activity are wetlands--the majority of which are fen peatlands that provide key ecosystem functions in the form of carbon (C) storage, water regulation, and habitat provision. Recently, some oil sands companies have constructed fen peatland watersheds ~40 km north of Fort McMurray, AB. This research examines the initial trajectory of C and water fluxes between a 32 ha constructed Fen-Upland watershed and the atmosphere since its construction (2013-2015). Initial trajectories of the constructed system are evaluated relative to three natural reference fen-upland ecosystems over the same period. Results from 2013 indicate that evapotranspiration (ET) from the constructed watershed (246 mm) was lower than ET measured at reference systems (300-400 mm), however 2014 and 2015 ET rates from the constructed watershed have increased to be within the range seen at reference systems, despite steadily declining precipitation (P) over the same period. This suggests sufficient hydrological self-regulation within the watershed as the region moves into what appears to be a drier period within the regional climate cycle. The constructed Fen was a C source (0.9 g C/m2/day) during the snow-free period of 2013, and has subsequently shifted to a small C sink (-1 g C/m2/day) in 2014 and 2015. These rates of C sequestration are within the range observed at nearby reference fens over the same time period, suggesting sufficient plant-water availability in a changing regional climate cycle. However, soil moisture and vegetation establishment have been the primary factors limiting C storage and ET in the Upland, which has experienced a slow trend towards net C uptake, but remains a C source (3.5 g C/m2/day) to date.

Session 120101 - POSTER SESSION - PART 2

Numerical modelling of sodium transport at a constructed fen in the Athabasca Oil Sands Region (AOSR), Alberta.

Sutton, Owen Price, Jonathan
University of Waterloo
ofsutton@uwaterloo.ca

In response to the legal obligation to investigate peatland reclamation in the AOSR a constructed fen was built on the Suncor Energy Inc. lease, using oil sands process-affected materials (containing residual contamination). Of particular concern is whether residual sodium (Na+) will be flushed from the system, or will accumulate in the rooting zone. The transport and fate of contaminants, and the response to projected climate change are unknown. Furthermore, the implications of the design choices on water and contaminant distributions are not understood. Therefore, a predictive hydrochemical model will be developed to assess the current and potential trajectories of the constructed fen. The objectives of the study are to: (1) determine accumulation rates of Na+ in the shallow subsurface, (2) investigate how modifications to the system geometry could favourably control water and contaminant redistribution, and (3) assess the long-term viability of using constructed fens as a technique to reclaim the post-extraction landscape and suggest recommendations to improve the performance of constructed systems. The numerical model will be developed in HYDRUS, coupled with PHREEQC. Sensitivity analyses will be conducted to evaluate model robustness, assess uncertainty, and quantify the influence that climate, and suboptimal geometry has on solute transport and water redistribution. Accumulation rates of Na+ will determine the fate of the constructed fen, and provide insight on the utility of using oil sands process-affected materials for peatland reclamation. Understanding the sensitivity of the system to altered climatic conditions will allow the design criteria for constructed peatlands to be refined. This has broad implications, not only for improving oil sands reclamation, but also for managing contamination and enhancing resilience to climatic stressors in all constructed wetlands. Finally, simulating deviations from the ideal system geometry will directly inform industry on the suitability of implementing landscape-scale reclamation using constructed fens in different geomorphic settings.

Session 120101 - POSTER SESSION - PART 2

CRCM5 dynamical downscaling over the CORDEX Arctic domain

Takhsha, Maryam Nikiema, Oumarou Lucas-Picher, Philippe Laprise, René Winger, Katja
UQAM
M.takhsha@gmail.com

As part of the CORDEX project, the fifth-generation Canadian Regional Climate Model (CRCM5) is used to simulate the Arctic climate for the historical period driven by reanalyses and for the RCP8.5 scenario driven by the MPI-ESM-LR CGCM output. In our study, we have investigated the effect of large-scale spectral nudging (SN) on the regional climate simulations. Analysis shows that SN has little impact on Arctic regions simulations of CRCM5.We have also conducted another experiment in which the CGCM-simulated sea-surface temperatures (SST) are empirically corrected and used as ocean boundary conditions for an Atmosphere-only GCM simulation (AGCM), which in turn provides the atmospheric lateral boundary conditions to drive

the RCM simulation. This is what we call the 3-step approach of dynamical downscaling (CGCM-AGCM-RCM). This approach has shown to considerably improve the historical simulations in Africa and it is now being assessed over the Arctic. Future projection using this method will be compared with the results obtained with the traditional 2-step dynamical downscaling to assess the impact of correcting systematic biases of SST upon future-climate projections.

Session 120101 - POSTER SESSION - PART 2

An innovative statistical post-processing system and its application during the 2015 Pan Am and Parapan Am Games

Teakles, Andrew Baik, Jonathan Montpetit, Jacques Antonopoulos, Stavros   Saran, Naysan
Environment Canada
andrew.teakles@canada.ca

An experimental infrastructure for the statistical post-processing of operational forecasts was applied to support researchers and meteorologist with air quality forecasts during the Toronto 2015 Pan Am and Parapan Am Games.   The system implements an open-source modular design and has extensible statistical modeling capabilities. It currently issues, in development mode, real-time experimental air quality forecasts for cities across Canada. Several statistical modeling approaches have been explored with the new modeling environment including linear, random forest, and Kalman filter prototypes for air quality forecasts. Batch updates of the statistical models occur weekly using parallel processing on a cluster computing environment. More computationally efficient, yet less flexible, online updating methods are also viable but are not implemented to date. The presentation will provide an overview of the modeling infrastructure and provide some examples of its diagnostic and forecasts capabilities.   This project has been done in collaboration with Weather Element section of Prediction Development Division (CMDW) at the Canadian Meteorological Center (CMC). Design element from the experimental statistical modeling infrastructure are being transferred to a pilot code renewal project, named PROGNOS (Prognostic Numerical Output Statistics) , to extend the capacity of the existing UMOS system for operational post-processing. PROGNOS aims to provide a more versatile, innovative post-processing system at a lower code maintenance cost.

Session 120101 - POSTER SESSION - PART 2

Relationship between Extensive and Persistent Extreme Cold Events in China and Stratospheric Circulation Anomalies

Yang, Hui
Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China.
yanghui@mail.iap.ac.cn

OLR daily mean data from NCAR in America and NCEP/NCAR reanalysis daily data of atmospheric circulation are explored for the analysis of the relationship between extensive and persistent extreme cold events in China and stratospheric circulation anomalies.OLR composite analysis of extensive and persistent extreme cold events indicated that negative OLR anomaly

(cold air) from Central Siberia affected China from north to south and the biggest negative OLR anomaly (cooling) stayed to the north of Nanling mountain. Therefore OLR can represent the spatial-temporal characteristics of winter low temperature in China and the activities of cold air. Further composite analysis on extensive and persistent extreme cold events had systematically revealed the evolution characteristics of atmospheric circulation in the stratosphere and troposphere and shown the circulation anomaly which played an important role in the occurring and vanishing of the cold events.The results showed that significant signal was shown in stratospheric circulation on day -10 (the time of ten days prior to the cold even occurrence), and the height anomaly in arctic stratosphere was positive which propagated downward and then affected the occurrence and development of the high-pressure ridge of Ural mountains in the middle troposphere. The stratospheric circulation in mid-latitude region also bore obvious change which propagated downward and then affected the enhancement of low-pressure trough east of Baikal-Balkhash Lake in the troposphere. Thus the historically rare cold event in China was associated with the changes of the stratospheric circulation. It was worth noting that the circulation changes in stratosphere were ahead of those in the troposphere, which provided a useful signal for the prediction of winter low temperature.

Session 120101 - POSTER SESSION - PART 2

Intraseasonal oscillation linkages to Yangtze Basin rainfall in the Meiyu season

Yao, Yonghong Lin, Hai Wu, Qigang Huang, Ying
Nanjing University
yyh@nju.edu.cn

The 10-20 and 30-60 day oscillations in the tropics and middle-high latitudes are dominant variations linked to summer Yangtze River Basin rainfall. Linkages are investigated separately in early and late onset Meiyu years using daily precipitation at 756 stations in China and NCEP/NCAR reanalysis data from 1979-2012. Development of the wet phase of Yangtze River Basin rainfall in both early and late Meiyu years is closely related to opposite convective phases of 30-60 and 10-20 day oscillations over the South China Sea and coastal southern China. In the 30-60 (10-20) day oscillations, active convection first develops in the Indian Ocean (western tropical Pacific),and moves northeastward (northwestward) with the 30-60 day active center moving much further north.In middle-high latitudes, 30-60 and 10-20 day oscillations have differing teleconnection patterns and wave train propagation. Early onset Meiyu years are associated with a teleconnection pattern from the Atlantic Ocean to the East Asian coast with the 30-60 day oscillation, and the East Asia Pacific (EAP) teleconnection pattern with the 10-20 day oscillation. The middle-high latitude 10-20 day oscillation originates from the high latitude ocean and in early Meiyu years propagates southeastward, enhancing the Lake Baikal high, but in late Meiyu years moves westward and enhances highs in Siberia and North China.Increased rainfall over the Yangtze Basin is attributed to phase locking of tropical and middle-high latitude oscillations, but the anomalous signal from middle-high latitudes appears farther in advance in early Meiyu years.

Session 120101 - POSTER SESSION - PART 2

Downscaling Simulation of the Arctic Climate using the High-Resolution Regional Atmospheric Model PWRF

Zhang, Minghong   Perrie, Will Long, Zhenxia
Bedford Institute of Oceanography
perriew@dfo-mpo.gc.ca

Atmospheric and oceanic components of the Arctic are transitioning to a more dynamic state, compared to earlier decades. Moreover, recent observed decreases in multi-year ice suggest that simulated projections of ice-free Arctic Ocean summers by 2030-2050 may underestimate the observed rate of change. Global Climate Models (GCMs) are useful tools to understand potential climate change on the scale of ocean basins but they lack the spatial resolution to give good estimates over the continental shelf, especially in semi-enclosed systems like the Beaufort and Chukchi Seas. Semi-enclosed seas typically respond to local forcing (including winds, heat fluxes, precipitation and runoff) which is not represented well in GCMs, thus rendering the analysis of their outputs less reliable for shelf and land-bounded waters. In order to better assess ocean climate change over the Arctic, we use a dynamical regional climate downscaling system for simulating the Beaufort Sea and west Canadian Arctic. As a first step, high-resolution, regional climate change projections of atmospheric forcing over the Arctic are conducted following IPCC climate change scenario RCP8.5, downscaling the coarse-resolution global climate model HadGEM-ES2 (1.250x1.50) estimates to finer scale, using the 25km Polar Weather Forecast and Research (PWRF) regional atmospheric model.We present a simulation of the Arctic climatology from the PWRF version 3.6 in comparison with the coarse resolution climate model HadGEM-ES2 and relatively finer ERA-Interim Reanalysis (0.750x0.750) datasets, during the historical period 1979-2004, representing the present climate, with a special focus on the intensity, frequency and tracks of Arctic storms using an advanced cyclone tracking scheme developed by the University of Melbourne. Our results suggest that the model PWRF can capture well the large scale circulation over the Arctic Basin and show improvements in surface fields including surface wind, temperature at 2 meters and surface radiation fluxes, in comparison with the GCM boundary forcing fields, namely HadGEM-ES2. Moreover, the PWRF results greatly improve the simulation in terms of the numbers and intensity of synoptic weather system cyclones over the Arctic basin. Compared with the ERA-Interim Reanalysis data, although the HadGEM-ES2 results greatly underestimate the number and intensity of cyclones in the Arctic Basin, the dynamically downscaled model PWRF results are able to capture the stronger and smaller sized cyclones in the Arctic Basin, in all months. In regards to the number of Arctic cyclones, the PWRF captures more small cyclones in the Beaufort, Barents and Kara Seas than the GCM during the winter time, comparable to that derived from the ERA-Interim Reanalysis; while in the summer months, the PWRF simulates a considerably higher number of cyclones in the whole Arctic Basin than the GCM, but still less than that suggested by the ERA-Interim Reanalysis. Our study not only validates the ability of PWRF to simulate the Arctic climatology, but also suggests that it is necessary to use a finer resolution coupled model to investigate climate change in the Arctic Ocean.