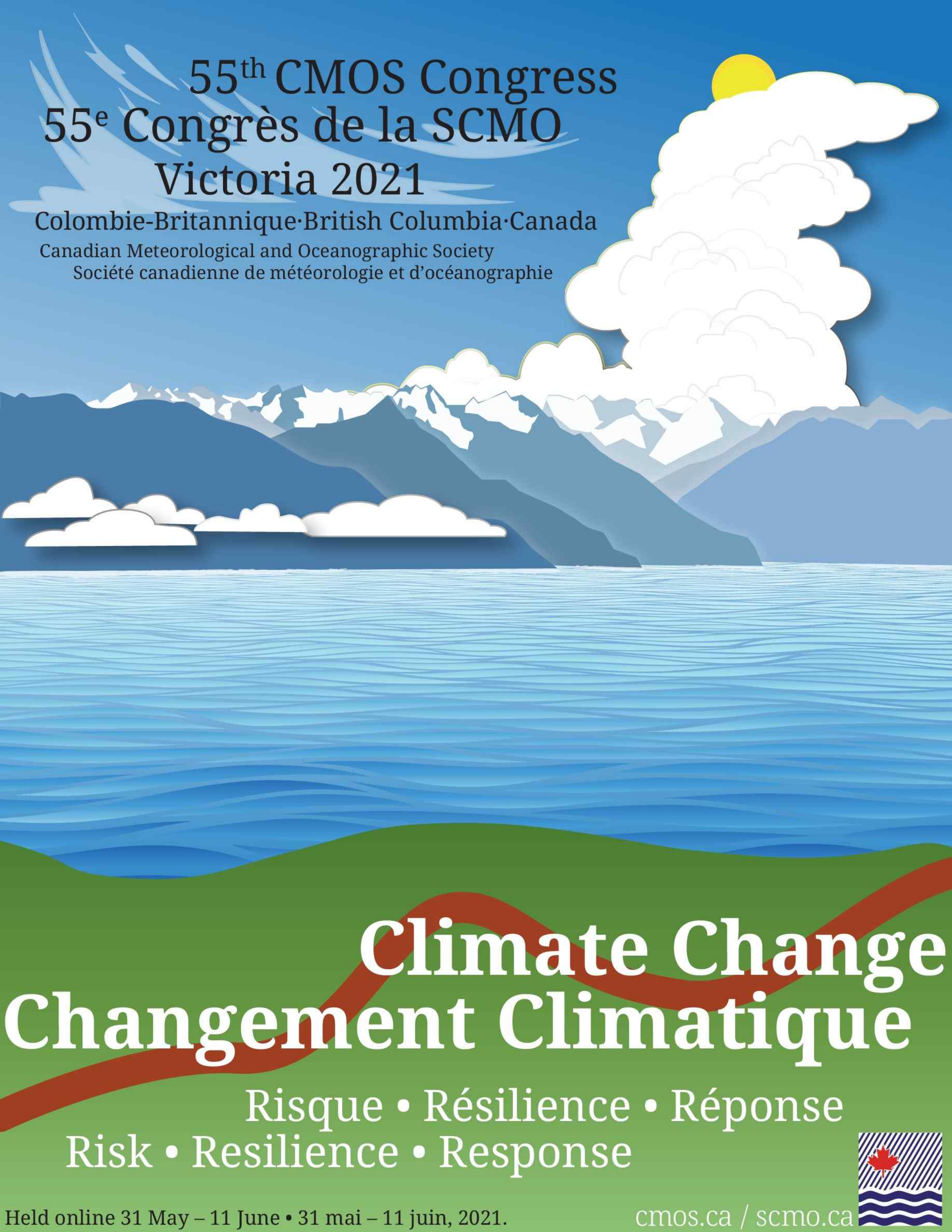

55th CMOS Congress
55e Congrès de la SCMO
Victoria 2021

Colombie-Britannique·British Columbia·Canada

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

Climate Change
Changement Climatique

Risque • Résilience • Réponse
Risk • Resilience • Response

Held online 31 May – 11 June • 31 mai – 11 juin, 2021.

cmos.ca / scmo.ca

Congrès Victoria Congress 2021

55 CMOS SCMO

We acknowledge and respect the lək̓ʷəŋən peoples on whose traditional territory the 2021 CMOS Congress stands and the Songhees, Esquimalt and W̱SÁNEĆ peoples whose historical relationships with the land continue to this day.

We understand that many of you will be joining us in this year's virtual Congress from outside of the City of Victoria. We encourage you to learn whose traditional territory you are participating from. One website where you can do this, Native Land (linked below, and if you click on this image), provides maps of indigenous treaties, territories, and languages.

https://native-land.ca/


Inuvialuit
Inuit
Inupiat
Dënéndeh
K'asho Got'ine
Inupiat
Sahtú Got'ine
Koyukon
Tanana
Hän
Shita Got'ine
Tłı̨chǫ Ndé
Inuit
Holikachuk
Upper Tanana
Dehcho Dene
NWT Métis Nation
Inuit
Carcross/Tagish
First Nation (Yukon)
Yup'ik/Cup'ik
Dene Tha'
Lingít Aaní (Tlingit)
Alutiiq (Sugpiaq)
Beaver
St'aschinuw
(Naskapi)
Gitanyow Lax'yip
Beaver Lake Cree
x̄a'isla wáwís (Haisla)
Nitassinan (Innu)
Helltsuk
Tsuu T'ina
Michif Piyii (Métis)
Quatsino
Okanagan
Anishinabewaki
Cree
Beothuk
Twana/Skokomish
Hunkpapa
Penobscot
Chepenefa
Odawa
Petun
Aucocisco
Ponca
Chit-dee-ni (Chetco)
Iowa
Peoria
Erie
Quinnipiac
Wailaki
Arapaho
Kiikaapoi (Kickapoo)
Tamien
Pamunkey

THE CITY OF VICTORIA — OFFICE OF THE MAYOR

Greetings from Mayor Lisa Helps

On behalf of the City of Victoria, it is my great pleasure to welcome you to the 55th CMOS Congress with the theme for 2021 being *Climate Change: Risk, Resilience and Response.*

It is an honour to have the Vancouver Island Chapter of CMOS hosting this virtual Congress with speakers and delegates from across the globe highlighting national observations, research and services that contribute to reducing society's risk to extreme weather, climate and other environmental events.

The City of Victoria is proud to be considered an urban sustainability leader inspiring innovation, pride and progress towards greater ecological integrity, livability, economic vitality, and community resiliency. Events like these align well with the vision we have for our city, region and planet.

I would like to take this opportunity to thank all of the volunteers, sponsors and organizers for making this exciting event possible.

Enjoy the Congress!

Sincerely,

Lisa Helps
Victoria Mayor

The City of Victoria recognizes the Songhees and Esquimalt Nations in whose traditional territories we live and work
"Hay swx qa"

No.1 Centennial Square Victoria British Columbia Canada V8W 1P6
Telephone (250) 361-0200 Fax (250) 361-0348 Email mayor@victoria.ca

Welcome from the Honourable Jonathan Wilkinson
Minister of Environment and Climate Change

It is my pleasure to welcome you to the 55th Congress of the Canadian Meteorological and Oceanographic Society (CMOS). The theme "*Climate Change: Risk, Resilience, Response*" reflects both the urgency of the climate crisis and Canadians' commitment to building a healthier future for our children and grandchildren.

In 1871, Canada provided initial funding toward a nationally coordinated public weather service, effectively establishing what we know today as the Meteorological Service of Canada (MSC). I hope that you take the unique opportunity provided by this Congress to celebrate the history, the people, and the evolution of Canada's weather services, and to share in envisioning its future.

Over the past 150 years, knowledge, tools, and services have continuously evolved to keep pace with advancements in science and technology and the changing needs of Canadians. During this time, partnerships between governments, academia, private entities, and civil society were essential to delivering weather services in Canada, and remain so today. There are many Canadians who have made outstanding contributions in the fields of meteorology and oceanography, including individuals whose leadership and actions have guided Canada's success internationally and at home. Most recently, Mr. David Grimes served two terms as President of the World Meteorological Organization and received the Order of Canada in 2020. Canada's rich history and ongoing scientific contributions are the foundation upon which we can tackle the complex challenges of the future in an inclusive and equitable manner, and remain resilient in the face of unprecedented weather.

Thank you for your valued contributions to advancing meteorological- and oceanographic-related science and policy. I invite you to take part in celebrating both the MSC's 150th and Environment and Climate Change Canada's 50th anniversaries, and wish you all the best for a successful Congress.

The Honourable Jonathan Wilkinson
Minister of Environment and Climate Change

Mot de bienvenue de l'honorable Jonathan Wilkinson

Ministre de l'Environnement et du Changement climatique

Je suis heureux de vous souhaiter la bienvenue au 55e Congrès de la Société canadienne de météorologie et d'océanographie. Le thème de cette année, « Les changements climatiques : risques, résilience et réponse », illustre à la fois l'urgence de la crise climatique et la détermination des Canadiens à créer un avenir plus sain pour leurs enfants et leurs petits-enfants.

En 1871, le Canada a affecté un financement initial pour un service météorologique public coordonné à l'échelle du pays, créant par le fait même ce que nous connaissons aujourd'hui comme étant le Service météorologique du Canada (SMC). J'espère que vous profitez de l'occasion unique offerte par ce congrès pour célébrer l'histoire, les employés et l'évolution des services météorologiques du Canada et forger l'avenir de ces services.

Au cours des 150 dernières années, les connaissances, les outils et les services n'ont cessé d'évoluer afin de suivre le rythme des progrès scientifiques et technologiques et l'évolution des besoins des Canadiens. Durant cette période, les partenariats entre les gouvernements, les universités, les entités privées et la société civile ont été essentiels à la prestation de services météorologiques au Canada, tout comme c'est encore le cas aujourd'hui. De nombreux Canadiens ont apporté d'énormes contributions dans les domaines de la météorologie et de l'océanographie, y compris des personnes dont le leadership et les gestes ont permis au Canada de briller sur la scène nationale et internationale. Plus récemment, M. David Grimes a effectué deux mandats à titre de président de l'Organisation météorologique mondiale, en plus de recevoir l'Ordre du Canada en 2020. La riche histoire et les contributions scientifiques continues du Canada constituent le socle sur lequel nous pouvons nous appuyer pour relever les défis complexes à venir de manière inclusive et équitable et demeurer résilients malgré des conditions météorologiques sans précédent.

Merci pour vos précieuses contributions qui font progresser les sciences et les politiques liées à la météorologie et à l'océanographie. Je vous invite à participer aux célébrations du 150e anniversaire du SMC et du 50e anniversaire d'Environnement et Changement climatique Canada, et vous souhaite à tous et à toutes un Congrès productif.

L'honorable Jonathan Wilkinson
Ministre de l'Environnement et du Changement climatique


CMOS 2021
Icebreaker
CMOS
SCMO
Come and join us at the CMOS 2021 Icebreaker Event on May 31st !
Meteorology Garden
Oceanography Garden
YOU ARE INVITED!
Wander around a virtual version of Victoria from the comfort of your own sweatpants.
Meet new people, join in on a game of 'Zoom Bingo' (win prizes!), and enjoy entertainment by renowned and award-winning Canadian Comedian, Derek Sequin !
Time: 1 pm PDT / 4 pm EDT
Location: https://gather.town/app/cUnHGHEsB3v5PP4c/CMOS2021

Icebreaker Reception
Monday, May 31
4:00pm EDT - 6:00pm EDT

Join us for the CMOS Icebreaker where there will be an opportunity to casually network with a virtual crowd of colleagues and old friends on the Gather.Town platform. The interactive virtual platform will transport you to downtown Victoria where you can wander around and meet new people, join in on a game of 'Zoom Bingo' (win prizes!), and enjoy hosting and entertainment by renowned and award-winning Canadian Comedian, Derek Seguin (https://www.derekseguin.com/).

Help us kick off CMOS 2021 and enjoy the icebreaker just like you would in real life. Of course, you must supply your own hors d'oeuvres and libations.

1:00pm PDT – Gather.town map opens and participants may join at their leisure.

1:15pm PDT – Welcome remarks from David Lemon, Social Committee Lead, and Matthew Asplin

2:00pm PDT – Entertainment by Derek Sequin and prize winner announced

2:55pm PDT – Additional prize winner announced.

3:00pm PDT – Event formally ends, but map remains live for two additional hours for mingling and informal socializing

We acknowledge the generous donation of a digital gift certificate in the value of $75.00 for our Icebreaker from Two Drunk Witches (https://www.twodrunkwitches.com/), a locally-owned Victoria-based Company that offers clean, natural self-care products. Thank you for supporting our Congress and congratulations to our recipient of this prize, Hayley Dosser!


CMOS 2021
CMOS
Canadian Meteorological and Oceanographic Society
SCMO
Come and join us at the CMOS 2021 Student Reception on June 1st !
Meteorology Garden
Oceanography Garden
YOU ARE INVITED!
Wander around a virtual version of Victoria from the comfort of your own sweatpants.
Discuss your current research, zoom fails, coding nightmares and the dreams and fears of returning to normal human interactions.
Time: 1 pm PDT / 4 pm EDT
Location: https://gather.town/app/cUnHGHEsB3v5PP4c/CMOS2021

Student Reception
Tuesday, June 1
4:00pm EDT - 6:00pm EDT

Join us for the CMOS student reception to meet fellow students in Atmospheric and Ocean sciences. We are using the GatherTown platform, allowing you to wander around a virtual version of Victoria from the comfort of your own sweatpants! You can use your avator to discuss your current research, zoom fails, coding nightmares and the dreams and fears of returning to normal human interactions. Unfortunately, you will have to supply your own libations.

We will place attendees into small groups for a pub style trivia event, the winners of which will receive gift cards.

1:00pm PDT – Gather.town map opens and participants may join at their leisure.

1:15pm PDT – Welcome remarks from Joey Martin and Liz Ramsey, Vancouver Island Student Representatives

2:00pm PDT – Pub style trivia

2:55pm PDT – Prize winners announced

3:00pm PDT – Event formally ends, but map remains live for two additional hours for mingling and informal socializing

TIME	ROOM	SESSION	CHAIR
May 31, 2021	**Monday - Day 1**		
11:00 - 11:30 EDT		OPENING SESSION	Marek Stastna David Fissel
11:30 - 12:30 EDT	ROOM A	110 Plenary - Andrew Weaver - Global warming: A question of priorities	Ken Denman
12:30 - 14:00 EDT	ROOM A	810 Atmosphere, Ocean, and Climate Dynamics - Part 1	Michael Waite Marek Stastna Adam Monahan Ron McTaggart-Cowan
12:30 - 14:00 EDT	ROOM B	250 General Session - Part 1 - Weather Prediction Modelling	C. Harold Ritchie
12:30 - 14:00 EDT	ROOM C	330 Environmental monitoring and observation at high latitudes and high altitudes: challenges, solutions and opportunities	Michael Allchin
12:30 - 14:00 EDT	ROOM D	870 In Memory of Paul LeBlond: Physical Oceanographic Research	Bill Crawford Susan Allen
14:00 - 14:30 EDT		NETWORKING / EXHIBITS	
14:30 - 15:15 EDT	ROOM A	1011 POSTER SESSION - PART 11 - Climate Variability	Adam Monahan James Anstey
14:30 - 15:15 EDT	ROOM B	1012 POSTER SESSION - PART 12 - In situ measurement of precipitation and snow cover: advances, challenges, and ongoing issues	Craig Smith Eva Mekis
14:30 - 15:15 EDT	ROOM C	1013 POSTER SESSION - PART 13 - Open Ocean Processes and Models	Paul Myers
14:30 - 15:15 EDT	ROOM D	1014 POSTER SESSION - PART 14 - Panel Discussiion: Canada and the UN Decade of Ocean Science for Sustainable Development	Helen Joseph
14:30 - 15:15 EDT	ROOM E	1015 POSTER SESSION - PART 15 - The Changing Arctic: Atmosphere and Land Surface	Matthew Asplin David Lemon
15:15 - 16:00 EDT	ROOM A	1021 POSTER SESSION - PART 21 - Space-Based Earth Observation: Providing Critical Information on our Planet	Maycira Costa
15:15 - 16:00 EDT	ROOM B	1022 POSTER SESSION - PART 22 - Weather, Severe Storms	Iain Russell Daniel Michelson
15:15 - 16:00 EDT	ROOM C	1023 POSTER SESSION - PART 23 - Biogeochemistry	Nadja Steiner Roberta Hamme

15:15 - 16:00 EDT	ROOM D	1024 POSTER SESSION - PART 24 - The Changing Arctic Ocean	Matthew Asplin David Lemon
15:15 - 16:00 EDT	ROOM E	1025 POSTER SESSION - PART 25 - Coastal Oceans, Hydrology and Modelling	Michael Foreman Angelica Pena
16:00 - 17:30 EDT	ROOM A	ICEBREAKER	
June 01, 2021	**Tuesday - Day 2**		
11:30 - 12:30 EDT	ROOM A	111 Plenary - Mark Jaccard - The Citizen's Guide to Climate Success	Ken Denman
12:30 - 14:00 EDT	ROOM A	620 Extreme Events in the Coupled Climate System - Part 1	Wm. Richard Peltier John Scinocca
12:30 - 14:00 EDT	ROOM B	252 General Session - Weather - Part 3 - Weather Data and Forecasting	Roland Stull
12:30 - 14:00 EDT	ROOM C	730 Producing, Providing and Communicating Useful Climate Information - Part 1	Emilia Paula Diaconescu Diane Chaumont Yannick Rousseau Elaine Barrow
12:30 - 14:00 EDT	ROOM D	820 Computational Methods, Machine Learning, and Model Development - Part 1	Michael Dunphy Christopher Subich Kristopher Rowe
12:30 - 14:00 EDT	ROOM E	310 Changing Arctic: Science and Policy Studies - Part1	Helen Joseph David Fissel
14:00 - 14:30 EDT		MENTORING SESSION - Professor Douw Steyn	Joseph Martin
14:00 - 14:30 EDT		NETWORKING / EXHIBITS	
14:30 - 16:00 EDT	ROOM A	621 Extreme Events in the Coupled Climate System - Part 2	Wm. Richard Peltier John Scinocca
14:30 - 16:00 EDT	ROOM B	251 General Session - Weather - Part 2 - Air Quality studies	Wanmin Gong
14:30 - 16:00 EDT	ROOM C	731 Producing, Providing and Communicating Useful Climate Information - Part 2	Emilia Paula Diaconescu Diane

			Chaumont Yannick Rousseau Elaine Barrow
14:30 - 16:00 EDT	ROOM D	821 Computational Methods, Machine Learning, and Model Development - Part 2	Michael Dunphy Christopher Subich Kristopher Rowe
14:30 - 16:00 EDT	ROOM E	311 Changing Arctic: Science and Policy Studies - Part 2	Helen Joseph David Fissel
16:00 - 18:00 EDT		STUDENT RECEPTION / EXHIBITS	
June 02, 2021	**Wednesday - Day 3**		
11:00 - 11:30 EDT		WELCOME - Minister of Environment and Climate Change Canada	Marek Stastna David Fissel
11:30 - 12:30 EDT	ROOM A	112 Plenary - Diane Campbell - Weather Services in Canada: our history, our future	Ken Denman Jim Abraham
12:30 - 14:00 EDT	ROOM A	813 Atmosphere, Ocean, and Climate Dynamics - Part 4	Michael Waite Marek Stastna Adam Monahan Ron McTaggart-Cowan
12:30 - 14:00 EDT	ROOM B	253 General Session - Weather - Part 4 - Observations and Mesoscale issues	Iain Russell Daniel Michelson
12:30 - 14:00 EDT	ROOM C	410 Pacific and Arctic marine biogeochemistry	Kristina Brown Birgit Rogalla Johanna Länger Christina Braybrook
12:30 - 14:00 EDT	ROOM D	520 General Session - Oceans	Michael Foreman
14:00 - 14:30 EDT		MENTORING SESSION - Matthew Corkum	Joseph Martin
14:00 - 14:30 EDT		NETWORKING / EXHIBITS	
14:30 - 15:15 EDT	ZOOM A	1031 POSTER SESSION - PART 11 - Climate Variability	Adam Monahan James Anstey

14:30 - 15:15 EDT	ZOOM B	1032 POSTER SESSION - PART 12 - In situ measurement of precipitation and snow cover: advances, challenges, and ongoing issues	Craig Smith Michael Earle
14:30 - 15:15 EDT	ZOOM C	1033 POSTER SESSION - PART 13 - Open Ocean Processes and Models	Neil Swart
14:30 - 15:15 EDT	ZOOM D	1034 POSTER SESSION - PART 14 - Panel Discussiion: Canada and the UN Decade of Ocean Science for Sustainable Development	Helen Joseph
14:30 - 15:15 EDT	ZOOM E	1035 POSTER SESSION - PART 15 - The Changing Arctic: Atmosphere and Land Surface	Matthew Asplin David Lemon
15:15 - 16:00 EDT	ZOOM A	1041 POSTER SESSION - PART 21 - Space-Based Earth Observation: Providing Critical Information on our Planet	Maycira Costa
15:15 - 16:00 EDT	ZOOM B	1042 POSTER SESSION - PART 22 - Weather, Severe Storms	Iain Russell Daniel Michelson
15:15 - 16:00 EDT	ZOOM C	1043 POSTER SESSION - PART 23 - Biogeochemistry	Nadja Steiner Roberta Hamme
15:15 - 16:00 EDT	ZOOM D	1044 POSTER SESSION - PART 24 - The Changing Arctic Ocean	Matthew Asplin David Lemon
15:15 - 16:00 EDT	ZOOM E	1045 POSTER SESSION - PART 25 - Coastal Oceans, Hydrology and Modelling	Michael Foreman Angelica Pena
16:00 - 16:30 EDT		NETWORKING / EXHIBITS	
18:00 - 19:30 EDT	ROOM A	Public Lecture - Can climate modeling keep up with climate change?	Ken Denman David Fissel
June 03, 2021	**Thursday - Day 4**		
11:00 - 11:30 EDT		WELCOME - BC Minister of of Environment and Climate Change Strategy	Matthew Asplin Marek Stastna
11:30 - 12:30 EDT	ROOM A	113 Plenary - Lisa Loseto - What can we learn about changing oceans and adaptation through the lens of Beluga whales?	Ken Denman Nadja Steiner
12:30 - 14:00 EDT	ROOM A	320 The Changing Arctic Ocean - Part 1	Stephanie Waterman Mary-Louise Timmermans
12:30 - 14:00 EDT	ROOM B	254 General Session - Weather - Part 5 - Weather forecasting topics	Terry Bullock
12:30 -	ROOM C	811 Atmosphere, Ocean, and Climate Dynamics - Part 2	Michael Waite

14:00 EDT			Marek Stastna Adam Monahan Ron McTaggart-Cowan
12:30 - 14:00 EDT	ROOM D	720 Integrating Climate Change Adaptation into Engineering and Environmental Design: Opportunities and Challenges - Part 1	Xin Qiu ZILEFAC ELVIS ASONG Andre Erler
12:30 - 14:00 EDT	ROOM E	510 Coastal Oceanography and Inland Waters - Part 1	Guoqi Han Jinyu Sheng
14:00 - 14:30 EDT		NETWORKING / EXHIBITS	
14:30 - 16:00 EDT	ROOM A	321 The Changing Arctic Ocean - Part 2	Stephanie Waterman Mary-Louise Timmermans
14:30 - 16:00 EDT	ROOM B	815 Atmosphere, Ocean, and Climate Dynamics - Part 6	Michael Waite Marek Stastna Adam Monahan Ron McTaggart-Cowan
14:30 - 16:00 EDT	ROOM C	511 Coastal Oceanography and Inland Waters - Part 2	Guoqi Han Jinyu Sheng
14:30 - 16:00 EDT	ROOM D	721 Integrating Climate Change Adaptation into Engineering and Environmental Design: Opportunities and Challenges - Part 2	Xin Qiu ZILEFAC ELVIS ASONG Andre Erler
14:30 - 16:00 EDT	ROOM E	1060 MSC-CMOS-01 Symposium on 150 Years of Weather Services in Canada	Jim Abraham Diane Campbell
16:00 - 16:30 EDT		NETWORKING / EXHIBITS	
16:30 - 18:00 EDT		Special Interest Group Meetings	
June 04, 2021	**Friday - Day 5**		
11:00 -	ROOM A	732 Producing, Providing and Communicating Useful Climate	Emilia Paula

12:30 EDT		Information - Part 3	Diaconescu Diane Chaumont Yannick Rousseau Elaine Barrow
11:00 - 12:30 EDT	ROOM B	880 General Session - Interdisciplinary	Bill Crawford
11:00 - 12:30 EDT	ROOM C	850 The North Atlantic Ocean: Circulation, physical processes, and interactions with biogeochemistry. - Part 1	Paul Myers Douglas Wallace Mathilde Jutras Marine Decuypere Noémie Planat
12:30 - 16:00 EDT		EDUCATORS DAY	
12:30 - 14:00 EDT	ROOM A	240 Severe Storms and Associated Hazards - Part 1	John Hanesiak David Sills
12:30 - 14:00 EDT	ROOM B	255 General Session - Weather - Part 6 - Weather Radar	Frédéric Fabry
12:30 - 14:00 EDT	ROOM C	630 Actual and future climatology of winter precipitation (solid, mixed and liquid) and hail and their impacts.	Sebastien Biner Dominique Paquin Alain Mailhot
12:30 - 14:00 EDT	ROOM D	512 Coastal Oceanography and Inland Waters - Part 3	Guoqi Han Jinyu Sheng
14:00 - 14:30 EDT		NETWORKING / EXHIBITS	
14:30 - 16:00 EDT	ROOM A	241 Severe Storms and Associated Hazards - Part 2	John Hanesiak David Sills
14:30 - 16:00 EDT	ROOM B	256 General Session - Weather - Part 7 - Precipitation and local weather issues	George Isaac
14:30 - 16:00 EDT	ROOM C	851 The North Atlantic Ocean: Circulation, physical processes, and interactions with biogeochemistry - Part 2	Paul Myers Douglas Wallace Mathilde Jutras Marine Decuypere Noémie Planat
14:30 - 16:00 EDT	ROOM D	513 Coastal Oceanography and Inland Waters - Part 4	Guoqi Han Jinyu Sheng
16:00 -		NETWORKING / EXHIBITS	

16:30 EDT			
June 07, 2021	**Monday - Day 6**		
11:30 - 12:30 EDT	ROOM A	114 Plenary - Shawn Marshall - The Slippery Slope from Glaciology to Climate Change to Science Policy	Ken Denman
12:30 - 14:00 EDT	ROOM A	242 Severe Storms and Associated Hazards - Part 3	John Hanesiak David Sills
12:30 - 14:00 EDT	ROOM B	640 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 1	Kaley Walker Thomas Piekutowski
12:30 - 14:00 EDT	ROOM C	812 Atmosphere, Ocean, and Climate Dynamics - Part 3	Michael Waite Marek Stastna Adam Monahan Ron McTaggart-Cowan
12:30 - 14:00 EDT	ROOM D	610 Climate Variability and Predictability - Part 1	Hai Lin Bin Yu
12:30 - 14:00 EDT	ROOM E	340 The Changing Arctic Atmosphere - Part 1	William Ward James King Rachel Chang Patrick Hayes
14:00 - 14:30 EDT		NETWORKING / EXHIBITS	
14:30 - 16:00 EDT	ROOM A	243 Severe Storms and Associated Hazards - Part 4	John Hanesiak David Sills
14:30 - 16:00 EDT	ROOM B	641 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 2	Kaley Walker Yi Huang
14:30 - 16:00 EDT	ROOM C	814 Atmosphere, Ocean, and Climate Dynamics - Part 5	Michael Waite Marek Stastna Adam Monahan Ron McTaggart-Cowan
14:30 - 16:00 EDT	ROOM D	611 Climate Variability and Predictability - Part 2	Hai Lin Bin Yu
14:30 - 16:00 EDT	ROOM E	341 The Changing Arctic Atmosphere - Part 2	William Ward James King Rachel Chang Patrick Hayes
16:00 - 16:30 EDT		NETWORKING / EXHIBITS	
June 08,	**Tuesday - Day 7**		

2021			
11:30 - 12:30 EDT	ROOM A	115 Plenary - Paul Snelgrove - Sustaining Marine Biodiversity on a Complex Ocean Planet	Ken Denman
12:30 - 14:00 EDT	ROOM A	322 The Changing Arctic Ocean - Part 3	Stephanie Waterman Mary-Louise Timmermans
12:30 - 14:00 EDT	ROOM B	642 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 3	Matt Arkett Taryn Tomlinson
12:30 - 14:00 EDT	ROOM D	612 Climate Variability and Predictability - Part 3	Hai Lin Bin Yu
14:00 - 14:30 EDT		MENTORING SESSION - Professor Colin Goldblatt	Joseph Martin
14:00 - 14:30 EDT		NETWORKING / EXHIBITS	
14:30 - 16:00 EDT	ROOM A	323 The Changing Arctic Ocean - Part 4	Stephanie Waterman Mary-Louise Timmermans
14:30 - 16:00 EDT	ROOM C	342 The Changing Arctic Atmosphere - Part 3	William Ward James King Rachel Chang Patrick Hayes
14:30 - 16:00 EDT	ZOOM E	1061 MSC-CMOS-02 Symposium on 150 Years of Weather Services in Canada	Veronique Bouchet David Harper
16:00 - 16:30 EDT		NETWORKING / EXHIBITS	
June 09, 2021	**Wednesday - Day 8**		
11:30 - 12:30 EDT	ROOM A	116 Plenary - Johanna Wagstaffe - Climate change communication: Thoughts from a newsroom scientist	Ken Denman Armel Castellan
12:30 - 14:00 EDT	ROOM A	910 Hydrologic Modelling of Floods and Droughts	Jeremy Fyke Tricia Stadnyk Arelia Schoeneberg
12:30 - 14:00 EDT	ROOM B	740 Building Climate Resilient Communities - Part 1	Gordon McBean Paul Kovacs
12:30 - 14:00 EDT	ROOM C	643 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 4	Matt Arkett Shannon Kaya
12:30 -	ROOM D	230 Atmospheric Rivers and Extratropical Cyclones:	Stephen Dery

14:00 EDT		Dynamics, Classification, and Prediction - Part 1	Melinda Brugman Rita So
14:00 - 14:30 EDT		NETWORKING / EXHIBITS	
14:30 - 16:00 EDT	ROOM A	920 General Session - Hydrology	Arelia Schoeneberg
14:30 - 16:00 EDT	ROOM B	741 Building Climate Resilient Communities - Part 2	Gordon McBean Paul Kovacs
14:30 - 16:00 EDT	ROOM C	644 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 5	Paul Kushner Kaley Walker Felicia Kolonjari Thomas Piekutowski Yi Huang Matt Arkett
14:30 - 16:00 EDT	ROOM D	231 Atmospheric Rivers and Extratropical Cyclones: Dynamics, Classification, and Prediction - Part 2	Stephen Dery Melinda Brugman Rita So
16:00 - 16:30 EDT		NETWORKING / EXHIBITS	
19:00 - 20:00 EDT	ROOM A	Annual CMOS Awards Ceremony	Denis Bourque Marek Stastna
June 10, 2021	**Thursday - Day 9**		
11:30 - 12:30 EDT	ROOM A	117 Plenary - Erin Bertrand - Towards transforming our understanding of how ocean metabolism responds to and influences global change	Ken Denman Roberta Hamme
12:30 - 14:00 EDT	ROOM A	650 Collaborative Earth System Modelling in Canada - Part 1	Paul Kushner Julie Theriault Kirsten Zickfeld Neil Swart Nathan Gillett
12:30 - 14:00 EDT	ROOM B	830 Coastal ocean modelling: processes and applications - Part 1	Sebastien Donnet Laura Bianucci Andry Ratsimandresy

			Thomas Guyondet
12:30 - 14:00 EDT	ROOM C	710 Advances in process-based land surface modelling - Part 1	Joe Melton Elyn Humphreys
12:30 - 14:00 EDT	ROOM D	860 Developing Ocean Modelling Capacity in Canada - Part 1	David Greenberg Paul Myers Frederic Dupont Neil Swart Katja Fennel Susan Allen Youyu Lu Gregory Smith
14:00 - 14:30 EDT		NETWORKING / EXHIBITS	
14:30 - 16:00 EDT	ROOM A	831 Coastal ocean modelling: processes and applications - Part 2	Sebastien Donnet Laura Bianucci Andry Ratsimandresy Thomas Guyondet
14:30 - 16:00 EDT	ROOM B	711 Advances in process-based land surface modelling - Part 2	Joe Melton Elyn Humphreys
14:30 - 16:00 EDT	ROOM C	861 Developing Ocean Modelling Capacity in Canada - Part 2	David Greenberg Paul Myers Frederic Dupont Neil Swart Katja Fennel Susan Allen Youyu Lu Gregory Smith
14:30 - 16:00 EDT	ZOOM E	1062 MSC-CMOS-03 Symposium on 150 Years of Weather Services in Canada	Ken Macdonald Russ White
16:00 - 16:30 EDT		NETWORKING / EXHIBITS	
June 11, 2021	**Friday - Day 10**		
11:00 - 12:30 EDT	ROOM A	220 Town Hall on Canada and the UN Decade of Ocean Science for Sustainable Development	Helen Joseph

11:00 - 12:30 EDT	ROOM B	750 General Session - Climate change	Ken Denman Geoff Strong
12:30 - 14:00 EDT	ROOM A	651 Collaborative Earth System Modelling in Canada - Part 2	Paul Kushner Julie Theriault Kirsten Zickfeld Neil Swart Nathan Gillett
12:30 - 14:00 EDT	ROOM B	210 In situ measurement of precipitation and snow cover: advances, challenges, and ongoing issues - Part 1	Craig Smith Eva Mekis Michael Earle
12:30 - 14:00 EDT	ROOM C	832 Coastal ocean modelling: processes and applications - Part 3	Sebastien Donnet Laura Bianucci Andry Ratsimandresy Thomas Guyondet
12:30 - 14:00 EDT	ROOM D	862 Developing Ocean Modelling Capacity in Canada - Part 3	David Greenberg Paul Myers Frederic Dupont Neil Swart Katja Fennel Susan Allen Youyu Lu Gregory Smith
12:30 - 14:00 EDT	ROOM E	343 The Changing Arctic Atmosphere - Part 4	William Ward James King Rachel Chang Patrick Hayes
14:00 - 14:30 EDT		NETWORKING / EXHIBITS	
14:30 - 16:00 EDT	ROOM A	211 In situ measurement of precipitation and snow cover: advances, challenges, and ongoing issues - Part 2	Craig Smith Eva Mekis Michael Earle
14:30 - 16:00 EDT	ROOM B	652 Collaborative Earth System Modelling in Canada - Part 3	Paul Kushner Julie Theriault Kirsten Zickfeld Neil Swart Nathan Gillett
14:30 - 16:00 EDT	ROOM C	863 Developing Ocean Modelling Capacity in Canada - Part 4	David Greenberg Paul Myers Frederic Dupont Neil Swart Katja

			Fennel Susan Allen Youyu Lu Gregory Smith
14:30 - 16:00 EDT	ROOM D	344 The Changing Arctic Atmosphere - Part 5	William Ward James King Rachel Chang Patrick Hayes
16:00 - 16:30 EDT		CLOSING SESSION	

Weather	Arctic	Oceans/Lakes	Climate Change	Hydrology/ Interdisciplinary	Educators' Day	Other

CMOS Congress 2021 (Week 1): Program at a Glance

Time (ET)	Monday May 31	Tuesday June 1	Wednesday June 2	Thursday June 3	Friday June 4	
11:00 AM	**Welcome - Mayor of Victoria**	**Welcome/Opening Session**	**Welcome/Opening Session**	**Welcome - BC Minister ECC**	**Scientific Session XIX (3 concurrent)**	Educators' Day activities begin at 12:00 PM(ET)
11:30 AM	Plenary 1 **Andrew Weaver** Global Warming: A Question of Priorities	Plenary 2 **Mark Jaccard** The Citizen's Guide to Climate Success	Plenary 3 **Diane Campbell** Weather Services in Canada: our history, our future	Plenary 4 **Lisa Loseto** What can we learn about changing oceans and adaptation through the lens of beluga whales?	**732**	
					880	
12:00 PM					**850**	**Educators' Day Plenary Ellen Field**
12:30 PM	**Scientific Session I (4 concurrent)**	**Scientific Session II (5 concurrent)**	**Scientific Session IV (4 concurrent)**	**Scientific Session V (5 concurrent)**	**Scientific Session VII (4 concurrent)**	**Project Wet - Introduction to educational resources presented by Liz Nicholls (12:30 ET-1:15 ET)**
	810	**620**	**813**	**320**	**240**	
1:00 PM	**250**	**252**	**253**	**254**	**255**	
	330	**730**	**410**	**811**	**630**	15-minute Health Break
1:30 PM	**870**	**820**	**520**	**720**	**512**	**Prairie Climate Centre and Climate Atlas Demo presented by Danny Blair (1:30 ET - 2:15 ET)**
		310		**510**		
2:00 PM	**Networking/Exhibits 1**	**Networking/ Exhibits 2**; **Mentoring Session**	**Networking/ Exhibits 3**; **Mentoring Session**	**Networking/Exhibits 5**	**Networking/Exhibits 7**	
2:30 PM	**Poster Presentations I: (5 concurrent, 45 min. talks)**	**Scientific Session III (5 concurrent)**	**Poster Presentations II: *Q&A in five concurrent sessions***	**Scientific Session VI (4 concurrent) MSC 150**	**Scientific Session VIII (4 Concurrent)**	**Ocean School Presentation and Demo**
	P11; **P12**	**621**	**P31**; **P32**	**321**	**241**	
	P13; **P14**	**251**	**P33**; **P34**	**815**	**256**	
3:00 PM	**P15**	**731**	**P35**	**511**	**851**	
	P21; **P22**	**821**	**P41**; **P42**	**721**	**513**	15-minute Health Break
3:30 PM	**P23**; **P24**	**311**	**P43**; **P44**	**MSC - 150 Years WX Services #1**		**Mini Panel:** **Communicating the Effects of Climate Change, Present and Future, to our Children. Lisa Losetto, Johanna Wagstaffe, Andrew Weaver**
	P25		**P45**			
4:00 PM	**Icebreaker Event**	**Student Reception/Exhibits**	**Networking/Exhibits 4**	**Networking/Exhibits 6**	**Networking/Exhibits 8**	
4:30 PM						**Area-Focused Breakout Rooms (Ocean School, Prairie Climate Centre, Project WET)**
						Group Discussion, Feedback, Breakout Room Overview and Thanks
5:00 PM						
5:30 PM						
6:00 PM			**Public Speaker**			
6:30 PM						
7:00 PM						
7:30 PM						

Weather	Arctic	Oceans/Lakes	Climate Change	Hydrology/ Interdisciplinary	Other

CMOS Congress 2021 (Week 2): Program at a Glance

Time (ET)	Monday June 7	Tuesday June 8	Wednesday June 9	Thursday June 10	Friday June 11
11:00 AM	Opening Session	Opening Session	Opening Session	Opening Session	Scientific Session XIX (2 concurrent)
11:30 AM	Plenary 5 **Shawn Marshall** The Slippery Slope from Glaciology to Climate Change to Science Policy	Plenary 6 **Paul Snelgrove** Sustaining Marine Biodiversity on a Complex Ocean Platform	Plenary 7 **Johanna Wagstaffe** Climate Change Communication: Thoughts from a newsroom scientist	Plenary 8 **Erin Bertrand** Towards transforming our understanding of how ocean metabolism responds to and influences global change	**220**
					750
12:00 PM					
12:30 PM	**Scientific Session IX (5 concurrent)**	**Scientific Session XI (4 concurrent)**	**Scientific Session XIII (4 concurrent)**	**Scientific Session XV (4 concurrent)**	**Scientific Session XVII (5 concurrent)**
	242	**322**	**910**	**650**	**651**
1:00 PM	**640**	**642**	**740**	**830**	**210**
	812	**612**	**643**	**710**	**832**
1:30 PM	**610**		**230**	**860**	**862**
	340				**343**
2:00 PM	**Networking/Exhibits 9**	**Networking/ Exhibits 11** / **Mentoring Session**	**Networking/Exhibits 13**	**Networking/Exhibits 15**	**Networking/Exhibits 17**
2:30 PM	**Scientific Session X (5 concurrent)**	**Scientific Session XII (2 concurrent) MSC 150**	**Scientific Session XIV (4 concurrent)**	**Scientific Session XVI (3 concurrent) MSC 150**	**Scientific Session XVIII (4 concurrent)**
	243	**323**	**920**	**831**	**211**
3:00 PM	**641**	**342**	**741**	**711**	**652**
	814		**644**	**861**	**863**
3:30 PM	**611**		**231**		**344**
	341	**MSC - 150 Years WX Services #2**		**MSC - 150 Years WX Services #3**	
4:00 PM	**Networking/Exhibits 10**	**Networking/Exhibits 12**	**Networking/Exhibits 14**	**Networking/Exhibits 16**	**Closing Ceremony**
4:30 PM			**Awards Ceremony**		
5:00 PM					
5:30 PM					
6:00 PM					

Day 1 – 31 May 2021

Andrew Weaver, Professor, University of Victoria, and Former Leader of the BC Green Party ------ Dr. Andrew J. Weaver is a Professor in the School of Earth and Ocean Sciences at the University of Victoria. He was also the Canada Research Chair in Climate Modelling and Analysis until he was elected as a BC Green Party MLA in the 2013 BC Provincial Election representing the riding of Oak Bay-Gordon Head. In 2015 Dr. Weaver assumed leadership of the BC Green Party, leading them to an historic election result in the 2017 provincial election with three elected MLAs holding the balance of power in an NDP minority government. He returned to UVic after completing two terms as an MLA. Dr. Weaver received his B.Sc (Mathematics and Physics) from the University of Victoria in 1983, a Master of Advanced Studies in Mathematics from Cambridge University in 1984, and a PhD in Applied Mathematics from the University of British Columbia in 1987. He has authored or coauthored over 200 peer-reviewed papers in climate, meteorology, oceanography, earth science, policy, education and anthropology journals. He was a Lead Author in the United Nations Intergovernmental Panel on Climate Change 2nd, 3rd, 4th and 5th scientific assessments. He was the Chief Editor of the Journal of Climate from 2005-2009. Dr. Weaver is a Fellow of the Royal Society of Canada, Canadian Meteorological and Oceanographic Society, American Meteorological Society, American Geophysical Union and the American Association for the Advancement of Science. Over the years he has received a number of awards including the NSERC-Steacie, Killam and Guggenheim Fellowships and the CMOS President's Prize, the Royal Society of Canada Miroslaw Romanowski Medal and the A.G. Huntsman Award for Excellence in Marine Science. In 2008 he was appointed to the Order of British Columbia and in 2014 he received an honourary D.Sc. degree from McMaster University. For his work developing British Columbia's CleanBC economic plan collaboratively with the BC NDP, he and the Minister of Environment, George Heyman, received 2020 Clean 16 and Clean 50 awards for outstanding contributions to sustainable development and clean capitalism in Canada. His book, Keeping our Cool: Canada in a Warming World was published by Viking Canada in September 2008. His second book, Generation Us: The Challenge of Global Warming was published by Raven books in 2011.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
11:30	Global warming: A question of priorities	Andrew Weaver		

Session: 110 Plenary - Andrew Weaver - Global warming: A question of priorities Plénière - Andrew Weaver - Le réchauffement climatique: une question de priorités

31/05/2021 11:30

ID: 11183 Invited plenary speaker

Poster Order:

Global warming: A question of priorities

Andrew Weaver [1]

1

Presented by / Présenté par: ***Andrew Weaver***
Contact: weaver@uvic.ca

Over the last century, scientific understanding of the causes and consequences of global warming has evolved to the point that it is, for all intents and purposes, an extremely well understood problem. The fundamental question facing society is whether or not the present generation has a moral and/or ethical obligation to future generations in terms of the type of world we leave as our legacy. Science alone cannot, and will not, ever answer this question. In this talk I'll explore the challenges and opportunities associated with curbing the increase of atmospheric greenhouse gases, with particular emphasis on the role that the scientific community can play. As a specific case study, I'll detail my journey into and out of politics, after extensively publishing in the field of climate science, as a Lead Author in the IPCC 2nd, 3rd, 4th and 5th Scientific Assessments, and serving as the Chief Editor of the Journal of Climate for five years. I'll also discuss the development of British Columbia's CleanBC economic/climate plan that occurred when the BC Green Party held the balance of power in BC's minority government from 2017 to 2020. I'll conclude by emphasizing the need for more evidence-based decision-making within the political establishment if we collectively wish to reverse the disturbing trend towards decision-based evidence-making in the formation of provincial and national policy

Day 2 – 1 June 2021

Mark Jaccard, Professor, Simon Fraser University, School of Resource and Environmental Management ------ Mark has been a professor since 1986 in the School of Resource and Environmental Management at Vancouver's Simon Fraser University. The only exception is 1992 to 1997, when he took a leave of absence to serve as Chair and CEO of the British Columbia Utilities Commission. His PhD is from the Energy Economics and Policy Institute at the University of Grenoble. He has published over 100 academic papers, most of these related to his principal research focus: the design and application of energy-economy models that assess the effectiveness of sustainable energy and climate policies. For this career research, he was named a Fellow of the Royal Society of Canada in 2009 and British Columbia's Academic of the Year in 2008. He has contributed to several major processes and assessments, including the Intergovernmental Panel on Climate Change (93-96 and 2010-2012), the China Council for International Cooperation on Environment and Development (1995-2001 and 2007-2009), Canada's National Roundtable on the Environment and the Economy (2006-2009), British Columbia's Climate Action Team (2007-2009), and the Global Energy Assessment (2008-2012). In 2006, his book, Sustainable Fossil Fuels, won the Donner Prize for top policy book in Canada. At Simon Fraser University he teaches graduate and undergraduate versions of an interdisciplinary course in energy and materials sustainability, covering basic physics, technologies, economics, policy and human cognition and behavior.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
11:30	The Citizen's Guide to Climate Success	Mark Jaccard		

Session: 111 Plenary - Mark Jaccard - The Citizen's Guide to Climate Success Plénière - Mark Jaccard - Le guide du citoyen pour sauver la planète

01/06/2021 11:30

ID: 11246 Invited plenary speaker

Poster Order:

The Citizen's Guide to Climate Success

Mark jaccard [1]

[1] Simon Fraser University

Presented by / Présenté par: ***Mark jaccard***
Contact: jaccard@sfu.ca

In this talk, Mark Jaccard speaks on how climate-concerned citizens can overcome myths that hinder us from acting in time to prevent extreme climate impacts. Their actions can involve personal consumption choices (electric vehicles, heat pumps) but these only have an effect if citizens are also engaged in the political process and civil society to elect and support climate-sincere politicians. These personal and collective efforts must align with and foster a global strategy of decarbonization, especially in developing countries. Be ready to learn what is required on a simple path to climate success and what you can contribute.

Day 3 – 2 June 2021

Diane Campbell, Assistant Deputy Minister, Meteorological Service of Canada (MSC), ECCC ------ Diane Campbell studied Marine Biology at the University of Guelph and started her career working in the research laboratories at the Canada Centre for Inland Waters. Her work included toxicity studies on invertebrates and fish in the Great Lakes, biomonitoring projects in northern Ontario, and national water quality assessments. She worked as a science advisor in both the Office of Energy Research and Development, and the Office of Environmental Affairs, at Natural Resources Canada, prior to becoming a science manager in the CANMET mineral and energy technology laboratories. After serving as the science advisor to the Assistant Deputy Minister of the Earth Science Sector, she joined Environment Canada as the National Director of Environmental Assessment. She progressed to more senior positions, returning to the Earth Sciences Sector as the Director General of the Sector's Research Programs Branch where she oversaw the delivery of horizontal earth sciences, mapping and climate change related research programs. "What attracted me to the MSC was the opportunity to lead science-based programs in one of Canada's historic scientific institutions where its services touch Canadians on a daily basis" says Diane. "The MSC is a very high performing organization where people take great pride in their work and their service to Canadians." She joined the Meteorological Service of Canada in 2008 as the Director General of the Weather and Environmental Prediction Services where she has led many of MSC's major cost recovery services, service strategy development, product development and national dissemination systems. When the MSC re-organized in 2013-14 she took on the role of Director General of Prediction Services also overseeing service delivery in prediction operations across the country. In 2018, Diane became MSC's Associate Assistant Deputy Minister. Throughout her 35 year-plus career, Diane has led major transformation initiatives; focused on workplace analysis and succession, and championed workplace and workforce wellness. She serves as both the MSC's champion of Mental Health, and as the Environment and Climate Change Canada's Mental Health Co-Champion (along with a union co-champion). She took several years off mid-career to raise two children. She experienced personally how our workplace has changed for the better over the past 30 years to support people through different stages in the careers and personal lives. Diane feels this trend must continue in order to attract and retain Canada's talented workforce. Diane and her husband live in the Gatineau Hills. When she is not working the former sports mom loves spending time outdoors, which she says, "grounds me and replenishes my energy levels." Favourite pastimes include hiking, gardening and travelling as well as relaxing with a good book.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
11:30	Weather Services in Canada: our history, our future	Diane Campbell		

Session: 112 Plenary - Diane Campbell - Weather Services in Canada: our history, our future Plénière - Diane Campbell - Les services météorologiques au Canada: notre histoire, **02/06/2021 11:30**

notre avenir

ID: 11242 Invited plenary speaker

Poster Order:

Weather Services in Canada: our history, our future

Diane Campbell [1]

[1] Meteorological Service of Canada

Presented by / Présenté par: ***Diane Campbell***

Contact: diane.campbell@canada.ca

This year we are celebrating 150 years of weather services in Canada. This journey has evolved from a $5,000 Cdn federal government investment approved on May 1, 1871 to establish a network of weather observing stations all the way to a varied and diverse array of sensors across Canada and in space; high performance computing and earth system modelling; and the evolution of specialized services to keep Canadians safe and resilient. Throughout these years new partnerships and collaborations have emerged to grow Canada's weather enterprise. This plenary talk will highlight some of the key moments in the history of weather-related science and services at the Meteorological Service of Canada. It will explore the evolving roles of government, academia and the private sector in creating and delivering weather services. Finally, this talk will look to the future of weather services as unprecedented weather continues to impact our country. Disruptive forces are creating challenges and opportunities. Capabilities derived from earth system modelling and the use environmental intelligence will become a strategic asset in addressing national and global concerns around such topics as water, food, and energy security. The role of the global weather enterprise is quickly evolving with new players and new capabilities. MSC is looking ahead to build the partnerships needed to support the next 150 years of services to Canadians.

Day 4 – 3 June 2021

Lisa Loseto, Research Scientist, Arctic Aquatic Research Division, DFO ---- Research Scientist, Arctic Ecosystems and Biotracers. Lisa conducts research that focuses on characterizing beluga health as means to understand ecosystem health in the Western Canadian Arctic. She combines food web biotracers and habitat modeling to gain insight into predator-prey interactions and ecosystem energetics. Her research on beluga diet and habitat use combines Western science and traditional ecological knowledge (TEK). Her research programs are carried out in partnership with communities and co-management boards of the Inuvialuit Settlement Region. She strives to serve all Canadians by providing knowledge and advice to decision makers and by helping to empower the people of the north through scientific knowledge combined with their own knowledge of their ecosystem and home.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
11:30	What can we learn about changing oceans and adaptation through the lens of Beluga whales?	Lisa Loseto		

Session: 113 Plenary - Lisa Loseto - What can we learn about changing oceans and adaptation through the lens of Beluga whales? Plénière - Lisa Loseto - Que peuvent nous apprendre les bélugas sur l'évolution des océans et l'adaptation?

03/06/2021 11:30

ID: 11253 Invited plenary speaker

Poster Order:

What can we learn about changing oceans and adaptation through the lens of Beluga whales?

Lisa Loseto [1]

[1] Arctic Aquatic Research Division, Fisheries and Oceans Canada, Winnipeg, MB.

Presented by / Présenté par: ***Lisa Loseto***
Contact: Lisa.Loseto@dfo-mpo.gc.ca

The Beluga whale (Delphinapterus leucas), is a sentinel species, with over 20 populations ranging throughout the circumpolar Arctic. It is a long lived species, situated at a high trophic level that sea ice associated and demonstrates a diversity of habitat use within the circumpolar range. These attributes combined with the importance of this species to Inuit make it an ideal indicator to track ocean health and consider these implications more broadly. The Eastern

Beaufort Sea (EBS) beluga population is regarded nationally and internationally as a population of ‘no concern’, yet may be one of the world’s most well-studied populations. In contrast to population management efforts that invest in research for mitigation and recovery efforts (e.g., Cook Inlet beluga populations), management of EBS belugas has benefitted from a concerted, pro-active conservation approach to ensure sustainability of the traditional harvest, including the development of two Marine Protected Areas (MPAs) and long-term (>40 year) research and monitoring programs. The sustained research agenda can be attributed in part to a progressive land claim agreement that empowers Inuvialuit as co-managers of marine resources that is responsive to community questions, management needs, and scientific investigations. A collaborative beluga research program has set baselines for what is believed to be ‘normal’ for a suite of >20 health metrics (e.g. hormone levels, diet, diseases) that can be assessed with regional and local scale drivers (e.g. sea ice loss). Here we share unusual observations from events in 2014 and 2019 that co-inside with oceanic anomalies, and present information on subtle changes in beluga health that may represent underlying changes at the population or ecosystem level in response to regional scale changes.

Day 6 – 7 June 2021

Shawn Marshall, Professor, University of Calgary, Science Advisor to ECCC ---- Shawn Marshall joined the University of Calgary Department of Geography in 2000. Marshall's research interests include glacier dynamics, cryosphere-climate processes, paleoclimatology, and mountain meteorology. Current research projects include field and modelling studies in the Canadian Rockies, the Canadian Arctic, and Greenland. He held a Canada Research Chair in Climate Change from 2007-2017, studying glacier and ice sheet response to climate change.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
11:30	The Slippery Slope from Glaciology to Climate Change to	Shawn Marshall		

Session: 114 Plenary - Shawn Marshall - The Slippery Slope from Glaciology to Climate Change to Science Policy Plénière - Shawn Marshall - La pente glissante de la glaciologie aux changements climatiques à la politique scientifique **07/06/2021 11:30**

ID: 11251 Invited plenary speaker

Poster Order:

The Slippery Slope from Glaciology to Climate Change to Science Policy

Shawn Marshall [1]

[1] Professor, Department of Geography, University of Calgary

Presented by / Présenté par: ***Shawn Marshall***
Contact: shawn.marshall@ucalgary.ca

Like most of us working in the realm of Earth system science, I was drawn into this profession through some combination of a passion for the environment, a penchant for physics, and some measure of serendipity. In my case, the latter intervened when I was a 4th year undergraduate student studying Engineering Physics at the University of Toronto. UBC's Garry Clarke, the world's foremost glaciologist, gave a seminar in the Physics Department and I found myself enchanted with the prospect of applying heretofore theoretical conceptions of thermodynamics, continuum mechanics, and numerical modelling to real-world problems where you could also spend some time in the mountains, keeping company with glaciers. I followed Garry back to UBC for graduate school, and some 30 years later, I continue to work on and think about many of the challenging questions concerning glacier dynamics, Ice Ages, the role of glaciers and ice sheets in the climate system. There are many good problems to work on in this area, and this presentation will include a high-level overview of some outstanding glaciological challenges. Within this, there has been an explosion of interest in glacier and ice sheet response to climate change, and most of the world's glaciologists have been inexorably drawn into the world of climate change science. Glaciers and ice sheets play a critical role in global sea level rise, regional water resource stress, and broader climate system dynamics, and no country (save Greenland) has more glacial landscape to understand than Canada. There is also a fatalistic and tragic dimension to documenting global glacier demise, as one of many manifestations of the cumulative impacts of climate change. This experience is pushing many climate scientists to consider how they can make a broader contribution to society, to ensure that the science is being heard. While the world of science policy is

much more complicated than physics, there is no question that we need more scientific voices at the table to help shape environmental policy, and there is some urgency to this. I will share some reflections on this topic based on my initial experience as a science advisor at Environment and Climate Change Canada.

Day 7 – 8 June 2021

Paul Snelgrove, Professor, Memorial University, Science Advisor to DFO ---- Dr. Snelgrove received a BSc. Hons degree in Biology at Memorial in 1984, a Master's degree in Oceanography from McGill University in 1984 and a PhD from the Massachusetts Institute of Technology and Biology Department at Woods Hole Oceanographic Institution in 1993. He spent 3 years in New Jersey as a Postdoctoral Fellow with Fred and Judy Grassle at the Institute of Marine and Coastal Sciences, followed by 8 months as a Killam Postdoctoral fellow with Jon Grant in the Department of Oceanography at Dalhousie University. In 1996 he returned to Newfoundland as an NSERC Industrial Chair in Fisheries Conservation, prior to taking up a position as a Canada Research Chair in Boreal and Cold Ocean Systems in 2002 at the Ocean Science Centre. Dr. Snelgrove led the synthesis of the International Census of Marine Life research program, as a member of the program's Scientific Steering Committee. He then published the book "Discoveries of the Census of Marine Life: Making Ocean Life Count" with Cambridge University Press in 2010 and was a TED Global speaker in 2011. Also in 2010 he was awarded the Parsons Medal for Achievement in Interdisciplinary Ocean Sciences in Canada by DFO. In 2012 he held the Knapp Visiting Chair at the University of San Diego and was a Walter and Andée de Nottbeck Foundation Senior Research Fellow at the Tvärminnen Zoological Station, University of Helsinki. He was then awarded the 2013 Timothy Parsons Medal for Excellence in Marine Sciences in Canada, and in 2015 Memorial University awarded him the title; University Research Professor. Among his many awards and achievements, Dr. Snelgrove sits on numerous advisory boards in Canada and internationally and frequently sits on review panels and editorial boards.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
11:30	Sustaining Marine Biodiversity on a Complex Ocean Planet	Paul Snelgrove		

Session: 115 Plenary - Paul Snelgrove - Sustaining Marine Biodiversity on a Complex Ocean Planet Plénière - Paul Snelgrove - Soutenir la biodiversité marine dans une planète bleue complexe **08/06/2021 11:30**

ID: 11249 Invited plenary speaker

Poster Order:

Sustaining Marine Biodiversity on a Complex Ocean Planet

Paul Snelgrove [1]

[1] Departments of Ocean Sciences and Biology, Memorial University of Newfoundland St. John's NL A1C 5S7 Canada

Presented by / Présenté par: ***Paul Snelgrove***

Contact: psnelgrove@mun.ca

Noting increasing impacts of human activities on ocean life, conserving the diverse biota that drive Earth’s largest ecosystem and life support system creates one of the great scientific and societal challenges of our time. We must consider daunting spatial and temporal scales, and the many dynamic and complex oceanographic processes and societal pressures, including climate change, that influence marine ecosystems and their functioning. These challenges require new types of collaboration and communication to bring together the many facets of marine research that can and should influence ocean policy in Canada and beyond. In this presentation I draw on my experiences and activities as a researcher, program leader, and Departmental Science Advisor for DFO to help advance a sustainable ocean agenda. In particular, I focus on research needs to inform conservation strategies, with a particular emphasis on how population and ecosystem connectivity and functional roles could help to shape sustainable ocean use planning. I also consider the role of transdisciplinary research in addressing societal needs and in translating technical science knowledge and discovery to real world application.

Day 8 – 9 June 2021

Johanna Wagstaffe, CBC Meteorologist, Vancouver ----Johanna Wagstaffe is the on-air meteorologist, seismologist and scientist for CBC VANCOUVER NEWS and CBC NEWS NETWORK. She has been covering national and international weather stories for the CBC News: Weather Centre since the summer of 2007. Wagstaffe's strong background in seismology and earth science has led her to cover major seismic events, space missions and the Copenhagen and Paris Climate Change conference. She has hosted two award-winning CBC Vancouver podcasts: Fault Lines, 2050: Degrees of Change and continues to work on various CBC original podcast projects. She is a vital resource for CBC and provides expert insight into breaking weather stories, as well as providing context to weather patterns and science stories in her “Science Smart” series. You can catch 'Science Smart’ on CBC’s Our Vancouver and online. She graduated with an honours degree in geophysics from The University of Western Ontario. She was first exposed to weather forecasting as a summer intern at the Environment Canada Severe Weather Centre, then obtained her post-graduate meteorology certificate from York University. She first joined CBC Vancouver News and CBC News Now as the on-camera meteorologist in Fall 2012. Outside of work, Wagstaffe enjoys running, teaching children about weather and science and flying. She got her pilot's license when she was 17 years old and still flies with her father in a 1943 Aeronca on the weekends.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
11:30	Climate change communication: Thoughts from a newsroom scientist	Johanna Wagstaffe		

Session: 116 Plenary - Johanna Wagstaffe - Climate change communication: Thoughts from a newsroom scientist Plénière - Johanna Wagstaffe - Communication sur les changements climatiques : Réflexions d’une scientifique à la salle des nouvelles **09/06/2021 11:30**

ID: 11252 Invited plenary speaker

Poster Order:

Climate change communication: Thoughts from a newsroom scientist

Johanna Wagstaffe [1]

[1] CBC Vancouver

Presented by / Présenté par: ***Johanna Wagstaffe***
Contact: johanna.wagstaffe@cbc.ca

Science communication has never been more important. The climate crisis demands connection with the public, a spotlight on the science that is shaping our world, and an effective way to interpret data for policymakers. Informing the public requires engaging the public. And while scientists and journalists alike have encountered challenges in the past, the public's demand for climate change coverage is accelerating. The way we communicate science also needs to evolve in an ever-changing media landscape. Expanding platforms, changes to the way people are accessing news, and the audience’s growing scientific literacy -- there are more opportunities than ever to get important information across. But the content needs to be tailored. Sharing the facts and providing the evidence remain the most important part of the messaging, but offering a ‘‘heartbeat’ can cultivate a sense of belonging and shared purpose with the public. In this presentation I will share my successes, and the challenges I have faced with communicating climate change science through various narrative forms. I look forward to creating more dialogue and sharing ideas on this topic with the scientific community in attendance.

Day 9 – 10 June 2021

Erin Bertrand, Associate Professor, Dalhousie University ---- Associate Professor and Canada Research Chair in Marine Microbial Proteomics. Erin's research is driven by her passion for connecting molecular-level processes with global scale implications. Before Erin moved to Halifax, she was a Postdoctoral Fellow at Scripps Inst. of Oceanography and the J. Craig Venter Institute in California and earned her PhD from the MIT/WHOI Joint Program. When Erin isn't in the lab, classroom or at sea, you can find her running on beautiful Nova Scotia trails or listening to live music in Halifax.

Time	*Abstract Title*	Presenter	Poster	Add to

	Order	Calendar
11:30 Towards transforming our understanding of how ocean metabolism responds to and influences global change	Erin Bertrand	

Session: 117 Plenary - Erin Bertrand - Towards transforming our understanding of how ocean metabolism responds to and influences global change Plénière - Erin Bertrand - Vers une transformation de notre compréhension de la façon dont le métabolisme océanique réagit au changement mondial et l'influence **10/06/2021 11:30**

ID: 11250 Invited plenary speaker

Poster Order:

Towards transforming our understanding of how ocean metabolism responds to and influences global change

Erin Bertrand [1]

[1] Department of Biology, Dalhousie University

Presented by / Présenté par: ***Erin Bertrand***
Contact: erin.bertrand@dal.ca

Ocean metabolism is the basis for our planetary life support system. It links cellular biochemical processes with ecosystem-scale cycling of carbon, nutrients and oxygen. Understanding how ocean metabolism will respond to and influence global change is of growing importance. However, our current predictive models are not specifically linked to processes underpinning microbial growth, and so cannot incorporate the large and growing body of work that quantitatively describes critical feedback interactions within and between organisms and their environment. In this talk, I will discuss how recent applications of molecular measurements, in combination with modeling approaches, show promise for improving our view of ocean metabolism and the feedbacks that control its interactions with environmental change. I will also discuss the nascent global program BioGeoSCAPES, which aims to reveal how metabolisms in the ocean are structured and regulated by linking new tools, across molecular and biogeochemical observations, with models in a standardized framework. We seek input from all Canadian researchers on BioGeoSCAPES, as Canadian contributions to this global program are currently being formulated.

Plenary Speakers

May 31, 2021 @ 11:30-12:30 EDT Andrew Weaver, Professor, University of Victoria, and Former Leader of the BC Green Party

Global warming: A question of priorities

Over the last century, scientific understanding of the causes and consequences of global warming has evolved to the point that it is, for all intents and purposes, an extremely well understood problem. The fundamental question facing society is whether or not the present generation has a moral and/or ethical obligation to future generations in terms of the type of world we leave as our legacy. Science alone cannot, and will not, ever answer this question.

In this talk I'll explore the challenges and opportunities associated with curbing the increase of atmospheric greenhouse gases, with particular emphasis on the role that the scientific community can play. As a specific case study, I'll detail my journey into and out of politics, after extensively publishing in the field of climate science, as a Lead Author in the IPCC 2nd, 3rd, 4th and 5th Scientific Assessments, and serving as the Chief Editor of the Journal of Climate for five years. I'll also discuss the development of British Columbia's CleanBC economic/climate plan that occurred when the BC Green Party held the balance of power in BC's minority government from 2017 to 2020.

I'll conclude by emphasizing the need for more evidence-based decision-making within the political establishment if we collectively wish to reverse the disturbing trend towards decision-based evidence-making in the formation of provincial and national policy.

Biography: Dr. Andrew J. Weaver is a Professor in the School of Earth and Ocean Sciences at the University of Victoria. He was also the Canada Research Chair in Climate Modelling and Analysis until he was elected as a BC Green Party MLA in the 2013 BC Provincial Election representing the riding of Oak Bay-Gordon Head. In 2015 Dr. Weaver assumed leadership of the BC Green Party, leading them to an historic election result in the 2017 provincial election with three elected MLAs holding the balance of power in an NDP minority government. He returned to UVic after completing two terms as an MLA.

Dr. Weaver received his B.Sc (Mathematics and Physics) from the University of Victoria in 1983, a Master of Advanced Studies in Mathematics from Cambridge University in 1984, and a PhD in Applied Mathematics from the University of British Columbia in 1987. He has authored or coauthored over 200 peer-reviewed papers in climate, meteorology, oceanography, earth science, policy, education and anthropology journals. He was a Lead Author in the United Nations Intergovernmental Panel on Climate Change 2nd, 3rd, 4th and 5th scientific assessments. He was the Chief Editor of the Journal of Climate from 2005-2009.

Dr. Weaver is a Fellow of the Royal Society of Canada, Canadian Meteorological and Oceanographic Society, American Meteorological Society, American Geophysical Union and the American Association for the Advancement of Science. Over the years he has received a number of awards including the NSERC-Steacie, Killam and Guggenheim Fellowships and the CMOS President’s Prize, the Royal Society of Canada Miroslaw Romanowski Medal and the A.G. Huntsman Award for Excellence in Marine Science. In 2008 he was appointed to the Order of British Columbia and in 2014 he received an honourary D.Sc. degree from McMaster University.

For his work developing British Columbia's CleanBC economic plan collaboratively with the BC NDP, he and the Minister of Environment, George Heyman, received 2020 Clean 16 and Clean 50 awards for outstanding contributions to sustainable development and clean capitalism in Canada.

His book, Keeping our Cool: Canada in a Warming World was published by Viking Canada in September 2008. His second book, Generation Us: The Challenge of Global Warming was published by Raven books in 2011.

June 1, 2021 @ 11:30-12:30 EDT Mark Jaccard, Professor, Simon Fraser University, School of Resource and Environmental Management

The Citizen's Guide to Climate Success

In this talk, Mark Jaccard speaks on how climate-concerned citizens can overcome myths that hinder us from acting in time to prevent extreme climate impacts. Their actions can involve personal consumption choices (electric vehicles, heat pumps) but these only have an effect if citizens are also engaged in the political process and civil society to elect and support climate-sincere politicians. These personal and collective efforts must align with and foster a global strategy of decarbonization, especially in developing countries. Be ready to learn what is required on a simple path to climate success and what you can contribute.

Biography: https://www.sfu.ca/rem/people/profiles/jaccard.html

Mark has been a professor since 1986 in the School of Resource and Environmental Management at Vancouver's Simon Fraser University. The only exception is 1992 to 1997, when he took a leave of absence to serve as Chair and CEO of the British Columbia Utilities Commission. His PhD is from the Energy Economics and Policy Institute at the University of Grenoble. He has published over 100 academic papers, most of these related to his principal research focus: the design and application of energy-economy models that assess the effectiveness of sustainable energy and climate policies. For this career research, he was named a Fellow of the Royal Society of Canada in 2009 and British Columbia's Academic of the Year in 2008. He has contributed to several major processes and assessments, including the Intergovernmental Panel on Climate Change (93-96 and 2010-2012), the China Council for International Cooperation on Environment and Development (1995-2001 and 2007-2009), Canada's National Roundtable on the Environment and the Economy (2006-2009), British Columbia's Climate Action Team (2007-2009), and the Global Energy Assessment (2008-2012). In 2006, his book, Sustainable Fossil Fuels, won the Donner Prize for top policy book in Canada. At Simon Fraser University he teaches graduate and undergraduate versions of an interdisciplinary course in energy and materials sustainability, covering basic physics, technologies, economics, policy and human cognition and behavior.

June 2, 2021 @ 11:30-12:30 EDT Diane Campbell, Assistant Deputy Minister, Meteorological Service of Canada (MSC), ECCC

Weather Services in Canada: our history, our future

This year we are celebrating 150 years of weather services in Canada. This journey has evolved from a $5,000 Cdn federal government investment approved on May 1, 1871 to establish a network of weather observing stations all the way to a varied and diverse array of sensors across Canada and in space; high performance computing and earth system modelling; and the evolution of specialized services to keep Canadians safe and resilient. Throughout these years new partnerships and collaborations have emerged to grow Canada's weather enterprise.

This plenary talk will highlight some of the key moments in the history of weather-related science and services at the Meteorological Service of Canada. It will explore the evolving roles of government, academia and the private sector in creating and delivering weather services. Finally, this talk will look to the future of weather services as unprecedented weather continues to impact our country. Disruptive forces are creating challenges and opportunities. Capabilities derived from earth system modelling and the use environmental intelligence will become a strategic asset in addressing national and global concerns around such topics as water, food, and energy security. The role of the global weather enterprise is quickly evolving with new players and new capabilities. MSC is looking ahead to build the partnerships needed to support the next 150 years of services to Canadians.

Biography: Diane Campbell studied Marine Biology at the University of Guelph and started her career working in the research laboratories at the Canada Centre for Inland Waters. Her work included toxicity studies on invertebrates and fish in the Great Lakes, biomonitoring projects in northern Ontario, and national water quality assessments.

She worked as a science advisor in both the Office of Energy Research and Development, and the Office of Environmental Affairs, at Natural Resources Canada, prior to becoming a science manager in the CANMET mineral and energy technology laboratories. After serving as the science advisor to the Assistant Deputy Minister of the Earth Science Sector, she joined Environment Canada as the National Director of Environmental Assessment. She progressed to more senior positions, returning to the Earth Sciences Sector as the Director General of the Sector's Research Programs Branch where she oversaw the delivery of horizontal earth sciences, mapping and climate change related research programs.

"What attracted me to the MSC was the opportunity to lead science-based programs in one of Canada's historic scientific institutions where its services touch Canadians on a daily basis" says Diane. "The MSC is a very high performing organization where people take great pride in their work and their service to Canadians." She joined the Meteorological Service of Canada in 2008 as the Director General of the Weather and Environmental Prediction Services where she has led many of MSC's major cost recovery services, service strategy development, product development and national dissemination systems. When the MSC re-organized in 2013-14 she took on the role of Director General of Prediction Services also overseeing service delivery in prediction operations across the country. In 2018, Diane became MSC's Associate Assistant Deputy Minister.

Throughout her 35 year-plus career, Diane has led major transformation initiatives; focused on workplace analysis and succession, and championed workplace and workforce wellness. She serves as both the MSC's champion of Mental Health, and as the Environment and Climate Change Canada's Mental Health Co-Champion (along with a union co-champion). She took several years off mid-career to raise two children. She experienced personally how our workplace has changed for the better over the past 30 years to support people through different stages in the careers and personal lives. Diane feels this trend must continue in order to attract and retain Canada’s talented workforce.

Diane and her husband live in the Gatineau Hills. When she is not working the former sports mom loves spending time outdoors, which she says, “grounds me and replenishes my energy levels.” Favourite pastimes include hiking, gardening and travelling as well as relaxing with a good book.

June 3, 2021 @ 11:30-12:30 EDT Lisa Loseto, Research Scientist, Arctic Aquatic Research Division, DFO

What can we learn about changing oceans and adaptation through the lens of Beluga whales?

"The Beluga whale (Delphinapterus leucas), is a sentinel species, with over 20 populations ranging throughout the circumpolar Arctic. It is a long lived species, situated at a high trophic level that sea ice associated and demonstrates a diversity of habitat use within the circumpolar range. These attributes combined with the importance of this species to Inuit make it an ideal indicator to track ocean health and consider these implications more broadly.

The Eastern Beaufort Sea (EBS) beluga population is regarded nationally and internationally as a population of ‘no concern’, yet may be one of the world’s most well-studied populations. In contrast to population management efforts that invest in research for mitigation and recovery efforts (e.g., Cook Inlet beluga populations), management of EBS belugas has benefitted from a concerted, pro-active conservation approach to ensure sustainability of the traditional harvest, including the development of two Marine Protected Areas (MPAs) and long-term (>40 year) research and monitoring programs.

The sustained research agenda can be attributed in part to a progressive land claim agreement that empowers Inuvialuit as co-managers of marine resources that is responsive to community questions, management needs, and scientific investigations. A collaborative beluga research program has set baselines for what is believed to be ‘normal’ for a suite of >20 health metrics (e.g. hormone levels, diet, diseases) that can be assessed with regional and local scale drivers (e.g. sea ice loss). Here we share unusual observations from events in 2014 and 2019 that co-inside with oceanic anomalies, and present information on subtle changes in beluga health that may represent underlying changes at the population or ecosystem level in response to regional scale changes."

Biography: https://profils-profiles.science.gc.ca/en/profile/lisa-l-loseto

Research Scientist, Arctic Ecosystems and Biotracers. Lisa conducts research that focuses on characterizing beluga health as means to understand ecosystem health in the Western Canadian Arctic. She combines food web biotracers and habitat modeling to gain insight into predator-prey interactions and ecosystem energetics. Her research on beluga diet and habitat use combines Western science and traditional ecological knowledge (TEK). Her research programs are carried out in partnership with communities and co-management boards of the Inuvialuit Settlement Region. She strives to serve all Canadians by providing knowledge and advice to decision makers and by helping to empower the people of the north through scientific knowledge combined with their own knowledge of their ecosystem and home.

June 7, 2021 @ 11:30-12:30 EDT Shawn Marshall, Professor, University of Calgary, Science Advisor to ECCC

The Slippery Slope from Glaciology to Climate Change to Science Policy

Like most of us working in the realm of Earth system science, I was drawn into this profession through some combination of a passion for the environment, a penchant for physics, and some measure of serendipity. In my case, the latter intervened when I was a 4th year undergraduate student studying Engineering Physics at the University of Toronto. UBC's Garry Clarke, the world's foremost glaciologist, gave a seminar in the Physics Department and I found myself enchanted with the prospect of applying heretofore theoretical conceptions of thermodynamics, continuum mechanics, and numerical modelling to real-world problems where you could also spend some time in the mountains, keeping company with glaciers. I followed Garry back to UBC for graduate school, and some 30 years later, I continue to work on and think about many of the challenging questions concerning glacier dynamics, Ice Ages, the role of glaciers and ice sheets in the climate system. There are many good problems to work on in this area, and this presentation will include a high-level overview of some outstanding glaciological challenges. Within this, there has been an explosion of interest in glacier and ice sheet response to climate change, and most of the world's glaciologists have been inexorably drawn into the world of climate change science. Glaciers and ice sheets play a critical role in global sea level rise, regional water resource stress, and broader climate system dynamics, and no country (save Greenland) has more glacial landscape to understand than Canada. There is also a fatalistic and tragic dimension to documenting global glacier demise, as one of many manifestations of the cumulative impacts of climate change. This experience is pushing many climate scientists to consider how they can make a broader contribution to society, to ensure that the science is being heard. While the world of science policy is much more complicated than physics, there is no question that we need more scientific voices at the table to help shape environmental policy, and there is some urgency to this. I will share some reflections on this topic based on my initial experience as a science advisor at Environment and Climate Change Canada.

Biography:
https://www.ucalgary.ca/research/scholars/marshall-shawn

Shawn Marshall joined the University of Calgary Department of Geography in 2000. Marshall's research interests include glacier dynamics, cryosphere-climate processes, paleoclimatology, and mountain meteorology. Current research projects include field and modelling studies in the Canadian Rockies, the Canadian Arctic, and Greenland. He held a Canada Research Chair in Climate Change from 2007-2017, studying glacier and ice sheet response to climate change.

June 8, 2021 @ 11:30-12:30 EDT Paul Snelgrove, Professor, Memorial University, Science Advisor to DFO

Sustaining Marine Biodiversity on a Complex Ocean Planet

Noting increasing impacts of human activities on ocean life, conserving the diverse biota that drive Earth's largest ecosystem and life support system creates one of the great scientific and societal challenges of our time. We must consider daunting spatial and temporal scales, and the many dynamic and complex oceanographic processes and societal pressures, including climate change, that influence marine ecosystems and their functioning. These challenges require new types of collaboration and communication to bring together the many facets of marine research that can and should influence ocean policy in Canada and beyond. In this presentation I draw on my experiences and activities as a researcher, program leader, and Departmental Science Advisor for DFO to help advance a sustainable ocean agenda. In particular, I focus on research needs to inform conservation strategies, with a particular emphasis on how population and ecosystem connectivity and functional roles could help to shape sustainable ocean use planning. I also consider the role of transdisciplinary research in addressing societal needs and in translating technical science knowledge and discovery to real world application.

Biography: https://www.mun.ca/osc/psnelgrove/

Dr. Snelgrove received a BSc. Hons degree in Biology at Memorial in 1984, a Master's degree in Oceanography from McGill University in 1984 and a PhD from the Massachusetts Institute of Technology and Biology Department at Woods Hole Oceanographic Institution in 1993. He spent 3 years in New Jersey as a Postdoctoral Fellow with Fred and Judy Grassle at the Institute of Marine and Coastal Sciences, followed by 8 months as a Killam Postdoctoral fellow with Jon Grant in the Department of Oceanography at Dalhousie University.

In 1996 he returned to Newfoundland as an NSERC Industrial Chair in Fisheries Conservation, prior to taking up a position as a Canada Research Chair in Boreal and Cold Ocean Systems in 2002 at the Ocean Science Centre.

Dr. Snelgrove led the synthesis of the International Census of Marine Life research program, as a member of the program's Scientific Steering Committee. He then published the book "Discoveries of the Census of Marine Life: Making Ocean Life Count" with Cambridge University Press in 2010 and was a TED Global speaker in 2011. Also in 2010 he was awarded the Parsons Medal for Achievement in Interdisciplinary Ocean Sciences in Canada by DFO. In 2012 he held the Knapp Visiting Chair at the University of San Diego and was a Walter and Andée de Nottbeck Foundation Senior Research Fellow at the Tvärminnen Zoological Station, University of Helsinki. He was then awarded the 2013 Timothy Parsons Medal for Excellence in Marine Sciences in Canada, and in 2015 Memorial University awarded him the title; University Research Professor. Among his many awards and achievements, Dr. Snelgrove sits on numerous advisory boards in Canada and internationally and frequently sits on review panels and editorial boards.

June 9, 2021 @ 11:30-12:30 EDT Johanna Wagstaffe, CBC Meteorologist, Vancouver

Climate change communication: Thoughts from a newsroom scientist

Science communication has never been more important. The climate crisis demands connection with the public, a spotlight on the science that is shaping our world, and an effective way to interpret data for policymakers. Informing the public requires engaging the public. And while scientists and journalists alike have encountered challenges in the past, the public's demand for climate change coverage is accelerating. The way we communicate science also needs to evolve in an ever-changing media landscape. Expanding platforms, changes to the way people are accessing news, and the audience’s growing scientific literacy -- there are more opportunities than ever to get important information across. But the content needs to be tailored. Sharing the facts and providing the evidence remain the most important part of the messaging, but offering a ‘‘heartbeat’ can cultivate a sense of belonging and shared purpose with the public. In this presentation I will share my successes, and the challenges I have faced with communicating climate change science through various narrative forms. I look forward to creating more dialogue and sharing ideas on this topic with the scientific community in attendance.

Biography: https://www.cbc.ca/mediacentre/bio/johanna-wagstaffe

Johanna Wagstaffe is the on-air meteorologist, seismologist and scientist for CBC VANCOUVER NEWS and CBC NEWS NETWORK. She has been covering national and international weather stories for the CBC News: Weather Centre since the summer of 2007.

Wagstaffe's strong background in seismology and earth science has led her to cover major seismic events, space missions and the Copenhagen and Paris Climate Change conference. She has hosted two award-winning CBC Vancouver podcasts: Fault Lines, 2050: Degrees of Change and continues to work on various CBC original podcast projects.

She is a vital resource for CBC and provides expert insight into breaking weather stories, as well as providing context to weather patterns and science stories in her “Science Smart” series. You can catch 'Science Smart’ on CBC’s Our Vancouver and online.

She graduated with an honours degree in geophysics from The University of Western Ontario. She was first exposed to weather forecasting as a summer intern at the Environment Canada Severe Weather Centre, then obtained her post-graduate meteorology certificate from York University. She first joined CBC Vancouver News and CBC News Now as the on-camera meteorologist in Fall 2012.

Outside of work, Wagstaffe enjoys running, teaching children about weather and science and flying. She got her pilot's license when she was 17 years old and still flies with her father in a 1943 Aeronca on the weekends.

June 10, 2021 @ 11:30-12:30 EDT Erin Bertrand, Associate Professor, Dalhousie University

Towards transforming our understanding of how ocean metabolism responds to and influences global change

Ocean metabolism is the basis for our planetary life support system. It links cellular biochemical processes with ecosystem-scale cycling of carbon, nutrients and oxygen. Understanding how ocean metabolism will respond to and influence global change is of growing importance. However, our current predictive models are not specifically linked to processes underpinning microbial growth, and so cannot incorporate the large and growing body of work that quantitatively describes critical feedback interactions within and between organisms and their environment. In this talk, I will discuss how recent applications of molecular measurements, in combination with modeling approaches, show promise for improving our view of ocean metabolism and the feedbacks that control its interactions with environmental change. I will also discuss the nascent global program BioGeoSCAPES, which aims to reveal how metabolisms in the ocean are structured and regulated by linking new tools, across molecular and biogeochemical observations, with models in a standardized framework. We seek input from all Canadian researchers on BioGeoSCAPES, as Canadian contributions to this global program are currently being formulated.

Biography: https://www.dal.ca/faculty/science/biology/faculty-staff/our-faculty/erin-bertrand.html

Associate Professor and Canada Research Chair in Marine Microbial Proteomics. Erin's research is driven by her passion for connecting molecular-level processes with global scale implications. Before Erin moved to Halifax, she was a Postdoctoral Fellow at Scripps Inst. of Oceanography and the J. Craig Venter Institute in California and earned her PhD from the MIT/WHOI Joint Program. When Erin isn't in the lab, classroom or at sea, you can find her running on beautiful Nova Scotia trails or listening to live music in Halifax.

Day 1 – 31 May 2021

Oral

Convenors: Adam Monahan (University of Victoria) Ron McTaggart-Cowan (ECCC) Marek Stastna (University of Waterloo) Michael Waite (University of Waterloo) This session combines submissions that document studies of the dynamics of the atmosphere, oceans and/or climate system. The scope of the session is deliberately broad in order to include research that spans a broad range of spatial and temporal scales. Studies of the dynamics of mesoscale processes that act on hourly timescales are as welcome in this session as those that document the evolution of planetary-scale structures in a changing climate. Such investigations may include diagnoses and theoretical studies of forecast, climate, and process models, or studies based on reanalysis and other observational datasets; however, any topic that is relevant to atmosphere, ocean, or climate dynamics will fit well into this session

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Internal wave shoaling and boundary layer modulation for realistic slopes	Marek Stastna		
12:45	Extreme wave run-up on beaches	Carmen Holmes-Smith		
13:00	Characterising the internal wave dynamics of Barkley Canyon	Kurtis Anstey		
13:15	Parameterizing non-propagating drag in the ocean	Jody Klymak		

Convenor: Peter Taylor (York University) This session will include contributions related to weather that do not fit into any of the other sessions.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar

12:30	An Update on CMC's Nowcasting of Weather Elements on Grid Project	Lewis Poulin
12:45	Comparing the Prediction Systems of the major NWP producing Centres	Tom Robinson
13:00	PROGNOS: Chapter 2 - Advances in the next statistical post-processing system of the Meteorological Service of Canada (MSC)	Christian Saad
13:15	NWP verification against own analysis by using a Data Assimilation confidence mask	Barbara Casati
13:30	An automated prototype system for the verification of marine forecasts issued by Environment and Climate Change Canada	Nelson Shum

Convenors: Michael Allchin(University of Calgary), Ravi Sankar (University of Calgary) Amplification of atmospheric warming at high latitudes and high altitudes is already impacting natural and human systems, shifting baseline climatologies, and altering the frequency and magnitude of extreme meteorological events. However, understanding of trends affecting specific components of climatological, hydrological, ecological and socio-economic systems, and of the potential for interactions between them, is often hampered by a paucity of long-term high-quality data. Many parts of the North and mountainous regions are difficult to access, hindering the tasks of installing and servicing instrumentation arrays, and substantially increasing logistical overheads. Consequently, datasets are often relatively short, locally-focused, and of limited scope. This session will provide a forum for discussion of all aspects of the challenges associated with the observation and monitoring of high-latitude and/or high-altitude environments (including, but not limited to, those focusing on meteorological phenomena). We invite presentations describing hurdles encountered, solutions developed, and future opportunities identified. The session's scope is intended to be broad: topics might include, for example, the benefits and pitfalls of combining ground and remotely-sensed observations; approaches for integrating 'other ways of knowing', including indigenous ecological and meteorological knowledge, with conventional scientific methods; options for incorporating data-gathering through 'citizen science' participation; best practices for encouraging universally high standards of data stewardship (e.g. FAIR principles, CARE principles for Indigenous Data Governance), thereby treating data as an asset rather than a raw material; avenues for developing frameworks within which to share the burden of gathering and curating data among a broader base of potential end-users; and consideration of how progress might be made towards a full digital twinning of key environmental contexts. We encourage consideration of 'outside-the-box' approaches: our goal is to provide an opportunity for constructive discussion of novel ideas which will help to advance understanding of changing influences and responses in these fascinating landscapes.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	The Arctic Observing Summit - Highlighting the importance of a sustained, pan-Arctic observing system in providing the tools and information needed for evidence-based decision making at all levels	Ravi Darwin SANKAR		
12:45	Drone Observations of Surface-Based Winter Temperature Inversions in Eureka, Nunavut	Alexey Tikhomirov		
13:00	On Closing the Loop of the UTLS Aerosol,	Jean-Pierre Blanchet		

	Cloud, Convection and Precipitation Interactions	
13:15	Aerosol hygroscopicity in the high Arctic summer and fall	Patrick Duplessis

Convenors: Susan Allen (University of British Columbia), David Fissel (ASL Environmental Sciences Inc.) Paul LeBlond (December 30, 1938 - February 8, 2020) was a distinguished scientist and one of Canada's leading physical oceanographers, most notably in his role as a Professor of Oceanography at the University of British Columbia (UBC) from 1964 -2007. His excellence in oceanographic research was reflected in the many honours awarded to him, including: the President's Prize, the J.P. Tully Medal, and as a Fellow of the Canadian Meteorological & Oceanographic Society (CMOS); Honorary Doctorate in Science, Memorial University of Newfoundland and Labrador; Fellow of the Royal Society of Canada; Foreign Member of the Russian Academy of Natural Science; and the Warren Wooster Award, North Pacific Marine Science Organization (PICES). Paul's research interests were very broad including eddies, coastal oceanography and implications of physical oceanography on fisheries. A focus was ocean waves, ranging from surface waves, to tides, internal waves and tsunamis generated by underwater landslides. This research extended to beach processes and gas bubble dynamics. He was a mentor to many UBC graduate students, including those that he supervised in their research activities and who attended his graduate student lectures, His collaborative research extended to many scientific peers at UBC, and with colleagues from across Canada and internationally. In this session, colleagues and collaborators of Paul are invited to present the results of recent research studies, which were inspired by, or related to, the influence of Paul.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Animal and Argo-float derived observations of seamount-attached	Tetjana Ross		

	eddies in the Northeast Pacific	
12:45	An examination of deep-water renewal events in Saanich Inlet, B.C.	Grayson Soetaert
13:00	Lagrangian “spaghetti” in a coastal sea- an analysis of virtual particle trajectories in the Strait of Georgia	Samuel Stevens
13:15	Update on "estuary/ocean exchange controlled by spring-neap tidal mixing"	Susan Allen
13:30	HF radar observations of wintertime surface currents over Hecate Strait, British Columbia	Patrick Cummins

Day 1 - Posters

POSTER SESSION

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
	Quantifying the role of internal climate variability in snow cover trends over northern Québec and Labrador	Dominic Morin	610P01	
	Sub-seasonal variability of meridional activity of Western Pacific subtropical high and its extended range forecast during boreal late summer	Ping Liang	610P02	
	Oceanic oscillations and the climate of late 18th Century Canada: A	C. Thomas Shay	610P03	

Progress Report		
Quantification of the resolvable scales of regional-scale CO2 transport in the context of imperfect meteorology: the predictability of CO2 at a regional scale	Jinwoong Kim	610P04
Investigating the spread of surface albedo and snow sensitivity in CMIP6 models	Libo Wang	650P01
Attribution of temperature changes in Canada: CMIP6 study	Elizaveta Malinina	750P01

POSTER SESSION

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
	Solid Precipitation Transfer Function Evaluation when applied at independent sites	Megan Hartwell	210P01	
	Inverse and Forward Models for Sound Propagation through Snowpacks	Nicholas Kinar	210P02	
	Update of the Canadian historical snow survey dataset (1928-2020)	Colleen Mortimer	210P03	
	Comparison of the precipitation measurements during the Saint John River Experiment on Cold	Julie M. Thériault	210P04	

	Season Storms			
	Intercomparison of Lambrecht automated precipitation gauge observations with established historical manual precipitation data	Stephnie Watson	210P06	
	Under which conditions do westward moving storms cross the continental divide between Alberta and British Columbia? A case study of two spring storms during 2019.	Nicolas Leroux	210P07	

POSTER SESSION

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
	Late-Holocene summer sea-surface conditions in the North Water polynya (northern Baffin Bay)	Kelsey Koerner	320P07	
	Identification of Mesoscale Ocean Eddies via Deep Learning	Uriel Zajaczkovski	820P01	
	Controls and variability of the retroflection of the Labrador Current	Carolina Dufour	850P01	
	Potential Students On Ice bottle trajectories using Ariane	Natasha Ridenour	850P03	
	Class 4 and other sea-ice-related verification of the Regional Canadian operational ice-ocean	Yvonnick Le Clainche	860P01	

	prediction system			
	The operational Sea Surface Temperature (SST) analysis at the Canadian Center for Meteorological and Environmental Prediction (CCMEP)	Dorina Surcel Colan	860P03	
	Configuration of a Model of Eastern Canadian Freshwater Discharge to the Northwest Atlantic	Rick Danielson	910P01	

POSTER SESSION

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
	The National Research Vessel Task Team and Modular Ocean Research Infrastructure. A Flexible, Scalable and Affordable Approach to Oceangoing Research in Canada and Worldwide.	Douglas Bancroft	220P01	
	Ocean Observatory Science: Preparing for the Next Decade of Success	Richard Dewey	220P02	
	Contribution to the Global Telecommunication System (GTS) – Marine Environmental Data Section (Fisheries and Oceans Canada)	Zhimin Ma	220P03	
	Programs in Marine Environmental Data Section (Fisheries and Oceans Canada)	Jenny Chiu	220P04	

POSTER SESSION

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
	Modelling Study of the Summertime Arctic Liquid Clouds	Roya Ghahreman	330P02	
	Development and validation of a blended pan-Arctic soil temperature dataset	Tyler Herrington	330P03	
	Remote Sensing analysis of Kluane Lake dust plumes: lidar-derived analysis of links between coarse mode (CM) AODs and surface, CM particle-volume concentration	Seyedali Sayedain	340P01	
	Ice nucleation characteristics of size-segregated aerosol samples and precipitation samples in the Arctic summer	Colleen Henschel	340P03	
	The relative roles of Arctic and Antarctic sea-ice loss in the response to greenhouse warming	Stephanie Hay	340P05	
	Sensibility of Optically Thin Ice Clouds Types on Available Potential Energy Budget Variation During the Arctic Polar	Housseyni Sankare	410P04	

POSTER SESSION

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
	SPACE-BASED EARTH OBSERVATION DATA ANALYSIS PROJECTS SUPPORTED BY THE CANADIAN SPACE AGENCY	Marcus Dejmek	640P01	
	Trans-pacific CO Transport as Observed by MOPITT	Zahra Vaziri	640P02	
	An Update on Long-term CO Trends as Observed by MOPITT	Zahra Vaziri	640P03	
	High-resolution NWP model simulations in support of EarthCARE satellite algorithm development studies involving cloud, aerosol and radiation.	Zhipeng Qu	640P04	
	Continuous radiative closure assessment of EarthCARE retrievals	Jason Cole	640P05	
	Ocean surface winds from dual-polarization RADARSAT Constellation Mission images	Alexander Komarov	640P06	
	Matrix Decomposition of Tundra Vegetation	Daniel Hogg	640P07	

POSTER SESSION

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
	A major upgrade to HAILCAST: Insights	Julian Brimelow	240P01	

	and lessons learned			
	The New Alert Ready Severe Thunderstorm Alert	Wade Szilagyi	240P02	
	Modeling Ground Clutter RhoHV as a Random Walk Process	Paul Ford	250P01	
	Monitoring Doppler radial winds from the new Canadian S-band radars	David Lobon	250P02	
	Adapting Meteorological Training Strategies During a Pandemic	Natalie Werbitski	250P03	
	Atmospheric data assimilation innovations in ECCC's Global Deterministic Prediction System	Alain Beaulne	250P04	
	A quality control system for historical in situ precipitation data	Xiaolan Wang	660P01	

POSTER SESSION

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
	Using consumer-grade trail cameras to observe leaf phenology in remote locations across Maritime Canada	Lynsay Spafford	330P04	
	Wind-driven vertical displacements drive subsurface oxygen variability on isopycnals in the subarctic Northeast Pacific	Ahron Cervania	410P01	

	Interactions of bacteria with heavy metals in Arctic snow and frost flowers	Roya Mortazavi	410P02	
	Bubble Dynamics in the Labrador Sea: Assessing Accuracy of Gas Exchange Models Through Comparison with Autonomous N₂ Measurements	Cassandra Purdon	850P02	
	Evaluating GEOS-Chem for air quality applications in Quebec, Canada	Nicole Trieu	880P02	
	Development of Canadian Hydrometeorological Standards for description, siting and operation, data qualification and transmission	Ted Weick	920P02	

POSTER SESSION

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
	Ice, winds, and tides: uncovering ocean processes in the Canadian Arctic Archipelago	Lina M. Rotermund	320P01	
	Remote sensing of aerosol-cloud interaction over the Arctic: context of indirect aerosol effects	Keyvan Ranjbar	320P02	
	Estimating turbulence in the Arctic Ocean at the Canada Basin shelf-break	Ruby Yee	320P03	

	Heat and Fresh Water Storage and Transports in the Arctic Ocean’s Beaufort Gyre	Mary-Louise Timmermans	320P04	
	Spatial variability of Arctic Ocean diffusivity from a pan-Arctic observational record	Hayley Dosser	320P05	
	Pacific Water pathway in the Arctic Ocean: a view from numerical modelling	Xianmin Hu	320P06	
	Investigating uncertainties in the NASA Eulerian Snow On Sea Ice Model and assessing the impact on sea ice thickness derived from ICESat-2 observations	Alex Cabaj	350P01	

POSTER SESSION

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
	Fractal Analysis of Coastal Surface Drifters in the Salish Sea	Edward Mason	510P01	
	Modelling circulation of Baynes Sound, British Columbia, with Finite Volume Community Ocean Model (FVCOM)	Maxim Krassovski	830P01	
	Evaluation of a high resolution ocean forecasting system for the port of Saint John, New Brunswick	Stephanne Taylor	860P02	

Seasonal variation of tidal flows in the Kitikmeot Sea	Chengzhu Xu	860P04
Extracting an ambient sound recording from a deep water and high current location off Northern Labrador	Josiane Ostiguy	870P01
Improvements in Dynamic Performances of an Inductive Profiling CTD	Mathieu Dever	880P01
Global-scale data-driven hydroclimatic system analyses	Guanhui Cheng	920P01

Day 2 – 1 June 2021

Oral

Convenor: W. Richard Peltier (University of Toronto) Both in the modern context of continued global warming of the lower atmosphere and in the context of episodes of climate system warming in the distant past, extreme events have accompanied adjustments to the operation of the Earth System. Under modern conditions, extreme precipitation events have become increasingly common and more extreme in their impacts globally through the flooding of human settlements. Similarly, heat waves and their impact upon wild fire frequency and severity exact a mounting toll on both the built and natural environments. These effects and others associated with biological diversity that may be equally extreme in terms of species extinction are hallmarks of a system in transition from a relatively stable and equable Holocene climate that persisted for thousands of years into an anthropocene characterized by significant temperature increase. During the evolution of Earth out of the last ice-age into the Holocene interglacial, extreme events also accompanied this transition from extreme cold into a state of Holocene warmth. These were of similar import but, interestingly, were much more deeply connected to the global ocean circulation than with the atmosphere and its water cycle.. These events included the Dansgaard-Oeschger oscillations and parent Heinrich events of Marine Isotope Stage 3 (MIS3) during a period of maximum continental ice cover. During the deglaciation vent that followed, there occurred the Bolling-Allerod warming event during which global sea level rose by as much as 30 m on global average. This was followed by the Younger-Dryas cold reversal which began 12,800 years ago and which returned the system to glacial conditions for 1000 years. Immediately following this event. North Africa was green but by approximately 4000 years ago the Sahara was rapidly desertified and severe impacts were felt on the human settlements that were developing in the eastern Mediterranean and the Levant as modern agriculture was emerging. The goal in this symposium will be to organize a comparison of the extreme events that characterized these two periods of warming transition both statistically and mechanistically. The proposed session, which would work best in two back-to-back segments, will cut across all of the themes of the CMIOS meeting.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Past and future changes in extreme precipitation across the globe	Francis Zwiers		
13:00	Projected Changes in Hydro-climatic Extremes in the Athabasca River Basin	Andre Erler		
13:30	Dynamically Downscaled Climate Change Projections for South and Southeast Asia: Mean and Extreme Monsoon Precipitation Changes and Physics Parameterization Impacts	Yiling Huo		
13:45	FURTHER PROBING THE MECHANISMS DRIVING REGIONAL PROJECTIONS OF EXTREME PRECIPITATION	Thabo Mpanza		

INTENSITY

Convenor: Peter Taylor (York University) This session will include contributions related to weather that do not fit into any of the other sessions.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Introducing the World Meteorological Organization's (WMO) Upcoming New Unified Data Policy	Jim M.C. Young		
12:45	ECCC improvements to data assimilation, wind speed retrieval, ice motion tracking and ice monitoring from the RADARSAT Constellation Mission	Benjamin Deschamps		
13:00	All-sky microwave radiance assimilation in Environment Canada's Global Deterministic Weather Prediction system	maziar bani shahabadi		
13:15	Implementation of observations dependent on slant columns of the atmosphere in Environment Canada's weather forecast system.	Josep Aparicio		
13:30	Assimilation of the Integrated Multi-satellitE Retrievals (IMERG) data in the Canadian Precipitation Analysis (CaPA)	Franck Lespinas		
13:45	MetPort: An Ocean Protect Plan Marine Weather Demonstration Project	Cindy Freeman		

Convernors: Yannick Rousseau (Ouranos), Diane Chaumont (Ouranos), Isabelle Charron (Ouranos), Elaine Barrow(CCCS), Emilia Diaconescu (CCCS) Climate services play a central role in the preparation and diffusion of climate datasets that are both scientifically sound and useful to identify vulnerabilities, anticipate the impacts of climate change, and adapt human activities and infrastructure to their environment. Not only do these services provide climate information (e.g., the Canadian Centre for Climate Services created a portal to improve data access), they also form a bridge between hard science (climatologists generating data representing the state of the atmosphere over several decades on a physics standpoint) and application (experts using climate information to guide decisions). As the Climate Services Partnership puts it, the translation and transfer of climate information are key components of this collaborative process that seeks to improve resilience against climate hazards. Although climate data have greatly improved in terms of coverage, availability and accessibility, challenges remain with respect to processing and communication approaches. The goal of this session is to encourage climate service providers to share their experience, which will allow to identify data-related aspects that need improvement, along with tracks that are worth exploring. Block A aims to discuss topics related to the production of useful climate data: • Recent improvements with respect to variables that were less studied or for which there is limited confidence, such as wind, freezing rain and snow; • Data transformation methods; • Quality control methods; • Quantification of uncertainty level and integration into risk and impact assessment. Block B aims to discuss topics associated with the manner in which climate information is communicated: • Short- and longer-term vision in the field of climate services; • Getting the stakeholders involved in the overall process; • Efficient communication of climate concepts to stakeholders (e.g., terminology, interpretation of results, uncertainty); • Is large-scale diffusion of usable climate information achievable or desirable? • Contribution of climate services to science-based decisions.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	100 years of Weather	Ha-		

	Observations from the Meteorological Service of Canada in Wikimedia Commons (Wikipedia)	Loan Phan
12:45	Public Access to the Canadian Climate Data and Metadata Image Files – Prototype	Anna Deptuch-Stapf
13:00	Accessing Canada's Weather and Climate Data through OGC APIs and Geospatial Web Services	Alexandre Leroux
13:15	Producing and Providing Canada's Daily Climate Records – A New Path to Releasing Climate Data Geospatially for Canadians	Rick Fleetwood
13:30	2020 Catastrophes in Canada: Insured loss insights on extreme weather	Caroline Floyd

Convenors: Christopher Subich (ECCC) Michael Dunphy (Fisheries and Oceans Canada) Kris Rowe (Argonne National Laboratory) This session focuses on recent advances in software engineering, computational physics, scientific computing, and machine learning related to the development of models for the atmosphere, ocean, land surface, and cryosphere. We invite submissions on: * New and improved numerical schemes---including high-order and adaptive techniques * The challenges of new computing architectures---including GPU computing, massive parallelism, hardware acceleration, cloud computing, and edge computing * The problems of big data---including data storage, processing, visualization, and machine learning / artificial intelligence * The management and development of high-quality scientific software---including language choice, project organization, continuous integration and deployment, as well as best practices for debugging and optimization. The goal of this session is the rapid dissemination of newly developed methods and techniques, even if they have not yet been deployed inside a large forecasting or analysis system.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	International Collaboration on Exascale Computing, Data Handling, and AI	Véronique Bouchet		
12:45	How to Port Your Scientific Software to GPU Architectures—Without Tears	Kristopher Rowe		
13:00	Augmenting eddy parameterizations with machine learning in global ocean simulations using SmartSim	Andrew Shao		
13:15	Empirical Bifurcation Analysis of Atmospheric Stable Boundary Layer Regime Occupation	Liz Ramsey		
13:30	An improved neural network model for shortwave radiative feedbacks quantification	Aliia Shakirova		

Convenors: David Fissel (ASL Environmental Sciences Inc.), Helen Joseph (HCJ Consulting) This interdisciplinary session will present emerging scientific results on the rapidly changing physical environment of the Canadian Arctic, over the past few decades. The underlying causes of these changes, in terms of the cryosphere, oceanography, hydrology and meteorology, are being addressed through observational- and modeling-based research. Papers will be presented on the changes in the Arctic environment, and their underlying causes. The results of the scientific studies will be relevant to developing policies, including those on the ecosystem, the Indigenous peoples of the Arctic, and commercial activities including shipping. Papers are sought from research and science activities in the following areas: (i) Arctic Meteorology and Climate; (ii) Arctic Oceanography; (iii) the Cryosphere including sea ice, glaciers, terrestrial and marine snowfall and snow accumulation; (iv) interdisciplinary papers on Arctic

Ecosystems and (v) policy papers on the Human Dimension of the Changing Arctic.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Variability of the Beaufort Ice-Ocean Environment: A Synthesis Report	Philip Osborne		
13:00	Incursions of Sea Ice into the eastern Canadian Beaufort Sea in Late Summer: A Case Study in 2018	David Fissel		
13:15	Freshwater, heat, and volume fluxes through Barrow Strait in the Canadian Arctic Archipelago	Clark Richards		
13:30	Impacts of 1°, 2°, and 4°C of global warming on ship navigation in the Canadian Arctic	Lawrence Mudryk		

Convenor: W. Richard Peltier (University of Toronto) Both in the modern context of continued global warming of the lower atmosphere and in the context of episodes of climate system warming in the distant past, extreme events have accompanied adjustments to the operation of the Earth System. Under modern conditions, extreme precipitation events have become increasingly common and more extreme in their impacts globally through the flooding of human settlements. Similarly, heat waves and their impact upon wild fire frequency and severity exact a mounting toll on both the built and natural environments. These effects and others associated with biological diversity that may be equally extreme in terms of species extinction are hallmarks of a system in transition from a relatively stable and equable Holocene climate that persisted for thousands of years into an anthropocene characterized by significant temperature increase. During the evolution of Earth out of the last ice-age into the Holocene interglacial, extreme events also accompanied this transition from extreme cold into a state of

Holocene warmth. These were of similar import but, interestingly, were much more deeply connected to the global ocean circulation than with the atmosphere and its water cycle.. These events included the Dansgaard-Oeschger oscillations and parent Heinrich events of Marine Isotope Stage 3 (MIS3) during a period of maximum continental ice cover. During the deglaciation vent that followed, there occurred the Bolling-Allerod warming event during which global sea level rose by as much as 30 m on global average. This was followed by the Younger-Dryas cold reversal which began 12,800 years ago and which returned the system to glacial conditions for 1000 years. Immediately following this event. North Africa was green but by approximately 4000 years ago the Sahara was rapidly desertified and severe impacts were felt on the human settlements that were developing in the eastern Mediterranean and the Levant as modern agriculture was emerging. The goal in this symposium will be to organize a comparison of the extreme events that characterized these two periods of warming transition both statistically and mechanistically. The proposed session, which would work best in two back-to-back segments, will cut across all of the themes of the CMIOS meeting.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	Green Sahara and its climatic consequence: from past to future	Francesco S.R. Pausata		
15:00	The KPP Trigger of Rapid AMOC Intensification in the Nonlinear Dansgaard-Oeschger Relaxation Oscillation	Yuchen Ma		
15:15	Out of the Ice-Age: Tidally forced Ice Stream Instabilities and Extreme Climate Impacts	Jesse Velay-Vitow		
15:30	Near and far-field expressions of Heinrich events and Dansgaard-Oeschger oscillations	Deepak Chandan		

15:45	Extreme weather characteristics over the Eastern Mediterranean during the mid-Holocene inferred from a dynamical downscaling experiment	Fengyi Xie		

Convenor: Peter Taylor (York University) This session will include contributions related to weather that do not fit into any of the other sessions.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	The Chemically Coupled ECCC Global Deterministic Prediction System (GDPS): The impact of ozone radiative coupling on weather forecasting	Jean de Grandpre		
14:45	The Chemically Coupled ECCC Global Deterministic Prediction System (GDPS): Evaluation of ozone analyses and forecasts.	Caroline Jouan		
15:00	The ECCC Chemically Coupled NWP System: Parametrization of Ozone Depletion Processes	Irena Ivanova		
15:15	The September 2020 wildfire smoke event: meteorology and societal impacts on North America’s West Coast	Armel Castellan		
15:30	The September 2020 wildfire smoke episode: air quality impacts and context for British Columbia’s Interior	Robert Nissen		
15:45	An analysis of the September 2020	Bob Kochtubajda		

	Smoke Event on the Canadian Prairies	
16:00	Environment and Climate Change Canada's FireWork wildfire air quality forecast model analysis for the 2020 fire season and recent developments	Jack Chen

Convernors: Yannick Rousseau (Ouranos), Diane Chaumont (Ouranos), Isabelle Charron (Ouranos), Elaine Barrow(CCCS), Emilia Diaconescu (CCCS) Climate services play a central role in the preparation and diffusion of climate datasets that are both scientifically sound and useful to identify vulnerabilities, anticipate the impacts of climate change, and adapt human activities and infrastructure to their environment. Not only do these services provide climate information (e.g., the Canadian Centre for Climate Services created a portal to improve data access), they also form a bridge between hard science (climatologists generating data representing the state of the atmosphere over several decades on a physics standpoint) and application (experts using climate information to guide decisions). As the Climate Services Partnership puts it, the translation and transfer of climate information are key components of this collaborative process that seeks to improve resilience against climate hazards. Although climate data have greatly improved in terms of coverage, availability and accessibility, challenges remain with respect to processing and communication approaches. The goal of this session is to encourage climate service providers to share their experience, which will allow to identify data-related aspects that need improvement, along with tracks that are worth exploring. Block A aims to discuss topics related to the production of useful climate data: • Recent improvements with respect to variables that were less studied or for which there is limited confidence, such as wind, freezing rain and snow; • Data transformation methods; • Quality control methods; • Quantification of uncertainty level and integration into risk and impact assessment. Block B aims to discuss topics associated with the manner in which climate information is communicated: • Short- and longer-term vision in the field of climate services; • Getting the stakeholders involved in the overall process; • Efficient communication of climate concepts to stakeholders (e.g., terminology, interpretation of results, uncertainty); • Is large-scale diffusion of usable climate information achievable or desirable? • Contribution of climate services to science-based decisions.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	Evaluation and Quality Control Function of the Copernicus Climate Data Store	Carlo Lacagnina		
15:00	Fitting Centuries' old Historical Weather Data to Modern Standards	Victoria Slonosky		
15:15	Producing and evaluating a Canada-wide dataset of future fire weather projections	Laura Van Vliet		
15:30	Towards standardized access to UVic's wave measurements from the BC Coast.	Clayton HIles		

Convenors: Christopher Subich (ECCC) Michael Dunphy (Fisheries and Oceans Canada) Kris Rowe (Argonne National Laboratory) This session focuses on recent advances in software engineering, computational physics, scientific computing, and machine learning related to the development of models for the atmosphere, ocean, land surface, and cryosphere. We invite submissions on: * New and improved numerical schemes---including high-order and adaptive techniques * The challenges of new computing architectures---including GPU computing, massive parallelism, hardware acceleration, cloud computing, and edge computing * The problems of big data---including data storage, processing, visualization, and machine learning / artificial intelligence * The management and development of high-quality scientific software---including language choice, project organization, continuous integration and deployment, as well as best practices for debugging and optimization. The goal of this session is the rapid dissemination of newly developed methods and techniques, even if they have not yet been deployed inside a large forecasting or analysis system.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	Assessing Uncertainty in Ocean Surface Drift Prediction using Fuzzy Numbers	Hauke Blanken		
14:45	Are we minimizing the appropriate errors in data assimilation for weather forecasting?	Frederic Fabry		
15:00	Evaluating the Effects of Storage-and-Release Events on Aircraft-based Mass-Balance Methodology Using a Regional Air Quality Model	Sepehr Fathi		
15:15	A Tide-Surge model of the Northwest Atlantic - measures of performance and sensitivity studies	David Greenberg		
15:30	WAVETRISK-OCEAN: an adaptive dynamical core for ocean modelling	Nicholas Kevlahan		
15:45	Instabilities and noise in implicit, semi-Lagrangian integration of the shallow water equations	Christopher Subich		

Convenors: David Fissel (ASL Environmental Sciences Inc.), Helen Joseph (HCJ Consulting) This interdisciplinary session will present emerging scientific results on the rapidly changing physical environment of the Canadian Arctic, over the past few decades. The underlying causes of these changes, in terms of the cryosphere, oceanography, hydrology and meteorology, are being addressed through observational- and modeling-based research. Papers will be presented on the changes in the Arctic environment, and their underlying causes. The results of the scientific studies will be relevant to developing policies, including those on the ecosystem, the Indigenous peoples of the Arctic, and commercial activities including shipping. Papers are sought from research and science activities in the following areas: (i) Arctic Meteorology and Climate; (ii) Arctic Oceanography; (iii) the Cryosphere including sea ice, glaciers, terrestrial and marine snowfall and snow accumulation; (iv) interdisciplinary papers on Arctic Ecosystems and (v) policy papers on the Human Dimension of the Changing Arctic.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	Changing sea-ice ecosystems and associated ecosystem services	Nadja Steiner		
14:45	Bridging Inuit knowledge and oceanographic research in Nunatsiavut	Breanna Bishop		

Day 3 – 2 June 2021

Oral

Convenors: Adam Monahan (University of Victoria) Ron McTaggart-Cowan (ECCC) Marek Stastna (University of Waterloo) Michael Waite (University of Waterloo) This session combines submissions that document studies of the dynamics of the atmosphere, oceans and/or climate system. The scope of the session is deliberately broad in order to include research that spans a broad range of spatial and temporal scales. Studies of the dynamics of mesoscale processes that act on hourly timescales are as welcome in this session as those that document the evolution of planetary-scale structures in a changing climate. Such investigations may include diagnoses and theoretical studies of forecast, climate, and process models, or studies based on reanalysis and other observational datasets; however, any topic that is relevant to atmosphere, ocean, or climate dynamics will fit well into this session

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	The soundproof quasi-elastic dynamical core of the Global Environmental Multiscale (GEM) model	Syed Zahid Husain		
12:45	Horizontal diffusion along height in GEM Model based on a terrain following vertical coordinates	Abdessamad Qaddouri		
13:00	First model evaluations of height-resolved diurnal water vapour cycles using lidar observations in an Arctic environment	Shannon Hicks-Jalali		
13:15	The evaluation of numerically-driven wildfire smoke plume rise and fire behavior system	Nadya Moisseeva		
13:30	Case study of a PL simulated with the developmental version of the convection-permitting Canadian Regional Climate Model (CRCM6)	Marta Moreno Ibáñez		

Convenor: Peter Taylor (York University) This session will include contributions related to weather that do not fit into any of the other sessions.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Investigation of the fine-scale flow field in	Aurélie Desroches-Lapointe		

	the Canadian Rockies using Doppler Lidar during spring precipitation events	
12:45	Representativeness of Coastal Stations for Verifying Open-Water 10 Metre Wind Forecasts	Nelson Shum
13:00	The Cape Breton Weather Station Mesonet	Jonathan Buffett
13:15	The Cape Breton Weather Station Mesonet – Forecast Applications	Chris Fogarty
13:30	Characterizing summer fogs during the Halifax Fog and Air Quality Study	Joelle Dionne
13:45	Constant Flux Layers with Gravitational Settling: deposition to an underlying surface and links to fog.	Peter Taylor

Convenors: Birgit Rogalla (University of British Columbia), Johanna Länger (University of Victoria), Christina Braybrook (University of Calgary), Kristina Brown (Department of Fisheries and Oceans, Canada) From the smallest interactions to large scale features, this session invites contributions from a variety of perspectives, including direct and remote observations, mechanistic and predictive models, and conceptual representations that advance our understanding of the impacts of continued change to the Arctic sea ice system on ocean biogeochemical cycles. We encourage submissions that help quantify and characterize these impacts, including but not limited to: small-scale process studies, combined observation-modelling studies, laboratory experiments, the sea ice carbon pump, trace metal cycling, and numerical models. We hope this session will facilitate conversations across the sea ice and ocean biogeochemistry community and will encourage combined approaches to these questions.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Anthropogenic Changes to the Carbonate Chemistry Balance of a Coastal Sea	Tereza Jarnikova		
12:45	Estimating the Northeast Pacific Ocean Carbon Sink Using a Neural Network Approach	Patrick Duke		
13:00	The Canadian Arctic Archipelago's Carbon Sink: a model based evaluation	Johanna Länger		
13:15	The role of sea ice melt in the missing Arctic Ocean carbon uptake	Benjamin Richaud		
13:30	The role of sediment in sea ice for Mn in the Canada Basin	Birgit Rogalla		

Convenor: TBA

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	A Synthetic Climatology of Dense Fog and Low Stratus Ceilings in the Canadian Arctic With Emphasis on Marine Areas	William Burrows		
12:45	Variability and spatial clustering of wind direction over large Canadian lakes	Dominique Brunet		
13:00	Nutrients boost by a strong winter storm in the Gulf of Maine	Hui Shen		

Day 4 – 3 June 2021

Oral

Convenors: Stephanie Waterman(University of British Columbia), Mary-Louise Timmermans (Yale University) The Arctic region is undergoing the most rapid climate changes on Earth, with unprecedented atmosphere and ocean temperature increases, and melting sea ice, permafrost, glaciers and snow. The ocean is a focal point of change, with warming, freshening, and circulation changes that link to the sea ice, atmosphere, and land. It is imperative to evaluate our present understanding of how the Arctic Ocean works and how it is changing in order to address knowledge gaps and make viable future predictions. This session invites submissions that investigate physical Arctic Ocean processes. We encourage studies that encompass observational, theoretical and numerical approaches to better understand the Arctic Ocean in a changing climate.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Temporal and spatial variability in Atlantic Water in the Arctic from observations	Alice Richards		
12:45	The Arctic's leaky plug: The changing nature of ice export along Nares Strait	Kent Moore		
13:00	Atmospheric, oceanic, and sea-ice variability along Nares Strait: a numerical model study	Yarisbel Garcia Quintana		
13:15	Reversal of Baffin Bay Transport Through Davis and Nares Strait Towards the Arctic Ocean due to Anomalous Winds and Ekman Transports	Paul Myers		
13:30	A changing Arctic Ocean:	John Smith		

How measured and modeled 129I distributions indicate fundamental shifts in circulation between 1994 and 2015

Convenor: Peter Taylor (York University) This session will include contributions related to weather that do not fit into any of the other sessions.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	History of the Canadian Hurricane Centre	Chris Fogarty		
12:45	Abstract: Developing a greater understanding of high impact, shallow, lake-induced snow events in the Toronto region.	Arnold Ashton		
13:00	Weather Elements on Grid: the new post-processing approach at the Meteorological Service of Canada Élements du temps sur grille: la nouvelle approche de post-traitement du Service météorologique du Canada.	Daniel Figueras Nieto		
13:15	Icing and Wind Forecasts for Wind Energy	Franco Petrucci		
13:30	Improving the Spatial and Temporal Resolution of the Existing Fire Weather Index System for Operational Use by Wildfire Agencies	Christopher Rodell		

Convenors: Adam Monahan (University of Victoria) Ron McTaggart-Cowan (ECCC) Marek Stastna (University of Waterloo) Michael Waite (University of Waterloo) This session combines submissions that document studies of the dynamics of the atmosphere, oceans and/or climate system. The scope of the session is deliberately broad in order to include research that spans a broad range of spatial and temporal scales. Studies of the dynamics of mesoscale processes that act on hourly timescales are as welcome in this session as those that document the evolution of planetary-scale structures in a changing climate. Such investigations may include diagnoses and theoretical studies of forecast, climate, and process models, or studies based on reanalysis and other observational datasets; however, any topic that is relevant to atmosphere, ocean, or climate dynamics will fit well into this session

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Shear mediates downward heat fluxes in unstably stratified environments	Andrew Grace		
12:45	Scale Separation in Double-Diffusive Internal Seiches	Nicolas Castro-Folker		
13:00	Ekman-inertial instability	Nicolas Grisouard		
13:15	Numerical Study of the Ekman-Inertial Instability in a 2D Non-Stratified Flow	Fabiola Trujano Jiménez		

Convenors: Dr. Elvis Z. Asong (Climalogik Inc.), Dr. Xin Qiu (SLR Consulting), Dr. Andre Erler (Aquanty Inc.) It is now unequivocal that anthropogenic climate change presents substantial uncertainty and shapes important decisions about the structure of economies, human development, natural resource use, and ways to reduce vulnerability and risks to extreme weather. Risks related to this uncertainty has grown as the 21st century progresses, along with the recognition that these risks must be factored into the design, construction, location, and operation of key cross-sectoral infrastructure and resource planning. But how do managers and professionals plan for uncertain climate change magnitudes and timelines? This challenging question often leads to adoption of a “wait and see” holding pattern, in the hope that climate science can be improved, and uncertainties narrowed before decision-making becomes urgent. However, postponing an honest assessment of climate change risks and assuming a “business-as-usual” approach to planning is a risky proposition. Since it is certain that the global climate is changing, planning that assumes a constant climate from the past, present, and into the future is, unfortunately, flawed. In short, there is no time like the present to begin factoring practical climate change considerations into cross-sectoral decision making, even considering uncertainty in the magnitude of future change. We invite contributions in the areas: a) Tailoring of climate scenarios information for use in conjunction with sector-specific impacts, vulnerability, and risk models. Particularly, statistical and dynamical downscaling (including bias correction) of: • High-resolution weather forecasts for user applications • Climate projections for site-specific real-world applications. The focus here is on downscaling of extreme events b) Methods and tools for making vulnerable investments climate resilient. Both bottom-up and top-down impacts, vulnerability, and risk integration approaches and combinations thereof are desirable c) Approaches for treatment of weather- and climate-related uncertainty and non-stationarity as they impact coping ranges, critical thresholds, vulnerabilities, and success criteria for different projects are welcome

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Bridging climate research and the practical application: Examples from the Pacific Climate Impacts Consortium	Markus Schnorbus		
13:00	Climate change and rainfall intensity–duration–frequency (IDF)	Jean-Luc Martel		

	curves: overview of science and guidelines for adaptation			
13:15	Extreme Climatic Design Parameters under Changing Climate for Design and Evaluation of Infrastructure	Hamidreza Shirkhani		
13:30	WMO Integrated Global Observing System	Thinesh Sornalingam		

Convenors: Guoqi Han (Fisheries and Oceans Canada), Jinyu Sheng (Dalhousie University) This special session will focus on all aspects of observing and modelling physical and biogeochemical processes in coastal domains, shelf seas, estuaries and inland waters. Topics include but are not limited to coastal physical oceanography, storm surges, tsunamis, estuarine dynamics, hydrology and hydrodynamics of large lakes, mixing and dispersion of materials. Contributions related to both observational and modelling aspects of biogeochemistry in coastal and inland waters are also welcome.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Deep Waters in British Columbia Mainland Fjords Show Rapid Warming and Deoxygenation From 1951 to 2020	Jennifer Jackson		
12:45	Coastal Wavewatch III wave model to form basis of nearshore hazard prediction	Leah Cicon		
13:00	Stratification and mixing in the Kitikmeot Sea in the Canadian Arctic Archipelago	Yasaman Afsharipour		

13:15	Evaluation of a Global Total Water Level Model in the Presence of Radiational S2 Tide	Pengcheng Wang
13:30	Testing the storm surge capability in the CONCEPTS 1/12th degree resolution Arctic-North Atlantic ice-ocean configuration	Frederic Dupont

Convenors: Stephanie Waterman(University of British Columbia), Mary-Louise Timmermans (Yale University) The Arctic region is undergoing the most rapid climate changes on Earth, with unprecedented atmosphere and ocean temperature increases, and melting sea ice, permafrost, glaciers and snow. The ocean is a focal point of change, with warming, freshening, and circulation changes that link to the sea ice, atmosphere, and land. It is imperative to evaluate our present understanding of how the Arctic Ocean works and how it is changing in order to address knowledge gaps and make viable future predictions. This session invites submissions that investigate physical Arctic Ocean processes. We encourage studies that encompass observational, theoretical and numerical approaches to better understand the Arctic Ocean in a changing climate.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	Synoptic Wind Forcing of the Flaw Lead in the Southern Beaufort Sea Ice Cover	Matthew Asplin		
14:45	A four-month lead predictor of open-water onset in Bering Strait	Youyu Lu		
15:00	Predicting Lagrangian trajectories for drifting objects in the Marginal Ice Zone	Graig Sutherland		
15:15	Phytoplankton dynamics	Lucas Barbedo		

	in the Hudson Bay System, an ocean color satellite perspective			
15:30	Decline of Arctic 'ice factories' delayed by negative feedbacks	Sam Cornish		

Convenors: Adam Monahan (University of Victoria) Ron McTaggart-Cowan (ECCC) Marek Stastna (University of Waterloo) Michael Waite (University of Waterloo) This session combines submissions that document studies of the dynamics of the atmosphere, oceans and/or climate system. The scope of the session is deliberately broad in order to include research that spans a broad range of spatial and temporal scales. Studies of the dynamics of mesoscale processes that act on hourly timescales are as welcome in this session as those that document the evolution of planetary-scale structures in a changing climate. Such investigations may include diagnoses and theoretical studies of forecast, climate, and process models, or studies based on reanalysis and other observational datasets; however, any topic that is relevant to atmosphere, ocean, or climate dynamics will fit well into this session

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	Regional mechanisms underlying the climate response to aerosol forcing	Haruki Hirasawa		
14:45	Irreducible Southern Ocean State Uncertainty due to Global Ocean Initial Conditions	Hansi Singh		
15:00	Present-day and Future Impacts of Extratropical Cyclone Location on Antarctic Sea Ice	Jamie Ward		
15:15	Changes in Cross-Equatorial Ocean Heat Transport Impact Hemispheric	Oghenekevwe C. Oghenechovwen		

	Climate and Hydrologic Cycle Sensitivity			
15:30	Impacts of Stratospheric Ozone Extremes on Arctic High Cloud	Karen Smith		

Convenors: Guoqi Han (Fisheries and Oceans Canada), Jinyu Sheng (Dalhousie University) This special session will focus on all aspects of observing and modelling physical and biogeochemical processes in coastal domains, shelf seas, estuaries and inland waters. Topics include but are not limited to coastal physical oceanography, storm surges, tsunamis, estuarine dynamics, hydrology and hydrodynamics of large lakes, mixing and dispersion of materials. Contributions related to both observational and modelling aspects of biogeochemistry in coastal and inland waters are also welcome.

Time	***Abstract Title***	**Presenter**	**Poster Order**	**Add to Calendar**
14:30	Using a bistatic coherent Doppler sonar to measure the motion of sediment along the bottom: a direct measurement of bedload transport.	Len Zedel		
14:45	Nested-Grid Numerical Ocean Circulation Models for the Eastern Canadian Shelf	Kyoko Ohashi		
15:00	Differential renewal of deep-water drives reaction layering in seasonally anoxic Saanich Inlet	Roberta Hamme		
15:15	Hydrodynamic Modelling of Wind-Driven Flows in Large Lakes	Parna Parsapour-Moghaddam		
15:30	Response of sea level to tide, atmospheric	Shiliang Shan		

pressure, wind forcing
and river discharge in
the Kitimat Fjord System

Convenors: Dr. Elvis Z. Asong (Climalogik Inc.), Dr. Xin Qiu (SLR Consulting), Dr. Andre Erler (Aquanty Inc.) It is now unequivocal that anthropogenic climate change presents substantial uncertainty and shapes important decisions about the structure of economies, human development, natural resource use, and ways to reduce vulnerability and risks to extreme weather. Risks related to this uncertainty has grown as the 21st century progresses, along with the recognition that these risks must be factored into the design, construction, location, and operation of key cross-sectoral infrastructure and resource planning. But how do managers and professionals plan for uncertain climate change magnitudes and timelines? This challenging question often leads to adoption of a “wait and see” holding pattern, in the hope that climate science can be improved, and uncertainties narrowed before decision-making becomes urgent. However, postponing an honest assessment of climate change risks and assuming a “business-as-usual” approach to planning is a risky proposition. Since it is certain that the global climate is changing, planning that assumes a constant climate from the past, present, and into the future is, unfortunately, flawed. In short, there is no time like the present to begin factoring practical climate change considerations into cross-sectoral decision making, even considering uncertainty in the magnitude of future change. We invite contributions in the areas: a) Tailoring of climate scenarios information for use in conjunction with sector-specific impacts, vulnerability, and risk models. Particularly, statistical and dynamical downscaling (including bias correction) of: • High-resolution weather forecasts for user applications • Climate projections for site-specific real-world applications. The focus here is on downscaling of extreme events b) Methods and tools for making vulnerable investments climate resilient. Both bottom-up and top-down impacts, vulnerability, and risk integration approaches and combinations thereof are desirable c) Approaches for treatment of weather- and climate-related uncertainty and non-stationarity as they impact coping ranges, critical thresholds, vulnerabilities, and success criteria for different projects are welcome

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	The Consultant's Role in Assisting Clients to Adapt to, and Mitigate Against, the Effects of Climate Change	Klas Ohman		
14:45	On the use of annual maxima to estimate long period wind speed return levels	Mohamed Ali Ben Alaya		
15:00	Preliminary Assessment of the Influence of Climate Change on Thunderstorm Winds for Five Selected Cities in South Ontario	Sihan Li		
15:15	Evaluation LID practices over Renton City in Washington under climate change conditions	Yasir Abduljaleel		
15:30	District of Ucluelet Coastal Flood Hazard Analysis	Clayton HIles		

Panel Session: Significant moments in the evolution of Canada's Weather Services Co-Chairs: - Diane Campbell, Assistant Deputy Minister, Meteorological Service of Canada (MSC), Environment and Climate Change Canada (ECCC) - Jim Abraham, President-Elect, Canadian Meteorological and Oceanographic Society Summary: The Symposium on 150 Years of Weather Services in Canada is an opportunity to celebrate the rich history and numerous achievements in weather services in Canada. This opening Session will be an opportunity to meet with past Order of Canada recipients who have made outstanding contributions to meteorology and whose leadership and actions have guided Canada's success internationally and at home. Through a combination of presentations and panel discussion, participants will share in the experiences and transformative moments over their careers, and gain insight on their perspectives for the future of Canada’s weather enterprise. Panelists: - David Grimes, Recently retired Assistant Deputy Minister (ADM) of the MSC and past President of the World Meteorological Organization (2011 - 2019) - Gordon McBean, Professor Emeritus, Department of Geography, Western University; ADM of MSC (1994-2000) - David Phillips, Senior Climatologist, MSC, ECCC - Pierre L. Morrissette, Founder of Pelmorex Media Inc. - James P. Bruce, International Institute for Sustainable Development Board Member (1997-2004), ADM of MSC (1980-1985) (written submission)

Day 5 – 4 June 2021

Oral

Convernors: Yannick Rousseau (Ouranos), Diane Chaumont (Ouranos), Isabelle Charron (Ouranos), Elaine Barrow(CCCS), Emilia Diaconescu (CCCS) Climate services play a central role in the preparation and diffusion of climate datasets that are both scientifically sound and useful to identify vulnerabilities, anticipate the impacts of climate change, and adapt human activities and infrastructure to their environment. Not only do these services provide climate information (e.g., the Canadian Centre for Climate Services created a portal to improve data access), they also form a bridge between hard science (climatologists generating data representing the state of the atmosphere over several decades on a physics standpoint) and application (experts using climate information to guide decisions). As the Climate Services Partnership puts it, the translation and transfer of climate information are key components of this collaborative process that seeks to improve resilience against climate hazards. Although climate data have greatly improved in terms of coverage, availability and accessibility, challenges remain with respect to processing and communication approaches. The goal of this session is to encourage climate service providers to share their experience, which will allow to identify data-related aspects that need improvement, along with tracks that are worth exploring. Block A aims to discuss topics related to the production of useful climate data: • Recent improvements with respect to variables that were less studied or for which there is limited confidence, such as wind, freezing rain and snow; • Data transformation methods; • Quality control methods; • Quantification of uncertainty level and integration into risk and impact assessment. Block B aims to discuss topics associated with the manner in which climate information is communicated: • Short- and longer-term vision in the field of climate services; • Getting the stakeholders involved in the overall process; • Efficient communication of climate concepts to stakeholders (e.g., terminology, interpretation of results, uncertainty); • Is large-scale diffusion of usable climate information achievable or desirable? • Contribution of climate services to science-based decisions.

Time	***Abstract Title***	**Presenter**	**Poster Order**	**Add to Calendar**
11:00	From science to services: providing useful climate information to users	Lindsay Matthews		
11:15	Climate services at Ouranos: the road ahead	Gabriel Rondeau-Genesse		
11:30	District of Ucluelet Coastal Flood Hazard Mapping and Planning Support	Tamsin Lyle		

Convenor: TBA This session will include contributions of an interdisciplinary nature that do not fit into any of the other sessions.

Time	***Abstract Title***	**Presenter**	**Poster Order**	**Add to Calendar**
11:00	Recherche en Prévision Numérique Contributions to Numerical Weather Prediction	C. Harold Ritchie		
11:15	Changing pattern of persistent positive anomalies in geopotential heights and wildfires in western	Aseem Sharma		

	North America	
11:30	Mechanisms responsible for the triggering of summertime nocturnal rainfall events over the Great Plains	Iaroslav Verevkin
11:45	A geophysically motivated take on correlated (equation) error	Rick Danielson
12:00	Residual resampling for the assessment of tidal harmonic regression uncertainty	Silvia Innocenti

Convenors: Mathilde Jutras (McGill University), Paul Myers (University of Alberta), Douglas Wallace (Dalhousie University, Department of Oceanography), Noémie Planat (McGill University) , Marine Decuypere (McGill University) The North Atlantic Ocean connects the Arctic Ocean with the Tropics and South Atlantic. More than a conduit, process within this basin play important driving roles on the world's oceans and on the climate system, on multiple spatial and temporal scales. The North Atlantic sees deep water formation, supplying gases to the deep ocean and causing the transformation of light northward flowing waters into dense southward flowing deep waters. Both of these process may be sensitive to the input of low salinity waters and thus impact the large scale Meridional Overturning Circulation. The low salinity waters generally enter the basin in narrow and strong boundary currents and the exchange with the less stratified interiors is crucial, yet is likely governed by small scale and temporally rapid processes. The western shelf of the North Atlantic also hosts highly biologically productive areas and the complex interaction between two important boundary currents: the Labrador Current and the Gulf Stream. Our understanding of the mechanisms driving all these processes, their variability and their interactions can still be improved, as well as their relation and influence on biogeochemistry. Our knowledge of the oceanography of the North Atlantic is growing rapidly with the increasing resolution of climate models and the increasing amount of available observations. This session will present papers that advance this understanding. Papers that link modelling and observations are especially appreciated. Theoretical papers and process studies will also be considered. This session invites papers on all aspects of the North Atlantic Ocean, including oceanic circulation, physical processes, and interaction between physics and biogeochemistry. Topics could include, but arenot restricted to, boundary circulation, connections between the North Atlantic and the Arctic outflow, the subpolar gyre, the AMOC, and the connection with biogeochemistry.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
11:00	Sea Surface Temperature Trends and Variability in the Northwest Atlantic	Jonathan Coyne		
11:15	Physical-biogeochemical interactions on the Newfoundland and Labrador shelf.	Frédéric Cyr		
11:30	Modelling Hudson Strait Waters: Pathways, structure, and multi-year variability	Natasha Ridenour		
11:45	Isolating Dissolved Inorganic Carbon’s Sources of Temporal Variability in the Northwest Atlantic Ocean	Claire Boteler		
12:00	Variations of the Scotian Slope Water from analysis of a global ocean reanalysis product	Yongxing Ma		

Convenors: Dr. David Sills, Dr. John Hanesiak Of the top ten most costly natural disasters in Canada, eight were caused by severe storms. Of those, four resulted in losses of over a billion dollars – and three of those occurred in the last decade. Climate change is expected to only increase the probability of such disasters occurring in the future. This session will be dedicated to severe storms and associated hazards in Canada and abroad over all seasons, ranging from synoptic-scale storms to warm season mesoscale convective systems and supercells. The goal of the session is to highlight new insights that improve our physical understanding and prediction capabilities for such events. Examples include, but not limited to, tornadoes and tornadic storms, storms that produce severe wind, hail, and/or flash flooding, and snow and ice storms,. We will be emphasizing research that seeks to answer specific scientific questions rather than provide general overviews of a topic. It is expected that there will be one 30-min invited presentation to lead off the session.

Time	***Abstract Title***	**Presenter**	**Poster Order**	**Add to Calendar**
12:30	Forward Into the Past	Harold Brooks		
13:00	Canadian tornadoes in Prairie Provinces from 1826-1939 - A comprehensive database	Jay Anderson		
13:15	Severe Weather Forecasting and Risk Communication: A Look back at Hurricane Dorian in Eastern Canada	Roberta McArthur		
13:30	Predecessor Rain Events in Ontario	Daniel & Jerry Liota & Shields		

Convenor: Peter Taylor (York University) This session will include contributions related to weather that do not fit into any of the other sessions.

Time	***Abstract Title***	**Presenter**	**Poster Order**	**Add to Calendar**
14:30	Precipitation forecast enhancement with a hybrid of analog ensemble and	Yingkai Sha		

	convolutional neural networks	
14:45	Comparison of gridding methods for monthly precipitation for trend analysis in Canada	Kian Abbasnezhadi
15:00	NWP model simulations of lake breezes: The impact of accounting for 3D solar radiative transfer for cloudy atmospheres	Howard W. Barker
15:15	Impact of Athabasca oil sands operations on mercury levels in air and deposition	Ashu Dastoor
15:30	Simulation of airborne tree pollen in Canada and the potential synergy with air pollution.	Alain Robichaud

Convenors: Dominique Paquin (Ouranos), Sébastien Biner (Ouranos), Alain Mailhot (INRS-ETE) Solid (snow, hail, sleet) or mixed (rain on snow, ice) precipitation can have significant impacts on Canadian society. Direct impacts, such as transport disruptions during snowstorms, freezing rain episodes disrupting movement or damage to crops during hailstorms are easier to assess. Indirect impacts can sometimes be more subtle, such as those caused by changes in snow density or weight during rain-on-snow events or by reduced snow cover. In order to assess these impacts, current and future, it is important to understand the formation of this precipitation which can see its frequency, intensity, location and duration modified by climate change. This session focuses on the understanding, current state and anticipated changes of winter precipitation events (solid, mixed, liquid) and hail both in terms of their representation in climate models and from the point of view of their impacts. This is in order to have a better understanding of the current situation as well as the risks that this type of hazard poses to our societies. We therefore invite people who have studied these phenomena and events to provide a summary for this session. Presentations on the ability of climate models to represent these phenomena, on the repercussions that particular events may have had, on the anticipated changes of these phenomena on Canadian territory and on current and future adaptation methods are welcome.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Changing statistics of "big snow" events: The North East US in the Canadian Regional Climate Model (CRCM5) ClimEx large ensemble	Gavin Schmidt		
12:45	High-resolution 21st-century projections of rain and snow using regional climate model simulations over British Columbia, Canada	Dhouha Ouali		
13:00	Projected changes to the risk of wind-driven rain on building in Canada under +0.5°C to +3.5°C global warming above the recent period: an ensemble of CanRCM4	Dae Il Jeong		
13:15	Deep learning to identify long-duration mixed precipitation over Montréal using a large database of the Canadian Regional climate model version 5 (CRCM5)	Magdalena Mittermeier		
13:30	Quantifying the Impact of Precipitation Type Algorithm Selection on Projected	Christopher McCray		

	Changes to Freezing Rain Events in an Ensemble of Regional Climate Model Simulations			
13:45	Projected change in freezing rain indicators useful for adaptation to climate change using CRCM5 data	Émilie Bresson		

Convenors: Guoqi Han (Fisheries and Oceans Canada), Jinyu Sheng (Dalhousie University) This special session will focus on all aspects of observing and modelling physical and biogeochemical processes in coastal domains, shelf seas, estuaries and inland waters. Topics include but are not limited to coastal physical oceanography, storm surges, tsunamis, estuarine dynamics, hydrology and hydrodynamics of large lakes, mixing and dispersion of materials. Contributions related to both observational and modelling aspects of biogeochemistry in coastal and inland waters are also welcome.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	A proxy for net discharge estimations in tidal rivers	Pascal Matte		
12:45	Numerical Study of Interactions between Tides and Storm Surges over the Eastern Canadian Shelf	Shengmu Yang		
13:00	The impact of wave breaking, Langmuir turbulence and conservative Stokes drift effects on the upper ocean dynamics under hurricane conditions	Colin Hughes		
13:15	Modelling the interannual variability of biogeochemical conditions along the	Angelica Pena		

British Columbia
continental margin

Convenors: Dr. David Sills, Dr. John Hanesiak Of the top ten most costly natural disasters in Canada, eight were caused by severe storms. Of those, four resulted in losses of over a billion dollars – and three of those occurred in the last decade. Climate change is expected to only increase the probability of such disasters occurring in the future. This session will be dedicated to severe storms and associated hazards in Canada and abroad over all seasons, ranging from synoptic-scale storms to warm season mesoscale convective systems and supercells. The goal of the session is to highlight new insights that improve our physical understanding and prediction capabilities for such events. Examples include, but not limited to, tornadoes and tornadic storms, storms that produce severe wind, hail, and/or flash flooding, and snow and ice storms,. We will be emphasizing research that seeks to answer specific scientific questions rather than provide general overviews of a topic. It is expected that there will be one 30-min invited presentation to lead off the session.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	The Making of Canada's First Billion Dollar Hailstorm	Julian Brimelow		
14:45	Lightning activity during the June 13, 2020 Calgary hailstorm	Bob Kochtubajda		
15:00	Polarimetric radar observations of the June 13th 2020, Alberta Hailstorm. Sudesh Boodoo, Julian Brimelow, Daniel Michelson, Norman Donaldson, Peter Rodriguez, Paul Joe. Meteorological Research Division,	Sudesh Boodoo		

	Science and Technology Branch, Environment and Climate Change Canada	
15:15	Exploring the Morphology and Evolution of the 4 July 2020 Tornadic Supercell in Southern Saskatchewan, SK, Canada	Mostofa Kamal
15:30	PGW FUTURE CHANGE OF HAIL OVER THE NORTHERN PLAINS AND CANADIAN PRAIRIES BASED ON WRF-HAILCAST SIMULATIONS	Daniel Betancourt

Convenor: Peter Taylor (York University) This session will include contributions related to weather that do not fit into any of the other sessions.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	Precipitation forecast enhancement with a hybrid of analog ensemble and convolutional neural networks	Yingkai Sha		
14:45	Comparison of gridding methods for monthly precipitation for trend analysis in Canada	Kian Abbasnezhadi		
15:00	NWP model simulations of lake breezes: The impact of accounting for 3D solar radiative transfer for cloudy atmospheres	Howard W. Barker		
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	mercury levels in air and deposition	
15:30	Simulation of airborne tree pollen in Canada and the potential synergy with air pollution.	Alain Robichaud

Convenors: Mathilde Jutras (McGill University), Paul Myers (University of Alberta), Douglas Wallace (Dalhousie University, Department of Oceanography), Noémie Planat (McGill University) , Marine Decuypere (McGill University) The North Atlantic Ocean connects the Arctic Ocean with the Tropics and South Atlantic. More than a conduit, process within this basin play important driving roles on the world's oceans and on the climate system, on multiple spatial and temporal scales. The North Atlantic sees deep water formation, supplying gases to the deep ocean and causing the transformation of light northward flowing waters into dense southward flowing deep waters. Both of these process may be sensitive to the input of low salinity waters and thus impact the large scale Meridional Overturning Circulation. The low salinity waters generally enter the basin in narrow and strong boundary currents and the exchange with the less stratified interiors is crucial, yet is likely governed by small scale and temporally rapid processes. The western shelf of the North Atlantic also hosts highly biologically productive areas and the complex interaction between two important boundary currents: the Labrador Current and the Gulf Stream. Our understanding of the mechanisms driving all these processes, their variability and their interactions can still be improved, as well as their relation and influence on biogeochemistry. Our knowledge of the oceanography of the North Atlantic is growing rapidly with the increasing resolution of climate models and the increasing amount of available observations. This session will present papers that advance this understanding. Papers that link modelling and observations are especially appreciated. Theoretical papers and process studies will also be considered. This session invites papers on all aspects of the North Atlantic Ocean, including oceanic circulation, physical processes, and interaction between physics and biogeochemistry. Topics could include, but arenot restricted to, boundary circulation, connections between the North Atlantic and the Arctic outflow, the subpolar gyre, the AMOC, and the connection with biogeochemistry.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	Carbon export in the central Labrador Sea: insights from the in situ, sensor-based observations	Dariia Atamanchuk		
14:45	Tracking Irminger Ring's properties throughout the Labrador Sea using a sub-mesoscale ocean model	Clark Pennelly		
15:00	Ongoing AMOC and related sea level and temperature changes after achieving the Paris targets	Michael Sigmond		
15:15	Sensitivity of convective overturning and turbulent mixing of dissolved gases in the Labrador Sea to atmospheric forcing	Romina Piunno		
15:30	Drivers of the Decline of the Atlantic Meridional Overturning Circulation under Climate Change in a Hierarchy of Climate Models	Anne-Sophie Fortin		

Convenors: Guoqi Han (Fisheries and Oceans Canada), Jinyu Sheng (Dalhousie University) This special session will focus on all aspects of observing and modelling physical and biogeochemical processes in coastal domains, shelf seas, estuaries and inland waters. Topics include but are not limited to coastal physical oceanography, storm surges, tsunamis, estuarine dynamics, hydrology and hydrodynamics of large lakes, mixing and dispersion of materials. Contributions related to both observational and modelling aspects of biogeochemistry in coastal and inland waters are also welcome.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	Altimetry-derived currents along the shelf edge and continental slope off British Columbia	Guoqi Han		
14:45	Surface wave impacts on upper ocean dynamics under realistic and idealized hurricanes	Guoqiang Liu		
15:00	Diurnal current response to the sea breeze on the inner shelf off the southern Caspian Sea	Mina Masoud		
15:30	Glider-based observations of fine-scale processes on the Scotian Shelf	Clark Richards		
15:30	A sensitivity study of the Gulf of St. Lawrence water masses in response to atmospheric forcing using the operational Canadian coastal ice-ocean prediction system	Francois Roy		

Day 6 – 7 June 2021

Oral

Convenors: Dr. David Sills, Dr. John Hanesiak Of the top ten most costly natural disasters in Canada, eight were caused by severe storms. Of those, four resulted in losses of over a billion dollars – and three of those occurred in the last decade. Climate change is expected to only increase the probability of such disasters occurring in the future. This session will be dedicated to severe storms and associated hazards in Canada and abroad over all seasons, ranging from synoptic-scale storms to warm season mesoscale convective systems and supercells. The goal of the session is to highlight new insights that improve our physical understanding and prediction capabilities for such events. Examples include, but not limited to, tornadoes and tornadic storms, storms that produce severe wind, hail, and/or flash flooding, and snow and ice storms,. We will be emphasizing research that seeks to answer specific scientific questions rather than provide general overviews of a topic. It is expected that there will be one 30-min invited presentation to lead off the session.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	The Catastrophic October 2019 Snow Storm Over Southern Manitoba, Canada	John Hanesiak		
12:45	A Hybrid Convective – Synoptic Windstorm Over Southern Ontario 04-May-2018	Robert Kuhn		
13:00	On Using Artificial Intelligence to Diagnose Precipitation Phase from Vertical Profiles	Dominique Brunet		
13:15	Extreme ice pellets storm on 12 January 2020 in southern Québec, Canada	Mathieu Lachapelle		
13:30	Utilizing lightning strike density information to aid in the forecasting Severe Thunderstorms	Melvin Lemmon		

Convenor: Kaley Walker (U. Toronto) Co-convenors: Matt Arkett (ECCC), Yi Huang (McGill U.), Felicia Kolonjari (ECCC), Paul Kushner (U. Toronto), Thomas Piekutowski (CSA) Space-based Earth observation provides a unique global perspective on our planet's atmosphere and surface, including the oceans, land, vegetation, ice, and snow. Current and planned satellite missions from Canada and international agencies have provided and will provide a wealth of new information about the Earth system and that can be used to investigate a wide range of environmental and scientific questions and provide vital data for societal needs. This session encourages contributions from across the full Earth observation value chain, upstream, midstream and downstream. This includes new measurement technologies and techniques, both passive and active; retrieval algorithms; demonstration and calibration of instruments; validation of satellite products; assimilation of data into numerical models; scientific results and discoveries; operational utilization and development of services.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Canada and the international Group on Earth Observations (GEO)	David Harper		
12:45	Advancing Climate Change Science through SBEO	Felicia Kolonjari		
13:00	WildFireSat: Operationalizing of Wildfire Remote Sensing Science	Joshua Johnston		
13:15	Canadian activities in preparation for Science & Applications of data from the SWOT mission	Jean Bergeron		
13:30	Arctic ice information from the RADARSAT Constellation Mission for data assimilation	Alexander Komarov		

Convenors: Adam Monahan (University of Victoria) Ron McTaggart-Cowan (ECCC) Marek Stastna (University of Waterloo) Michael Waite (University of Waterloo) This session combines submissions that document studies of the dynamics of the atmosphere, oceans and/or climate system. The scope of the session is deliberately broad in order to include research that spans a broad range of spatial and temporal scales. Studies of the dynamics of mesoscale processes that act on hourly timescales are as welcome in this session as those that document the evolution of planetary-scale structures in a changing climate. Such investigations may include diagnoses and theoretical studies of forecast, climate, and process models, or studies based on reanalysis and other observational datasets; however, any topic that is relevant to atmosphere, ocean, or climate dynamics will fit well into this session

Time	***Abstract Title***	**Presenter**	**Poster Order**	**Add to Calendar**
12:30	Albedo changes drive under ice horizontal transport	Donovan Allum		
12:45	Observed changes in physical water properties off Vancouver Island	Michaela Maier		
13:00	Seasonal and interannual inorganic carbon and oxygen dynamics in the Northeast Pacific	Ana C. Franco		
13:15	A Global Review of Marine Heatwaves' physical processes	Sofia Darmaraki		

Convenors: Bin Yu (ECCC), Hai Lin(ECCC) This session invites contributions that deal with climate variability and predictions on subseasonal, seasonal, interannual and decadal-interdecadal time scales. Contributions are solicited on topics including studies of the Madden-Julian Oscillation (MJO) and tropical waves, El Nino/Southern Oscillation (ENSO), atmospheric circulation patterns, tropical-extratropical interaction and teleconnections, and impacts of these processes on predictability and predictions. Equally welcome are contributions on extended- and long-range weather forecasts, and predictions of climate variability on various time scales, including ensemble and initialization techniques, model development, forecast skill assessment, downscaling and calibration, and end-user value and applications. Results from diagnostic, modelling, model inter-comparison, and theoretical approaches are all welcome.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	A new perspective of extratropical influences on ENSO variability	Sang-Wook Yeh		
13:00	The Empirical Bias Correction of Climate Projections	John Scinocca		
13:15	Warm and Cool Season Reconstruction and Assessment of the Long-term Hydroclimatic Variability of the Canadian Prairie Provinces through the Development of the Canadian Prairies Paleo Drought Atlas (CPPDA)	Samantha Kerr		
13:30	Second Generation of Homogenized Wind Speed for trend analysis in Canada	Megan Hartwell		
13:45	Interhemispheric asymmetry of surface wind projections in CanESM5 climate change simulations	Bin Yu		

Convenors: Patrick L. Hayes (University of Montreal) Rachel Chang (Dalhousie University) James King (University of Montreal) William Ward (University of New Brunswick) The Arctic atmosphere is changing rapidly. These changes are observed over various timescales in atmospheric composition, sea-ice extent, interactions with lower latitudes, and atmospheric inputs from land, snow, ice and oceans. Furthermore, understanding the changing Arctic atmosphere during both the summer and winter is an essential part of understanding the global atmospheric system. However, measurements within this harsh environment are especially challenging and sparse measurement coverage, temporally and spatially, means our understanding of this important region of the atmosphere is limited. This session addresses the radiative, chemical, and transport processes which influence the Arctic atmospheric. Thus, submissions on all aspects of the Arctic atmosphere are welcomed, including new instruments, new measurements, new sites, and new modeling efforts, with an emphasis on new insights into this complex and important atmospheric system. Submissions could cover processes from the ground to the mesopause. Of particular interest is the sensitivity of the Arctic region to changes in inputs/emissions that result in large effects when amplified through feedback mechanisms as well as the impact of an annual polar light/dark cycle, in contrast to a daily cycle, on radiative processes and the energy balance of the Arctic atmosphere.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Modelling atmospheric composition in the summertime Arctic: Impact of northern wildfire emissions	Wanmin Gong		
12:45	Ground-based FTIR Retrievals of PAN at the Polar Environment Atmospheric Research Laboratory	Tyler Wizenberg		
13:00	First Results from a New Micro-pulse Lidar at the High Arctic Polar Environment Atmospheric Research Laboratory (PEARL)	Victoria Pinnegar		
13:15	Quantifying the climate impact of present and future Arctic shipping: new modelling results from the SEANA project	Jo Browse		

Convenors: Dr. David Sills, Dr. John Hanesiak Of the top ten most costly natural disasters in Canada, eight were caused by severe storms. Of those, four resulted in losses of over a billion dollars – and three of those occurred in the last decade. Climate change is expected to only increase the probability of such disasters occurring in the future. This session will be dedicated to severe storms and associated hazards in Canada and abroad over all seasons, ranging from synoptic-scale storms to warm season mesoscale convective systems and supercells. The goal of the session is to highlight new insights that improve our physical understanding and prediction capabilities for such events. Examples include, but not limited to, tornadoes and tornadic storms, storms that produce severe wind, hail, and/or flash flooding, and snow and ice storms,. We will be emphasizing research that seeks to answer specific scientific questions rather than provide general overviews of a topic. It is expected that there will be one 30-min invited presentation to lead off the session.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	The Making of Canada's First Billion Dollar Hailstorm	Julian Brimelow		
14:45	Lightning activity during the June 13, 2020 Calgary hailstorm	Bob Kochtubajda		
15:00	Polarimetric radar observations of the June 13th 2020, Alberta Hailstorm. Sudesh Boodoo, Julian Brimelow, Daniel Michelson, Norman Donaldson, Peter Rodriguez, Paul Joe. Meteorological Research Division, Science and Technology Branch, Environment and Climate Change Canada	Sudesh Boodoo		
15:15	Exploring the Morphology and Evolution of the 4	Mostofa Kamal		

	July 2020 Tornadic Supercell in Southern Saskatchewan, SK, Canada			
15:30	PGW FUTURE CHANGE OF HAIL OVER THE NORTHERN PLAINS AND CANADIAN PRAIRIES BASED ON WRF-HAILCAST SIMULATIONS	Daniel Betancourt		

Convenor: Kaley Walker (U. Toronto) Co-convenors: Matt Arkett (ECCC), Yi Huang (McGill U.), Felicia Kolonjari (ECCC), Paul Kushner (U. Toronto), Thomas Piekutowski (CSA) Space-based Earth observation provides a unique global perspective on our planet's atmosphere and surface, including the oceans, land, vegetation, ice, and snow. Current and planned satellite missions from Canada and international agencies have provided and will provide a wealth of new information about the Earth system and that can be used to investigate a wide range of environmental and scientific questions and provide vital data for societal needs. This session encourages contributions from across the full Earth observation value chain, upstream, midstream and downstream. This includes new measurement technologies and techniques, both passive and active; retrieval algorithms; demonstration and calibration of instruments; validation of satellite products; assimilation of data into numerical models; scientific results and discoveries; operational utilization and development of services.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	MOPITT and Fires Around the World	James Drummond		
14:45	Estimating wildfire emissions of ammonia using Cross-track Infrared Sounder (CrIS) profile information	Ellen Eckert		
15:00	Towards an improved	Debora Griffin		

	understanding of nitrogen dioxide emissions from forest fires			
15:15	MOPITT Data Enhancement Through Cloud Detection Improvement	Heba Marey		
15:30	Examining the accuracy of satellite retrievals of trace-gas emissions and lifetimes using high-resolution plume modelling.	Zoe Davis		

Convenors: Adam Monahan (University of Victoria) Ron McTaggart-Cowan (ECCC) Marek Stastna (University of Waterloo) Michael Waite (University of Waterloo) This session combines submissions that document studies of the dynamics of the atmosphere, oceans and/or climate system. The scope of the session is deliberately broad in order to include research that spans a broad range of spatial and temporal scales. Studies of the dynamics of mesoscale processes that act on hourly timescales are as welcome in this session as those that document the evolution of planetary-scale structures in a changing climate. Such investigations may include diagnoses and theoretical studies of forecast, climate, and process models, or studies based on reanalysis and other observational datasets; however, any topic that is relevant to atmosphere, ocean, or climate dynamics will fit well into this session

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	Role of Diurnal Cycle in the Maritime Continent Barrier Effect on MJO Propagation in an AGCM	Boualem Khouider		
14:45	Toward a Stochastic Relaxation for the Quasi-Equilibrium Theory of	Etienne Leclerc		

	Cumulus Parameterization: Multicloud Instability, Multiple Equilibria, and Chaotic Dynamics	
15:00	Kinetic Energy Spectral, Energy Cascade, and Subgrid Parameterisation Analysis of Radiative-Convective Equilibrium	Kwan tsaan Lai
15:15	Evaluation of dry and wet extremes changes with warming using a passive water vapor	Marie-Pier Labonté
15:30	Prospect of increased disruption to the QBO in a changing climate	James Anstey

Convenors: Bin Yu (ECCC), Hai Lin(ECCC) This session invites contributions that deal with climate variability and predictions on subseasonal, seasonal, interannual and decadal-interdecadal time scales. Contributions are solicited on topics including studies of the Madden-Julian Oscillation (MJO) and tropical waves, El Nino/Southern Oscillation (ENSO), atmospheric circulation patterns, tropical-extratropical interaction and teleconnections, and impacts of these processes on predictability and predictions. Equally welcome are contributions on extended- and long-range weather forecasts, and predictions of climate variability on various time scales, including ensemble and initialization techniques, model development, forecast skill assessment, downscaling and calibration, and end-user value and applications. Results from diagnostic, modelling, model inter-comparison, and theoretical approaches are all welcome.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	Warmer and more volatile; why does summertime temperature variance increase as the	Lucas Vargas Zeppetello		

	climate warms?	
15:00	Human influence on daily temperature variability over land	Megan Kirchmeier-Young
15:15	Comparison of the Atlantic Meridional Overturning Circulation indicators and its impact on regional climate	Jing Zhang
15:30	Downscaling the Ocean Response to the Madden-Julian Oscillation in the Northwest Atlantic	Christoph Renkl
15:45	Climate change-induced variabilities in climate extremes on the Black Sea region of Turkey	Omar alsenjar

Convenors: Patrick L. Hayes (University of Montreal) Rachel Chang (Dalhousie University) James King (University of Montreal) William Ward (University of New Brunswick) The Arctic atmosphere is changing rapidly. These changes are observed over various timescales in atmospheric composition, sea-ice extent, interactions with lower latitudes, and atmospheric inputs from land, snow, ice and oceans. Furthermore, understanding the changing Arctic atmosphere during both the summer and winter is an essential part of understanding the global atmospheric system. However, measurements within this harsh environment are especially challenging and sparse measurement coverage, temporally and spatially, means our understanding of this important region of the atmosphere is limited. This session addresses the radiative, chemical, and transport processes which influence the Arctic atmospheric. Thus, submissions on all aspects of the Arctic atmosphere are welcomed, including new instruments, new measurements, new sites, and new modeling efforts, with an emphasis on new insights into this complex and important atmospheric system. Submissions could cover processes from the ground to the mesopause. Of particular interest is the sensitivity of the Arctic region to changes in inputs/emissions that result in large effects when amplified through feedback mechanisms as well as the impact of an annual polar light/dark cycle, in contrast to a daily cycle, on radiative processes and the energy balance of the Arctic atmosphere.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	The ice-nucleating ability of high-latitude dust from the Copper River, Alaska	Sarah Barr		
15:00	Environmental and climatic impacts of dust emissions from mines in Greenland	Christian Juncher Jørgensen		
15:30	The Importance of Mineral Dust and Proteinaceous Ice Nucleating Particles in the Canadian High Arctic during the Fall of 2018	Jingwei Yun		

Day 7 – 8 June 2021

Oral

Convenors: Stephanie Waterman(University of British Columbia), Mary-Louise Timmermans (Yale University) The Arctic region is undergoing the most rapid climate changes on Earth, with unprecedented atmosphere and ocean temperature increases, and melting sea ice, permafrost, glaciers and snow. The ocean is a focal point of change, with warming, freshening, and circulation changes that link to the sea ice, atmosphere, and land. It is imperative to evaluate our present understanding of how the Arctic Ocean works and how it is changing in order to address knowledge gaps and make viable future predictions. This session invites submissions that investigate physical Arctic Ocean processes. We encourage studies that encompass observational, theoretical and numerical approaches to better understand the Arctic Ocean in a changing climate.

Time	*Abstract Title*	Presenter	Poster	Add to

		Order	Calendar
12:30	Decadal observations of internal wave energy and shear in the western Arctic	Elizabeth Fine	
12:45	Changes in internal wave-driven mixing across the Arctic Ocean	Hayley Dosser	
13:00	Impacts of spatially varied vertical mixing in an Arctic Ocean model	Ben O'Connor	
13:15	Impact of vertical mixing and freshwater input on summertime net community production in Canadian Arctic and Subarctic waters: Insights from in situ measurements and numerical simulations	Philippe Tortell	
13:30	Responses of Atlantic water inflow through Fram Strait to Arctic storms	Zhenxia Long	

Convenor: Kaley Walker (U. Toronto) Co-convenors: Matt Arkett (ECCC), Yi Huang (McGill U.), Felicia Kolonjari (ECCC), Paul Kushner (U. Toronto), Thomas Piekutowski (CSA) Space-based Earth observation provides a unique global perspective on our planet's atmosphere and surface, including the oceans, land, vegetation, ice, and snow. Current and planned satellite missions from Canada and international agencies have provided and will provide a wealth of new information about the Earth system and that can be used to investigate a wide range of environmental and scientific questions and provide vital data for societal needs. This session encourages contributions from across the full Earth observation value chain, upstream, midstream and downstream. This includes new measurement technologies and techniques, both passive and active; retrieval algorithms; demonstration and calibration of instruments; validation of satellite products; assimilation of data into numerical models; scientific results and discoveries; operational utilization and development of services.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	OSIRIS on Odin: Twenty years of Scientific Achievements	Doug Degenstein		
12:45	Air Emissions from the Canadian Oil Sands as seen from space	Chris McLinden		
13:00	The MAESTRO Spectrophotometer on Canada's SCISAT satellite: Advances in data processing and improved data products	C. Thomas McElroy		
13:15	Assessment of the quality of ACE-FTS stratospheric ozone data	Patrick Sheese		
13:30	Using the COVID-19 flight disruption to constrain aviation-induced cirrus	Ruth Digby		

Convenors: Bin Yu (ECCC), Hai Lin(ECCC) This session invites contributions that deal with climate variability and predictions on subseasonal, seasonal, interannual and decadal-interdecadal time scales. Contributions are solicited on topics including studies of the Madden-Julian Oscillation (MJO) and tropical waves, El Nino/Southern Oscillation (ENSO), atmospheric circulation patterns, tropical-extratropical interaction and teleconnections, and impacts of these processes on predictability and predictions. Equally welcome are contributions on extended- and long-range weather forecasts, and predictions of climate variability on various time scales, including ensemble and initialization techniques, model development, forecast skill assessment, downscaling and calibration, and end-user value and applications. Results from diagnostic, modelling, model inter-comparison, and theoretical approaches are all welcome.

Time	*Abstract Title*	Presenter	Poster	Add to

		Order	Calendar
12:30	Potential impact of preceding Aleutian Low variation on the El Niño-Southern Oscillation during the following winter	Shangfeng Chen	
13:00	Application of CanESM5 to seasonal and decadal forecasting	William Merryfield	
13:15	Decadal climate predictions with the initialized CanESM5 large ensemble	Reinel Sospedra-Alfonso	
13:30	Improving seasonal predictions with GEM5 based coupled model	Hai Lin	
13:45	Seasonal Forecast Skill and Potential Predictability of Arctic Sea Ice in Two Versions of a Dynamical Forecast System	Joseph Martin	

Convenors: Stephanie Waterman(University of British Columbia), Mary-Louise Timmermans (Yale University) The Arctic region is undergoing the most rapid climate changes on Earth, with unprecedented atmosphere and ocean temperature increases, and melting sea ice, permafrost, glaciers and snow. The ocean is a focal point of change, with warming, freshening, and circulation changes that link to the sea ice, atmosphere, and land. It is imperative to evaluate our present understanding of how the Arctic Ocean works and how it is changing in order to address knowledge gaps and make viable future predictions. This session invites submissions that investigate physical Arctic Ocean processes. We encourage studies that encompass observational, theoretical and numerical approaches to better understand the Arctic Ocean in a changing climate.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	Developing a large ensemble of Arctic wave projections with neural networks	Mercè Casas Prat		
14:45	Arctic Amplification of Anthropogenic Forcing: A Vector Autoregressive Analysis	Maximilian Göbel		
15:00	Contribution of ocean physics and dynamics to Arctic Ocean warming in global AOGCMs	Oleg Saenko		
15:15	Climate Models Underestimate Arctic Sea Ice Climate Sensitivity	Glenn Rudebusch		
15:30	Observationally-constrained projections of Arctic warming	Yongxiao Liang		

Convenors: Patrick L. Hayes (University of Montreal) Rachel Chang (Dalhousie University) James King (University of Montreal) William Ward (University of New Brunswick) The Arctic atmosphere is changing rapidly. These changes are observed over various timescales in atmospheric composition, sea-ice extent, interactions with lower latitudes, and atmospheric inputs from land, snow, ice and oceans. Furthermore, understanding the changing Arctic atmosphere during both the summer and winter is an essential part of understanding the global atmospheric system. However, measurements within this harsh environment are especially challenging and sparse measurement coverage, temporally and spatially, means our understanding of this important region of the atmosphere is limited. This session addresses the radiative, chemical, and transport processes which influence the Arctic atmospheric. Thus, submissions on all aspects of the Arctic atmosphere are welcomed, including new instruments, new measurements, new sites, and new modeling efforts, with an emphasis on new insights into this complex and important atmospheric system. Submissions could cover processes from the ground to the mesopause. Of particular interest is the sensitivity of the

Arctic region to changes in inputs/emissions that result in large effects when amplified through feedback mechanisms as well as the impact of an annual polar light/dark cycle, in contrast to a daily cycle, on radiative processes and the energy balance of the Arctic atmosphere.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	Performance of the Canadian deterministic prediction systems over the Arctic during the winter and summer YOPP Special Observing Periods	Barbara Casati		
14:45	Impact of model resolution on the representation of the wind field along Nares Strat	Kent Moore		
15:00	The lagged impact of autumn surface temperature conditions on the wintertime Beaufort High.	Maria-Fernanda Lozano		
15:15	The consequences of increased global latent heating for the Arctic Atmosphere	Robert Fajber		
15:30	Impacts of Arctic climate change on synoptic cyclones	Minghong Zhang		

Day 8 – 9 June 2021

Oral

Convenors: Arelia Schoeneberg, Pacific Climate Impacts Consortium, University of Victoria Tricia Stadnyk, Canada Research Chair (Hydrologic Modelling), University of Calgary Jeremy Fyke, Canadian Centre for Climate Services (ECCC) The magnitude and frequency of floods and droughts is likely to change significantly in a warming climate. To characterize changing hydrologic extremes, and develop responses that ensure resilience to future flood and drought impacts, unique approaches for hydrologic modelling are needed. Classic hydrologic model calibration methods struggle to provide model instances that adequately capture extreme high and low flow conditions, tending instead toward more common mean flow conditions. Similarly, many statistical downscaling and climate model selection approaches are not well-designed to explore the widest range of future hydrologic uncertainty. Gridded meteorological datasets used to calibrate hydrologic models may be biased, particularly in complex or sparsely-observed landscapes. Most hydrologic models in turn lack adequate representation of critical human management in watersheds, such as climate-change-dependent land use, water demand, and flood and drought mitigation. Recognizing an acute need for improved hydrologic modelling in support of consequential climate-aware flood and drought risk assessments, we welcome presentations on all topics related to projecting future Canadian hydrologic conditions. This includes, but is not limited to developing hydrologic models with enhanced functionality such as dynamic vegetation, glaciers, and human/hydrology interactions; constructing hydrologically-informed gridded meteorological datasets, GCM selection in support of hydrologic uncertainty quantification, statistical downscaling guided by hydrologic model needs, unique calibration, validation and uncertainty approaches, and uncertainty assessment and regionalization approaches in support of decision making. We would like to open the dialogue on options for professional designations for hydrologist working in this field and ask authors to share their successes or roadblocks. Recent findings from a study on professional designations for hydrologists, by the Canadian Society for Hydrologic Sciences (CSHS) and Canadian Water Resources Association (CWRA), will be shared in a discussion. We strive to promote equity and diversity in our session and look forward to your submissions.

Time	***Abstract Title***	**Presenter**	**Poster Order**	**Add to Calendar**
12:30	Spatial flood coherence needs more attention in hydrologic	Manuela Brunner		

	modeling	
12:48	One size does not fit all: Leveraging flexibility of hydrological model structure for improved prediction	James Craig
13:06	Integrating climate change into present-day engineering design decisions – The City of Grand Forks case study	Lawrence Bird
13:24	A new approach for modelling the spatial extent of agricultural drought	Seoncheol Park
13:42	Climatic Changes to Streamflow and Snow Indicators Used in Decision Making in British Columbia	Arelia Schoeneberg

Convenors: Gordon McBean (Western University and ILCR), Paul Kovacs (ICLR and Western University) When recovering from the pandemic, it is important for Planet Earth to address the Global Agenda 2030 and to bounce forward sustainably and enhance the resilience of Canadian communities. The World Economic Forum's Global Risk Report and Global Agenda 2030 provide a framework for action. The global climate is changing, and Canada is warming at about twice the rate of the planet. To reduce the impacts on Canadians and all societies there is need to address these issues through climate research addressing the impacts, resilience and most effective responses. The pillars of the Sendai Framework for Disaster Risk Reduction provide a framework for synthesis; understanding disaster risk; strengthening disaster risk governance to manage disaster risk; actions for disaster risk reduction for resilience; and enhancing disaster preparedness for effective response including warnings systems for near term through the decades. Communities, including Indigenous communities, have different natural, socio-economic, health and geopolitical systems and will need different strategies. To enable the most effective and continuing implementation, frameworks for measurement and evaluation of action to reduce risks will be examined and recommendations provided on how the frameworks can be used for optimum future benefits. The Session will include presentations across the disciplines and the climate-weather-environmental, governance and societal issues as the most effectively motivate and providing scientific basis for implementing the building of climate resilient communities.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Building Climate Resilient Communities – International Dimensions	Gordon McBean		
12:45	Heat Environments of Canadian Communities	James Voogt		
13:00	Cities Adapt to Extreme Wildfires	Esther Lambert		
13:15	Building Climate Resilient Communities and Health Systems	Anna Gunz		
13:30	Adaptation in Indigenous Communities	Brennan Vogel		

Convenor: Kaley Walker (U. Toronto) Co-convenors: Matt Arkett (ECCC), Yi Huang (McGill U.), Felicia Kolonjari (ECCC), Paul Kushner (U. Toronto), Thomas Piekutowski (CSA) Space-based Earth observation provides a unique global perspective on our planet's atmosphere and surface, including the oceans, land, vegetation, ice, and snow. Current and planned satellite missions from Canada and international agencies have provided and will provide a wealth of new information about the Earth system and that can be used to investigate a wide range of environmental and scientific questions and provide vital data for societal needs. This session encourages contributions from across the full Earth observation value chain, upstream, midstream and downstream. This includes new measurement technologies and techniques, both passive and active; retrieval algorithms; demonstration and calibration of instruments; validation of satellite products; assimilation of data into numerical models; scientific results and discoveries; operational utilization and development of services.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Satellite Observations of Landfast Ice in the Beaufort Sea Region: Features and Trends in the 21th Century	Alexander Trishchenko		
12:45	Large-scale Arctic sea ice motion from Sentinel-1 and the RADARSAT Constellation Mission	Stephen Howell		
13:00	Using CloudSat-CPR estimates of snowfall to constrain gridded snow water equivalent products	Fraser King		
13:15	Characteristics of the convectively injected moisture plumes in the extratropical lower stratosphere and their observability by satellite instruments	Xun Wang		
13:30	Satellite observation of thermodynamic conditions in the tropical tropopause layer under the impact of tropical cyclones	Jing Feng		

Convenors: Rita So (Environment and Climate Change Canada), Stephen Déry (University of Northern British Columbia), Melinda (Mindy) Brugman (Environment and Climate Change Canada) An atmospheric river (AR) can be generally defined as a long, narrow, and transient corridor of strong horizontal water vapour transport that is typically associated with a low-level jet stream ahead of the cold front of an extratropical cyclone (EC). Each AR-related storm event may be composed of one or more ECs and can produce heavy precipitation when they are forced upwards by mountains or frontal lifting, which can also lead to severe floods, landslides, and/or avalanches depending on the overall regional sensitivities due to land use, snow cover and antecedent moisture conditions. At times, an EC behind a passing AR can generate a strong wind storm to further worsen conditions. Although scientific understanding of ARs and the associated cyclones has advanced to a remarkable extent in the past decades, accurate operational forecast and communication of the systems and potential hazards remain challenging. This session focuses on various issues of ARs and ECs, including their mutual coupling and feedback mechanisms, thermodynamic responses to climate change, statistical-dynamical forecast methods, tracking algorithms, and classification schemes. Abstracts related to the intraseasonal-to-seasonal variability of ARs/ECs and extreme event case studies are also encouraged.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	A New Scale to Classify Extratropical Cyclones and Atmospheric Rivers: Recent Case Studies	Rita So		
12:45	Heavy Precipitation Shifted Downwind by Strong Moist Jets Helped Trigger Major West Coast Landslides During 2020	Melinda Brugman		
13:00	High-Impact Weather Review: Analysis of a Powerful Atmospheric River System Affecting the South Coast of British Columbia during 29 January–01 February 2020	Matthew MacDonald		
13:15	A tale of two atmospheric rivers affecting Pacific and Atlantic Canada	Ruping Mo		

	during 1–2 December 2020			
13:30	Snow and Ice Factors: Including Antecedent Conditions and Sensitivities into Rating Extratropical Cyclones and Atmospheric River Impacts	Melinda M Brugman		

Convenor: Arelia Schoeneberg, Pacific Climate Impacts Consortium, University of Victoria

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	Using a Hybrid Optimal Interpolation-Ensemble Kalman Filter approach in the Canadian Precipitation Analysis (CaPA)	Dikra Khedhaouiria		
14:45	A Novel Method for Interpolating Daily Station Rainfall Data using a Stochastic Lattice Model	Boualem Khouider		
15:00	Effects of Climate Change on Navigability Indicators for the Lower Athabasca River	Daniel Peters		
15:15	Forecasting categorical ice cover conditions at Lake St. Lawrence and Beauharnois Canal using multinomial logistic regression	Natalie Gervasi		
15:30	Predictability of sea ice in the Gulf of St. Lawrence on seasonal timescales	David Brickman		

Convenors: Gordon McBean (Western University and ILCR), Paul Kovacs (ICLR and Western University) When recovering from the pandemic, it is important for Planet Earth to address the Global Agenda 2030 and to bounce forward sustainably and enhance the resilience of Canadian communities. The World Economic Forum's Global Risk Report and Global Agenda 2030 provide a framework for action. The global climate is changing, and Canada is warming at about twice the rate of the planet. To reduce the impacts on Canadians and all societies there is need to address these issues through climate research addressing the impacts, resilience and most effective responses. The pillars of the Sendai Framework for Disaster Risk Reduction provide a framework for synthesis; understanding disaster risk; strengthening disaster risk governance to manage disaster risk; actions for disaster risk reduction for resilience; and enhancing disaster preparedness for effective response including warnings systems for near term through the decades. Communities, including Indigenous communities, have different natural, socio-economic, health and geopolitical systems and will need different strategies. To enable the most effective and continuing implementation, frameworks for measurement and evaluation of action to reduce risks will be examined and recommendations provided on how the frameworks can be used for optimum future benefits. The Session will include presentations across the disciplines and the climate-weather-environmental, governance and societal issues as the most effectively motivate and providing scientific basis for implementing the building of climate resilient communities.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	Construction Codes – Building Climate Resilient Communities	Dan Sandink		
14:45	Knowledge Synthesis of the Economics of Adaptation	Bohan Li		
15:00	The local governance approach to resilient	Sebastian Weissenberger		

	communities in Quebec's coastal and littoral communities			
15:15	Utilizing the ENVISION modelling framework to identify risks and evaluate the performance of biomass crops under future climate scenarios in Canada	Brent Coleman		
15:30	Canadian cities resiliency to extreme heat : Numerical scenarios with GEM	Sylvie Leroyer		
15:45	Addressing Climate Change Impacts on Canada by Building Resilient Communities - Synthesis	Gordon McBean		

Convenor: Kaley Walker (U. Toronto) Co-convenors: Matt Arkett (ECCC), Yi Huang (McGill U.), Felicia Kolonjari (ECCC), Paul Kushner (U. Toronto), Thomas Piekutowski (CSA) Space-based Earth observation provides a unique global perspective on our planet's atmosphere and surface, including the oceans, land, vegetation, ice, and snow. Current and planned satellite missions from Canada and international agencies have provided and will provide a wealth of new information about the Earth system and that can be used to investigate a wide range of environmental and scientific questions and provide vital data for societal needs. This session encourages contributions from across the full Earth observation value chain, upstream, midstream and downstream. This includes new measurement technologies and techniques, both passive and active; retrieval algorithms; demonstration and calibration of instruments; validation of satellite products; assimilation of data into numerical models; scientific results and discoveries; operational utilization and development of services.

Time	*Abstract Title*	Presenter	Poster	Add to

		Order	Calendar
14:30	Progress toward a Canadian-led Arctic Observing Mission (AOM)	Ray Nassar	
14:45	Development of a new Canadian-led satellite mission for seasonal snow mass	Chris Derksen	
15:00	The proposed Chemical and Aerosol Sounding Satellite (CASS) Mission	Kaley Walker	
15:15	An overview of the NASA A-CCP satellite mission and Canadian participation	Jason Cole	
15:30	HAWC - a Canadian instrument suite for measurements of clouds, aerosol and water vapour: Simulations and applications	Landon Rieger	

Convenors: Rita So (Environment and Climate Change Canada), Stephen Déry (University of Northern British Columbia), Melinda (Mindy) Brugman (Environment and Climate Change Canada) An atmospheric river (AR) can be generally defined as a long, narrow, and transient corridor of strong horizontal water vapour transport that is typically associated with a low-level jet stream ahead of the cold front of an extratropical cyclone (EC). Each AR-related storm event may be composed of one or more ECs and can produce heavy precipitation when they are forced upwards by mountains or frontal lifting, which can also lead to severe floods, landslides, and/or avalanches depending on the overall regional sensitivities due to land use, snow cover and antecedent moisture conditions. At times, an EC behind a passing AR can generate a strong wind storm to further worsen conditions. Although scientific understanding of ARs and the associated cyclones has advanced to a remarkable extent in the past decades, accurate operational forecast and communication of the systems and potential hazards remain challenging. This session focuses on various issues of

ARs and ECs, including their mutual coupling and feedback mechanisms, thermodynamic responses to climate change, statistical-dynamical forecast methods, tracking algorithms, and classification schemes. Abstracts related to the intraseasonal-to-seasonal variability of ARs/ECs and extreme event case studies are also encouraged.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	Connecting Seasonal Extratropical Cyclone Variability with Predictor Fields using Self-Organizing Maps	Rebekah Cavanagh		
14:45	Role of Atmospheric Rivers (ARs) and Cyclone Clustering during Winter Extreme Precipitation Regimes (EPRs) in the eastern United States and southeastern Canada	Yeechian Low		
15:00	Reanalysis of a historical atmospheric river affecting the west coast of North America in January 1896	Ruping Mo		
15:15	Future intensification of high-impact storms associated with extreme atmospheric moisture transport over North America	Alex Cannon		

Day 9 – 10 June 2021

Oral

Convenors: Neil Swart (ECCC), Paul Kushner (UofT), Julie Thériault (UQAM), Kirsten Zickfeld (SFU), Nathan Gillett (ECCC) Earth System Models (ESMs) are the principle tools used to understand and attribute past climate changes, to make projections of future climate, and near term environmental predictions. As such, they provide key information for mitigation, adaptation, and developing climate resilient societies. Development, application, and analysis of these models represent significant scientific and technical challenges, which are difficult for individual organizations to address alone. New technologies, including advanced version control systems, reproducible runtime environments (containers), community analysis packages, and common computing resources are enabling broader collaboration from development to analysis. These tools are helping to break down the technical barriers which have often hampered collaborations between Government and Academic research teams in Canada. This session invites presentations on Earth System Models and modelling applications in Canada, ranging from model descriptions, through to analysis procedures. In particular we invite submissions focused on Canadian modelling systems, such as CanESM, the UVic ESCM and GEM-NEMO; on systems and approaches designed to enable broader collaboration with these tools; on challenges and opportunities for collaboration; and on the scientific results emerging from such collaborations.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Atmospheric radiative transfer in the Canadian Earth System Model	Jason Cole		
12:48	Oceananigans.ShallowWaterModel: a fast and friendly solver for a shallow water fluid on CPUs and GPUs	Francis Poulin		
13:06	Enabling portability and collaborative development of the Canadian Earth System Model (CanESM)	Neil Swart		
13:24	Community perspective and use cases for collaborative development with CanESM	Paul Kushner		

13:35	From Global Data Processing and Forecasting Systems to Earth Systems Prediction: A World Meteorological Organisation Perspective	Michel Jean

Convenors: Laura Bianucci (Institute of Ocean Sciences, Fisheries and Oceans Canada) Thomas Guyondet (Gulf Fisheries Centre, Fisheries and Oceans Canada) Andry Ratsimandresy (Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada) Sebastien Donnet (Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada) The coastal zone is the region of the ocean that is the most subjected to direct human pressures. For instance, activities such as fishing and aquaculture farming benefit from rich coastal ecosystems and their proximity to the shoreline; the latter is also true for land activities related to transportation, wastewater disposal, etc. Furthermore, the coastal zone is strongly connected to the open ocean and the changes happening offshore. Therefore, direct anthropogenic perturbations along with other pressures exerted by climate change (e.g. warming, acidification, deoxygenation) can lead to negative effects in the coastal ocean, such as pollution, hypoxia, ocean acidification, sea level rise, and loss of ecosystem diversity. Numerical models of the coastal ocean can be used to understand the physical and biogeochemical drivers in different regions, how these processes can change in the future, and what the implications of these changes could be. Furthermore, these models can also be applied to provide useful information for regulators, managers, industries, and coastal users in general. The complexity of coastal regions, both in terms of geography and physical and biogeochemical dynamics, makes these modelling exercises challenging and region-specific. Nevertheless, commonalities can be drawn among different regions and models, such that the modelling community can benefit immensely by sharing experiences and results. This session welcomes contributions about any aspect of coastal ocean models, from specific applications in given regions to more general process-oriented studies, including hydrodynamics-only as well as coupled models (physical-biogeochemical, -ice, -sediments, etc.).

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Coastal Modelling into the Future and into the Past	Susan Allen		
13:00	Coastal Ice-Ocean Prediction System for the East Coast of Canada (CIOPS-E) version 2: Updates and improvements	Gregory C. Smith		
13:15	Operationalisation of Canada's OPP Port Ocean Prediction Systems (POPS) by CHS and ECCC for E-Navigation Dynamic Hydrographic Products delivery	Ji Lei		
13:30	Deriving E-Navigation products from coastal and port prediction systems	Fraser Davidson		

Convenors: Joe Melton (ECCC), Elyn Humphreys (Carleton University) Climate change impacts all aspects of the land surface's interactions with the atmosphere. These evolving interactions have important feedback effects on both regional and global climate systems. To best understand how to adapt to current and future climate change, we require skillful projections of the land surface response to a warmer climate, increased atmospheric carbon dioxide concentrations, land use change and disturbances, vegetation change, accelerated nutrient cycling, and other perturbations. While process-based land surface models are well suited to address these intricate and emerging global change problems, they will require extensive development and evaluation. This session showcases research relating to process-based land surface model evaluation, application, and development. The diverse perspectives offered from site-level micrometeorological studies, regional analyses, and coupled land surface-atmosphere interaction studies can offer unique insights into how best to represent these complex systems. We encourage submissions derived from any process-based model, and in particular, those utilizing the Canadian Land Surface Scheme including Biogeochemical Cycles (CLASSIC) terrestrial ecosystem model. CLASSIC is the Canadian community open-source successor to the coupled Canadian Land Surface Scheme (CLASS) and Canadian Terrestrial Ecosystem Model (CTEM) framework with a long history in the Canadian land surface modelling community starting from its early development in 1987. {We suggest our proposed session could be cross-listed with the Biogeochemistry theme}

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Performance of CLASSIC In the Earth System Model - Snow Model Intercomparison Project (ESM-SnowMIP)	Paul Bartlett		
12:45	Why do land surface models overestimate evaporation?	Gesa Meyer		
13:00	Fire effects on forest-atmosphere interactions in Amazonia	Gabriel de Oliveira		
13:15	Benchmarking TRENDY land surface models: How to account for observational uncertainties	Christian Seiler		

Convenors: Paul Myers (University of Alberta), Youyu Lu (DFO – BIO), Susan Allen (University of British Columbia), Greg Smith (ECCC), David Greenberg (DFO – BIO retired), Frederic Dupont (ECCC), Katja Fennel (Dalhousie University), Neil Swart (ECCC - CCCMA) Ocean circulation and biogeochemical models are widely used for both research and operational forecasting. However, there are challenges for small research groups to handle the increasing complexity of the model codes, evaluation with various observational datasets, and analysis of the increasing amount of model output data. This session aims to stimulate discussions on potential coordination and collaboration between

Canadian government laboratories and universities in the development, evaluation and analysis of ocean circulation and biogeochemical models for hindcast and forecast at various time scales. Specific topics may include: 1) progress of model research and applications in various regions with different spatial resolutions; 2) new evaluation and analysis results that demonstrate the strength and weakness of the models; 3) improvements in model numerics and parameterization of sub-grid processes; 4) new analysis methods; 5) new forcing and evaluation datasets; 6) model inter-comparison; and 7) data presentation and visualization tools; etc.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	The Copernicus global 1/12° oceanic and sea ice reanalysis	Gilles Garric		
12:45	CanTODS: A new pan-Canadian ocean downscaling system for climate and seasonal predictions	Nadja Steiner		
13:00	A 30-year historical ocean and sea ice simulation with a medium-resolution model for Canada's 3 Oceans	Xianmin Hu		
13:15	Improvement in watermass and monitoring in the Pan-Canadian Operational Regional Ocean Data Assimilation System	Audrey-Anne Gauthier		
13:30	Ocean data assimilation in the Canadian Center for Meteorological and Environmental Prediction	kchikhar Chikhar		

Convenors: Laura Bianucci (Institute of Ocean Sciences, Fisheries and Oceans Canada) Thomas Guyondet (Gulf Fisheries Centre, Fisheries and Oceans

Canada) Andry Ratsimandresy (Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada) Sebastien Donnet (Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada) The coastal zone is the region of the ocean that is the most subjected to direct human pressures. For instance, activities such as fishing and aquaculture farming benefit from rich coastal ecosystems and their proximity to the shoreline; the latter is also true for land activities related to transportation, wastewater disposal, etc. Furthermore, the coastal zone is strongly connected to the open ocean and the changes happening offshore. Therefore, direct anthropogenic perturbations along with other pressures exerted by climate change (e.g. warming, acidification, deoxygenation) can lead to negative effects in the coastal ocean, such as pollution, hypoxia, ocean acidification, sea level rise, and loss of ecosystem diversity. Numerical models of the coastal ocean can be used to understand the physical and biogeochemical drivers in different regions, how these processes can change in the future, and what the implications of these changes could be. Furthermore, these models can also be applied to provide useful information for regulators, managers, industries, and coastal users in general. The complexity of coastal regions, both in terms of geography and physical and biogeochemical dynamics, makes these modelling exercises challenging and region-specific. Nevertheless, commonalities can be drawn among different regions and models, such that the modelling community can benefit immensely by sharing experiences and results. This session welcomes contributions about any aspect of coastal ocean models, from specific applications in given regions to more general process-oriented studies, including hydrodynamics-only as well as coupled models (physical-biogeochemical, -ice, -sediments, etc.).

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	Upwelling and daily sea breeze impacts on inlets along the central west coast of Vancouver Island	Michael Foreman		
14:45	The Ocean Circulation in Queen Charlotte Strait,	Andy (Yuehua) Lin		

	British Columbia: Results from an Unstructured-Grid Numerical Model	
15:00	Tidal impacts on seasonal circulation and hydrographic variability over the eastern Canadian shelf	Yuan Wang
15:15	Modeling the variability of sea level in the Coast of Bays region of Newfoundland	andry ratsimandresy
15:30	Coastally Trapped Waves in a broad, mid-latitude fjord	Sebastien Donnet

Convenors: Joe Melton (ECCC), Elyn Humphreys (Carleton University) Climate change impacts all aspects of the land surface's interactions with the atmosphere. These evolving interactions have important feedback effects on both regional and global climate systems. To best understand how to adapt to current and future climate change, we require skillful projections of the land surface response to a warmer climate, increased atmospheric carbon dioxide concentrations, land use change and disturbances, vegetation change, accelerated nutrient cycling, and other perturbations. While process-based land surface models are well suited to address these intricate and emerging global change problems, they will require extensive development and evaluation. This session showcases research relating to process-based land surface model evaluation, application, and development. The diverse perspectives offered from site-level micrometeorological studies, regional analyses, and coupled land surface-atmosphere interaction studies can offer unique insights into how best to represent these complex systems. We encourage submissions derived from any process-based model, and in particular, those utilizing the Canadian Land Surface Scheme including Biogeochemical Cycles (CLASSIC) terrestrial ecosystem model. CLASSIC is the Canadian community open-source successor to the coupled Canadian Land Surface Scheme (CLASS) and Canadian Terrestrial Ecosystem Model (CTEM) framework with a long history in the

Canadian land surface modelling community starting from its early development in 1987. {We suggest our proposed session could be cross-listed with the Biogeochemistry theme}

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	Evaluation of CLASSIC version 1.1 at a diverse collection of FLUXNET2015 eddy covariance sites	Joe Melton		
14:45	The potential significance of ericoid mycorrhizal fungi in ombrotrophic peatlands: a modeling study	Siya Shao		
15:00	Biogenic soil NOx emissions in a global air quality model	Diane Pendlebury		
15:15	Optimization of maximum photosynthetic carboxylation rate (Vc,max) in CLASSIC for North America's boreal forests using eddy covariance data	Bo Qu		
15:30	Uncertainty in global land surface energy, water, and CO2 fluxes due to model structure, driving meteorological data, and land cover characterization	Vivek Arora		

Convenors: Paul Myers (University of Alberta), Youyu Lu (DFO – BIO), Susan Allen (University of British Columbia), Greg Smith (ECCC), David Greenberg (DFO – BIO retired), Frederic Dupont (ECCC), Katja Fennel (Dalhousie University), Neil Swart (ECCC - CCCMA) Ocean circulation and biogeochemical models are widely used for both research and operational forecasting. However, there are challenges for small research groups to handle the increasing complexity of the model codes, evaluation with various observational datasets, and analysis of the increasing amount of model output data. This session aims to stimulate discussions on potential coordination and collaboration between Canadian government laboratories and universities in the development, evaluation and analysis of ocean circulation and biogeochemical models for hindcast and forecast at various time scales. Specific topics may include: 1) progress of model research and applications in various regions with different spatial resolutions; 2) new evaluation and analysis results that demonstrate the strength and weakness of the models; 3) improvements in model numerics and parameterization of sub-grid processes; 4) new analysis methods; 5) new forcing and evaluation datasets; 6) model inter-comparison; and 7) data presentation and visualization tools; etc.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	Iceberg modelling with NEMO	Juliana Marson		
15:00	Sensitivity Experiments with the Louvain-la-Neuve (LIM3) Sea-Ice Model	Liam Buchart		
15:15	Online Tidal Harmonic Analysis	Yimin Liu		
15:30	AtaaMap v1.0: a new high-resolution bed map of the Canadian Arctic	Andrew Hamilton		

Day 10 – 11 June 2021

Oral

Convenor: Geoff Strong

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
11:00	Historical Snow Measurement over	Hong Lin		

	Canada and Data Quality Control	
11:15	Could agriculture be replaced? Evaluating the potential climate impacts of an emerging technology	Andrew MacDougall
11:30	Projected Changes to Temperature, Sea Level Rise and Storms for the Gulf of Maine region in 2050	Lucy Chisholm
11:45	Canada's Net Zero challenge: Action by concerned citizens	Charles Lin
12:00	Interdisciplinary Climate Science Advocacy	Geoff Strong

Convenors: Neil Swart (ECCC), Paul Kushner (UofT), Julie Thériault (UQAM), Kirsten Zickfeld (SFU), Nathan Gillett (ECCC) Earth System Models (ESMs) are the principle tools used to understand and attribute past climate changes, to make projections of future climate, and near term environmental predictions. As such, they provide key information for mitigation, adaptation, and developing climate resilient societies. Development, application, and analysis of these models represent significant scientific and technical challenges, which are difficult for individual organizations to address alone. New technologies, including advanced version control systems, reproducible runtime environments (containers), community analysis packages, and common computing resources are enabling broader collaboration from development to analysis. These tools are helping to break down the technical barriers which have often hampered collaborations between Government and Academic research teams in Canada. This session invites presentations on Earth System Models and modelling applications in Canada, ranging from model descriptions, through to analysis procedures. In particular we invite submissions focused on Canadian modelling systems, such as CanESM, the UVic ESCM and GEM-NEMO; on systems and approaches designed to enable broader collaboration with these tools; on challenges and opportunities for collaboration; and on the scientific results emerging from such collaborations.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Quantifying changes in the marine carbon sink in Canadian Waters and its future trajectory	Parsa Gooya		
12:48	Transition from land carbon sink to land carbon source in temperature overshoot scenarios	Sabine Mathesius		
13:06	Isolating the Climate-driven and CO₂-driven Components of the Zero Emissions Commitment	Rachel Chimuka		
13:24	Quantifying the effectiveness of deliberate carbon dioxide removal from the atmosphere	Kirsten Zickfeld		
13:35	Investigating the Dependence of the Effectiveness of Carbon Dioxide Removal on the Amount and Rate of Removal	Chloe Papalazarou		

Convenors: Craig D. Smith, Eva Mekis, Michael Earle, (ECCC) Precipitation is a critical component of the hydrological cycle and is a fundamental observation for water resource and flood forecasting, climate monitoring, and numerical weather prediction and verification. Reliable in situ measurements with known uncertainties are crucial for identifying and characterizing the impacts of climate change, even as remote sensing techniques continue to develop and improve. This session will solicit submissions on the in situ measurement of snow cover parameters (such as snow depth and snow water equivalent) and all phases of precipitation, including but not limited to: 1) emerging observation techniques (such as non-catchment precipitation measurements); 2) precipitation gauge transfer function development and application; 3) challenges with existing observing networks; 4) instrument performance issues; 5) post-measurement data processing and quality control; and 6) future opportunities.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Data hiding in plain sight: retrieving historical snow depth measurements in northern Canada through staffed airport Meteorological Aerodrome Reports (METAR)	Andrew C.W. Leung		
12:45	Deep-learning-based precipitation observation quality control	Yingkai Sha		
13:00	The hourly wind-bias adjusted precipitation data set from the ECCC automated surface observation network (2001-2019)	Craig Smith		
13:15	Development of a New Transfer Function Using the Iqaluit Supersite for Adjusting Arctic Precipitation Measurements	Eva Mekis		
13:30	Precipitation gauge collection efficiency with wind speed and hydrometeor fall velocity	Jeffery Hoover		

Convenors: Laura Bianucci (Institute of Ocean Sciences, Fisheries and Oceans Canada) Thomas Guyondet (Gulf Fisheries Centre, Fisheries and Oceans Canada) Andry Ratsimandresy (Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada) Sebastien Donnet (Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada) The coastal zone is the region of the ocean that is the most subjected to direct human pressures. For instance, activities such as fishing and aquaculture farming benefit from rich coastal ecosystems and their proximity to the shoreline; the latter is also true for land activities related to transportation, wastewater disposal, etc. Furthermore, the coastal zone is strongly connected to the open ocean and the changes happening offshore. Therefore, direct anthropogenic perturbations along with other pressures exerted by climate change (e.g. warming, acidification, deoxygenation) can lead to negative effects in the coastal ocean, such as pollution, hypoxia, ocean acidification, sea level rise, and loss of ecosystem diversity. Numerical models of the coastal ocean can be used to understand the physical and biogeochemical drivers in different regions, how these processes can change in the future, and what the implications of these changes could be. Furthermore, these models can also be applied to provide useful information for regulators, managers, industries, and coastal users in general. The complexity of coastal regions, both in terms of geography and physical and biogeochemical dynamics, makes these modelling exercises challenging and region-specific. Nevertheless, commonalities can be drawn among different regions and models, such that the modelling community can benefit immensely by sharing experiences and results. This session welcomes contributions about any aspect of coastal ocean models, from specific applications in given regions to more general process-oriented studies, including hydrodynamics-only as well as coupled models (physical-biogeochemical, -ice, -sediments, etc.).

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Development and implementation of an operational capacity for aquatic oil spill dispersion modelling at the Canadian Centre for Meteorological and Environmental Prediction	Yves Pelletier		
12:45	Influence of climate	Eric Oliver		

	variability and hydroelectric development on oceanography and sea ice in a subarctic fjord	
13:00	Modelling oxygen dynamics in Discovery Islands, B.C.	Laura Bianucci
13:15	Coupled hydro-biogeochemical modelling to support shellfish aquaculture management in Baynes Sound (British Columbia)	Thomas Guyondet
13:30	Using coastal circulation models to assess connectivity among regions with aquaculture interests	Wendy Callendar

Convenors: Paul Myers (University of Alberta), Youyu Lu (DFO – BIO), Susan Allen (University of British Columbia), Greg Smith (ECCC), David Greenberg (DFO – BIO retired), Frederic Dupont (ECCC), Katja Fennel (Dalhousie University), Neil Swart (ECCC - CCCMA) Ocean circulation and biogeochemical models are widely used for both research and operational forecasting. However, there are challenges for small research groups to handle the increasing complexity of the model codes, evaluation with various observational datasets, and analysis of the increasing amount of model output data. This session aims to stimulate discussions on potential coordination and collaboration between Canadian government laboratories and universities in the development, evaluation and analysis of ocean circulation and biogeochemical models for hindcast and forecast at various time scales. Specific topics may include: 1) progress of model research and applications in various regions with different spatial resolutions; 2) new evaluation and analysis results that demonstrate the strength and weakness of the models; 3) improvements in model numerics and parameterization of sub-grid processes; 4) new analysis methods; 5) new forcing and evaluation datasets; 6) model inter-comparison; and 7) data presentation and visualization tools; etc.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	The Balance Between Atmospheric and Lateral Buoyancy Fluxes in Labrador Sea Water Formation	Laura Gillard		
12:45	Variability on the Scotian Shelf: Insight From Both Models and Observations	Michael Casey		
13:00	Evaluation of eddy-properties in operational oceanographic analysis systems	Gregory Smith		
13:15	A North Atlantic ocean-ice downscaling system for hindcasts and climate change projections	Guoqi Han		
13:30	Variations of marine heat waves from the analysis of a high-resolution ocean model	Li Zhai		

Convenors: Patrick L. Hayes (University of Montreal) Rachel Chang (Dalhousie University) James King (University of Montreal) William Ward (University of New Brunswick) The Arctic atmosphere is changing rapidly. These changes are observed over various timescales in atmospheric composition, sea-ice extent, interactions with lower latitudes, and atmospheric inputs from land, snow, ice and oceans. Furthermore, understanding the changing Arctic atmosphere during both the summer and winter is an essential part of understanding the global atmospheric system. However, measurements within this harsh environment are especially challenging and sparse measurement coverage, temporally and spatially, means our understanding of this important region of the atmosphere is limited. This session addresses the radiative, chemical, and transport processes which influence the Arctic atmospheric. Thus, submissions on all aspects of the Arctic atmosphere are welcomed, including new instruments, new measurements, new sites, and new modeling efforts, with an emphasis on new insights into this complex and important atmospheric system. Submissions could cover processes from the ground to the mesopause. Of particular interest is the sensitivity of the Arctic region to changes in inputs/emissions that result in large effects when amplified through feedback mechanisms as well as the impact of an annual polar light/dark cycle, in contrast to a daily cycle, on radiative processes and the energy balance of the Arctic atmosphere.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:30	Retrieving arctic ice clouds optical properties using a far-infrared radiometer	Ludovick Pelletier		
12:45	Infrared remote sensing of Arctic cloud microphysical properties: Preliminary results from Eureka, Nunavut	Joseph Hung		
13:15	Gravity wave measurements from two lidars at Eureka, Nunavut during a winter with exceptionally low stratospheric ozone	Emily McCullough		
13:30	Detection and ray tracing of gravity waves in the Arctic upper atmosphere	Dustin Fraser		

Convenors: Craig D. Smith, Eva Mekis, Michael Earle, (ECCC) Precipitation is a critical component of the hydrological cycle and is a fundamental observation for water resource and flood forecasting, climate monitoring, and numerical weather prediction and verification. Reliable in situ measurements with known uncertainties are crucial for identifying and characterizing the impacts of climate change, even as remote sensing techniques continue to develop and improve. This session will solicit submissions on the in situ measurement of snow cover parameters (such as snow depth and snow water equivalent) and all phases of precipitation, including but not limited to: 1) emerging observation techniques (such as non-catchment precipitation measurements); 2) precipitation gauge transfer function development and application; 3) challenges with existing observing networks; 4) instrument performance issues; 5) post-measurement data processing and quality control; and 6) future opportunities.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	The Evolution of Automatic Snow Depth Measurements and the status of Snowfall mesurements.	Claude Labine		
14:45	Using optical disdrometers to complement automated precipitation gauges in observing networks	Michael Earle		
15:00	Evaluation of LiDAR snow depth estimates from portable consumer devices and their application towards advancing citizen science	Fraser King		
15:15	Which snow water equivalent manual measurement method should be used as the reference of the true SWE?	Maxime Beaudoin-Galaise		
15:30	On the Optimal Network Design of the Surface Precipitation Network in Canada	Dominique Brunet		

Convenors: Neil Swart (ECCC), Paul Kushner (UofT), Julie Thériault (UQAM), Kirsten Zickfeld (SFU), Nathan Gillett (ECCC) Earth System Models (ESMs) are the principle tools used to understand and attribute past climate changes, to make projections of future climate, and near term environmental predictions. As such, they provide key information for mitigation, adaptation, and developing climate resilient societies. Development, application, and analysis of these models represent significant scientific and technical challenges, which are difficult for individual organizations to address alone. New technologies, including advanced version control systems, reproducible runtime environments (containers), community analysis packages, and common computing resources are enabling broader collaboration from development to analysis. These tools are helping to break down the technical barriers which have often hampered collaborations between Government and Academic research teams in Canada. This session invites presentations on Earth System Models and modelling applications in Canada, ranging from model descriptions, through to analysis procedures. In particular we invite submissions focused on Canadian modelling systems, such as CanESM, the UVic ESCM and GEM-NEMO; on systems and approaches designed to enable broader collaboration with these tools; on challenges and opportunities for collaboration; and on the scientific results emerging from such collaborations.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	The role of the basic state in the CanESM5 response to future sea ice loss	Michael Sigmond		
14:45	Design and execution of the long coupled simulations of PAMIP Tier 3	Alexandre Audette		
15:00	Missing Freshwater Found at Depth in the Canada Basin of the CESM Climate Model	Erica Rosenblum		
15:15	Cloud Feedbacks from CanSESM2 to CanESM5 and their influence on Climate Sensitivity	John Virgin		
15:30	Total inorganic chlorine climatologies from CMAM39 and ACE-	Laura Saunders		

	FTS, a comparison study			
15:45	Is warming proportional to cumulative carbon emissions because heat and carbon are mixed into the ocean by the same processes?	Nathan Gillett		

Convenors: Paul Myers (University of Alberta), Youyu Lu (DFO – BIO), Susan Allen (University of British Columbia), Greg Smith (ECCC), David Greenberg (DFO – BIO retired), Frederic Dupont (ECCC), Katja Fennel (Dalhousie University), Neil Swart (ECCC - CCCMA) Ocean circulation and biogeochemical models are widely used for both research and operational forecasting. However, there are challenges for small research groups to handle the increasing complexity of the model codes, evaluation with various observational datasets, and analysis of the increasing amount of model output data. This session aims to stimulate discussions on potential coordination and collaboration between Canadian government laboratories and universities in the development, evaluation and analysis of ocean circulation and biogeochemical models for hindcast and forecast at various time scales. Specific topics may include: 1) progress of model research and applications in various regions with different spatial resolutions; 2) new evaluation and analysis results that demonstrate the strength and weakness of the models; 3) improvements in model numerics and parameterization of sub-grid processes; 4) new analysis methods; 5) new forcing and evaluation datasets; 6) model inter-comparison; and 7) data presentation and visualization tools; etc.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:30	Ocean model derived vs <i>in situ</i> sound speed profiles and sonar performance prediction in the Forecasting Acoustic VAriability 2020 (FAVA	Cristina Tollefsen		

	2020) experiment	
14:45	Understanding Sources of Uncertainty and Forecast Error in a Medium Range Coupled Ensemble Sea Ice Prediction System	K Andrew Peterson
15:00	Wave-current interactions during Hurricanes Earl and Igor over the northwest Atlantic	Shangfei Lin

Convenors: Patrick L. Hayes (University of Montreal) Rachel Chang (Dalhousie University) James King (University of Montreal) William Ward (University of New Brunswick) The Arctic atmosphere is changing rapidly. These changes are observed over various timescales in atmospheric composition, sea-ice extent, interactions with lower latitudes, and atmospheric inputs from land, snow, ice and oceans. Furthermore, understanding the changing Arctic atmosphere during both the summer and winter is an essential part of understanding the global atmospheric system. However, measurements within this harsh environment are especially challenging and sparse measurement coverage, temporally and spatially, means our understanding of this important region of the atmosphere is limited. This session addresses the radiative, chemical, and transport processes which influence the Arctic atmospheric. Thus, submissions on all aspects of the Arctic atmosphere are welcomed, including new instruments, new measurements, new sites, and new modeling efforts, with an emphasis on new insights into this complex and important atmospheric system. Submissions could cover processes from the ground to the mesopause. Of particular interest is the sensitivity of the Arctic region to changes in inputs/emissions that result in large effects when amplified through feedback mechanisms as well as the impact of an annual polar light/dark cycle, in contrast to a daily cycle, on radiative processes and the energy balance of the Arctic atmosphere.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar

14:30	The Exceptional 2019/2020 Arctic Stratospheric Vortex: Stratospheric Ozone Loss and Transport, and Links to the Troposphere	Gloria Manney
15:00	Unprecedented spring 2020 ozone depletion in the context of 20 years of measurements at Eureka, Canada	Kristof Bognar
15:15	Sudden Stratospheric Warmings Signatures in the Polar Mesopause Region	William Ward
15:30	Radiative and Dynamical Heating Rate Trends in the Polar Winter Atmosphere	Kevin Bloxam

Opening Sessions

Monday May 31 (11:00 – 11:30 AM Eastern Daylight Time)

Opening Ceremonies 55th CMOS Congress

Welcome and Territorial Acknowledgement by David Fissel – Chair, 55th CMOS Congress

Welcome and introduction by Marek Stastna, CMOS President

Welcome from the Mayor of Victoria

Highlights of Today's Activities – David Fissel

Other Opening Sessions

Tuesday June 1 (11:00 – 11:30 AM Eastern Time)

Welcome and Territorial Acknowledgement by Matthew Asplin – Vice-Chair, 55th CMOS Congress

Keynote Remarks on CMOS Present and Future by Marek Stastna, CMOS President and Jim Abraham, CMOS Vice-President

Highlights of Today's Activities – Matthew Asplin

Wednesday June 2 (11:00 – 11:30 AM Eastern Time)

Welcome and Territorial Acknowledgement by David Fissel – Chair, 55th CMOS Congress
Welcome and introductions by Marek Stastna, CMOS President
Opening Remarks from the Honourable Chris Bittle, Parliamentary Secretary on behalf of the Minister of Environment and Climate Change Canada
Highlights of Today's Activities – David Fissel

Thursday June 3 (11:00 – 11:30 AM Eastern Time)

Welcome and Territorial Acknowledgement by Matthew Asplin – Vice-Chair, 55th CMOS Congress;
Welcome and introductions by Marek Stastna, CMOS President;
Welcome from the BC Minister of Environment and Climate Change;
Highlights of Today's Activities – Matthew Asplin

Monday June 7 (11:00 – 11:30 AM Eastern Time)

Welcome and Territorial Acknowledgement by David Fissel – Chair, 55th CMOS Congress,
Highlights of Today's Activities – David Fissel

Tuesday June 8 (11:00 – 11:30 AM Eastern Time)

Welcome and Territorial Acknowledgement by Matthew Asplin – Vice-Chair, 55th CMOS Congress;
Updates on Congress Activities - David Fissel;
Highlight World Oceans Day today - Matthew Asplin;
Highlights of Today's Activities – Matthew Asplin;

Wednesday June 9 (11:00 – 11:30 AM Eastern Time)

Welcome and Territorial Acknowledgement by David Fissel – Chair, 55th CMOS Congress;
Update on Congress Activities;
Highlights of Today's Activities – David Fissel

Thursday June 9 (11:00 – 11:30 AM Eastern Time)

Welcome and Territorial Acknowledgement by Matthew Asplin – Vice-Chair, 55th CMOS;
Update on Congress Activities;
Highlights of Today's Activities – Matthew Asplin

Closing Session

Friday June 11, 4:00 PM (EDT), 1 PM (PDT)

Introductions – David Fissel and Matthew Asplin, Chair and Vice-Chair 55th Congress

Remarks from Jim Abraham, Incoming President of CMOS

Remarks from Yanping Li and Francis Zweirs, CMOS 56th Congress, Saskatoon in 2022

Thank you and Acknowledgements to Contributors to 55th Congress - David Fissel and Matthew Asplin

55 CMOS SCMO

Congrès Victoria Congress 2021

Canadian Meteorological and Oceanographic Society (CMOS)
La Société canadienne de météorologie et d'océanographie (SCMO)

CMOS Awards Ceremony

Wednesday June 9, 4:30 PM (EDT), 1:30 PM (PDT)

The annual CMOS awards ceremony recognizes outstanding scientific contributions.

Moderator/MC: **Dennis Bourque**

- **Diane Campbell**, Assistant Deputy Minister, Meteorological Service of Canada
- **Paul Myers**, Chair, Canadian National Committee, Scientific Committee on Ocean Research (CNC-SCOR)
- **Marek Stastna**, President, Canadian Meteorological and Oceanographic Society
- **Jim Abraham**, Vice-President, Canadian Meteorological and Oceanographic Society

International Science Council SCOR Scientific Committee on Oceanic Research
Canadian National Committee

Environment and Climate Change Canada   Environnement et Changement climatique Canada

OCEAN NETWORKS CANADA

MEOPAR

CMOS Awards Ceremony
Wednesday, June 9
4:30pm EDT - 6:00pm EDT

The annual CMOS awards ceremony recognizes outstanding scientific contributions.

Moderator/MC: Denis Bourque
Presenters:
- Diane Campbell, Assistant Deputy Minister, Meteorological Service of Canada
- Paul Myers, Chair, Canadian National Committee, Scientific Committee on Ocean Research (CNC-SCOR)
- Marek Stastna, President, Canadian Meteorological and Oceanographic Society
- Jim Abraham, Vice-President, Canadian Meteorological and Oceanographic Society

Agenda
1. Introduction
2, Patterson Medal, Meteorological Service of Canada
3. CNC-SCOR Early Career Ocean Scientist Award
4. CMOS Scholarships
5. CMOS Awards
6. CMOS President Handover
7. Concluding Remarks

Special Sessions

MSC 150 Anniversary Panels

Day 4 - 3 June 2021

Panel Session: Significant moments in the evolution of Canada's Weather Services Co-Chairs: - Diane Campbell, Assistant Deputy Minister, Meteorological Service of Canada (MSC), Environment and Climate Change Canada (ECCC) - Jim Abraham, President-Elect, Canadian Meteorological and Oceanographic Society Summary: The Symposium on 150 Years of Weather Services in Canada is an opportunity to celebrate the rich history and numerous achievements in weather services in Canada. This opening Session will be an opportunity to meet with past Order of Canada recipients who have made outstanding contributions to meteorology and whose leadership and actions have guided Canada's success internationally and at home. Through a combination of presentations and panel discussion, participants will share in the experiences and transformative moments over their careers, and gain insight on their perspectives for the future of Canada's weather enterprise. Panelists: - David Grimes, Recently retired Assistant Deputy Minister (ADM) of the MSC and past President of the World Meteorological Organization (2011 - 2019) - Gordon McBean, Professor Emeritus, Department of Geography, Western University; ADM of MSC (1994-2000) - David Phillips, Senior Climatologist, MSC, ECCC - Pierre L. Morrissette, Founder of Pelmorex Media Inc. - James P. Bruce, International Institute for Sustainable Development Board Member (1997-2004), ADM of MSC (1980-1985) (written submission)

Day 7 – 8 June 2021

Panel Session: From Integrated Monitoring to Predictions and Weather Forecasts: Where we've come from and where we're headed Co-Chairs • Véronique Bouchet, Director General, Canadian Centre for Meteorological and Environmental Prediction • David Harper, Director General, Monitoring and Data Services Directorate Summary: This Session will explore the past and future directions of monitoring and numerical forecast systems in Canada. Numerical modelling relies on a wide range of observations, collected from a variety of in-situ and remote sensors operating on different platforms across the world. These observations are essential to numerical weather prediction and forecasts, highlighting the need to evolve data capture technologies to help strengthen numerical modelling systems. High-performance computing and sophisticated data assimilation techniques enable a growing volume of observations to be absorbed by numerical models, thereby allowing the coupling of different Earth System data components to increase long-range forecasts and the production of a wider range of weather-related elements, from global to urban scales. Moving towards full numerical representations of the Earth will help to meet the evolving needs of Canadians for accurate and timely information on weather, water and environmental conditions, 24 hours a day, 7 days a week. Partnerships with the academic sector are central to the evolution of numerical modelling and monitoring systems in Canada as they allow us to continuously push the edge of our knowledge, and shape the next generation of experts needed to secure a resilient and sustainable Earth prediction system for Canada. Panelists • Robert Daigle, Director, Atmospheric Monitoring Division, Meteorological Service of Canada (MSC), Environment and Climate Change Canada (ECCC) • Véronique Bouchet, Director General, Canadian Centre for Meteorological and Environmental Prediction, MSC, ECCC • Natacha Bernier, Director, Meteorological Research, Science and Technology Branch, ECCC • Paul Kushner, Physics Department, University of Toronto • Michel Jean, Associate Emeritus, ECCC

Day 9 – 10 June 2021

Panel Session: Canada’s Strengths in Providing Weather Services Co-Chairs: • Russ White, Director General, Prediction Services Directorate, Meteorological Service of Canada (MSC), Environment and Climate Change Canada (ECCC) • Ken Macdonald, Executive Director, National Programs and Business Development, MSC, ECCC Summary: This Session will explore the past and future directions of how weather services are delivered in Canada. It will begin with a historical perspective – From Telegraph to the Internet – describing the origins of weather services in Canada, and how they evolved over the past 150 years to where they are today. It will then look to the future from three perspectives. First from the perspective of a specialized user of weather services – the emergency management community and how their needs are changing. Second, from the perspective of the national meteorological organization – MSC. Finally, from the perspective of a private sector weather broadcaster – the Weather Network. Vulnerabilities to weather are changing, as are the means to deliver services. The sessional will offer perspectives on service deliver in the digital age of the coming few decades. Panelists • Dave Phillips, Senior Climatologist, MSC • Sue Henry, Chief, Calgary Emergency Management

Agency • Paul Mason, Executive Director, Nova Scotia Emergency Management Office • Dennis Dudley, Acting Director, Prediction Operations West, Prediction Services Directorate, MSC • Chris Scott, Director of Meteorology, Pelmorex Media Inc. – The Weather Network

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Other Special Sessions

Day 2 - 1 June 2021

Mentoring Session

Moderators: Joseph Martin and Elizabeth Ramsay

Douw Steyn: Professor Emeritus, Dept. of Earth, Ocean and Atmospheric Sciences, University of British Columbia (publications@cmos.ca)

Introduction of the speaker
followed by a 5-10 minute presentation by the speaker (outline career opportunities and how to address these), followed by questions and answers and general discussion.

Day 3 - 2 June 2021
Mentoring Session

Moderators: Joseph Martin and Elizabeth Ramsay

Matthew Corkum: Meteorologist at Dynasty Power (matthewbcorkum@gmail.com)

This student mentorship event will feature a 5 to 10 minute presentation by Dr. Mathew Corkum about career paths and opportunities followed by a group discussion moderated by CMOS student representative, Joey Martin.

Matthew Corkum is the Head Meteorologist at Dynasty Power, a commodity trading company. Matthew completed his PhD in Atmospheric Science at York University prior to joining Dynasty Power, where he forecast wind and solar energy markets.

(Introduction of the speaker followed by a 5-10 minute presentation by the speaker (outline career opportunities and how to address these), followed by questions and answer and general discussion.)

Day 7 - 8 June 2021

Mentoring Session

Moderators: Joseph Martin and Elizabeth Ramsay

Colin Goldblatt: Associate Professor, School of Earth and Ocean Sciences, University of Victoria (czg@uvic.ca)

Introduction of the speaker followed by a 5-10 minute presentation by the speaker (outline career opportunities and how to address these), followed by questions and answer and general discussion.

Day 10 – 11 June 2021

220 Town Hall on Canada and the UN Decade of Ocean Science for Sustainable Development

Convenors:

Andrea White, Ecosystems and Oceans Science, Fisheries and Oceans Canada (andrea.white@dfo-mpo.gc.ca)

Helen Joseph, Past-Chair, CMOS Arctic Special Interest Group, and HCJ Consulting (Helen@hcjconsulting.ca)

Canada has pledged to support the United Nations Decade of Ocean Science for Sustainable Development (2021-2030) that will deliver “the ocean we need for the future we want”. The Ocean Decade provides a once-in-a-lifetime opportunity for all ocean stakeholders to apply critical ocean science and knowledge to reverse the cycle of decline in ocean health and support the sustainable development of our ocean. However, Canadian success requires a coordinated approach to identify collaborative ocean initiatives that are inclusive of all stakeholder groups and members of civil society, and that will create new ideas, solutions, partnerships, and applications. This session will summarize the UN Decade concept, feature a suite of speakers who will highlight examples of collaborative Canadian science programs relevant to the Ocean Decade objectives, and provide an opportunity to discuss how together we can generate and share ocean-related data and knowledge by the people for the people, to advance sustainable ocean development in Canada and globally.

Confirmed Speakers:

Melissa Anderson
Melissa Anderson is an Assistant Professor of Economic Geology at the University of Toronto. Her work focuses on understanding the links between tectonics, magmatism, and hydrothermal systems in submarine subduction-related settings. Melissa's research involves sea-going research cruises, bathymetric mapping, deployment of large platforms (e.g. remotely-operated vehicles and autonomous underwater vehicles) for seafloor observations and sampling, and collection and interpretation of a wide range of geophysical datasets. Melissa is also a co-chair of Canada's National Research Vessel Task Team whose mission is to improve Canadian researcher's access to ships and infrastructure.

Shayla Fitzsimmons
Shayla Fitzsimmons is the Executive Director of the Atlantic Regional Association of the Canadian Integrated Ocean Observing System (CIOOS Atlantic), where she applies her scientific and managerial background to advance best practices for management of and access to Canada's ocean data. She holds an MBA (2017), a MSc in Chemistry (2011), and a BSc in Chemistry and Computer Science from Dalhousie University. Shayla is currently involved in several initiatives to explore and advance data sharing, including the exploration of human factor challenges in the open sharing of ocean data.

Kim Juniper
Kim Juniper is Chief Scientist with Ocean Networks Canada (ONC), a University of Victoria-based organization that operates cabled ocean observatories in the Pacific and Arctic Oceans. Kim is also a Professor in the University of Victoria's School of Earth and Ocean Sciences, and holder of the British Columbia Leadership Chair in Ocean Ecosystems and Global Change. He has authored more than 120 peer-reviewed publications on the microbiology, biogeochemistry

and ecology of deep-sea hydrothermal vents, and low oxygen and other marine habitats.

Paul Myers

Paul Myers is a physical oceanographer, professor and Associate Research Chair in the Department of Earth and Atmospheric Sciences at the University of Alberta, as well as co-Associate Dean Research for the Faculty of Science. Professor Myers' research focuses on the role of freshwater in the ocean, as well as links between the Arctic and North Atlantic oceans involving a combination of the analysis of oceanographic data with numerical modeling. Paul is also interested in the role of ocean-cryosphere links and how the ocean may impact, and may be impacted by, the enhanced melting presently occurring on the Greenland Ice Sheet. He is a former CMOS president, is the Chair of the Canadian National Committee for SCOR, and Secretary of the international SCOR Executive.

Eric Peterson

Eric Peterson runs the Hakai Institute (hakai.org), which operates ecological observatories and laboratories on BC's coastal margin. Hakai's science is inclusive, stretching from "icefields to oceans" and across the spectrum from physics and biogeochemistry to biodiversity and community ecology. While remaining solidly rooted in intensive long term study of its reference sites, Hakai has expanded its scale to regional, trans-boundary, national and global networks, in part via participation in the Canadian Integrated Ocean Observing System (CIOOS). Hakai tries to be a catalyst, drawing together partners from academia, government, First Nations and industry. Hakai is part of the Tula Foundation, an operating charity Eric and Christina Munck founded in 2002. Prior to that Eric was a technology entrepreneur, and long, long ago was a research scientist.

55th CMOS Congress
55e Congrès de la SCMO
Victoria 2021

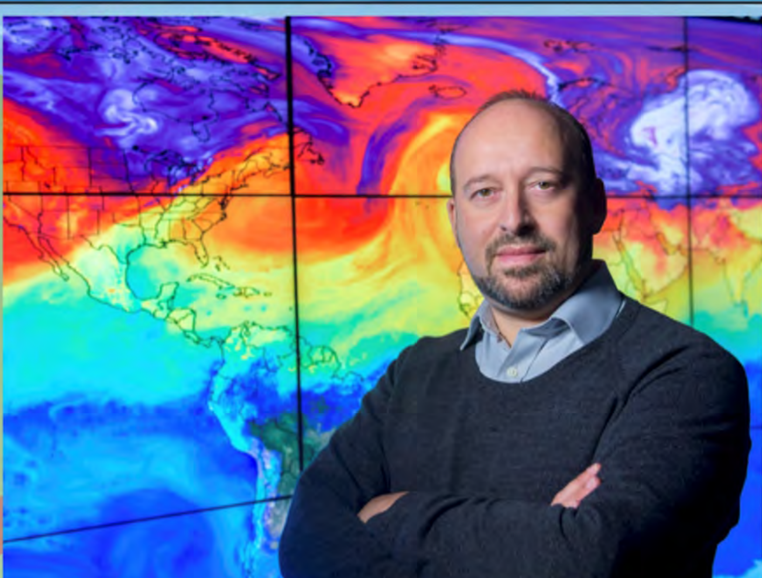
Colombie-Britannique·British Columbia·Canada

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

Free Public Lecture

Dr. Gavin A. Schmidt

Can climate modelling keep up with climate change?



Gavin Schmidt is the Director of the NASA Goddard Institute for Space Studies

Over the last forty years, Earth System Models have become more and more comprehensive and detailed. Dr. Schmidt will address some of the current issues at the leading edges of model development and the continuing importance of model evaluation for predictions.

Wednesday, June 2, 2021
18:00 – 19:30 EDT
15:00 – 16:30 PDT

The event is **free** and will take place **online.** No pre-registration is required.
Details are available from:
https://cmos.ca/site/congress/publiclecture

55 CMOS SCMO Congrès Victoria Congress 2021

PUBLIC LECTURE

The event is free of charge by Zoom, and no pre-registration is required.

Date: Wednesday, June 2, 2021

Time: 18:00 – 19:30 EDT

The Public Speaker: **Dr. Gavin A. Schmidt***, NASA Goddard Institute for Space Studies*

Can climate modeling keep up with climate change?

Over the last forty years, Earth System Models have become more and more comprehensive and detailed. They have assimilated previously independent modeling efforts in ocean circulation, atmospheric composition, the stratosphere, land surface, and the cryosphere, and are today demonstrably more skillful than earlier efforts. Yet the structural uncertainty in the latest model projections is actually increasing. Meanwhile, impacts of climate change on, for instance, wildfires, tropical cyclones and sea level, appear to be increasing faster than we have been able to predict. I will address some of the current issues at the bleeding edges of model development and the continuing importance of model evaluation for predictions.

Biography: *Gavin Schmidt is the Director of the NASA Goddard Institute for Space Studies and works on the simulation of climate in the past, present and possible futures using the GISS Earth System Model. Before working at GISS, he was a postdoc at McGill University and maintains strong ties with Canadian climate scientists. He was the author with Joshua Wolfe of "Climate Change: Picturing the Science" in 2009, and in 2011 was the inaugural recipient of the AGU Climate Communications Prize. He is a fellow of the AGU and AAAS. His 2014 TED Talk on climate modeling has been viewed over a million times. Schmidt was one of the IPCC contributing scientists named in the joint award of the 2007 Nobel Peace Prize. He was named in November 2004 as one of Scientific American's "Top 50 Research Leaders" of the year. In an effort to ensure effective fulfillment of the Biden Administration's climate science objectives for NASA, the agency has established a new position of senior climate advisor and selected Gavin Schmidt, director of NASA's Goddard Institute for Space Studies in New York, to serve in the role in an acting capacity until a permanent appointment is made.*

Canadian Meteorological and Oceanographic Society (CMOS)
La Société canadienne de météorologie et d'océanographie (SCMO)

Educators' Day – CMOS Victoria 2021

Description

Educators' Day at CMOS Victoria 2021 will be a one day event within the overall Congress framework.

Friday June 4, 2021:12:00 PM to 5:00 PM Eastern Time

All activities will be conducted online. The intended audience is K-12 school teachers and other educators of grade school children. Some Sessions will be suitable for classroom audiences.

Objectives

This annual event provides opportunities for teachers and other educators to learn some innovative approaches and activities for teaching the science of weather, oceans and related environmental sciences. This year will have a focus on the effects of climate change in these sciences. The information will be applicable to teaching over a wide range of ages. Participants will learn ways to incorporate real-time data, and enjoy hands-on activities (virtually) for curriculum and program planning.

Times

Educators Day will feature 4.5 hours of activities including a plenary session, mini-panel discussion, introduction to educational resources and presentations by Project WET, Ocean School and Prairie Climate Center. We will also have a break-out session at the end of the day's events.

Program details can be found on Page 2 of this circular.

Times for each time zone across Canada are shown below.

PDT 09:00 -- 14:00
MDT 10:00 -- 15:00
CDT 11:00 -- 16:00
EDT 12:00 -- 17:00
ADT 13:00 -- 18:00
NDT 13:30 -- 18:30

Recorded Version of Educators' Day

For participants who are unable to attend the live online sessions of June 4, each session will be recorded for viewing starting on June 7, 2021 over the following week and beyond through the CMOS Congress 2021 online platform.

Other Details

- No cost to participants
- Materials that will be required for interactive sessions will be circulated virtually prior to Educators Day to all registered participants

Program

Time Slot (ET)	Activity	Speaker(s)
30 mins 12:00 – 12:30 PM	Educators' Day Plenary Speaker	Ellen Field
45 mins 12:30 – 1:15 PM	Project WET - Introduction to the program instructional resources and professional development workshops for K-12 educators	Lizabeth Nicholls and Maxine Koskie
15 mins 1:15-1:30	Health Break	
45 mins 1:30 - 2:15 PM	Prairie Climate Centre and Climate Atlas Demo	Danny Blair
60 mins 2:15 - 3:15	Ocean School (https://oceanschool.nfb.ca/) to give a presentation and demo	Heather De Lagran and Erika Sullivan
15 mins 3:15 - 3:30	Health Break	
45 mins 3:30 - 4:15 PM	Mini Panel of Congress Plenary Speakers - Communicating the Effects Climate Change, Present and Future, to our Children	Andrew Weaver, Johanna Wagstaffe and Lisa Loseto
30 mins 4:15 - 4:45 PM	Parallel breakout sessions	
15 mins 4:45 - 5:00 PM	Report back from breakout groups Overview + Thanks	

Registration

Online registration is now open !!

Link to registration site: https://www.cmos.ca/event/2021CongressRegistration

How to register:

- Create a profile on the CMOS registration site if you do not already have one by clicking on the 'create profile' link on the registration site
- Once you have created the profile, you can go back to the registration site to register for the congress
- Select 'Educators under 'Type of registration' and then enter the code "classroom21" to avail free registration

Canadian Meteorological and Oceanographic Society (CMOS)
La Société canadienne de météorologie et d'océanographie (SCMO)

Journée des éducateurs – SCMO Victoria 2021

Description

La journée des éducateurs au congrès SCMO Victoria 2021 sera un événement de seulement un jour dans le cadre du congrès complet.
Le vendredi 4 juin 2021 : 12 h 00 à 17 h 00, temps de l'est
Toutes les activités se dérouleront en ligne. L'audience prévue est constituée des professeurs de la maternelle à la 12e année ainsi que les autres éducateurs d'enfants d'âge scolaire. Quelques-unes des sessions seront adaptées aux classes scolaires.

Objectifs

Cet événement annuel fourni les possibilités aux enseignants et autres éducateurs d'apprendre au sujet des approches et activités innovatrices pour enseigner la science de la météo, des océans et les sciences environnementales reliées. Cette année, l'accent sera mis sur les effets du changement climatique dans ces sciences. L'information présentée sera applicable à l'instruction parmi une grande variété d'âges. Les participants apprendront comment intégrer des données en temps réel et profiteront d'activités pratiques (virtuellement) pour la planification des programmes d'études et des programmes.

Temps

La journée des éducateurs comportera de 4,5 heures d'activités incluant une session plénière, min-panel de discussion, introduction aux ressources éducatives et les présentations par Projet WET, l'École de l'Océan et le Centre climatique des Prairies, ainsi qu'une session de petits groupes. Les détails du programme se trouvent à la deuxième page de cette circulaire.
Pour chaque zone horaire au Canada, les heures sont indiqués ci-dessous.
PDT 09:00 -- 14:00
MDT 10:00 -- 15:00
CDT 11:00 -- 16:00
EDT 12:00 -- 17:00
ADT 13:00 -- 18:00
NDT 13:30 -- 18:30

Version enregistrer de la journée des éducateurs

Pour les participants qui n'auront pas la chance d'être présent aux sessions en ligne en direct le 4 juin, chaque session sera enregistrée et disponible, commençant le 7 juin, pour être visionné au cours de la semaine suivante et au-delà à travers la plateforme en ligne du congrès SCMO 2021.

Autres détails

- Il n'aura aucune coût pour les participants
- Les matériaux nécessaires pour les sessions interactives seront distribués virtuellement à tous les participants inscrits avant la journée des éducateurs

Programme

Créneau horaire (ET)	Activité	Orateur(s)
30 minutes 12:00 – 12:30 PM	Orateur plénière de la journée des éducateurs	Ellen Field
45 minutes 12:30 – 1:15 PM	Project WET - Introduction aux ressources pédagogiques du programme et aux ateliers de développement professionnel pour les éducateurs de la maternelle à la 12e année	Lizabeth Nicholls et Maxine Koskie
15 minutes 1:15-1:30	Pause santé	
45 minutes 1:30 - 2:15 PM	Centre climatique des Prairies et démonstration de l'Atlas climatique	Danny Blair
60 minutes 2:15 - 3:15	L'École de l'Océan (https://ecoledelocean.onf.ca/): présentation et démonstration	Heather De Lagran et Erika Sullivan
15 minutes 3:15 - 3:30	Pause santé	
45 minutes 3:30 - 4:15 PM	Mini-panel d'orateurs plénières du congrès - Communiquer les effets du changement climatique, présent et futur, à nos enfants	Andrew Weaver, Johanna Wagstaffe et Lisa Loseto
30 minutes 4:15 - 4:45 PM	Sessions de petits-groupes parallèles	
15 minutes 4:45 - 5:00 PM	Rapport des groupes de discussion Vue d'ensemble + remerciements	

Inscription

L'inscription en ligne est maintenant ouverte!!
Le lien au site d'inscription : https://www.cmos.ca/event/2021CongressRegistration
Comment inscrire :

- Créez un profil sur le site d'inscription SCMO si vous n'en avez pas déjà en cliquant sur le lien 'créer un profil'
- Quand votre profil est créé, vous pouvez retourner au site d'inscription pour s'inscrire au congrès
- Sélectionnez 'Éducateurs' sous 'Type d'enregistrement' et ensuite entrez le code 'classroom21' pour bénéficier d'une inscription gratuite

Day 1 – 31 May 2021

Oral

Session: 810 Atmosphere, Ocean, and Climate Dynamics - Part 1 Dynamique de l'atmosphère, des océans et du climat - Partie 1

31/05/2021 12:30

ID: 10713 Contributed abstract

Poster Order:

Internal wave shoaling and boundary layer modulation for realistic slopes

Marek Stastna [1] , *William Xu* [2]

[1]

[2] Bedford Institute of Oceanography

Presented by / Présenté par: ***Marek Stastna***

Contact: mmstastn@uwaterloo.ca

Internal wave shoaling has been identified as a ubiquitously occurring process that contributes to cross-boundary layer transport, and sediment resuspension. A considerable body of research is available, and spans field, experimental and computational studies. There is a gulf between the majority of field research and experimental/computational approaches due to the low slopes typically observed in the field. I will discuss high resolution simulations that attempt to bridge the gap. Internal waves shoaling over a linear slope are simulated with resolution high enough so that the transformation of the wave as the turning point is reached, and the boundary layer development beneath the deformed wave are well resolved. We find that multiple separation regions develop in the boundary layer, and result in a roll up and ejection of vorticity. This in turn yields bursts of cross-boundary layer transport, and turbulence within the pycnocline. We conclude with some discussion of the role of changes in the pycnocline thickness.

Session: 810 Atmosphere, Ocean, and Climate Dynamics - Part 1 Dynamique de l'atmosphère, des océans et du climat - Partie 1

31/05/2021 12:45

ID: 10895 Contributed abstract

Poster Order:

Extreme wave run-up on beaches

Carmen Holmes-Smith [1] , *Johannes Gemmrich* [2] , *Leah Cicon* [3]

[1] University of Victoria
[2] University of Victoria
[3] University of Victoria

Presented by / Présenté par: ***Carmen Holmes-Smith***
Contact: carmen.holmes.smith@gmail.com

Wave run-up is the extent that water reaches up a sloping beach from breaking waves, with the magnitude determined by both wave set-up and swash uprush. Although unexpected run-up poses a significant hazard that can result in serious injury or even death, little is known about the characteristics of wave run-up on beaches. Using data from over a year of video monitoring, this study address outstanding questions in the field regarding run-up statistics and the drivers behind extreme events. Extreme run-up is defined as the tail-end of the distribution of run-up extent up a sloping beach. This wave hazard poses a serious risk to people both recreating in the surf-zone and walking along the beach that may be caught off guard by an extreme run-up event. The long-term statistics of wave run-up are extracted from video data taken at Wickaninnish Beach near Tofino, B.C. Both a visible light camera and an infrared camera are installed, and a thresholding method is applied to the video footage to extract a time-series. We discuss whether extreme run-up events can be correlated to offshore conditions, such as wave height or wave period, or are more often the result of bore-bore capture, which occurs when a faster moving wave overtakes a slower moving wave. Using the obtained statistics in conjunction with observational data from a wave buoy deployed in 20 m water depth, we investigate patterns between the likelihood of occurrence of extreme run-up events and the nearshore sea-state. Extreme run-up occurring as a result of bore-bore capture can be identified by tracing individual wave fronts in the timestack. The relative importance of these two primary processes, bore-bore capture and large off shore waves propagating onto the beach, is evaluated. The results of this research will improve the tools used by Parks Canada, municipalities, and Search and Rescue for wave hazard assessment in an effort to reduce injuries and fatalities. Beyond the societal impact, this work studies the physical processes of an incoming wave field to better understand the evolution of a wave as it moves from offshore to onshore.

ID: 11182 Contributed abstract

Poster Order:

Characterising the internal wave dynamics of Barkley Canyon

Kurtis Anstey [1]

[1] University of Victoria

Presented by / Présenté par: ***Kurtis Anstey***

Contact: kurtis.anstey@live.ca

This research, in progress, will characterise the internal wave field at Barkley Canyon, off the coast of Vancouver Island, to provide information regarding regional mixing processes and what drives them. Internal waves are slow moving, low frequency, underwater gravity waves that exist within density gradients in the ocean interior. When interacting with irregular topography, such as canyons, internal wave energy can become focused and drive high-frequency dissipative processes. Breaking and scattering of internal waves, solibores, and upwelling within canyon topography can lead to transport of nutrients, heat, O2, and CO2, that can affect both climate processes and biological productivity. To build on a body of research regarding dissipative canyon phenomena in the Vancouver Island Continental Shelf region, time-series velocity data were obtained from two Acoustic Doppler Current Profiler instruments, part of Ocean Networks Canada's NEPTUNE cabled observatory. Four overlapping years of data coverage are being analysed to identify forcing by tides, weather, and regional currents, along with topographic dependencies both within the canyon and on the nearby continental slope. Spectral analysis (power spectral density, rotary analysis, and spectrograms) in both 1- and 2-D will allow for estimates of relative power and rotation, and characterisation of temporal trends ranging from seasonal to interannual. The state of the spectral continuum will be evaluated for seasonal shifts in energy dissipation, and compared to accepted internal wave theory for the open ocean (Garrett and Munk spectrum) to estimate canyon contributions to local mixing processes. Finally, a comprehensive assessment of data quality, instrument calibration feedback, and generation of applicable analysis tools will assist Ocean Networks Canada in continuing to provide publicly available data and research opportunities.

ID: 10843 Contributed abstract

Poster Order:

Parameterizing non-propagating drag in the ocean

Jody Klymak [1]

[1] University of Victoria

Presented by / Présenté par: ***Jody Klymak***

Contact: jklymak@uvic.ca

Stratified flow over rough topography generates drag due to the creation of internal waves, and due to partially blocked flows creating flow separations and hydraulics. The former process has received significant attention in the ocean as generated "lee waves" that radiate from the topography and break at height. However, blocking flow breaks locally to the topography, leading to so-called non-propagating drag, and recent work indicates this drag can dominate the drag due to radiating internal waves. Here I discuss recent efforts to parameterize this drag in a way that is appropriate for large-scale circulation models. It is noteworthy that for relatively slow flows the non-propagating drag is linear with velocity, contrary to quadratic drag laws used to model non-propagating drag in the atmosphere.

Session: 250 General Session - Part 1 - Weather Prediction Modelling Séance générale — partie 1 - Modélisation des prévisions météorologiques **31/05/2021 12:30**

ID: 10942 Contributed abstract

Poster Order:

An Update on CMC's Nowcasting of Weather Elements on Grid Project

Lewis Poulin [1]

[1] ECCC Canadian Meteorological Centre

Presented by / Présenté par: ***Lewis Poulin***

Contact: lewis.poulin@canada.ca

The recent status, ongoing developments and plans for the Canadian Meteorological Centre's Nowcasting of Weather Elements on Grid (NCWEonG) project will be presented. This includes an overview of the prototype Nowcasting system's performance for significant thunderstorm and hail events during the

summer of 2020. A review of the challenges and work undertaken in the fall of 2021 and winter 2020-2021 to improve the system for the Nowcasting on grid of winter weather will be discussed.

Session: 250 General Session - Part 1 - Weather Prediction Modelling Séance générale — partie 1 - Modélisation des prévisions météorologiques **31/05/2021 12:45**

ID: 10693 Contributed abstract

Poster Order:

Comparing the Prediction Systems of the major NWP producing Centres

Tom Robinson [1]

[1] Environment and Climate Change Canada

Presented by / Présenté par: ***Tom Robinson***
Contact: tom.robinson3@canada.ca

Under the auspices of the WMO’s former Commission for Basic Systems (CBS), the world’s major NWP producing Centres have exchanged NWP verification statistics since the early 1990’s. A standardized set of procedures and practices for the verification of deterministic model upper air parameters and Mean Sea Level Pressure were adopted in 1998 and updated in 2012. Since then, standards have also been adopted for the exchange of surface parameter verification. Ensemble Prediction System verification data have also been exchanged for many years, under a similar CBS program. These programs have the goal of achieving fair and equitable ways to compare NWP outputs with different characteristics. The statistics are publicly available from the web sites of the Lead Centre for Deterministic NWP Verification (hosted by the ECMWF) and the Lead Centre for Ensemble Prediction Systems (hosted by JMA), respectively. The goals of the presentation are to provide an overview of these verification programs and to show prediction system inter-comparisons, with emphasis on how Canadian prediction system performance has evolved over the years in comparison to the other major NWP producers. These programs have been presented at previous CMOS conferences, but not since 2011, so it provides an opportunity to introduce them to a new generation.

Session: 250 General Session - Part 1 - Weather Prediction Modelling Séance générale — partie 1 - Modélisation des **31/05/2021 13:00**

prévisions météorologiques

ID: 10749 Contributed abstract

Poster Order:

PROGNOS: Chapter 2 - Advances in the next statistical post-processing system of the Meteorological Service of Canada (MSC)

Stavros Antonopoulos [1] , *Jonathan Baik* [2] , *Yves Chartier* [3] , *Serge Dogny* [4] , *Cassidy Donaldson* [5] , *Imad Idrissi* [6] , *Jacques Montpetit* [7] , *Davis Phan-Tran* [8] , *Christian Saad* [9]

[1] Weather Elements Section, Meteorological Service of Canada, Environment and Climate Change Canada
[2] Applied Science and Development – Atlantic, Meteorological Service of Canada, Environment and Climate Change Canada
[3] Weather Elements Section, Meteorological Service of Canada, Environment and Climate Change Canada
[4] Scientific Application Development, Meteorological Service of Canada, Environment and Climate Change Canada
[5] Applied Science and Development – Atlantic, Meteorological Service of Canada, Environment and Climate Change Canada
[6] Weather Elements Section, Meteorological Service of Canada, Environment and Climate Change Canada
[7] Weather Elements Section, Meteorological Service of Canada, Environment and Climate Change Canada
[8] Weather Elements Section, Meteorological Service of Canada, Environment and Climate Change Canada
[9] Weather Elements Section, Meteorological Service of Canada, Environment and Climate Change Canada

Presented by / Présenté par: ***Christian Saad***
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In the summer of the 150th anniversary of the MSC, PROGNOS, the upcoming statistical post-processing system for weather and environmental forecast, will have reached a major milestone in its development with an experimental implementation under an operational setting. The current presentation is an overview of the infrastructure and latest updates to the system since its first introduction to the CMOS community in 2018. Flexibility, extensibility, portability, low-cost maintainability and computational efficiency are but a few design characteristics of PROGNOS. The development of the system makes use of current best practices in software engineering including modularity, loose coupling, reusability, testability and strong cohesion to name a few. PROGNOS boasts a well-rounded infrastructure with promising abilities for further research and development. Recent integrations at the inlet of the system include data

derived from numerical model predictions. A cohesive, comprehensive and structured relational database was tailored for PROGNOS use in SQLite format. In addition, data pre-processing capabilities facilitate the use of model and/or seasonal transition schemes. Monitoring functionalities were also integrated to produce statistical model diagnostics, to monitor data quality and to enable verification of PROGNOS forecasts. The system currently adjusts systematic biases of surface dry-bulb and dew point temperatures as well as of wind speed and direction forecasts from the Regional Deterministic Prediction System in real-time at weather stations across Canada and northern United States using multiple linear regression. The ability to relatively easily interchange statistical methods was demonstrated by the integration of such techniques as Random Forest and Kalman Filter, preparing the road ahead for further machine learning applications. Future plans include expanding its application to other numerical weather or environmental prediction models as well as other predictands and statistical techniques.

Session: 250 General Session - Part 1 - Weather Prediction Modelling Séance générale — partie 1 - Modélisation des prévisions météorologiques

31/05/2021 13:15

ID: 10780 Contributed abstract

Poster Order:

NWP verification against own analysis by using a Data Assimilation confidence mask

Barbara Casati [1] , *Vincent Fortin* [2] , *Franck Lespinas* [3] , *Dikraa Khedhaouiria* [4]

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Presented by / Présenté par: ***Barbara Casati***
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Numerical Model Prediction (NWP) verification against station measurements from a surface network is affected by sub-tile representativeness issues. Moreover, the station network is often not representative of the whole verification domain (e.g. usually coastal stations are predominant) and large unpopulated regions (such as oceans, Polar regions, deserts) are usually under-sampled. Gridded analyses mitigate these issues (partially address the sub-tile representativeness, and sample homogeneously the verification

domain), further than merging station network measurements to radar and satellite retrieval estimates, in a physical coherent fashion, over the same NWP grid. Verification against own analysis, despite quite convenient, is however hampered by its dependence on the NWP background model (which renders the verification “incestuous”), further than being affected by the uncertainties introduced by retrieval algorithms and Data Assimilation (DA) procedures. In this study we investigate the use of a gridded NWP own analysis for verification, by applying a mask to reduce the background model contribution. The mask weights the verification scores to account for the amounts of observations assimilated and their associated uncertainty, as estimated from DA. We illustrate the approach by using the Canadian Precipitation Analysis (CaPA), which assimilates station measurements, radar and satellite-based (IMERG) observations. The approach aims to propose a simple -yet effective- better practice for verification against own analysis.

Session: 250 General Session - Part 1 - Weather Prediction Modelling Séance générale — partie 1 - Modélisation des prévisions météorologiques **31/05/2021 13:30**

ID: 10690 Contributed abstract

Poster Order:

An automated prototype system for the verification of marine forecasts issued by Environment and Climate Change Canada

Nelson Shum [1] , *Tim Bullock* [2]

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Presented by / Présenté par: ***Nelson Shum***
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The Meteorological Service of Canada (MSC) of Environment and Climate Change Canada issues marine forecasts that cover much of the navigable waters of Canada. Updated several times daily, these forecasts provide predictions of winds, waves, and weather conditions up to five days in advance. In response to the need for a nationally consistent way of assessing the accuracy of these marine forecasts, the Performance Measurement Section of MSC's Policy, Planning and Partnerships Directorate has developed an automated prototype system which focuses on the verification of forecast wind speeds and directions. The prototype system is based on the multi-valued verification approach, which produces a number of new performance measures. These provide a more comprehensive assessment of forecast accuracy than a

system that is based on the traditional approach of comparing forecasts over a region against the observations taken at a point in that region. This new verification approach also allows a variety of observation sources to be seamlessly incorporated into the verification process. Presently, the system is ingesting data from buoys, ships, lighthouses and other coastal weather stations , as well as those derived from advanced scatterometer (ASCAT) sensors onboard EUMETSAT's METOP series of polar orbiting satellites. The presentation will discuss the components of the system, introduce the measures it produces, and illustrate how these measures support performance assessment.

Session: 330 Environmental monitoring and observation at high latitudes and high altitudes: challenges, solutions and opportunities Surveillance et observation de l'environnement en hautes latitudes et en hautes altitudes : défis, solutions et possibilités **31/05/2021 12:30**

ID: 11074 Contributed abstract

Poster Order:

The Arctic Observing Summit - Highlighting the importance of a sustained, pan-Arctic observing system in providing the tools and information needed for evidence-based decision making at all levels

Maribeth Murray [1] , *Ravi Darwin SANKAR* [2] , *Michael Allchin* [3]

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Presented by / Présenté par: ***Ravi Darwin SANKAR***
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The Arctic Observing Summit fosters communication, international collaboration and coordination of long-term observations aimed at improving understanding of and response to system-scale Arctic change. It is a global forum for optimizing resource allocation, and minimizing gaps and duplication, through coordination of the acquisition and exchange of observational data among researchers, federal/government agencies, Indigenous and northern peoples, non-governmental organizations, the private sector and others involved or interested in long-term observing activities. The AOS originated from widespread agreement on the need to improve the coverage and coordination of pan-Arctic observing, and the communication and utilization of observational information to and by the widest possible audience for the purposes of basic research,

problem solving, and decision-making. In this presentation, we review the outcomes of the 2020 Summit and focus on the emerging challenges ahead including maintaining research-based observing while increasing operational observing, establishing the cost-benefit of observing and monitoring programs, networks, and systems to project long-term trajectories and information flow on short time scales.

Session: 330 Environmental monitoring and observation at high latitudes and high altitudes: challenges, solutions and opportunities Surveillance et observation de l'environnement en hautes latitudes et en hautes altitudes : défis, solutions et possibilités **31/05/2021 12:45**

ID: 11162 Contributed abstract

Poster Order:

Drone Observations of Surface-Based Winter Temperature Inversions in Eureka, Nunavut

Alexey Tikhomirov [1] , *Glen Lesins* [2] , *James Drummond* [3]

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Presented by / Présenté par: ***Alexey Tikhomirov***
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The strong surface-based temperature inversion (SBI), often observed in the Hight Arctic during winter months, is responsible modulating the surface-atmosphere heat, mass and momentum exchanges and critical for satellite validation studies of “skin” and “surface air” temperatures. To study the SBI two commercial Remotely Piloted Aircraft Systems (DJI Matrice 100 and M210-RTK) were flown at the Polar Environment Atmospheric Research Laboratory (PEARL), Eureka, Nunavut, Canada, at 80N latitude during the February–March field campaigns in 2017-2020. The drones were equipped with a temperature measurement system built on a Raspberry Pi single-board computer, three platinum wire temperature sensors, GNSS receiver, and a pressure sensor. In the paper we demonstrate that the drones can be effectively used in the High Arctic to measure vertical temperature profiles up to 60 m above the ground and sea ice surface. The inversion lapse rates within the 0-10 m layer of the ground are found to be ~0.1-0.3 C/m (~100-300 C/km). In the 10-60 m layer the SBI is characterized by the inversion lapse rates of ~0.02-0.04 C/m (~20-40 C/km) or less. Above the sea ice, the temperature profiles are found to be isothermal

above a shallow unstable surface layer revealing the impact of sensible heat flux through the ice. The results of the drone SBI measurements were validated against the data from the flux tower, radiosondes and weather stations in Eureka. The drones have been a useful tool to provide a rapid three-dimensional picture of the air temperature distribution and to evaluate the influence of local topography on the SBI structure above the ground. The challenges and their solutions of conducting drone operations in the winter High Arctic associated with cold environment, polar night and poor performance of navigation systems are also discussed in the paper.

Session: 330 Environmental monitoring and observation at high latitudes and high altitudes: challenges, solutions and opportunities Surveillance et observation de l'environnement en hautes latitudes et en hautes altitudes : défis, solutions et possibilités

31/05/2021 13:00

ID: 11153 Contributed abstract

Poster Order:

On Closing the Loop of the UTLS Aerosol, Cloud, Convection and Precipitation Interactions

Jean-Pierre Blanchet [1], *Yann Blanchard* [2], *Adam Bourassa* [3], *Doug Degenstein* [4], *Pierre Gauthier* [5], *Yi Huang* [6], *Jeff Langille* [7], *Ludovick Pelletier* [8], *Landon Rieger* [9]

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Presented by / Présenté par: ***Jean-Pierre Blanchet***
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Cloud and aerosol processes are among the leading climate change uncertainties and a deep challenge for atmospheric model simulations. Particular attention has been focused on the lower troposphere region, especially around marines and urbanized boundary layers. Relatively less effort has been paid to the upper troposphere and lower stratosphere (UTLS) region despite growing evidence of a strong coupling between aerosol and the atmospheric water cycle there. In lean aerosol and water vapor environment, at cold temperatures with the high sensitivity of the long-wave radiation, especially in the far IR, to water concentrations, the coupling between IFN, cloud formation, precipitation initiation become critical for the radiation balance from convective to large scales. Furthermore, deep convective injection of aerosols and water in the UTLS feeds back on cloud radiative forcing to promote further convection. In this study, we present the rational for launching coupled limb-nadir viewing and highly sensitive satellite instruments to address the key aerosol, clouds, convection and precipitation (ACCP) processes in the global UTLS and Polar regions. Of prime targets are the ice nucleation and cloud particle size linked to background aerosols in the Junge layer, volcanic plumes and local convective systems. We demonstrate how accurate 3D samplings of aerosol and cloud microphysics from 3 Canadian instruments, ALI, SHOW and TICFIRE, jointly with the active instruments on NASA's A-CCP mission can drastically constrain the loop feedback of ACCP processes.

Session: 330 Environmental monitoring and observation at high latitudes and high altitudes: challenges, solutions and opportunities Surveillance et observation de l'environnement en hautes latitudes et en hautes altitudes : défis, solutions et possibilités

31/05/2021 13:15

ID: 11173 Contributed abstract

Poster Order:

Aerosol hygroscopicity in the high Arctic summer and fall

Patrick Duplessis [1] , *Linn Karlsson* [2] , *Paul Zieger* [3] , *Rachel Chang* [4] , *Michael Wheeler* [5] , *Richard Leaitch* [6] , *Andrea Baccarini* [7] , *Julia Schmale* [8]

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Presented by / Présenté par: ***Patrick Duplessis***
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The Arctic is warming at twice the rate of the global temperature average increase. The observed changes propagate through the whole climate system and yet they are not completely understood. Aerosol particles and clouds play a major role in that system and are among the main contributors to the overall uncertainties in Arctic and global climate predictions. We studied fog droplets and aerosol particles near the North Pole in August and September 2018 with the Arctic Ocean 2018 expedition on board the I/B Oden. The study was set around the re-freezing period to analyze the changes in aerosol and cloud microphysics with the changing season. Droplets and interstitial particles were sampled through different inlets including a ground-based counterflow virtual impactor (GCVI) inlet, which sampled only droplets. We dried the samples and reactivated them in a cloud condensation nuclei counter at different supersaturations to measure their hygroscopicity. We found that even particles smaller than 100 nm were present in the dried droplet residuals but that even at high supersaturation they were not all reactivating. The reactivation ratio generally decreased with decreasing temperature, which could suggest that ice microphysics is at play. General results with a focus on particular events will be presented.

Session: 870 In Memory of Paul LeBlond: Physical Oceanographic Research À la mémoire de Paul LeBlond : Recherche en océanographie physique

31/05/2021 12:30

ID: 11083 Contributed abstract

Poster Order:

Animal and Argo-float derived observations of seamount-attached eddies in the Northeast Pacific

Tetjana Ross [1] , *Cherisse Du Preez* [2] , *Debby Ianson* [3]

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Presented by / Présenté par: ***Tetjana Ross***
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There has been an Argo float circling S<u>G</u>aan <u>K</u>inghlas-Bowie seamount since Oct 2020. Although this single float does not provide conclusive evidence, it supports the long-standing supposition that a Taylor cone circulation may be present and helping to retain larvae and increase productivity over this uniquely shallow seamount. We describe the flow around S<u>G</u>aan <u>K</u>inghlas-Bowie seamount using a combination of nearly 20-years of trajectory and hydrographic data from Argo floats that passed near S<u>G</u>aan <u>K</u>inghlas-Bowie seamount and remotely operated vehicle (ROV) imagery of sessile organisms. Some coral species provide natural current meters. They are known to orient across the mean-flow direction --like catcher's mitts-- and the degree of curvature across the organism is related to the flow strength. Corals integrate the flow over many years, while floppier organisms indicate the instantaneous flow direction allowing biological assessment of current across multiple time scales. The medium timescales can be filled in with the Argo-floats' Lagragian and geostrophic views of flow around S<u>G</u>aan <u>K</u>inghlas-Bowie seamount to paint a surprising picture. This work ties in with a number of aspects of Paul LeBlond's scientific legacy. Our title is a play on the title of a 1997 paper he co-authored ("Observations of seamount-attached eddies in the North Pacific"). Paul contributed to several drifter studies, improving our understanding of eddies and other mesoscale features of circulation in the North Pacific. He also had a strong interest in linking physical oceanographic processes to biological systems and would almost certainly have appreciated the idea of observing the many years of biological growth and the stories that the animals tell – rather than just deploying current-meters.

Session: 870 In Memory of Paul LeBlond: Physical Oceanographic Research À la mémoire de Paul LeBlond : Recherche en océanographie physique

31/05/2021 12:45

ID: 10828 Contributed abstract

Poster Order:

An examination of deep-water renewal events in Saanich Inlet, B.C.

Grayson Soetaert [1] , *Roberta Hamme* [2]

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Presented by / Présenté par: ***Grayson Soetaert***
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Saanich Inlet is a seasonally anoxic fjord-type estuary in southeast Vancouver Island that experiences deep-water renewal (DWR) events in the late summer/early fall each year. These events replenish bottom waters in oxygen and some nutrients. Saanich Inlet provides an easy-access environmental laboratory for studies of community and chemical responses to intermittent anoxia. Knowing when bottom waters are reoxygenated will aid cruise planning. DWR occurs when waters (denser than the basin's deep-water) outside the basin can retain high density as they travel along the shallow elongate sill at the mouth of the basin. This happens only during neap tides. The strength of these events is variable with some years showing fewer strong DWRs, hypothesized here to be related to upwelling dynamics off the continental shelf. A node installed on the sill provided a time-series of density at 90m depth from 2012-2019. Density changes for a given event were compared to tidal current speeds and the Bakun Index to examine their relative influence on the strength of a DWR event. We found that tidal speeds are the main driver in causing a DWR event, with stronger events occurring at speeds below 0.9 m s-1. Upwelling also plays an important role in determining strength of a DWR by supplying denser water to the region. Events where tidal speeds were low but showed weaker renewals occurred during downwelling. Examination of near-daily profiles in 2016 provided a look at the duration of DWR events from the minimum in tidal speed to post-mixing. These data suggest an adjustment period related to the density of the incoming water, though further analysis in other years is required to confirm. The DWR process of Saanich Inlet can provide a look at DWR processes in other restricted estuaries around the region, potentially assisting prediction of events like fish kills.

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31/05/2021 13:00

ID: 10912 Contributed abstract

Poster Order:

Lagrangian "spaghetti" in a coastal sea- an analysis of virtual particle trajectories in the Strait of Georgia

Samuel W Stevens [1] , *Rich Pawlowicz* [2] , *Susan E Allen* [3]

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Presented by / Présenté par: ***Samuel Stevens***
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The improving resolution and accuracy of coastal models has made the Lagrangian analysis of virtual particle trajectories increasingly feasible in complex coastal areas; however, extracting information from the “spaghetti” of trajectories it is not always straightforward. Here, we present various Lagrangian analyses from the intermediate layer of the Strait of Georgia, BC: the most voluminous water mass in the Salish Sea that, as the ultimate destination for a large portion of Greater Vancouver’s wastewater, plays a key role in dispersing contaminants around the region. The analyses are derived from Ariane particle tracking experiments in hindcast velocity fields produced by SalishSeaCast, a regional 3D model. Lagrangian statistics provide information on the dispersion characteristics of the layer, while an analysis of intermediate water inflow trajectories uses spatially varying Transit Time Distributions (TTDs) to produce inflow transit time maps. From these maps we identify various loops and boundary currents, establishing the prevailing transport pathways and time-scales of the inflows. To study transport on smaller scales, we use an ellipse recognition algorithm to identify circular motion in the trajectories which we then separate into dynamical classes based on their physical properties for analysis. In combination, these Lagrangian analyses give an overview of the Strait of Georgia intermediate water transport ranging from regional scales to sub-mesoscales.

Session: 870 In Memory of Paul LeBlond: Physical Oceanographic Research À la mémoire de Paul LeBlond : Recherche en océanographie physique

31/05/2021 13:15

ID: 10846 Contributed abstract

Poster Order:

Update on "estuary/ocean exchange controlled by spring-neap tidal mixing"

Susan Allen [1] , *Nancy Soontiens* [2] , *Michael Dunphy* [3] , *Elise Olson* [4] , *Doug Latornell* [5]

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Presented by / Présenté par: ***Susan Allen***
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The Strait of Georgia is fresh due to the outflow of the Fraser and other rivers. As in most estuaries, this drives an estuarine flow with surface flow out toward the ocean, replaced by an intermediate depth inflow from the ocean. In the

Salish Sea, however, the exchange needs to pass through the region of very strong tidal mixing in Haro Strait. In 1990, Griffin and LeBlond published on the estuarine exchange through Haro Strait and how it was modulated by the spring-neap tidal cycle. Their research was based on observations and dynamics. They showed strong fluxes of the freshest surface water occurred during weak tides, during the freshet, and with winds to the south in the Strait of Georgia. Here we will expand on that research using the results of the numerical model SalishSeaCast. SalishSeaCast replicates the processes in Griffin and LeBlond's observations and the recent observations of deep water inflows into the Strait of Georgia. The model allows us to look easily at both surface fluxes moving out of the estuary and the deep incoming fluxes moving into the estuary. We expand on the dynamics of Griffin and LeBlond to characterize the force driving the estuarine circulation as a buoyancy force due to both the freshness in the Strait of Georgia and the saltiness of Juan de Fuca Strait. The model also allows quantification of the exchange flow in terms of its nutrient, carbon and oxygen fluxes and an exploration of the spatial variability of the flow across the Straits and vertically.

Session: 870 In Memory of Paul LeBlond: Physical Oceanographic Research À la mémoire de Paul LeBlond : Recherche en océanographie physique **31/05/2021 13:30**

ID: 10689 Contributed abstract

Poster Order:

HF radar observations of wintertime surface currents over Hecate Strait, British Columbia

Patrick Cummins [1] , *Hauke Blanken* [2] , *Charles Hannah* [3]

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Presented by / Présenté par: ***Patrick Cummins***
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Hecate Strait is the 90 km wide channel separating Haida Gwaii from the British Columbia mainland. An oceanographic HF radar (CODAR) system was deployed along the Strait by Fisheries and Oceans Canada to provide near-real time observations of surface currents to strengthen regional marine safety, including search-and-rescue operations. The Hecate Strait CODAR system, now maintained and operated by Ocean Networks Canada, has been providing a near-continuous stream of data since November 2020. These data consist of

surface currents on a grid that spans central-northern Hecate Strait at a horizontal resolution of 5 km. Comparisons of rotary spectra and tidal current ellipses with historical current meter observations suggest that vector currents from the Hecate Strait CODAR system are reasonably accurate and can be used to describe the circulation and variability of ocean currents over the Strait. The observations are used to characterize the regional wintertime circulation, as well as to assess results from CIOPS-West, an ocean model being run operationally by Environment and Climate Change Canada. Results show that the sub-tidal variability is closely related to local wind forcing. A vector regression of surface currents to winds demonstrates that the magnitude of sub-tidal currents in the centre of the Strait is 1-2% of the wind speed, rotated about 30 degrees to the right of the wind vector. Inter-comparisons with the CIOPS-West model show good agreement in the pattern of mean wintertime currents at the surface.

Day 1 – 31 May 2021 & Day 3 – 2 June 2021

Posters

Session: 1011 POSTER SESSION - PART 11 - Climate Variability AFFICHES - PARTIE 11 - La variabilité du climat

ID: 11214 Contributed abstract

Poster Order: 610P01

Quantifying the role of internal climate variability in snow cover trends over northern Québec and Labrador

Dominic Morin [1] , *Martin Leduc* [2] , *René Laprise* [3] , *Ross Brown* [4]

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Presented by / Présenté par: ***Dominic Morin***
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The climate of northern regions of Québec and Labrador has been changing more rapidly over recent decades, the exact causes and mechanisms responsible for this accelerated change are still uncertain. Besides the strong Arctic warming observed since the 90s, it is expected that internal climate variability can superimposes onto the forced signal from anthropogenic activity by either amplifying or attenuating it. This natural variability in the global

atmosphere and ocean circulation is driving local changes into the environment which impact local communities living in Nunavik (northern Québec) and Nunatsiavut (Labrador). The main goal of this project is to disentangle the main sources of natural variability affecting local temperature, precipitation and snow cover in the northern regions by linking these variables with climate variability indices such as the North Atlantic Oscillation (NAO) and the Atlantic Multidecadal Oscillation (AMO), but also with local feedbacks involving sea-ice cover of the Hudson Bay and Labrador Sea. This analysis will be performed using an ensemble of simulations based on the Canadian Regional Climate Model version 5 (CRCM5), which includes a 50-members initial-condition ensemble (ClimEx project; Leduc et al. 2019), a reanalysis-driven run and different global climate models as lateral boundary conditions. Series from the ERA5-Land reanalysis and meteorological stations will be used to evaluate the performance of the CRCM5 simulations over the historical period. Here, I will present results from the analysis of the simulated climate trends and variability of temperature, precipitation, snow cover and sea ice. In addition, correlations between these variables and natural climate variability indices (NAO & AMO) will be presented for different regions of northern Québec and coastal Labrador.

Session: 1011 POSTER SESSION - PART 11 - Climate Variability AFFICHES - PARTIE 11 - La variabilité du climat

ID: 11215 Contributed abstract

Poster Order: 610P02

Sub-seasonal variability of meridional activity of Western Pacific subtropical high and its extended range forecast during boreal late summer

Ping Liang [1] , *Qiwen Qian* [2]

[1]

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Presented by / Présenté par: ***Ping Liang***
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Sub-seasonal variability of meridional activity of Western Pacific subtropical high (WPSH) exerts important influences on spatial distribution and persistence of anomalous weather and climate in East Asian monsoon region. The sub-seasonal variability of meridional activity of the WPSH and its associating atmospheric evolutions during boreal late summer are investigated basing on a newly defined index. And the extended range forecast of the sub-seasonal variability of the WPSH are further evaluated by using CFSv2 real time forecast

data. The 10-30dy sub-seasonal meridional activity of the WPSH is influenced by wave trains in mid-high latitudes and convection propagation from tropics. The meridional activity of the WPSH on sub-seasonal time scale of 40-50 days is closely related to the convection anomalies under the interaction between MJO (Madden-Julian Oscillation) and MISO (monsoon intra-seasonal oscillation). The sub-seasonal variability of the WPSH can be well forecasted with lead time about 15 days in CFSv2 forecast system. It is still a challenge for the CFSv2 to forecast the sub-seasonal variability of the WPSH with longer lead time.

Session: 1011 POSTER SESSION - PART 11 - Climate Variability AFFICHES - PARTIE 11 - La variabilité du climat

ID: 11218 Contributed abstract

Poster Order: 610P03

Oceanic oscillations and the climate of late 18th Century Canada: A Progress Report

C. Thomas Shay Shay [1] , *Shannon Parker* [2] , *Elaina Waters* [3] , *Matthew Crowdy* [4]

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[4] None

Presented by / Présenté par: ***C. Thomas Shay***
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This paper explores the effects of ENSO and PDO on the past climates of Central Saskatchewan, Canada. We focus on 1) the winters (DJF) of the 1791 El Niño which also witnessed a positive PDO and the La Niña event of 1790 that also saw a positive PDO. El Niños of the past few decades have brought warmer and drier winters with weaker winds to the western Canadian prairies. In view of this, we propose two hypotheses: 1. Such weather will be felt in central Saskatchewan during the oceanic events of the late 20th Century. 2. The 1790s may also have faced similar changes. We tested these ideas using two sources: Environment Canada data for North Battleford in western Saskatchewan and daily observations from Manchester House, a nearby Hudson’s Bay Company trading post. Our initial results suggest that: 1. Mean hourly winter (DJF) winds at North Battleford were significantly less during the El Niño of 1982-1983 than the La Niña of 1973-1974. Moreover, mean temperatures were five degrees warmer and half as much snow and rain fell during the El Niño. 2. The historic

data show similar results. At Manchester House, average wind strength per day during the El Niño winter of 1790-91 was lower than during the La Niña winter of 1789-90. The El Niño winter was also warmer with less snow. We plan to further test our ideas by analysing more years of data for both North Battleford and Manchester House, and will add Cumberland House, a trading post in eastern Saskatchewan. Moreover, we will examine recent and historic oceanic events in relation to fires, floods and droughts. C. T. S. led the project, S.P. compiled tables, formulated codes and conducted statistics, E. W. transcribed fur trade records and M. C. worked on summary tables.

Session: 1011 POSTER SESSION - PART 11 - Climate Variability AFFICHES - PARTIE 11 - La variabilité du climat

ID: 11223 Contributed abstract

Poster Order: 610P04

Quantification of the resolvable scales of regional-scale CO2 transport in the context of imperfect meteorology: the predictability of CO2 at a regional scale

Jinwoong Kim [1] , *Saroja Polavarapu* [2] , *Dylan Jones* [3] , *Douglas Chan* [4] , *Michael Neish* [5]

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Presented by / Présenté par: ***Jinwoong Kim***
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The error in the constituent transport model is an important source of uncertainty when estimating surface CO2 fluxes via an atmospheric model inversion. Although the component of transport error due to imperfect meteorology can be significant, it is often neglected in atmospheric inverse models. As we enter a data rich era of CO2 measurements there is a need to estimate CO2 fluxes at increasingly higher spatial resolutions but the contribution of transport model error to flux estimation error increases with spatial resolution. In this presentation, the predictability of CO2 on weather and seasonal time scales is investigated and the resolvable scales of CO2 transport due to errors in meteorology is quantified in the context of the regional version of GEM-MACH-GHG. This model is based on an operational weather forecast model and a chemical transport model at Environment and Climate Change

Canada. We characterize the extent to which errors in meteorological initial conditions (ICs) and lateral boundary conditions (LBCs) impact the quality of atmospheric CO2 transport across spatial scales. A series of experiments is conducted using different permutations of meteorological ICs and LBCs that possess varying levels of accuracy, based on ICs from the operational analyses and LBCs provided by the global GEM-MACH-GHG. We find that the transport error of CO2 is more sensitive to errors in meteorology at smaller scales than at larger scales, and that surface CO2 fluxes are important for the predictability of CO2 at the largest scales. We also determine the spatial scales resolvable in the context of uncertain meteorology. The result suggests that the improvement in meteorological analyses for ICs and LBCs through a data assimilation system could be helpful in further resolving finer spatial scales of CO2 at regional scales.

Session: 1011 POSTER SESSION - PART 11 - Climate Variability AFFICHES - PARTIE 11 - La variabilité du climat

ID: 10885 Contributed abstract

Poster Order: 650P01

Investigating the spread of surface albedo and snow sensitivity in CMIP6 models

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Presented by / Présenté par: ***Libo Wang***
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A large spread in surface albedo in the presence of snow (particularly across the boreal forest) was found in climate models evaluated during Phase 3 and Phase 5 of the Coupled Model Intercomparison Project (CMIP). We demonstrate that this large albedo spread persists in CMIP6 climate models. Knowledge based on the previous generations of CMIP models has shown that for the Northern Hemisphere on average, the large surface albedo spread is the primary source of uncertainties in simulated snow-albedo feedback strength, which accounts for much of the spread in simulated 21st century warming at high northern latitudes. However, the albedo biases depend heavily on the prescribed vegetation characteristics as well as their modeled interactions with snow. Furthermore, the contributions of model variation in the sensitivity of

snow loss to the spread in snow albedo feedback are non-negligible. Based on these expectations we examine how CMIP6 model spread in simulated surface albedo varies regionally accounting for vegetation type and considering differences in the modeled sensitivity of snow cover loss. Preliminary results of this analysis will inform a large portion of uncertainty related to linkages between land cover, simulated winter albedo, snow sensitivity and warming across different vegetation dominated regions of the Northern hemisphere middle to high latitudes.

Session: 1011 POSTER SESSION - PART 11 - Climate Variability AFFICHES - PARTIE 11 - La variabilité du climat

ID: 10829 Contributed abstract

Poster Order: 750P01

Attribution of temperature changes in Canada: CMIP6 study

Elizaveta Malinina [1] , *Nathan Gillett* [2] , *Xuebin Zhang* [3]

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Presented by / Présenté par: ***Elizaveta Malinina***
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While the temperature is rising everywhere in the world, northern regions experience the most rapid warming. In this presentation, based on previous global and regional analyses, we provide an update on attribution of the these temperature changes in Canada. Using the climate models simulations from DAMIP (Detection and Attribution Model Intercomparison Project, a part of CMIP6) from 1850 to 2020, we evaluate the contribution of natural as well as anthropogenic forcings (including aerosols and greenhouse gases forcing) to the temperature change.

Session: 1012 POSTER SESSION - PART 12 - In situ measurement of precipitation and snow cover: advances, challenges, and ongoing issues AFFICHES - PARTIE 12 - Mesure in situ des précipitations et de la couverture de neige : progrès, défis et situations actuelles

ID: 10653 Contributed abstract

Poster Order: 210P01

Solid Precipitation Transfer Function Evaluation when applied at independent sites

Megan Hartwell [1] , *Jerry Brunner* [2] , *Lucie Vincent* [3]

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Presented by / Présenté par: ***Megan Hartwell***
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The measurements of solid precipitation in windy conditions requires great care. The Double Fence Automated Reference (DFAR) does a very good job of accurately measuring precipitation, and the underlying research goal is to replicate these measurements using smaller wind shields, such as the Single Alter. The objective of this study is to find a model that best corrects the precipitation that is measured by the Single Alter configuration and brings it closer to the precipitation measured by the DFAR. A suite of transfer functions, including existing and newly proposed functions, is fit to the data from the United States Marshall Field Site. The functions and their parameters derived from this site are then applied to the measurements taken at Caribou Creek and Bratt’s Lake sites in Canada, to test the application of these functions when applied to sites in different climates. The accuracy of these transfer functions is evaluated using the squared correlation, root mean square error and bias between the observed and predicted DFAR measurements. The time series structure is also examined and deemed to not be of concern in the model fitting. The best models are shown to be of the form of the Universal Transfer Function.

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ID: 10750 Contributed abstract

Poster Order: 210P02

Inverse and Forward Models for Sound Propagation through Snowpacks

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Presented by / Présenté par: ***Nicholas Kinar***
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Acoustic observations of snow can be used to non-invasively measure snowpack depth, density, snow water equivalent, liquid water content and temperature. These acoustic observations are dependent on the use of inverse models of sound wave propagation through layered porous media. These models have been mostly adapted from seismology and sonar applications where the inverse model approximates the forward model. This is because the inverse model is ill-posed and small changes in initial conditions can cause errors in the reconstructed parameters corresponding to snowpack physical properties. Explicit Green's function solutions for sound propagation through a layered snowpack are used to examine how the inverse model is impacted by acoustic scattering by irregularities within the snowpack including liquid water, ice layers, and vegetation. Marchenko equations and focusing functions are then used to make the inverse model more well-posed. Solutions for combining forward and inverse models using the Vanishing Constant Filter (VCF) calculate sound attenuation through snowpacks using well-posed forward and inverse models to constrain the inverse model. The solutions are demonstrated using synthetic data and field observations from the Chione electronic system which sends audible sound waves into a snowpack and receives the sound wave reflections. The system is comprised of a loudspeaker set at an offset distance to an array of miniature microphones, both are located a few metres above the snowpack. The loudspeaker produces a source sound sequence, and the microphones detect the reflection response of the snowpack. This talk will discuss acoustic observations of snowpacks and limitations of the forward and inverse models using examples of snowpack observations taken from different seasonal snowpack environments in Canada.

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ID: 10786 Contributed abstract

Poster Order: 210P03

Update of the Canadian historical snow survey dataset (1928-2020)

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Presented by / Présenté par: ***Colleen Mortimer***
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Reliable and timely in-situ information of snow water equivalent (SWE) – the depth of water that would be produced if all the snow melted – is critical for climate monitoring, evaluation of hydrological and climate models, and for applied research. The Canadian historical snow survey dataset combines manual and automated pan-Canadian SWE observations collected by national, provincial and territorial agencies as well as hydro-power companies. Snow depth and density observations are also included when available. The latest update of this dataset, which contains data until 2016, was completed in 2017 [1]. We have conducted an effort to update, expand and clean this dataset. This updated dataset, compiled from 15 different sources, includes information on snow water equivalent for all provinces and territories that measure SWE. Data were updated to July 2020, additional data sources were included (Government of Northwest Territories, Government of Newfoundland and Labrador, Saskatchewan Water Security Agency), and a significant data cleaning effort was conducted. Data received from various providers were standardized and merged to a netcdf data format. Dataset cleaning involved correction of metadata, removal of duplicate observations, standardizing data quality flags, and quality control of the records. Duplicate sites that were the result of multiple prior database updates were identified and merged. Data quality flags from reporting agencies were cleaned and consolidated. Quality control was conducted on this final dataset and included range thresholds for snow depth, density, and SWE. Outlier detection using the Robust Mahalonibis Distance was applied to automated measurements. The final dataset includes over one million SWE measurements from 2559 different locations and will be publicly available on the Open Government Data Portal in spring 2021. References [1] Brown, R., B Fang, and L Mudryk. Atmosphere-Ocean 57, no. 2 (2019): 149-156.

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ID: 10900 Contributed abstract

Poster Order: 210P04

Comparison of the precipitation measurements during the Saint John

River Experiment on Cold Season Storms

Julie M. Thériault [1] , *Nicolas R. Leroux* [2] , *Hadleigh D. Thompson* [3] , *Dominique Boisvert* [4] , *Julie Poingt* [5] , *Lisa Rickard* [6] , *Vincent Vionnet* [7] , *Stephen J. Déry* [8]

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Presented by / Présenté par: ***Julie M. Thériault***
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Accurately measuring the amount and phase of precipitation during the cold season in the Upper Saint John River Basin on the boarder of New Brunswick, Quebec and Maine (United States) is critical. The occurrence of successive storms drives snow accumulation on the ground during the winter and when combined with spring rainfall and/or anomalously high temperatures, can result in catastrophic flooding events for this basin. During the 2020-21 Saint John River Experiment on Cold Season Storms (SAJESS), meteorological instruments were installed near Edmundston, New Brunswick, to measure precipitation phase and amount. These include a K63 Hotplate precipitation gauge (Pond Engineering), a Parsivel2 disdrometer (OTT), and a Micro Rain Radar (MRR2, Metek). Meteorological data, such as air temperature, wind speed, and net radiation were also recorded at the site. This station was installed near an Environment and Climate Change Canada weather station, which is equipped with a Geonor precipitation gauge in a single-Alter shield, a 10-m wind sensor, and snow depth sensors. The goal of this presentation is to compare the precipitation measured by the unshielded K63 Hotplate and the shielded Geonor precipitation gauge, with the ability of the hotplate to accurately measure the amount of solid, liquid, and mixed precipitation being assessed against the shielded Geonor. Precipitation type is determined from the laser-optical disdrometer and linked to ambient atmospheric conditions. Preliminary analyses suggest that solid and mixed precipitation amounts were better estimated by the Pond Hotplate precipitation gauge than by the shielded Geonor, whereas liquid precipitation measurements from the two precipitation gauges were similar. In summary, this analysis is a first step towards increasing our understanding and characterization of cold season precipitation events in the Upper Saint John River Basin, which is critical for flood forecasting in this basin.

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ID: 10979 Contributed abstract

Poster Order: 210P06

Intercomparison of Lambrecht automated precipitation gauge observations with established historical manual precipitation data

Stephnie Watson [1] , *Eva Mekis* [2] , *Craig D. Smith* [3] , *John MacPhee* [4] , *Martin Elie* [5]

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Presented by / Présenté par: ***Stephnie Watson***
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As organizations look towards more automated methods and gauges for collecting precipitation data, it is important to highlight the need for comparisons of the new gauges against recognized and traceable reference measurements. The preservation, maintenance, and analysis of overlapping and co-located site measurements and techniques are important components of consistent, reliable and long-term homogeneous measurements across Canada. Intercomparisons and traceability studies ensure that end users understand the nuances, limitations and impacts of new instrument introduction on data accuracy and homogeneity. In an effort to modernize and streamline observations in the NAV CANADA observation network for transportation safety purposes, automatic Lambrecht rain [e]H3 heated tipping bucket/weighing precipitation gauges have been installed at many airports to replace manual observation of precipitation. This transition has raised concerns about the accuracy and homogeneity of the precipitation observations, especially for solid precipitation events that are well known to be prone to large measurement errors. The existing overlap of automated Lambrecht gauge measurements with manual observations at four sites representing different climate conditions creates an opportunity to establish the relationship between the old and new instruments & methods. This study compares co-located precipitation measurements at Dorval, Downsview, Prince George and Whitehorse observation sites, where Lambrecht gauges have been installed along with existing operational manual snow (Nipher) and rain (Type B) gauges. When available, the overlapping weighing precipitation gauge (OTT Pluvio2L or Geonor T-200B) data is also included in the

intercomparison. The intercomparison timeframe is the overlapping period within 2019-2020. This presentation will discuss preliminary intercomparison results and their implications for data users as well as future enhanced project plans.

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ID: 10949 Contributed abstract

Poster Order: 210P07

Under which conditions do westward moving storms cross the continental divide between Alberta and British Columbia? A case study of two spring storms during 2019.

Nicolas Leroux [1] , *Julie Thériault* [2] , *Alejandro Di Luca* [3] , *Melissa Cholette* [4] , *Hadleigh Thompson* [5]

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Presented by / Présenté par: ***Nicolas Leroux***
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The eastern side of the Canadian Rockies can be subject to intense spring storms, for instance, the event that caused the 2013 Alberta flood. Being able to predict if moisture embedded in upslope flow on the eastern side has the potential to cross the continental divide to the western side is essential. Precipitation falling west of the divide contributes to the Pacific Ocean and precipitation falling on to the east contributes to the Arctic and Atlantic Oceans. The goal of this study is to determine the factors that allow precipitation to cross the continental divide westward from Alberta to British Columbia. This case study focuses on two westward moving storms that occurred during the Storms and Precipitation Across the continental Divide Experiment (SPADE) campaign in the spring of 2019. Meteorological conditions and precipitation at the surface were measured during both storms. During the first storm, precipitation at the surface was observed only on the east side of the divide, conversely, during the second storm precipitation was observed on both sides. The goal of this presentation is to characterize the available moisture and precipitation that

produced these contrasting horizontal gradients of precipitation across the divide. To address this, GEM simulations covering a central portion of Canadian Rockies were conducted at 2.5 km resolution. The simulated precipitation at the surface compared well with the observations, including the differing precipitation amounts and types during each storm. Based on Froude number calculations, both storms had the potential to cross the continental divide, but the second storm carried more moisture and condensate at higher altitudes than the first storm, leading to precipitation on both sides. Overall, this work highlights some of the challenges of predicting precipitation in the complex terrain of western Canada.

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ID: 10949 Contributed abstract

Poster Order: 210P07

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Presented by / Présenté par: ***Nicolas Leroux***
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The eastern side of the Canadian Rockies can be subject to intense spring storms, for instance, the event that caused the 2013 Alberta flood. Being able to predict if moisture embedded in upslope flow on the eastern side has the potential to cross the continental divide to the western side is essential. Precipitation falling west of the divide contributes to the Pacific Ocean and precipitation falling on to the east contributes to the Arctic and Atlantic Oceans. The goal of this study is to determine the factors that allow precipitation to cross the continental divide westward from Alberta to British Columbia. This case study focuses on two westward moving storms that occurred during the Storms

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Session: 1013 POSTER SESSION - PART 13 - Open Ocean Processes and Models AFFICHES - PARTIE 13 - Processus et modèles Open Ocean

ID: 10934 Contributed abstract

Poster Order: 320P07

Late-Holocene summer sea-surface conditions in the North Water polynya (northern Baffin Bay)

Kelsey Koerner [1] , *Audrey Limoges* [2] , *Nicolas Van Nieuwenhove* [3] , *Thomas Richerol* [4] , *Guillaume Massé* [5] , *Sofia Ribeiro* [6]

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Presented by / Présenté par: ***Kelsey Koerner***
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The North Water (NOW) polynya (i.e., area of open water in a region with high sea ice concentrations) in northern Baffin Bay is the largest recurrent polynya in the Arctic. Its formation and maintenance are tightly coupled with the

consolidation of ice bridges in Nares Strait and northerly winds that push newly formed sea ice out of the region, as well as upwelling of relatively warm water masses. In recent years, interannual variability in the polynya formation and extent have been linked to instabilities in ice bridge formation. We investigated changes to the sea-surface conditions of the NOW polynya with respect to long-term past climatic variability. We present results from the analysis of dinoflagellate cyst (dinocyst) assemblages preserved in a sediment core collected from the central region of the polynya covering the last ca. 3800 years. From ca. 3800 to 2500 years BP, high abundances of the dinocyst taxa <i>Operculodinium centrocarpum</i> and <i>Spiniferites elongatus</i> suggest a long open water season and heightened summer sea-surface salinities. Between 2500 to 1500 years BP, an increase in cold-water taxa <i>Islandinium minutum </i>, <i>Islandinium? cezare</i>, and <i>Echindinium karaense</i> suggest gradual sea-surface cooling and increased sea-ice influence. A continued presence of the cold-water taxa and low autotrophic abundances suggest sustained sea-surface cooling and a shorter open water season between 1500 to 156 years BP. The last ca. 50 years of our record (1965 to 2015 CE) show a rapid increase in dinocyst fluxes and autotrophic taxa, the last decade being dominated by the cyst of <i>Pentapharsodinium dalei</i>, suggesting longer open-water and stratified sea-surface conditions linked to increased Arctic sea-ice melt and glacial run-off. Continued Arctic warming may lead to a shift from a recurrently forming NOW polynya to a seasonally open gateway between northern Baffin Bay and the Arctic.

Session: 1013 POSTER SESSION - PART 13 - Open Ocean Processes and Models AFFICHES - PARTIE 13 - Processus et modèles Open Ocean

ID: 10670 Contributed abstract

Poster Order: 850P01

Controls and variability of the retroflection of the Labrador Current

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Presented by / Présenté par: ***Carolina Dufour***
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Large variations have been observed in the properties of waters in the Slope Sea and along the eastern shelf of North America, triggering episodic strong warming events along the slope and in the Gulf of Maine, and deoxygenation in the St Lawrence Estuary. The water properties vary according to the ratio of Labrador Current waters and Gulf Stream waters that reach the area. Jutras et al. (2020) previously reported that this ratio may be controlled by the Scotian Shelf-break Current, an extension of the Labrador Current, and not by the position or strength of the Gulf Stream. When the Labrador Current is strong, little of the southward flowing Labrador Current waters follow the coast all the way to the Scotian Shelf. Instead, most of the waters are retroflected east towards the North Atlantic. The deflection of the Labrador Current occurs mostly between Flemish Cap and the southern tip of the Grand Banks. Therefore, the retroflection of the Labrador Current affects both the properties of Slope waters and of the subpolar North Atlantic, with possible implications on the thermohaline and gyre circulations. Here, we attempt to quantify this retroflection, as well as investigate its variability and possible drivers. To study the retroflection, we use the ocean daily velocities from the 1/12° Glorys reanalysis over the 1993-2018 period. We consider two approaches: an Eulerian approach, examining the volume transport of the Labrador Current, and a Lagrangian approach, examining the trajectories of virtual Lagrangian particles seeded in the Labrador Current. From these analyses, we define a retroflection index, which provides us with a time series portraying whether the waters are retroflected towards the North Atlantic or pursue their journey around the Grand Banks towards the Slope Sea. This index is then used to examine this fate under different climatic conditions and environmental forcings, in order to identify the potential drivers of this retroflection and understand what controls its variability.

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ID: 11019 Contributed abstract

Poster Order: 850P03

Potential Students On Ice bottle trajectories using Ariane

Natasha Ridenour [1] , *Liam Buchart* [2] , *Inge Deschepper* [3] , *Eric Galbraith* [4] , *Julliana Marson* [5] , *Paul Myers* [6] , *Clark Pennelly* [7] , *Tahya Weiss-Gibbons* [8]

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Presented by / Présenté par: ***Natasha Ridenour***
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For the last two decades, the Students On Ice (SOI; https://studentsonice.com/) project has created a platform to engage northern youth in Arctic science. Among other activities, youth are able to partake in cruises on the Canadian Coast Guard research vessel, Amundsen, and drop drifter bottles into the ocean. Some of these bottles have been recovered and reported back to SOI on when and where they were found, including regions throughout the Arctic and western Europe. Here, we combine the observational drifter bottle data with a high resolution regional ocean model (the Arctic and Northern Hemispheric Atlantic configuration with NEMO) paired with the lagrangian tracking tool Ariane to track these virtual drifters in the ocean model fields. Our goal is to provide potential drift tracks of the bottles, and to compare the observed and model drift tracks. These results will be passed on to the youth involved in the SOI project. Forward tracking is used for the bottle drop locations, while backward tracking is used on the bottle recovery locations for those that were found. We track each bottle for two years from the drop or recovery date using 10,000 particles for each bottle. Our analysis evaluates the spread of particles, as well as the percentage of particles that are found near the drop or recovery location of the bottles. We also show common pathways that the drifter bottles were likely to have taken.

Session: 1013 POSTER SESSION - PART 13 - Open Ocean Processes and Models AFFICHES - PARTIE 13 - Processus et modèles Open Ocean

ID: 10811 Contributed abstract

Poster Order: 860P01

Class 4 and other sea-ice-related verification of the Regional Canadian operational ice-ocean prediction system

Yvonnick Le Clainche [1] , *Yukie Hata* [2] , *Greg Smith* [3] , *Jinshan Xu* [4] , *Fraser Davidson* [5] , *Yimin Liu* [6] , *Frédéric Dupont* [7] , *Ji Lei* [8] , *Mo Rokibul Islam* [9]

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Presented by / Présenté par: ***Yvonnick Le Clainche***
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Ice-ocean analysis and forecasting systems have been developed and operationally implemented under the Canadian Operational Network of Coupled Environmental Prediction Systems (CONCEPTS), an inter-departmental initiative involving Environment and Climate Change Canada (ECCC), Fisheries and Oceans Canada (DFO) and the Department of National Defense (DND). The GODAE OceanView (GOV) Class 4 metrics are calculated for the Regional Ice-Ocean Prediction Systems (RIOPS), whose the geographical domain covers the North Atlantic, the Arctic and the North-East Pacific. Statistics of the difference between the observations and the “model equivalents” are calculated into various sub-areas allowing to better assess the quality of RIOPS forecasts and their skills in key regions of interest for Canada, such as the North-East Pacific, the North-West Atlantic or the Canadian Arctic. This is necessary to guide and enhance operational model uses in those areas. Other sea-ice-related metrics will be presented, such as sea-ice drift and sea-ice thickness errors.

Session: 1013 POSTER SESSION - PART 13 - Open Ocean Processes and Models AFFICHES - PARTIE 13 - Processus et modèles Open Ocean

ID: 11067 Contributed abstract

Poster Order: 860P03

The operational Sea Surface Temperature (SST) analysis at the Canadian Center for Meteorological and Environmental Prediction (CCMEP)

Dorina Surcel Colan [1], *Audrey-Anne Gauthier* [2], *Kamel Chikhar* [3], *Gregory C. Smith* [4]

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Presented by / Présenté par: ***Dorina Surcel Colan***
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As part of its operational prediction program, CCMEP produces a daily, global, 0.1° analysis of SST using in situ and satellite data. It currently assimilates satellite data from AVHRR, AMSR2 and VIIRS instruments, in situ observations from fixed and drifting buoys and from ships and it uses ice information from CCMEP global ice concentration analysis. The SST analysis is an important contributor to forecast skill for numerical weather and ocean prediction systems. At CCMEP, forecast models use the SST analysis from local scale to global scale. This study presents the description of SST analysis with emphasis on the later implementations. It assesses the impact of assimilating different satellite datasets to the quality of global SST analysis. Verification against independent data and against GMPE (Group for High Resolution SST - GHRSST) product are also presented.

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ID: 10840 Contributed abstract

Poster Order: 910P01

Configuration of a Model of Eastern Canadian Freshwater Discharge to the Northwest Atlantic

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Presented by / Présenté par: ***Rick Danielson***
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The WRFHydro model is configured to perform climate simulations of freshwater discharge from a fixed eastern North American river network at one-km resolution. Piecewise calibration is performed for individual catchment areas

using historical precipitation estimates, and preferentially, with respect to natural observed river flows that are not influenced by dams and reservoir controls. Bias in daily to annual flows are considered with respect to free model parameters, as well as atmospheric forcing (i.e., precipitation), with historical forcing given by the three-hourly North American Regional Reanalysis (NARR) and six-hourly Canadian Meteorological Service (CMC) products, and future climate forcing given by six-hourly regional WRF simulations. Following a semi-automated model calibration, future climate discharge trends are discussed for a given parameterization of hydrologic processes.

Session: 1014 POSTER SESSION - PART 14 - Panel Discussiion: Canada and the UN Decade of Ocean Science for Sustainable Development AFFICHES - PARTIE 14 - Le Canada et la Décennie des Nations Unies pour les sciences océaniques au service du développement durable

ID: 10671 Contributed abstract

Poster Order: 220P01

The National Research Vessel Task Team and Modular Ocean Research Infrastructure. A Flexible, Scalable and Affordable Approach to Oceangoing Research in Canada and Worldwide.

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Presented by / Présenté par: ***Douglas Bancroft***
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The availability of research vessels is critical for the ability of Canadian scientists, across all disciplines, to explore and monitor, observe and understand our country’s marine environment and vast ocean spaces. This capacity has been diminishing for decades despite a growing need for scientific information about our ocean environment. MEOPAR, as a Network of Centres of Excellence which funds research, trains students, mobilizes knowledge and communicates results in marine risk and resilience across Canada, is very conscious of this problem. MEOPAR does not own or operate vessels of its own. We believe this has allowed the Network to take an objective view on what has now become a crisis for Canada’s ability to research, explore and monitor our vast ocean spaces. MEOPAR developed a report on this matter, which concluded that a national, multi-sectoral dialogue was required to address this issue across the country. Such a discussion, motivated by the very difficult

situation, led to a detailed examination of the gaps and obstacles precluding researchers from accessing ship time to conduct experiments on Canada's offshore waters. It further sought to uncover new opportunities for the provision of research vessel capacity that are efficient and cost-effective. Following this, MEOPAR established a National Research Vessel Task Team (NRVTT) to collate and further analyze examine needs and opportunities across the country and provide advice on ways forward. This team quickly grew to over 30 Canadian and international researchers, industry, and government partners, and it has developed a vision for the future of Canada's vessel needs for offshore research. One of the first potential solutions to come out of NRVTT discussions is the development of Modular Ocean Research Infrastructure (MORI) as an alternative pathway for support of sophisticated, vessel-based ocean research that would potentially be more flexible, economical, scalable, and delivered faster than construction or purchase of a new fleet of specialized research vessels.

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ID: 11160   Contributed abstract

Poster Order: 220P02

Ocean Observatory Science: Preparing for the Next Decade of Success

Richard Dewey [1] , *Kim Juniper* [2] , *Steve Mihaly* [3] , *Martin Heesemann* [4] , *Martin Scherwath* [5] , *Fabio De Leo* [6] , *Joe Needoba* [7] , *Lanfranco Muzi* [8] , *Jasper Kanes* [9] , *Manman Wang* [10] , *Anna Diedericks* [11]

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Presented by / Présenté par: ***Richard Dewey***
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In February 2006 Ocean Networks Canada (ONC) turned on our first underwater Node and started streaming high resolution data from the ocean to the Internet. This was soon followed by expansions throughout the Salish Sea (VNEUS) and Northeast Pacific (NEPTUNE). By 2021, ONC has installed more than a 1000 sensors in the Pacific, Arctic, and Atlantic oceans and the data archive, accessed through the Ocean s 2.0 interface, contains more than a petabyte of interdisciplinary ocean data. While the information contained in this data has broad utility, including long-term assessments of climate change and ocean health, a primary objective has always been to advance Canadian marine science and establish Canada as a leader in ocean observing technology. In this presentation we will summarize some of the scientific highlights from the past 15 years and look forward to maintaining Canada's leadership role in sustained ocean observation and ocean intelligence.

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ID: 11243 Contributed abstract

Poster Order: 220P03

Contribution to the Global Telecommunication System (GTS) – Marine Environmental Data Section (Fisheries and Oceans Canada)

Zhimin Ma [1] , *Luc Bujold* [2] , *Di Wan* [3] , *Anh Tran* [4] , *Jenny Chiu* [5] , *Krista Sun* [6]

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Presented by / Présenté par: ***Zhimin Ma***
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The Global Telecommunication System (GTS) is a global network to efficiently and effectively transmit, exchange, and distribute surface-based and satellite-based, meteorological and oceanographic information within the framework of the World Weather Watch Programme. Marine Environmental Data Service

Section (MEDS) in Fisheries and Oceans Canada (DFO) as the National Oceanographic data Center (NODC) for Canada, has been disseminating and acquiring oceanographic information to and from the GTS for more than 25 years. MEDS disseminates oceanographic data collected by autonomous instruments, and research cruises to the GTS. Furthermore, MEDS acquires the global data from the GTS, and decodes the data into metadata, observational records, performs a suite of quality control tests including various range tests, geographic location test, and spike test. The quality controlled data are finally archived into an Oracle database and an Indexed Sequential Access Method (ISAM) database. MEDS makes the quality controlled GTS data available to Canadians, other Canadian agencies and departments, and other global data centers such as US National Centers for Environmental Information, and Copernicus, the European Union's Earth Observation Programme (Europe's eyes on Earth). In the near future, MEDS plans to expand its ability including visual QC and generation of netCDF products that can serve scientific and non-scientific communities and contribute to modelling forecast and emergency responses.

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ID: 11244 Contributed abstract

Poster Order: 220P04

Programs in Marine Environmental Data Section (Fisheries and Oceans Canada)

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Presented by / Présenté par: ***Jenny Chiu***

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The DFO Ocean Science - Marine Environmental Data Section (MEDS) provides long-term data stewardship for Canadian oceanographic data acquired

through collaboration with national and international programs, and other government agencies and departments, conducted in ocean areas adjacent to Canada, and to disseminate data, data products, and services to the marine community. MEDS is a recognized IODE National Ocean Data Center (NODC). MEDS develops and maintains data applications to acquire the data from various data sources and data formats, performs quality control, integration into the data archive, and provides access to the data and data products. MEDS also provides national coordination especially for data submission to international data centers. Ongoing national programs include the Canadian Wave Data acquired from the ECCC MSC wave buoy data from the GOES/Iridium network, the national Tides and Water Levels Data Archive water level from observations obtained from the CHS water level network and as the Data Assembly Centre (DAC) for programs such as Argo Canada and gliders. MEDS will be looking at modernizing its applications and computing infrastructure in the near future to move towards DFO IT supported technologies and moving off its legacy/aging systems. The modernization will improve ability to adapt to emerging technologies, and data standards. The tides and water levels data archive will soon be migrated to the cloud-based CHS Integrated Water Level System (IWLS) as part of the DFO Water Level System Renewal project to consolidate all the water level related data and metadata into a single source.

Session: 1015 POSTER SESSION - PART 15 - The Changing Arctic: Atmosphere and Land Surface AFFICHES - PARTIE 15 - L’évolution de l’Arctique: Atmosphere and Land Surface

ID: 10867   Contributed abstract

Poster Order: 330P02

Modelling Study of the Summertime Arctic Liquid Clouds

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Presented by / Présenté par: ***Roya Ghahreman***
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Investigation of the Arctic cloud microphysics is carried out by using a fully

coupled version of GEM-MACH, the Environment and Climate Change Canada's (ECCC) online air quality forecast model. Model simulations are compared with the in-situ aircraft observations conducted during the July 2014 NETCARE field campaign results based from Resolute, NU, Canada. The field campaign consisted of two periods with distinct conditions: relatively pristine and relatively polluted Arctic atmosphere. The model simulations show overall higher cloud droplet number concentration (CDNC) and smaller droplet size for the more polluted period than the relatively pristine period. Further sensitivity analysis indicates that the higher aerosol loading during the polluted period is responsible for the increase in CDNC and decreased droplet size. The higher aerosol loading also resulted in a moderate increase in cloud liquid water content (LWC), a decrease in precipitation, and an overall more cloud presence in the area. Overall, the model and observation results both indicate the activation of aerosol in the size range of 50-100 nm during the polluted and pristine periods, and aerosol even smaller than 50 nm during the pristine period. The inclusion of dimethyl sulfide (DMS) in GEM-MACH also leads to an increase in CDNC and smaller droplet sizes, which led to increased LWC and decreased precipitation. It also improves the model simulated aerosol size distribution in the Arctic marine boundary layer compared to the in-situ observations particularly in the size range between 60 and 200 nm.

Session: 1015 POSTER SESSION - PART 15 - The Changing Arctic: Atmosphere and Land Surface AFFICHES - PARTIE 15 - L'évolution de l'Arctique: Atmosphere and Land Surface

ID: 11052 Contributed abstract

Poster Order: 330P03

Development and validation of a blended pan-Arctic soil temperature dataset

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Presented by / Présenté par: ***Tyler Herrington***
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Arctic soils are estimated to contain roughly twice the amount of carbon currently residing in the atmosphere. With continued warming, thawing and decomposition of permafrost soil carbon could result in a positive feedback on warming. Recent research has shown that the ERA5 reanalysis product may overestimate soil temperatures over permafrost regions, however a

comprehensive evaluation of soil temperature estimates from reanalysis products over the permafrost zone has not yet been performed. Here we quantify the overall uncertainty in Arctic soil temperature estimates from the newest generation of reanalysis products (ERA5, ERA-Interim, JRA-55, MERRA2, and CFSR) along with GLDAS, a land data assimilation system (LDAS). Following the successful use of blended ensembles to improve reanalysis estimates of snow water equivalent (SWE), and satellite derived estimates of soil moisture, we also develop a new blended Arctic soil temperature product, with the aim to improve gridded soil temperature estimates at high-latitudes. We employ Triple Collocation to estimate uncertainties in reanalysis and LDAS-based Arctic soil temperatures, and inform our blended ensemble, as this procedure has been shown in soil moisture, and precipitation applications to improve product performance relative to a simple equally-weighted (naïve) blended product. The performance of the blended Arctic soil temperature product is then validated against in-situ soil temperature estimates across Alaska, the Canadian Arctic, and Eurasia.

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ID: 11101 Contributed abstract

Poster Order: 340P01

Remote Sensing analysis of Kluane Lake dust plumes: lidar-derived analysis of links between coarse mode (CM) AODs and surface, CM particle-volume concentration

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Presented by / Présenté par: ***Seyedali Sayedain***
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The Kluane Lake region in the Canadian Yukon territory is subject to regular drainage-flow dust plumes emanating from the Slims River basin. We have recently employed ground-based, passive and active remote sensing (RS) techniques to analyze the complementarity and redundancy of such RS retrievals relative to springtime Kluane Lake measurements made using a suite of microphysical and meteorological instruments. The results build on previous

correlation analyses carried out between ground-based CM (coarse mode) AOD retrievals from CIMEL (AERONET/AEOCAN) sunphotometry / sky radiometry measurements and their surface microphysical analogues of CM particle-volume concentration (vc). In this continuation of that work a correlative analysis is carried out between CM AODs derived from m wavelength Doppler (HSRL) lidar profiles and CM CIMEL-derivedμthe 1.5 AODs. This analysis yields valuable information on the CM contribution of clouds to the latter CM AODs and thus the interpretation of the more complex correlations between CM AODs and vc values.

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ID: 10794   Contributed abstract

Poster Order: 340P03

Ice nucleation characteristics of size-segregated aerosol samples and precipitation samples in the Arctic summer

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Presented by / Présenté par: ***Colleen Henschel***
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The Arctic is extremely sensitive to climate change, warming at a rate that is 2 to 3 times faster than the global average. The effects of aerosols on climate are still highly uncertain, especially with regards to their effects on cloud formation. Aerosols that act as ice nucleating particles (INP), which allow for the formation of ice crystals in clouds at temperatures warmer than that required for homogeneous freezing, are of particular importance as they are required for the formation of mixed-phase clouds. Since current models struggle to reproduce the ice and water content in observed cloud formations, in depth studies of aerosols acting as INP are required to better understand their distribution and mechanisms for formation. In order to better understand the role of Arctic aerosols in the climate system, size segregated aerosol samples and co-collected precipitation samples were analyzed to measure ion concentrations, INP concentrations, and sulfur isotope characteristics. These samples were collected aboard the Canadian Coast Guard ship Amundsen during July and August of 2016 as part of the Network for Environmental Tropospheric

Characteristics of Aerosols in Remote Environments (NETCARE) campaign. We observed variations in INP concentrations for different aerosol sizes and spatial distributions with freezing temperatures ranging from -3.5 to -21.5 degrees Celsius and smaller variations in precipitation sample concentrations with freezing temperatures ranging from -9 to -24 degrees Celsius. These findings may provide a deeper understanding of the origins and spatial distributions of INP.

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ID: 11072 Contributed abstract

Poster Order: 340P05

The relative roles of Arctic and Antarctic sea-ice loss in the response to greenhouse warming

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Presented by / Présenté par: ***Stephanie Hay***
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While Antarctic sea-ice area has increased over the satellite era, state-of-the-art climate models ubiquitously project Antarctic sea-ice to decrease over the coming century, much as they do for Arctic sea-ice. We seek to address the question of how the climate will respond to sea-ice loss in both hemispheres separately and coincidentally. We have carried out fully coupled climate model simulations under different albedo parameter settings to determine the relative importance of each hemisphere's sea-ice loss. By perturbing the albedo of the snow overlying the sea ice and the albedo of the bare sea ice, we obtain a suite of simulations to assess the linearity and additivity of sea-ice loss. Globally, we find the response to sea-ice loss in each hemisphere exhibits a high degree of linearity and additivity. Specifically, we find that the tropical response is driven to a greater extent by Antarctic sea-ice loss rather than Arctic sea-ice loss, and that Antarctic sea-ice loss drives a small but statistically significant amount of Arctic warming. We do not find that Arctic sea-ice loss drives an equivalent response in the Antarctic. We derive an extension to classical pattern scaling utilizing three controlling parameters. Using our suite of simulations, we simultaneously compute the sensitivity patterns to Arctic sea-ice loss, to Antarctic sea-ice loss, and to tropical warming. With this, we determine that the

statistically significant response to Antarctic sea-ice loss in the Northern Hemisphere is mediated by tropical warming, and that Eurasian cooling scales approximately equally with both Arctic and Antarctic sea-ice loss.

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ID: 11150 Contributed abstract

Poster Order: 410P04

Sensibility of Optically Thin Ice Clouds Types on Available Potential Energy Budget Variation During the Arctic Polar

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Presented by / Présenté par: ***Housseyni Sankare***
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Observations reveal the prevalence of two types of optically thin ice cloud (TICs) in the Arctic, especially during the cold season. The first type, TIC-1 consisting of small and none-precipitating ice crystals, is undetected to the CloudSat radar. The second type, TIC-2, detected by CloudSat and the lidar of CALIPSO is characterized by a low concentration of large precipitating ice crystals. Energy budget diagnostics are effective ways to investigate the effects of atmospheric processes. In this study, a reanalysis-driven simulation based on the GEM4 model, the Canadian Regional Climate Model (CRCM6), is used with the Predicted Particle Properties (P3) scheme of Milbrandt and Morrison (2016), to produce an ensemble of 3 km resolution simulations. Five simulations are performed with clear sky, overcast louds, TIC1, TIC2 and no change conditions as a reference case. Then, the energy cycle diagnostic from Nikiéma and Laprise (2013) is applied to analyze the energy budget of the atmospheric circulation for each cloud types and sky conditions. A comparative analysis is carried out to investigate the effects of the thin ice clouds forcing on the energy balance according to their type. Overall, this study contributes to evaluating the relative importance of polar clouds on the atmospheric circulation and storm generation.

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ID: 11077 Contributed abstract

Poster Order: 640P01

SPACE-BASED EARTH OBSERVATION DATA ANALYSIS PROJECTS SUPPORTED BY THE CANADIAN SPACE AGENCY

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Scientific analysis of Space Based Earth Observation data is a critical element of the mid- and downstream segments of the Earth Observation value chain. New observations lead to new knowledge of physical, chemical and biological processes of the Earth system. When used to improve Canadian Earth System models, environmental prediction and climate projection services to Canadians are made better, more accurate and robust. For well over a decade, the Canadian Space Agency (CSA) has funded scientific research grants to Canadian universities for analysis of data flowing from Space-Based Earth Observation systems in which the CSA invested. These grants involve significant collaborations with government researchers. This presentation will focus on research projects awarded in 2017 and in 2021 that use satellite datasets to improve understanding of the Earth system. The talk will highlight academic-government collaborations, the Earth system models they advance, scientific publications that result, HQP trained, and international collaborations enabled.

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ID: 10866 Contributed abstract

Poster Order: 640P02

Trans-pacific CO Transport as Observed by MOPITT

Zahra Vaziri Zanjani [1] , *Florian Nichitiu* [2] , *Jiansheng Zou* [3] , *James Drummond* [4]

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Presented by / Présenté par: ***Zahra Vaziri***
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The Measurements Of Pollution in The Troposphere (MOPITT) instrument onboard the Terra satellite has been providing measurements of CO over the past 21 years (2000 to present). Intercontinental trans-pacific transport of pollution from eastern Asia to North America has been observed by CO from MOPITT. The transport happens mainly in the spring (March and April) of each year which causes an enhancement of CO levels in western North America in late spring. A typical CO transport event over the North Pacific takes on average 6 to 8 days. In this study, by using monthly latitudinal averages of CO, it is observed that the trans-pacific transport band is interrupted at the location of the Rocky Mountains at an approximate longitude of 250° (110°W). In the lower troposphere (at 900 hPa) the spring CO transport band indicates an accumulation of CO in front of the Rocky Mountains and at higher altitudes (600 hPa and above) is uninterrupted. The instrument and this study have been funded by the Canadian Space Agency.

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ID: 10871 Contributed abstract

Poster Order: 640P03

An Update on Long-term CO Trends as Observed by MOPITT

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Presented by / Présenté par: ***Zahra Vaziri***
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Atmospheric carbon monoxide (CO) is measured by satellite instruments as a means of detecting pollution and fires all over the globe. The Measurement Of Pollution in The Troposphere (MOPITT) instrument onboard the Terra satellite has been providing measurements of CO over the past 21 years (2000 to present). This data is invaluable in the sense that it is measured by the same instrument providing a homogenous record over a long period of time giving insight into long-term trends of this atmospheric specie. This study presents long-term CO total column averages over some cities such as New York, Beijing, Delhi and Moscow updated for the current lifetime of the MOPITT mission. MOPITT level 3, version 8, thermal infrared derived CO total column amounts were used to conduct this study. The results show a generally decreasing trend following previous studies. A comparison of CO measurements taken at the Mauna Loa observatory with MOPITT CO data validates this decreasing trend. The instrument and this study have been funded by the Canadian Space Agency.

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ID: 10965 Contributed abstract

Poster Order: 640P04

High-resolution NWP model simulations in support of EarthCARE satellite algorithm development studies involving cloud, aerosol and radiation.

Zhipeng Qu [1] , *Dave Donovan* [2] , *Howard W. Barker* [3] , *Jason N. S. Cole* [4] , *Jason A. Milbrandt* [5] , *Sylvie Leroyer* [6] , *Stéphane Bélair* [7] , *Manon Faucher* [8]

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Presented by / Présenté par: ***Zhipeng Qu***
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The EarthCARE satellite mission, with an expected launch date of 2023, aims to deliver unprecedented synergistic datasets that will allow scientists to study global relationships between clouds, aerosols and radiation. The mission will have active and passive sensors that will provide data for retrieval of vertical profiles of cloud and aerosol properties. Retrievals will be verified via radiative closure assessment using passive radiances not used for retrievals. The use of advanced 3D Monte Carlo radiative transfer (RT) models in the EarthCARE mission enhances the level of accuracy for the closure assessment. As 3D RT can be very sensitive to distributions and geometric structure of clouds, it is crucial to have realistic atmospheric test data for development and verification of retrieval algorithms. Further, it is necessary to have high-resolution atmospheric data to simulate sub-pixel variability for the radar and lidar instrument onboard the EarthCARE satellite. Thus, three high-resolution test frames were produced by Environment and Climate Change Canada’s Global Environmental Multiscale (GEM) model. Each frame is 6200 km long and 200 km wide with horizontal grid-spacing of 250 m. The test frames span large ranges of meteorological and surface conditions, and are therefore ideal for testing satellite algorithms. Moreover, due to the high resolution of the test frames they can also be useful for other satellite instrument developments, as well as studies on UTLS water vapor distribution and data assimilation of satellite observations. Data for all three test frames are publicly available.

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ID: 11046 Contributed abstract

Poster Order: 640P05

Continuous radiative closure assessment of EarthCARE retrievals

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Presented by / Présenté par: ***Jason Cole***
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The EarthCARE satellite mission, whose expected launch date is in 2023, aims to deliver unprecedented synergistic datasets that will allow scientists to study global relationships between clouds, aerosols, and radiation. Top-of-atmosphere (TOA) broadband radiances will be measured by EarthCARE's BroadBand Radiometer (BBR). The BBR has three along-track views (nadir plus 53 degrees fore and aft), an across-track swath of 30 km, and pixel resolution of ~0.6 km. These radiances are subsequently converted into BB upwelling solar and infrared fluxes at TOA. Both 1D and 3D forward radiative transfer models will operate on clouds and aerosols derived from passive and active measurements made concurrently by EarthCARE's multi-spectral radiometer, backscattering lidar, and cloud-profiling radar, but not tfrom its BBR. These simulated TOA radiances and fluxes will then be compared to their BBR counterparts, thereby defining a continuous radiative closure assessment of the quality of retrieved cloud and aerosols products. This paper will describe EarthCARE's radiative products, the radiative closure assessment methodology, and its application to three NWP model-generated scenes that have been used by EarthCARE's international retrieval algorithm development science team.

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ID: 10772 Contributed abstract

Poster Order: 640P06

Ocean surface winds from dual-polarization RADARSAT Constellation Mission images

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Presented by / Présenté par: ***Alexander Komarov***
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Ocean surface wind speed retrieval from synthetic aperture radar (SAR) data is important for various meteorological applications including wind data assimilation in Environment and Climate Change Canada (ECCC) numerical weather prediction systems. Furthermore, SAR wind speed is a critical

component in our techniques for automated extraction of ice information from SAR for subsequent data assimilation in ice prediction systems. With the transition from RADARSAT-2 to the RADARSAT Constellation mission (RCM), the wind retrieval approaches operating with RADARSAT-2 dual-polarization (HH-HV and VV-VH) images need to be adapted, as the noise floor characteristics of RCM beam modes are different compared to RADARSAT-2. Here, we present new empirical wind retrieval approaches independent of wind direction and operating with three types of RCM data: ScanSAR 50 m (SC50M) VV-VH, SC50M HH-HV, and ScanSAR Low Noise (SCLN) images. The retrieval models were built based on hundreds of RCM images acquired over the Canadian East and West coasts collocated and coincided with ECCC ocean buoy observations over a 12 months period. Our results demonstrate that the proposed models perform consistently better (e.g., RMSE = 1.49 m/s for SC50M HH-HV independent subset) compared to the conventionally used CMOD-type models that require input wind direction (RMSE = 2.06 m/s for the same subset), which is particularly the case at high wind speeds. The developed wind retrieval models are being integrated in ECCC ice and wind data assimilation systems.

Session: 1021 POSTER SESSION - PART 21 - Space-Based Earth Observation: Providing Critical Information on our Planet AFFICHES - PARTIE 21 - Observation de la Terre depuis l'espace : informations essentielles sur notre planète

ID: 10886 Contributed abstract

Poster Order: 640P07

Matrix Decomposition of Tundra Vegetation

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Radiative heat transfer is one of the primary drivers of climate change. Surface albedo is a key quantity which directly impacts the global heat balance. Furthermore, vegetation composition has a large impact on surface albedo, which provides clear motivation for precisely quantifying the surface vegetation characteristics. Satellites such as MODIS and Sentinel-3 provide vast amounts of remote sensing data such as NDVI (normalized difference vegetation index) and biomass, however a significant challenge is in the interpretation and assimilation of these datasets. Three central challenges are the large volume of

data to assimilate, the existence of multiple timescales, as well as the complexity of the physical process of radiation transfer. In this work, we introduce the vegetation matrix, which provides an analytic description of the composition of a given biome. We present this method applied to the Arctic tundra, and we note the extensibility of this method, as it can be generalized to other regions. The primary benefit of this approach is that it extracts robust correlations from a noisy dataset. By transforming from the spatial domain to the space defined by the vegetation matrix, we filter out transient effects. Additionally, we present a treatment of the disparate timescales of seasonal variability, intra-annual variability as well as changes to the vegetation composition. Our approach provides a parametrization of tundra dynamics that resolves each of these timescales independently. In this work, we provide a retrospective analysis of changes to the Arctic vegetation from 2000-2020, projections for future trends in the Arctic tundra, as well as an analysis of the dependence of surface albedo on tundra vegetation. Furthermore, we use these results to refine existing estimates on the strength of the SAF (Snow Albedo Feedback), a nonlinear feedback process which has a critical impact on climate change.

Session: 1022 POSTER SESSION - PART 22 - Weather, Severe Storms AFFICHES - PARTIE 22 - Weather, Severe Storms

ID: 10972 Contributed abstract

Poster Order: 240P01

A major upgrade to HAILCAST: Insights and lessons learned

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It has been over 20 years since the last significant changes were made to the HAILCAST model in Canada. Recently, we completed major upgrades to the model. This involved running the model for millions of combinations of microphysics schemes. Various new modelling frameworks were also tested. Runs were made using 105 atmospheric profiles from NWP models, modified using observations to represent low-level air feeding the storms' updrafts. Model output was evaluated against a high-confidence dataset of hail observations retrieved from the Canadian prairies and the eastern and mid-western CONUS. The atmospheric profiles were associated with environments that supported thunderstorms with no surface hail reports through hailstorms that produced hail near 10 cm in diameter. The best-performing combinations of microphysics schemes were objectively identified using a cost function applied across several hail-size classes. In this way, we were able to significantly improve the performance of HAILCAST and eradicate biases for certain size classes. Undertaking this research raised several questions: What are the realistic limits of accuracy for hail forecasts? Which processes are important to model correctly when forecasting hail? Do these results offer us any valuable insight into the growth and melting of natural hail? Where do we go from here?

Session: 1022 POSTER SESSION - PART 22 - Weather, Severe Storms AFFICHES - PARTIE 22 - Weather, Severe Storms

ID: 11094 Contributed abstract

Poster Order: 240P02

The New Alert Ready Severe Thunderstorm Alert

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Alert Ready is Canada's emergency priority alerting system that delivers critical and potential life-saving alerts to Canadians through television, radio and LTE-connected and compatible wireless devices. These alerts are Broadcast Intrusive, meaning that when an alert is sent, the receiving device will immediately display the alert message, interrupting current programing. Incorporating social science outcomes with technology, the Meteorological Service of Canada is developing a Broadcast Intrusive Severe Thunderstorm Alert in order to influence public behavior when life-threatening thunderstorms, hail diameter ≥ 7 cm and, or wind ≥ 130 kilometers per hour, are occurring or expected to occur. Once implemented, the Severe Thunderstorm Alert will join the suite of other natural disaster alerts that are already available in the Alert Ready system that include tornados, hurricanes, flash floods and earthquakes.

Session: 1022 POSTER SESSION - PART 22 - Weather, Severe Storms AFFICHES - PARTIE 22 - Weather, Severe Storms

ID: 10700 Contributed abstract

Poster Order: 250P01

Modeling Ground Clutter RhoHV as a Random Walk Process

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The identification and suppression of ground clutter, the echoes from ground targets, is an important function of radar data processing in meteorology. Common techniques for its detection are echo climatology and masking and Doppler signal processing. These techniques have varying degrees of success and run the risk of eliminating some echoes from real meteorological targets. Since radar backscattering from ground targets possessing irregular shapes are postulated to be random in nature, it must considered to be a problem in geometric optics when the size of these targets are well above both the Rayleigh and Mie size regimes. The challenge is to identify a property of the echoes that signals random scattering. One parameter, the copolar correlation coefficient RhoHV between horizontal (H) and vertical (V) polarization radar signals is a measure of the variety of hydrometeor shapes in a pulse volume (Keat et al. 2016). Low values of RhoHV are observed in the presence of ground clutter. What specific range of RhoHV suggests this random scattering process? Does the range vary? If so, when? We use Rayleigh's (1905) solution of the isotropic random walk problem to define probability density functions for various radar pulse numbers. We then predict an upper limit of RhoHV that corresponds to a desirable probability threshold below which random targets should be found. Possible applications are discussed.

Session: 1022 POSTER SESSION - PART 22 - Weather, Severe Storms AFFICHES - PARTIE 22 - Weather, Severe Storms

ID: 10954 Contributed abstract

Poster Order: 250P02

Monitoring Doppler radial winds from the new Canadian S-band radars

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While Doppler Radial Winds (DRWs) are routinely assimilated in many operational weather prediction centres worldwide, the estimation of error statistics for these measurements remains an active research topic. In view of the assimilation of Canadian DWRs, this study describes the implementation of a monitoring system for these measurements. A key component of this monitoring system is the routine computation of background residuals, the difference between observed DRWs and their simulated equivalent from short-term NWP forecasts. This study details how these residuals are obtained, and it outlines some of their general characteristics. A novel aspect of this work is the use of a forward operator that simulates DRWs on very slanted columns that follow the trajectory of a radar beam in a standard atmosphere. This geometry makes it easier to implement various strategies for the averaging/superobbing of observations. One such strategy that will be described involves the averaging of a decreasing number of observations with increasing range from the radars to obtain an approximately regular observation volume area that is comparable to the model grid box tile. One challenge that arise when using a forward operator working with very slanted columns is that the simulated radar beam can intersect the same terrain-following model level in more than one location. This interferes with the interpolation routines of our assimilation system which assume monotonic progression of model levels. In these locations, observations have to be rejected. Fortunately, it will be shown that such multi-crossings only occur near to the radars located in regions with significant topography and can be removed at the moment of assimilation. Finally, a preliminary assessment of the nature of background residuals for a selection of the new Canadian S-band radars will be given.

Session: 1022 POSTER SESSION - PART 22 - Weather, Severe Storms AFFICHES - PARTIE 22 - Weather, Severe Storms

ID: 10822 Contributed abstract

Poster Order: 250P03

Adapting Meteorological Training Strategies During a Pandemic

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Traditionally, meteorological training for onboarding meteorologists new to the role of an operational Aeronautical Meteorological Forecaster is a very tactile and immersive experience that endeavours to closely simulate the operational forecasting environment. The unexpected onset of the COVID-19 pandemic in March of 2020 suddenly necessitated some modifications to the training methods used at the Canadian Meteorological Aviation Centre (CMAC). Recognizing that there is a risk to the uninterrupted delivery of critical operational products and services provided by the CMAC without the ongoing meteorological training of new operational forecasters, we needed to quickly adapt our planned training strategies in response to these new circumstances. Though we continue to address the ongoing challenge of how to best support meteorological training, we have already applied various adaptive strategies including: the development and introduction of a suite of remote tools, virtual training workshops, customized simulator training with adjustments for physical distancing, transformation to operational workspaces, and implementation of cohort models. Although the transition from traditional training strategies to these new approaches has not always been without complications, our meteorological training has continued to allow for new forecasters to successfully integrate into CMAC operations. There have been many opportunities along the way to learn from both our accomplishments as well as our missteps, continually helping to cultivate resiliency within our training program. The pandemic has taught us that unexpected (and sometimes even unprecedented) challenges can occur, and while we cannot always anticipate these events, we can position ourselves to respond to unknown challenges by remaining adaptable and curious to try new approaches.

Session: 1022 POSTER SESSION - PART 22 - Weather, Severe Storms AFFICHES - PARTIE 22 - Weather, Severe Storms

ID: 11076 Contributed abstract

Poster Order: 250P04

Atmospheric data assimilation innovations in ECCC’s Global Deterministic Prediction System

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Presented by / Présenté par: ***Alain Beaulne***
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At Environment and Climate Change Canada (ECCC), the Research in Data Assimilation for Numerical Prediction (RPN-AD) and Data Assimilation and Quality Control (CMDA) sections have collaborated to atmospheric data assimilation innovations accepted for the next operational release of the Global Deterministic Prediction System (GDPS), planned for the end of 2021. The GDPS currently assimilates about 13.5 million observations each day, producing analyses (initial conditions) for numerical weather prediction (NWP). Optimizing the use of existing observations is essential in order to improve these initial conditions, which then lead to better NWP forecasts. Proposed innovations in this area include slant-path radiative transfer calculations for satellite radiances and gps radio-occultation observations, the assimilation of some cloud affected temperature sensitive satellite radiances, radiative transfer computation on model levels, new bias correction schemes for aircraft and ground-based gps observations, and reduced observation errors for drifter and buoy pressure observations. In the GDPS, the process of integrating meteorological observations to a short-term NWP forecast, in order to produce an analysis, is accomplished by the four-dimensional ensemble-variational (4D-EnVar) scheme, which makes use of ensemble members produced by the Global Ensemble Prediction System (GEPS). Proposed innovations in this area include the use of scale-dependent localization, new weights given to the static and flow-dependent components of the background-error covariance matrix and the use of version 5 of the Global Environmental Multi-scale model (GEM5) based GEPS ensembles. Results from two and a half months experiments executed during the Summer 2019 and Winter 2020 periods show short to medium range statistically significant improvements for both hemisphere and the Tropics, over the vertical domain, and for the various prognostic variables. The proposed changes are expected to reduce the 5-day 500-hPa geopotential height RMSE over the northern hemisphere by ~3% (~1,2 m), pursuing the slow but steady increase in global weather forecasts accuracy.

Session: 1022 POSTER SESSION - PART 22 - Weather, Severe Storms AFFICHES - PARTIE 22 - Weather, Severe Storms

ID: 10659 Contributed abstract

Poster Order: 660P01

A quality control system for historical in situ precipitation data

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In situ precipitation data are recorded at observing stations typically using either manual or automated gauges (some countries have ruler measurements of snowfall, which were then converted to their water equivalent using some version ratio). Unfortunately, there are random erroneous values, which could be unusually large values or false 0s. The latter usually arose from mis-recorded missing values (i.e., missing values were mis-recorded as 0 precipitation in the climate Archive). In doing quality control (QC) of Canadian in situ precipitation data records, we have found that it is necessary to apply a pair of QC procedures to identify these two types of random errors: one procedure is applied to the untransformed monthly precipitation series, which is good at finding outliers of unusually large values; another is applied to the log-transformed monthly precipitation series, log(P+0.1) (in mm), which is good at identifying outliers of zero or near-zero monthly total precipitation. The four nearest stations' data for the same month are used to determine if the suspect outlier is a real extreme value or an erroneous value. All the monthly values identified to be erroneous are set to missing, and so are the corresponding daily values.

Session: 1023 POSTER SESSION - PART 23 - Biogeochemistry AFFICHES - PARTIE 23 - La biogéochimie

ID: 10699 Contributed abstract

Poster Order: 330P04

Using consumer-grade trail cameras to observe leaf phenology in remote locations across Maritime Canada

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Leaf phenology, the timing of leaf life cycle events, is a vital indicator of terrestrial biosphere function. The influence of global change upon leafing phenology in mid to high latitude regions is uncertain due to a complex interaction of drivers and lack of temporally and spatially resolved baseline data. Leaf phenology has been observed manually for millennia, and through satellite platforms for decades. A novel technique of monitoring leaf phenology known as near remote sensing employing time-lapse photography at the canopy level (or phenocams) allows for objective observations with high temporal and spatial resolution, and can be performed with camera systems ranging in cost from ~$200 to $2000 USD. We deployed 13 solar-powered consumer-grade trail camera stations across a climate gradient in Nova Scotia, Canada to observe leaf phenology of locally abundant species over the 2019 and 2020 growing seasons. To examine the influence of thermal, photoperiodic, and genetic drivers, our remote phenology monitoring stations were situated in comparative edaphic and topographic contexts and complemented with relative humidity and ambient temperature sensors. We observed variability in the timing of leaf budburst, peak of season greenness, redness, senescence, and abscission between and within species, despite similar degrees of environmental forcing. Moving forward, we will apply our insights to develop species specific process based models of leaf phenology, and test the wider application of our techniques to observational records from other regions. This work demonstrates the complexity of environmental influence upon leaf phenology, as well as the utility of consumer-grade phenocams in monitoring leafing phenology in remote regions of Maritime Canada.

Session: 1023 POSTER SESSION - PART 23 - Biogeochemistry AFFICHES - PARTIE 23 - La biogéochimie

ID: 11149 Contributed abstract

Poster Order: 410P01

Wind-driven vertical displacements drive subsurface oxygen variability on isopycnals in the subarctic Northeast Pacific

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Six decades of observations from Ocean Station Papa ("OSP", 50°N, 145°W) have pinpointed the subarctic Northeast Pacific as a region experiencing ocean deoxygenation at a rate exceeding the global mean. Identifying the drivers behind this rapid deoxygenation is of critical importance for predicting future conditions. However, with typically three observations per year in recent decades, trends may be biased if the observations occur during times when oxygen concentration is not representative of the mean state due to natural variability. The growing implementation of optical dissolved oxygen sensors ("optodes") on autonomous platforms—such as Argo profiling floats and gliders—and the development of methods to ensure data quality provide additional data and context to evaluate local patterns of oxygen variability and the role they may play in setting the long-term trend. In this study, we use 8 Argo floats equipped with optodes in conjunction with OSP observations to evaluate local patterns of oxygen variability. First, we developed a methodology to correct a time lag in the raw oxygen profiles caused by slow optode response using estimates of float velocity from the onboard CTD. Second, we updated some floats' gain values, correcting for optode drift over time, by comparison to spatially and temporally collocated OSP profiles. Finally, we compiled depth profiles of water properties measured by floats within a 150 km radius of OSP and generated time-series of properties from 2009-2016 on the $\sigma\Theta$ = 26.5 kg m-3 isopycnal, which is in the permanent pycnocline where the greatest on-isopycnal deoxygenation trends have been reported. These compiled data suggest that local wind patterns may drive a shift in water mass present at OSP, however this does not appear to account for the entire observed variability in oxygen. Changing wind-driven circulation may contribute additional oxygen variability on this isopycnal by vertically displacing the layer to shallower depths where organic matter respiration is enhanced or by a change in horizontal advection that increase the age of the water.

Session: 1023 POSTER SESSION - PART 23 - Biogeochemistry AFFICHES - PARTIE 23 - La biogéochimie

ID: 11123 Contributed abstract

Poster Order: 410P02

Interactions of bacteria with heavy metals in Arctic snow and frost flowers

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Arctic has an impact in global energy and moisture budgets which has been modified in recent years by the increased long-range transports of pollutants and anthropogenic industrial activities. One of the categories of the pollutants in Arctic is heavy metals. Our goal was to explore the potential interactions between metal and metal-interacting bacteria with freezing processes in five different Arctic snow and frost flowers using techniques such as triple quad ICP-MS/MS, HR-TEM/EDS, and next generation sequencing (NGS). Our results have indicated that each Arctic snowpack types and frost flowers showed: i) varied distinct heavy metal content. 27 metals: (transition metals, metalloids, alkali metal/earth metal, actinides, & lanthanides) were detected with the highest concentrated elements as Iron, Mercury, and Strontium; 8 rare elements (0.002 – 1.8 µg/L). The highest and least variations were observed in fresh snow and frost flower respectively; yet both had high concentration of 238U. ii) a diverse community of bacteria capable of interacting with heavy metals (resistance/tolerance): blowing snow (1239), surface hoar snow (2243), windpack (2431), frost flowers (1440), and Montreal urban snow (5498) with specific bacterial genera such as: Azospirillum (surface hoar snow), Paenibacillus (blowing snow), and Cycloclasticus, (frost flower); bacteria with confirmed or associated ice nucleation activity: Pseudomonas genera, Flavobacterium, Corynebacterium, and Pseudoxanthomonas. iv) distinct ice nucleation temperature that was partly associated with its microbial population; type and concentrations of its nano size metals. Interestingly the highest ice nucleation activity was recorded for Arctic fresh snow (-9.5 ± 1°C). This study provides a base line on the detection of pollutants and metals in Arcitc and their possible impact on climate change via Arctic for future studies.

Session: 1023 POSTER SESSION - PART 23 - Biogeochemistry
AFFICHES - PARTIE 23 - La biogéochimie

ID: 11109 Contributed abstract

Poster Order: 850P02

Bubble Dynamics in the Labrador Sea: Assessing Accuracy of Gas Exchange Models Through Comparison with Autonomous N₂

Measurements

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Air-sea gas exchange plays an essential role in understanding the ocean's ability to sequester CO₂ from the atmosphere and the processes by which biologically important gases such as O₂ are supplied to the ocean. Here, we use N₂ as a tracer for the physical processes affecting the flux of gases across the air-sea interface: molecular diffusion and entrainment of bubbles into the water by breaking waves. In areas of deep convection, such as the Labrador Sea, accurately quantifying bubbles processes is important to advancing climate models, since in these locations air-sea gas exchange directly controls the ocean's ability to distribute gases to the deep ocean. We investigated bubble mediated gas fluxes using in situ measurements from the K1 mooring in the Labrador Sea during the fall of 2016, utilizing a gas tension device (GTD) measuring the total pressure of dissolved gases. Combining the GTD measurements with data from a separate dissolved oxygen sensor allowed us to determine N₂ concentrations in the upper water column. We compare these observations to a surface layer box model incorporating gas exchange using parametrizations that either exclude or explicitly include bubble processes. We further assess the sensitivity of our model to different estimates of wind speed, to the calibration of the O₂ sensor, and to mixed layer depth. Our results highlight the necessity to include bubble processes when calculating gas exchange to mitigate underestimations, but show that correction factors should be used to mitigate overestimations when incorporating these bubble processes.

Session: 1023 POSTER SESSION - PART 23 - Biogeochemistry AFFICHES - PARTIE 23 - La biogéochimie

ID: 11003 Contributed abstract

Poster Order: 880P02

Evaluating GEOS-Chem for air quality applications in Quebec, Canada

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Presented by / Présenté par: ***Nicole Trieu***
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Over the past decade, the number of days with poor air quality has decreased in Quebec. While the province's air quality is generally good, some municipalities are subject to atmospheric pollution levels that occasionally exceed Canadian standards. Poor air quality is more significant near urban centers and emission sources such as transportation infrastructure and certain industries. Air pollutants from such sources can cause adverse effects on the environment and human health. In this work, a global chemical transport model (GEOS-Chem) is evaluated to understand its accuracy in predicting air pollutants in Quebec using measurements from the province's Réseau de surveillance de la qualité de l'air du Québec (RSQAQ). Simulations are conducted using both 2° lat. x 2.5° lon. and 0.5° lat. x 0.625° lon. resolutions from 2012 to 2016. Comparison between simulation results and measurements shows that GEOS-Chem is overestimating surface ozone (O3), fine particles (PM2.5) and sulphur dioxide (SO2) and underestimating nitrogen oxides (NOx ≡ NO + NO2) and carbon monoxide (CO) in Quebec. However, comparisons of time series of pollution concentrations still demonstrate reasonable model accuracy when comparing to RSQAQ measurements. These results suggest that the GEOS-Chem model can be used to better understand of Quebec's air quality and give insights that can be used for environmental policymaking.

Session: 1023 POSTER SESSION - PART 23 - Biogeochemistry
AFFICHES - PARTIE 23 - La biogéochimie

ID: 11256 Contributed abstract

Poster Order: 920P02

Development of Canadian Hydrometeorological Standards for description, siting and operation, data qualification and transmission

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Recent efforts by Environment and Climate Change Canada to expand collaboration between local, provincial, federal, and private hydrometeorological networks have highlighted inconsistencies in data collection, production, dissemination, and a lack of documentation on operating procedures. There is no common National Standard for hydrometeorological data collection in Canada, with which an agency can compare its operations and therefore recognize gaps and deficiencies. A framework is therefore needed that describes industry best practices, promotes improvement in quality management procedures and transparent reporting of metadata, data, policies, and practices to the public and other data users. As shared data becomes more and more available in the public realm, its important to be able to share metadata, data, and other information about network operations in a transparent and coordinated fashion. Funded by the Standards Council of Canada with in-kind support from Environment and Climate Change Canada, a series of four National Standards are now being developed by CSA Group, with the assistance of technical experts employed by public agencies (federal, provincial, local), the private sector and NGOs. These standards target network operators but will also provide useful context for data users. This poster is intended to outline the current status of this initiative.

Session: 1024 POSTER SESSION - PART 24 - The Changing Arctic Ocean AFFICHES - PARTIE 24 - L’évolution de l’océan Arctique

ID: 10964 Contributed abstract

Poster Order: 320P01

Ice, winds, and tides: uncovering ocean processes in the Canadian Arctic Archipelago

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We investigate the physical processes that modify and mix the water masses passing through Barrow Strait within the Canadian Arctic Archipelago. We present oceanic, sea ice, and atmospheric properties from Barrow Strait spanning 20 years from 1998 to 2018. Ocean currents, water temperature and salinity at fixed depths, and sea ice thickness and velocity were measured intermittently at five mooring locations across the strait. A nearby meteorological station also provided air temperature, wind speed, and direction. In this region, understanding water mass modification and mixing processes is crucial as the export of these water masses into the North Atlantic, in particular low-salinity waters, play an important role in the global thermohaline circulation. Past studies have shown that water mass properties also impact local nutrient fluxes, primary production, and sea ice conditions, which are important to northern communities. Notably, Barrow Strait is included in the new designation of the Tallurutiup Imanga National Marine Conservation Area. Our focus is on processes that lead to water mass modification, including mixing through internal waves generated by tides interacting with the variable seafloor topography or by wind, and on surface processes such as formation of cold, salty or low-salinity waters as sea ice grows or melts. Here we highlight the temporal and vertical structure of the internal tide in Barrow Strait and its influence on mixing, as well as wind driven internal waves and their generation and modification by seasonal sea ice cover.

Session: 1024 POSTER SESSION - PART 24 - The Changing Arctic Ocean AFFICHES - PARTIE 24 - L'évolution de l'océan Arctique

ID: 11079 Contributed abstract

Poster Order: 320P03

Estimating turbulence in the Arctic Ocean at the Canada Basin shelf-break

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Presented by / Présenté par: ***Ruby Yee***
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151 full-depth profiles of temperature microstructure were obtained over the shelf, break, and slope of the Canada Basin during a November 2018 research cruise using a MicroRider-1000 (Rockland Scientific) mounted on a conductivity-temperature-depth (CTD) rosette. From these profiles we estimate two main turbulent parameters: the dissipation rate of temperature variance and turbulent kinetic energy, from which turbulent diffusivities can be derived. Estimates are made by fitting theoretical Kraichnan spectra to observed temperature gradient spectra over the inertial-convective subrange where data is well-resolved, and by assuming the turbulent diffusivities of temperature and density (κ_T and κ_ρ) are equal. We outline a set of criteria for rejecting profiles based on 1) resemblance to the Kraichnan spectral form and 2) wake contamination in regions of decreased CTD rosette fall speed. We will discuss some fundamental assumptions associated with the use of temperature microstructure for turbulence estimation in the Arctic Ocean, including whether $\kappa_T = \kappa_\rho$ in the presence of double diffusion. Finally, we present general observations on the patterns of turbulent mixing in 15 sections crossing the shelf-break between Barrow and Mackenzie Canyons.

Session: 1024 POSTER SESSION - PART 24 - The Changing Arctic Ocean AFFICHES - PARTIE 24 - L'évolution de l'océan Arctique

ID: 10975 Contributed abstract

Poster Order: 320P04

Heat and Fresh Water Storage and Transports in the Arctic Ocean's Beaufort Gyre

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Presented by / Présenté par: ***Mary-Louise Timmermans***
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The Beaufort Gyre (BG) is one of the Arctic Ocean's main dynamical sea ice and ocean circulation systems, its major freshwater reservoir, and a prominent region of upper-ocean heat storage. We present and interpret observations of

freshwater and heat content from the Beaufort Gyre Observing System (BGOS), and examine mechanisms and consequences of freshwater and heat accumulation and release. Over the seventeen-year lifetime of the BGOS, observations indicate freshwater content has increased almost 40%, and there has been a doubling in upper-ocean heat content. We show how the freshwater and heat variability on a range of timescales is attributed to dynamic and thermodynamic forcing and trends. BG changes are explored in context with broader changes in Arctic sea-ice and climate.

Session: 1024 POSTER SESSION - PART 24 - The Changing Arctic Ocean AFFICHES - PARTIE 24 - L'évolution de l'océan Arctique

ID: 11136 Contributed abstract

Poster Order: 320P05

Spatial variability of Arctic Ocean diffusivity from a pan-Arctic observational record

Hayley Dosser [1] , *Melanie Chanona* [2] , *Stephanie Waterman* [3] , *Nicole Shibley* [4] , *Mary-Louise Timmermans* [5]

[1] University of British Columbia
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Presented by / Présenté par: ***Hayley Dosser***
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Diapycnal mixing in the Arctic Ocean has historically been low compared to other oceans, and is driven primarily by three sources of energy: winds, tides, and the differential diffusion of heat and salt. Double-diffusive staircases span much of the central Arctic and make important contributions to diapycnal mixing, such that internal waves are often not the dominant mixing mechanism. Although these low levels of Arctic Ocean mixing have been well-established for decades, spatial variability in diffusivity is poorly known. Here we present the first ever gridded product for Arctic Ocean diapycnal diffusivity that accounts for both internal wave-driven and double-diffusive mixing processes. To create this product, we use dissipation estimates from a strain-based finescale parameterization applied to pan-Arctic hydrographic profiles spanning 18 years, in combination with an identification and assessment of double-diffusive mixing processes. Our observational record includes a combination of Ice-Tethered Profiler data in the central Arctic and ship-based profiles from the Canadian

Arctic shelf. We find that accurately estimating diffusivity requires accounting for not only the presence of double-diffusive staircases, but also for variations in mixing efficiency associated with marginally turbulent internal wave-driven mixing. We determine that pronounced regional differences in the strength and prevalence of internal wave-driven mixing are the dominant source of variability in our diffusivity estimates, with the highest values on the continental shelf and near the basin margins. Our results suggest that regional-average values of diapycnal diffusivity may be sufficient to provide significantly improved representations of Arctic Ocean mixing in modelling studies.

Session: 1024 POSTER SESSION - PART 24 - The Changing Arctic Ocean AFFICHES - PARTIE 24 - L'évolution de l'océan Arctique

ID: 10694 Contributed abstract

Poster Order: 320P06

Pacific Water pathway in the Arctic Ocean: a view from numerical modelling

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Presented by / Présenté par: ***Xianmin Hu***
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Pacific inflow through the narrow and shallow Bering Strait is an important source of freshwater, heat, and nutrients to the Arctic Ocean. However, its pathway, circulating within and leaving the Arctic Ocean, still has a large uncertainty in the literature. The existence of the freshwater dome--Beaufort Gyre--was proposed to impact the pathway of Pacific Water flowing out of the Arctic Ocean, however, it requires further examination under a realistic high status of Beaufort Gyre freshwater. The observed freshwater accumulation within the Beaufort Gyre since the early 2000s provides a perfect opportunity to conduct such a study. Here we set up a set of regional NEMO based configurations with nominal horizontal resolutions of 1/4° and 1/12° in longitude/latitude, and use an online passive tracer to track the Pacific Water over the period 2002-2016. Both simulations show that Pacific Water mainly follows the Transpolar Route over the integration period, with a limited amount

being able to flow eastward along the Alaskan coast to enter the Canadian Arctic Archipelago. It is also found that the higher resolution simulation can produce a more realistic Beaufort Gyre circulation and maintain the high freshwater content status after 2007, while the 1/4° simulation fails.

Session: 1024 POSTER SESSION - PART 24 - The Changing Arctic Ocean AFFICHES - PARTIE 24 - L'évolution de l'océan Arctique

ID: 11232 Contributed abstract

Poster Order: 350P01

Investigating uncertainties in the NASA Eulerian Snow On Sea Ice Model and assessing the impact on sea ice thickness derived from ICESat-2 observations

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Presented by / Présenté par: ***Alex Cabaj***
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Snow on Arctic sea ice plays many, sometimes contrasting roles in Arctic climate feedbacks. For example, the presence of snow on sea ice can enhance sea ice growth by increasing the sea ice albedo, or conversely, inhibit sea ice growth by insulating ice from the cold atmosphere. Estimates of snow depth on Arctic sea ice are also a key input for deriving sea ice thickness from sea ice altimetry measurements, such as those from ICESat-2. The recent version of the NASA Eulerian Snow On Sea Ice Model (NESOSIM), version 1.1, is a model which can produce snow depth and density estimates over Arctic sea ice for this purpose. NESOSIM is a 2-layer model with simple representations of the processes of snow accumulation, wind packing, loss due to blowing snow, and redistribution due to sea ice motion. Relative to version 1.0, NESOSIM 1.1 features a more extended model domain, and reanalysis snowfall input scaled to observed snowfall retrieved from CloudSat satellite radar reflectivity measurements. In this work, we present a systematic calibration of the NESOSIM model free parameters to airborne snow radar measurements from Operation IceBridge. Furthermore, we investigate uncertainties in snow depth and uncertainties in derived sea ice thickness.

Session: 1025 POSTER SESSION - PART 25 - Coastal Oceans, Hydrology and Modelling AFFICHES - PARTIE 25 - Coastal Oceans, Hydrology and Modelling

ID: 11180 Contributed abstract

Poster Order: 510P01

Fractal Analysis of Coastal Surface Drifters in the Salish Sea

Edward Mason [1]

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Presented by / Présenté par: ***Edward Mason***

Contact: emason@eoas.ubc.ca

Fractal dimension has been extensively applied to trajectories of surface drifters in the open ocean to study mesoscale systems. A practice of mesoscale studies is to ignore small-scale phenomena citing non-importance to mesoscale flows, these practices cannot, therefore, be transferred to small-scale studies, there exists an important gap in the knowledge of whether the same techniques can be transferred to study localized flows in inland seas. In this project, we analyse the spatial variability of the fractal dimension of surface flows in the Salish Sea, and justify a) the appropriate temporal and spatial scales on which the values are valid and b) the applicability of the mesoscale methods to the small-scale problem. To do so, we apply three fractal dimension calculation methods, a box-counting method, a modification of the scaling exponent method, and the Grassberger-Procaccia algorithm, to observed surface trajectories in the Salish Sea. We also compare the seasonal variability of the calculated fractal dimensions and discuss them in terms of external forcing. We find fractal dimensions in the Salish Sea are valid on spatial scales of 10m to 20km, and temporal scales of 30 minutes to 6 hours. We also note that the largest fractal dimensions are in the widest part of the Strait of Georgia where fresh water is added to the system by means of the Fraser River, suggesting that a strongly stratified water column, affected by inertial processes, may produce the greatest variability in a drift trajectory. We also find evidence relating to stratification when looking at the seasonal variability, winter dimensions are generally smaller than summer values, hinting again that stratification is proportional to fractal dimension. These findings allow us to argue that, with a little tweaking, pre-existing methods used to calculate the fractal dimension of mesoscale flows are applicable to small-scale systems.

Session: 1025 POSTER SESSION - PART 25 - Coastal Oceans,

Hydrology and Modelling AFFICHES - PARTIE 25 - Coastal Oceans, Hydrology and Modelling

ID: 10849 Contributed abstract

Poster Order: 830P01

Modelling circulation of Baynes Sound, British Columbia, with Finite Volume Community Ocean Model (FVCOM)

Maxim Krassovski [1] , *Mike Foreman* [2] , *Thomas Guyondet* [3] , *Terri Sutherland* [4] , *Ramón Filgueira* [5]

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Presented by / Présenté par: ***Maxim Krassovski***
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Baynes Sound is one of the most prolific shellfish regions in British Columbia significantly contributing to the total province’s production of clams and oysters. As part of a project to assess the ecological carrying capacity of the region and provide guidance on future expansion of the bivalve industry, coupled physical and biogeochemical models have been developed and applied to simulate the present and planned future ecosystems. The development and evaluation of the physical circulation model, an application of the Finite Volume Community Ocean Model, will be described in this presentation. Though the circulation within Baynes Sound is predominantly estuarine, tidal mixing and seasonal variability in the winds and river discharges are found to play important roles.

Session: 1025 POSTER SESSION - PART 25 - Coastal Oceans, Hydrology and Modelling AFFICHES - PARTIE 25 - Coastal Oceans, Hydrology and Modelling

ID: 11059 Contributed abstract

Poster Order: 860P02

Evaluation of a high resolution ocean forecasting system for the port of Saint John, New Brunswick

Stephanne Taylor [1] , *Sarah MacDermid* [2] , *Michael Dunphy* [3] , *Maxim Krassovski* [4] , *Ji Lei* [5] , *Youyu Lu* [6]

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Presented by / Présenté par: ***Stephanne Taylor***
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A high-resolution ocean forecasting model has been developed using NEMO 3.6 for the port of Saint John, New Brunswick. It is nearing implementation as an operations-ready system, and provides 48h forecasts for eventual use in e-navigation and emergency response systems. This system is the first of several high-resolution forecasting systems developed under the Oceans Protection Plan to be developed, and provides new opportunities for collaboration with biologists, biogeochemists, ocean-going scientists, modellers, and others. We present preliminary forecast model results and forecast evaluation metrics.

Session: 1025 POSTER SESSION - PART 25 - Coastal Oceans, Hydrology and Modelling AFFICHES - PARTIE 25 - Coastal Oceans, Hydrology and Modelling

ID: 11068 Contributed abstract

Poster Order: 860P04

Seasonal variation of tidal flows in the Kitikmeot Sea

Chengzhu Xu [1] , *Yongsheng Wu* [2] , *William J. Williams* [3]

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Presented by / Présenté par: ***Chengzhu Xu***
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Located in the southern Canadian Arctic Archipelago, the Kitikmeot Sea is covered by the sea ice during most of the year, whose concentration and thickness exhibits strong seasonal variation. Within the Kitikmeot Sea, strong

tidal currents are found near locations where shallow sills are present. Recent observations indicated that the presence of the sea ice may lead to the velocity shear of surface oceanic currents and thus can largely damp tidal currents, which are an important hydrodynamic process for the mass transport under the sea ice since the wind stress is mostly isolated by the sea ice. In this study, we investigate the tidal dynamics of the Kitikmeot Sea under the coverage of sea ice, and the potential influences of the sea ice on the mass transport in the ice-ocean mixing layer. The study is carried out using a high-resolution, ice-ocean coupled model based on the Finite Volume Community Ocean Model (FVCOM). The model resolution of the elements varies from 1 km in near-shore waters to 12 km in open waters, depending on local variations of width of channels, complexity of coastline, water depth, and gradient of the water depth. In the vertical direction, the model employs the generalized terrain-following coordinate (GTFC) system with 40 vertical layers. In deep waters, the GTFC system is a hybrid system of z levels and regular sigma levels, whereas in shallow waters, it is equivalent to the uniform sigma coordinate system. With this type of configuration, the model is able to accurately represent flow dynamics at locations where topographical features are present, especially tidal flows over shallow sills. We will examine the effects of sea ice on tidal elevations and currents in the Kitikmeot Sea by comparing model results in the winter and the summer, and analyze mechanisms such as the drag due to the presence of sea ice on tidal propagation.

Session: 1025 POSTER SESSION - PART 25 - Coastal Oceans, Hydrology and Modelling AFFICHES - PARTIE 25 - Coastal Oceans, Hydrology and Modelling

ID: 10887   Contributed abstract

Poster Order: 870P01

Extracting an ambient sound recording from a deep water and high current location off Northern Labrador

Josiane Ostiguy [1] , *Len Zedel* [2]

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Presented by / Présenté par: ***Josiane Ostiguy***
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Ambient sound data was recorded over a 6 month period from October 2017 to March 2018 and over a 15 month period from July 2019 to September 2020. This data was recorded at a depth of 500 m from a mooring at the northeastern

edge of Saglek Bank off Northern Labrador. At the mooring location, tidal currents (at 500 m depth) reach speeds up to ~50 cm/s. The high current speeds result in a significant tilting of the mooring with the current meter often indicating tilts in excess of 20 degrees. Further, the high speeds lead to mooring noise which corrupts the ambient sound data. We use the current meter data to identify periods of reduced current speeds where sound data is not corrupted, thereby recovering a record of naturally occurring sounds. We use the reduced data set to explore noise levels in this area of the ocean that sees limited shipping activity. Within the quiet periods of the sound recordings, whale calls are clearly heard.

Session: 1025 POSTER SESSION - PART 25 - Coastal Oceans, Hydrology and Modelling AFFICHES - PARTIE 25 - Coastal Oceans, Hydrology and Modelling

ID: 10869 Contributed abstract

Poster Order: 880P01

Improvements in Dynamic Performances of an Inductive Profiling CTD

Mathieu Dever [1] , *Clark Richards* [2] , *Susan Wijffles* [3] , *Annie Wong* [4]

[1] RBR and Woods Hole Oceanographic Institution
[2] Fisheries and Oceans Canada
[3] Woods Hole Oceanographic Institution
[4] University of Washington

Presented by / Présenté par: ***Mathieu Dever***
Contact: mathieu.dever@rbr-global.com

Conductivity-Temperature-Depth instruments (CTDs) profiling through the ocean water column provide an immense wealth of information on the vertical structure of the ocean. It is now well-established, however, that relatively large errors in ocean salinity can be generated when CTDs sample across temperature gradients. These so-called "dynamic errors" are generated by two main physical processes: A misalignment of the measured temperature and conductivity, necessary to compute ocean salinity, and the thermal-mass of the conductivity cell that introduces temperature errors that directly impacts salinity estimates. Reducing dynamic errors is a key challenge for any user of profile data, including large observational program, such as Argo, that relies on high-quality data. In this work, we analyze the dynamic response of the RBRargo3 C.T.D. to rapid changes in temperature to characterize dynamic errors. We utilize data collected both in the laboratory and in the field to demonstrate that both sources of errors can be effectively corrected for. The computational

method to correct dynamic errors is developed to be applicable to the data in both post-processing, or onboard the sampling platforms. This presents a key advantage for sampling platforms traditionally applying bin-averaging techniques to reduce the volume of data to be remotely transmitted (e.g., profiling floats): it allows salinity corrections to be performed on the full-resolution dataset, before any binning is applied. This computational technique leads to significant improvements in salinity observations obtained from the RBRargo3 C.T.D., an inductive CTD increasingly used on profiling floats.

Session: 1025 POSTER SESSION - PART 25 - Coastal Oceans, Hydrology and Modelling AFFICHES - PARTIE 25 - Coastal Oceans, Hydrology and Modelling

ID: 11181 Contributed abstract

Poster Order: 920P01

Global-scale data-driven hydroclimatic system analyses

Guanhui Cheng [1] , *Gordon Huang* [2] , *Cong Dong* [3]

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Presented by / Présenté par: ***Guanhui Cheng***

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The potential impacts of global climate on global streamflow are quantified through a global-scale data-driven hydroclimatic analysis system (GDHCA). GDHCA is composed of four modules, i.e., hybrid correlation analyses, ensemble hydroclimatic modeling, post-modeling sensitivity analyses, and sensitivity reanalyses. It is applied to analyze the potential associations of monthly streamflow in nearly 10,000 catchments all over the world with 20 climate indices (e.g., La Nina and El Nino) from 1951 to 2010. Due to the diversities of temporal scales, optional methods/approaches, predictor selections, sample splits, catchments and other factors, a total number of nearly 100 billion simulations are conducted. According to the results that have been extracted from a large number of ones, the climate indices can explain more than approximately half of streamflow changes and variations for almost all catchments. Their impacts on streamflow are higher than 90% for nearly 1/3 of global catchments of which most are in sparsely-populated areas, reflecting the trade-off between climatic and anthropogenic impacts on global streamflow. Many other results are still being analyzed, e.g., individual hydrological impacts of every climate index, and associations of climatic impacts with non-climatic

factors.

Day 2 – 1 June 2021

Oral

Session: 620 Extreme Events in the Coupled Climate System - Part 1 Événements extrêmes dans le système climatique couplé - Partie 1

01/06/2021 12:30

ID: 10678 Invited session speaker

Poster Order:

Past and future changes in extreme precipitation across the globe

Francis Zwiers [1] , *Qiaohong Sun* [2] , *Chao Li* [3] , *Xuebin Zhang* [4]

[1] Pacific Climate Impacts Consortium
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[3] East China Normal University
[4] Environment and Climate Change Canada

Presented by / Présenté par: ***Francis Zwiers***
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Evidence of the impact of anthropogenic forcing on extreme precipitation is strengthening, and yet remains enigmatic in many respects. Recently updated statistics describing observed changes in precipitation extremes at thousands of observing stations across the globe show intensification of 1-day precipitation extremes that is consistent with Clausius-Clapeyron. Intensification is also seen in many IPCC regions where data are available. Attribution studies using different methods, observations, and ESMs, including a recent study that applies an attribution formalism directly to station data, find sufficient correspondence between observed and CMIP6 ESM-simulated changes in extreme precipitation to attribute observed changes to anthropogenic forcing globally, and in three of four large continental scale areas with sufficient station data coverage (North America, Western Eurasia, and Eastern Eurasia). Nevertheless, intensification is not observed in all IPCC regions, and can only be detected in a small fraction of individual station records. Moreover, intensification does not occur uniformly across continents where human influence can be detected, with organized spatial patterns of change that are not clearly reproduced by ESMs under historical forcing, presumably due to the impact of regional forcing and response mechanisms that may not be well represented by ESMs and the effects of low frequency climate variability. The

ESMs project a consistent pattern of extreme precipitation change for the future across emissions scenarios, with intensification occurring over most of the globe, including almost all land areas, and weakening occurring in subtropical areas where the downwelling branches of the Hadley circulation appear to strengthen. The projected changes in extreme precipitation generally scale well with warming where intensification occurs. Nevertheless, there are subtle variations in the pattern of response in the intensity and frequency of extreme precipitation when comparing different forcing scenarios, with heavily discussed “hot spots” such as the Mediterranean and South African regions being evident in the projected response patterns at lower forcing levels. These projected patterns of change may help to explain why anthropogenic influence has not been detected in the fourth continental scale region considered, Oceania, which encompasses the Maritime Continent, Australia and New Zealand.

Session: 620 Extreme Events in the Coupled Climate System - Part 1 Événements extrêmes dans le système climatique couplé - Partie 1

01/06/2021 13:00

ID: 11255 Contributed abstract

Poster Order:

Projected Changes in Hydro-climatic Extremes in the Athabasca River Basin

A. R. Erler [1], *H-T. Hwang* [2], *O. Khader* [3], *S. J. Berg* [4], *E. A. Sudicky* [5], *J. P. Jones* [6], *W. R. Peltier* [7]

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Presented by / Présenté par: ***Andre Erler***
Contact: aerler@aquanty.com

There is a need to assess the potential impact of climate change on water resources in the Athabasca river basin (ARB). Of particular interest are potential changes in hydrologic and climatic extremes. Modeling of the hydro-climate of the ARB is both interesting and challenging: located directly in the lee of the Rocky Mountains, the headwater region is dominated by orographic precipitation and snowmelt, while the downstream area is characterized by a

sub-humid (dry) climate due to the rain shadow effect. Furthermore, the hydrology of the ARB is dominated by strong surface water-groundwater interaction combined with peatland dynamics, which maintain a much more humid system, than would otherwise be expected. Here we present a comprehensive assessment of projected changes in climatic and hydrologic extreme events in the ARB, based on dynamically downscaled regional climate projections combined with integrated surface-subsurface hydrologic simulations. The regional climate projections are based on an ensemble of simulations at 10km resolution employing the Weather Research and Forecasting model; preliminary results suggest that increases in precipitation extremes by 20% may be expected. The climate projections are then used to drive simulations of the basin hydrology, using the fully integrated HydroGeoSphere model. Of particular interest are large-scale flood and drought events, which are characterized by complex land-surface processes and are strongly influenced by antecedent groundwater conditions. Extreme events will be analyzed statistically (using extreme value theory) and on a process level, highlighting the interaction between groundwater, surface water and atmosphere. Implications for, e.g., oil sands mining will be considered.

Session: 620 Extreme Events in the Coupled Climate System - Part 1 Événements extrêmes dans le système climatique couplé - Partie 1

01/06/2021 13:30

ID: 10831 Contributed abstract

Poster Order:

Dynamically Downscaled Climate Change Projections for South and Southeast Asia: Mean and Extreme Monsoon Precipitation Changes and Physics Parameterization Impacts

Yiling Huo [1]

[1]

Presented by / Présenté par: ***Yiling Huo***
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The extreme concentration of population over South and Southeast (SE) Asia makes it critical to accurately understand the global warming impact on the South and SE Asian monsoon. Here we describe a series of climate projections that have been constructed using the Weather Research and Forecasting Model (WRF) for South and SE Asia to downscale a global warming simulation constructed using the Community Earth System Model under the representative concentration pathway 8.5 (RCP8.5) scenario. A physics-based mini ensemble is employed to investigate the sensitivity of the projected change of the

monsoon to the implementation of different parameterization schemes for processes that are not explicitly resolved at the spatial resolutions at which WRF has been employed. We analyze the impact of the global warming process on not only mean precipitation but also precipitation extremes. All projections are characterized by a consistent increase in summer monsoon average precipitation and a fattening of the tail of the daily rainfall distribution. Both the average and extreme precipitation increases are projected to be slightly larger than expectation based upon the Clausius–Clapeyron thermodynamic reference of 7%/°C of surface warming in most parts of India. This further increase can be primarily explained by the fact that surface warming is projected to be smaller than the warming in the mid-troposphere, where a significant portion of rain originates, while dynamical effects play only a secondary role. In contrast, the projected increases of both the average rainfall intensity and the extreme precipitation are generally smaller than 7%/°C in SE Asia due to increased high-level moisture divergence. However, the quality of SE Asian monsoon simulation is sensitive to the version of WRF and version 4 performs much better than version 3. Additional efforts have also been made to incorporate a higher resolution ocean model to the dynamical downscaling pipeline.

Session: 620 Extreme Events in the Coupled Climate System - Part 1 Événements extrêmes dans le système climatique couplé - Partie 1 **01/06/2021 13:45**

ID: 10899 Contributed abstract

Poster Order:

FURTHER PROBING THE MECHANISMS DRIVING REGIONAL PROJECTIONS OF EXTREME PRECIPITATION INTENSITY

Thabo Mpanza [1]

[1] York University

Presented by / Présenté par: ***Thabo Mpanza***
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M.A. Thabo Mpanza and Neil F. Tandon Regional projections of extreme precipitation intensity (EPI) are strongly influenced by regional projections of “extreme ascent,”. Earlier studies are suggesting that long-term changes in eddy length and vertical stability are key factors influencing extreme ascent projections. We performed controlled experiments using the System for Atmospheric Modeling (SAM). Domains we chosen in the subtropical South Atlantic, where the Canadian Earth System Model version 2 (CanESM2)

projects weakening of extreme ascent. SAM was forced with large-scale temperature, moisture and winds from CanESM2 during extreme events in the historical (1981-2000) and future (2081-2100) periods. SAM qualitatively reproduced CanESM2's projected changes in EPI. To gain further insight into physical mechanisms, we performed "isolation runs" in which some of the CRM's large-scale forcings were changed to their future values, while keeping all other forcings fixed to historical values. In all cases, long-term changes in horizontal advection were the dominant driver of projected decreases in EPI.

Session: 252 General Session - Weather - Part 3 - Weather Data and Forecasting Séance générale — La météorologie - Partie 3 - Données météorologiques et prévisions **01/06/2021 12:30**

ID: 11041 Contributed abstract

Poster Order:

Introducing the World Meteorological Organization's (WMO) Upcoming New Unified Data Policy

Jim M.C. Young [1]

[1] Environment & Climate Change Canada

Presented by / Présenté par: ***Jim M.C. Young***
Contact: jim.young@ec.gc.ca

The World Meteorological Organization (WMO) and its predecessor, the International Meteorological Organization, have coordinated, regulated and promoted free and open exchange of weather, climate and water data since 1873, and has created a global standardized network, which is the cornerstone of weather, climate and hydrological services. Explosive growth in demand for data, products and services make international data exchange more important than ever. The WMO is adopting a unified approach to Earth system monitoring and prediction, which will require integration of data from all disciplines into a common framework. Building upon the existing resolutions covering meteorological, hydrological and climate data, the WMO is embarking on a new overarching resolution to have one unified data policy for all WMO domains and disciplines, which includes Weather, Climate, Hydrology, Atmospheric Composition, Cryosphere, Oceans, and Space Weather. In the Weather domain, the policy covers Surface-based, Space-based observation data as well as global analysis fields provided by numerical weather prediction systems. The proposed policy will maintain a two-tiered ("mandatory" and "recommended") approach to the international provision and exchange of Earth System data. As part of the engagement of stakeholders for the proposed

policy, the WMO Data Conference was conducted virtually on November 16-19, 2020. There were participation from government, academia, private sector and development partner organizations from around the world. This presentation will seek to build upon engagement with the Canadian weather, water and climate community on the proposed WMO data policy reform.

Session: 252 General Session - Weather - Part 3 - Weather Data and Forecasting Séance générale — La météorologie - Partie 3 - Données météorologiques et prévisions **01/06/2021 13:00**

ID: 10667 Contributed abstract

Poster Order:

All-sky microwave radiance assimilation in Environment Canada's Global Deterministic Weather Prediction system

maziar bani shahabadi [1] , *mark buehner* [2] , *stéphane laroche* [3] , *sylvain heilliette* [4]

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Presented by / Présenté par: ***maziar bani shahabadi***
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It is important to include radiance data affected by clouds and precipitation in data assimilation systems, as these data are often associated with meteorologically important areas. Cloud-affected radiances are discarded in the current operational data assimilation systems at Environment and Climate Change Canada (ECCC) due to the limitations of forecast model physics, radiative transfer model, and non-linearity of the observation operator. During the past ten years, many Numerical Weather Prediction (NWP) centers have implemented the assimilation of the cloud-affected radiances with the all-sky approach, using a symmetric observation error standard deviation (stddev) as a function of the observed and simulated hydrometeor amount. This study presents our recent efforts to incorporate non-precipitating channels 4-5 of AMSUA observations over ocean with the all-sky approach in the ECCC 4DEnVar system. The symmetric error stddev is used for the quality control and assimilation of cloudy observations. Background error covariances with cloud variable was constructed by outputting the model clouds in the 256-member global EnKF system and cloud variable was included as an additional analysis variable. The assimilation experiments show the number of AMSUA channel 4-5 assimilated observations in the all-sky experiment is 5-12% higher than in the clear-sky experiment. Statistically significant reductions in error stddev by 1-4% for the temperature, specific humidity, and horizontal wind forecasts up to a lead time of 4 days were achieved in the lower troposphere. The all-sky experiment without cloud as control variable produces similar results, indicating that the improvements are mainly due to using clouds for computing the innovations combined with the cloud-dependent observation error stddev. To save time during the analysis, it was therefore decided to exclude cloud from control vector for the all-sky assimilation of these cloud-affected radiances in the next upgrade of the ECCC forecast systems in Fall 2021.

Session: 252 General Session - Weather - Part 3 - Weather Data and Forecasting Séance générale — La météorologie - Partie 3 - Données météorologiques et prévisions

01/06/2021 13:15

ID: 11061 Contributed abstract

Poster Order:

Implementation of observations dependent on slant columns of the atmosphere in Environment Canada’s weather forecast system.

Josep Aparicio [1] , *Maziar Bani Shahabadi* [2] , *Mark Buehner* [3] , *David Lobon* [4]

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Presented by / Présenté par: ***Josep Aparicio***
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A number of observations, among them most radiances, probe the atmosphere at different altitude layers at the same time. Until recently, ECCC’s system was treating these layers as being perfectly vertical. However, most often, the layers that the observation is sensitive to, are somewhat slant, for instance, due to a sensor scanning sideways over a swath. Thus the upper and lower layers are not exactly on top of each other, but span several tens of km horizontally. Whereas this is minor if the model resolution is low, progressively higher resolution of weather models requires considering the actual shape of the observation, and notably this inclination. The expected gain is a better representation of regions of substantial horizontal gradients, such as near fronts, jet streams, and polar vortices. This should lead to better location of these structures, when observational information is injected to the model, and

better timing of the subsequent evolution of these structures. We will show that, indeed, significant improvements are obtained with these structures. Therefore, significant effort was dedicated to describe these shapes cost-effectively. This slant technology was put into the upcoming version of ECCC's weather forecast system for nearly all radiances, and for GNSS Radio Occultations. Additional observation types may be added in the future.

Session: 252 General Session - Weather - Part 3 - Weather Data and Forecasting Séance générale — La météorologie - Partie 3 - Données météorologiques et prévisions

01/06/2021 13:30

ID: 11098 Contributed abstract

Poster Order:

Assimilation of the Integrated Multi-satellitE Retrievals (IMERG) data in the Canadian Precipitation Analysis (CaPA)

Franck Lespinas [1] , *Guy Roy* [2] , *Vincent Fortin* [3] , *Dorothy Durnford* [4] , *Dikra Khedhaouria* [5] , *Stéphane Belair* [6]

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Presented by / Présenté par: ***Franck Lespinas***

Contact: franck.lespinas@canada.ca

The Canadian Precipitation Analysis (CaPA) developed by Environment and Climate Change Canada (ECCC) provides near real-time quantitative precipitation estimates for North America. So far, CaPA assimilated precipitation observations only from ground stations and from radars, which are then combined with a forecast provided by a numerical weather forecast model. This approach has proven to be robust in the past and the CaPA system has since been constantly improved over time, notably by increasing the number of observations. Among the many innovations that will be implemented in the next operational version of the regional deterministic analysis of precipitation (RDPA) system is the assimilation of the IMERG product as an additional source of observations. The IMERG algorithm combines information from the constellation of GPM satellites to estimate precipitation over most of the Earth's surface. The assimilation of IMERG data in RDPA leads to a significant increase in the skill of precipitation analyses, especially in areas with a limited number of stations and /

or radars. The results also show that the confidence index values are increased in most regions and that IMERG provides valuable information on rainfall over water bodies.

Session: 252 General Session - Weather - Part 3 - Weather Data and Forecasting Séance générale — La météorologie - Partie 3 - Données météorologiques et prévisions **01/06/2021 13:45**

ID: 10748 Contributed abstract

Poster Order:

MetPort: An Ocean Protect Plan Marine Weather Demonstration Project

Cindy Freeman [1] , *Jamie McLean* [2]

[1] Meteorological Service of Canada
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Presented by / Présenté par: ***Cindy Freeman***
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The Ocean Protection Plan (OPP) is an interagency, interdepartmental initiative that, in part, aims to improve the safety of Canada’s marine community. The role of the Meteorological Service of Canada (MSC) in this initiative is to provide enhanced weather information through a time-bound demonstration project, providing new marine-based weather observations and forecasts to support decision-making. Through consultations with clients and partners, locations were selected for the deployment of five marine weather buoys (three on the East Coast and two on the West Coast), for which marine weather forecasts are produced. The MSC has developed a portal called MetPort that provides clients with access to the real-time weather and sea state observations collected at each of the five OPP buoys. This portal also provides high-resolution, high-frequency weather and sea state forecasts for all five sites, in two different graphical formats, as well as a marine weather evaluation and discussion. This innovative portal is a demonstration project and a proof of concept, which will gather requirements from the user community that in turn could inform the future direction of Marine Services for the Meteorological Service of Canada.

Session: 730 Producing, Providing and Communicating Useful Climate Information - Part 1 Produire, fournir et communiquer des informations climatiques utiles - Partie 1 **01/06/2021 12:30**

ID: 11036 Contributed abstract

Poster Order:

100 years of Weather Observations from the Meteorological Service of Canada in Wikimedia Commons (Wikipedia)

Ha-Loan Phan [1] , *Pierre Choffet* [2] , *Miguel Tremblay* [3]

[1] Wikimedia Canada
[2] Wikimedia Canada
[3] ECCC

Presented by / Présenté par: ***Ha-Loan Phan***
Contact: hphan@wikimedia.ca

Wikimedia Canada, the Canadian chapter of the Wikimedia Foundation, received a grant in 2019 from Environment and Climate Change Canada. The project consists of uploading 100 years of weather data from 8,756 weather stations across Canada to Wikimedia Commons, a data repository that feeds, among others, the Wikipedia encyclopedia. The uploading and sharing of governmental and institutional big data in Commons is a world premiere. This provides a collective workspace with features and computing capabilities for different organizations. This project aims for the free access to data for as many people as possible, their reuse and their potential crossing with other data. We will explain how we adapted the Meteorological Service of Canada data model to the Commons model, and what new features are now available, thanks to this data import. We will explore some of the tools developed and how to improve Wikipedia articles from Canadian locations, in all languages. We want to demonstrate the strong potential of such an approach that could inspire new projects by governments in the open data field.

Session: 730 Producing, Providing and Communicating Useful Climate Information - Part 1 Produire, fournir et communiquer des informations climatiques utiles - Partie 1 **01/06/2021 12:45**

ID: 11147 Contributed abstract

Poster Order:

Public Access to the Canadian Climate Data and Metadata Image Files – Prototype

Anna Deptuch-Stapf [1] , *Chris Kocot* [2]

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Presented by / Présenté par: ***Anna Deptuch-Stapf***
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MSC (Meteorological Services of Canada) is working toward making millions of historically significant meteorological measurements easily accessible as image files to both researchers and the general public. Hundreds of boxes of paper forms with meteorological data from stations across Canada since about 1840 are effectively out of reach of any but the most dedicated climatologists and researchers. Values of temperature and precipitation were extracted into digital elemental data but other measurements and observations of episodic phenomena such as appearance of the Northern Lights, snow, lightning or hail as well as observer’s remarks remain inaccessible. A multi-year effort is underway to scan a subset of these MSC forms, known as “2304" daily forms, and save the digital images in the National Climate Archives. The presentation will describe an effort to provide Internet access to these scans. Fast and easy access to Canadian National Climate Archives vast collection of scanned paper records promotes exploration, discovery, and use of these important climate data. As well as for individual research scientists and curious members of the public, we foresee application of this capability by projects such as ACRE (Atmospheric Circulation Reconstruction over the Earth), the McGill DRAW (Data Rescue: Archives and Weather) or ODR (Open Data Rescue Organization) among others.

Session: 730 Producing, Providing and Communicating Useful Climate Information - Part 1 Produire, fournir et communiquer des informations climatiques utiles - Partie 1 **01/06/2021 13:00**

ID: 10776 Contributed abstract

Poster Order:

Accessing Canada's Weather and Climate Data through OGC APIs and Geospatial Web Services

Alexandre Leroux [1]

[1] Environment and Climate Change Canada

Presented by / Présenté par: ***Alexandre Leroux***
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The MSC GeoMet platform provides public access to the Meteorological Service

of Canada (MSC) and Environment and Climate Change Canada (ECCC) data via interoperable web services and application programming interfaces (API). Through open standards, users can freely and quickly access thousands of real-time and archived weather, climate and water datasets and products and integrate them in their domain-specific applications and decision support systems. Users can build mobile apps, create interactive web maps, and display and animate MSC data in desktop software. MSC GeoMet also enables on demand raw data clipping and reprojection, on demand format conversion and custom visualization.

Session: 730 Producing, Providing and Communicating Useful Climate Information - Part 1 Produire, fournir et communiquer des informations climatiques utiles - Partie 1 **01/06/2021 13:15**

ID: 10764 Contributed abstract

Poster Order:

Producing and Providing Canada's Daily Climate Records – A New Path to Releasing Climate Data Geospatially for Canadians

Rick Fleetwood [1] , *Judy Kwan* [2] , *Russell Emery* [3] , *Carrington Pomeroy* [4] , *Tom Kralidis* [5]

[1] Environment and Climate Change Canada
[2] Environment and Climate Change Canada
[3] Environment and Climate Change Canada
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Presented by / Présenté par: ***Rick Fleetwood***
Contact: judy.kwan@canada.ca

Anomalous weather resulting in temperature and precipitation extremes (records) occur almost every day somewhere in Canada. Questions such as what is the highest temperature or the greatest snowfall on record for a specific day of the year, especially during record-breaking weather events, remain highly relevant and top-of-mind for many Canadians. The daily climate records database, also known as Long Term Climate Extremes (LTCE) for Canada, was developed to address the fragmentation of climate information due to station changes (opening, closing, relocation, etc.) over time. For approximately 750 locations in Canada, “virtual” climate stations have been developed by joining (threading) climate data for an urban location, from nearby stations to make a long-term dataset. Each long-term dataset consists of the extremes (record values) of daily maximum/minimum temperatures, total precipitation and

snowfall for each day of the year. Many of the longest datasets of extremes date as far back as the 1800s. This presentation will discuss the purpose, history and development of the LTCE for Canada as well as the methods and efforts to produce this information daily by the Meteorological Service of Canada (MSC). It will also highlight the collaboration between the MSC and the Canadian Centre for Climate Services on the public release of the LTCE on the MSC GeoMet API platform to improve access availability to climate data for all Canadians.

Session: 730 Producing, Providing and Communicating Useful Climate Information - Part 1 Produire, fournir et communiquer des informations climatiques utiles - Partie 1 **01/06/2021 13:30**

ID: 10761 Contributed abstract

Poster Order:

2020 Catastrophes in Canada: Insured loss insights on extreme weather

Caroline Floyd [1] , *Laura Twidle* [2]

[1] CatIQ
[2] CatIQ

Presented by / Présenté par: ***Caroline Floyd***
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While a global pandemic paused many aspects of our lives in 2020, extreme weather events gave us no reprieve. Natural and human-made disasters, known as "catastrophes" in the insurance industry, broke records worldwide last year, and Canada was no exception. Insured losses in Canada from catastrophic events in 2020 were nearly CAN $2.4 billion, continuing the past decade's trend of increasing annual losses. More than $2.3 billion of that loss came from just six events. Identifying and preparing for the more frequent, more severe extreme weather events anticipated with climate change is key to reducing impacts on Canadians. Insured loss data in combination with climate data and mitigation techniques can provide decision-makers with the necessary information to act. This presentation analyzes the meteorological factors at work in natural catastrophes and the geographical distribution of Canada's NatCATs, with emphasis on 2020, using data collected by Catastrophe Indices and Quantification Inc. (CatIQ), Canada's insured loss and exposure indices provider. Analysis will include a close look at 2020 loss data and its relation to the Canadian catastrophe loss database.

Session: 820 Computational Methods, Machine Learning, and Model Development - Part 1 Méthodes computationnelles, apprentissage machine et développement de modèles - Partie 1 **01/06/2021 12:30**

ID: 10930 Contributed abstract

Poster Order:

International Collaboration on Exascale Computing, Data Handling, and AI

Véronique Bouchet [1] , *Chiashi Muroi* [2] , *Wenchao Cao* [3] , *Charles Schwartz* [4]

[1] Meteorological Service of Canada, ECCC
[2] Japanese Meteorological Administration
[3] World Meteorological Organization
[4] Meteorological Service of Canada, ECCC

Presented by / Présenté par: ***Véronique Bouchet***
Contact: veronique.bouchet@canada.ca

Advances over the past few decades in numerical prediction for weather, climate, atmospheric composition and environmental conditions are intrinsically linked to the development of high-performance computing. It has led to rapid progress with Earth System Models of increasing resolution combined in ensemble systems and expanding data assimilation capacity. With it, emerged new challenges such as increasing volumes of manipulated data as used and generated by these systems, and new opportunities for these big data sources in the context of artificial intelligence and machine learning approaches. We have now reached a turning point where the expected need of future numerical systems will exceed the capacity of hardware technology to supply it on its own. This signifies a change of paradigm for the numerical prediction community who will need to complement the evolution of computing technology with fundamental research on modelling systems, innovations on data handling and application of AI, and engage in new partnerships to seek technological solutions adapted to its challenges. Furthermore these advances would need to serve the entire numerical prediction community from leading edge forecast centres to weather services in developing countries. The presentation will expand on the scientific and technical challenges as well as accelerating international activities in this area, including through the World Meteorological Organization.

Session: 820 Computational Methods, Machine Learning, and Model Development - Part 1 Méthodes computationnelles, apprentissage machine et développement de modèles - Partie 1 **01/06/2021 12:45**

ID: 10974 Contributed abstract

Poster Order:

How to Port Your Scientific Software to GPU Architectures—Without Tears

Kristopher Rowe [1]

[1] Argonne National Laboratory

Presented by / Présenté par: ***Kristopher Rowe***

Contact: krowe@anl.gov

Traditionally, developing scientific software for general purpose graphical processing unit (GPU) architectures has required the use of highly specialized, often vendor specific, low-level programming models—such as CUDA—to achieve optimal performance. The resulting technical barrier has meant that many scientific domains have been slow to adopt the use of this technology; however, the next generation of exascale supercomputers will have a highly heterogeneous architecture—utilizing many GPUs in each compute node. Further, while the GPU market was once dominated by a single vendor, multiple vendors now offer high-end GPUs which will be integrated into exascale systems. The necessities of software portability across multiple vendor GPU architectures and a lower technical barrier to entry have caused a recent explosion in the number of programming models available for writing scientific software for GPU platforms. A significant undertaking of the U.S. Department of Energy's (DOE) Exascale Computing Project (ECP) is to rapidly port to GPU architectures many widely used science codes critical to the DOE's mission. This talk will give an overview of this effort—with a specific emphasis on computational fluid dynamics (CFD) applications. Portable programming models for GPUs—such as OpenMP offload, SYCL/DPC++, and OCCA—will be presented and contrasted. Best practices will be discussed, including the identification and extraction of critical compute kernels, the development of so called mini-apps—lightweight proxies for scientific applications which allow for rapid prototyping, and the use of API and math libraries. Finally, a vignette will feature efforts at Argonne Leadership Computing Facility to help prepare nekRS—a port of the Gordon Bell Prize winning Nek5000 CFD code to GPU architectures—for the upcoming Aurora exascale supercomputer.

Session: 820 Computational Methods, Machine Learning, and Model Development - Part 1 Méthodes computationnelles, apprentissage machine et développement de modèles - Partie 1 **01/06/2021 13:00**

ID: 11135 Contributed abstract

Poster Order:

Augmenting eddy parameterizations with machine learning in global ocean simulations using SmartSim

Andrew Shao [1] , *Scott Bachman* [2] , *Matthew Ellis* [3] , *Gustavo Marques* [4] , *Sam Partee* [5] , *Alessandro Rigazzi* [6]

[1] Environment and Climate Change Canada
[2] National Center for Atmospheric Research
[3] Hewlett Packard Enterprise
[4] National Center for Atmospheric Research
[5] Hewlett Packard Enterprise
[6] Hewlett Packard Enterprise

Presented by / Présenté par: ***Andrew Shao***
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The use of machine learning (ML) in numerical models of oceans shows great potential, but is complicated by scientific, numerical, and technical challenges. These include: 1) understanding which portions of the model can benefit from ML, 2) ensuring physical fidelity and numerical stability, and 3) interfacing Fortran with Python, the language of choice for most ML packages. Here, we describe the results of replacing a prognostic equation of eddy kinetic energy (EKE) with a neural network in both the NEMO and MOM6 ocean models using the SmartSim software package which enables online, distributed, GPU-based inference within a Fortran, C, C++, and Python codebase. First, a neural network is trained on downsampled output from a 1/10 eddy-resolving model. Then, SmartSim is used to enable online inferences of EKE, i.e. the neural network makes predictions as the model is timestepped forward. These ML-based estimates of EKE are in turn used to estimate eddy diffusivities in parameterizations of the mixing and stirring by mesoscale eddies. Using the ML-based surrogate, the NEMO/MOM6-based eddy-permitting, 1/4-degree simulations yield more realistic estimates of EKE and diffusivities (as compared to eddy-resolving simulations and observations) than the prognostic approach particularly in the tropics, western boundary currents, and Arctic Ocean. The impact of these spatiotemporally-varying diffusivities on the large-scale oceanic circulation are evaluated using JRA-55-forced, multidecadal, global simulations. These results represent some of the first, practical examples of enhancing realistic simulations of the ocean with ML. The general framework presented

methods with traditional numerical techniques.

Session: 820 Computational Methods, Machine Learning, and Model Development - Part 1 Méthodes computationnelles, apprentissage machine et développement de modèles - Partie 1 **01/06/2021 13:15**

ID: 10657 Contributed abstract

Poster Order:

Empirical Bifurcation Analysis of Atmospheric Stable Boundary Layer Regime Occupation

Liz Ramsey [1] , *Adam Monahan* [2]

[1]

[2] University of Victoria

Presented by / Présenté par: ***Liz Ramsey***
Contact: anomaliz.ramsey@gmail.com

Turbulent collapse and recovery are both observed to occur abruptly in the atmospheric stable boundary layer (SBL). The understanding and predictability of turbulent recovery remains limited, reducing numerical weather prediction accuracy. Previous studies have shown that regime occupation is the result of the net effect of highly variable processes, from turbulent to synoptic scales making stochastic methods a compelling approach. Idealized single column stable boundary layer models have shown that under some circumstances regimes can be related to the stable branches of model equilibria, and an additional unstable equilibrium is predicted. This work seeks observational evidence of this bistability using a data driven stochastic method. The drift and diffusion coefficients of the stochastic differential equation of an input time series are approximated from their averaged time tendencies. These approximated coefficients are fit using Gaussian Process Regression. Probabilistic estimates of the system's equilibrium points are then found and used to create a bifurcation diagram without making any prior assumptions on the dynamical form of the system. This entirely data driven bifurcation diagram is compared to modelled predictions. The analysis is repeated on several meteorological towers around the world to assess the influence of the local meteorological setting and surface conditions. This work provides empirical insights into the nature of regime transitions and the extent to which the SBL displays hysteresis.

Session: 820 Computational Methods, Machine Learning, and Model Development - Part 1 Méthodes computationnelles, apprentissage machine et développement de modèles - Partie 1 **01/06/2021 13:30**

ID: 10848 Contributed abstract

Poster Order:

An improved neural network model for shortwave radiative feedbacks quantification

Aliia Shakirova [1] , *Yi Huang* [2]

[1] McGill University
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Presented by / Présenté par: ***Aliia Shakirova***
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A new approach to climate feedbacks quantification using the neural network (NN) model has been introduced in this study. The nonlinear NN method has proven itself to be an accurate emulator of the radiative transfer model and can replace computationally expensive radiative transfer calculations. A NN emulator of shortwave radiation has been developed based on the fifth-generation ECMWF Reanalysis data and was successfully tested for the prediction of shortwave radiative fluxes from atmospheric and surface variables. The NN approach allows to directly evaluate both univariate and multivariate nonlinear effects of the radiative feedbacks of surface albedo, water vapor, and cloud and can be implemented to evaluate coupling between the climatological variables of interest. It is shown that the NN model better quantifies the shortwave albedo feedback in the Arctic region compared to the linear kernel method. Moreover, in the case of large albedo perturbations caused by the Arctic sea ice melt, the NN method more accurately captures the nonlinearity in the surface albedo feedback.

Session: 310 Changing Arctic: Science and Policy Studies - Part1 L’évolution de l’Arctique : études scientifiques et politiques - Partie 1 **01/06/2021 12:30**

ID: 11233 Invited session speaker

Poster Order:

Variability of the Beaufort Ice-Ocean Environment: A Synthesis Report

Philip Osborne [1] , *Alexandre Forest* [2] , *Humfrey Melling* [3] , *Kanae Komaki* [4] , *Simon Morissette* [5] , *Philippe Benoit* [6] , *Jasmin Chana* [7] , *David Hurley* [8] , *Shawn Meredyk* [9]

[1] Golder Associates
[2] Amundsen Science
[3] Institute of Ocean Sciences - Fisheries and Oceans Canada
[4] Amundsen Science
[5] Amundsen Science
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[9] Amundsen Science

Presented by / Présenté par: ***Philip Osborne***
Contact: Phil_Osborne@golder.com

This paper will present a summary of the work completed from 2009 to 2020 by Amundsen Science, in collaboration with IMG-Golder (Golder) and Fisheries and Oceans Canada (DFO), under Phase 1 through 3 of the Variability in the Beaufort Ice-Ocean Environment: A Synthesis Report project, part of the Beaufort Sea Regional Strategic Environmental Assessment (BRSEA). The objective of the Synthesis Report is to summarize the physical marine environment by incorporating analysis and review of existing data, new data obtained from mooring observatories in the southern Beaufort Sea, and state-of-the-art modelling products. A primary focus of the report is the identification of seasonal and inter-annual trends and variability in the ice-ocean environment. High data recovery rates (>90%) reflect a successful mooring program resulting in high quality data across 17 sites, including near-continuous datasets at several sites. The synthesis also includes a longer-term perspective with overviews of the climatology for wind, waves and sea ice providing additional context for interpreting the trends and variability in the observatory data. Up-looking sonars (IPS) on the moorings along with satellite imagery of the area from 2009 to 2019 is used to provide a summary of sea ice climate and wave climate at mooring sites. Conductivity and temperature data are used to characterize and assess the variability in the physical properties of the water column. Several case studies of ocean circulation are developed including characteristics, variability, and features of the shelfbreak jet and off-shelf currents; an investigation of eddies; and a closer look at a storm event, an upwelling event, and a potential downwelling event. A subset of the decade long dataset is used to provide comparisons of the mooring data and the Regional Ice-Ocean Prediction System (RIOPS) model, a high-resolution operational ocean forecast model with 3-hourly data. Results from the Synthesis Report are available in the public domain and provide the basis for further integration with Arctic policies and strategies requiring a robust description of the physical

environment of the Beaufort Sea.

Session: 310 Changing Arctic: Science and Policy Studies - Part1 L'évolution de l'Arctique : études scientifiques et politiques - Partie 1

01/06/2021 13:00

ID: 10686 Contributed abstract

Poster Order:

Incursions of Sea Ice into the eastern Canadian Beaufort Sea in Late Summer: A Case Study in 2018

David Fissel [1] , *Keath Borg* [2] , *Matthew Asplin* [3] , *Humfrey Melling* [4]

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[2] ASL Environmental Sciences Inc.
[3] ASL Environmental Sciences Inc.
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Presented by / Présenté par: ***David Fissel***
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The changing late summer ice regime of the continental shelf of the Canadian Beaufort Sea has been characterized by a trend to reduced sea ice coverage, along with a considerable amount of interannual variability. The sea ice drafts and velocities, as measured with upward looking sonar instruments at three moorings, have been analysed from 1999 to 2018 on an offshore transect to the north of Tuktoyaktuk, NWT. Over this 20 year period, the onset date of sufficient sea ice to allow sea ice velocity measurements has been delayed by 28 days and 26 days, respectively. However, in early October 2018 the moorings were unable to be recovered due to the presence of heavy pack ice. When recovered the following year, the measurements revealed that sufficient ice was present as early as September 16, 2018, which was 15 days earlier than the next earliest year (2001) over the last two decades. The heavy pack ice, in the late summer of 2018, was an impediment to ship-based transits between the Canadian Beaufort Sea and the the Northwest Passage shipping route. The heavy pack ice appeared to originate in the western portion of the “Last Ice Area” of the Arctic Ocean, off the northern coast of the Canadian Arctic Archipelago. The meteorological and oceanographic conditions that led to the anomalous southern incursion of the pack ice were analysed using gridded ERA5 wind data sets as well as the measured ice velocities from the moorings. Prolonged episodes of winds from the north, combined with the greater mobility of the pack ice in the Last Ice Area, contributed to the early incursions of pack ice into the eastern Beaufort Sea continental margin. The changing meteorological and sea

ice conditions may have implications for restricting regional late-summer ship movements in the future.

Session: 310 Changing Arctic: Science and Policy Studies - Part1 L’évolution de l’Arctique : études scientifiques et politiques - Partie 1

01/06/2021 13:15

ID: 11164 Contributed abstract

Poster Order:

Freshwater, heat, and volume fluxes through Barrow Strait in the Canadian Arctic Archipelago

Clark Richards [1] , *Shannon Nudds* [2] , *Doug Schillinger* [3]

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[2] DFO Bedford Institute of Oceanography
[3] DFO Bedford Institute of Oceanography

Presented by / Présenté par: ***Clark Richards***
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In 1998 the Canadian Department of Fisheries and Oceans (DFO) began a concerted effort to monitor ocean currents and water properties in Barrow Strait in the Canadian Northwest Passage. Barrow Strait (part of Lancaster Sound) is one of three pathways for export from the Arctic Ocean through the Canadian Arctic Archipelago (CAA). The resulting time series of freshwater and volume transports, measured continuously until 2011, has proven to be a critical measurement for understanding variability in downstream regions (particularly Baffin Bay, The Labrador shelf, and Eastern Canada) as well as an important diagnostic for validation of models of the Arctic region. Moored monitoring along the Barrow Strait transect was restarted in 2017, and data recovered in summer 2019 permit evaluation of trends and changes in variability of the fluxes in the intervening years. We present here an updated time series of water properties and fluxes from Barrow Strait, including a discussion of ice properties and ecosystem changes.

Session: 310 Changing Arctic: Science and Policy Studies - Part1 L’évolution de l’Arctique : études scientifiques et politiques - Partie 1

01/06/2021 13:30

ID: 10757 Contributed abstract

Poster Order:

Impacts of 1°, 2°, and 4°C of global warming on ship navigation in the Canadian Arctic

Lawrence Mudryk [1] , *Jackie Dawson* [2] , *Stephen Howell* [3] , *Chris Derksen* [4] , *Tom Zagon* [5] , *Mike Brady* [6]

[1] Environment and Climate Change Canada
[2] University of Ottawa
[3] Environment and Climate Change Canada
[4] Environment and Climate Change Canada
[5] Environment and Climate Change Canada
[6] Environment and Climate Change Canada

Presented by / Présenté par: ***Lawrence Mudryk***
Contact: lawrence.mudryk@canada.ca

Reductions in Arctic sea ice caused by climate change will create a more accessible Arctic, impacting trade and transportation and necessitating policy concerning environmental sustainability and Inuit governance. We present an analysis of climate model simulations to project changes in ship navigability at 1ºC, 2ºC, and 4ºC of global warming above preindustrial. In our analysis, we implemented the current operational criteria used by Arctic shipping companies (based on the Polar Code) to decide if a specific location is safe to navigate and applied that criteria to projected Canadian Arctic sea ice conditions throughout the 21st century. We assessed projected accessibility across a full range of ship classes at three levels of spatial granularity: broad-scale Canadian Arctic changes, changes to selected regions representative of Canadian supply routes, and community-level changes to seasonality which impact resupply for Canadian Northern residents. Results of the above analysis have numerous Canadian policy-related impacts which I will highlight: 1. Economic development: The largest increases in navigability occur in the Beaufort Sea indicating that this region has the potential to become a busier trade and transportation corridor in the future (navigable 100-200 days a year by 2ºC of warming). If fact, this may be a more viable region for trade development than the Northwest Passage. 2. Maritime disaster preparedness: Along some major trade routes, substantial increases to season length are possible if operators are willing to assume additional risk and operate under marginally unsafe conditions. In these circumstances, the desire to increase profit may promote increased risk and result in more rescue operations. 3. Inuit Governance: The potential for development in the Beaufort Sea and neighboring Inuvialuit region will require policy considerations and could realize improved economic self-determination in the Inuvialuit region if managed properly. 4. Food security: Local changes in accessibility for maritime resupply depend strongly on

matter greatly if changes are large enough to enable marine shipments more than once per year. This will lead to lower food prices and lower rates of food insecurity in the region, with cascading implications for local health outcomes and reduced carbon emission associated with air shipments. 5. Environmental sustainability: For some regions, increased navigation of certain ship classes can be expected to pose ecosystem-related concerns.

Session: 621 Extreme Events in the Coupled Climate System - Part 2 Événements extrêmes dans le système climatique couplé - Partie 2

01/06/2021 14:30

ID: 10666 Invited session speaker

Poster Order:

Green Sahara and its climatic consequence: from past to future

Francesco S.R. Pausata [1] , *Roberto Ingrosso* [2]

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Presented by / Présenté par: ***Francesco S.R. Pausata***
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In the Sahara and Sahel region, rainfall is closely linked to the intensity of the West African Monsoon (WAM), which is crucial for the socio-economic stability of millions of people living in sub-Saharan Africa. One of the most dramatic changes in the WAM occurred between 12,000–5,000 years BP, when increased summer rainfall led to an expansion of the North African lakes and wetlands and an extension of grassland and shrubland into areas that are now desert, giving origin to the so-called “Green Sahara” or African Humid Period. However, model experiments have not been able to fully reproduce the intensification and geographical expansion of the WAM during this period and its potential teleconnections has hardly been investigated. We will present how the feedbacks of land cover and the associated dust emission changes play a critical role in enhancing WAM strength and we will discuss the far afield impacts of such WAM intesification on the El Nino-Southern Oscillation (ENSO) variability, tropical cyclone (TC) activity as well as Arctic Amplification during the African Humid Period. The African Humid Period offers a great opportunity to learn from the past to get insights on and critically assess the global ramifications associated with a potential natural or geo-engineered regreening of Sahel and Sahara region. We will then present new results from high-resolution regional climate simulations and show how future global warming associated to geo-engineering projects of re-greening of the Sahel (e.g., building of the Great Green Wall) may alter the WAM strength and impact climate extremes in northern Africa.

Session: 621 Extreme Events in the Coupled Climate System - Part 2 Événements extrêmes dans le système climatique couplé - Partie 2

01/06/2021 15:00

ID: 10834 Contributed abstract

Poster Order:

The KPP Trigger of Rapid AMOC Intensification in the Nonlinear Dansgaard-Oeschger Relaxation Oscillation

Yuchen Ma [1] , *Yuchen Ma* [2] , *Deepak Chandan* [3]

[1] University of Toronto
[2] University of Toronto
[3] University of Toronto

Presented by / Présenté par: ***Yuchen Ma***
Contact: 599252578@qq.com

Millennium timescale Dansgaard-Oeschger (D-O) oscillations of glacial climate dominated climate variability during Marine Isotopic Stage 3 (MIS3), for which was first provided on the basis of oxygen isotopic data from a Greenland ice-core 25 years ago. Individual oscillations of the D-O cycle are characterized by an abrupt warming in Northern Hemisphere air temperature followed by a slow cooling back to cold “stadial” conditions. This highly non-linear oscillation of glacial climate has recently been shown to arise naturally in a fully coupled modern climate model. Diagnostic analysis of this simulation reveals that the fast transitions from cold stadial to warm interstadial conditions in a typical D-O oscillation are characterized by the appearance of a large polynya in the Irminger Sea region which opens due to the onset of intense vertical mixing below the sea ice lid. Through detailed stability analysis of the water column beneath the region where the polynya first forms, together with analysis of the parametrization of vertical diapycnal diffusivity implemented in the climate model (the KPP parametrization scheme), we show how the opening of the polynya can be controlled by the joint influence of different contributions to this parameterization scheme. We also perform further climate model simulations with different settings on diapycnal diffusivities and show that the characteristic period of the Dansgaard-Oeschger oscillation is also controlled by the detailed nature of this parameterization scheme.

Session: 621 Extreme Events in the Coupled Climate System - Part 2 Événements extrêmes dans le système climatique couplé - Partie 2

01/06/2021 15:15

ID: 10640 Contributed abstract

Poster Order:

Out of the Ice-Age: Tidally forced Ice Stream Instabilities and Extreme Climate Impacts

Jesse Velay-Vitow [1]

[1]

Presented by / Présenté par: ***Jesse Velay-Vitow***
Contact: jvitow@physics.utoronto.ca

In the 10,000 years preceding the Holocene interglacial, Canadian ice streams terminating in the Atlantic and Arctic oceans have apparently been rendered unstable by high amplitude tides. In the Atlantic, episodic collapses of the Hudson Strait Ice Stream are the most famous examples and have come to be referred to as Heinrich events. During such H events, large armadas of icebergs were released from the Hudson Strait which began to melt during transport by the North Atlantic Drift into the Greenland, Iceland and Norwegian Seas. The meltwater so produced led to a marked reduction in the strength of the Atlantic Meridional Overturning Circulation (AMOC) and a sharp cooling of (primarily) Northern Hemisphere climate. We present results suggestive that the lunar semidiurnal tide (M2), which was of significantly higher amplitude under glacial maximum conditions than it is at present, was responsible for triggering the H-instability process, and also provided continuous forcing of ice stream retreat thereafter, as recently described in Velay-Vitow, Peltier and Stuhne (JGR Oceans 2020). In the case of the most recent H event, termed H1, the resumption of the AMOC strength triggered the equally extreme Bolling-Allerod warming event. This strong warming, combined with a high amplitude M2 tide in the Arctic Ocean appears also to have forced a rapid disintegration of the Amundsen Gulf ice stream which filled the channel currently occupied by the MacKenzie River. This ice stream is important in the deglacial history of the Canadian land mass as it is the route through which meltwater from Lake Agassiz and other pro-glacial was later able to flow into the Arctic Ocean to trigger the onset of extreme northern hemisphere cooling associated with the Younger Dryas event as recently described in Velay-Vitow and Peltier (GRL 2020).

Session: 621 Extreme Events in the Coupled Climate System - Part 2 Événements extrêmes dans le système climatique couplé - Partie 2

01/06/2021 15:30

ID: 10891 Contributed abstract

Poster Order:

Near and far-field expressions of Heinrich events and Dansgaard-Oeschger oscillations

Deepak Chandan [1] , *Jesse Velay-Vitow* [2]

[1] University of Toronto
[2] University of Toronto

Presented by / Présenté par: ***Deepak Chandan***
Contact: dchandan@atmosp.physics.utoronto.ca

The Dansgaard-Oeschger (DO) events were extreme climate oscillations during Marine Isotope Stage 3 during which the climate of the North Atlantic experienced several rapid transitions between stadial (glacial) and interstadial (interglacial) phases. These oscillations are best recorded in the ice-cores that have been retrieved from the Greenland ice sheet and which show transitions in local surface air temperature of ~15C on millennium timescale. Based on contemporaneous records obtained from sedimentary cores in the North Atlantic it is now understood that these oscillations were themselves triggered by yet another extreme phenomenon active during glacial climates -- Heinrich events. While the Greenland ice sheet preserves the best record of changes associated with these events, the impacts of these events were not limited to the vicinity of the North Atlantic and several climate proxies record local climate variations in phase with the DO cycles at far off places. Understanding the ability of climate models to replicate both the recorded near- and far-field influences of these extreme events occurring in the North Atlantic is clearly of relevance to our ability to forecast the effects of any tipping-point changes in the North Atlantic overturning circulation that has be argued as a probable outcome of ongoing anthropogenic warming. Fortunately, these climatic phenomena have recently been shown to be reproduced in a fully coupled model of atmosphere-ocean-sea ice dynamics and which provides us with the opportunity to study the spatially coherent patterns of changes these events induce. Here we show the impacts of these extreme events on the climate in the vicinity of the North Atlantic and in localities that are far removed and compare the modeled predictions to proxy-inferences where such inferences are available.

Session: 621 Extreme Events in the Coupled Climate System - Part 2 Événements extrêmes dans le système climatique couplé - Partie 2

01/06/2021
15:45

ID: 10917 Contributed abstract

Poster Order:

Extreme weather characteristics over the Eastern Mediterranean during the mid-Holocene inferred from a dynamical downscaling experiment

Fengyi Xie [1] , *Deepak Chandan* [2]

1

2

Presented by / Présenté par: ***Fengyi Xie***

Contact: fengyi.xie@mail.utoronto.ca

The mid-Holocene (~7000 - 5000 years before present) was a period when humanity rapidly flourished and transitioned from a hunter-gatherer lifestyle to one based on settled farming. City-states emerged during this period in the Levant and the surrounding regions of the Eastern Mediterranean, because of which the region is referred to as the 'cradle of civilization'. Settlement locations were not decided at random, rather, the availability of water (for consumption and for crops) and access to hunting or farming grounds were some of the critical factors that were considered in the decision process. These factors were dictated by the mid-Holocene climate, which was different from the climate today because of differences in the Earth's orbital parameters. Global climate models can be used to study the large-scale differences between the climates of today and the mid-Holocene, however, model results at very high spatial and at very high temporal resolutions are necessary if one wants to infer the local climatological features, as well as the extreme weather patterns that are characteristic of the mid-Holocene climate. This can be accomplished by using a high-resolution regional atmospheric model (WRF) to dynamically downscale the mid-Holocene climate simulated by a global coupled-climate model (CESM). Here, we discuss results on the extreme weather characteristics of the mid-Holocene climate obtained from this highly complex dynamical downscaling effort.

Session: 251 General Session - Weather - Part 2 - Air Quality studies Séance générale — La météorologie - Partie 2 - Étude sur la qualité de l'air

01/06/2021
14:30

ID: 10762 Contributed abstract

Poster Order:

The Chemically Coupled ECCC Global Deterministic Prediction System (GDPS): The impact of ozone radiative coupling on weather forecasting

Jean de Grandpre [1] , *Yves Rochon* [2] , *Irena Ivanova* [3] , *Michael Sitwell* [4] , *Matt Reszka* [5] , *Caroline Jouan* [6] , *Paul Vaillancourt* [7] , *Sylvain Menard* [8]

[1] ECCC, AQRD, Dorval
[2] ECCC, AQRD, Downsview
[3] ECCC, AQRD, Dorval
[4] ECCC, AQRD, Downsview
[5] ECCC, CMC, Dorval
[6] ECCC, CMC, Dorval
[7] ECCC, MRD, Dorval
[8] ECCC, CMC, Dorval

Presented by / Présenté par: ***Jean de Grandpre***
Contact: jean.degrandpre@canada.ca

The stratosphere is an important component of numerical weather prediction systems. A comprehensive representation of stratospheric processes is necessary to improve the assimilation of satellite observations, which is the core of today's assimilation systems. The inclusion of ozone as a prognostic and radiatively coupled constituent is one of the key steps toward a comprehensive modelling of stratospheric processes. It allows models to simulate the complex dynamical-radiative and photochemical interactions needed for improving the representation of the mean state and variability of the stratosphere. In this study we will present an evaluation of the ozone coupled version of the ECCC Global Deterministic Prediction system. The system includes the assimilation of real time ozone measurements from several nadir viewing instruments such as OMI, GOME-2 and OMPS as well as ozone profiles from the MLS instrument. The associated forecast model (GEM) includes a linearized on-line photochemical module which computes ozone production and sink terms at every time step. The resulting meteorological forecasts were evaluated in different regions and at various lead times against analyses and observations during summer and winter periods. The overall benefits associated with the implementation of an ozone coupled version of GEM in the operational ECCC global deterministic system will be discussed.

ID: 10990 Contributed abstract

Poster Order:

The Chemically Coupled ECCC Global Deterministic Prediction System (GDPS): Evaluation of ozone analyses and forecasts.

Caroline Jouan [1] , *Yves Rochon* [2] , *Jean DeGrandpré* [3] , *Mateusz Reszka* [4] , *Michael Sitwell* [5] , *Irena Ivanova* [6]

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Presented by / Présenté par: ***Caroline Jouan***
Contact: Caroline.Jouan@canada.ca

Ozone analyses and forecasting systems rely on the assimilation of different types of measurements obtained from nadir viewing and limb sounding instruments. The assimilation of integrated measurements from the former instruments is necessary to constrain the analyses of total ozone columns whereas the assimilation of profiles is required to constrain the ozone vertical distribution. The characteristics of the assimilated observational datasets determine the quality of the ozone analyses and forecasts. This is particularly important in the context of the development of ozone-radiation coupling, in which ozone is a prognostic constituent used for the computation of heating rates, in a numerical weather prediction system. In this study, the ECCC GDPS is used for evaluating the impact of assimilating various observational datasets on the quality of ozone analyses and forecasts, in different regions including the Upper Troposphere and Lower Stratosphere regions where the ozone predictably extends to several days. Several assimilation cycles are performed using different choice of satellite ozone retrievals including total and partial ozone columns and ozone profiles retrieved from the Microwave Limb Sounder (MLS) instrument. The performance of the chemical data assimilation and forecasting system is evaluated over summer and winter periods and

based Brewer spectrophotometers and additional measurements from the Optical Spectrograph and InfraRed Imaging System (OSIRIS) and from the Atmospheric Chemistry Experiment – Fourier Transform Spectrometer (ACE-FTS) satellite instruments.

Session: 251 General Session - Weather - Part 2 - Air Quality studies Séance générale — La météorologie - Partie 2 - Étude sur la qualité de l'air

01/06/2021 15:00

ID: 11115 Contributed abstract

Poster Order:

The ECCC Chemically Coupled NWP System: Parametrization of Ozone Depletion Processes

Irena Ivanova [1] , *Jean de Grandprés* [2] , *Yves Rochon* [3] , *Mateusz Reszka* [4] , *Paul Vaillancourt* [5] , *Caroline Jouan* [6] , *Michael Sitwell* [7] , *Sylvain Menard* [8]

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[7] Environment and Climate Change Canada, Air Quality Research Division, Modeling & Integration Research Section (ARQI), Toronto, Canada
[8] Environment and Climate Change Canada, Meteorological Service of Canada, National Predictions Development Division (CMDD), Numerical Weather Predictions Section (CMDN), Dorval, Canada

Presented by / Présenté par: ***Irena Ivanova***
Contact: irena.ivanova@ec.gc.ca

The Environment and Climate Change Canada (ECCC) Global Deterministic Prediction System (GDPS) is being upgraded to allow for the data assimilation and modeling of chemically reactive gases, with the goal to improve the numerical forecasting of weather, air quality and the UV index. The initial approach for the reactive gases was to target stratospheric ozone, for its radiative impact, and to build a "coupled system" where the chemical scheme was coupled to the GDPS improving the systems ability to represent interactions between meteorology and chemistry. The weather forecast model is the Global Environment Multiscale (GEM) model. For stratospheric ozone, the chemical tendencies above the tropopause are computed by the linearised photochemical scheme LINOZ. The coupling between composition and weather is through the prognostic ozone field from LINOZ, which is used in the GEM radiation scheme, while the previous model used ozone climatology in the radiation scheme. In parallel with the model system, the use of observations in the 3D-Var ozone data assimilation system also evolved to include real time measurements of total and partial ozone columns from various instruments as well as ozone profiles from MLS. The chemically coupled GDPS system has been running experimentally in near-real time since June 2019, providing daily analyses and forecasts of stratospheric ozone and UV index at 25km resolution and 84 vertical levels. Validation of forecasting cycles against various observational dataset show that the impact of ozone assimilation on the meteorology is not insignificant and lead to overall improvement of the medium range forecasts at various lead times depending on the region in both winter and summer seasons. The capability of the coupled system to capture the 2020 Arctic and Antarctic ozone depletion events will be evaluated against ozone observations and independent analyses. The role of the heterogeneous chemistry and the polar vortex dynamics during the ozone depletion events and their impact on ozone forecasts will be discussed.

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01/06/2021 15:15

ID: 11197 Contributed abstract

Poster Order:

The September 2020 wildfire smoke event: meteorology and societal impacts on North America’s West Coast

Armel Castellan [1] , *Robert Nissen* [2] , *Johanna Wagstaffe* [3] , *Sarah Henderson* [4]

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[3] MSC partner with CBC
[4] BCCDC

Presented by / Présenté par: ***Armel Castellan***
Contact: Armel.Castellan@canada.ca

The 2020 wildfire season in British Columbia was quiet (4.3% of normal hectares burned), with only a handful of Fires of Note, mainly in August. However, a remarkable wildfire smoke episode occurred in September as a consequence of a massive wildfire outbreak in the western United States. Strong, easterly outflow winds carried thick smoke plumes from Washington, Oregon and northern California over the Pacific Ocean. The wildfire plumes subsequently curved towards the north and back east, invading the southern coast of British Columbia. The cold surface waters of the Pacific Ocean contributed to low-level temperature inversions, which strongly restricted vertical dispersion. Compared to July and August, the longer nights of September helped prolong the low-level temperature inversions. Further restrictions to visibility were a product of hygroscopic growth of smoke particles due to high relative humidities. As a result, multi-day average PM2.5 concentrations for the heavily populated southern Vancouver Island and Lower Mainland exceeded the worst multi-day averages from the record-breaking 2017 and 2018 wildfire seasons. Total hours of restricted visibilities over the 10-day event due to smoke were almost double those of 2018. This event attained the number 2 ranking for David Phillip's top 10 weather events of Canada for 2020. Temporarily, local and international media made legitimate comparisons of "world's worst air quality" between Vancouver/Portland/San Francisco to the usual suspects in India and China. Smoky days were associated with an approximately 50% increase in acute respiratory health outcomes, such as physician visits for asthma. In this presentation, we will discuss an overview of the anomalous nature of this smoke event, the significant societal impacts and the continued educational responsibility Environment and Climate Change Canada, air quality stakeholders and media all have.

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01/06/2021 15:30

ID: 11106 Contributed abstract

Poster Order:

The September 2020 wildfire smoke episode: air quality impacts and context for British Columbia's Interior

Robert Nissen [1] , *Keith Jones* [2]

[1] Environment and Climate Change Canada
[2] Environment and Climate Change Canada

Presented by / Présenté par: ***Robert Nissen***
Contact: robert.nissen@canada.ca

The 2020 wildfire season in British Columbia was much less active than a typical year with only a few wildfires of note mainly in July and August. However, a remarkable wildfire smoke episode occurred in September primarily as a consequence of massive wildfire outbreaks occurring over the western United States. The wildfire plumes invaded the British Columbia Interior from the south. Near the international border, 6-day average PM&sub2.5; concentrations were up to nine times the British Columbia 24-hour air quality objective. Compared to July and August, the longer nights of September contributed to stronger low-level temperature inversions, which impaired dispersion, especially in the deeper valleys. However, impacts decreased further north, with only 23 hours of PM&sub2.5; concentrations exceeding 25 μg m&sup-3;. Low to mid-level winds gradually advected the smoke plume to the east, thereby ending the episode. It is informative in the analysis of this event to compare with previous wildfire smoke episodes, especially the 2017 and 2018 extreme wildfire smoke seasons, to gain context. Early analyses indicate this event was comparable to the 2017 and 2018 seasons for some short-term PM&sub2.5; concentration metrics in the southern Interior. A more detailed analysis involving different intensity-duration thresholds is underway, and will be included in the presentation.

Session: 251 General Session - Weather - Part 2 - Air Quality studies Séance générale — La météorologie - Partie 2 - Étude sur la qualité de l'air **01/06/2021 15:45**

ID: 10732 Contributed abstract

Poster Order:

An analysis of the September 2020 Smoke Event on the Canadian Prairies

Bob Kochtubajda [1] , *Curtis Mooney* [2]

[1] ECCC - Meteorological Service of Canada
[2] ECCC - Meteorological Service of Canada

Presented by / Présenté par: ***Bob Kochtubajda***
Contact: bob.kochtubajda@canada.ca

The September 2020 smoke event affected several regions of Canada. This study examines the event and its impacts on the Canadian Prairies using

various data sets including satellite data, upper air soundings, surface observations and numerical weather prediction output. Synoptic analyses, back trajectory calculations and satellite imagery indicate that the smoke transported to the Prairies originated from the wildfires in Washington, Oregon and California. The impact in Alberta of smoke from the forest fires led to prolonged visibility reductions and periods of reduced air quality and elevated concentrations of particulate matter smaller than 2.5 μm in diameter (PM2.5). For example, the weather station at the Calgary International Airport (YYC) reported 105 h of forest fire smoke between September 14 and 21, and visibilities between 6 and 8 km. Smoke in September at YYC is unusual. The average number of smoke hours is 7.9 h (based on data from 2010-2019). The 24-h average Alberta Ambient Air Quality Objective (AAAQO) for PM2.5 is 29 μg m-3 based on health effects. Daily average PM2.5 concentrations on September 18 and 19 at the Calgary Central-Inglewood, Calgary Southeast, and Calgary-Varsity monitoring sites varied from 34.0 μg m-3 to 42.2 μg m-3 which exceed the PM2.5 24-h AAAQO. Health effects of the event will also be reviewed.

Session: 251 General Session - Weather - Part 2 - Air Quality studies Séance générale — La météorologie - Partie 2 - Étude sur la qualité de l'air

01/06/2021 16:00

ID: 11194 Contributed abstract

Poster Order:

Environment and Climate Change Canada’s FireWork wildfire air quality forecast model analysis for the 2020 fire season and recent developments

Jack Chen [1] , *Ayodeji Akingunola* [2] , *Kerry Anderson* [3] , *Peter Englefield* [4] , *Paul Makar* [5] , *Daniel Thompson* [6] , *Rita So* [7] , *Debora Griffin* [8] , *Mike Moran* [9] , *Rodrigo Munoz-Alpizar* [10] , *Konstantinos Menelaou* [11]

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[9] Air Quality Research Division, Environment and Climate Change Canada
[10] Meteorological Service of Canada, Environment and Climate Change Canada
[11] Meteorological Service of Canada, Environment and Climate Change Canada

Presented by / Présenté par: ***Jack Chen***
Contact: jack.chen@canada.ca

2020 was an unprecedented year in many aspects; despite historically low wildland fire activity across Canada, it was a record-breaking, disastrous fire year for many regions in the U.S. Extreme wildland fires consumed close to 3 million hectares of forests over the three western states: Washington, Oregon and California. Smoke from fires contributed to significant air quality degradation across the region. Several episodes of high PM2.5 concentrations and poor visibility were observed over western Canadian cities and provinces. Since 2016, Environment and Climate Change Canada's FireWork numerical air quality modelling system has been providing forecast guidance including the results of wildland fire events across North America. FireWork is a collaborative system with the Canadian Forest Service's Canadian Wildland Fire Information System (CWFIS) and Canadian Forest Fire Emissions Prediction System (CFFEPS) providing near-real-time fire information. The system captured several extreme air quality episodes in September 2020 as result of wildfire smoke. In this work, we will present an analysis of FireWork's model forecasts on the September 2020 episodes with air pollutant measurement comparisons and modelled visibility parameters. We will show recent developments in the treatments of wildfire emissions and results on the sensitivity to model configurations.

Session: 731 Producing, Providing and Communicating Useful Climate Information - Part 2 Produire, fournir et communiquer des informations climatiques utiles - Partie 2 **01/06/2021 14:30**

ID: 10652 Invited session speaker

Poster Order:

Evaluation and Quality Control Function of the Copernicus Climate Data Store

Carlo Lacagnina [1] , *Francisco J. Doblas-Reyes* [2]

[1] Barcelona Supercomputing Center (BSC)
[2] Barcelona Supercomputing Center (BSC)

Presented by / Présenté par: ***Carlo Lacagnina***
Contact: carlo.lacagnina@bsc.es

The Climate Data Store (CDS) is the cornerstone of the Copernicus Climate

Change Service (C3S). The CDS provides comprehensive information on past, present and potential future climate for a diverse range of users. The CDS delivers a number of climate datasets, including Essential Climate Variables (ECVs) from satellite and in-situ observations, as well as climate projections, seasonal forecasts and reanalyses. Tailored climate indicators derived from specific sectoral needs (e.g. water, energy, agriculture, etc.) are also provided. These indicators are generated by the Sectoral Information System (SIS) component of C3S, which aims to demonstrate best practice in the use of C3S data and information for sectoral applications. The Evaluation and Quality Control (EQC) function of the C3S provides a user-led overarching EQC service for the whole CDS. In particular, the EQC for CDS function aims to (i) provide information about the technical and scientific quality and fitness-for-purpose of the data and (ii) map evolving user needs into viable user requirements to ensure a user-oriented evolution of the CDS. Importantly, the EQC function defines a consistent framework based on common protocols and workflows for the provision of quality assurance information of C3S datasets (product generation, user documentation, uncertainty characterization, known issues, etc.). Furthermore, an independent evaluation of the quality of these datasets ensures that the information is robust and sufficient for users to judge the fitness for purpose of the data for their application. The results of EQC activities are constantly updated and presented in a homogeneous way for all data on the CDS catalogue. The EQC information is summarized in a table providing a quick overview of the dataset, through which detailed reports for the different elements of the EQC process can be accessed. In this way the CDS guides the users to the specific information of interest. Besides the option of downloading datasets, the CDS also provides interactive processing software (the Toolbox), which allows users to create applications and visualizations based on the data content of the CDS. The EQC function assesses documentation and technical methods of the Toolbox components, building on internationally-recognized standards for software quality. In addition, the EQC activities provide guidelines towards the future extensions of the Toolbox that support the traceability and reproducibility of both the data and the methods. Finally, the EQC function is completed by the continuous monitoring of the overall quality of the CDS service through key performance indicators (KPIs) made available in a dashboard under development. As the C3S is a user-driven climate service, continuous monitoring includes measuring users' satisfaction with the CDS. This is achieved through the user requirement assessment, resulting in recommendations periodically developed for improvement and expansion of the CDS datasets, products and infrastructure, indicators and applications. Therefore, the EQC activities are essential for the C3S to guarantee the usability of its authoritative information. This presentation will show an end-to-end holistic approach that the EQC function is building to become an integral and operational component of the C3S.

ID: 10745 Contributed abstract

Poster Order:

Fitting Centuries' old Historical Weather Data to Modern Standards

Victoria Slonosky [1] , *Renée Sieber* [2] , *Frédéric Fabry* [3]

[1] McGill University
[2] McGill University
[3] McGill University

Presented by / Présenté par: ***Victoria Slonosky***
Contact: victoria.slonosky@mail.mcgill.ca

Historical weather observations comprise an important source for climate research as they provide comparisons to current and future conditions. To be able to compare past observations to present ones, we need to be able to convert past measurements into common standard formats. Historically, weather observations were measured with different instruments; past standards are not always compatible with modern data standards. Some data correction processes such as pressure adjustment have changed over time as knowledge of physics and measurements of altitude have been refined; observations such as cloud type or weather phenomena can be difficult to convert. As part of the McGill DRAW (Data Rescue: Archives and Weather) project, we are transcribing 100 years of McGill Observatory logbooks and exporting them into SEF (station exchange format), which has been recognized as the standard for data rescue by the European Copernicus Programme. In anticipation of emergent standards, we built in traceability for quality control of historical weather content. Traceability enables a piece of information to be tracked through the entire data rescue process, from register book to scanned image (see also the MSC historical image project) to transcription to final export. Certain aspects of traceability are not easily compatible with all export formats; additional concepts may need to be retrofitted so data transformation accommodates new standards. This work reveals the need to document and account for the changing practices in data collection and processing. We conclude with thoughts on tools needed for local data production, and potential conflicts with international standardization.

Useful Climate Information - Part 2 Produire, fournir et communiquer des informations climatiques utiles - Partie 2 **15:15**

ID: 11028 Contributed abstract

Poster Order:

Producing and evaluating a Canada-wide dataset of future fire weather projections

Laura Van Vliet [1] , *Jeremy Fyke* [2] , *Piyush Jain* [3] , *Carrington Pomeroy* [4] , *Derek Van der Kamp* [5]

[1] Environment and Climate Change Canada
[2] Environment and Climate Change Canada
[3] Natural Resources Canada
[4] Environment and Climate Change Canada
[5] Natural Resources Canada

Presented by / Présenté par: ***Laura Van Vliet***
Contact: jeremy.fyke@canada.ca

The Canadian Centre for Climate Services (CCCS) provides access to climate information in order to enable Canadians to become more resilient to climate change. Wildfire risk, and changes to this risk resulting from climate change, is of key concern. Wildfire causes some of the most expensive natural disasters in Canada in terms of insured damages (including the most expensive, the 2016 Fort McMurray wildfire). Wildfires are demonstrably increasing in likelihood and severity, and this change can be unequivocally linked to human-induced climate change. Working with the Canadian Forest Service, CCCS is producing preliminary historical and future fire weather index (FWI) projections across Canada based on the multivariate-bias-corrected CanLEADv1, a 50 member ensemble derived from CanESM2 and CanESM2-driven CanRCM4 simulations on a 0.5-degree grid. This talk will explore the methods for production and evaluation of fire weather projections for Canada and present preliminary results. To validate results and identify biases, historical CanLEAD-FWI output is evaluated against independent observation-based FWI that use in-situ station data. Inputs to the FWI system and challenges in estimating the required meteorological variables from limited model output will be discussed.

Session: 731 Producing, Providing and Communicating Useful Climate Information - Part 2 Produire, fournir et communiquer des informations climatiques utiles - Partie 2 **01/06/2021 15:30**

ID: 11120 Contributed abstract

Poster Order:

Towards standardized access to UVic’s wave measurements from the BC Coast.

Clayton HIles [1] , *Brad Buckham* [2] , *Pramod Thupaki* [3]

[1] The Univesity of Victoria
[2] The University of VIctoria
[3] Hakai Institute

Presented by / Présenté par: ***Clayton HIles***
Contact: cehiles@uvic.ca

Surface gravity waves are among the most important environmental factors which drive design of engineering systems in the coastal zone. Detailed knowledge of wave conditions is becoming increasingly important as the climate norms of the past century are upset by climate change and sea level rise. Wave measurements are needed close to shore to better understand the impacts of wave conditions on engineering systems in the coastal zone. Furthermore, those measurements must be sufficiently detailed and documented so that trends in the climate might be detected. UVic’s Pacific Regional Institute for Marine Energy Discovery is an industrial research lab supporting the development of marine renewables in BC. This group has been operating a wave observation network on the BC West Coast for over a decade. The resulting data archive is now hundreds of gigabytes, and contains data from a multitude of different stations, platforms, and sensors. Currently the size of the data archive, the multitude of file formats, and the ad-hoc nature of meta-data documentation presents a significant barrier for researchers looking to use of this wave data to support their work. This presentation will provide an overview of UVic’s efforts to standardize it’s wave data archive to adhere to Climate Forecast and NCEI NetCDF conventions, including embedded meta-data. Some shortcomings of current standards as applied to wave data will be discussed. The presentation will also briefly cover a collaborative effort, including UVic and Hakai Institute, to make UVic's wave data available to the wider research community though the Canadian Integrated Ocean Observing System (CIOOS). Finally, the utility of data standardization and the CIOOS ERRDAP server will be demonstrated though several examples.

Session: 821 Computational Methods, Machine Learning, and Model Development - Part 2 Méthodes computationnelles, apprentissage machine et développement de modèles - Partie 2

01/06/2021
14:30

ID: 11118 Contributed abstract

Poster Order:

Assessing Uncertainty in Ocean Surface Drift Prediction using Fuzzy Numbers

Hauke Blanken [1] , *Caterina Valeo* [2] , *Charles Hannah* [3] , *Usman Khan* [4] , *Tamas Juhasz* [5]

[1] University of Victoria/Fisheries and Oceans Canada
[2] University of Victoria
[3] Fisheries and Oceans Canada
[4] York University
[5] Fisheries and Oceans Canada

Presented by / Présenté par: ***Hauke Blanken***
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A fuzzy number-based method is proposed to propagate uncertainties in surface drift prediction through a trajectory model. This model is used to explore the effect of parameterizing direct wind drag on the drifting object based on its geometry, and using measured winds to parameterize shear and rotational dynamics in the ocean surface currents along with wave-driven circulation and near-surface wind shear. Parameterizations are formulated in a deterministic manner that avoids the commonly required specification of empirical leeway coefficients. Observations of ocean currents and winds at Ocean Station Papa in the northeast Pacific are used to force the trajectory model in order to focus on uncertainties arising from physical processes. Computed trajectories are compared against observed trajectories from five different types of surface drifters, and optimal combinations of forcing parameterizations are identified for each type of drifter. The model performance is assessed using a novel skill metric that combines traditional assessment of trajectory accuracy with penalties for overestimation of uncertainty. When using optimal parameterizations, the model is shown to correctly identify the area in which drifters are expected to be found for the majority of a seven day simulation. Early results of efforts to include forcing from hydrodynamic models in this method are also discussed.

Session: 821 Computational Methods, Machine Learning, and Model Development - Part 2 Méthodes computationnelles, apprentissage machine et développement de modèles - Partie 2 **01/06/2021 14:45**

ID: 10850 Contributed abstract

Poster Order:

Are we minimizing the appropriate errors in data assimilation for weather forecasting?

Frederic Fabry [1] , *Valentina Glazatov* [2]

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Presented by / Présenté par: ***Frederic Fabry***
Contact: frederic.fabry@mcgill.ca

Data assimilation approaches and algorithms generally seek to minimize errors on model fields at analysis time and at the resolution of the model to help reduce forecast errors. While this is the best assimilation strategy to improve analyses, does it lead to the best forecasts? If not, what error minimization criterium should be used for smaller initial condition errors to result in improved forecast skill? Four criteria were considered, as well as their combination: lower errors at analysis time, at two times, on smoothed fields, and on time tendencies. Existing forecasts from the Canadian Global Ensemble Prediction System were analyzed to determine the extent with which lower errors in different types of initial condition errors were associated with better forecasts. Best short-term forecasts (<3 days) are obtained when errors on initial condition values at analysis time are the lowest; however, best longer-term forecasts arise from analyses that had the lowest errors on the 12-hr tendencies prior to analysis time. In parallel, having lower errors at two times simultaneously (at analysis time and 12 hrs before) or on smoothed fields proved a worse strategy than minimizing errors on initial condition values for all forecast times. These findings suggest that the error minimization strategy to be used at assimilation may need to change depending on the type of forecasts sought, and emphasize the value of also minimizing tendency errors, not errors at multiple times.

Session: 821 Computational Methods, Machine Learning, and Model Development - Part 2 Méthodes computationnelles, apprentissage machine et développement de modèles - Partie 2 **01/06/2021 15:00**

ID: 11236 Contributed abstract

Poster Order:

Evaluating the Effects of Storage-and-Release Events on Aircraft-based Mass-Balance Methodology Using a Regional Air Quality Model

Sepehr Fathi [1] , *Mark Gordon* [2] , *Paul Makar* [3] , *Ayodeji Akingunola* [4] , *Andrea Darlington* [5] , *John Liggio* [6] , *Katherine*

Hayden [7] , *Shao-Meng Li* [8]

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Presented by / Présenté par: ***Sepehr Fathi***
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We investigate uncertainties in algorithms used to retrieve emissions from aircraft observations using a combination of the Top-down Emission Rate Retrieval Algorithm (TERRA) and a regional chemical transport model, Environment and Climate Change Canada's Global Environmental Multiscale – Modelling Air-quality and CHemistry (GEM-MACH). Emissions retrieval algorithms such as TERRA, where the mass-balance approach is utilized, require specific conditions in order to generate emission estimates from aircraft observations – essentially, that meteorological conditions and source emission rates are relatively constant during the time of the observations. Here, we investigate the impact of meteorological variability on emissions retrieval accuracy, by using GEM-MACH output as a proxy for real world chemical and meteorological fields, in which simulated aircraft sampling of the GEM-MACH output were used for input into TERRA. This approach allows the state of the atmosphere used for TERRA inputs to be characterized in time and 3D space; the input meteorology and chemistry is "known", and thus potential means for improving TERRA emissions retrievals and determining the factors affecting retrieval accuracy may be investigated. Comparisons between GEM-MACH meteorology and input emissions and the resulting TERRA retrievals were made to show that emissions retrieval accuracy can be predicted via three key a priori determined criteria during the observation sampling period: (1) changes to the gradient Richardson number, (2) variations in the wind direction at plume height, and (3) upwind to downwind concentration ratio, when weighted by the ratio of upwind to downwind concentration standard deviation. We show that cases where these criteria indicate high variability or high upwind emissions can

result in “storage-and-release” events within the sampled region, which decrease emission retrieval accuracy. TERRA has been previously applied only to cases under relatively time-invariant conditions and thus avoided these uncertainties. The range of meteorological conditions considered here also shows that storage-and-release may adversely affect TERRA emission retrievals; the criteria provide a useful means for predicting retrieval accuracy in advance. We also introduce a flight strategy whereby emissions retrieval uncertainties associated with storage-and-release may greatly be reduced – doubling flights over a given facility in order to measure and account for the factors associated with storage-and-release, by estimating the temporal trends in the evolution of the system during the flight/sampling time.

Session: 821 Computational Methods, Machine Learning, and Model Development - Part 2 Méthodes computationnelles, apprentissage machine et développement de modèles - Partie 2 **01/06/2021 15:15**

ID: 10669 Contributed abstract

Poster Order:

A Tide-Surge model of the Northwest Atlantic - measures of performance and sensitivity studies

David Greenberg [1] , *Florent Lyard* [2]

[1] Bedford Istitute of Oceanography
[2] LEGOS, CNRS

Presented by / Présenté par: ***David Greenberg***
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We have developed an efficient finite-element tide-surge model for the Northwest Atlantic. It can compute the sea levels for over a year in three hours on a decent laptop computer. It does a reasonable job of predicting the full tide-surge water level and the residual signal when the predicted tide is removed. We look at several different methods for evaluating the accuracy of the model and consider methods to improve extreme water level predictions. Sensitivity tests show how the different components of the tidal and meteorological forcing influence the solutions.

Session: 821 Computational Methods, Machine Learning, **01/06/2021**

and Model Development - Part 2 Méthodes computationnelles, apprentissage machine et développement de modèles - Partie 2 15:30

ID: 10630 Contributed abstract

Poster Order:

WAVETRISK-OCEAN: an adaptive dynamical core for ocean modelling

Nicholas Kevlahan [1]

[1]

Presented by / Présenté par: ***Nicholas Kevlahan***
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This talk introduces WAVETRISK-OCEAN, an incompressible version of the atmosphere model WAVETRISK. This new model is built on the same wavelet-based dynamically adaptive core as WAVETRISK, which itself uses DYNAMICO's mimetic vector-invariant multilayer shallow water formulation. Both codes use a Lagrangian vertical coordinate with conservative remapping. The ocean variant solves the incompressible multilayer shallow water equations with a Ripa type thermodynamic treatment of horizontal density gradients. Time integration uses barotropic-baroclinic mode splitting via an implicit free surface formulation, which is about 15 times faster than explicit time stepping. The barotropic and baroclinic estimates of the free surface are reconciled at each time step using layer dilation. No slip boundary conditions at coastlines are approximated using volume penalization. Results are presented for a standard set of ocean model test cases adapted to the sphere (seamount, upwelling and baroclinic jet) as well as turbulent wind-driven gyre flow in simplified geometries. An innovative feature of WAVETRISK-OCEAN is that it could be coupled easily to the WAVETRISK atmosphere model, providing a simple integrated Earth system model using a consistent modelling framework.

Session: 821 Computational Methods, Machine Learning, and Model Development - Part 2 Méthodes computationnelles, apprentissage machine et développement de modèles - Partie 2 **01/06/2021 15:45**

ID: 10675 Contributed abstract

Poster Order:

Instabilities and noise in implicit, semi-Lagrangian integration of the shallow water equations

Christopher Subich [1]

[1] Environment & Climate Change Canada

Presented by / Présenté par: ***Christopher Subich***
Contact: christopher.subich@canada.ca

Fully or semi-implicit semi-Lagrangian integration is a well-understood, widely-applied technique for the integration of the Euler equations of atmospheric motion. In this method, advection of mass and momentum is treated in a coordinate system following fluid motion, while gravity and sound waves are treated in an Eulerian frame with fully or partially-implicit treatment of the forcing terms. This approach is considered stable for large timesteps, allowing forecasts to use timesteps associated with Courant numbers much larger than 1. However, proofs of the stability of this method rely on restrictive lienarizations of the flow, generally about a state of rest or of uniform motion. This work illustrates the limitation of this analysis using the one-dimensional shallow water equations as a model. When linearized about a steady-state flow over topography, the resulting discrete equations show a variety of linear instabilities related to a generalized orographic resonance and to combined spatial/temporal frequency aliasing. These linear instabilities may evolve to manifest as high-frequency "noise" that plagues atmospheric forecasts with insufficient diffusion or dissipation.

Session: 311 Changing Arctic: Science and Policy Studies - Part 2 L'évolution de l'Arctique : études scientifiques et politiques - Partie 2

01/06/2021 14:30

ID: 10788 Contributed abstract

Poster Order:

Changing sea-ice ecosystems and associated ecosystem services

Nadja Steiner [1] , *Jeff Bowman* [2] , *Karley Campbell* [3] , *Eeva Eronen-Rasimus* [4] , *Marianne Falardeau* [5] , *Hauke Flores* [6] , *Agneta Fransson* [7] , *Melissa Chierici* [8] , *Helena Herr* [9] , *Stephen Insley* [10] , *Hanna Kauko* [11] , *Delphine Lannuzel* [12]

[1] Fisheries and Oceans Canada
[2] Scripps Institution of Oceanography
[3] The Arctic University of Norway
[4] University of Helsinki
[5] Université Laval
[6] Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung

[7] Norwegian Polar Institute
[8] Institute of Marine Research
[9] Center of Natural History (CeNak), Universität Hamburg,
[10] Wildlife Conservation Society Canada
[11] Norwegian Polar Institute
[12] Institute for Marine and Antarctic Studies

Presented by / Présenté par: ***Nadja Steiner***
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Climate change related changes to the sea-ice and snow system include changes in thickness, extent, consistency, light transmission, and biogeochemical processes, all of which impact the sea-ice ecosystem. The sea-ice ecosystem in turn supports all four key ecosystem services. Supporting services are provided in the form of habitat, including feeding grounds and nurseries for microbes, meiofauna, fish, birds and mammals. The key species Arctic cod (Boreogadus saida) and Antarctic krill (Euphausia superba) are tightly linked to the sea-ice ecosystem and transfer carbon from sea-ice primary producers to higher trophic level fish, mammal species and humans. Through, harvesting and the supply of potential medicinal products and genetic resources, the system contributes to provisioning services. The sea-ice scape and its biology provide a multitude of cultural services, such as inspiration and attraction for cultural activities, tourism and research, and provide the base for Indigenous and local knowledge systems, cultural identity and spirituality. In addition, the sea-ice ecosystem contributes to climate regulating services through light regulation, the production of biogenic aerosols, halogen oxidation and the release or uptake of greenhouse gases, such as carbon dioxide. The ongoing changes in the polar regions have large impacts on sea-ice ecosystems and the ecosystem services sea ice provides to society. While the response of sea-ice associated primary production to environmental change is regionally variable, the effect on ice-associated mammals and birds are predominantly negative, subsequently impacting human harvesting and cultural services in both polar regions. Conservation can help preserve important species. However, the key mitigation measure that can slow the transition to a strictly seasonal ice cover with climate change, reduce the overall loss of sea ice habitats from the ocean, and thus preserve the unique ecosystem services provided by sea ice and their contributions to human-well being is a reduction in carbon emissions.

ID: 11151 Contributed abstract

Poster Order:

Bridging Inuit knowledge and oceanographic research in Nunatsiavut

Breanna Bishop [1] , *Eric Oliver* [2] , *Claudio Aporta* [3]

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[3] Dalhousie University

Presented by / Présenté par: ***Breanna Bishop***
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Coastal communities in Nunatsiavut, the Inuit self-governing region of northern Labrador, have deep ties to the marine environment. Sea ice acts as an extension of the land, providing critical infrastructure as a travelling and hunting platform for Labrador Inuit during the sea ice season. Likewise, during the open water season the ocean has been used to travel, hunt, and harvest for millennia. As climate change increasingly impacts northern regions, changes to oceanographic and sea ice conditions can significantly modify how and when Labrador Inuit are able to travel and access important harvesting areas. These changes need to be accounted for in ongoing policy development and decision making in Nunatsiavut, which is strengthened through including knowledge from both Inuit and oceanographic scientific perspectives. Within oceanographic research contexts, analysis that complements and builds from Inuit ocean knowledge can help situate research at temporal and spatial scales that are the most relevant for communities, where bridging Inuit and oceanographic ways of knowing can offer a robust approach to understanding localized oceanographic processes and change. Through participatory mapping and semi-structured interviews that took place in Rigolet and Hopedale in 2019, community members worked with the authors to map local oceanographic features including ocean currents and sea ice, as well as related conditions, trends and changes taking place in the regions. Spatial rendering of Inuit knowledge from this collaborative work was applied to both constrain and validate an oceanographic model for the region. The results of this approach demonstrate the utility of maps in bridging oceanographic and Inuit knowledge, as they helped to facilitate mutual understanding, knowledge translation and generation amongst Inuit knowledge holders and the researchers.

Day 3 – 2 June 2021

Oral

Session: 813 Atmosphere, Ocean, and Climate Dynamics - Part 4 Dynamique de l'atmosphère, des océans et du climat - Partie 4

02/06/2021 12:30

ID: 10672 Contributed abstract

Poster Order:

The soundproof quasi-elastic dynamical core of the Global Environmental Multiscale (GEM) model

Syed Zahid Husain [1] , *Abdessamad Qaddouri* [2] , *Claude Girard* [3]

[1]

[2] Environment and Climate Change Canada

[3] Environment and Climate Change Canada

Presented by / Présenté par: ***Syed Zahid Husain***

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The elastic Euler Equations, widely used by the numerical weather prediction models, permit vertically-propagating sound waves that – although being meteorologically insignificant – are numerically problematic as they impose severe restrictions on the model time-step requirements. Over the past decades, this has led to an extensive range of research in search of "soundproof" approximations to the Euler system that can eliminate the problematic acoustic modes while correctly capturing all other dynamical modes of interest. In this regard, the "quasi-elastic" approximation, which combines the concepts of the hydrostatic approximation for the large scales and the anelastic approximation for the small scales, represents a major breakthrough. The underlying approximation is based on a reasonable assumption that any non-hydrostatic departure in the total density from its hydrostatic counterpart is negligible. Recently, a new dynamical core based on the quasi-elastic approximation has been developed within Environment and Climate Change Canada's operational Global Environmental Multiscale (GEM) model. The implementation of the new dynamical core followed the minimal-modification approach where all the important numerical aspects of the operational model are kept unchanged except for a small change to the definition of the pressure-based terrain-following vertical coordinate. The quasi-elastic dynamical core has been comprehensively evaluated using a broad range of tests including two-dimensional idealized cases as well as three-dimensional deterministic forecasting systems covering both hydrostatic and non-hydrostatic scales. Overall, the computational performance of the new quasi-elastic dynamical core has been found to be very similar to the operational models for both hydrostatic and nonhydrostatic scenarios. More importantly, for all the tests carried out, the new core produced results that are statistically equivalent when compared to the operational GEM model. As a result, unlike the operational GEM model that

uses two separate dynamical cores based on two sets of equations for hydrostatic and nonhydrostatic forecasts, the new quasi-elastic model will allow to maintain a single dynamical core for all situations without compromising accuracy and computational performance.

Session: 813 Atmosphere, Ocean, and Climate Dynamics - Part 4 Dynamique de l’atmosphère, des océans et du climat - Partie 4

02/06/2021 12:45

ID: 10953 Contributed abstract

Poster Order:

Horizontal diffusion along height in GEM Model based on a terrain following vertical coordinates

Abdessamad Qaddouri [1] , *Janusz A. Pudykiewicz* [2]

[1] Environment Canada
[2] Environment Canada

Presented by / Présenté par: ***Abdessamad Qaddouri***
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The diffusion process included in weather models is one of the main mechanisms controlling the transfer of energy between different scales of motion. Although the basic equations describing this relevant process are known, there are several issues related to the incorporation of the diffusion operator in the non-orthogonal terrain coordinate system. These aspects are discussed in this presentation and are illustrated by an experiment comparing the new diffusion operator to the old formulation used in the Global Multi-Scale Environmental (GEM) model.

Session: 813 Atmosphere, Ocean, and Climate Dynamics - Part 4 Dynamique de l’atmosphère, des océans et du climat - Partie 4

02/06/2021 13:00

ID: 10802 Contributed abstract

Poster Order:

First model evaluations of height-resolved diurnal water vapour cycles using lidar observations in an Arctic environment

Shannon Hicks-Jalali [1] , *Zen Mariani* [2] , *Barbara Casati* [3] , *Sylvie*

Leroyer [4] , *Francois Lemay* [5] , *Robert J. Crawford* [6]

[1] Environment and Climate Change Canada
[2] Environment and Climate Change Canada
[3] Environment and Climate Change Canada
[4] Environment and Climate Change Canada
[5] Environment and Climate Change Canada
[6] Environment and Climate Change Canada

Presented by / Présenté par: ***Shannon Hicks-Jalali***
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The diurnal cycle of atmospheric water vapour is an essential component of the hydrological cycle. Diurnal water vapour (WV) cycles are complex and are a product of several mechanisms, including evapotranspiration, advection, large-scale vertical motion, and precipitation. Numerical Weather Prediction (NWP) models rely on high-quality WV input to provide accurate forecasts, which is particularly difficult in the Arctic due to its extreme weather and harsh environment. Diurnal WV cycle observations are excellent tools for evaluating NWPs due to their dependence on multiple processes. Differential Absorption Lidars (DIALs) are well suited to providing height-resolved diurnal cycles in the boundary layer due to their high vertical and temporal resolution. We use the novel Vaisala pre-production DIAL, installed in Iqaluit, Nunavut (63.75 N, 68.55 W), to calculate seasonal height-resolved diurnal WV cycles from 100 m to 1500 m altitude. We find that the first 250 m of the DIAL diurnal cycle magnitudes agree well with the co-located surface station measurements. The phases of the cycle shift with altitude and the amplitudes generally increase with altitude. In the summer, all instruments observe a strong 24 hr cycle. As the amount of solar radiation decreases over the year, the 24 hr cycle weakens and the 12 hr cycle begins to dominate in all instruments. We also compare the DIAL observations to the Environment and Climate Change Canada (ECCC) NWP model. We evaluate the initial water vapour fields, constrained by the assimilation of humidity, as well as the diurnal cycle over the 24 hour forecast.

Session: 813 Atmosphere, Ocean, and Climate Dynamics - Part 4 Dynamique de l’atmosphère, des océans et du climat - Partie 4

02/06/2021 13:15

ID: 10687 Contributed abstract

Poster Order:

The evaluation of numerically-driven wildfire smoke plume rise and fire behavior system

Nadya Moisseeva [1] , *Christopher Rodell* [2] , *Jiaxin Wang* [3] , *Rosie Howard* [4] , *Timothy Chui* [5] , *Roland Schigas* [6] , *Roland Stull* [7]

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Presented by / Présenté par: ***Nadya Moisseeva***
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The buoyant rise of wildfire smoke and the resultant vertical distribution of particulates in the atmosphere have a strong influence on downwind pollutant concentrations and provide key input into air quality modelling systems. Due to inherent complexity of wildfire plume dynamics, uncertainties associated with fire input parameters and scarcity of model evaluation data, smoke injection height predictions remain subject to large errors. In this work, we introduce a simple energy-balance parameterization for estimating the mean centerline height for smoke plumes from fires of arbitrary shape and intensity. Using high-resolution numerical simulations, we demonstrate that there exist a linear dimensionless relationship and a characteristic fire velocity scale, which govern the vertical penetration distance of the plume in the atmosphere above the boundary layer. We also apply the approach as an automated classifier to distinguish penetrative vs. non-penetrative plumes and extend it to capture the full vertical distribution of smoke in the atmosphere. In order to constrain fire input parameters for the proposed parameterization, we use numerical weather forecasts and remotely sensed data to drive a fire-behavior prediction system. Finally, we evaluate the proposed approach with satellite observations and compare it with existing methods used within smoke modelling frameworks. The broad goal of this work is to better our understanding of wildfire plume rise dynamics and improve smoke dispersion predictions for air quality applications.

Session: 813 Atmosphere, Ocean, and Climate Dynamics - Part 4 Dynamique de l’atmosphère, des océans et du climat - Partie 4

02/06/2021 13:30

ID: 10712 Contributed abstract

Poster Order:

Case study of a PL simulated with the developmental version of the

convection-permitting Canadian Regional Climate Model (CRCM6)

Marta Moreno Ibáñez [1] , *René Laprise* [2] , *Philippe Gachon* [3]

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Presented by / Présenté par: ***Marta Moreno Ibáñez***
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Polar lows (PLs) are high-latitude mesoscale weather systems associated with severe weather such as gale-force winds, which can reach hurricane force, and heavy snow showers. Therefore, they pose a threat to coastal communities, marine transportation and oil and gas platforms when they form near seasonal sea-ice margin and shorelines. PL forecasting has long remained a challenge due to the small size and short lifetime of these systems. Nevertheless, the representation of PLs in numerical models has significantly improved with the advent of high-resolution atmospheric models. As a result, these atmospheric models have become a powerful tool to forecast PLs and to study the development mechanisms of PLs. In this work, we present a case study of an observed PL that developed in the winter season of 2019. First, we conducted high-resolution simulations of the PL using the developmental version of the convection-permitting Canadian Regional Climate Model (CRCM6). The model has a horizontal grid cell size of 2.5 km and 62 levels in the vertical. The simulations were hourly driven by the ERA5 reanalysis, which was also used for the initial atmospheric conditions. An ensemble of short-range forecasts were initialised at different times with the aim of evaluating the impact of different initial conditions on the representation of the PL. Spaghetti plots of the sea level pressure field simulated by the different simulations clearly show the impact of the initial conditions on the forecasting of the PL. Second, the results of the simulations were verified against observational data in order to assess the skill of the model at reproducing the characteristics of the observed PL. In particular, the results of the simulations were compared to Infra-Red (IR) satellite imagery and scatterometer wind estimates to verify whether the location and intensity of the simulated PL were similar to those of the observed one. Finally, the output of the simulation that better captured the PL development was analyzed in order to better understand the role that different mechanisms play in the formation and intensification of the PL. Particular attention was given to surface sensible and latent heat fluxes as well as to the temperature profile at the PL location.

Session: 253 General Session - Weather - Part 4 - Observations and Mesoscale issues Séance générale — La météorologie - Partie 4 - Observations et problèmes de méso-échelle **02/06/2021 12:30**

ID: 11062 Contributed abstract

Poster Order:

Investigation of the fine-scale flow field in the Canadian Rockies using Doppler Lidar during spring precipitation events

Aurélie Desroches-Lapointe [1] , *Zen Mariani* [2] , *Nicolas R. Leroux* [3] , *Julie M. Thériault* [4]

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[2] Meteorological Research Division, Environment and Climate Change Canada
[3] Université du Québec à Montréal (UQAM)
[4] Université du Québec à Montréal (UQAM)

Presented by / Présenté par: ***Aurélie Desroches-Lapointe***
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The mountain snowpack is the primary source of fresh-water to downstream communities and is a key element in the assessment of natural hazards, such as flooding. Snow depth shows important variability across multiple scales. In complex terrain, the local wind flow as well as orographic and thermal effects drive fine-scale deposition of precipitation. In this presentation, ground-based Doppler Lidars performing vertical staring and velocity-azimuth display (VAD) scans are used to investigate the fine-scale flow field in the Kananaskis Valley, Alberta, located in the Canadian Rockies. The purpose is to characterize the planetary boundary layer flow field associated with precipitation events. Laser-optical disdrometers were deployed to measure hydrometeor characteristics, such as fall speed and size, as these characteristics influence flow-particles interactions leading to various deposition patterns. Instruments operated continuously from April to June 2019 at two sites and were deployed at different elevation along the Fortress Mountain (1591 m and 2076 m a.g.l.). Thirteen precipitation events were documented as part of the Storm and Precipitation Across the continental Divide Experiment (SPADE). It is found that the near-surface flow field is more parallel to the valley, which runs north-south, during precipitation events than during clear days. Most precipitation events are associated with a northerly wind component at the surface whereas only two are associated with a southerly component. The turbulence was mainly attributed to surface heating leading to updrafts prior to most precipitation events, in agreement with the diurnal cycle. The development of clouds and precipitation layers aloft also initiated turbulence due to aloft cooling. This is particularly observed later during precipitation events and at lower altitudes. Data suggest

maximal mechanical mixing by wind shear at the boundary layer top inducing cooling aloft. Overall, this study contributes to better understanding the fine-scale flow field associated with precipitation in complex terrain.

Session: 253 General Session - Weather - Part 4 - Observations and Mesoscale issues Séance générale — La météorologie - Partie 4 - Observations et problèmes de méso-échelle **02/06/2021 12:45**

ID: 10691 Contributed abstract

Poster Order:

Representativeness of Coastal Stations for Verifying Open-Water 10 Metre Wind Forecasts

Nelson Shum [1] , *Tim Bullock* [2]

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Presented by / Présenté par: ***Nelson Shum***
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When assessing the accuracy of open-water wind forecasts at 10 metres above mean sea level, observations from coastal stations and those located on small islands are often used to augment observations from marine buoys to verify the values predicted. The underlying assumption is that observations from land stations that are well-exposed to the marine environment behave very similarly to observations collected from marine buoys. To test the validity of this assumption, we consider the 10 metre ASCAT (scatterometer) wind fields as a reference; we examine the correlation between wind measurements from coastal stations and the ASCAT open-water wind measurements (in the vicinity of the stations); the same correlation is then made with measurements from marine buoys, and the results are compared. The study shows that despite the proximity to the marine environment of the coastal stations examined, their observed winds show very different characteristics than the winds observed by marine buoys. The results suggest a strong land influence on the coastal station wind measurements, despite the stations' surrounding environment being dominated by water. These findings have implications for how coastal stations should be treated when they are used to verify open-water wind forecasts, and gridded Numerical Weather Prediction forecasts in general.

Session: 253 General Session - Weather - Part 4 - Observations and Mesoscale issues Séance générale — La météorologie - Partie 4 - Observations et problèmes de méso-échelle **02/06/2021 13:00**

ID: 11202 Contributed abstract

Poster Order:

The Cape Breton Weather Station Mesonet

Jonathan Buffett [1]

[1]

Presented by / Présenté par: ***Jonathan Buffett***

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The Cape Breton Mesonet is a network of 84 automated weather stations in eastern Nova Scotia. Each station transmits live data to the Cape Breton Mesonet website. The live and archived data is open-source, free for anyone to use. The project intends to expose mesoscale weather patterns using stations placed in strategic areas to observe specific weather phenomena. Stations are situated within a 5 to 20 km radius of each other. Wind velocity, temperature, humidity, precipitation, pressure, solar radiation and sea surface temperature are recorded. The project focuses mainly on air temperature, water temperature, wind velocity and barometric pressure. Such patterns are often too localized to be resolved by standard observing networks who's stations are spaced far apart. The project has scientific goals, which include underscoring advantages of high density data collection for forecasters, local governments and the general public as we face a changing climate. In recording such data, the Cape Breton Mesonet highlights our need for mesoscale climate data which modern technology has made possible. The mesonet has successfully monitored local terrain enhanced wind events in Cape Breton. These wind events can be damaging, volatile and difficult to forecast, proving that mesonets are invaluable and should be considered a critical tool for forecasters. This will aid in raising awareness of mesoscale weather events and therefore improve local area forecasts and analysis in the future.

Session: 253 General Session - Weather - Part 4 - Observations and Mesoscale issues Séance générale — La météorologie - Partie 4 - Observations et problèmes de méso-échelle **02/06/2021 13:15**

ID: 10817 Contributed abstract

Poster Order:

The Cape Breton Weather Station Mesonet – Forecast Applications

Chris Fogarty [1]

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Presented by / Présenté par: ***Chris Fogarty***

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Over the past 5 years a dense network of Davis Instruments weather stations were installed at various locations around Cape Breton island in eastern Nova Scotia. The network was established to observe and study the many microclimates in the regions which includes very hilly terrain and oceanic influences. Combining the in-situ station data with satellite imagery and high-resolution numerical weather model fields provides a comprehensive understanding of localized weather phenomena. One key benefit has been a more refined understanding of the local terrain-enhanced wind events known as 'Les Suetes' and the identification of a lesser-known "reverse Les Suetes" effect. The data from the mesonet is not only useful in real time but as a means for regional weather forecasters to learn and become more experienced forecasting for the area.

Session: 253 General Session - Weather - Part 4 - Observations and Mesoscale issues Séance générale — La météorologie - Partie 4 - Observations et problèmes de méso-échelle **02/06/2021 13:30**

ID: 11161 Contributed abstract

Poster Order:

Characterizing summer fogs during the Halifax Fog and Air Quality Study

Joelle Dionne [1] , *Baban Nagare* [2] , *R. Christian Fitzner* [3] , *Patrick Duplessis* [4] , *Cameron Power* [5] , *Aldona Wiacek* [6] , *Cora Young* [7] , *Rachel Chang* [8]

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Presented by / Présenté par: ***Joelle Dionne***
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Fog is a well-known meteorological hazard in Maritime Canada, but its physical properties are challenging to quantify. We will examine fog events observed during May-August 2019 by the Halifax Fog and Air Quality Study (HaliFAQS) in Halifax, Nova Scotia. Fog droplet data were collected with a Fog Monitor (FM-120, Droplet Measurement Technologies), and wind data were collected on-site with an Airpointer. We will use meteorological data from various stations around Halifax to provide a regional view of the expanse and timing of the fog events. We will examine characterize the relationship between fog microphysical properties, as well as their possible relation to surrounding observed meteorological conditions in the region, on time-scales varying from during single fog events to spring versus summer seasonality.

Session: 253 General Session - Weather - Part 4 - Observations and Mesoscale issues Séance générale — La météorologie - Partie 4 - Observations et problèmes de méso-échelle	**02/06/2021 13:45**

ID: 10647 Contributed abstract

Poster Order:

Constant Flux Layers with Gravitational Settling: deposition to an underlying surface and links to fog.

Peter Taylor [1]

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Presented by / Présenté par: ***Peter Taylor***
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The turbulent boundary layer concepts of constant flux layers (CFL) and surface roughness lengths are extended to include gravitational settling (GS) and surface deposition of fog or cloud droplets in neutrally stratified atmospheric surface boundary layers (CFLGS). Investigating details of how fog/cloud droplet water content is treated within the surface boundary layer of models such as WRF leads one to look at deposition of fog droplets towards underlying ground/water surfaces. This can be a mix of gravitational settling and turbulence

causing droplets to impact the surface. WRF can include turbulent deposition for vegetation but, until we added it, was not representing turbulent deposition velocities for water surfaces.

Session: 410 Pacific and Arctic marine biogeochemistry
Biogéochimie marine du Pacifique et de l'Arctique **02/06/2021 12:30**

ID: 11108 Contributed abstract

Poster Order:

Anthropogenic Changes to the Carbonate Chemistry Balance of a Coastal Sea

Tereza Jarnikova [1] , *Susan E. Allen* [2] , *Debby Ianson* [3] , *Elise M. Olson* [4] , *Andrew E. Shao* [5]

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Presented by / Présenté par: ***Tereza Jarnikova***
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Coastal regions are typically characterized by considerable physical variability that in turn leads to dramatic variability in coastal carbonate chemistry. Recent shipboard and mooring-based observations have shown large spatial and temporal variations of carbonate chemistry parameters, including air-sea CO2 flux and aragonite saturation state, in one prominent coastal region - the Salish Sea. The range of the observed variability in the regional carbonate system is significantly larger than the global anthropogenic change, complicating the detection of secular carbon trends. Simultaneously, sparse observations limit understanding of the carbonate balance as a whole. Here, we use a highly resolved coastal model, SalishSeaCast, to characterize the drivers of the carbonate chemistry balance of the Salish Sea, with an emphasis on air-sea CO2 flux and aragonite saturation state. We then investigate the impact of a relatively modest increase in anthropogenic carbon in this region in the context of the governing physical and biological dynamics of the system. We examine the striking effects of the anthropogenic change to date on the inorganic carbon balance of the system, highlighting impacts on the aragonite saturation state of the system and its buffering capacity, as well as suggesting some bounds for the regional air-sea and lateral carbon fluxes. We then use the GLODAP dataset of global coastal carbon observations to consider our results in the

context of other regions of the Pacific Rim and the global coastal ocean.

Session: 410 Pacific and Arctic marine biogeochemistry
Biogéochimie marine du Pacifique et de l'Arctique **02/06/2021 12:45**

ID: 11058 Contributed abstract

Poster Order:

Estimating the Northeast Pacific Ocean Carbon Sink Using a Neural Network Approach

Patrick Duke [1] , *Roberta Hamme* [2] , *Debby Ianson* [3] , *Peter Landschützer* [4] , *Mohamed Ahmed* [5]

[1] University of Victoria
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Presented by / Présenté par: ***Patrick Duke***
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As countries around the world continue to update their carbon emission reduction commitments, we require a better understanding of how the global carbon sinks may be shifting under climate change. With the ocean taking up nearly a quarter of anthropogenic emissions annually, there is an urgent need for higher spatially and temporally resolved observations of marine carbon fluxes. Understanding natural variability in the marine carbon system can help inform observational programs, optimize modelling for future climate projections, and inform adequate climate actions. Here, we use a neural network approach as a method of gap-filling sparse observations to basin wide estimates. We compiled partial pressure of CO2 (pCO2) observations from regional sources and the international SOCAT database, as well as a range of predictor variables including physical oceanographic reanalysis products, and satellite based biological estimates. With the predictor variables acting as proxies for known processes affecting pCO2, we are able to create non-linear relationships to interpolate observations from 1998-2019 in the Northeast Pacific. Using wind speed and atmospheric CO2, we evaluate spatiotemporal dynamics of carbon uptake from the atmosphere. Focusing on the open ocean, distinct seasonal, interannual, and decadal patterns emerge. In general, surface ocean pCO2 increases in parallel with the atmospheric increase due to anthropogenic input. We see strong fluxes in the winter months dominated by higher winds due to seasonal storms and a larger gradient between the surface ocean and the

atmosphere due to solubility changes. When looking at specific events, such as Pacific marine heatwaves in the 2010's, we investigate carbon uptake hindered by surface stratification, increased temperatures, and low wind speeds. The insights from such a high resolution, regional look at marine carbon fluxes are just beginning to be mined, with observations across the coastal to open ocean continuum next to be resolved.

Session: 410 Pacific and Arctic marine biogeochemistry
Biogéochimie marine du Pacifique et de l'Arctique **02/06/2021 13:00**

ID: 10945 Contributed abstract

Poster Order:

The Canadian Arctic Archipelago's Carbon Sink: a model based evaluation

Johanna Länger [1] , *Nadja Steiner* [2] , *Adam Monahan* [3] , *Tessa Sou* [4] , *Eric Mortenson* [5] , *Mohammed Ahmed* [6]

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[3] Universtiy of Victoria
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Presented by / Présenté par: ***Johanna Länger***
Contact: jlanger@uvic.ca

Sea-ice has a huge influence on the air-sea gas exchange, and along with many other factors, the sea-ice properties in the Canadian Arctic are expected to change massively in future years. The ability of this region to be a sink for atmospheric carbon and the seasonal and interannual variability in the air-sea carbon fluxes are important for future predictions of atmospheric CO2, ocean acidification and its impacts on marine life, and need to be evaluated. In recent years, observation based estimates and empirical models for ocean properties influencing the air-sea flux of CO2 were developed. However, due to the seasonal inacessability and remoteness of the Canadian Arctic, observations are still sparse and potentially seasonally biased. To get a more comprehensive understanding of this region and its CO2 budget, the numerical model CanOE-CSIB (Canadian Ocean Ecosystem model - Canadian sea-ice-biogeochemical model) within the NEMO framework (Nucleus for European Modelling of the Ocean) is applied. With a numerical model, an obeservation bias in existing empirical models as well as the spatial and regional footprint of observations

can be quantified. The aim is to evaluate the seasonal and interannual variability for the last decade and to assess empirical models for carbon uptake and the carbon budget from a modelling perspective.

Session: 410 Pacific and Arctic marine biogeochemistry
Biogéochimie marine du Pacifique et de l'Arctique **02/06/2021 13:15**

ID: 10997 Contributed abstract

Poster Order:

The role of sea ice melt in the missing Arctic Ocean carbon uptake

Benjamin Richaud [1] , *Katja Fennel* [2] , *Eric Oliver* [3] , *Mike DeGrandpre* [4] , *Timothée Bourgeois* [5] , *Xianmin Hu* [6] , *Youyu Lu* [7]

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Presented by / Présenté par: ***Benjamin Richaud***
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The Arctic Ocean is undersaturated in CO2, and currently acts as a carbon sink. This oceanic uptake is controlled by sea ice, which can prevent gas exchanges between the atmosphere and the ocean and has major impacts on stratification, primary production and carbon tracer concentrations. Given the rapidly changing ice-scape in an acidifying Arctic Ocean, a better quantification of carbon uptake is necessary. To this end, this study investigates the link between the seasonal cycle of sea ice and the oceanic uptake of CO2. The storage of carbon in sea ice, with a high alkalinity to dissolved inorganic carbon (DIC) ratio, is suspected to increase oceanic carbon uptake in seasonally ice-covered areas by amplifying the pCO2 seasonal cycle. This amplification should be dependent on the alkalinity-to-DIC ratio in ice. These two hypotheses were tested and confirmed using a simple parametrization of carbon storage in sea ice implemented in a 1D physical-biogeochemical ocean model. We found a linear relation between ice melt and the amplification of seasonal carbon uptake that is also supported by idealized theoretical arguments. We then applied this relationship to outputs from a CMIP6 model to accommodate for its lack of representation of carbon in sea ice, and in doing so, quantified the underestimation of carbon uptake in a future climate projection.

Session: 410 Pacific and Arctic marine biogeochemistry
Biogéochimie marine du Pacifique et de l'Arctique **02/06/2021 13:30**

ID: 10996 Contributed abstract

Poster Order:

The role of sediment in sea ice for Mn in the Canada Basin

Birgit Rogalla [1] , *Susan E. Allen* [2] , *Manuel Colombo* [3] , *Paul G. Myers* [4] , *Kristin J. Orians* [5]

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Presented by / Présenté par: ***Birgit Rogalla***
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In the Arctic Ocean, sea ice acts as a conveyor, transporting nutrients, pollutants, and gases from shelf regions into the basins. How important is this mechanism as a source for biogeochemical cycles in the upper ocean? We use a model of Manganese (Mn), an essential micronutrient, to trace the influence of rivers, sea ice, and sediments in order to understand the role of these components in the Canada Basin. Our three-dimensional model of dissolved Mn incorporates parameterizations for the main sources and sinks of Mn in the Arctic: river discharge, sediment resuspension, melt of sediment from sea ice, dust deposition, and reversible scavenging, while the advection and diffusion of tracers is provided by NEMO-TOP. The model runs offline with dynamics from the 1/12 degree Arctic and Northern Hemispheric Atlantic (ANHA12) configuration of NEMO and is evaluated with observations from the 2015 Canadian GEOTRACES cruises. Experiments from 2002 to 2019 indicate that the majority of external Mn in the Canada Basin surface layer comes from sediment released by sea ice, largely originating from the Siberian shelves. Intensified melt may increase the supply of nutrients to the ocean surface in the short term. However, much of the sea ice in the Canada Basin is supplied by the transpolar drift and its long term interruption would reduce the Canada Basin Mn supply. These results highlight the sensitivity of the Mn budget, as well as other nutrients found in ice-rafted sediments, to changes to the sea ice system.

Session: 520 General Session - Oceans Séance générale — Les océans **02/06/2021 12:30**

ID: 10673 Contributed abstract

Poster Order:

A Synthetic Climatology of Dense Fog and Low Stratus Ceilings in the Canadian Arctic With Emphasis on Marine Areas

William Burrows [1] , *Curtis Mooney* [2]

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Presented by / Présenté par: ***William Burrows***
Contact: william.burrows@canada.ca

Extensive areas of dense fog and low stratus occur in the Arctic, particularly over marine and adjacent coastal areas in the warm season, posing a hazard for aviation and shipping activities. Occurrence patterns are not well known over the Canadian Arctic, so there is need for a climatology as industrial activity increases there. Reliable regular meteorological observations are only available for a sparse network of mainly coastal stations. A synthetic climatology based on short-term forecasts derived from NWP models is the next best option for estimating an area-wide climatology. To establish occurrence patterns for dense fog and low stratus ceilings in the Arctic we analyzed forecasts at 10 km resolution for all months in 2016-2020 made by a comprehensive rule-based diagnostic model developed by Burrows and Toth (2010). This model runs twice daily at the Canadian Center for Meteorological and Environmental Prediction on all NWP platforms. It generates forecasts of dense fog and low stratus over the entire Canadian domain, and is widely used by Canadian operational forecasters. Verification at Arctic coastal stations shows the model correctly predicts more than 80% of occurrences of observed visibility ≤ 0.5 SM and more than 85% of occurrences of ceiling ≤ 500 ft, when they occur for three or more consecutive hours. Monthly and seasonal averages reveal large areas of dense fog and low stratus persisting over certain marine areas of the Arctic Archipelago and Beaufort Sea, many of which coincide with possible future shipping routes and oil drilling activity.

Session: 520 General Session - Oceans Séance générale — Les océans **02/06/2021 12:45**

ID: 11122 Contributed abstract

Poster Order:

Variability and spatial clustering of wind direction over large Canadian lakes

Dominique Brunet [1] , *Reza Valipour* [2] , *Ram Yerubandi* [3]

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Presented by / Présenté par: ***Dominique Brunet***
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Surface winds are the main drivers of currents in lakes. Lakes stratification and mixing are impacted by the dominant wind speed and direction, which in turn can influence water quality in lakes through biogeochemistry processes. A common simplifying assumption is to represent wind over the surface of lakes by a single wind vector, as measured by a weather buoy. In this presentation, we revisit this assumption by assessing the wind variability over 50 large lakes in Canada and northern United States. From ERA5-Land 10m wind reanalysis for 2016-2000, we compute the variability of wind direction using the squared pairwise distance of all grid cells within a lake. The number of buoys needed to estimate wind accurately in 4, 8 or 16 directions is deduced from spatial clustering of grid cells within a lake. Using the K-means algorithm to find spatial clustering of wind patterns, we find the minimal number of clusters needed to reduce the standard deviation of the wind variability within each cluster to less than, respectively, 45, 22.5 or 11.25 degrees. We then designate the optimal location to place buoys by minimizing the squared error between wind direction at a candidate location and all other locations within a cluster. We also find all acceptable locations, including possible land locations, for which the estimation error is below threshold. The optimal and acceptable locations are compared with the current locations of buoys operated by the Meteorological Service of Canada (MSC, Canada) and the National Data Buoy Center (NDBC, United States). We also assess the representativeness of wind direction measurements from current buoys and surface stations for each spatial cluster. Early results will be presented, with a particular focus on Lake of the Woods.

Session: 520 General Session - Oceans Séance générale — Les océans **02/06/2021 13:00**

ID: 11102 Contributed abstract

Poster Order:

Nutrients boost by a strong winter storm in the Gulf of Maine

Hui Shen [1] , *William Perrie* [2] , *Catherine Johnson* [3] , *Yongsheng Wu* [4]

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Presented by / Présenté par: ***Hui Shen***
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Previous studies have indicated that overall nitrate inputs through external interfaces are not enough to sustain the high productivity that is experienced in the Gulf of Maine (GoM). Here, we demonstrate that synoptic scale extreme weather storms in winter may be able to contribute a significant volume of nitrate into the GoM through external water mass influxes over short time periods, boosting nutrient influxes. As an example, a strong North Atlantic winter storm (Nor'easter) in January 2018 is investigated, with a focus on the associated ocean circulation responses in the GoM. The physical oceanographic conditions under the Nor'easter storm are simulated with a numerical model and the biogeochemical response is estimated by well known statistical models, based on observed properties of different water masses which dominant the general ocean circulation in the GoM. It is found that the intensive Nor'easter storm introduced a significant volume of nutrient-rich slope water into the GoM from the lower depth layers. A gross estimate of the associated nitrate gain is about 16.32% of the 'missing' nitrate supply, which is required to support the high productivity level, but which has not previously been accounted for in external sources. With the frequent visit of winter storms to the GoM, it is clear that the winter storm events can be a very important physical process to supply nitrate, exerting a strong positive ecological contribution to sustain high productivity in the GoM. The present study highlights the importance of storm events to the physical and ecological systems in coast regions. Such influence might be enhanced in the future climate, when more storms are projected to occur in this region.

Day 4 – 3 June 2021

Oral

Session: 320 The Changing Arctic Ocean - Part 1
L'évolution de l'océan Arctique - Partie 1 **03/06/2021 12:30**

ID: 10926 Contributed abstract

Poster Order:

Temporal and spatial variability in Atlantic Water in the Arctic from observations

Alice Richards [1] , *Helen Johnson* [2] , *Camille Lique* [3]

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Presented by / Présenté par: ***Alice Richards***
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Observational data from across the Arctic are used to investigate temporal and spatial variability in Atlantic Water throughout the Arctic basin from 1980s to the present day, with a focus on Atlantic Water heat and its potential influence on the upper water column. MIMOC climatological data are also used in the analysis. The inferred mechanisms behind Atlantic Water spread in the Arctic – both vertically and laterally into sub-basin interiors – are discussed, along with the local and remote influences on the Atlantic Water layer in different Arctic regions. The usefulness of the Atlantic Water core in tracking changes in the Atlantic Water layer is also assessed.

Session: 320 The Changing Arctic Ocean - Part 1
L'évolution de l'océan Arctique - Partie 1 **03/06/2021 12:45**

ID: 10813 Contributed abstract

Poster Order:

The Arctic's leaky plug: The changing nature of ice export along Nares Strait

Kent Moore [1] , *Steve Howell* [2] , *Mike Brady* [3]

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Presented by / Présenté par: ***Kent Moore***
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The ice arches that typically develop at the northern and southern ends of Nares Strait play an important role in modulating the export of multi-year sea ice out of the Arctic Ocean. As a result of global warming, the Arctic Ocean is evolving towards an ice pack that is younger, thinner and more mobile and the fate of its multi-year ice is becoming of increasing interest to both the scientific and policy communities. Here, we use sea ice motion retrievals derived from Sentinel-1 imagery to report on recent behaviour of these ice arches and the associated ice export. The past 5 years has seen early collapses of these arches as well as a year, only the second on record, in which an ice arch did not form along Nares Strait. We also show that the duration of arch formation has decreased over the past 20 years as ice in the region has thinned, while the ice area and volume fluxes have both increased. These results suggest that a transition is underway towards a state where the formation of these arches will become atypical with a concomitant increase in the export of multi-year ice accelerating the transition towards a younger and thinner Arctic ice pack.

Session: 320 The Changing Arctic Ocean - Part 1
L'évolution de l'océan Arctique - Partie 1 **03/06/2021 13:00**

ID: 11026 Contributed abstract

Poster Order:

Atmospheric, oceanic, and sea-ice variability along Nares Strait: a numerical model study

Yarisbel Garcia Quintana [1] , *Paul Myers* [2] , *Kent Moore* [3]

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Presented by / Présenté par: ***Yarisbel Garcia Quintana***
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Nares Strait (NS) is one of the main pathways connecting the Arctic Ocean to the North Atlantic. The multi-year sea-ice that is transported through the strait plays an important role in the mass balance of Arctic sea-ice as well as influencing the climate of the North Atlantic region. This transport is modulated by the formation of ice arches that form at the southern and northern of the strait. The arches also play an important role in the maintenance of one of the largest and most productive of Arctic polynyas, the North Water Polynya (NOW), that forms at the southern end of the strait. Given its significance, we use an eddy-permitting configuration of the Nucleus for European Modelling of the Ocean to explore ocean and sea-ice variability along NS, from 2002 to 2019. The model is coupled with the Louvain-la-Neuve (LIM2) sea ice thermodynamic and dynamic numerical model and is forced by the Canadian Meteorological Centre's Global Deterministic Prediction System Reforecasts.

Positive and negative degree days along the strait, are consistent with the warming that the region is experiencing. Sea-ice production/decay did not show any significant change other than an enhanced decay during the summers of 2017-1019. However, sea-ice thickness has decreased significantly since 2007. Model data indicates that since 2007 the northern NS upper 100m layer has become fresher, indicating an increase in the freshwater export out of the Arctic Ocean and through the strait. The southern portion of the strait, on the other hand, has become warmer and saltier, which would be consistent with an influx of Irminger Water as proposed by previous modelling results. These changes could impact the formation and stability of the ice arch and hence the cessation of ice transport down NS as well as contributing to changes in the characteristics of the NOW.

Session: 320 The Changing Arctic Ocean - Part 1
L'évolution de l'océan Arctique - Partie 1 **03/06/2021 13:15**

ID: 11177 Contributed abstract

Poster Order:

Reversal of Baffin Bay Transport Through Davis and Nares Strait Towards the Arctic Ocean due to Anomalous Winds and Ekman Transports

Paul Myers [1], *Chuanshuai Fu* [2], *Nathan Grivault* [3], *Xianmin Hu* [4], *Laura Gillard* [5], *Clark Pennelly* [6], *Laura Castro de la Guardia* [7], *Craig Lee* [8]

[1]

[2] University of Alberta
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Presented by / Présenté par: ***Paul Myers***
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Baffin Bay, a small ocean basin west of Greenland, exports cold and fresh Arctic Water to the North Atlantic while receiving northward flowing warm and salty Atlantic Water. The presence of this warm Atlantic Water along the west coast of Greenland has been shown to drive the retreat of tidewater glaciers in the Baffin Bay area. Enhanced melting in the early 2010s at Jakobshavn and other glaciers has been linked to warming ocean temperatures at this time. The oceanic processes that led to the enhanced transport of these warm waters into

Baffin Bay are still not fully explained. Here we show from a combination of observational and model studies that at the end of 2010, the net transport at Davis Strait, the southern gateway to Baffin Bay, changed direction from southward to northward, leading to significant oceanic heat transport into Baffin Bay. Anomalous winter winds over the Labrador Sea lead to onshore Ekman transports, trapping water masses associated with the West Greenland Current on the shelf so that they propagated north to Baffin Bay instead of entering the Labrador Sea. The anomalous winds also generated a positive transport signal that propagated cyclonically around Greenland rapidly carrying the signal north along the eastern side of Baffin Bay, leading also to a reversal of the net flow from the Arctic Ocean at Nares Strait. We also suggest it was this process that first led to the penetration of warm waters into Baffin Bay in 1997 that began the rapid melting of tidewaters glaciers such as Jakobshavn Isbrae.

Session: 320 The Changing Arctic Ocean - Part 1
L'évolution de l'océan Arctique - Partie 1 **03/06/2021 13:30**

ID: 11044 Contributed abstract

Poster Order:

A changing Arctic Ocean: How measured and modeled 129I distributions indicate fundamental shifts in circulation between 1994 and 2015

John Smith [1] , *Michael Karcher* [2] , *Nuria Casacuberta* [3] , *William Williams* [4] , *Tim Kenna* [5] , *William Smethie Jr.* [6]

[1] Bedford Institute of Oceanography
[2] Alfred Wegener Institute
[3] ETH Zurich
[4] Institute of Ocean Sciences
[5] Lamont Doherty Earth Observatory of Columbia University
[6] Lamont Doherty Earth Observatory of Columbia University

Presented by / Présenté par: ***John Smith***
Contact: john.smith@dfo-mpo.gc.ca

During the 1990s, discharges of 129I from European nuclear fuel reprocessing plants increased by an order of magnitude resulting in a large, well resolved, tracer spike whose passage through the Arctic and North Atlantic Oceans via the "Arctic Loop Current" has been followed by time series measurements over the past 25 years. This robust and rapidly changing tracer signal has been used in conjunction with other gas (e.g. CFC-11, SF6) and radionuclide tracers (e.g. 137Cs, 236U) to calculate transit time distributions (TTDs), provide time scales for biogeochmical processes and constrain water circulation and mixing time

scales for a wide range of high latitude water masses. 129I levels measured over the Lomonosov, Mendeleyev and Alpha Ridges in the Arctic Ocean during GEOTRACES cruises in 2015 are 10 times higher than those measured at the same locations in 1994-96 owing to the circulation of this tracer spike and delineate the boundary current transport of Atlantic Water bathymetrically steered by the ridge systems through the central Arctic. The tracer time series analysis illustrates the strong cyclonic boundary current flow that prevailed in the Canada Basin in 1994-96 when the Arctic Oscillation (AO) Index was strongly positive and its subsequent weakening under the more anticyclonic flow regime that followed a shift in the AO to a negative phase by 2015. These results indicate that the flow of surface and intermediate Atlantic water is highly advective, but that intermediate water undergoes significant inter-annual mixing during its initial entry into the Nansen Basin during its flow through the Barents Sea and Santa Anna Trough. Tracer 129I simulations determined using the applied circulation model, NAOSIM are in good agreement with the historical 129I results, thereby lending context to the interpretation of the large scale changes in arctic circulation and their relationship to shifts in climate indices.

Session: 254 General Session - Weather - Part 5 - Weather forecasting topics Séance générale — La météorologie - Partie 5 - Thèmes de prévisions météorologiques **03/06/2021 12:30**

ID: 10818 Contributed abstract

Poster Order:

History of the Canadian Hurricane Centre

Chris Fogarty [1] , *Jeremy March* [2]

[1] Canadian Hurricane Centre
[2] Canadian Hurricane Centre

Presented by / Présenté par: ***Chris Fogarty***
Contact: chris.fogarty@canada.ca

The Canadian Hurricane Centre (CHC) was established in the late 1980s after Hurricane Gloria (1985) struck the United States Eastern Seaboard which highlighted the need for a separate entity within the weather service to communicate the hazards in Canada. Various aspects of the CHC will be summarized in this presentation, including personnel over the years, the Centre’s international role in tropical cyclone prediction, software development, and notable events that served as turning points for forecast products and communications.

Session: 254 General Session - Weather - Part 5 - Weather forecasting topics Séance générale — La météorologie - Partie 5 - Thèmes de prévisions météorologiques **03/06/2021 12:45**

ID: 10875 Contributed abstract

Poster Order:

Abstract: Developing a greater understanding of high impact, shallow, lake-induced snow events in the Toronto region.

Arnold Ashton [1]

[1]

Presented by / Présenté par: ***Arnold Ashton***

Contact: arnoldashton@hotmail.com

The Greater Toronto and Hamilton Area (GTHA) receives the majority of its snow from synoptic events. However, periodically, conditions become favourable for a Lake Ontario snow band, dubbed the 'lake snake' because of its serpentine shape, to propel westwards into this densely populated region. Numerical weather models have often under-forecast these potentially high impact events in the past. But several recent examples over the 2020-2021 winter have suggested some improved mesoscale model performance for certain cases. However, there has also been a model tendency to forecast a few false alarms (null cases). Thermodynamic profiles will be analyzed to show how null cases can be identified beforehand to avoid false alarm snow forecasts. And comparisons with classic cases will help garner a greater understanding of the anatomy of these unusual mid-winter lake snow bands.

Session: 254 General Session - Weather - Part 5 - Weather forecasting topics Séance générale — La météorologie - Partie 5 - Thèmes de prévisions météorologiques **03/06/2021 13:00**

ID: 11015 Contributed abstract

Poster Order:

Weather Elements on Grid: the new post-processing approach at the Meteorological Service of Canada Élements du temps sur grille: la nouvelle approche de post-traitement du Service météorologique du Canada.

Daniel Figueras Nieto [1] , *Marc Verville* [2] , *Agnieszka Barszcz* [3] , *Rares Gheti* [4] , *Michael Jr. Powers* [5] , *Stéphane Beauregard* [6] , *Pascal*

Dehasse [7] , *Gérard Croteau* [8] , *Stéphane Gagnon* [9] , *Bertrand Denis* [10] , *Jacques Marcoux* [11] , *Didier Davignon* [12]

[1]
[2] ECCC
[3] ECCC
[4] ECCC
[5] ECCC
[6] ECCC
[7] ECCC
[8] ECCC
[9] ECCC
[10] ECCC (retired)
[11] ECCC
[12] ECCC

Presented by / Présenté par: ***Daniel Figueras Nieto***
Contact: daniel.figueras@canada.ca

New more fundamental developments are underway in the Meteorological Service of Canada's weather forecasting system. We are developing a modern post-processing system to replace ageing technologies and specifications. In our new approach, named Weather Elements on the Grid, all weather elements will be produced on a geo-referenced grid, allowing forecasts and products that leverage the ever-increasing spatial and temporal resolution of weather models. Using modular code, the number of redundancies is reduced in cross-platform maintenance. The benefits of this are twofold: streamlined development cycles and facilitating the integration of new information derived from numerical and environmental prediction systems. New post-processing methods have been introduced. One example is a more skillful Latent Heat Release Method that will replace the Bourgouin method for diagnosing precipitation types. Other examples include the new "conditional precipitation accumulation (QPF)" module. Finally, the increased collaboration between operational forecast offices and the development team have strengthened the user feedback loop, which has allowed a more efficient improvement of post-processing methods.
Une modernisation importante du système de production des prévisions nationales du Service météorologique du Canada est en cours. Un système de post-traitement plus moderne est en développement afin de remplacer des technologies et spécifications vieillissantes. Dans cette nouvelle approche appelée Éléments du temps sur grille, tous les éléments météorologiques sont calculés sur une grille géo référencée, ce qui permet de tirer pleinement parti des augmentations incessantes de résolution temporelle et spatiale des différents modèles. Grâce à une construction du code modulaire, les redondances sont réduites. Les avantages en sont doubles : des cycles d'innovations accélérés et il sera plus facile d'intégrer de nouvelles informations

provenant de systèmes de prévision numériques et environnementaux. Des nouvelles méthodes de post-traitement ont été développées. Par exemple, une nouvelle méthode basée sur le relâchement de chaleur latente remplacera la méthode de Bourgouin. D'autres exemples Incluent en autres le concept et le calcul des quantités de précipitations conditionnelles. ---- Finalement, une collaboration accrue entre les centres opérationnels de prévision et l'équipe de développement a renforcé la boucle de rétroaction ce qui a permis un développement plus efficace des méthodes de post-traitement.

Session: 254 General Session - Weather - Part 5 - Weather forecasting topics Séance générale — La météorologie - Partie 5 - Thèmes de prévisions météorologiques **03/06/2021 13:15**

ID: 11024 Contributed abstract

Poster Order:

Icing and Wind Forecasts for Wind Energy

Franco Petrucci [1] , *Simon-Philippe Breton* [2]

[1] Environnement et Changement climatique Canada
[2] Environnement et Changement climatique Canada

Presented by / Présenté par: ***Franco Petrucci***
Contact: franco.petrucci@canada.ca

At the Canadian Meteorological Centre, we have developed high-resolution (2.5 km) HRDPS forecasts of icing variables, that we output every 10 metres in height up to 300 meters, for 20 locations in the Gaspé Peninsula and the Maritimes. We are also running higher resolution gridded forecasts over the same area, 4 times a day, with wind (and solar) variable outputs every 3 minutes to better predict the onset and end of wind ramps. We will present icing and wind maps and time series of those forecasts using the Meteorological Service of Canada's new GeoMet API for geospatial web services.

Session: 254 General Session - Weather - Part 5 - Weather forecasting topics Séance générale — La météorologie - Partie 5 - Thèmes de prévisions météorologiques **03/06/2021 13:30**

ID: 10816 Contributed abstract

Poster Order:

Improving the Spatial and Temporal Resolution of the Existing Fire Weather Index System for Operational Use by Wildfire Agencies

Christopher Rodell [1] , *Nadya Moisseeva* [2] , *Rosie Howard* [3] , *Tim Chui* [4] , *Roland Stull* [5]

[1] University of British Columbia
[2] University of British Columbia
[3] University of British Columbia
[4] University of British Columbia
[5] University of British Columbia

Presented by / Présenté par: ***Christopher Rodell***
Contact: crodell@eoas.ubc.ca

The Canadian Forest Service Fire Weather Index (FWI) System, which has been adopted by wildfire agencies around the world, estimates how past/current/future weather affect wildfire behavior by tracking moisture content within the varied forest fuel layers across the landscape. Forecast predictions of the FWI parameters are used by provincial wildfire agencies as input to operational wildfire models. The output generated by these wildfire models is used to determine how finite resources (i.e., fire crews, aircraft etc.) for fire suppression response are deployed. While the main concepts of the FWI system are applied widely, forecast implementations differ. The current operational FWI system in Canada interpolates noon-local weather forecast data from 900-point locations across the country to empirically derive the six different indices/codes that comprise the system. The aim of this work is to revamp the FWI system to fully utilize numerical weather prediction (NWP) model calculations of fuel moisture codes/indices at every grid point within an NWP model, at 4-km and 12-km spatial resolution. The new NWP derived FWI system, named the Fire Weather Forecast (FWF) system, also resolves the more-weather-sensitive moisture codes/indices at a one-hour temporal resolution while the less-sensitive codes/indices are solved for once daily at noon local time. All the FWF products and associated meteorology are available on an interactive webpage with zoomable map, popup point forecast functionality, and active model comparison to observed meteorology/FWI values. The webpage and model were actively developed with input from Northwest Territories Government’s wildfire specialists and British Columbia Wildfire Service forecasters with the goal of providing new high spatial and temporal resolution FWI inputs for their operational wildfire models and daily incident command briefings

Part 2 Dynamique de l’atmosphère, des océans et du climat - Partie 2 **12:30**

ID: 10727 Contributed abstract

Poster Order:

Shear mediates downward heat fluxes in unstably stratified environments

Andrew Grace [1] , *Marek Stastna* [2] , *Kevin Lamb* [3] , *Andrea Scott* [4]

[1] University of Waterloo
[2] University of Waterloo
[3] University of Waterloo
[4] University of Waterloo

Presented by / Présenté par: ***Andrew Grace***
Contact: a2grace@uwaterloo.ca

Recently, the understanding of the dynamics of flows beneath ice cover has garnered much interest in the geophysical fluid dynamics community. Of particular importance is understanding how heat introduced via solar radiation is transported within the body of water. When freshwater temperatures are below 4 degrees celsius, heat added to the water column is destabilizing. In this scenario from a modeling standpoint, many sub-grid scale turbulence parameterizations respond by assuming that non-local mixing occurs and diffuse the heat throughout the water column. This approach, while generally useful, may be an over-simplification in some circumstances. In this talk we present numerical simulations of the dynamics of water below 4 degrees celsius in the presence of a background shear current and destabilizing thermal forcing. We show that below a critical threshold of shear, the system undergoes non-local convection and mixing. However, with a sufficient amount of shear, the shear layer remains stable, delaying the onset of convection. In some cases, eventual collapse leads to a rapid delivery of heat to the lower layers. The delayed onset of convection could have implications for heat transport in regions of high shear, such as river plumes.

Session: 811 Atmosphere, Ocean, and Climate Dynamics - Part 2 Dynamique de l’atmosphère, des océans et du climat - Partie 2 **03/06/2021 12:45**

ID: 10775 Contributed abstract

Poster Order:

Scale Separation in Double-Diffusive Internal Seiches

Nicolas Castro-Folker [1] , *Marek Stastna* [2]

[1] University of Waterloo
[2] University of Waterloo

Presented by / Présenté par: ***Nicolas Castro-Folker***
Contact: ncastrof@uwaterloo.ca

We extend previous work on the interaction between internal seiches and shear instabilities by investigating the mutual modulation of laboratory scale, nonlinear internal seiches and double-diffusive instabilities in the diffusive convection regime. We use spectral methods to perform two-dimensional, high-resolution, direct numerical simulations with free-slip and no-flux boundary conditions. We find that double-diffusion increases the buoyancy frequency while simultaneously enhancing the rate of viscous dissipation. Finally, we discuss the effect of nonlinear steepening and degradation of the seiche into wave trains, the individual waves of which are closer in horizontal scale to the motion produced by double-diffusive instabilities.

Session: 811 Atmosphere, Ocean, and Climate Dynamics - Part 2 Dynamique de l'atmosphère, des océans et du climat - Partie 2

03/06/2021 13:00

ID: 10677 Contributed abstract

Poster Order:

Ekman-inertial instability

Nicolas Grisouard [1] , *Varvara E. Zemskova* [2]

[1] University of Toronto
[2] University of Toronto

Presented by / Présenté par: ***Nicolas Grisouard***
Contact: nicolas.grisouard@utoronto.ca

We report on an instability arising in sub-surface, laterally sheared geostrophic flows. When the lateral shear of a horizontal flow in geostrophic balance has a sign opposite to the Coriolis parameter and exceeds it in magnitude, embedded perturbations are subjected to inertial instability, albeit modified by viscosity. When the perturbation arises from the surface of the fluid, the initial response is akin to a Stokes problem, with an initial flow aligned with the initial perturbation. The perturbation then grows quasi-inertially, rotation deflecting the velocity vector, which adopts a well-defined angle with the mean flow, and viscous stresses, transferring horizontal momentum downward. The combination of rotational and viscous effects in the dynamics of inertial instability prompts us to call this process “Ekman-inertial instability.” While the perturbation initially grows super-inertially, the growth rate then becomes sub-inertial, eventually tending back to the inertial value. The same process repeats downward as time progresses. Ekman-inertial transport aligns with the asymptotic orientation of the flow and grows exactly inertially with time once the initial disturbance has passed. Because of the strongly super-inertial initial growth rate, this instability might compete favourably against other instabilities arising in ocean fronts.

Session: 811 Atmosphere, Ocean, and Climate Dynamics - Part 2 Dynamique de l’atmosphère, des océans et du climat - Partie 2

03/06/2021 13:15

ID: 11140 Contributed abstract

Poster Order:

Numerical Study of the Ekman-Inertial Instability in a 2D Non-Stratified Flow

Fabiola Trujano Jiménez [1] , *Varvara E. Zemskova* [2] , *Nicolas Grisouard* [3]

[1] University of Toronto
[2] University of Toronto
[3] University of Toronto

Presented by / Présenté par: ***Fabiola Trujano Jiménez***
Contact: ftrujano@physics.utoronto.ca

Submesoscale flows play an important role in the ocean dynamics and climate, in particular by inducing large vertical velocities that enhance transport of mass, heat, gases and nutrients. These flows can become unstable and affect the submesoscale dynamics in ways that still remain unknown. The Ekman-Inertial Instability (EII) has recently been theoretically predicted to develop in submesoscale anticyclonic flows forced by a sudden change in surface wind stress, and grow at a much faster rate than other known submesoscale instabilities. The currently-existing description of EII is 1D and borrows elements from both Ekman layer dynamics and the inertial instability. Here, I present a numerical study of the development of EII in a 2D submesoscale filament within a non-stratified flow, and compare the results to those observed in classical Inertial Instability on one hand, and Ekman Layer dynamics on the other. Numerical simulations show that vertical pumping and energy dissipation are greater and earlier triggered in EII unstable flows.

Session: 720 Integrating Climate Change Adaptation into Engineering and Environmental Design: Opportunities and Challenges - Part 1 Intégrer l'adaptation aux changements climatiques dans la conception technique et environnementale : Occasions et défis - Partie 1

03/06/2021 12:30

ID: 11248 Invited session speaker

Poster Order:

Bridging climate research and the practical application: Examples from the Pacific Climate Impacts Consortium

Markus Schnorbus [1]

[1] Pacific Climate Impacts Consortium

Presented by / Présenté par: ***Markus Schnorbus***
Contact: mschnorb@uvic.ca

The Pacific Climate Impacts Consortium (PCIC) is a regional climate service centre at the University of Victoria that conducts quantitative studies on the impacts of climate change and climate variability in the Pacific and Yukon region. Results from this work provide regional climate stakeholders with the information they need to develop plans for reducing the risks associated with climate variability and change. In this way, PCIC plays an important bridging function between climate research and the practical application of that knowledge by decision makers. This presentation will discuss some the the impact modelling and consultation work that PCIC undertakes in order to provide regional stakeholders with actionable information with which to plan, design and adapt to climate change.

Session: 720 Integrating Climate Change Adaptation into Engineering and Environmental Design: Opportunities and Challenges - Part 1 Intégrer l'adaptation aux changements climatiques dans la conception technique et environnementale : Occasions et défis - Partie 1

03/06/2021 13:00

ID: 10804 Contributed abstract

Poster Order:

Climate change and rainfall intensity–duration–frequency (IDF) curves:

overview of science and guidelines for adaptation

Jean-Luc Martel [1] , *François Brissette* [2] , *Philippe Lucas-Picher* [3] , *Magali Troin* [4] , *Richard Arsenault* [5]

[1] École de technologie supérieure
[2] École de technologie supérieure
[3] Groupe de Météorologie de Grande Échelle et Climat
[4] HydroClimat
[5] École de technologie supérieure

Presented by / Présenté par: ***Jean-Luc Martel***
Contact: jean-luc.martel@etsmtl.ca

One of the most important impacts of a future warmer climate is the projected increase in the frequency and intensity of extreme rainfall events. This increasing trend in extreme rainfall is seen in both the observational record and climate model projections. However, a thorough review of the recent scientific literature paints a complex picture in which the intensification of rainfall extremes depends on a multitude of factors. While some projected rainfall indices follow the Clausius-Clapeyron relationship scaling of ~7% increase in rainfall per 1°C of warming, there is substantial evidence that this scaling depends on rainfall extremes frequency, with longer return period events seeing larger increases, leading to super Clausius-Clapeyron scaling in some cases. In recent years, climate model simulations at a finer spatial and temporal resolution, including convection-permitting models, have provided more reliable projections of sub-daily rainfall. Recent analyses indicate that the rainfall scaling may also increase as a function of duration, such that for shorter duration, longer return period events will likely see the largest rainfall increases in a warmer climate. This has broad implications on the design and the use of rainfall intensity–duration–frequency (IDF) curves, for which both an overall increase and a steepening can now be predicted. However, the current measures adopted by various governing bodies to adapt IDF curves to the future climate fail to recognize the possible super Clausius-Clapeyron scaling of extreme rainfall, and perhaps more importantly, the increasing scaling towards shorter duration rainfall and the most extreme rainfall events that will significantly impact stormwater runoff in cities and in small rural catchments. This presentation will discuss the remaining scientific gaps and offers technical recommendations for practitioners on how to adapt IDF curves to improve climate resilience.

Challenges - Part 1 Intégrer l'adaptation aux changements climatiques dans la conception technique et environnementale : Occasions et défis - Partie 1

ID: 10641 Contributed abstract

Poster Order:

Extreme Climatic Design Parameters under Changing Climate for Design and Evaluation of Infrastructure

Hamidreza Shirkhani [1] , *Zoubir Lounis* [2]

[1] National Research Council Canada
[2] National Research Council Canada

Presented by / Présenté par: ***Hamidreza Shirkhani***
Contact: hamidreza.shirkhani@nrc-cnrc.gc.ca

The extreme climatic design parameters, such as 50-year wind and 50-year snow loads, in the codes and standards for infrastructure design are based on historical observations. This assumes that the past climatic conditions will adequately represent the future climate over the design service life of infrastructure. However, climatic conditions and climatic loads on infrastructure are expected to change in the future due to the changing climate. Hence, there is a need to design infrastructure according to future projections of climatic design values to ensure their safety, serviceability, functionality, and durability. The future climatic conditions largely depend on the human-induced greenhouse gas emissions described by representative concentration pathways (RCPs). Climate models, forced by RCP emission scenarios, are used to project the future climatic variables. The emission scenarios and different responses of climatic models to the future emissions result in uncertainty in projections of climatic variables. The future emission uncertainty is shown to depend on the design life of infrastructure with higher uncertainty levels expected for long life infrastructure, such as highway bridges with a design life of 75 years. In addition, the level of uncertainty depends on the climate variable. Precipitation and wind-related parameters are more uncertain compared to other climatic parameters such as temperature-related parameters. Under the changing climate, the projected climatic design values vary with time, which is known as climate non-stationarity. It is shown that the level of non-stationarity depends on the type of climatic parameter and the design life of infrastructure. The infrastructure with longer design life exhibit higher levels of uncertainty and non-stationarity in the projected climatic design values. A number of climatic design values for locations across Canada are analyzed to illustrate the implications of climate change for climatic design parameters used for the design and evaluation of infrastructure.

Session: 720 Integrating Climate Change Adaptation into Engineering and Environmental Design: Opportunities and Challenges - Part 1 Intégrer l’adaptation aux changements climatiques dans la conception technique et environnementale : Occasions et défis - Partie 1

03/06/2021 13:30

ID: 11030 Contributed abstract

Poster Order:

WMO Integrated Global Observing System

Thinesh Sornalingam [1]

[1] Environment and Climate Change Canada

Presented by / Présenté par: ***Thinesh Sornalingam***

Contact: thinesh.sornalingam@canada.ca

In response to the need for a holistic and standards based approach to meteorological monitoring and data exchange, the World Meteorological Organization (WMO) has developed the WMO Integrated Global Observing System (WIGOS). While there has been numerous advancements in the meteorology domain, the current societal challenges caused by impacts of climate change require a much more coordinated effort from the global Earth observing networks. WIGOS provides an over-arching framework for the coordination and optimized evolution of existing observing systems, which will continue to be owned and operated by a diverse array of organizations and programmes. It supports better use of existing and emerging observational capabilities. WIGOS became operational in 2016. Regional and national implementation is now underway, following approval by respective WMO Regional Associations and national authorities of their tailored WIGOS implementation plans. Central to WIGOS is the integrated approach to establishing and operating observing capabilities and effectively sharing data with users. To achieve interoperability and compatibility WIGOS employs internationally accepted standards and best practices. Data compatibility is supported by the use of standardized data representation, formats and tools. WIGOS aims to improve the quality and availability of data and metadata in order to develop capacity and to improve accessibility. This is accomplished by utilizing the WIGOS metadata standard, which was recently adopted as the authoritative Canadian hydro-meteorological station metadata standard by the Standards Council of Canada and the CSA Group for describing national observing capabilities. Furthermore, by utilizing WIGOS tools such the Observing System Capability Analysis and Review Tool (OSCAR/Surface) to exchange WIGOS metadata and the WIGOS Data Quality Monitoring System (WDQMS) to ensure availability and quality of data.

Session: 510 Coastal Oceanography and Inland Waters - Part 1 Océanographie côtière et eaux intérieures - Partie 1 **03/06/2021 12:30**

ID: 11111 Contributed abstract

Poster Order:

Deep Waters in British Columbia Mainland Fjords Show Rapid Warming and Deoxygenation From 1951 to 2020

Jennifer Jackson [1] , *Laura Bianucci* [2] , *Charles Hannah* [3] , *Jessy Barrette* [4] , *Eddy Carmack* [5]

[1] Hakai Institute
[2] Fisheries and Oceans Canada
[3] Fisheries and Oceans Canada
[4] Hakai Institute
[5] Fisheries and Oceans Canada

Presented by / Présenté par: ***Jennifer Jackson***
Contact: jennifer.jackson@hakai.org

British Columbia's coastline has many complex fjord systems. A 70 year (1951–2020) time series analysis of temperature, salinity, and oxygen in four such fjords between 54 and 50 degrees N (Douglas Channel, Rivers Inlet, Knight Inlet and Bute Inlet) shows that changes were greatest in deep waters, defined as water that lies between the sill and the bottom. In Rivers, Knight and Bute Inlet, the deep water temperature increased by 1.2 to 1.3 degrees C over 70 years, up to two times the global average for open ocean waters at corresponding depths, while salinity increased by 0.1 to 0.2, and oxygen decreased by 0.4 to 0.7 $mL L^{-1}$. The most northern inlet, Douglas Channel, showed a temperature increase of 0.8 degrees C from 1951 to 2016, while trends in oxygen and salinity were not statistically significant. An analysis of Apparent Oxygen Utilization suggests that the deep waters in Douglas Channel are more readily exchanged with the outer coast than the three other fjords. Understanding the similarities and differences among British Columbia fjords, and how they are being impacted by climate change, are essential to determine how coastal marine ecosystems will be impacted in the coming years.

Session: 510 Coastal Oceanography and Inland Waters - Part 1 Océanographie côtière et eaux intérieures - Partie 1 **03/06/2021 12:45**

ID: 10684 Contributed abstract

Poster Order:

Coastal Wavewatch III wave model to form basis of nearshore hazard prediction

Leah Cicon [1] , *Johannes Gemmrich* [2] , *Carmen Holmes-Smith* [3]

[1] University of Victoria
[2] University of Victoria
[3] University of Victoria

Presented by / Présenté par: ***Leah Cicon***
Contact: lcicon@uvic.ca

Extreme wave runup and large unexpected waves present a serious threat to beach and water users in coastal areas. Risk assessment is challenging due to the complicated dynamics of the nearshore wave environment. Output parameters from a routine wave forecast are evaluated for their use in a predictive wave hazard model. The primary areas of interest are the Pacific Rim National Park and Tofino, BC beaches. A Wavewatch III model was calibrated for the entire BC coast extending into the open ocean with an unstructured grid with a 1000m minimum resolution. The model is forced by HRDPS 2.5km wind field and boundary conditions from ECCC's global wave model. A large number of spectrally derived wave parameters were compiled to quantify the sea state to correlate to runup measurements, extracted from camera systems installed at various beaches. These correlations obtained from more than 1.5 years of observational data will form the basis of the risk assessment model. In addition to the societal impact, this work addresses the scientific aspects of the wave field transition from the nearshore to wave runup, the physics of which are still debated. A similar type of analysis could be implemented in other coastal areas.

Session: 510 Coastal Oceanography and Inland Waters - Part 1 Océanographie côtière et eaux intérieures - Partie 1 **03/06/2021 13:00**

ID: 10695 Contributed abstract

Poster Order:

Stratification and mixing in the Kitikmeot Sea in the Canadian Arctic Archipelago

Chengzhu Xu [1] , *Yasaman Afsharipour* [2] , *Paul Myers* [3] , *Qi Zhou* [4]

[1] Bedford Institute of Oceanography

[2] University of Calgary
[3] University of Alberta
[4] University of Calgary

Presented by / Présenté par: ***Yasaman Afsharipour***
Contact: qi.zhou1@ucalgary.ca

The Kitikmeot Sea is a semi-enclosed, east-west waterway located in the southern Canadian Arctic Archipelago (CAA). The physical oceanographic conditions of the Kitikmeot Sea are different from channels in the northern CAA due to the existence of a substantial ice-free period each year. Through fluctuations of external forcings, such as solar radiation, wind stress, and freshwater input, the seasonal ice coverage leads to significant seasonal variation in the physical oceanographic conditions, in particular the stratification, circulation, and mixing. In the present work, the seasonal variation of these physical oceanographic conditions is diagnosed using numerical simulations with a 1/12-degree resolution. Our simulation results suggest that the ice-free season is characterized by a strong stratification but also the enhanced wind-driven mixing. The strengthening of the stratification is primarily due to the freshwater input from both ice melt and river discharge. During the peak runoff season, the salinity of the surface layer can reach as low as 15 psu. On the other hand, direct momentum input from the wind stress during the ice-free season can lead to strong along-shore currents, whose speed is an order of magnitude larger than the typical current speed during the ice-covered season, and significant deepening of the surface mixed layer. At locations where narrow straits and shallow sills are present, the tidal forcing is also expected to play an important role in the circulation and mixing. The relative importance of wind-driven mixing and tidal mixing will also be analyzed by comparing the results of simulations with and without tidal forcing.

Session: 510 Coastal Oceanography and Inland Waters - Part 1 Océanographie côtière et eaux intérieures - Partie 1 **03/06/2021 13:15**

ID: 10754 Contributed abstract

Poster Order:

Evaluation of a Global Total Water Level Model in the Presence of Radiational S2 Tide

Pengcheng Wang [1] , *Natacha Bernier* [2] , *Keith Thompson* [3] , *Tsubasa Kodaira* [4]

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[2] ECCC

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Presented by / Présenté par: ***Pengcheng Wang***
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A high-resolution (1/12o) global barotropic tide and surge model, based on the NEMO modelling framework, is developed to provide total water level (TWL) forecasts for the Canadian coast. The model has been tailored to provide TWL forecasts through the implementation of a new tidal nudging technique (via u in the momentum equation), and the addition of self-attraction and loading, and internal wave-drag. The tidal nudging includes both gravitational and radiational components. The model is forced by Environment and Climate Change Canada (ECCC) high temporal resolution (1 h) atmospheric pressure and wind reforecast fields. Model validation, using hourly observations for 2008, shows that tidal nudging improves tide predictions at 82% of the 304 coastal and offshore tide gauge stations even though the nudging is applied only in deep water. The average RMSE across all stations is reduced by 23%. The model is next used to forecast surges and TWL. We show that the combined tide-surge with nudging must be used for global operational forecasting and climate sensitivity studies due to nonlinear interaction between the gravitational and radiational S2 tides. We discuss practical problems and potential solutions that can arise when modelling S2 on global and regional scales. Finally, we show that the global TWL forecast system performs well at the 304 gauges.

Session: 510 Coastal Oceanography and Inland Waters - Part 1 Océanographie côtière et eaux intérieures - Partie 1 **03/06/2021 13:30**

ID: 10763 Contributed abstract

Poster Order:

Testing the storm surge capability in the CONCEPTS 1/12th degree resolution Arctic-North Atlantic ice-ocean configuration

Frederic Dupont [1] , *Oleksandr Huziy* [2] , *Ji Lei* [3] , *Yimin Liu* [4] , *Kamel Chikhar* [5] , *Audrey-Anne Gauthier* [6] , *Dorina Surcel-Colan* [7] , *Jean-François Lemieux* [8] , *Gregory Smith* [9] , *Youyu Lu* [10] , *Fraser Davidson* [11] , *ALain Caya* [12]

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Presented by / Présenté par: ***Frederic Dupont***
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The Canadian Operational Network of Coupled Environmental Prediction Systems (CONCEPTS) has developed a three-dimensional 5km Regional Ice-Ocean Prediction System (RIOPS) based on NEMO-CICE. The system, in a Pacific-extended domain, is operational since 2019, produces four 48h ice-ocean forecasts per day and provides 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 and on an increased resistance to tension and shear. Some interest have been raised regarding the storm surge capability of the system in Arctic waters since the model includes both wind and pressure forcing, while the region is not covered by any storm surge system at the moment. This capability is tested and presented hereafter with a focus in seasonal impact of ice cover.

Session: 321 The Changing Arctic Ocean - Part 2
L'évolution de l'océan Arctique - Partie 2 **03/06/2021 14:30**

ID: 11195 Contributed abstract

Poster Order:

Synoptic Wind Forcing of the Flaw Lead in the Southern Beaufort Sea Ice Cover

Matthew Asplin [1] , *David Babb* [2] , *David Fissel* [3] , *Keath Borg* [4] , *Robert Pickart* [5] , *Peigen Lin* [6] , *Francis Wiese* [7]

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Presented by / Présenté par: ***Matthew Asplin***
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The Marine Arctic Ecosystem Study (MARES) was a multidisciplinary study to improve our understanding of the physical processes important to the Southern Beaufort Sea marine ecosystem, and field studies were conducted from 2016 – 2018/19 in the Kaktovik to Mackenzie Delta region. Winds are a key physical forcing mechanism on dynamic and thermodynamic processes in Arctic sea ice and the upper mixed layer of the ocean. In the fall, the sea ice motion is largely free drift in response to wind and ocean current forcing, reaching ice speeds >100 cm/s. Wind forcing dominates sea ice motion when wind speeds exceed 4 m/s. As the ice concentration becomes high and the sea ice thickens into Winter, internal ice strength begins to develop and may inhibit sea ice motion and cause episodic cessation of sea ice motion (defined as less than 0.5 cm/s). The sea ice begins to break-up and disperse by late Spring, especially near the Mackenzie Canyon with the onset of the Mackenzie River freshet. Long-duration wind events (>10 days) affecting the southern Beaufort Sea were only found for easterly wind events, with six long-duration wind episodes occurring concurrently with the MARES field program. An event lasting 441 hours (18 days) was identified from 2–20 December 2017 and took place over young first-year sea ice cover. A second long-duration event was identified from 1–17 May 2018, lasting 384 hours (17 days), and occurring over high concentrations of thick first-year ice. These events represent important prolonged periods favouring upwelling conditions, especially in fall and spring when sea ice mobility is increased. Westward sea ice displacement is about 2% of the wind displacement, corresponding to ~100km and ~220km for the December 2017 and May 2018 events, respectively. Additional impacts on region-wide sea ice cover arising from these events are explored.

Session: 321 The Changing Arctic Ocean - Part 2
L’évolution de l’océan Arctique - Partie 2 **03/06/2021 14:45**

ID: 10938 Contributed abstract

Poster Order:

A four-month lead predictor of open-water onset in Bering Strait

Youyu Lu [1], *Hao Wei* [2], *Xiaofan Luo* [3], *Yali Wang* [4], *Xianmin Hu* [5], *Wei Zhao* [6]

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Presented by / Présenté par: ***Youyu Lu***
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This study reveals that the yearday of open-water onset (topen) in Bering Strait can be predicted with a lead time of about 4 months using a regression equation topen = 37.45CCN + 125.2 (in Julian days), with an averaged absolute error of 5 days and the maximum error of 12 days, where CCN is the ice concentration averaged from January 16th to February 15th near Cape Navarin. This "predictor" is revealed through analyzing the solution of a regional ocean and sea-ice model. A key factor contribution to the prediction is that the prior winter ice concentration is controlled by the sea surface temperature, and persists into the start of the melting phase near the marginal ice zone in the Cape Navarin area. As ice melts near Cape Navarin, successive melting due to solar heat absorption and lateral heat transport occurs rapidly downstream along Anadyr Current.

Session: 321 The Changing Arctic Ocean - Part 2
L'évolution de l'océan Arctique - Partie 2 **03/06/2021 15:00**

ID: 11127 Contributed abstract

Poster Order:

Predicting Lagrangian trajectories for drifting objects in the Marginal Ice Zone

Graig Sutherland [1], *Victor Aguiar* [2], *Lars-Robert Hole* [3], *Jean Rabault* [4], *Mohammed Dabboor* [5], *Oyvind Breivik* [6], *Atle Jensen* [7]

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Presented by / Présenté par: ***Graig Sutherland***
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For Lagrangian trajectory modeling of oil spills, it is common to include a leeway

coefficient - typically on the order of a few percent of the wind - to account for direct wind forcing on the object as well as to correct for model biases or missing physics in the model, which are expected to scale with the wind. In the marginal ice zone (MIZ), a "80/30" rule is typically implemented for trajectory modeling which assumes that: for ice concentrations less than 30% the oil drifts with the ocean plus leeway, above 80% the oil drifts with the ice velocity, and between these ice concentrations a linear weight of the two is used. As data is scarce the use of such a 80/30 rule is largely anecdotal. Presented here are observations from four drifters placed in the MIZ during late September 2018 at ice concentrations approximately from 10% to 90%. Using two operational ice-ocean prediction systems, we investigate the use of a linear velocity weight over all ice concentrations as well as allowing for a leeway coefficient for the ice velocity and determine the leeway coefficients which best predict the observed trajectory. Results suggest that including a leeway coefficient in the ice is effective in reducing drift bias and the results appear to be robust between the two choices of ice-ocean prediction systems and insensitive to the velocity weighting function in the MIZ.

Session: 321 The Changing Arctic Ocean - Part 2
L’évolution de l’océan Arctique - Partie 2 **03/06/2021 15:15**

ID: 11040 Contributed abstract

Poster Order:

Phytoplankton dynamics in the Hudson Bay System, an ocean color satellite perspective

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Presented by / Présenté par: ***Lucas Barbedo***
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The Hudson Bay System, the largest inland sea, has experienced disproportionate atmospheric warming and sea-ice decline relative to the whole Arctic Ocean during the last decades. Phytoplankton dynamics adjust its phenology and photoacclimation to adapt to Arctic Warming, consequently, affecting the whole marine ecosystem. Satellite ocean color radiometry revealed that, in recent decades, phytoplankton phenology has become dominated by a first peak throughout marginal ice zones in the spring and a second one in the fall. To investigate the interplays of phytoplankton dynamics, ocean, cryosphere, and atmospheric forcings. We applied a synergy of ocean color constellation,

sea-ice modeling, atmospheric reanalysis, climatic indices, and in situ bio-optics sampled in the Baffin Bay (GreenEdge, 2016), and in the Hudson Bay (BaySys Project, 2018). Sensibility analysis of satellite-derived phytoplankton production shows how uncertainties of photoacclimation, vertical distribution of chlorophyll-a concentration, and underwater light are propagated. However, satellites can not see below sea-ice, consequently, hidden an important component of annual production. The early sea-ice retreat has affected the balance between under-ice and pelagic blooms throughout marginal ice zones resulting in ice-edge bloom intensification. The strengthening of westerly winds caused by the strong north polar vortex during positive North Atlantic/Arctic Oscillation phases favors the formation of the northwest Hudson Bay polynya, a marine wildlife hotspot, where ice production and export, brine rejection, and efficient nutrient replenishment. As a result, the winter climate preconditions the upper layer for the subsequent development of ice-edge blooms. Pelagic fall blooms are triggered when the convective mixing, forced by the atmospheric cooling, and wind-driven turbulence expands the mixed layer, ventilates the pycnocline, and likely erodes the nitracline. The bloom finally ceases/collapses when the sea surface freezes. Although fall blooms may, in part, result from the advection of pigment-rich phytoplankton cells previously produced in the subsurface chlorophyll maximum, they are potentially productive and characterized by a size structure and photo-acclimation state like those blooming at the ice-edge earlier in summer.

Session: 321 The Changing Arctic Ocean - Part 2
L’évolution de l’océan Arctique - Partie 2 **03/06/2021 15:30**

ID: 10955 Contributed abstract

Poster Order:

Decline of Arctic 'ice factories' delayed by negative feedbacks

Sam Cornish [1] , *Yavor Kostov* [2] , *Helen Johnson* [3]

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Presented by / Présenté par: ***Sam Cornish***
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The loss of sea ice over past few decades shows a sea ice volume budget that is becoming increasingly dominated by its seasonal cycle. That cycle has intensified subtly: summertime melting is enhanced and winter freezing has increased slightly, despite the fact that Arctic warming is most intense in the winter. This raises the questions: why? And for how long can we expect winter sea ice growth to keep increasing? We pose these questions with a regional focus on the Kara and Laptev seas. These seas are often termed the ice factories of the Arctic because of their outsized contributions to the Arctic sea ice budget, primarily a consequence of their divergent settings. Using the CESM climate model ensemble, we investigate the key levers on ice production, and show that 20th Century and RCP8.5 changes can be skilfully reconstructed by a linear model including surface air temperatures, snow thickness, sea ice divergence and a knowledge of the sea ice volume at the onset of freezing. Enhanced divergence—associated with increasing sea ice mobility—and smaller ice volumes at the sea ice minimum lead to enhanced freezing. These are therefore negative feedbacks on sea ice loss. However, in CESM, once the September sea ice volume approaches zero, warming temperatures and a shortening freezing season outstrip the negative feedbacks, and ice production begins to decline. We analyse satellite and reanalysis data to attempt to interpret the prospects for the Arctic ice factories in the real world.

Session: 815 Atmosphere, Ocean, and Climate Dynamics - Part 6 Dynamique de l'atmosphère, des océans et du climat - Partie 6

03/06/2021 14:30

ID: 11018 Contributed abstract

Poster Order:

Regional mechanisms underlying the climate response to aerosol forcing

Haruki Hirasawa [1] , *Paul Kushner* [2] , *Michael Sigmond* [3] , *John Fyfe* [4] , *Clara Deser* [5]

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Presented by / Présenté par: ***Haruki Hirasawa***
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Anthropogenic aerosol emissions vary both spatially and temporally during the historical period. As a result, the effect of aerosol forcing changes with time and region. In this work, we discuss the influence of forced SST anomalies versus the direct atmospheric effect of aerosol forcing in determining the overall response using AGCM experiments in CanAM4 and CAM5 for the 1950s to

1970s and the 1970s to 2000s. While the pattern of SST anomalies dictates the precipitation changes over oceanic regions, the direct-atmospheric effect proves to be important in some land regions, such as in the Asian and African monsoon regions. Using additional CAM5 experiments, we further investigate how regional aspects of the perturbations play a role in the total response, by testing the effect of aerosol-forced anomalies in different ocean basins and by testing the effect of aerosol emissions from different regions. We find that a perturbation in one region can have remote influences on another region, with different regions having different effects on a given region, complicating simple explanations for the effect of aerosols on the climate. For example, we find in West Africa, Atlantic cooling reduces rainfall, while Pacific cooling increases it, resulting in a cancellation in the total Global ocean effect.

Session: 815 Atmosphere, Ocean, and Climate Dynamics - Part 6 Dynamique de l’atmosphère, des océans et du climat - Partie 6

03/06/2021 14:45

ID: 11112 Contributed abstract

Poster Order:

Irreducible Southern Ocean State Uncertainty due to Global Ocean Initial Conditions

Hansi Singh [1] , *Naomi Goldenson* [2] , *John Fyfe* [3] , *Lorenzo Polvani* [4]

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Presented by / Présenté par: ***Hansi Singh***
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How do ocean initial conditions impact historical and future climate projections in Earth system models? To answer this question, we use the 50-member Canadian Earth System Model (CanESM2) large ensemble, in which individual ensemble members are initialized using a strategic combination of different oceanic initial states and different atmospheric perturbations. We show that global ocean heat content anomalies associated with the different ocean initial states persist from initialization at year 1950 through the end of the simulations at year 2100. We also find that these anomalies most readily impact surface climate over the Southern Ocean. Ocean initial conditions affect Southern Ocean surface climate because persistent deep ocean temperature anomalies upwell along sloping isopycnal surfaces that delineate neighboring branches of

the Upper and Lower Cells of the Global Meridional Overturning Circulation. As a result, up to a quarter of the ensemble variance in Southern Ocean turbulent heat fluxes, heat uptake, and surface temperature trends can be traced to variance in the ocean initial state. Such a discernible impact of varying ocean initial conditions on ensemble variance over the Southern Ocean is evident throughout the full 150 simulation years of the ensemble, even though upper ocean temperature anomalies due to varying ocean initial conditions rapidly dissipate over the first two decades of model integration over much of the rest of the globe.

Session: 815 Atmosphere, Ocean, and Climate Dynamics - Part 6 Dynamique de l'atmosphère, des océans et du climat - Partie 6

03/06/2021 15:00

ID: 11172 Contributed abstract

Poster Order:

Present-day and Future Impacts of Extratropical Cyclone Location on Antarctic Sea Ice

Jamie Ward [1] , *Ashley Payne* [2]

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Presented by / Présenté par: ***Jamie Ward***
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Unlike the Arctic, Antarctic sea ice extent has increased over the last few decades and has limited regional warming despite increased lower atmosphere and ocean temperatures. Antarctic sea ice changes result from numerous ocean and atmosphere feedback mechanisms that occur over different spatial and temporal scales. In the atmosphere, synoptic-scale extratropical cyclones regularly pass over the subantarctic (i.e., latitudes higher than the polar front, or roughly 60°S) and are responsible for most of the Southern Hemisphere's poleward moisture transport and warm air advection. Storm moisture and temperature characteristics vary by source region and can impact resulting clouds, precipitation, and surface energy flux patterns over local sea ice. Because of these regionally-variable properties of extratropical cyclones, we hypothesize that sea ice response to extratropical cyclone activity also varies by location around the subantarctic. In this study, we use multiple forms of climate data to assess how sea ice responses to extratropical cyclone activity vary by longitude in the subantarctic. We first characterize geographical variability of present-day (1990-2019) extratropical cyclone-sea ice interactions with ECMWF

Reanalysis (ERA5) meteorological and energy flux data. We then use these findings to evaluate output from a fully-coupled, slab ocean Community Earth System model (CESM2) configuration over the same time period. To understand how extratropical cyclone moisture transport and temperature advection processes could change in different future warming scenarios, we will employ the same CESM2 setup to produce multiple simulations in the late twenty-first century for the Shared Socioeconomic Pathways (SSP) 1 and 5 warming scenarios with 2.6 and 8.5W/m2 radiative forcing, respectively. For each of these analyses, we examine cyclone-sea ice interactions separately for equal-area regions bound by the 0°E, 60°E, and -60°E meridians.

Session: 815 Atmosphere, Ocean, and Climate Dynamics - Part 6 Dynamique de l’atmosphère, des océans et du climat - Partie 6

03/06/2021 15:15

ID: 11185 Contributed abstract

Poster Order:

Changes in Cross-Equatorial Ocean Heat Transport Impact Hemispheric Climate and Hydrologic Cycle Sensitivity

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Presented by / Présenté par: ***Oghenekevwe C. Oghenechovwen***
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Do changes in how cross-equatorial energy transport is partitioned between the ocean and atmosphere impact the hemispheric climate response to forcings? In a set of abrupt CO₂-doubling experiments using the CESM1 with a slab ocean, we alter the ocean cross-equatorial heat transport and ascertain how changes in energy transport and its partitioning between the atmosphere and ocean impact climate and hydrological cycle sensitivity in each hemisphere. Changes in ocean cross-equatorial energy transport trigger compensating changes in atmospheric energy transport through changes in the Hadley cells and shifts in the Intertropical Convergence Zone. As a result, energy transport compensation between the ocean and atmosphere in both hemispheres is nearly perfect and the change in the total energy transport is small. However, the hemispheric climate sensitivity is positively correlated with the ocean heat transport convergence ($r = 0.98$) and negatively correlated with the atmospheric energy convergence ($r = -0.99$). The hemispheric climate sensitivity is controlled by the ocean heat transport convergence because greater surface heating

triggers a significant reduction in low, optically-thick clouds that reflect shortwave radiation. Furthermore, we also show that changes in ocean heat transport convergence control the hemispheric hydrologic cycle sensitivity, due to the impact of ocean heating on evaporation. A radiative kernel feedback analysis reveals how water vapour, clouds, surface albedo, and lapse rates are sensitive to atmosphere and ocean energy transport, and may thereby impact the hemispheric climate response to CO₂-doubling. Our work suggests that energy transport partitioning between atmosphere and ocean is an important control on the hemispheric climate response, particularly with respect to climate and hydrologic cycle sensitivity.

Session: 815 Atmosphere, Ocean, and Climate Dynamics - Part 6 Dynamique de l'atmosphère, des océans et du climat - Partie 6

03/06/2021 15:30

ID: 11205 Contributed abstract

Poster Order:

Impacts of Stratospheric Ozone Extremes on Arctic High Cloud

Karen Smith [1] , *Sarah Maleska* [2] , *John Virgin* [3]

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Presented by / Présenté par: ***Karen Smith***
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Stratospheric ozone depletion in the Antarctic is well known to cause changes in Southern Hemisphere tropospheric climate; however, because of its smaller magnitude in the Arctic, the effects of stratospheric ozone depletion on Northern Hemisphere tropospheric climate are not as obvious or well understood. Recent research using both global climate models and observational data has determined that the impact of ozone depletion on ozone extremes can affect interannual variability in tropospheric circulation in the Northern Hemisphere in spring. To further this work, we use a coupled chemistry–climate model to examine the difference in high cloud between years with anomalously low and high Arctic stratospheric ozone concentrations. We find that low ozone extremes during the late twentieth century, when ozone-depleting substances (ODS) emissions are higher, are related to a decrease in upper tropospheric stability and an increase in high cloud fraction, which may contribute to enhanced Arctic surface warming in spring through a positive longwave cloud radiative effect. A better understanding of how Arctic climate is affected by ODS

emissions, ozone depletion, and ozone extremes will lead to improved predictions of Arctic climate and its associated feedbacks with atmospheric fields as ozone levels recover.

Session: 511 Coastal Oceanography and Inland Waters - Part 2 Océanographie côtière et eaux intérieures - Partie 2 **03/06/2021 14:30**

ID: 11113 Contributed abstract

Poster Order:

Using a bistatic coherent Doppler sonar to measure the motion of sediment along the bottom: a direct measurement of bedload transport.

Len Zedel [1], *Alex Hay* [2], *Greg Wilson* [3], *Jenna Hare* [4]

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[3] Oregon State University
[4] Dalhousie University

Presented by / Présenté par: ***Len Zedel***
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By combining Doppler sonar measurements of velocity with coincident acoustic estimates of suspended sediment it is now possible to measure suspended sediment transport in rivers and in the coastal ocean. An equally important component of sediment transport is caused by sediments that roll or bounce along the bottom; this bedload transport contribution occurs in a region where conventional Doppler sonar systems cannot measure. Standard (accepted) measurements of bedload transport requires the use of invasive physical sampling techniques that are hard to automate in the field, and as a result, there is a need for remote bedload transport measurements comparable to those possible with Doppler sonar systems. Doppler sonar systems are used to measure water volume flow in rivers and there is a growing number of observations that correlate (apparent) riverbed velocity with bedload transport. Such observations suggest that Doppler sonar techniques hold potential for quantitative bedload measurements. In this presentation we report on a (field scale) laboratory experiment to evaluate direct bedload measurements made using a bistatic coherent Doppler sonar system; the MFDop. Tests were undertaken at the St. Anthony Falls Laboratory (SAFL) main flume facility which allows continuous measurement of bedload transport using traps built into the flume floor. Comparisons of MFDop bedload measurements agree favourably with those made using the SAFL traps and with bulk measurements based on the movement of sand dunes.

Session: 511 Coastal Oceanography and Inland Waters - Part 2 Océanographie côtière et eaux intérieures - Partie 2 **03/06/2021 14:45**

ID: 10855 Contributed abstract

Poster Order:

Nested-Grid Numerical Ocean Circulation Models for the Eastern Canadian Shelf

Kyoko Ohashi [1] , *Jinyu Sheng* [2]

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Presented by / Présenté par: ***Kyoko Ohashi***
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We present two types of nested-grid circulation modelling systems for the eastern Canadian shelf, constructed with the Regional Ocean Modeling System (ROMS). In both types of nested-grid modelling systems, relatively coarse horizontal resolutions are used in the outer domains, freeing them of the constraint of small time steps. The relatively fine spatiotemporal resolutions used in the inner domains enable more realistic simulations over the areas of interest. The first type of modelling system has three levels of nested grids, with the outermost model domain covering the area from Cape Hatteras to Hamilton Bank and the innermost domain covering the southwest Scotian Shelf. This modelling system is also coupled to the sea ice model known as CICE. The second type of modelling system is under development and currently consists only of the outermost model domain, covering the region from Cape Hatteras to Davis Strait. We describe methods of reducing model systematic bias and drift implemented in ROMS, such as the semi-prognostic method and spectral nudging. We present preliminary model results, validations, and descriptions of ongoing and future applications. In addition to studying the physical processes simulated by the circulation and sea ice models, these modelling systems will be used to address important issues such as the spatiotemporal variability of oxygen, and the relationship between the physical and biogeochemical processes over the eastern Canadian shelf.

Session: 511 Coastal Oceanography and Inland Waters - Part 2 Océanographie côtière et eaux intérieures - Partie 2 **03/06/2021 15:00**

ID: 11007 Contributed abstract

Poster Order:

Differential renewal of deep-water drives reaction layering in seasonally anoxic Saanich Inlet

Roberta Hamme [1] , *C. Erinn Raftery* [2]

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Presented by / Présenté par: ***Roberta Hamme***
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Oxygen deficient waters are expanding globally, making the study of biogeochemical transformations happening at low oxygen ever more pressing. Saanich Inlet, a seasonally anoxic fjord in SW British Columbia, presents an opportunity to study these transformations in an accessible, natural laboratory. A sill at the mouth of Saanich Inlet prevents flushing of the deep waters over most of the year, such that respiration of sinking organic matter creates anoxic conditions. However, in late summer / early fall, dense water occasionally flows over the sill, bringing oxygen and nitrate to the deep waters. Here, we present data from a series of cruises spanning two deep-water renewal events through the return to full anoxia. Sulfide and ammonium data demonstrate a complex layering of water masses after the last renewal. A pocket of sulfide-rich water formed within a month at mid-depths, followed by a sulfide-rich layer forming at the bottom. Sulfide concentrations grew more slowly between these two layers. Ammonium data tells a similar story of layering of waters with different redox states. Simultaneous dissolved N ^{<small>2</small>}/Ar gas and nitrate data show that initial denitrification rates were highest in the shallow sulfide pocket, with the next highest rate in the bottom waters, and the slowest rate in the layer between them. Data from nearby Ocean Networks Canada moorings demonstrate that waters with a range of densities entered the inlet during each deep-water renewal event. We hypothesize that these waters intruded into the inlet in several layers, resulting in different mixtures of varying proportions of previously anoxic and newly flushed water. Reactions in each layer then proceeded along their own cascade of anoxic reactions at different rates, depending on the proportion of water flushed. Understanding these dynamics in Saanich Inlet will help to inform our understanding of how oxygen deficient zones recover after flushing events.

Session: 511 Coastal Oceanography and Inland Waters - Part 2 Océanographie côtière et eaux intérieures - Partie 2 **03/06/2021 15:15**

ID: 11064 Contributed abstract

Poster Order:

Hydrodynamic Modelling of Wind-Driven Flows in Large Lakes

Parna Parsapour-Moghaddam [1] , *Pascal Matte* [2] , *Daniel Peters* [3] , *Yves Secretan* [4] , *Melanie Trudel* [5] , *Gabriela Llanet Siles* [6] , *Jean bergeron* [7]

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Presented by / Présenté par: ***Parna Parsapour-Moghaddam***
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Hydrology and hydrodynamics of medium to large lakes can be significantly impacted by winds. Wind-forced seiches can result in significant changes in surface water elevations and extents across inland water bodies. Examination of these dynamic processes is crucial for understanding connectivity and monitoring lakes and/or deltaic ecosystems. In the present study, we focus on the Peace-Athabasca Delta (PAD), which is one of the largest inland deltas in the world. This region is characterized by low topographic relief within the floodplains, complex network of interconnected lakes and rivers, resulting in an aquatic ecosystem that is internationally recognized by the Ramsar Convention on Wetlands and UNESCO World Heritage Sites. The dynamics of intermittent wind seiches in the PAD area, which can push water into low-lying terrain and expose mudflats, has received little attention and is thus still poorly understood. Our goal is to study wind setup and seiches effects on the hydrodynamics of the Mamawi lake, which is a shallow lake (< 3m depth and <200 km2 area) at the heart of the PAD. We first analyzed the historical water elevation with respect to the wind data to identify important wind setup and seiche events. We then used H2D2, a finite element shallow water model, to investigate the influence of the wind-forced events on the hydrodynamics of the study lake. To better predict the water surface elevation changes in the presence of wind, we tested the model sensitivity to different parameterizations of wind drag, bottom friction, wetting and drying, and mixing and turbulence. Statistical significance tests are conducted to quantify the sensitivity of the surface water results to each parameter. The outcome of the present study reveals how wind driven fluctuations could potentially change the hydrological and ecological balance of certain low-lying areas of the PAD.

Session: 511 Coastal Oceanography and Inland Waters - Part 2 Océanographie côtière et eaux intérieures - Partie 2 **03/06/2021 15:30**

ID: 10877 Contributed abstract

Poster Order:

Response of sea level to tide, atmospheric pressure, wind forcing and river discharge in the Kitimat Fjord System

Shiliang Shan [1] , *Charles Hannah* [2] , *Yongsheng Wu* [3]

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Presented by / Présenté par: ***Shiliang Shan***
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The response of sea level to tide, atmospheric pressure, wind forcing, and river discharge in the Kitimat Fjord System (KFS) is investigated by using observations from tide gauges and results from a high-resolution ocean circulation model. Tidal harmonic analysis of the observed hourly sea level at the head and mouth of Douglas Channel shows that the largest semidiurnal tide (M2) alone accounts for 79% of the total sea level variance, and the top four major tidal constituents (M2, S2, K1, and O1) account for 94% of the total variance. In addition, the amplitude of M2 increases slightly from 1.586 to 1.647 m between the mouth and the head. For the observed subtidal sea level, the local inverse barometer response due to the variation of atmospheric pressure accounts for 59% of the variance. The variation of subtidal sea level difference between the mouth and the head of Douglas Channel is observable and can be largely attributed to the along-channel wind (54%) with an additional 13% of the variation due to the daily-averaged and seasonal-cumulative river discharges. A fjord-shelf three-dimensional ocean circulation model for KFS is developed to simulate the sea level variability. The model performance in simulating the sea level is assessed by comparing model results with observed harmonic constituents of ~70 tidal stations inside the model domain and time series recorded at the two tide gauges of KFS. The modelled tides are in good agreement with observations with a domain-averaged root-mean-square error estimate of ~0.04 m for M2. For the subtidal sea level, the model is able to capture the observed synoptic variations. Further analysis suggests that the underestimates of subtidal sea level in the ocean circulation model are mainly due to the weaker-than-observed wind forcing taken from the atmospheric model especially during the peak of strong down-fjord katabatic wind events.

Session: 721 Integrating Climate Change Adaptation into Engineering and Environmental Design: Opportunities and Challenges - Part 2 Intégrer l'adaptation aux changements climatiques dans la conception technique et environnementale : Occasions et défis - Partie 2

03/06/2021 14:30

ID: 11247 Invited session speaker

Poster Order:

The Consultant's Role in Assisting Clients to Adapt to, and Mitigate Against, the Effects of Climate Change

Klas Ohman [1] , *Craig MacDonald* [2] , *Shane Thompson* [3]

[1] Associated Engineering Alberta Limited
[2] Associated Engineering Alberta Limited
[3] Associated Engineering Alberta Limited

Presented by / Présenté par: ***Klas Ohman***
Contact: Ohmank@ae.ca

AUTHOR(S): Klas Ohman, Ph.D., P.Eng., Craig MacDonald, M.Sc., EIT Shane Thompson, P. Eng. MBA ABSTRACT: A Consultant's role be they an engineer, scientist, economist, or an information technology specialist is to be in the customer service business relative to their client. In that context, this presentation explores the various approaches or avenues that consultants can best serve a client's needs to adapt to, or to mitigate against the effects of climate change. In some case's the client's needs are obvious; for example, design a stormwater retention pond to help a community address a catastrophic storm event that could flood or damage the respective community in an irreparable way (ie. to the extent of completely destroying it). Another situation, which can be more common and equally more challenging to address are those where climate change and mitigation aspects are much more difficult to identify; an office renovation, upgrading an IT system, or purchasing/leasing a construction site office trailer. How does climate change adaptation and/or mitigation fit into those scenarios? This presentation includes some common approaches Consultants use for their clients to address the effects of climate change and mitigate them. In addition, internal processes Consultants use to both market their services, but to also supplement gaps in them in this evolving field are also provided. Lastly, some clients don't see climate change as a threat to their business, and consequently don't see a need to mitigate against the threat. The role of the Consultant in this case is to nonetheless guide a client to understand the risks this belief can have on their business, if for no other reason

than to reduce the liability to the Consultant’s own business, reputation and self-interest (ie. business preservation).

Session: 721 Integrating Climate Change Adaptation into Engineering and Environmental Design: Opportunities and Challenges - Part 2 Intégrer l’adaptation aux changements climatiques dans la conception technique et environnementale : Occasions et défis - Partie 2

03/06/2021 14:45

ID: 11084 Contributed abstract

Poster Order:

On the use of annual maxima to estimate long period wind speed return levels

Mohamed Ali Ben Alaya [1] , *Francis W. Zwiers* [2] , *Xeubin Zhang* [3]

1
2
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Presented by / Présenté par: ***Mohamed Ali Ben Alaya***
Contact: mohamedalibenalaya@uvic.ca

The uniform risk engineering practices that are increasingly being adopted for structural design require estimates of the extreme wind loads with very low annual probabilities of exceedance, corresponding to return periods of up to 3000-years in some cases. In many circumstances, estimates are obtained by fitting an extreme value distribution to annual maximum wind speed observed over a few decades. A key assumption implicit in this practice is that wind speed annual maxima are max-stable, implying that their statistical behaviour is predictive of that of maxima calculated over multi-decadal or longer intervals. Departures from max-stability can exacerbate the uncertainty of long-period return level estimates by inducing systematic estimation bias as well. Observational records, however, are generally too short to assess max-stability. We therefore USE wind speed data from a large (50-member) ensemble of CanRCM4 simulations over North America to assess whether wind speed annual maxima are max-stable. While results are generally reassuring at the continental scale, disquieting evidence of a lack of max-stability is often found in the central and southern parts of the continent. Results show that when annual maximum wind speeds are not max-stable, long period return level extreme wind speeds tend to be underestimated, which would compromise reliability if used to design infrastructure such as tall buildings and towers.

Session: 721 Integrating Climate Change Adaptation into Engineering and Environmental Design: Opportunities and Challenges - Part 2 Intégrer l'adaptation aux changements climatiques dans la conception technique et environnementale : Occasions et défis - Partie 2

03/06/2021 15:00

ID: 10676 Contributed abstract

Poster Order:

Preliminary Assessment of the Influence of Climate Change on Thunderstorm Winds for Five Selected Cities in South Ontario

Sihan Li [1] , *Jeff Lundgren* [2] , *Mike Gibbons* [3] , *Peter Irwin* [4]

[1] RWDI
[2] RWDI
[3] RWDI
[4] RWDI

Presented by / Présenté par: ***Sihan Li***
Contact: sihan.li@rwdi.com

Climate change impact in the Canadian built environments has been investigated in some recent studies. Different climatic variables, such as wind, flood, and snow, were evaluated in future projected climates considering different possible emission scenarios. Among these climatic variables, extreme wind speeds can be a critical design parameter, especially for tall, slender, and large-span structures. Different weather events can induce extreme wind speeds. In wind engineering applications, extreme wind speeds induced by different weather mechanisms are often analyzed separately. Wind engineering typically considers three wind mechanisms: synoptic wind, thunderstorm wind, and hurricane wind. Future climate projections do not directly provide the automatic classification of different wind mechanisms. This study used a WRF simulation with the RCP 8.5 scenario to study the change of thunderstorm events in the future period between 2029 and 2049, which were compared with the simulations conducted between 1999 and 2019. The historical period simulations were used to compare with the historical ground observation at five selected meteorological stations in southeast Ontario. The thunderstorm events detected at the meteorological stations in the historical period were used as a benchmark to determine appropriate values for the Lifted Index and the Convective Available Potential Energy, which were used to classify the thunderstorm events in the WRF simulation. The identified thunderstorm-induced wind events in the future period were compared to those identified in the historical periods. The climate change influence on the thunderstorm wind events and the design level wind speeds were discussed.

Session: 721 Integrating Climate Change Adaptation into Engineering and Environmental Design: Opportunities and Challenges - Part 2 Intégrer l'adaptation aux changements climatiques dans la conception technique et environnementale : Occasions et défis - Partie 2

03/06/2021 15:30

ID: 11121 Contributed abstract

Poster Order:

District of Ucluelet Coastal Flood Hazard Analysis

Clayton HIles [1] , *Roy Walters* [2] , *Ignacio Beya* [3]

[1] Cascadia Coast Research Ltd
[2] Cascadia Coast Research Ltd.
[3] Cascadia Coast Research Ltd

Presented by / Présenté par: ***Clayton HIles***
Contact: clayton@cascadiacoast.com

The District of Ucluelet (DOU) is located on the rugged outer west coast of Vancouver Island and is exposed to significant coastal storms and potentially catastrophic tsunamis. These hazards are changing and worsening with climate change. Adaptation and resilience building in the face of these hazards requires that the DOU have a good understanding of the present-day and future hazards and risks. Previous technical works, as well as the lived experiences of Ucluelet residents, have established that coastal hazards are around the DOU are considerable. The aim of the presented work is to develop a technical basis for quantifying, in detail, the hazard of coastal storm flooding and tsunami inundation to the DOU, and to estimate how that hazard may change with a changing climate. The exposed shores of the DOU experience waves in excess of 20 m in height. To better quantify this hazard a wave run-up hind-cast was developed. This hind-cast was synthesized from various measured and modelled data sources. The work included the development of an unstructured spectral wave model to transfer wave conditions from off-shore to shoreline. Development of the hind-cast and evaluation to multiple near-shore observations will be presented in detail. The DOU is also directly adjacent the Cascadia Subsection Zone (CSZ). There is a rich and developing body of literature demonstrating the potential for the CSZ to generate a mega-thrust rupture and tsunami. However, there is still considerable uncertainty in the form and magnitude that such a rupture might take. Using fault models from recent research from the University of Victoria, this work modelled the propagation of many potential CSZ tsunami, and their inundation at the DOU. The results from

the various tsunami sources will be discussed and contrasted, illustrating the significant uncertainty in the hazard of a CSZ tsunami event.

Day 5 – 4 June 2021

Oral

Session: 732 Producing, Providing and Communicating Useful Climate Information - Part 3 Produire, fournir et communiquer des informations climatiques utiles - Partie 3 **04/06/2021 11:00**

ID: 11038 Contributed abstract

Poster Order:

From science to services: providing useful climate information to users

Lindsay Matthews [1] , *Jeremy Fyke* [2]

[1] Canadian Centre for Climate Services
[2] Canadian Centre for Climate Services

Presented by / Présenté par: ***Lindsay Matthews***
Contact: trevor.murdock@canada.ca

Organizations seek usable, interpretable, credible, and freely available climate information to inform on-the-ground planning. Climate services providers operate in the gap between climate science and planning by translating climate information to users. This translation is challenging, because the final translated information and data must be technically defensible, easy to use, plainly worded and directly relevant to actual user needs in real-world decision-making settings. To address these challenges, significant work is required between the production of climate data from the climate research community, and the actual release of this data and supporting guidance to users. User needs analytics for climate services is an emerging area of applied scholarship led by climate service providers globally. Findings from user engagement initiatives, web analytics, and usability analyses then inform further work to match user needs to available climate change data. Climate service providers must develop an appropriate mechanism for providing this data in a user-amenable format and ‘language’, and manage an iterative review process involving both the scientific and user communities. The Canadian Centre for Climate Services, in partnership with other government departments and regional climate services providers, have been undertaking extensive work to better understand user

needs to inform the delivery of climate data and information to end users. This presentation is intended to provide a window into this work flow, by outlining the important steps between user needs analysis and final information delivery to users. Several recent and ongoing case studies will be presented to showcase translation ‘successes’ and persistent communication and logistical challenges that often require significant time and resources to overcome.

Session: 732 Producing, Providing and Communicating Useful Climate Information - Part 3 Produire, fournir et communiquer des informations climatiques utiles - Partie 3 **04/06/2021 11:15**

ID: 10992 Contributed abstract

Poster Order:

Climate services at Ouranos: the road ahead

Gabriel Rondeau-Genesse [1]

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Presented by / Présenté par: ***Gabriel Rondeau-Genesse***
Contact: rondeau-genesse.gabriel@ouranos.ca

The climate services landscape in Canada and beyond has changed rapidly over the last few years, with the creation of new climate services centres, data portals and the diffusion of other public resources. Similarly, Ouranos has invested a substantial effort into producing new standardized climate scenarios, implementing novel analysis methods, and diffusing climate science through open access python libraries (xclim) and a data platform (PAVICS). In parallel, the involvement of Ouranos at a project-level has allowed it to address more complex, customized demands. This democratisation of climate science and climate services has had major impacts, one of which being that it is now relatively easy for stakeholders and scientists to access readily-available climate projections and tools that can be used to investigate climate change adaptation strategies or drive impact models. A reflection has been initiated on multiple fronts at Ouranos to rethink the support and material that should accompany climate scenarios, and to alleviate the risks of maladaptation coming from the misuse of publicly available climate data. An easier access to standardized climate data also means that there is a growing need in this matter, especially in the case of complex climate scenarios, which can be subject to a high degree of uncertainty. As a result, it is essential to find ways to integrate quality control and robustness more explicitly in the process of climate scenario production, but also to provide information that facilitates expert judgement and considers confidence levels. These abstract concepts are of

high importance in regions with poor observation data coverage (e.g. precipitation over northern Canada) and for less understood variables such as humidity or freezing rain. The talk aims to share the experience at Ouranos with regards to quality control and scenario support, and improvements planned for the upcoming years.

Session: 732 Producing, Providing and Communicating Useful Climate Information - Part 3 Produire, fournir et communiquer des informations climatiques utiles - Partie 3 **04/06/2021 11:30**

ID: 11097 Contributed abstract

Poster Order:

District of Ucluelet Coastal Flood Hazard Mapping and Planning Support

Tamsin Lyle [1] , *Robert Larson Larson* [2]

[1] Principal
[2] Project Manager

Presented by / Présenté par: ***Tamsin Lyle***
Contact: robert@ebbwater.ca

The District of Ucluelet (DOU) is located on the rugged outer west coast of Vancouver Island and is exposed to significant coastal storms and potentially catastrophic tsunamis. These hazards are changing and worsening with climate change. Adaptation and resilience building in the face of these hazards requires that the DOU have a good understanding of the present-day and future hazards and risks. However, despite using the best available science and data, there remain significant uncertainties (e.g. the rate of sea level rise, the size of tsunami waves from multiple potential sources). This presentation will describe how science information was presented to the community using narrative and visual tools to enable understanding and future decision-making despite the uncertainties. This presentation will focus on how technical results were translated into mapping and videos to communicate the multi-faceted character of the hazards to the public and decision-makers. We will discuss the challenges associated with consideration and communication of multiple sources of overlapping uncertainty, as well as the variability in hazard characteristics (frequency, magnitude, duration, warning time, changing trends with climate change, etc.) using existing standard practice for coastal flood hazard mapping and absence of guidance for tsunami hazard mapping. We will then discuss our evolved approach, which included narrative descriptions of climate change scenarios (e.g., “present-day” and “far-future”), preparation of a full suite of coastal flood and tsunami scenarios (from rare extreme events to

common events today and in the future) that were designed to inform different levels of land use and building decisions, based on the criticality of the issue. We will share the success and challenges of this work in hope of enabling other communities to better manage uncertainty in their understanding of hazard.

Session: 880 General Session - Interdisciplinary Séance générale — Interdisciplinaire **04/06/2021 11:00**

ID: 10961 Contributed abstract

Poster Order:

Recherche en Prévision Numérique Contributions to Numerical Weather Prediction

C. Harold Ritchie [1]

[1] Environment and Climate Change Canada

Presented by / Présenté par: ***C. Harold Ritchie***
Contact: elritchie@bellaliant.net

Early Canadian efforts in Numerical Weather Prediction (NWP) led to the establishment in 1959 in Montreal of what was then called the Dynamic Prediction Research (DPR) unit which subsequently was renamed Recherche en Prévision Numérique (RPN). In the intervening years, weather forecasting in Canada has been transformed from a manual process involving manually plotted weather charts and manually written forecasts based on human forecaster experience and expertise to an automated process performed by computers, now relying on experts to advance a complex set of computer codes. This transformation was made possible by the continual development of the Canadian NWP suites. Here we review the history of this transformation and the role played by the RPN scientists, a group at the forefront of NWP innovations. 2021 is the 150th birthday of the Meteorological Service of Canada (MSC) and is timely for this review since most of these innovations are in support of the operational MSC forecast systems. This presentation is structured as a historical review and documents RPN contributions to numerical methods, numerical modelling, data assimilation, and ensemble systems, with a look ahead to potential future systems. Through this review, we highlight the evolution of RPN contributions. We begin with early NWP efforts and continue through to environmental predictions with a broad range of applications. This synthesis is intended to be a helpful reference consolidating developments and generating broader interest for future work on NWP in Canada. Contributing co-authors on this presentation are Stéphane Bélair, Natacha B. Bernier, Mark Buehner, Martin Charron, Vincent Fortin, Louis Garand, Syed Husain, Pieter

Houtekamer, Stéphane Laroche, Jean-François Lemieux, Hai Lin, Jason Milbrandt, Herschel Mitchell, Pierre Pellerin, Janusz Pudykiewicz, Ron McTaggart-Cowan, Leo Separovic, Gregory C. Smith, Monique Tanguay and Paul Vaillancourt with affiliation Environment and Climate Change Canada, Recherche en Prévision Numérique Environnementale, Dorval, QC.

Session: 880 General Session - Interdisciplinary Séance générale — Interdisciplinaire **04/06/2021 11:15**

ID: 11048 Contributed abstract

Poster Order:

Changing pattern of persistent positive anomalies in geopotential heights and wildfires in western North America

Aseem Sharma [1] , *Piyush Jain* [2] , *Mike Flannigan* [3] , *John Abatzoglou* [4]

[1] Natural Resources Canada - Canadian Forest Service
[2] Natural Resources Canada - Canadian Forest Service
[3] University of Alberta
[4] University of California Merced

Presented by / Présenté par: ***Aseem Sharma***
Contact: aseem.sharma@canada.ca

Summertime atmospheric blocking is generally associated with extreme weather conditions that are likely to enable widespread wildfire activity. A limited number of studies explore changes in the atmospheric blocking events and co-occurring changes in wildfire activity, perhaps owing in part their focus on blocking characteristics and role of blocking occurrences on specific extreme weather events. This study identifies summertime persistent positive anomalies (PPA) in geopotential heights and evaluates their association with wildfire events in western North America. We examine the trends of summertime PPA events in western North America, analyze PPA events' contribution to this regional fire activity, and explore the association between PPA events and large-scale circulation patterns. To do so, we use European Center for Medium-Range Weather Forecast (ERA5) reanalysis 500-hPa geopotential height fields, surface air and dew point temperatures, 10 m wind speed, precipitation, Canadian Forest Fire Weather Index (FWI) for 1979-2020 and fire spread days data for 2002-2016. The fire spread days are defined as when the fire front advances 2 m per minute for at least 4 hours on a single day for fire with burned area > 5000 Ha. Our preliminary results indicate the presence of significant positive trends in PPA-days, FWI, temperature, vapor pressure deficit, and negative trends in relative humidity. The summertime PPA events' spatial extent has expanded significantly over the study period, although the frequency has not changed. The changes in PPA events are likely due to thermodynamic changes rather than being due to dynamical changes in midlatitude synoptic patterns. This study's findings may improve our understanding on the connections between PPA and wildfires, how it will change in warmer future climate scenarios, and enhance the predictability of extreme wildfire events in this region.

Session: 880 General Session - Interdisciplinary Séance générale — Interdisciplinaire **04/06/2021 11:30**

ID: 10782 Contributed abstract

Poster Order:

Mechanisms responsible for the triggering of summertime nocturnal rainfall events over the Great Plains

Iaroslav Verevkin [1] , *Ian Folkins* [2]

[1] Department of Physics and Atmospheric Science, Dalhousie University, Halifax, Nova Scotia, Canada
[2] Department of Physics and Atmospheric Science, Dalhousie University, Halifax, Nova Scotia, Canada

Presented by / Présenté par: ***Iaroslav Verevkin***
Contact: ir818820@dal.ca

Warm season precipitation over the Great Plains has a nocturnal maximum which is widely documented but is difficult to predict. We used TRMM rainfall and GFS forecast data for July-August 2007-2019. The Hovmöller diagram for the TRMM rainfall shows a rainfall feature initiated over the eastern slope of the Rocky Mountains at 21 UTC and propagating eastward with the maximum at 6 UTC over 98-92 W. Despite it may seem like this feature arises from “coherent” rain events that start in the Rocky Mountains and propagate all the way to 92 W, in fact, the rainfall events initiated over the Rocky Mountains propagate only up to 98 W, while the more eastern nocturnal rainfall events are not correlated with the rainfall events initiated over the Rocky Mountains. The rainfall events initiated over the Rocky Mountains and propagating eastward are connected to the positive surface pressure anomaly to the north; the nocturnal rainfall events between 95 W and 92 W are connected to the negative surface pressure anomaly over the Great Plains. It has also been found that on the west (east) of 104 W, the rainfall is mainly connected to the zonal (meridional) column vapour convergence. The zonal column vapour convergence is strong over the eastern slope of the Rocky Mountains in the afternoon, propagates eastward and fades

quickly. This propagative feature appears to be due to the interaction of the dynamically dominated dry high altitude regime to west of 102 W with the surface dominated regime with high surface storage. The meridional column vapour convergence is positive over the broad region of the Great Plains with the maximum overnigh and is linked to the Low-Level Jet.

Session: 880 General Session - Interdisciplinary Séance générale — Interdisciplinaire **04/06/2021 11:45**

ID: 10841 Contributed abstract

Poster Order:

A geophysically motivated take on correlated (equation) error

Rick Danielson [1]

[1] Fisheries and Oceans Canada

Presented by / Présenté par: ***Rick Danielson***
Contact: rick.danielson@dfo-mpo.gc.ca

It is possible to define a canonical regression model whose solution and interpretation seem to have been unknown to Lehmann (2008). We propose to study calibrated (C) and uncalibrated (U) measures composed of shared truth (t), shared error (e) and an unshared residual (eC or eU), allowing for an additive (a) and multiplicative (b) adjustment of t in U: C = t + e + eC U = a + b*t + e + eU. A curious observation is that although C and U may have independent measurement errors, it is only the appearance of a common term like e on the RHS that defines what we mean by “shared”, and for the moment we assume e is nonzero. The canonical errors-in-variables model is obtained by writing e as part of eC and eU, but note that a nonzero shared component implies that eC and eU are not strictly independent. Moreover, the relationship between C and U is not strictly linear if equation error is permitted. Equation error is the notion that a linear relationship between measurements is ad hoc, even in the absence of measurement error. Here, we extend that notion to the relationship between each and every measurement and shared truth (t), thus allowing for correlated (in e) and uncorrelated (in eC and eU) equation error. In turn, if we believe that measurement error is not the only component of shared error (e), then our starting assumption that e is nonzero seems reasonable, even if C and U are independently measured. All variables are specified in demonstrations of controlled solutions, where an analogy to waves and turbulence (in model signal and noise) is invoked. Lehmann, E. L. (2008). On the history and use of some standard statistical models, Probability and Statistics: Essays in Honor of David A. Freedman, Institute of Mathematical Statistics, Beachwood, Ohio, USA, 114–

126, doi:10.1214/193940307000000419.

Session: 880 General Session - Interdisciplinary Séance générale — Interdisciplinaire **04/06/2021 12:00**

ID: 10836 Contributed abstract

Poster Order:

Residual resampling for the assessment of tidal harmonic regression uncertainty

Silvia Innocenti [1] , *Pascal Matte* [2] , *Vincent Fortin* [3] , *Natacha Bernier* [4]

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Presented by / Présenté par: ***Silvia Innocenti***
Contact: silvia.innocenti@canada.ca

The precise understanding of tidal variability is crucial for obtaining reliable water level predictions for marine navigation, coastal surveillance and response during extreme weather events, and infrastructural design. Equally important, an accurate assessment of the uncertainty in tidal constituent estimations is essential in ensemble forecasting, and for constraining harmonic analyses based on remote data (e.g., satellite measurements). However, estimating the uncertainty associated with each tidal constituent represents a challenge since the observed records are typically short, and sampled at coarse temporal resolution or sparse locations. This prevents a sharp distinction between the deterministic tidal signal and the stochastic fluctuations of the observed water levels. Specifically, the interaction of tides and the other oceanic, meteorological, and hydrological phenomena results in significant broad-spectrum variability of the recorded signals due to various unresolved sources of variability. Hence, the residuals obtained after performing harmonic regressions are temporally correlated. Conventional methods for assessing the harmonic model uncertainty typically ignore this autocorrelation. In the present study, we used a Monte Carlo experiment to evaluate the effects of neglecting the residual autocorrelation when assessing the tidal constituent uncertainty. The estimation of regression parameter variability from three commonly used analytical techniques (the UTide and NSTide packages, and the IRLS method) and two residual resamplings (a moving-block and a semi-parametric bootstrap) are compared. We show that conventional methods(e.g., UTide and the IRLS) underestimate the parameter uncertainty since they rely on simplified

assumptions, such as normality and independence of the regression residuals. This may lead to incorrect assessments about the significance of one or more predictors. Conversely, the two bootstrap strategies and NSTiderely on a better representation of the residual autocorrelation structure, leading to more accurate parameter confidence intervals. Specifically, the moving-block bootstrap showed the best performance in assessing the parameter uncertainty. This method provides a simple alternative that can be easily applied to a wide range of residual autocorrelation structures typically needed in the development and implementation of marine and coastal forecasts

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Session: 850 The North Atlantic Ocean: Circulation, physical processes, and interactions with biogeochemistry. - Part 1
Océan Atlantique Nord : Circulation, processus physiques et interactions avec la biogéochimie - Partie 1 **04/06/2021 11:00**

ID: 10987 Contributed abstract

Poster Order:

Sea Surface Temperature Trends and Variability in the Northwest Atlantic

Jonathan Coyne [1] , *Eric Oliver* [2]

[1] Dalhousie University
[2] Dalhousie University

Presented by / Présenté par: ***Jonathan Coyne***
Contact: Jonathan.Coyne@dal.ca

Increases in ocean temperature and the presence of large multidecadal sea surface temperature (SST) oscillation have the potential to cause severe impacts on Northwest Atlantic ecosystems and fisheries. Differences between historical SST datasets for the regions have also been noted making it difficult to determine the “true” SST record. It is therefore imperative that steps be taken to take into account cross-dataset variability when determining warming trends and patterns of variability of SST in the Northwest Atlantic. Here, we use a novel multi-dataset approach consisting of observation-based data products and climate models, to determine long-term SST trends and yearly-to-multidecadal variability in Northwest Atlantic SST. SST was spatially averaged over continental slope and shelf regions of interest from North Carolina to Labrador, to simplify the data and allow for a multi-dataset approach. A climate model was used to determine the role of anthropogenic forcing in Northwest Atlantic SST. An extended empirical orthogonal function (EEOF) analysis was then use to determine leading modes of variability. The EEOF analysis results were then correlated with potential ocean and atmosphere predictors. Unprecedented

positive SST trends outside of the global climate models natural run variability were found in all regions of interest by the mid 21st century. The EEOF indicates that the two dominant modes of variability are associated with Atlantic Multidecadal Oscillation (AMO) and North Atlantic Oscillation (NAO) and that the SST signal may extend to the shelf and slope regions of the Northwest Atlantic. Comparisons between the leading EEOF modes with ocean and atmosphere predictors indicate support for positive NAO years forcing the Northwest Atlantic to a positive AMO regime.

Session: 850 The North Atlantic Ocean: Circulation, physical processes, and interactions with biogeochemistry. - Part 1
Océan Atlantique Nord : Circulation, processus physiques et interactions avec la biogéochimie - Partie 1 **04/06/2021 11:15**

ID: 10881 Invited session speaker

Poster Order:

Physical-biogeochemical interactions on the Newfoundland and Labrador shelf.

Frédéric Cyr [1]

[1] Fisheries and Oceans Canada (DFO)

Presented by / Présenté par: ***Frédéric Cyr***
Contact: Frederic.Cyr@dfo-mpo.gc.ca

Located on the western edge of the north Atlantic supbolar gyre, the Newfoundland and Labrador (NL) shelf is especially affected by large-scale ocean circulation changes. Such circulation changes impact not only the regional climate, but also the overall water masses composition, with consequences on physical conditions, nutrient availability, oxygen content, pH, etc. Systematic hydrographic observations on NL shelf have been carried out by Canada and other countries since the late 1940's. The observational program was reinforced in 1999 with the creation of the Atlantic Zone Monitoring Program (AZMP), ensuring enhanced seasonal coverage and new biogeochemical observations. In 2014, this monitoring was extended to ocean acidification parameters. Here we review historical physical-biogeochemical interactions on the NL shelf, with an emphasis on low frequency variability and cycles. Results suggest, for example, that winter conditions above the North Atlantic largely set the stage for the ocean physical and biogeochemical conditions on the NL shelf during the rest of the year. It is also shown that decadal changes of the sea-level pressure above the North Atlantic influences the subpolar gyre, and thus the interactions between the Labrador and the

North Atlantic currents, two major contributors to the NL shelf climate variability. This variability has in turn important consquences on the biogeochemistry and the overall productivity of the NL shelf ecosystem.

Session: 850 The North Atlantic Ocean: Circulation, physical processes, and interactions with biogeochemistry. - Part 1
Océan Atlantique Nord : Circulation, processus physiques et interactions avec la biogéochimie - Partie 1 **04/06/2021 11:30**

ID: 10642 Contributed abstract

Poster Order:

Modelling Hudson Strait Waters: Pathways, structure, and multi-year variability

Natasha Ridenour [1] , *Juliana Marson* [2] , *Paul Myers* [3]

[1] University of Alberta
[2] University of Manitoba
[3] University of Alberta

Presented by / Présenté par: ***Natasha Ridenour***
Contact: ridenour@ualberta.ca

Hudson Strait is the main gateway connecting Hudson Bay to the Northwest Atlantic. Flow in the strait consists of a westward current on the northern side, an eastward current on the southern side, and a southward cross strait flow. The westward flow on the northern side of the strait, termed the inflow, contains waters from the Baffin Island Current, and is the largest source of oceanic water to the Hudson Bay Complex (HBC). These waters play a role in the physical and biogeochemical systems of the HBC, where many Indigenous communities rely on the ocean for subsistence. Flow on the southern side of Hudson Strait, referred to as the outflow, contains, and is heavily influenced by, river discharge from Hudson and James Bays. These fresh waters are directed to the Labrador Sea, an area of deep convection and part of the larger Atlantic Meridional Overturning Circulation (AMOC). Most of what we know about the flow in Hudson Strait is based on a few year-long time series in the mid-2000s. Transports of the outflow have been estimated, however, due to instrument failure on the northern side of the strait, inflow transports are unknown. Additionally, pathways and multi-year variability of the two flows have yet to be studied. To fill these gaps in knowledge, we use a regional ocean model with a high resolution nest to understand the structure and variability of the flow, specifically the inflow, in Hudson Strait. We evaluate the model by using the most recent mooring deployment observations (2008-2009) and discuss the

structure and seasonal variability of property data, as well as velocities and transports on both sides of the strait. We use an online passive tracer as an additional tool to investigate pathways of both the inflow and outflow.

Session: 850 The North Atlantic Ocean: Circulation, physical processes, and interactions with biogeochemistry. - Part 1
Océan Atlantique Nord : Circulation, processus physiques et interactions avec la biogéochimie - Partie 1 **04/06/2021 11:45**

ID: 10870 Contributed abstract

Poster Order:

Isolating Dissolved Inorganic Carbon's Sources of Temporal Variability in the Northwest Atlantic Ocean

Claire Boteler [1] , *Michael Dowd* [2] , *Eric C. J. Oliver* [3] , *Elias T. Krainski* [4] , *Douglas W. R. Wallace* [5]

[1] Dalhousie University
[2] Dalhousie University
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[4] Dalhousie University and Universidade Federal do Parana, Departamento de Estatistica, Curitiba - Brazil
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Presented by / Présenté par: ***Claire Boteler***
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The NW Atlantic Ocean is an important global sink for atmospheric carbon produced by anthropogenic activities. However sparse and irregular sampling of ocean carbon make it difficult to capture a full picture of its spatio-temporal variations. Using observations of Dissolved Inorganic Carbon (DIC) from the GLOPAPv2 database (Olsen et al, 2016; Olsen et al, 2019) we used data-centric methods to disentangle DIC's sources of variability: seasonal, natural carbon variability, and excess carbon due to anthropogenic sources. A monthly time series of excess carbon, with confidence intervals, was estimated from a state space statistical model. Our region was separated into 3-depth layers and analyzed independently. The long-term trends of excess carbon were found to be higher than the trends of total DIC estimated directly from the observations in each depth layer. The summer sampling bias of DIC sampled data contributes to this difference in trend, with the largest impact in the surface waters. Our findings show that to analyze DIC's anthropogenic behaviour, it is recommended to first isolate its sources of variability, otherwise the long-term trend of anthropogenic carbon in the ocean would be underestimated.

Session: 850 The North Atlantic Ocean: Circulation, physical processes, and interactions with biogeochemistry. - Part 1 Océan Atlantique Nord : Circulation, processus physiques et interactions avec la biogéochimie - Partie 1 **04/06/2021 12:00**

ID: 11004 Contributed abstract

Poster Order:

Variations of the Scotian Slope Water from analysis of a global ocean reanalysis product

Yongxing Ma [1] , *Youyu Lu* [2]

[1] Bedford Institute of Oceanography, Fisheries and Oceans Canada
[2] Bedford Institute of Oceanography, Fisheries and Oceans Canada

Presented by / Présenté par: ***Yongxing Ma***
Contact: Youyu.Lu@dfo-mpo.gc.ca

The Scotian Slope (SS) is located at the crossroads of the two largest western boundary currents of the North Atlantic: the cold and fresh Labrador Current (LC), and the warm and salty Gulf Stream (GS). The variability of the properties of the Scotian Slope Water (SSW) is complex due to multiple influences from LC, GS and local atmosphere-ocean interactions. In this study, the temporal and spatial variations of the SSW properties are derived from analysis of the 1/12-degree data assimilative Global Ocean Physical Reanalysis (GLORYS12) product from 1993 tom 2019.The EOF analysis shows a spatial pattern of the salinity and temperature variations at SS that differs from other regions of North-West Atlantic, and in the vertical direction, this characteristic feature extends from surface to about 400 m depth. The time-series analysis shows that the SSW becomes warmer and more saline during the last two decades and contains more Gulf Stream Water (GSW) compared with the previous decades. We further explore the forcing mechanism of the SSW variations, including the westward intrusion of the LC near the Tail of Grand Banks of Newfoundland, the pathway of the GS, the meso-scale eddies and associated mixing processes.

Session: 240 Severe Storms and Associated Hazards - Part 1 Tempêtes violentes et risques - Partie 1 **04/06/2021 12:30**

ID: 10633 Invited session speaker

Poster Order:

Forward Into the Past

Harold Brooks [1]

[1] NOAA-National Severe Storms Laboratory

Presented by / Présenté par: ***Harold Brooks***
Contact: harold.brooks@noaa.gov

Although not in its infancy, the scientific study of climate change and severe thunderstorms is still in its adolescence. As it matures, we hope it builds bridges between what was learned by the previous generation (day-to-day weather forecasting) and what can provide useful information on longer time scales. There are two primary areas that the science has focused on: gaining an understanding of what has happened in the past (report databases) and developing relationships between environmental conditions and events (downscaling). In recent years, strides have been made in both areas that provide optimism that our understanding will improve dramatically in the next decade. 1. Historical databases of storms have been developed, expanded, and/or published in many parts of the world where limited information has been available. Although the expectation is that, given the exact same environmental conditions, the atmosphere would produce the same weather anywhere on the planet, there's no reason to believe that every location samples the range of conditions that could produce severe thunderstorms equally. Thus, having information on storm occurrence around the world can help us understand the true distribution of conditions that can lead to storms. 2. Improvements in reanalyses have been made. Increasing spatial and temporal resolution in "modern" reanalyses depict the spatial and temporal structure of the atmosphere in much greater detail. At the other extreme, the 20th Century Reanalysis provides a relatively good picture of large scale conditions well into the 19th Century. It has been used to drive convection-allowing models to depict severe weather events back to 1884 (at the time of writing). The length of record should allow for understating rare events, such as extended periods that are favorable for severe storms. I'll provide some examples from these topics, as well as try to see where we might be headed in the near future as a community. References to both Monty Python and the Firesign Theater are expected to form the backdrop.

Session: 240 Severe Storms and Associated Hazards - Part 1 Tempêtes violentes et risques - Partie 1 **04/06/2021 13:00**

ID: 10873 Contributed abstract

Poster Order:

Canadian tornadoes in Prairie Provinces from 1826-1939 - A comprehensive database

Jay Anderson [1] , *Patrick McCarthy* [2]

[1]
[2]

Presented by / Présenté par: ***Jay Anderson***
Contact: weatherwise@shaw.ca

Kendrew and Currie wrote in their 1955 "The Climate of Central Canada" publication: “They [tornadoes] probably occur in Alberta and Manitoba but there is no definite evidence,” while noting that Saskatchewan averaged about one per year. Today, an average of over forty tornadoes are reported each year on the Canadian Prairies, with many others likely undocumented. That impoverished estimate of historical tornadoes lingers to this day. As part of a larger, ongoing project, we have compiled a more complete historical database of 19th and early 20th century tornadoes from a multitude of sources, mostly unofficial and difficult to unearth. This presentation will summarize our research efforts to develop this database, covering the Canadian Prairie Provinces prior to 1940. This exhaustive effort has revealed a total of 580 rated tornadoes, including 144 with tornado tracks. The project also yielded a greatly enlarged list of tornado deaths and injuries for the period. The new database provides a much-improved documentation of the occurrence of tornadoes on the northern Great Plains and anecdotal evidence of the societal impact of summer severe weather before 1940. It will find ongoing value by providing a greater historical connection for the public and disaster managers and allows a more generous assessment of the impacts of climatic change. The presentation will outline the wide variety of approaches in our detective work and highlight some of the notable events. A summary of future work will also be shown.

Session: 240 Severe Storms and Associated Hazards - Part 1 Tempêtes violentes et risques - Partie 1 **04/06/2021 13:15**

ID: 10723 Contributed abstract

Poster Order:

Severe Weather Forecasting and Risk Communication: A Look back at Hurricane Dorian in Eastern Canada

Roberta McArthur [1]

[1] Environment and Climate Change Canada

Presented by / Présenté par: ***Roberta McArthur***
Contact: roberta.mcarthur@canada.ca

Hurricane Dorian is considered to be one of the most powerful hurricanes recorded in the open Atlantic Ocean outside of the Caribbean Sea and Gulf of Mexico. It is also the worst natural disaster to affect the eastern Bahamas due to its intense and prolonged duration over the area. The southeastern United States barely escaped Dorian's path as it paralleled the coast before turning back out into the open and Atlantic then towards Eastern Canada. Dorian made landfall near Halifax, Nova Scotia as a strong post-tropical storm, causing widespread impacts to much of the Maritimes, eastern Quebec, and Newfoundland and Labrador. The focus of this presentation will touch on these impacts and how the forecasts and associated risks were communicated to the public through the different perspectives of the forecasters working in the Canadian Hurricane Centre, the public and marine forecasters, and the weather preparedness meteorologists.

Session: 240 Severe Storms and Associated Hazards - Part 1 Tempêtes violentes et risques - Partie 1 **04/06/2021 13:30**

ID: 11201 Contributed abstract

Poster Order:

Predecessor Rain Events in Ontario

Daniel Liota [1] , *Jerry Shields* [2]

[1] Environment and Climate Change Canada
[2] Ontario Ministry of Natural Resources and Forestry

Presented by / Présenté par: ***Daniel & Jerry Liota & Shields***
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Floods make up the costliest natural disasters in Canada in terms of property damage and are a disproportional majority of disasters in Ontario as defined by the Canadian Disaster Database. Following the spring freshet, heavy rains that often result from thunderstorms are the most common cause of flooding. A Predecessor Rain Event (PRE) is a coherent region of heavy rainfall, with rainfall rates ≥ 100 mm per 24-hour period that can occur in excess of 1000 km poleward of recurving Tropical Cyclones (TCs). PREs occur most commonly during the summer months and can ensue on the order of days prior to the arrival of the main rain shields associated with TCs. PREs sustain themselves by the poleward transport of deep tropical moisture directly from the TC. Notable PREs in Ontario have resulted in high-impact weather events characterized by significant inland flooding. Flooding from PREs is exacerbated by urban landscapes and saturated antecedent conditions, which include the subsequent arrival of a main rain shield associated with a TC that follows a PRE. This session focuses on defining a PRE climatology for Ontario, including the linkages to the synoptic environment and to the parent TC. A database of PREs allows composite analysis on the synoptic scale. The findings are then compared to previous studies on this topic in the Central and Eastern United States. Even through the advancements of scientific understanding regarding extreme rainfall events and the remarkable improvement of numerical weather prediction, PREs continue to pose a significant challenge to operational forecasting and in communicating associated impacts. The aim of this session is to highlight the existence of PREs in Ontario and to demonstrate methods in an attempt to improve forecasting and messaging.

Session: 255 General Session - Weather - Part 6 - Weather Radar Séance générale — La météorologie - Partie 6 - Radar météo

04/06/2021 12:30

ID: 10747 Contributed abstract

Poster Order:

Replacement of the Canadian Weather Radar Network – an Update

Sylvain Laramée [1] , *Qian Li* [2] , *Pat Wong* [3] , *Peter Leibiuk* [4] , *Sylvain Savard* [5] , *Steven Brady* [6] , *Hamid Nasr* [7] , *Todd Benko* [8] , *Rick Czepita* [9] , *Sorin Pinzariu* [10] , *Alvin Au Duong* [11]

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[9] Canadian Weather Radar Replacement Program, Meteorological Service of Canada, ECCC
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[11] Canadian Weather Radar Replacement Program, Meteorological Service of Canada, ECCC

Presented by / Présenté par: ***Qian Li***
Contact: Qian.Li@Canada.ca

Getting new radars installed in 2020 was no easy feat. Early in the year, COVID-19 impacts immediately resulted in a two month “pause” in site construction activities when travel restrictions were both in country, inter-provincial and international. Despite the COVID-19 challenge, the Canadian Weather Radar Replacement Program (CWRRP) team worked with the vendor and other enablers to successfully replaced and installed 7 radars: Schuler (AB), Dryden (ON), Holyrood(NL), Woodlands(MB), Saint Françoise (QC) and Val d’Irene (QC), as well as a training-testing system in Ontario. By the end of the year, the Canadian weather radar network was operating with more “new” radars than “old”. The project remains on schedule for the delivery of another 7 radars in 2021, and continues to be within our budget parameters. Radars to be completed in 2021: King Radar ON, Gore NS, Britt ON, Aldergrove BC, Cold Lake AB (a new location for the Jimmy Lake Radar), and Carvel AB. Collaboration with key enablers is essential to ensuring a successful end-to-end project delivery. Through strong collaboration with the vendor, Science and Technology Branch and radar users, we are gaining a better understanding of the new radar system, from both hardware and software perspectives, and are working to optimize the scan strategy, improve signal processing and data quality. This paper will provide information and updates on the CWRRP in general, with a focus on challenges and mitigation measures put in place, as well as future construction timelines.

Session: 255 General Session - Weather - Part 6 - Weather Radar Séance générale — La météorologie - Partie 6 - Radar météo

04/06/2021 12:45

ID: 10835 Contributed abstract

Poster Order:

New Operational Dual-Polarization S-band Radar Products from the ECCC Canadian Radar Network

Janti Reid [1] , *Sudesh Boodoo* [2] , *Norman Donaldson* [3] , *David Hudak* [4] , *Daniel Michelson* [5] , *Ahmed Mahidjiba* [6]

[1] Forecast System Integration and Innovation, Meteorological Service of Canada, Environment and Climate Change Canada
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[3] Meteorological Research Division, Science and Technology Branch, Environment and Climate Change Canada
[4] Meteorological Research Division, Science and Technology Branch, Environment and Climate Change Canada
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[6] Canadian Meteorological Centre Operations, Meteorological Service of Canada, Environment and Climate Change Canada

Presented by / Présenté par: ***Janti Reid***
Contact: Janti.Reid@canada.ca

Environment and Climate Change Canada’s (ECCC) Meteorological Service of Canada (MSC) has undertaken the Canadian Weather Radar Replacement Program (CWRRP) to revitalize Canada’s existing radar infrastructure through the replacement of the existing Canadian Weather Radar Network with new dual-polarization (DP) S-band radars by 2023. By the end of 2020, ECCC has replaced 18 legacy C-band radars across Canada, which represents more than half of the radar network. One of the key goals of the CWRRP project is to modernize operational radar processing applications to ensure the continuity of ECCC radar products utilizing data acquired by these new radar systems. In 2020, new DP-based radar products developed by Science & Technology Branch (STB) were operationally implemented, namely DP quantitative precipitation estimation (DP QPE) and particle classification (PARCA). For the QPE product, new DP data are exploited within a quality control methodology to remove non-meteorological echoes from reflectivity fields and in a new rainfall rate algorithm. For the PARCA product, DP data are used to determine, by fuzzy logic means, the likely precipitation class encountered in each radar bin. Some of the available classes are rain, hail, wet snow, dry snow, crystals, and non-meteorological echo types such as ground clutter and biological. These new products were rolled out to the ECCC operational forecasting community in spring 2020 and DP QPE products were introduced to the public and external clients by the Canadian Meteorological Centre (CMC) Operations Division in the summer. Plans are underway to release a surface particle type product (SPTP) to the public in 2021. A description of these new radar algorithms and products, their application, status of their evaluation, and future plans will be presented.

Session: 255 General Session - Weather - Part 6 - Weather Radar Séance générale — La météorologie - Partie 6 - Radar météo

04/06/2021 13:15

ID: 10740 Contributed abstract

Poster Order:

New scan strategy for the Canadian weather radar network

Daniel Michelson [1] , *Lubna Bitar* [2] , *Sudesh Boodoo* [3] , *Norman Donaldson* [4] , *Stephen Holden* [5] , *Qian Li* [6] , *Janti Reid* [7] , *Vlado Stojanovic* [8]

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Presented by / Présenté par: ***Daniel Michelson***
Contact: daniel.michelson@canada.ca

The Canadian weather radar network is undergoing a generational renewal, with legacy C-band radars being replaced with new dual-polarization S-band systems. In 2020 the number of new radars became more than half of the total network (19 of 33). 2021 is significant in that more than half of Canada’s population will have their local radar replaced during this year alone. With radar renewal comes many significant changes, one of which is the way the radars are configured to collect basic data: the so-called scan strategy. Scan strategy design priorities can be grouped to serve three primary objectives: 1. Quantitative applications, prioritizing high data quality. 2. Semi-quantitative applications, prioritizing timeliness of data and vertical coverage. 3. Qualitative applications, prioritizing data reliability and horizontal coverage. In practise, these priorities are at odds with each other due to a combination of physical and technological constraints. Solutions inevitably involve balancing trade-offs to strategy, called PVOL6S, attempts to balance legacy requirements with increased quantitative application of the data. Seventeen sweeps of data at and above 0.4 degrees are acquired in top-down order every six minutes, containing dual-polarization, Doppler and conventional moments. As of 2020, there is a mountain version (PVOL6SM) with a lowest sweep of -0.3 degrees and a few other tweaks. ECCC continues to devote significant effort to improving the quality of basic acquired data. User feedback has helped us prioritize improvements to specific issues like clutter suppression, second-trip echoes, radio frequency interference, and data dropouts. Some improvements have been introduced, and we anticipate others as our familiarity of, and experience with, the new system increases. Several examples from our work thus far will be presented, together with the characteristics of PVOL6S.

Session: 255 General Session - Weather - Part 6 - Weather Radar Séance générale — La météorologie - Partie 6 - Radar météo **04/06/2021 13:45**

ID: 10766 Contributed abstract

Poster Order:

Canadian Radar Renewal Project: Status and availability of new products to users

Ahmed Mahidjiba [1], *Corinne Simard* [2], *Yacine Bouzid* [3], *Rabah Hachelaf* [4], *Ilyass Hajji* [5], *Meriem Kacimi* [6], *Sebastien Chouinard* [7], *Janti Reid* [8], *Sudesh Boodoo* [9]

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[7] Canadian Meteorological Centre Operations, Meteorological Service of Canada
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Presented by / Présenté par: ***Ahmed Mahidjiba***
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One of the most important milestones in the major Canadian radar network renewal project of Government of Canada's Meteorological Service of Canada (MSC) is improving the quality of precipitation products, among others, using dual polarization technology. Indeed, in addition to this new technology that significantly improves the quality of existing products and allows the emergence of new ones such as the Surface Particle Type Product (SPTP), the Doppler range increases from 120 km to 240 km creating several zones of overlap between radars. The frequency of data availability changes also from 10 min to 6 min for all the new S-Band products. These improvements obviously target products intended for experts such as operational forecasters but also the public and external clients. In this presentation, we will provide an overview on the status of the progress of this project as well as we will present the new high-quality products that are recently available to users through our various platforms. Some new products that will be available to users in the near future will be presented. Our operational production system and all the improvements that have been made to it to support this project will be also considered in this presentation.

Session: 630 Actual and future climatology of winter precipitation (solid, mixed and liquid) and hail and their impacts. Climatologie présente et future des précipitations hivernales (solides, mixtes et liquides) et de la grêle et de leurs impacts **04/06/2021 12:30**

ID: 10663 Invited session speaker

Poster Order:

Changing statistics of "big snow" events: The North East US in the Canadian Regional Climate Model (CRCM5) ClimEx large ensemble

Gavin Schmidt [1] , *Zhaoyue Bi* [2] , *Mohammad Radiyat* [3] , *Carolyn Silverman* [4] , *Matthew Spitz* [5] , *Brian Brettschneider* [6] , *Martin Leduc* [7] , *Dominique Paquin* [8]

[1] NASA GISS
[2] CU DSI
[3] CU DSI
[4] CU DSI
[5] CU DSI
[6] UAF
[7] Ouranos

[8] Ouranos

Presented by / Présenté par: ***Gavin Schmidt***
Contact: gavin.a.schmidt@nasa.gov

Heavy snowfall along the east coast of North America (from Georgia to Québec and Maritimes) can be extremely disruptive depending on their scale, but also depending on the preparedness and resilience of communities. This project makes it possible to quantify the projected changes in heavy snowfall, particularly with regard to rare events taking place in regions generally little affected by this type of event and less well prepared than in the north. The use of the ClimEx large-ensemble, CRCM5 simulations driven by CanESM2 over northeastern North America from 1955 to 2100, makes it possible to characterize the uncertainties associated with natural variability and to sample extreme events as a function of their spatial distribution. The analysis focuses on changes in frequency and occurrence, both daily and over several days, for extreme snowstorms with return periods of up to 50 years.

Session: 630 Actual and future climatology of winter precipitation (solid, mixed and liquid) and hail and their impacts. Climatologie présente et future des précipitations hivernales (solides, mixtes et liquides) et de la grêle et de leurs impacts **04/06/2021 12:45**

ID: 11131 Contributed abstract

Poster Order:

High-resolution 21st-century projections of rain and snow using regional climate model simulations over British Columbia, Canada

Dhouha Ouali [1] , *Charles Curry* [2]

[1] PCIC
[2] PCIC

Presented by / Présenté par: ***Dhouha Ouali***
Contact: douali@uvic.ca

Separation of precipitations into rain and snow is a key step for land surface and hydrological models. However, the accurate simulation of snow and rain amounts at air temperatures surrounding 0°C is still challenging, mainly due to temperature biases in the models. Most empirical information on rain-snow partitioning is derived from the occurrence frequency of rain and snow events,

as a function of air temperature, suggesting linear or sigmoidal transitions over several degrees surrounding 0°C. In this study, we leverage the substantial information available from the Canadian Regional Climate Model CanRCM4, over British Columbia to derive the statistical distribution of daily rain and snow amounts (not just relative frequency) as a function of temperature. The partitioning scheme yields very similar results to those found empirically for the occurrence frequency of rain or snow only, and evaluation against observed rainfall and snow water equivalent (SWE) data at specific locations is also conducted. To study future change, the CanRCM4 output is first downscaled and bias corrected using an observational gridded dataset, PNWNAmet, available for the 1971-2000 period with a spatial resolution of 1/16°. Spatiotemporal distributions of rainfall and SWE are then examined for future periods under the RCP8.5 scenario using the same precipitation phase partitioning scheme. One possible application of these results is to investigate projected changes in the characteristics of rain-on-snow events under a future warming climate.

Session: 630 Actual and future climatology of winter precipitation (solid, mixed and liquid) and hail and their impacts. Climatologie présente et future des précipitations hivernales (solides, mixtes et liquides) et de la grêle et de leurs impacts **04/06/2021 13:00**

ID: 10649 Contributed abstract

Poster Order:

Projected changes to the risk of wind-driven rain on building in Canada under +0.5°C to +3.5°C global warming above the recent period: an ensemble of CanRCM4

Dae Il Jeong [1] , *Alex Cannon* [2]

[1] Climate Research Division, Environment and Climate Change Canada, Toronto, Ontario, Canada
[2] Climate Research Division, Environment and Climate Change Canada, Victoria, British Columbia, Canada

Presented by / Présenté par: ***Dae Il Jeong***
Contact: daeil.jeong@canada.ca

Wind-driven rain (WDR) on building façades reduces hygrothermal performance and durability of wall assemblies. We evaluated projected changes to WDR exposure of building façades in Canada for future periods corresponding to specified levels (0.5~3.5°C) of global warming above the 1986-2016 baseline.

Projections are based on a large ensemble of Canadian Regional Climate Model (CanRCM4) simulations forced at the boundaries by the Canadian Earth System Model (CanESM2) under a business-as-usual emission scenario (RCP8.5). Annual and spell-specific timescale WDR indices are estimated from hourly meteorological variables using the semi-empirical approach of the International Organization for Standardization. The CanRCM4 ensemble reproduces spatial patterns of observed annual total rainfall, mean wind speed, and driving-rain index for the baseline period. Significant increases in annual and extreme spell indices of WDR are projected in the future, with larger increases seen over western and northern Canada and at higher global warming levels. These increases are mainly driven by the increases in rainfall amounts due to both increases in precipitation magnitude and the shift in phase of precipitation from snow to rain caused by warming. Consequently, increases in WDR exposure become an emerging future consideration for moisture-resilient design and management of buildings, especially in western and northern Canada. The WDR annual and spell-specific indices have similar adverse effects on building as the moisture index and driving rain wind pressure, respectively, that are used in the National Building Code of Canada; therefore, we will compare projected changes to the Canadian building design variables with the WDR indices in this presentation.

Session: 630 Actual and future climatology of winter precipitation (solid, mixed and liquid) and hail and their impacts. Climatologie présente et future des précipitations hivernales (solides, mixtes et liquides) et de la grêle et de leurs impacts

04/06/2021 13:15

ID: 10920 Contributed abstract

Poster Order:

Deep learning to identify long-duration mixed precipitation over Montréal using a large database of the Canadian Regional climate model version 5 (CRCM5)

Magdalena Mittermeier [1], *Émilie Bresson* [2], *Dominique Paquin* [3], *Ralf Ludwig* [4]

[1] Ludwig-Maximilians-Universität München
[2] Ouranos Consortium, Montréal, Québec, Canada
[3] Ouranos Consortium, Montréal, Québec, Canada
[4] Ludwig-Maximilians-Universität München

Presented by / Présenté par: ***Magdalena Mittermeier***
Contact: M.Mittermeier@campus.lmu.de

Long-duration mixed precipitation events (freezing rain and/or ice pellets) count as one of the costliest hydro-meteorological hazards in Canada and pose a great potential risk to infrastructure and human security. Understanding how climate change alters their occurrence is of high societal interest, particularly in urban areas. In this study, we explore the capability of identifying long-duration mixed precipitation over the Montréal area (Québec) in archived climate model data by a two-staged deep learning approach. In the first stage a convolutional neural network (CNN) is trained on the classification of the synoptic pattern related to the dominant dynamic mechanism leading to mixed precipitation in Montréal: pressure-driven channelling of winds along the St. Lawrence river valley. A large training database for this supervised deep learning task is derived from an ensemble of the CRCM5. The CRCM5 uses the diagnostic method by Bourgouin to simulate mixed precipitation in-line, whereof training examples and labels for the CNN can be obtained. The CNN correctly identifies 90 % of the Bourgouin mixed precipitation cases. A high type I error is reduced in a second stage by applying a temperature condition. We show an evaluation of the two-staged deep learning approach on an CRCM5 run driven by ERA-Interim reanalysis. The trained CNN plus the temperature condition can be applied to ensembles of regional climate models on the North America grid of the Coordinated Regional Downscaling Experiment (CORDEX-NA).

Session: 630 Actual and future climatology of winter precipitation (solid, mixed and liquid) and hail and their impacts. Climatologie présente et future des précipitations hivernales (solides, mixtes et liquides) et de la grêle et de leurs impacts **04/06/2021 13:30**

ID: 10650 Contributed abstract

Poster Order:

Quantifying the Impact of Precipitation Type Algorithm Selection on Projected Changes to Freezing Rain Events in an Ensemble of Regional Climate Model Simulations

Christopher McCray [1] , *Julie Thériault* [2] , *Dominique Paquin* [3] , *Émilie Bresson* [4]

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Presented by / Présenté par: ***Christopher McCray***
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Freezing rain is a hazardous winter weather phenomenon that can result in substantial socioeconomic impacts, including dangerous road conditions and catastrophic damage to trees and power lines. Stakeholders, including governments and electric utilities, therefore require information as to how the frequency and intensity of freezing rain events may change in a warming climate. While several studies have examined these possible changes, a more complete understanding of the various sources of uncertainty associated with these projections is needed to provide more actionable information to stakeholders. A key source of uncertainty is related to the method of detection of freezing rain in model output. In most cases, precipitation type must be identified offline based on vertical profiles of temperature and humidity. In this presentation, we identify changes in freezing rain frequency and intensity over North America using an ensemble of simulations of the fifth-generation Canadian Regional Climate Model (CRCM5) driven by a range of different global models. We apply several existing precipitation type algorithms (e.g., Cantin and Bachand 1993, Ramer 1993, Baldwin et al. 1994, Bourgouin 2000) to model output and examine how algorithm selection impacts the representation of the past climatology of freezing rain as well as the projected changes to freezing rain events under future climate scenarios. We plan to expand this analysis to additional regional climate model ensembles such as NA-CORDEX and NARCCAP, allowing us to quantify the full range of uncertainties associated with future projections of freezing rain.

Session: 630 Actual and future climatology of winter precipitation (solid, mixed and liquid) and hail and their impacts. Climatologie présente et future des précipitations hivernales (solides, mixtes et liquides) et de la grêle et de leurs impacts

04/06/2021 13:45

ID: 10758 Contributed abstract

Poster Order:

Projected change in freezing rain indicators useful for adaptation to climate change using CRCM5 data

Émilie Bresson [1], *Dominique Paquin* [2]

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Presented by / Présenté par: ***Émilie Bresson***
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Freezing rain is winter hazard occurring mostly in Eastern Canada. Freezing rain events can have tremendous consequences on several sectors, such as transport, energy supply or infrastructure management for cities. Stakeholders need information about projected change in freezing rain event behaviour in adequacy with their activities in order to adapt, and then prevent damages and/or economical losses in the future. Several projects carried out in collaboration with various users have made it possible to determine a list of the primary needs in freezing rain indicators, which are: number of hours, rate, accumulation and number of events per year. In this study, these indicators were calculated over eight regions of interest in Eastern Canada using the fifth-generation Canadian Regional Climate Model (CRCM5) data. Climate models do not produce freezing rain directly, a diagnostic method is mandatory. Most of the freezing rain diagnostic methods are used offline with climate model outputs. The CRCM5 has an implemented diagnostic method for freezing rain detection, which had been evaluated as satisfactory. The indicators were calculated using twelve CRCM5 simulations, driven by four global climate models. Calculations were performed for all events, as well as for short, long and extreme ones (with accumulation larger than 10 mm), as interest can be on different type of event depending on the considered sector. This study gives an extensive portrait of the projected change in the freezing rain indicators of primary needs for users to help them to best adapt.

Session: 512 Coastal Oceanography and Inland Waters - Part 3 Océanographie côtière et eaux intérieures - Partie 3 **04/06/2021 12:30**

ID: 11082 Contributed abstract

Poster Order:

A proxy for net discharge estimations in tidal rivers

Pascal Matte [1] , *Jean-Éric Tremblay* [2] , *Daniel Bourgault* [3] , *Silvia Innocenti* [4] , *David Jay* [5]

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Presented by / Présenté par: ***Pascal Matte***
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Monitoring discharge from rivers to the ocean is critical to understand estuarine circulation, stratification and mixing. This input of freshwater is an important component of the global water cycle and directly impacts estuarine ecology and morphodynamics. However, there are methodological difficulties in the measurement or estimation of net discharge at locations within rivers influenced by tides and reversing flows. Typically, standard rating curves relating water levels to discharge do not apply to tidal environments. More advanced dynamic rating curves or physically-based approaches have been proposed with some success; these usually rely on water level measurements at more than one station. Despite these recent efforts, accurately and efficiently estimating freshwater discharge from water levels in tidal rivers remains challenging, especially if data are spatially limited (e.g. at only a few distant stations) or temporally sparse (e.g. high and low water level records). In this contribution, we show that daily tidal datum levels – i.e. higher high water (HHW), mean water level (MWL), lower low water (LLW) – can be used as proxies for the estimation of net discharges using simple relationships derived from tidal theory. In particular, LLWs are the best predictors of discharge among all tested proxies. This can be explained by the behavior of LLW over the neap-spring cycle, associated with the nonlinear growth of low-frequency compound tides (e.g. MSf). This behavior leads to an along-channel neap-spring reversal of LLW, marking the transition between the estuary and tidal river. At this point of transition, LLWs become invariant to neap-spring variations and the relation between LLW and discharge is direct. Moreover, in many tidal rivers, the location of LLW inversion is coincident with a marked change in river morphology and does not vary with river flow. These fundamental properties make this tidal datum proxy attractive for predicting discharge, especially given that only data at one station is needed. Furthermore, it can be used to reconstruct discharges with tidal extrema observations only, which often characterizes the nineteenth-century tidal records. The performance of the approach is assessed in the St. Lawrence and Columbia Rivers. We also explore how winds may explain part of the residual variance, and how neap-spring storage effects may be accounted for at locations different from the LLW transition point.

Session: 512 Coastal Oceanography and Inland Waters - Part 3 Océanographie côtière et eaux intérieures - Partie 3 **04/06/2021 12:45**

ID: 10901 Contributed abstract

Poster Order:

Numerical Study of Interactions between Tides and Storm Surges over the Eastern Canadian Shelf

Shengmu Yang [1] , *Jinyu Sheng* [2]

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Presented by / Présenté par: ***Shengmu Yang***
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A three-dimensional (3D) ocean circulation model in the barotropic mode based on the Regional Ocean Modeling System (ROMS) is used to investigate interactions between tides and storm surges during extreme weather events. The hourly atmospheric reanalysis known as ERA5 produced by the European Centre for Medium-Range Weather Forecasts (ECMWF) is used to drive the ocean circulation model. The model performance in simulating tides and storm surge is assessed by comparing model results with the observed water levels at tidal gauge stations and previous tidal model results. Model results during extreme weather events in the past are used to examine non-linear interactions between tidal currents and storm-driven currents over several coastal waters of the eastern Canadian shelf including the Bay of Fundy, Georgia Bank, Scotian Shelf and Gulf of St. Lawrence.

Session: 512 Coastal Oceanography and Inland Waters - Part 3 Océanographie côtière et eaux intérieures - Partie 3 **04/06/2021 13:00**

ID: 11145 Contributed abstract

Poster Order:

The impact of wave breaking, Langmuir turbulence and conservative Stokes drift effects on the upper ocean dynamics under hurricane conditions

Colin Hughes [1] , *Guoqiang Liu* [2] , *Will Perrie* [3] , *Jinyu Sheng* [4]

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Presented by / Présenté par: ***Colin Hughes***
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Ocean surface gravity waves can modulate the ocean currents and vertical mixing in the upper ocean through air-sea interactions, wave breaking, Coriolis-Stokes forcing, Langmuir turbulence (LT) and the vortex force. However, the roles of these wave induced processes remain to be studied. This study examines the impact of these wave generated dynamics on the turbulent kinetic

energy (TKE), thermal structure and currents in the upper ocean from numerical model results under idealized hurricane forcing. Six numerical experiments using a coupled circulation-wave model were conducted with hurricanes moving at three different translation speeds. The wave related simulations include two fully coupled experiments and three additional coupled experiments in which wave effects are selectively disabled (LT, wave breaking and conservative Stokes drift effects). Model results in coupled experiments are compared with a baseline circulation simulation. Our results indicate that wave breaking has the biggest impact on the ocean currents, temperature and TKE in the upper ocean during hurricanes. However, all three main effects of waves on currents contribute to vertical mixing and the two-way fully coupled experiment differs the most from the Base experiment. The combined wave effects reduce the surface currents by over 1 m/s in the front two quadrants of the hurricane and enhance the cold wake and near-surface cooling by as much as 0.6℃, predominantly to the right of the storm track. We found that wave contributions to the cooling are inversely proportional to the hurricane translation speed, although their contributions to currents and TKE are proportional to hurricane translation speed. SST differences can alter the latent heat flux driving the hurricanes, suggesting that wave dynamics should be included in hurricane forecast models. Future studies will examine real hurricane case studies.

Session: 512 Coastal Oceanography and Inland Waters - Part 3 Océanographie côtière et eaux intérieures - Partie 3 **04/06/2021 13:15**

ID: 11157 Contributed abstract

Poster Order:

Modelling the interannual variability of biogeochemical conditions along the British Columbia continental margin

Angelica Pena [1] , *William Crawford* [2] , *Isaac Fine* [3]

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Presented by / Présenté par: ***Angelica Pena***
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The British Columbia continental margin is located within a dynamic transition zone where the Pacific Ocean Current bifurcates into the northeastward-flowing Alaska Current and the southeastward flowing California Current. Previous studies have shown significant interannual to decadal variability in oceanographic conditions related to large-scale climate events. A regional

coupled circulation-biogeochemical (ROMS) model of this region has been developed to gain a better understanding of the processes determining the temporal and spatial distribution of low oxygen waters in the BC coast. In this study, preliminary results from a multi-year hindcast simulation (1981-2018) are used to examine trends and anomalies in subsurface oxygen, to identify areas most vulnerable to hypoxia and to determine main temporal and spatial variations on the transport of low oxygen waters to the BC shelf.

Session: 241 Severe Storms and Associated Hazards - Part 2 Tempêtes violentes et risques - Partie 2 **04/06/2021 14:30**

ID: 10970 Contributed abstract

Poster Order:

The Making of Canada’s First Billion Dollar Hailstorm

Julian Brimelow [1] , *Sudesh Boodoo* [2] , *Norbert Driedger* [3] , *Jason Milbrandt* [4] , *Daniel Michelson* [5] , *Peter Rodriguez* [6] , *Norman Donaldson* [7]

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Presented by / Présenté par: ***Julian Brimelow***
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Early on the evening of 13 June, 2020 a severe thunderstorm developed rapidly over the central portions of Calgary. In the following hour, the storm drifted northeastwards and inflicted an estimated 1.3 million dollars of hail and flood damage over the northeastern portions of the city. We provide an overview of the evolution of atmospheric conditions in the lead up to the storm and discuss possible mechanisms behind the formation of the storm, reasons for its severity and for it producing copious amounts of significant severe hail (maximum dimension > 5 cm). Details of how the event unfolded and the nature of the damage are also discussed. An analysis of historical surface conditions and hail data find that the antecedent conditions on this day were unusual, and that it is very rare for a storm to produce significant severe hail this early in the storm season. Data from the new S-band, dual-polarization radar at Strathmore are

used to describe the evolution of the storm and the benefits of the new suite of dual-polarization products will be presented.

Session: 241 Severe Storms and Associated Hazards - Part 2 Tempêtes violentes et risques - Partie 2 **04/06/2021 14:45**

ID: 10865 Contributed abstract

Poster Order:

Lightning activity during the June 13, 2020 Calgary hailstorm

Bob Kochtubajda [1] , *Julian Brimelow* [2]

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Presented by / Présenté par: ***Bob Kochtubajda***
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On June 13, 2020, the city of Calgary experienced a devastating hailstorm accompanied by torrential rain and lightning that caused about $1.3 billion dollars in insured property damage. The thunderstorm developed over south-central Calgary near 0025 UTC June 14, and rapidly intensified in the next 15-20 minutes to a severe storm. This study examines the spatial and temporal characteristics of 2,032 (cloud-to-ground and cloud) lightning flashes detected by the Canadian Lightning Detection Network over the city. In addition to severe weather reports, we also quantify the evolution of the severity of the storm using data from the Strathmore radar. The first CG lightning strike occurred at 0029 UTC, approximately 20 km southwest of the international airport. The northeastern portion of Calgary experienced the majority of the lightning with 1668 total flashes discharged between 0036-0221 UTC June 14. This is the same area that experienced the worst hail damage and flooding. Total lightning rates averaged 15.4 flashes/min (fpm) during the storm. The thunderstorm was most active from 0125 UTC to 0153 UTC averaging 30.8 fpm (peak of 53 fpm). Positive polarity CG flashes during this period accounted for 56% of the CGs discharged. In severe storms, lightning jumps (sudden increases in total lightning flash rate) are often precursors to severe weather on the ground. Lightning activity associated with the storm NE of the city when it was producing golfball-sized hail, and the presence/absence of a lightning jump will be discussed.

Session: 241 Severe Storms and Associated Hazards - Part 2 Tempêtes violentes et risques - Partie 2 **04/06/2021 15:00**

ID: 10859 Contributed abstract

Poster Order:

Polarimetric radar observations of the June 13th 2020, Alberta Hailstorm. Sudesh Boodoo, Julian Brimelow, Daniel Michelson, Norman Donaldson, Peter Rodriguez, Paul Joe. Meteorological Research Division, Science and Technology Branch, Environment and Climate Change Canada

Sudesh Boodoo [1] , *Julian Brimelow* [2] , *Daniel Michelson* [3] , *Norman Donaldson* [4] , *Peter Rodriguez* [5] , *Paul Joe* [6]

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Presented by / Présenté par: ***Sudesh Boodoo***
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In the evening of June 13, 2020, a series of severe thunderstorms developed over southern Alberta and tracked northeastwards. The storm cells produced golf ball size and larger hail, and significant flash flooding reported in many areas. Most recent estimates of insured losses from this event sits at 1.3 billion dollars. Farther to the south east of Calgary, two supercell storms tracked northeastwards to the east of Lethbridge and produced intense rainfall, giant hail and a weak tornado. A hailstone measuring approximately 10 cm in diameter was reported north of Brooks. Furthermore, large amounts of small hail and intense rain produced flooding in many regions. In late 2019, Environment and Climate Change Canada (ECCC) installed an S-band radar with polarimetric capability at Strathmore, Alberta as part of the Canadian Weather Radar Replacement Program (CWRRP). Polarimetric radar measurements supplement conventional radar reflectivity and velocity, with differential reflectivity, differential phase and co-polar correlation coefficients. These additional moments provide information on hydrometeor shapes, sizes, orientation and composition. Radar observations shows several severe convective cells with echotop heights exceeding 15.0 km over Calgary area early in the event. The maximum reflectivity observed in a convective cell was 77.5 dBZ and many other storm cells showed reflectivities greater than 70 dBZ over the storm's duration. Differential reflectivity measurements indicated regions of strong updrafts in the thunderstorms. Other polarimetric features of interest were local minimum of co-polar correlation coefficients; in mixed

at S-band and distinct polarimetric signatures of three body scatter spikes. This presentation will focus on the radar observations, and their relation to storm structure and surface observations from this event. In addition, conventional and polarimetric detection of hail are compared for this event.

Session: 241 Severe Storms and Associated Hazards - Part 2 Tempêtes violentes et risques - Partie 2 **04/06/2021 15:15**

ID: 10925 Contributed abstract

Poster Order:

Exploring the Morphology and Evolution of the 4 July 2020 Tornadic Supercell in Southern Saskatchewan, SK, Canada

Mostofa Kamal [1] , *Yanping Li* [2] , *Zhenhua Li* [3]

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Presented by / Présenté par: ***Mostofa Kamal***
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On July 4, 2020, an isolated supercell thunderstorm produced at least three confirmed tornadoes and softball size hail between 4:30 to 6:30 pm (CST) in south Saskatchewan, although the Environment and Climate Change Canada's thunderstorm outlook predicted a marginal environment for severe thunderstorm development and associated hazard risk. As with any real-time case with forecast errors, the July 4th supercell event offers excellent opportunities to analyze this case to understand prairie supercell morphology and evolution that may improve similar future forecasts. This study investigated the initiation, organization, and dissipation of various stages of the observed tornadic supercells using surface analysis, upper-air charts, reflectivity, RADAR data, satellite imagery, and lightning data. In the early morning hours, we found that approximately 50 milibar deep inversion layer (a.k.a., lid) resulted from elevated heating due to the very high terrain of the Rocky Mountain. The lid suppressed surface-based convection until afternoon; hence, increasing local evapotranspiration due to clear sky conditions coupled with advected abundant moisture from the Great Plains by the southwesterly and southeasterly surface winds resulting in a deep moist boundary layer and enormous convective available potential energy. The lid also allowed the air to stay very cold and dry aloft. The passage of the leading edge of a cold front provided the necessary

push to break the lid and results in explosive convective cell development. One of the convective cells became a supercell thunderstorm when the strong vertical wind shear present on the day tilted the updraft and stretched the horizontal vorticity leading to a mesocyclone development, a characteristic of a supercell. The combined influence of the cyclogenesis in connection with the left exit (divergence) and the right entrance (convergence) region of the jet streak and frontal convergence at the surface resulted in the development and maintenance of the tornadic supercell.

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ID: 10838 Contributed abstract

Poster Order:

PGW FUTURE CHANGE OF HAIL OVER THE NORTHERN PLAINS AND CANADIAN PRAIRIES BASED ON WRF-HAILCAST SIMULATIONS

Daniel Betancourt [1] , *John Hanesiak* [2] , *Zhenhua Li* [3] , *Yanping Li* [4] , *Julian Brimelow* [5] , *George Liu* [6]

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Presented by / Présenté par: ***Daniel Betancourt***
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Hail is a destructive severe weather phenomena that can cause considerable damage to property and agricultural crops. It is therefore important to understand current patterns in the occurrence of severe hail, and how these may shift in the future due to anthropogenic warming. In this study, a coupled cloud-hail and hail-growth model (HAILCAST) was forced with high resolution (4 km) convective-permitting Weather Research and Forecasting (WRF) model output in a control (CTRL) simulation and Pseudo-Global Warming (PGW) scenario for the period 2000-2013 over the Northern Plains and Canadian Prairies. The PGW approach involves applying future climate perturbations derived from CMIP5 to the lateral and initial boundary conditions (ERA-Interim) of the WRF-CTRL simulation [Liu et al., Climate Dyn., 49, 71-95 (2017)]. Results show non-contiguous maxima in occurrence of hail across the region over Alberta and the Upper Midwest/eastern Prairies in the CTRL simulation.

The most extreme hail occurrence (> 4 cm and > 6 cm diameter) is limited to southeastern portions of the study area. Gradients from west to east occur with respect to contributions from elevated versus surface convective processes; and between thermodynamic (buoyancy) versus dynamic (windshear) mechanisms during hail formation. In spite of widespread increases in thermodynamic parameters and instability in the PGW scenario, a spatially coherent pattern of decreased hail frequency and metrics occur over southeastern portions of the domain. Previous studies using Global Circulation Models (GCMs) have shown similar decreases in occurrence and size of hail over the same regions which have been attributed to increased melting and/or convective inhibition. The role of increased atmospheric capping in suppressing hail-producing convection is demonstrated in this study; as is the effect of increased melting on hailstone metrics.

Session: 256 General Session - Weather - Part 7 - Precipitation and local weather issues Séance générale — La météorologie - Partie 7 - Précipitations et problèmes météorologiques locaux **04/06/2021 14:30**

ID: 10969 Contributed abstract

Poster Order:

Precipitation forecast enhancement with a hybrid of analog ensemble and convolutional neural networks

Yingkai Sha [1] , *David John Gagne II* [2] , *Gregory West* [3] , *Roland Stull* [4]

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Presented by / Présenté par: ***Yingkai Sha***
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A novel precipitation ensemble forecast post-processing methodology is proposed based on the analog ensemble (AnEn) and convolutional neural network (CNN). This AnEn-CNN hybrid scheme takes the ensemble mean of Global Ensemble Forecast System (GEFS) 3 hourly, 0.25-degree precipitation forecasts from +9 hours to +6 days as inputs and produces bias-corrected, calibrated, and equiprobable ensemble members. The AnEn-CNN hybrid scheme is tested and verified through post-processing experiments conducted in British Columbia (BC), Canada, and based on the 12-generation GEFS reforecast from 2017 to 2019. Distribution- and threshold-based ensemble

verifications indicate that, compared with conventionally used AnEn, the AnEn-CNN hybrid scheme produces more skillful calibrations; these calibrations are also more reliable for drizzle and extreme precipitation events. The AnEn-CNN hybrid scheme is expected to be operated daily at Weather Forecast Research Team (WFRT), UBC, and produces high-quality, physically realistic precipitation realizations that can be further used in hydrological applications (e.g., watershed-scale downscaling).

Session: 256 General Session - Weather - Part 7 - Precipitation and local weather issues Séance générale — La météorologie - Partie 7 - Précipitations et problèmes météorologiques locaux **04/06/2021 14:45**

ID: 11042 Contributed abstract

Poster Order:

Comparison of gridding methods for monthly precipitation for trend analysis in Canada

Kian Abbasnezhadi [1] , *Xiaolan Wang* [2]

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Presented by / Présenté par: ***Kian Abbasnezhadi***
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During the last couple of decades, Canada's national and regional climate trend assessment has been based on a set of gridded temperature and precipitation monthly anomalies, known as the Canadian Gridded (CanGRD) data, which were produced using Optimal Interpolation (OI). In CanGRD, temperature anomalies and normalized precipitation anomalies at 463 stations of the Adjusted/Homogenized Canadian Climate Data (AHCCD) are interpolated to a 50-km equal-area grid over Canada. The input AHCCD precipitation data had been previously adjusted for known problems such as wind-induced gauge undercatch, wetting loss, and trace amounts. Joined stations series were also tested and adjusted. However, the performance of the CanGRD gridding method (i.e., the OI method) has never been evaluated against other gridding methods. The objective of this study is to evaluate CanGRD method against an ordinary kriging (KG) method. To this end, an observation-based ANUSPLIN-gridded monthly precipitation dataset (which is based on precipitation data from 3000+ stations) was used as the truth dataset, and ANUSPLIN estimates of monthly precipitation amounts at the 463 AHCCD stations were used as input data to the gridding models. In search for a better way to use KG, we took two approaches to apply KG: (1) KGGP approach, in which KG was applied directly to the monthly total precipitation amounts; and (2) KG-GNGA approach, in which KG was applied separately to the monthly normals (for each calendar month) and the monthly anomalies. The gridded normals (GN) and the gridded anomalies (GA) were then combined together (GN+GA) for comparison with the gridded precipitation (GP) from the KG-GP approach to find out which of the two approaches is more skillful. The gridded anomalies (GA) from the KG-GNGA approach is comparable, and was compared with the CanGRD data, noting that in the CanGRD method, the anomalies rather than precipitation totals are gridded. In both evaluations, the gridded datasets were compared against their counterparts derived from the truth dataset using skill measurements such as Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and Pattern Correlation Score (PCS). The results show that (1) the KG-GNGA approach notably outperforms the KG-GP approach, and (2) the KG-GNGA method significantly outperforms the OI method used in CanGRD. This study is being expanded to include other gridding methods in the comparison.

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ID: 10966 Contributed abstract

Poster Order:

NWP model simulations of lake breezes: The impact of accounting for 3D solar radiative transfer for cloudy atmospheres

Howard W. Barker [1] , *Zhipeng Qu* [2] , *Yaolun Yin* [3]

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Presented by / Présenté par: ***Howard W. Barker***
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Current NWP models compute solar radiative fluxes with 1D solutions of the radiative transfer (RT) equation. This means that clouds simulated within the NWP model cast shadows at nadir regardless of solar zenith angle. This methodology is referred to as the Independent Column Approximation (ICA). As clouds, precipitation, and lake breezes themselves depend entirely on solar heating of land surfaces, it is hypothesised that the 1D-ICA approach is, at times, inadequate due to improper casting of cloud shadows and 2D

distributions of simulated surface irradiances. The purpose of this study is to explore whether the 1D-ICA's erroneous cloud shadows impacts the forecast of lake breezes, and their associated clouds and precipitation, along the north shore of Lake Ontario. Experiments were performed with the Global Environmental Multiscale (GEM) NWP model with idealized model settings, at horizontal grid-spacing of 250 m. A computationally efficient adjustment to GEM's 1D-ICA direct- and diffuse-beam surface irradiance fields was used. It is shown that these adjustments capture 3D RT effects extremely well. This study will assess GEM's response to adjusted 1D-ICA surface irradiances. This should help decide whether it is worth considering use of a computationally expensive 3D solar RT model in GEM.

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ID: 11087 Contributed abstract

Poster Order:

Impact of Athabasca oil sands operations on mercury levels in air and deposition

Ashu Dastoor [1] , *Andrei Ryjkov* [2] , *Gregor Kos* [3] , *Junhua Zhang* [4] , *Jane Kirk* [5] , *Matthew Parsons* [6] , *Alexandra Steffen* [7]

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Presented by / Présenté par: ***Ashu Dastoor***
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Oil sands upgrading facilities in the Athabasca Oil Sands Region (AOSR) in Alberta, Canada, have been reporting mercury (Hg) emissions to public government databases (National Pollutant Release Inventory (NPRI)) since the year 2000, yet the relative impact of these emissions on the environment remains unknown. A 3D process-based Hg model, GEM-MACH-Hg, was applied to simulate the Hg burden in and around the AOSR from 2012 to 2015 using NPRI reported emissions. The impact of oil sands developments on Hg levels in the AOSR, relative to contributions from other sources such as global anthropogenic and wildfires emission influencing Hg levels in the region, was assessed. In addition, the relative importance of year-to-year changes in emissions from the above sources and meteorological conditions to inter-annual variations in Hg deposition was examined. As a result of global-scale transport and long lifetime of gaseous elemental Hg (Hg(0)), surface air concentrations of Hg(0) in the AOSR reflected the background Hg(0) levels in Canada. By comparison, ambient concentrations of total oxidised Hg (the efficiently deposited Hg species) in the AOSR were elevated above background levels up to 60% within 50 km of the oil sands Hg emission sources. Hg emissions from wildfire events led to episodes of high ambient Hg(0) concentrations and deposition enrichments in northern Alberta, including the AOSR. On a broad spatial scale, imported Hg from global sources dominated the annual background deposition in the AOSR, with present-day anthropogenic emissions contributing to 40%, and geogenic emissions and re-emissions of legacy mercury deposition contributing to 60% of background Hg deposition. Whereas, oil sands emissions were responsible for significant enhancements in Hg deposition fluxes in the immediate vicinity of oil sands Hg emission sources, which were about 10 times larger in winter than summer. The spatial extent of the oil sands emissions influence on Hg deposition was also greater in winter relative to summer (~100 km vs 30 km from Hg emitting facilities). Wintertime deposition also displayed significantly higher inter-annual variations as a result of the changes in meteorological conditions (such as precipitation amounts, wind speed, surface air temperature, solar insolation, and snowpack dynamics) and oil sands Hg emissions. Hg runoff in spring flood, constituting the majority of annual Hg runoff, is mainly derived from seasonal snowpack Hg loadings and mobilization of Hg from surface soils, both of which are sensitive to Hg emissions from oil sands developments. Model results suggest that sustained efforts to reduce anthropogenic Hg emissions from both global and oil sands sources are required to mitigate the impacts of Hg contamination in the AOSR.

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ID: 11031 Contributed abstract

Poster Order:

Simulation of airborne tree pollen in Canada and the potential synergy with air pollution.

Alain Robichaud [1]

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Presented by / Présenté par: ***Alain Robichaud***
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Pollen allergy is of growing importance in the context of global warming (reported increase allergy sensitization within urban population and longer pollen season). Simulating airborne pollen is thus essential given the high public health impact in North America and elsewhere. Moreover, there is a growing evidence for a link between air pollution, atmospheric chemistry, some specific meteorological conditions and the allergenic power of the pollen grain. However, the simulation and prediction of this phenomenon is difficult and controversial and further research (modelling and development) is required to better protect the Canadian public against the associated health risk. Moreover, improving understanding and modelling of airborne pollen are quite challenging in the context of limited bioaerosols monitoring such as in Canada. In this talk, preliminary results of modelling of airborne tree pollen grain are presented along with gaps in the knowledge and possible future improvements. However, this effort would be successful only if monitoring of bioaerosols is adequately addressed in the future agenda.

Session: 851 The North Atlantic Ocean: Circulation, physical processes, and interactions with biogeochemistry - Part 2
Océan Atlantique Nord : Circulation, processus physiques et interactions avec la biogéochimie - Partie 2 **04/06/2021 14:30**

ID: 11190 Invited session speaker

Poster Order:

Carbon export in the central Labrador Sea: insights from the in situ, sensor-based observations

Dariia Atamanchuk [1] , *Jannes Koelling* [2] , *Douglas Wallace* [3]

[1] Dalhousie University
[2] Dalhousie University
[3] Dalhousie University

Presented by / Présenté par: ***Dariia Atamanchuk***
Contact: dariia.atamanchuk@dal.ca

Carbon export from the surface sunlit area to the dark interior of the global ocean 1) provides deep-ocean ecosystems with energy and 2) removes carbon away from the surface ocean and atmosphere to the depth. Quantification of the

export, also called biological carbon pump or export production, is based, historically, on the data from sediment traps, observations of particle-reactive tracers or particle filtration, and uses parameterization in terms of Net Primary Production (NPP) and particle sinking flux (Martin Curve). Here we use a novel approach to export production, taking full advantage of the modern-day in situ observations of the ocean surface and its interior. We will present a unique capability of SeaCycler, a profiling surface piercing mooring, to deliver high-frequency chemical, physical and biooptical time-series of sensor-based vertical profiles of the upper 150m of the central Labrador Sea to constrain Net Community Production (NCP), export production and export efficiency (T100). We compare estimates of NCP based on inorganic carbon profiles with estimates from nitrate and oxygen budgets and demonstrate that profiles of dissolved chemical and bio-optical parameters extending into sub-euphotic zone waters provide an alternative, more suited for the new observations technological approach to the calculation of export efficiency using chemical mass balance. We will further demonstrate the potential of the mass-balance based metrics in quantifying export production in late Winter - early Spring in the Labrador Sea when subduction type export pathways of organic carbon dominate. These export pathways are often overlooked in the global estimates. Still, they constitute a large fraction of high-latitude carbon export that may be affected as a result of reduced vertical mixing and deep-water formation.

Session: 851 The North Atlantic Ocean: Circulation, physical processes, and interactions with biogeochemistry - Part 2
Océan Atlantique Nord : Circulation, processus physiques et interactions avec la biogéochimie - Partie 2 **04/06/2021 14:45**

ID: 11050 Contributed abstract

Poster Order:

Tracking Irminger Ring's properties throughout the Labrador Sea using a sub-mesoscale ocean model

Clark Pennelly [1] , *Paul Myers* [2]

[1] University of Alberta
[2] University of Alberta

Presented by / Présenté par: ***Clark Pennelly***
Contact: pennelly@ualberta.ca

A 1/60° numerical simulation is carried out within the Labrador Sea to investigate eddies produced along the western coast of Greenland. These eddies, known as Irminger Rings, carry relatively buoyant water from the West

Greenland Current system into the interior Labrador Sea, surviving for up to 2 years. We detect and track 232 eddies produced within our 14 year simulation. Eddies generally travel southwestwards after formation, and eddies whose trajectory is close to the continental slope tend to have a reduced lifespan and quicker speed than those which drift into the interior deep basin. Irminger Rings start with a significant layer of freshwater that erodes rather quickly during the convective winter. We find that eddies which spawn further north are more likely to end up influenced by the boundary currents, while those which form to the south are more likely to enter the deep interior basin. While the formation rate of eddies is generally uniform across our 2005-2018 simulation, eddies are far more likely to decay during the convective wintertime. We find that most eddies quickly decay within a few months, although some survive long enough to endure two convective winters. All Irminger Rings increase the local stratification in the Labrador Sea, limiting convection. However, the eddies which live for 2 winters experience a significant buoyancy loss over a long time span such that may produce Labrador Sea Water within their core during their second winter. While this constitutes a small volume of Labrador Sea Water, it does update our understanding of Irminger Ring's role on stratifying the Labrador Sea.

Session: 851 The North Atlantic Ocean: Circulation, physical processes, and interactions with biogeochemistry - Part 2
Océan Atlantique Nord : Circulation, processus physiques et interactions avec la biogéochimie - Partie 2 **04/06/2021 15:00**

ID: 11032 Contributed abstract

Poster Order:

Ongoing AMOC and related sea level and temperature changes after achieving the Paris targets

Michael Sigmond [1] , *John Fyfe* [2] , *Oleg Saenko* [3] , *Neil Swart* [4]

[1] Environment and Climate Change Canada
[2] Environment and Climate Change Canada
[3] Environment and Climate Change Canada
[4] Environment and Climate Change Canada

Presented by / Présenté par: ***Michael Sigmond***
Contact: Michael.Sigmond@canada.ca

While the Atlantic Meridional Overturning Circulation (AMOC) is expected to weaken under increasing greenhouse gases, it is unclear how it would respond to stabilization of global warming of 1.5 or 2.0°C, the Paris Agreement

temperature targets, or 3.0°C, the expected warming by 2100 under current emission reduction policies. Based on stabilized warming simulations with two Earth System Models we find that after temperature stabilization, the AMOC declines for 5-10 years, followed by a 150-year recovery to a level that is approximately independent of the considered stabilization scenario. The AMOC recovery has important implications for North Atlantic steric sea level rise, which by 2600 is simulated to be 25-31% less than the global mean, and for North Atlantic surface temperatures, which continue to increase despite global mean surface temperature stabilization. These results show that substantial ongoing climate trends are likely to occur after global mean temperature has stabilized.

Session: 851 The North Atlantic Ocean: Circulation, physical processes, and interactions with biogeochemistry - Part 2
Océan Atlantique Nord : Circulation, processus physiques et interactions avec la biogéochimie - Partie 2 **04/06/2021 15:15**

ID: 10795 Contributed abstract

Poster Order:

Sensitivity of convective overturning and turbulent mixing of dissolved gases in the Labrador Sea to atmospheric forcing

Romina Piunno [1] , *Kent Moore* [2]

[1] University of Toronto
[2] University of Toronto

Presented by / Présenté par: ***Romina Piunno***
Contact: romina.piunno@mail.utoronto.ca

Deep oceanic convection occurs in few locations around the globe. One such location is found in the Labrador Sea where dense waters subside to depths in excess of 2km below the surface. The weak stratification preconditions the water column for deep convection, triggered by wintertime surface cooling associated with high wind speed events. The convected water brings with it dissolved gases, such as Carbon Dioxide, which are in constant flux between ocean and atmosphere. It is thought that this process of turbulent boundary layer interactions coupled with deep convection is responsible for mixing these gases into the deep ocean, making the ocean the largest sink of anthropogenic carbon. The convective overturning process depends on the temperature and salinity profiles which, together dictate density and thus the static stability of the water column. We have adapted a widely used one-dimensional mixed-layer model, referred to as PWP, to include a parameterization of the air-sea flux of gases such as Oxygen and Carbon Dioxide. With the model, we investigate the

sensitivity of deep-water formation and the vertical profile of these gases to various atmospheric forcing parameters. Overturning in the Labrador Sea is most active during the winter months when heat flux out of the ocean is at its maximum. It is found that overturning is far more sensitive to thermal forcing than it is to freshwater forcing within the range of forcings typical to the Labrador Sea. We explore the impact of this sensitivity, including the dependence of the atmospheric forcing on modes of climate variability such as the NAO, has on the role that the Labrador Sea plays as a marine sink for anthropogenic carbon.

Session: 851 The North Atlantic Ocean: Circulation, physical processes, and interactions with biogeochemistry - Part 2
Océan Atlantique Nord : Circulation, processus physiques et interactions avec la biogéochimie - Partie 2 **04/06/2021 15:30**

ID: 11085 Contributed abstract

Poster Order:

Drivers of the Decline of the Atlantic Meridional Overturning Circulation under Climate Change in a Hierarchy of Climate Models

Anne-Sophie Fortin [1] , *Carolina Dufour* [2] , *Timothy Merlis* [3]

[1] McGill University
[2] McGill University
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Presented by / Présenté par: ***Anne-Sophie Fortin***
Contact: anne-sophie.fortin@mail.mcgill.ca

Over the past decades, oceans have absorbed most of the heat energy added to the climate system by human activities, which has damped global warming. This heat energy is redistributed into the ocean interior by the Meridional Overturning Circulation (MOC) with large impacts on regional and global climates. Changes in the MOC pattern and strength are thus important to understand and quantify. Here, we investigate the magnitude and spatial distribution of the climate response of the various drivers of the Atlantic MOC (AMOC), such as geostrophic transport, wind-driven transport, and mesoscale eddy transport. A hierarchy of three climate models of varying resolution in the ocean (1°, 0.25°, 0.10°) called the CM2-O suite is used. The AMOC shows the strongest reduction under climate change in the eddy-parameterized model while the weakest is found in the eddy-permitting model. The decomposition of the AMOC into its drivers reveals that most of the AMOC reduction is due to a weakening of the geostrophic transport driven by temperature anomalies. In contrast, changes in wind-driven transport have little

effect, except in the eddy-rich model where it contributes significantly to the AMOC decline. Changes in the mesoscale eddy transport contribute to $\approx \! 20\%$ of the AMOC decline in the eddy-rich and eddy-parameterized models, but induce very little change in the eddy-permitting model.

Session: 513 Coastal Oceanography and Inland Waters - Part 4 Océanographie côtière et eaux intérieures - Partie 4 **04/06/2021 14:30**

ID: 10882 Contributed abstract

Poster Order:

Altimetry-derived currents along the shelf edge and continental slope off British Columbia

Guoqi Han [1] , *Nancy Chen* [2]

[1] Fisheries and Oceans Canada
[2] Fisheries and Oceans Canada

Presented by / Présenté par: ***Guoqi Han***
Contact: Guoqi.Han@dfo-mpo.gc.ca

Temporal and spatial variations of surface currents along the shelf edge and continental slope of British Columbia are investigated using 10-day along-track satellite altimetry sea surface height data from October 1992 to December 2020. The geostrophic surface currents are in the direction normal to the satellite track (positive poleward) and represent approximately the along-shelf flow. The calculated geostrophic surface currents are further averaged both seasonally and along track. At a track off West Vancouver Island, the winter surface current is poleward and the summer surface current is equatorward, with the long-term mean surface current close to zero. At a track in the mouth of the Queen Charlotte Sound, the surface current is poleward year-round, stronger in winter and weaker in summer. Three is no apparent long-term trend in the surface current over 1992-2020. In contrast, interannual variations are evident. For example, stronger equatorward surface current in the summers of 2015 and 2016, and stronger poleward surface current in the falls of 2015-2016 and 2016-2017. In summer/fall 2020 the equatorward surface current at the West Vancouver Island transect was stronger than normal and the poleward surface current at the Queen Charlotte Sound transect is weaker than normal. El Niño and La Niña events as well as the Pacific Decadal Oscillations are important large –scale factors affecting the interannual current variations.

Session: 513 Coastal Oceanography and Inland Waters - Part 4 Océanographie côtière et eaux intérieures - Partie 4 **04/06/2021 14:45**

ID: 11163 Contributed abstract

Poster Order:

Surface wave impacts on upper ocean dynamics under realistic and idealized hurricanes

Guoqiang Liu [1] , *Will Perrie* [2]

[1] DFO, Bedford Institute of Oceanography
[2] DFO, Bedford Institute of Oceanography

Presented by / Présenté par: ***Guoqiang Liu***
Contact: william.perrie@dfo-mpo.gc.ca

A one-dimensional ocean model GOTM is modified by incorporating surface wave effects, including wave breaking, Langmuir circulation and Coriolis-Stokes force. This newly-modified model is applied to simulate the upper ocean responses to hurricane cases, Arthur (2014) and Felix (1995). The simulation results demonstrate that the incorporation of wave effects, particularly the wave breaking and Langmuir circulation, improves the GOTM simulations. Wave effects improve the simulations of the upper ocean thermal responses by significantly reducing the underestimates in the upper ocean cooling and deepening of the mixed layer depth, which leads to better agreement with observations. For an idealized hurricane case, the wave breaking induced momentum and energy fluxes, Langmuir turbulence and wave evolving dependent stress are incorporated into a coupled wave-current model, COAWST. We find that the largest impacts on upper ocean currents and temperature, are due to wave breaking induced momentum and energy fluxes, compared to the other processes, Langmuir turbulence and other conservative wave related terms. The wave – dependent stress impacts the near inertial current significantly. If wave impacts are ignored, we find that there is a large overestimate in wind power input, about 10%–40%, occurring on the right sides and rear regions of the hurricanes. By changing the momentum flux at the surface, the effects of surface waves on near inertia currents can reach depths of ~100 m, the resulting reduction in the near-inertial velocity can exceed 0.1 m/s, and the reduction in the near-inertial energy (NIE) increases to 20%. These effects of surface waves on upper ocean dynamics, on the currents and thermal re-distribution are notable. Feedbacks of these modified ocean properties must therefore affect hurricane intensify and should be included in coupled atmosphere-ocean studies.

Session: 513 Coastal Oceanography and Inland Waters - Part 4 Océanographie côtière et eaux intérieures - Partie 4 **04/06/2021 15:00**

ID: 11206 Contributed abstract

Poster Order:

Diurnal current response to the sea breeze on the inner shelf off the southern Caspian Sea

Mina Masoud [1] , *Rich Pawlowicz* [2]

[1]

[2] Dept. of Earth, Ocean and Atmospheric Sciences, University of British Columbia, 2207 Main Mall, Vancouver, B.C. Canada V6T 1Z4

Presented by / Présenté par: ***Mina Masoud***

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The sea breeze system is the dominant atmospheric forcing at high frequency in the southern Caspian Sea. Here, we describe and interpret current meter observations on the continental margins of the southern Caspian from 2013 to 2014 to identify and characterize the water column's response to the sea breeze system. Time series analysis provides evidence for diurnal baroclinic current signals with amplitudes of -0.2-0.2 m/s and surface height changes in range of -0.15-0.15 m. A two-layer model, including interfacial and bottom friction is used to further investigate the sea breeze response. This model is able to reproduce the structure, amplitudes, and phases of observed diurnal current fluctuations, explaining half of the variance at frequencies at 1 cpd and higher. The sea breeze response thus results in a "tide-like" daily cycle which is actually linked to the local forcing all along the southern Caspian coast.

Session: 513 Coastal Oceanography and Inland Waters - Part 4 Océanographie côtière et eaux intérieures - Partie 4 **04/06/2021 15:15**

ID: 10760 Contributed abstract

Poster Order:

A sensitivity study of the Gulf of St. Lawrence water masses in response to atmospheric forcing using the operational Canadian coastal ice-ocean prediction system

Francois Roy [1] , *Gregory C. Smith* [2] , *Jean-Philippe Paquin* [3] , *Sarah MacDermid* [4] , *Audrey-Anne Gauthier* [5]

[1] Environnement Canada
[2] Environnement Canada
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[4] Environnement Canada
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Presented by / Présenté par: ***Francois Roy***
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The Gulf of St. Lawrence (GSL) water masses evolve under a complex estuarine circulation. Continental freshwaters travel downstream at the ocean surface and mix with the cold waters entering the GSL through Belle-Isle Strait (Labrador Current), and with some of the warmer and saltier Atlantic waters entering through Cabot Strait at depth in the Laurentian Channel that crosses the continental shelf outside the GSL and connects to the Gulf Stream area. Extreme weather events and a strong heat loss in fall and winter lead to the formation of a sea ice cover and a thickening of the cold intermediate layer (CIL, ~30-150m). We study how these water masses respond to different atmospheric forcing in simulations of the Canadian Ice Ocean Prediction System East (CIOPS-E). CIOPS-E is based on the NEMO-CICE modeling framework applied to a northwest Atlantic 1/36 degree (~2 km) resolution domain. The domain covers the Gulf Stream region and the Canadian east coast, including the Grand Banks, the Labrador and Scotian Shelves, and the GSL. The atmospheric forcing is taken from different configurations of the Canadian weather forecast system (33 km to 2.5 km resolution). We examine the sensitivity of the model in terms of how the atmospheric forcing modulates the evolution of water masses in the characterized circulation of the GSL. Using multi-year simulations, we quantify the response of water mass transports over seasonal to inter-annual time scales. We characterize the response of water mass renewal time scales from different regions and depths of the GSL. Finally, we look at how the boundary inputs from Cabot and Belle-Isle straits are sensitive to the different atmospheric forcing sets and how it affects the circulation within the GSL. The results shed light on the interpretation of multi-decadal simulations or climate projections that use relatively low-resolution atmospheric forcing.

ID: 11165 Contributed abstract

Poster Order:

Glider-based observations of fine-scale processes on the Scotian Shelf

Clark Richards [1]

[1] DFO Bedford Institute of Oceanography

Presented by / Présenté par: ***Clark Richards***

Contact: clark.richards@gmail.com

As part of the Atlantic Zone Monitoring Program (AZMP), Fisheries and Oceans Canada has been monitoring regular sections on the Scotian Shelf for physical, chemical, and biological properties. In 2017, the regular ship-based sampling was supplemented by a fleet of gliders, with a focus on sampling the Halifax Line. Previous glider work highlighted the ability to be able to resolve seasonal variability (missed by the biannual ship survey). Additionally, the high spatial and temporal resolution of the glider data provides insights into fine-scale structures and processes. Here we highlight some of these processes, including signatures of lateral exchange and double diffusive staircases, along with some of the sampling and data processing considerations required to resolve such processes.

Day 6 – 7 June 2021

Oral

Session: 242 Severe Storms and Associated Hazards - Part 3 Tempêtes violentes et risques - Partie 3 **07/06/2021 12:30**

ID: 10793 Contributed abstract

Poster Order:

The Catastrophic October 2019 Snow Storm Over Southern Manitoba, Canada

John Hanesiak [1] , *Ronald Stewart* [2] , *Dylan Painchaud-Niemi* [3] , *Shawn Milrad* [4] , *George Liu* [5] , *Michael Vieira* [6] , *Julie Theriault* [7] , *Melissa Cholette* [8] , *Kyle Ziolkowski* [9]

[1] University of Manitoba
[2] University of Manitoba
[3] University of Manitoba

[4] Embry-Riddle Aeronautical University
[5] University of Manitoba
[6] Manitoba Hydro
[7] Université du Québec à Montréal
[8] Environment and Climate Change Canada
[9] Environment and Climate Change Canada

Presented by / Présenté par: ***John Hanesiak***
Contact: john.hanesiak@umanitoba.ca

A devastating storm struck southern Manitoba, Canada October 10-13 2019, producing a large region of mainly sticky and wet snow. Snow accumulations reached 75 cm, wind gusts exceeded 100 km h-1, and surface temperatures remained near 0°C for 48 consecutive hours over many areas. It produced the largest October snowfall and was the earliest to produce at least 20 cm since 1872 in Winnipeg. These factors led to devastation and, for Manitoba Hydro, was unprecedented for wood pole, tower and power line damage. For the City of Winnipeg, this was the most damaging storm to its trees ever recorded. The storm was unique in its evolution over a short longitudinal distance, producing elevated convection related to buoyancy-driven instability and conditional symmetric instability (CSI), with a moist absolutely unstable layer (MAUL) near 500 hPa. These instabilities were released by large-scale and mesoscale lift generated by lower-tropospheric warm advection and frontogenesis, differential cyclonic vorticity advection, and jet streak dynamics. Precipitation bands, elevated convection, and lake effect “squalls” enhanced local snowfall accumulations. It was inferred that a seeder-feeder mechanism involving ice crystals from cold mid-level clouds was critical to producing this lake-effect precipitation from the warm, low-level, lake generated clouds. A 1D microphysical model confirmed that little refreezing of wet snow would have occurred below a near-surface (< 100 m deep) inversion with maximum wet bulb temperature of 0.4°C measured by a sounding at the University of Manitoba campus; at least some of the surface snow would therefore have been wet despite occurring at sub-freezing temperatures. With strong winds occurring during and after wet/sticky snow and leaves still largely on the vegetation, these factors collectively led to the extreme impacts. The combined severe conditions within this event were, by several measures, the most prolonged experienced in Winnipeg over the 1953-2020 period.

Session: 242 Severe Storms and Associated Hazards - Part 3 Tempêtes violentes et risques - Partie 3 **07/06/2021 12:45**

ID: 10981 Contributed abstract

Poster Order:

A Hybrid Convective – Synoptic Windstorm Over Southern Ontario 04-May-2018

Robert Kuhn [1]

[1] ECCC

Presented by / Présenté par: ***Robert Kuhn***
Contact: Rob.Kuhn@canada.ca

Historically very strong winds occurred with a rapidly deepening Texas low that tracked across the Great Lakes on 04-May-2018. Damaging winds occurred from both a line of severe thunderstorms and then in the wake of a sharp cold front that raced east across Southern Ontario in the afternoon and early evening. This storm caused significant wind damage, power outages, and effects on transportation. The set up, forecast issues, evolution and impacts of this memorable and high impact spring windstorm will be discussed.

Session: 242 Severe Storms and Associated Hazards - Part 3 Tempêtes violentes et risques - Partie 3 **07/06/2021 13:00**

ID: 11126 Contributed abstract

Poster Order:

On Using Artificial Intelligence to Diagnose Precipitation Phase from Vertical Profiles

Dominique Brunet [1] , *John Rafael Quinto* [2]

[1] Environment and Climate Change Canada
[2] Environment and Climate Change Canada

Presented by / Présenté par: ***Dominique Brunet***
Contact: Dominique.Brunet@canada.ca

In Canada, winter hazards such as rain-on-snow, freezing rain, and heavy snowfall can have a large impact on transportation and electricity infrastructure, while potentially causing death or injury. In particular, according to the Canadian Institute for Health Information, falls on ice are by far the most common weather-related injuries, resulting in 10,000 hospitalizations per year. To help Canadians stay safe, it is necessary to correctly forecast the phase of precipitation. Precipitation types are traditionally determined operationally at Environment Canada from Bourgouin's method. With the recent advent of more powerful machine learning and artificial intelligence methods, we propose to revisit the precipitation phase diagnostic. Using ERA5 and ERA5-Land model re-analyses as the reference, we trained several recurrent neural networks (RNN) on vertical profiles of temperature and moisture to infer the snow fraction – the ratio of solid precipitation to total precipitation. We then defined thresholds to classify precipitation into three classes: solid, liquid or mixed. The best performing neural network for regressing snow fraction is found to be a Gated Recurrent Unit (GRU) RNN using profiles up to 500 hPa above the surface of both temperature and relative humidity. For classifying precipitation phase, the balanced accuracy on a held-out dataset is 92%, clearly outperforming the 65% balanced accuracy for Bourgouin's method. These preliminary results indicate the great potential of the proposed algorithm for determining snow fraction and precipitation phase from observed or forecasted vertical profiles.

Session: 242 Severe Storms and Associated Hazards - Part 3 Tempêtes violentes et risques - Partie 3 **07/06/2021 13:15**

ID: 11078 Contributed abstract

Poster Order:

Extreme ice pellets storm on 12 January 2020 in southern Québec, Canada

Mathieu Lachapelle [1] , *Julie Thériault* [2]

[1] UQAM
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Presented by / Présenté par: ***Mathieu Lachapelle***
Contact: lachapelle.mathieu@courrier.uqam.ca

Freezing rain and ice pellets can lead to hazardous weather conditions during the winter season when the surface temperature is near 0°C. These two precipitation types are difficult to predict because they are produced under similar atmospheric conditions, composed of a melting layer aloft and a refreezing layer near the surface. They are also difficult to report as they often occur simultaneously. On 12 January 2020, around 50 mm of ice pellets accumulated in the Montreal area. The goal of this study is to identify the atmospheric conditions and the microphysical processes that led to ice pellets and their characteristics during this storm. To do so, automatic measurements with an optical-laser disdrometer and micro rain radar as well as microphotographs of particles were analyzed. The timing of the precipitation types is investigated in details. It was found that ice pellets occurred simultaneously with pristine ice crystals during more than 8 hours. Many

microphotographs showed that ice pellets collected pristine crystals that are often stuck to the surface of the particles. Many ice pellets were also rimed, indicating the existence of supercooled cloud droplets in the refreezing layer. The time-evolution of the riming rate and the number concentration of ice crystals at the beginning of ice pellets suggests that ice pellets were characterized by the glaciation of the supercooled cloud in the refreezing layer. Further studies are needed to explain the origin of the pristine ice crystal and their contribution to the production of ice pellets. Overall, this research highlights the importance of ice nucleation at temperature near 0 °C that can impact the severity of a storm by producing ice pellets instead of freezing rain.

Session: 242 Severe Storms and Associated Hazards - Part 3 Tempêtes violentes et risques - Partie 3 **07/06/2021 13:30**

ID: 11168 Contributed abstract

Poster Order:

Utilizing lightning strike density information to aid in the forecasting Severe Thunderstorms

Melvin Lemmon [1]

1

Presented by / Présenté par: ***Melvin Lemmon***

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Operational Meteorologist use a variety of data sources and key characteristics to help highlight thunderstorm intensity. Viewing lightning strike information graphically as a lightning density product can be useful to help aid lead-time and the confidence of severe weather onset. This is particularly true in remote areas where RADAR data may not be available. This presentation will serve as an introduction to this idea and demonstrate the validity of the concept with examples from some severe weather events.

Session: 640 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 1 Observation de la Terre depuis l’espace : informations essentielles sur notre planète - Partie 1 **07/06/2021 12:30**

ID: 10998 Contributed abstract

Poster Order:

Canada and the international Group on Earth Observations (GEO)

David Harper [1] , *Shannon Kaya* [2] , *Carla schmitt* [3]

[1]

[2] ECCC

[3] ECCC

Presented by / Présenté par: ***David Harper***

Contact: david.harper@canada.ca

Canada has been involved with the international Group on Earth Observation (GEO) for over 15 years, working collaboratively with global experts and leaders to advance common goals. Along with promoting open data and interoperability, GEO hosts many theme-based groups from climate change and biodiversity to agriculture and health. This presentation focuses on Canada's involvement with GEO, recent successes, and a path forward to ensure that Canada benefits from all the opportunities presented by GEO. The discussion will highlight engagements with both GEO's regional and global communities, Canada's leadership in three GEO flagship initiatives related to agriculture, biodiversity and mercury monitoring, and will elaborate on supporting the Canadian SBEO private sector through GEO activities. Recognizing that the volume and use of Space-based Earth Observation (SBEO) data and technology is growing quickly, along with users needs to support decision-making on a variety of application areas, Canada's participation in GEO will help maximize the benefits of both in-situ and satellite data through regional and global GEO collaborations. Canada will continue to strengthen our national GEO community and increase our GEO participation to align with Canadian priorities, sharing opportunities for collaboration with Canadian government, academia and industry alike.

Session: 640 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 1 Observation de la Terre depuis l'espace : informations essentielles sur notre planète - Partie 1 **07/06/2021 12:45**

ID: 11125 Contributed abstract

Poster Order:

Advancing Climate Change Science through SBEO

Felicia Kolonjari [1] , *Daniel Bednar* [2] , *Caren Binding* [3] , *Jason Cole* [4] , *Chris Derksen* [5] , *Joshua Johnston* [6] , *Chris McLinden* [7] , *Ray Nassar* [8] , *Thomas Piekutowski* [9] , *Helena van Mierlo* [10]

[1] Environment and Climate Change Canada
[2] Canadian Space Agency
[3] Environment and Climate Change Canada
[4] Environment and Climate Change Canada
[5] Environment and Climate Change Canada
[6] Natural Resources Canada
[7] Environment and Climate Change Canada
[8] Environment and Climate Change Canada
[9] Canadian Space Agency
[10] Canadian Space Agency

Presented by / Présenté par: ***Felicia Kolonjari***
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In December 2020, the Government of Canada released its new climate science plan entitled Climate Science 2050: Advancing Science and Knowledge on Climate Change (CS2050). CS2050 provides both a national synthesis of climate change science needs in Canada as well as key outcomes that will ultimately inform progress toward a climate-resilient, net-zero Canada. Simultaneous to the ongoing progression of climate change, the space-based Earth observation (SBEO) landscape is evolving. To address key climate challenges, Canada's SBEO capabilities must keep pace. Advances in SBEO technology can provide faster, more accurate, and cost-effective ways to address Canada's climate challenges. This presentation will provide an overview of the key opportunities in which SBEO can support the advancement of climate change science in Canada and highlight emerging new missions under development through partnerships between Government departments and the Canadian Space Agency.

Session: 640 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 1 Observation de la Terre depuis l'espace : informations essentielles sur notre planète - Partie 1 **07/06/2021 13:00**

ID: 11006 Contributed abstract

Poster Order:

WildFireSat: Operationalizing of Wildfire Remote Sensing Science

Joshua Johnston [1] , *Dan Thompson* [2] , *Didier Davignon* [3] , *Helena van Mierlo* [4] , *Daniel Johnston* [5] , *Alan Cantin* [6] , *Colin McFayden* [7]

[1] Canadian Forest Service
[2] Canadian Forest Service

[3] Environment and Climate Change Canada
[4] Canadian Space Agency
[5] Canadian Forest Service
[6] Canadian Forest Service
[7] Ontario Ministry of Natural Resources and Forestry, Aviation, Forest Fire and Emergency Services

Presented by / Présenté par: ***Joshua Johnston***
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The Government of Canada has provided pan-departmental support for the initiation of the WildFireSat satellite mission, to be launched in or around 2026. The mission aims to adapt fire monitoring science to deliver the world's first truly operational dedicated wildfire monitoring satellite mission. WildFireSat is designed to address critical gaps in satellite fire monitoring for Canada's unique geography, and to primarily address the needs of wildfire and smoke management. This presentation provides a summary of the system design, alignment with existing systems, value added data products, data delivery systems, and knowledge transfer strategy. The mission will deliver comprehensive situational awareness to Canadian fire managers and decision-makers in near-real-time, and support smoke and air quality forecast services.

Session: 640 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 1 Observation de la Terre depuis l'espace : informations essentielles sur notre planète - Partie 1 **07/06/2021 13:15**

ID: 10683 Contributed abstract

Poster Order:

Canadian activities in preparation for Science & Applications of data from the SWOT mission

Jean Bergeron [1] , *Marcus Dejmek* [2] , *Thomas Piekutowski* [3]

[1] Canadian Space Agency
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[3] Canadian Space Agency

Presented by / Présenté par: ***Jean Bergeron***
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The Surface Water and Ocean Topography (SWOT) mission is being jointly

developed by NASA and the French space agency (CNES), with contributions from the Canadian Space Agency (CSA) and the United Kingdom Space Agency (UKSA). It aims to provide spaceborne measurements of surface water elevation over inland water bodies and oceans. CSA supports SWOT science activities through grants to Canadian universities and through shared investments with Environment and Climate Change Canada, and with Fisheries and Oceans Canada. These activities involve field work, improvement of numerical models, and preparations for cal/val and use of SWOT satellite data. Over time, these science activities have evolved significantly and permitted the development of rich scientific collaborations with colleagues in the US and France. The presentation provides a portrait of Canadian-led SWOT science activities supported by CSA, including the preparation of applications that will benefit Canadians such as monitoring and forecasting inland water bodies, rivers, estuaries and coastal ocean zones.

Session: 640 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 1 Observation de la Terre depuis l'espace : informations essentielles sur notre planète - Partie 1 **07/06/2021 13:30**

ID: 10771 Contributed abstract

Poster Order:

Arctic ice information from the RADARSAT Constellation Mission for data assimilation

Alexander Komarov [1] , *Mark Buehner* [2]

[1] Environment and Climate Change Canada
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Presented by / Présenté par: ***Alexander Komarov***
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Data assimilation component of Regional Ice-Ocean Prediction System (RIOPS) at Environment and Climate Change Canada's (ECCC) currently uses satellite data such as passive microwave SSM/I, AMSR2 and active microwave ASCAT. Manually produced Canadian Ice Service (CIS) ice charts are also assimilated, but their spatial and temporal coverage is limited. Therefore, we conduct direct assimilation of synthetic aperture radar (SAR) observations in the RIOPS system. We recently demonstrated that year-long assimilation of ice and open water retrievals derived from RADARSAT-2 HH-HV data in ECCC RIOPS improves ice concentration analyses, particularly in the situations where the high spatial resolution is important including small inland lakes and the areas

located near the shoreline, and where CIS ice charts are not available. With the transition from RADARSAT-2 to the RADARSAT Constellation mission (RCM), our techniques for automated retrieval of ice information (initially developed for RADARSAT-2) are being adapted and verified, as the RCM instrument characteristics, such as spatial resolution and noise floor are different. SAR wind speed extraction is a critical component for our ice information retrieval algorithms. We developed new wind retrieval models for ScanSAR HH-HV RCM data and plugged them in our ice/water and ice concentration retrieval approaches. The adapted techniques have been run for hundreds of RCM images (acquired over a six months period) with corresponding CIS image analysis products. Verification of the results against CIS image analyses revealed a very high accuracy of 99.6% for pure ice and water retrievals. This suggests that the proposed approaches are well suited for automated extraction of ice information from RCM for subsequent data assimilation in RIOPS.

Session: 812 Atmosphere, Ocean, and Climate Dynamics - Part 3 Dynamique de l'atmosphère, des océans et du climat - Partie 3 **07/06/2021 12:30**

ID: 10717 Contributed abstract

Poster Order:

Albedo changes drive under ice horizontal transport

Donovan Allum [1] , *Andrew Grace* [2] , *Marek Stastna* [3]

[1] University of Waterloo
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[3] University of Waterloo

Presented by / Présenté par: ***Donovan Allum***
Contact: dallum@uwaterloo.ca

Variations in snow cover, ice type or even gaps in ice all affect the albedo, or equivalently the amount of solar radiation that enters the water column. We report on the results of high resolution non-hydrostatic simulations of albedo variations. We find these drive systematic vertical and horizontal motions that take form of outward moving gravity currents near the surface and upwelling of cool water from the bottom. Additionally, the existence of albedo variations result in more - not less - convection when compared to simulations with uniform albedo. While the solar radiation drives cold water convection, and hence a vortex rich environment, we find the gravity current region is nearly irrotational. We discuss the effects of the nonlinear equation state in the sub four degree parameter regime, as well as the effect of free slip versus no slip

upper boundaries.

Session: 812 Atmosphere, Ocean, and Climate Dynamics - Part 3 Dynamique de l'atmosphère, des océans et du climat - Partie 3 **07/06/2021 12:45**

ID: 10791 Contributed abstract

Poster Order:

Observed changes in physical water properties off Vancouver Island

Michaela Maier [1] , *Debby Ianson* [2] , *Roberta Hamme* [3]

[1] University of Victoria
[2] University of Victoria
[3] University of Victoria

Presented by / Présenté par: ***Michaela Maier***
Contact: mmaier@uvic.ca

The Vancouver Island shelf and slope is an ecologically and economically important area off western Canada. Recent work has shown oxygen losses on constant density surfaces on the shelf, with multiple possible causes for this decline. Two main water masses affect this area: cold, fresh, oxygenated Pacific Subarctic Upper Water and warm, salty, oxygen-depleted Pacific Equatorial Water (PEW). Their mixing ratios can be examined by the changes in the temperature and salinity combinations on constant isopycnals – commonly referred to as 'spice'. Changes in spice in the area can be caused by one, or a combination, of three drivers: a change in the ratio of the two water masses, a change in the spiciness of their sources, or a change in the upwelling regime lifting these isopycnals onto the shelf. To investigate the changes in spice and infer the importance of each driver to these changes, 35 years' worth of observational T-S data off Vancouver Island are analyzed and related to changes in the water mass ratios, sources, and upwelling intensity. A first look at the data reveals a strong interannual variability of spice on the 26.5 isopycnal. Since the spicier PEW is notably oxygen-depleted, tracking its changing contribution to the area is assumed to provide valuable information on the expected oxygen concentrations off Vancouver Island.

Session: 812 Atmosphere, Ocean, and Climate Dynamics - Part 3 Dynamique de l'atmosphère, des océans et du climat **07/06/2021 13:00**

- Partie 3

ID: 10989 Contributed abstract

Poster Order:

Seasonal and interannual inorganic carbon and oxygen dynamics in the Northeast Pacific

Ana C. Franco [1] , *Debby Ianson* [2] , *Adam H. Monahan* [3] , *Philippe D. Tortell* [4]

[1] UBC
[2] DFO and UVic
[3] UVic
[4] UBC

Presented by / Présenté par: ***Ana C. Franco***
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The long-term progression of ocean acidification and deoxygenation in the Northeast Pacific is superimposed on substantial natural variability. In addition to the seasonal cycle, the Pacific Decadal Oscillation (PDO) is known to play a role in driving the natural interannual variability. Yet, the magnitude of this variability, especially periods of lower pH and oxygen poorly known. Here we quantify the seasonal and interannual variability in observed Dissolved Inorganic Carbon (DIC), pH and oxygen using long term time series observations from the Line P program in the Northeast Pacific. Preliminary results show that the mean amplitude of the DIC seasonal cycle is similar across Line P (23-30 μmol/kg) and decreases with depth to less than 5 μmol/kg at 60 to 70 m. In contrast, the non-seasonal variability (quantified as the standard deviation after removing the seasonal amplitude) remains approximately constant with depth, ranging between 10 – 20 μmol/kg. Here we explore the role of the PDO in driving this residual variability, as well as the impact in the seasonal cycle entrainment depth during warm and cold phases.

Session: 812 Atmosphere, Ocean, and Climate Dynamics - Part 3 Dynamique de l’atmosphère, des océans et du climat - Partie 3

07/06/2021 13:15

ID: 10888 Contributed abstract

Poster Order:

A Global Review of Marine Heatwaves’ physical processes

Sofia Darmaraki [1] , *Eric Oliver* [2]

[1] University of Dalhousie
[2] University of Dalhousie

Presented by / Présenté par: *Sofia Darmaraki*
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Prolonged periods of anomalously warm ocean temperatures, termed as Marine Heatwaves (MHWs), have been seen to exert substantial pressure on marine ecosystems and fisheries industries around the world. This includes widespread marine species die-offs, toxic algal blooms and abrupt regime shifts in coastal marine ecosystems as well as changes in the distribution of commercial species, on a scale of weeks to months. Recent studies have indicated a significant increase in MHW frequency and intensity since the early 20 th century, a trend which is likely to continue in the 21 st century, under projected anthropogenic warming. Here, we perform a mixed layer heat budget analysis on past (1993-2018) MHWs, to explore the distribution of the physical processes governing events, over selected regions of the global ocean. Using a widely-used standardized methodology we first identify the complete set of events in each region and then we diagnose the relative role of local physical processes (e.g. atmosphere fluxes, ocean advection, small-scale ocean processes) on the onset and decline of each individual MHW. We then determine the dominant contributors, emerging on average, for the events at each location and for different seasons. This information offers a degree of event predictability, as we link MHW occurrence with region-specific ocean and atmosphere drivers that may be forecasted in short timescales. It can also serve as early warning indicators for future events in the region, which are especially pertinent to fisheries and marine industries directly impacted by MHWs.

Session: 610 Climate Variability and Predictability - Part 1
La variabilité et la prévisibilité du climat - Partie 1 **07/06/2021 12:30**

ID: 11227 Invited session speaker

Poster Order:

A new perspective of extratropical influences on ENSO variability

Sang-Wook Yeh [1]

[1]

Presented by / Présenté par: *Sang-Wook Yeh*
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El-Nino-Southern Oscillation (ENSO) is one of the strongest natural variability in the tropical Pacific via atmosphere–ocean coupled processes. Furthermore, the ENSO is unique among climate phenomenon in terms of its projection beyond the tropical Pacific that influences patterns of weather and climate variability over the globe. Therefore, the understanding of the ENSO has been a long standing issue in climate science during the past several decades. While there are a number of studies on the influence of extratropical processes on ENSO variability, little attention has been paid to the influence of Arctic sea ice loss on ENSO variability. By analyzing observational datasets as well as idealized climate model experiments, we argued that anomalous Arctic sea ice concentration variations have the potential to influence tropical Pacific sea surface temperature variability via atmosphere-ocean coupled processes in the eastern subtropical North Pacific. We found that a positive phase of North Pacific Oscillation–like atmospheric circulation, which is modulated by a sea ice reduction in the Pacific Arctic sector, triggers El Niño–like warming in the central tropical Pacific. In this talk, furthermore, we emphasize that the greenhouse gas forcing plays an important role to bridge the Arctic-tropics connections. These imply that connections between the Arctic and the tropics should be considered for further understanding of changes in El Niño and other tropical Pacific climate variability in a changing climate.

Session: 610 Climate Variability and Predictability - Part 1
La variabilité et la prévisibilité du climat - Partie 1 **07/06/2021 13:00**

ID: 11224 Contributed abstract

Poster Order:

The Empirical Bias Correction of Climate Projections

John Scinocca [1] , *Slava Kharin* [2]

1

2

Presented by / Présenté par: ***John Scinocca***

Contact: john.scinocca@canada.ca

Climate models and/or their output are usually bias-corrected for climate impact studies. The underlying assumption of these corrections is that climate biases are essentially stationary between historical and future climate states. Under very strong climate change, the validity of this assumption is uncertain, so the practical benefit of bias corrections remains an open question. Here, this issue is addressed in the context of bias correcting the climate models themselves.

Employing the ARPEGE, LMDZ and CanAM4 atmospheric models, we undertook experiments in which one centre’s atmospheric model takes another centre’s coupled model as observations during the historical period, to define the bias correction, and as the reference under future projections of strong climate change, to evaluate its impact. This allows testing of the stationarity assumption directly from the historical through future periods for three different models. These experiments provide evidence for the validity of the new bias-corrected model approach. In particular, temperature, wind and pressure biases are reduced by 40–60% and, with few exceptions, more than 50% of the improvement obtained over the historical period is on average preserved after 100 years of strong climate change. Below 3 °C global average surface temperature increase, these corrections globally retain 80% of their benefit.

Session: 610 Climate Variability and Predictability - Part 1
La variabilité et la prévisibilité du climat - Partie 1 **07/06/2021 13:15**

ID: 11229 Contributed abstract

Poster Order:

Warm and Cool Season Reconstruction and Assessment of the Long-term Hydroclimatic Variability of the Canadian Prairie Provinces through the Development of the Canadian Prairies Paleo Drought Atlas (CPPDA)

Samantha Kerr [1] , *Yuliya Andreichuk* [2] , *David Sauchyn* [3]

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[2] Werklund School of Agriculture Technology, Olds, Alberta
[3] Department of Geography and Environmental Studies, University of Regina, Saskatchewan

Presented by / Présenté par: ***Samantha Kerr***
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Persistent, large-area droughts are among the most damaging natural disasters, having major effects on agriculture, industry, forestry, human health and society, and ecosystems. In the Canadian Prairie provinces of the sub-humid continental interior, changing climatic conditions, and shifts between periods of extreme wet and dry weather, emphasize the need for a better understanding of past and future variability of the regional hydroclimate. Using over 180 multi-species tree-ring chronologies, the warm (May through August) and cool (December through April) season Standardized Precipitation Evapotranspiration Index (SPEI) was reconstructed from 1400-2018 on a 10-km grid spanning the Canadian Prairies. These geospatial paleo-drought data extend back to 1200 over a smaller

geographic area. Seasonal SPEI maps, comprising the newly developed Canadian Prairies Paleo Drought Atlas (CPPDA), visually represent the hydroclimatic variability across the Canadian Prairies over past centuries, including the timing, intensity, and spatial extent of major multi-year droughts and excessive moisture events. Wavelet analysis was also examined to determine possible potential connections between hydroclimatic variables and the influence of large-scale ocean-atmosphere oscillations (i.e., the Pacific Decadal Oscillation (PDO) and the El Niño Southern Oscillation (ENSO)).

Session: 610 Climate Variability and Predictability - Part 1
La variabilité et la prévisibilité du climat - Partie 1 **07/06/2021 13:30**

ID: 11210 Contributed abstract

Poster Order:

Second Generation of Homogenized Wind Speed for trend analysis in Canada

Megan Hartwell [1] , *Lucie Vincent* [2]

[1] Environment and Climate Change Canada
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Presented by / Présenté par: ***Megan Hartwell***
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A second generation of homogenized near-surface monthly wind speed is being developed for trend analysis. This will provide an update to the existing dataset, including more stations and an additional 14 years of observations. Long-term series covering as much as possible the 1953-2020 period were prepared by merging observations into single records in order to extend long series of hourly data into recent time (which was not done in the first generation dataset). Hourly wind speeds were checked for quality and adjusted for changes in anemometers heights from nonstandard to the standard 10-m level. Monthly mean wind speeds were then calculated and tested for homogeneity using neighbour’s observations and simulated gridded data from the Canadian Climate models (CanESM2 and CanESM5) as reference series. Non-climatic shifts, mainly caused by relocation and change of instruments, were adjusted when needed. The trends from this dataset are being examined to determine if they uphold the results of the first generation over the longer time period, which showed that the near-surface wind speed had decreased throughout western Canada and most part of southern Canada (with the exception of the Maritimes) in all seasons and increased in the central Canadian Arctic over 1953-2006.

Session: 610 Climate Variability and Predictability - Part 1
La variabilité et la prévisibilité du climat - Partie 1 **07/06/2021 13:45**

ID: 10725 Contributed abstract

Poster Order:

Interhemispheric asymmetry of surface wind projections in CanESM5 climate change simulations

Bin Yu [1] , *Xuebin Zhang* [2] , *Guilong Li* [3] , *Wei Yu* [4]

[1] Climate Research Division, ECCC
[2] Climate Research Division, ECCC
[3] Climate Research Division, ECCC
[4] National Prediction Development, ECCC

Presented by / Présenté par: ***Bin Yu***
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The internal climate variability contributes to various aspects of climate change projections. This presentation will report results of the ensemble mean and spread of future projections of global surface mean and extreme winds in boreal winter, based on single model initial-condition simulations forced by the SSP5-8.5 high-emissions scenario from a 50-member ensemble of CanESM5 models. Over the next half century, both seasonal mean and extreme winds are projected to decrease broadly over northern mid-latitudes and increase across tropical and southern subtropical regions, an interhemispheric asymmetry feature relevant to large-scale changes in surface temperature and atmospheric circulation. Large ensemble spreads are apparent in the mean and extreme wind changes, including spatial pattern and magnitude of the projected trends. The internal climate variability generated components of the mean and extreme wind trends exhibit large-scale spatial coherences, and are comparable to the externally anthropogenic forced components of the trends.

Session: 340 The Changing Arctic Atmosphere - Part 1
L’évolution de l’atmosphère arctique - Partie 1 **07/06/2021 12:30**

ID: 10939 Contributed abstract

Poster Order:

Modelling atmospheric composition in the summertime Arctic: Impact of northern wildfire emissions

Wanmin Gong [1] , *Stephen Beagley* [2] , *Roya Ghahreman* [3]

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Presented by / Présenté par: ***Wanmin Gong***
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The summertime Arctic is generally characterised by a relatively clean lower atmosphere due to the slower transport from the lower latitudes and more efficient wet deposition. However, it has become evident that northern boreal forest fire plumes can be transported into the Arctic during summer, which will have an impact on the local radiation balance given the availability of shortwave radiation, high surface albedo, and the persistent presence of strongly reflective low-level stratus cloud decks in the Arctic summer. In this study, model simulations of the Arctic atmospheric composition were carried out for the summer of 2014, using the ECCC air quality prediction model GEM-MACH, coinciding with a summertime field study campaign conducted over the Canadian Archipelago. The model simulations indicate that the study area was impacted by the wildfire emissions from the North American boreal region during the latter part of the field campaign. Analysis showed that the transport of northern wildfire emissions to the Arctic was strongly influenced by the dynamic behaviour of the polar dome. The precipitation associated with the uplifting of the air mass over the polar dome was responsible for scavenging some of the aerosols during the transport. The pan-Arctic simulations show that, for summer 2014, the North American boreal wildfire emissions had greater impact to the Arctic overall than the wildfires in Siberia. The impact from fires in Siberia was limited to longer-lived secondary pollutants, e.g., O3. North American wildfire emissions dominated the contribution to the transport and deposition of black carbon to the Canadian eastern Arctic, posing potential implication for sea ice melt over the Northwest Passage sea route. The northern wildfire emissions also contributed significantly to the increases in aerosol optical depth and cloud condensation nuclei over the Arctic in summertime, which could affect regional radiative forcing via aerosol direct and indirect effects.

Session: 340 The Changing Arctic Atmosphere - Part 1
L'évolution de l'atmosphère arctique - Partie 1 **07/06/2021 12:45**

ID: 10950 Contributed abstract

Poster Order:

Ground-based FTIR Retrievals of PAN at the Polar Environment Atmospheric Research Laboratory

Tyler Wizenberg [1] , *Kimberly Strong* [2] , *Emmanuel Mahieu* [3] , *Bruno Franco* [4]

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Presented by / Présenté par: ***Tyler Wizenberg***
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Peroxyacetyl Nitrate (PAN) is a key reservoir species of tropospheric nitrogen radicals (NOx = NO + NO2), having significant implications for the production of tropospheric ozone. The atmospheric lifetime of PAN is strongly temperature dependent, ranging from approximately 1 hour at 298K to several weeks at the colder temperatures of the upper troposphere and lower stratosphere (UTLS). This property allows PAN to be transported vast distances in the UTLS from mid-latitude sources to the high Arctic region, where it can influence NOx and O3 budgets, contributing to the pollution phenomenon known as ‘Arctic haze’. Previous measurements of PAN in the Arctic were made primarily on a campaign basis via in situ measurement techniques, providing limited information on long-term concentrations and trends. In this presentation, we will describe a new ground-based retrieval method for PAN using the Bruker 125HR Fourier transform infrared spectrometer at the Polar Environment Atmospheric Research Laboratory (PEARL) in Eureka, Nunavut, and its application to obtain a long time series of total columns over the high Arctic. Comparisons against measurements from the Infrared Atmospheric Sounding Interferometer (IASI) satellite instruments and the GEOS-Chem chemical transport model will be shown, and evidence of a significant enhancement in PAN total columns in August 2017, resulting from the long-range transport of wildfire plumes, will be discussed.

Session: 340 The Changing Arctic Atmosphere - Part 1
L’évolution de l’atmosphère arctique - Partie 1 **07/06/2021 13:00**

ID: 10959 Contributed abstract

Poster Order:

First Results from a New Micro-pulse Lidar at the High Arctic Polar Environment Atmospheric Research Laboratory (PEARL)

Victoria Pinnegar [1] , *Robert Sica* [2] , *Emily McCullough* [3] , *Pierre F.*

Fogal [4] , *Ellsworth J. Welton* [5] , *Norman T. O'Neill* [6] , *Kimberly Strong* [7] , *James Drummond* [8]

[1] Western University
[2] Western University
[3] Dalhousie University
[4] University of Toronto
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Presented by / Présenté par: ***Victoria Pinnegar***
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To improve our understanding of the transport of particulates, as well as studying the impact of these particulates on interpreting ozone trends and their role in the formation of fog and clouds, we are establishing 4 nodes in the new Canadian Micro-Pulse Lidar Network (MPLCAN). MPLs have been deployed to London (ON), Sherbrooke, Halifax, and now in Eureka, NU. A fifth micro-pulse lidar (MPL) already established in Toronto has joined the network. These instruments are part of the global NASA Micro-pulse Lidar Network. The MPLs will allow the structure of the atmosphere to be profiled in both height and time, for both the amount and type of particulates present, in addition to discriminating the phase of water in developing clouds, precipitation, and fog. Eureka’s MPL is located at the PEARL Zero Altitude PEARL Auxiliary Laboratory (ØPAL; 80° N, 86° W) in partnership with the Canadian Network for the Detection of Atmospheric Change (CANDAC). We plan to deliver and install the instrument in spring of 2021, and then validate its calibration previously obtained in the South. Using the co-located CANDAC Rayleigh-Mie-Raman Lidar (CRL), the atmospheric profiles from the MPL’s initial measurements will be intercompared to validate the backscatter and depolarization measurements. The result of this validation, along with examples of the MPLCAN network capabilities, will be presented.

Session: 340 The Changing Arctic Atmosphere - Part 1
L’évolution de l’atmosphère arctique - Partie 1 **07/06/2021 13:15**

ID: 10963 Invited session speaker

Poster Order:

Quantifying the climate impact of present and future Arctic shipping: new modelling results from the SEANA project

Jo Browse [1] , *Alexander Kurganskiy* [2] , *Manuel Dall'osto* [3] , *Anna Jones* [4] , *Thomas Lachlan-Cope* [5] , *Congbo Song* [6] , *Roy Harrison* [7] , *Neil Harris* [8] , *Valerio Ferracci* [9] , *James Brean* [10] , *David Beddows* [11] , *Zongbo Shi* [12]

[1] University of Exeter
[2] University of Exeter
[3] University of Birmingham
[4] British Antarctic Survey
[5] British Antarctic Survey
[6] University of Birmingham
[7] University of Birmingham
[8] University of Cranfield
[9] University of Cranfield
[10] University of Birmingham
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Presented by / Présenté par: ***Jo Browse***
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Shipping is one of the most important sources of anthropogenic aerosol in the marine atmosphere contributing 5-8% of global SO2 emissions and 2% of BC emissions. Secondary aerosols formed from shipping emissions, such as sulfate can directly reflect short-wave radiation, leading to a cooling effect. On the other hand, BC from shipping emissions can absorb) long-wave radiation, causing warming. Additionally, aerosol emitted from ships can increase cloud droplet number brightening marine clouds and cooling the surface. Quantifying the impact of shipping is challenging due to large uncertainties in the natural marine aerosol baseline. This is particularly true in the Arctic where the sources and processes controlling marine aerosol are unclear. Shipping in the Arctic is expected to significantly expand in the next few decades as sea-ice retreats. This expansion is potentially mitigated by new IMO regulations which are expected to reduce SO2 emissions from shipping by approximately 80%. However, the retreat of sea-ice is also expected to shift the natural baseline and shipping impacts on the aerosol system must be judged in the context of this rapidly evolving system. Here, we present modelling projections of multiple shipping scenarios (with and without new legislation) from the SEANA (shipping emissions in the Arctic and North Atlantic) project. Our results suggest that (in some regions) present day shipping may contribute significantly to background aerosol mass (~10%) and boundary layer cloud condensation nuclei (up to 14%). Our modelling also indicates the potential success of IMO regulations with predicted regional decrease in aerosol associated with reductions in ship-fuel sulphur content over the next 50-years (despite expansion of the shipping industry at high latitudes). However, this response is predicated on adherence

of the shipping industry to (generally voluntary) guidelines and in many regions any benefits are counteracted due to the expansion of other industries (i.e. flaring).

Session: 243 Severe Storms and Associated Hazards - Part 4 Tempêtes violentes et risques - Partie 4 **07/06/2021 14:30**

ID: 10697 Contributed abstract

Poster Order:

The Northern Tornadoes Project – Spinning the Science Forward

David Sills [1]

[1] Western University

Presented by / Présenté par: ***David Sills***
Contact: David.Sills@uwo.ca

The Northern Tornadoes Project (NTP) began in 2017 as a partnership between Western Engineering and ImpactWX aiming to better detect tornado occurrence throughout Canada, improve severe and extreme weather prediction, mitigate against harm to people and property, and investigate future implications of climate change. The project was initially limited in scope – attempting to find at least a few undocumented tornadoes in the northern forests of Ontario and Quebec. After successfully demonstrating that the NTP could more than double the tornado count in those provinces, the NTP endeavoured to detect, assess and document every tornado that occurs across Canada. New partners have also been brought on including Western Libraries, University of Manitoba, York University, Pelmorex's The Weather Network and academic institutions outside of Canada. As the project evolved, new techniques and technologies were required to enable the NTP to meet its ambitious scientific goals. Cutting-edge remote sensing capacity, including drones, aircraft and satellites, needed to be employed and the latest techniques adopted. New means of analyzing wind damage were required. Even a new set of definitions related to tornadoes and related phenomenon had to be developed. The NTP is also generating new, research-quality data sets that are being used by a number of different types of users. All NTP data are open source in order to foster further innovation. The presentation will provide a number of detailed examples showing how the NTP is 'spinning the science forward.'

Session: 243 Severe Storms and Associated Hazards - Part 4 Tempêtes violentes et risques - Partie 4 **07/06/2021 14:45**

ID: 10792 Contributed abstract

Poster Order:

Quantifying Tornadic Damage to Low-Level Vegetation Through Remote Sensing

Connell Miller [1] , *David Sills* [2] , *Gregory Kopp* [3]

[1] Western University
[2] Western University
[3] Western University

Presented by / Présenté par: ***Connell Miller***
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Damage surveys performed by the Northern Tornadoes Project (NTP) use the framework of the Enhanced Fujita (EF) Scale, which categorizes the intensity of a tornado through observable damage indicators. These damage indicators provide varying degrees of damage, ranging in intensity from the threshold of visible damage to total destruction. The degree of damage then provides the expected wind speed range that is associated with that level of damage. However, ground damage surveys in the Prairie regions of Canada can be particularly challenging due to the low population density and lack of forested areas, leading to sparse structural and tree damage (and therefore, a lack of damage indicators) in many events. Low-level vegetation such as agricultural crops and prairie grasses, far more plentiful in such regions, often shows signs of damage following a tornado. Such damage is apparent using high-resolution satellite imagery, particularly when comparing images from before and after the tornado event. However, there is currently no empirical way of quantifying this damage and relating it to the EF Scale. To that end, this study will examine several tornadoes that occurred in Canada in 2020 to demonstrate how satellite imagery in both the visible (RGB) and near-infrared (NI) spectrum can be used to calculate a Normalized Difference Vegetation Index (NDVI) and empirically quantify the damage done to vegetation. Development of this empirical data set will lead to the final goal of the project - using the correlation between the percent change in the NDVI value and the EF-Scale to establish a damage indicator for vegetation based on remote sensing.

Session: 243 Severe Storms and Associated Hazards - Part 4 Tempêtes violentes et risques - Partie 4 **07/06/2021 15:00**

ID: 10777 Contributed abstract

Poster Order:

Fujita-Style Aerial Analysis of Significant Tornadoes

Aaron Jaffe [1] , *David Sills* [2]

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Presented by / Présenté par: ***Aaron Jaffe***
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Tornadoes and other severe wind events pose a significant threat to lives and infrastructure across Canada and around the world. The Northern Tornadoes Project (NTP), based at Western University and in partnership with ImpactWX, University of Manitoba, York University and The Weather Network, aims to better detect tornado occurrence throughout Canada, improve severe and extreme weather prediction, mitigate against harm to people and property, and investigate future implications due to climate change. Aircraft surveys are one of the many ways that NTP collects data for and analyzes severe wind events, capturing high-resolution aerial imagery (5 cm) of damage swaths and the surrounding area. They are typically conducted for significant events that occur in forested areas, where other forms of surveying the damage are insufficient or infeasible. This imagery is analyzed by NTP to classify as tornado or downburst and to determine details such as length, width, wind speed, and EF-rating. It is also used for longer-term research purposes, both internally and by external partners. As of the 2020 season, to improve the aerial analyses, NTP has begun performing manual identification of treefall patterns for selected events. These “Fujita-style” analyses are useful in separating tornadic damage from associated ‘straight-line’ wind damage caused by downbursts, and also give some insight into the character of the tornado while providing an interesting visual representation of wind patterns. Such analyses have been performed for several recent tornado events across Canada, most notably the Brooks Lake tornado that occurred on June 8th, 2020, in northwestern Ontario. The analysis determined the tornado to have a length of 31.5 km and maximum width of 2440 m, making it the widest recorded tornado in Canadian history. Though officially rated at EF2, it was possibly the strongest tornado of the 2020 season. Numerous downbursts were also identified along each side of the tornado track.

Session: 243 Severe Storms and Associated Hazards - Part 4 Tempêtes violentes et risques - Partie 4 **07/06/2021 15:15**

ID: 10803 Contributed abstract

Poster Order:

Hunting for Canada’s Forgotten Tornadoes

Joanne Kunkel [1] , *John Hanesiak* [2] , *David Sills* [3] , *Leslie Elliot* [4] , *Gregory Kopp* [5]

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Presented by / Présenté par: ***Joanne Kunkel***
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Knowledge of Canada’s tornado climatology is improving; however, a gap remains in our current understanding due to underreporting of events. Tornadoes have likely been going unreported or undetected in sparsely population regions across the country and identifying these ‘forgotten’ events will lead to an improved Canadian tornado climatology. This is currently an area of research for the Northern Tornadoes Project out of Western University, where historical tornado events are being identified within Canada’s forested regions using high-resolution satellite imagery. A collection of 120 x 120 km boxes (484 total) was created covering most the country (excluding the extreme north). Using 3-m satellite imagery provided by Planet (www.planet.com), 281 of the 484 boxes were manually searched, covering an area of more than 4 million square kilometres. This resulted in over 150 previously unknown tornadoes being discovered across the country, stretching from British Columbia to New Brunswick. 203 boxes were characterized as primarily agriculture and/or tundra, where tree cover was less than 25% of the box area. Tornado scars in forests are rarely visible with 3-m resolution satellite imagery within these terrain types, therefore such boxes were excluded from the search. Current techniques to date these historical events include the use of Landviewer and Google Earth satellite imagery, archived US Storm Prediction Center mesoanalysis products, historical lightning and radar data, and US Weather Prediction Center archived surface analyses and radar composites. A lack of such data prior to 2005 makes dating events difficult beyond the year of occurrence. Forest damage from these historical events is also being rated; using the Enhanced Fujita scale if they occurred 2013 or after (the EF scale was adopted in Canada in 2013) or the Fujita scale for events before that time.

Session: 243 Severe Storms and Associated Hazards - Part 4 Tempêtes violentes et risques - Partie 4 **07/06/2021 15:30**

ID: 10800 Contributed abstract

Poster Order:

Canada’s First and Only F5/EF5 Tornado: Observational and Modelling Analysis

Chun-Chih Wang [1] , *John Hanesiak* [2] , *Justin Hobson* [3]

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[3] Environment and Climate Change Canada

Presented by / Présenté par: ***Chun-Chih Wang***
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In the late afternoon of 22 June 2007, Canada’s first and only F5/EF5 tornado touched down and impacted the western portion of Elie, Manitoba; one of the authors’ observed the entire event. An observational and Weather Research and Forecasting (WRF) model analysis was undertaken to characterize the pre-storm environment and processes leading to storm initiation and maturation; with the goal of better understanding the case and contribute to future prediction of such events. WRF adequately reproduced the synoptic and mesoscale environment, including a supercell-like storm in the region of interest, and supplemented available observations. The pre-storm environment in the Red River Valley was primed for supercells with C, high MLCAPE (°surface dewpoints of 21-24>3000 J kg-1) and strong low-level shear (~15 m s-1 0-1 km; 0-1km SRH 330 m2 s-2; 0-3km SRH 350 m2 s-2), ahead of a cold front within the warm sector of a slow moving surface low in the southwest Interlake. WRF revealed a deepening very moist boundary layer over the day with possible moisture “pooling” in lower elevation areas. A targeted 1800 UTC Winnipeg sounding revealed high (-120 J kg-1) convective inhibition (CIN), making a tornado forecast difficult given uncertain triggering strength. Storm triggering mechanisms were complex with multiple possible causes, and may have been slightly different between observational versus model analysis, indicating a critical need for real mesoscale observations. Once initiated, the storm became tornadic, moved slowly (SSE at ~5 m s-1) and persisted for ~40 min; WRF produced a persistent updraft helicity track very near Elie. Both model and observations showed a congealed SE-ward moving MCS soon after discrete convection. Although WRF triggering mechanisms may have been slightly different than observations, it showed valuable utility in depicting the evolving storm environment to fill gaps in observations.

ID: 10988 Contributed abstract

Poster Order:

MOPITT and Fires Around the World

James Drummond [1] , *MOPITT team* [2]

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Presented by / Présenté par: ***James Drummond***
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The Measurements Of Pollution In The Troposphere (MOPITT) instrument was launched on 18th December 1999 on the Terra spacecraft and both the spacecraft and instrument are still healthy after more than two decades. MOPITT measures carbon monoxide (CO) over the globe providing a unique window of pollution in the troposphere. This long-time single-instrument series permits both short (seasonally) and long (decadal) studies. MOPITT has the unique of ability to provide altitude profiles and spatial information simultaneously and so it appropriate for studying regional events such as fire seasons. In additional, since MOPITT is carefully validated, it is possible to look at trends regionally and globally through two decades. When in the 1990s we designed MOPITT it was expected that it would significantly take time to transport and process the raw instrument data into the final products. We never envisaged the computer resources and the communications speed that we have now. But as a result, the retrievals of MOPITT have been improved and the time between measurement and final products is now more than a day rather than weeks or months. This talk will concentrate on fire events in Canada, in the Western States and Australia which have in the recent news and MOPITT’s ability to watch them in “near-real time”. MOPITT was provided to NASA's Terra spacecraft by the Canadian Space Agency and was built by COMDEV of Cambridge, Ontario. Data processing is performed by the MOPITT team at the National Center for Atmospheric Research, Boulder, CO. Instrument control is by the MOPITT team at the University of Toronto.

Session: 641 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 2 Observation de la Terre depuis l’espace : informations essentielles sur notre planète - Partie 2 **07/06/2021 14:45**

ID: 10719 Contributed abstract

Poster Order:

Estimating wildfire emissions of ammonia using Cross-track Infrared Sounder (CrIS) profile information

Ellen Eckert [1] , *Zoe Y. W. Davis* [2] , *Mark W. Shephard* [3] , *Chris A. McLinden* [4] , *Debora Griffin* [5] , *Susann Tegtmeier* [6] , *Yue Jia* [7] , *Karen E. Cady-Pereira* [8]

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Presented by / Présenté par: ***Ellen Eckert***
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Ammonia plays an important role for air, soil and water quality, as well as aerosol formation and plant growth. Ground-based measurements of ammonia are sporadic, and cannot provide the coverage required for global emission estimates. Satellite measurements can help address this monitoring gap. The Cross-track Infrared Sounder (CrIS) product provides a unique tool because some information on the vertical distribution of ammonia is derived from the profile retrievals in addition to vertical column densities (VCDs). Emission rates are retrieved by fitting measured vertical column densities (VCDs) to a three-dimensional function of the wind speed and spatial coordinates. This method requires VCDs to be rotated given the wind-direction to remove wind-direction as a fitting variable. The vertical information given by CrIS provides the potential for more accurate emission estimates as wind-direction and -speed at each profile level can be taken into account. The application of the vertical profile of wind also allows more accurate estimates of plume width, which can vary significantly in the traditional VCD rotation depending on the altitudes of wind used for the rotation. This approach was developed and validated using synthetic satellite measurements of plumes simulated by the FLEXPART (v10.0) model to better understand the impact of variability in the vertical profile of the wind. The methodology was then applied using select cases of CrIS satellite observations to estimate forest fire emissions of NH3. Preliminary results of this study will be presented.

Session: 641 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 2 Observation de la Terre depuis l'espace : informations essentielles sur notre planète - Partie 2 **07/06/2021 15:00**

ID: 10995 Contributed abstract

Poster Order:

Towards an improved understanding of nitrogen dioxide emissions from forest fires

Debora Griffin [1] , *Jack Chen* [2] , *Enrico Dammers* [3] , *Cristen Adams* [4] , *Ayodeji Akingunola* [5] , *Paul Makar* [6] , *Lukas Fehr* [7] , *Adam Bourassa* [8] , *Doug Degenstein* [9] , *Katherine Hayden* [10] , *Sumi Wren* [11] , *John Liggio* [12]

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Presented by / Présenté par: ***Debora Griffin***
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Smoke from wildfires is a significant source of air pollution, which can adversely impact ecosystems and the air quality over downwind populated areas. With the increasing intensity and severity of wildfires recently, the threat to air quality is also expected to increase. Emissions from wildfires are most commonly estimated by a bottom-up approach, using proxies such fuel type, burn area, and emission factors. However, emissions can also be derived with a top-down approach, using satellite observed Fire Radiative Power. Furthermore, wildfire emissions can also be estimated directly from satellite-borne observations of pollutants. In this work, advancements and improvements to the satellite based determination of forest fire NOx emissions via satellite are discussed. Specifically, we use TROPOMI (Tropospheric Monitoring Instrument) high spatial-resolution satellite datasets, including information on plume height and effects of aerosol scattering on the satellite vertical column densities to provide satellite-derived biomass burning emissions of nitrogen dioxide (NOx). Furthermore, we explore the capabilities of satellite-derived measurements and provide new insights into the satellite-derived understanding of fire NOx emissions, with respect to differences in fuel type, diurnal patterns and different burning stages.

Session: 641 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 2 Observation de la Terre depuis l'espace : informations essentielles sur notre planète - Partie 2 **07/06/2021 15:15**

ID: 10759 Contributed abstract

Poster Order:

MOPITT Data Enhancement Through Cloud Detection Improvement

Heba Marey [1] , *James R. Drummond* [2] , *Dylan Jones* [3] , *Helen Worden* [4] , *Merritt Deeter* [5] , *Sara Martínez-Alonso* [6] , *Debbie Mao* [7] , *John Gille* [8]

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Presented by / Présenté par: ***Heba Marey***
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The Measurements of Pollution in the Troposphere (MOPITT) satellite instrument has measured tropospheric CO continuously since March 2000, providing the longest continuous dataset of CO from space. During its long mission, data processing has been updated to improve the quality of CO retrievals. It has a global successful retrieval rate that is about 30%. The spatial seasonal variations demonstrated that while the data coverage in some places reaches 30% in summer, this number drops to less than 10% in winter due to significant cloud cover. Therefore, we investigate the current MOPITT cloud detection algorithm and consider approaches to enhance the data coverage. The MOPITT CO total column (TC) data were modified by turning off the cloud detection scheme which means all MOPITT data were used to produce retrievals regardless of the cloud detection. Analysis of the CO TC standard (cloud filtered) and non-standard product (non-cloud masked) are conducted for selected days using Moderate Resolution Imaging Spectroradiometer (MODIS) cloud height and cloud mask. Results showed some coherent structures that were observed frequently in the non-masked CO that were not present in the standard product and could be CO features. Results illustrated that, a significant number of low cloud cases were rejected in the standard product. Those missing areas match the coherent patterns that were detected in the non-masked CO product. Further, analysis of IASI CO TC indicates an evidence of strong CO features that are observed in the non-cloud-masked product. Using a combination of MODIS cloud products and the MOPITT radiance itself, we are able to discriminate and detect these features and as a consequence a new revision of the MOPITT retrieval dataset will be able to include these features.
The MOPITT instrument and this work has been funded by the Canadian Space Agency.

Session: 641 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 2 Observation de la Terre depuis l’espace : informations essentielles sur notre planète - Partie 2 **07/06/2021 15:30**

ID: 10703 Contributed abstract

Poster Order:

Examining the accuracy of satellite retrievals of trace-gas emissions and lifetimes using high-resolution plume modelling.

Zoe Davis [1] , *Debora Griffin* [2] , *Yue Jia* [3] , *Susann Tegtmeier* [4] , *Mallory Loria* [5] , *Chris A McLinden* [6]

[1]

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Presented by / Présenté par: ***Zoe Davis***
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A recent method uses satellite measurements to estimate lifetimes and emissions of trace-gases from point sources (Fioletov et al., 2015). The method retrieves emissions by fitting measured vertical column densities (VCDs) of trace-gases to a three-dimensional function of the wind speed and spatial coordinates. In this study, “synthetic” satellite observations of prescribed emissions were generated using a plume model to examine the accuracy of the retrieved emissions. The FLEXPART (v10.0) Lagrangian transport and dispersion model simulated the plume from a point source over a multi-day simulation period at a resolution much higher than current satellite observations. The study aims to determine how various assumptions in the retrieval method and local meteorological conditions affect the accuracy and precision of emissions. These assumptions include that a vertical mean of the wind profile can accurately represent the downwind transport of the plume’s vertical column. In the retrieval method, the VCDs’ pixel locations are rotated around the source using wind direction such that all plumes have a common wind direction. Retrievals that rotated VCDs using a vertical mean wind will be compared to retrievals using VCDs determined by rotating the vertical profile of trace-gas at each altitude using the respective wind-direction. The impact of local meteorological factors on the two approaches will be presented, including atmospheric stability, vertical wind shear, and boundary layer height. The study aims to suggest which altitude(s) of the vertical profile of winds achieve the most accurate retrievals based on the meteorological conditions. The study will also examine the impact on retrieval accuracy due to satellite resolution, trace-gas lifetime, plume source altitude, number of overpasses, and random and systematic errors. This study will also present the same sensitivity studies applied to a second, “line-density”, satellite retrieval method (Adams et al., 2019; Goldberg et al., 2019).

Session: 814 Atmosphere, Ocean, and Climate Dynamics - Part 5 Dynamique de l’atmosphère, des océans et du climat - Partie 5

07/06/2021 14:30

ID: 10810 Contributed abstract

Poster Order:

Role of Diurnal Cycle in the Maritime Continent Barrier Effect on MJO

Propagation in an AGCM

Boualem Khouider [1] , *R. S. Ajayamohan* [2] , *V. Praveen* [3] , *A. J Majda* [4]

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Presented by / Présenté par: ***Boualem Khouider***
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The barrier effect of Maritime Continents (MC) in stalling or modifying the propagation characteristics of MJO is widely accepted. The strong diurnal cycle of convection over MC plays a dominant role in reshaping the MJO behaviour over MC. The relative contribution of the strength of the diurnal variability over MC in modifying the propagation characteristics of MJO is studied here, with the help of a coarse-resolution Atmospheric General Circulation Model (AGCM). The dry dynamical core of the AGCM is coupled to the multicloud parameterization piggybacked with a dynamical bulk boundary layer model. A set of sensitivity experiments is carried out by systematically varying the strength of the MC diurnal flux to assess the impact of diurnal variability on MJO propagation. The effect of deterministic and stochastic diurnal forcings on MJO characteristics is also studied. It is found that the Kelvin wave power of precipitation decreases as the diurnal flux increases in both stochastic and deterministic forcing experiments. The precipitation variance over the Indo-Pacific warm pool region decreases with the increase in diurnal forcing, indicating the blocking of precipitation over MC. Due to the increase in precipitation variance over MC, the weakening of precipitation variance over the West Pacific is evident in all experiments. The striking difference between deterministic and stochastic diurnal forcings experiments is that the strength needed to attain the same level of blocking for the deterministic case is almost double to that of the stochastic case. The stochastic diurnal flux over MC seems to be more detrimental in blocking MJO propagation. It is further found that as the strength of MC diurnal flux increases, the strength of regional Hadley circulation reversal becomes more prominent.

Session: 814 Atmosphere, Ocean, and Climate Dynamics - Part 5 Dynamique de l'atmosphère, des océans et du climat - Partie 5

07/06/2021 14:45

ID: 11012 Contributed abstract

Poster Order:

Toward a Stochastic Relaxation for the Quasi-Equilibrium Theory of Cumulus Parameterization: Multicloud Instability, Multiple Equilibria, and Chaotic Dynamics

Boualem Khouider [1] , *Etienne Leclerc* [2]

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Presented by / Présenté par: ***Etienne Leclerc***
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The representation of clouds and organized tropical convection remains one of the biggest sources of uncertainties in climate and long-term weather prediction models. Some of the most common cumulus parameterization schemes, namely, mass-flux schemes, rely on the quasi-equilibrium (QE) closure, which assumes that convection consumes the large-scale instability and restores large-scale equilibrium instantaneously. However, the QE hypothesis has been challenged both conceptually and in practice. Subsequently, the QE assumption was relaxed, and instead, prognostic equations for the cloud work function (CWF) and the cumulus kinetic energy (CKE) were derived and used. It was shown that even if the CWF kernel serves to damp the CWF, the prognostic system exhibits damped oscillations on a timescale of a few hours, giving parameterized-cumulus-clouds enough memory to interact with each other, with the environment, and with stratiform anvils in particular. Herein, we show that when cloud-cloud interactions are reintroduced into the CWF-CKE equations, the coupled system becomes unstable. Moreover, we couple the CWF-CKE prognostic equations to dynamical equations for the cloud area fractions, based on the mean field limit of a stochastic multicloud model. Qualitative analysis and numerical simulations show that the CKE-CWF-cloud area fraction equations exhibit interesting dynamics including multiple equilibria, limit cycles, and chaotic behavior both when the large-scale forcing is held fixed and when it oscillates with various frequencies. This is representative of cumulus convection variability, and its capability to transition between various regimes of organization at multiple scales and regimes of scattered convection, in an intermittent and chaotic fashion.

Session: 814 Atmosphere, Ocean, and Climate Dynamics - Part 5 Dynamique de l'atmosphère, des océans et du climat - Partie 5

07/06/2021 15:00

ID: 10960 Contributed abstract

Poster Order:

Kinetic Energy Spectral, Energy Cascade, and Subgrid Parameterisation Analysis of Radiative-Convective Equilibrium

Kwan tsaan Lai [1] , *Michael Waite* [2]

[1] University of Waterloo
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Presented by / Présenté par: ***Kwan tsaan Lai***
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In this project, radiative-convective equilibrium (RCE) is used to investigate atmospheric kinetic energy spectrum and subgrid parameterisation in idealised simulations. RCE is an idealised climate system driven by sensible and latent heat fluxes at the surface. It is ideal for studying the energy spectrum and budget because it generates a large-scale flow with many different scales. The preliminary results show that microphysics parameterisation can affect self aggregation. The -5/3 spectrum is found in a narrow range of wavelength in the lower troposphere, the upper troposphere, and the lower stratosphere. Divergent kinetic energy dominates the kinetic energy spectrum. The buoyancy flux dominates the rate of change of the kinetic energy in the lower and upper troposphere and the divergence of vertical flux dominates the rate of change of the kinetic energy in the lower stratosphere. Direct energy cascade is found in the lower and upper troposphere and inverse energy cascade is found in the lower stratosphere. Further investigation of analysis of subfilter energy transfer and backscatter-allowing subgrid turbulence schemes are proposed.

Session: 814 Atmosphere, Ocean, and Climate Dynamics - Part 5 Dynamique de l’atmosphère, des océans et du climat - Partie 5

07/06/2021
15:15

ID: 10837 Contributed abstract

Poster Order:

Evaluation of dry and wet extremes changes with warming using a passive water vapor

Marie-Pier Labonté [1] , *Timothy M. Merlis* [2]

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Presented by / Présenté par: ***Marie-Pier Labonté***
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Hydroclimatic extremes, such as heavy daily rainfall and dry spells, are expected to intensify under anthropogenic warming. Often, these changes are diagnostically related to thermodynamic increases in humidity with warming. We developed a framework that uses an on-line calculation of the thermodynamic-induced changes of the full precipitation distribution with warming in an idealized moist atmospheric general circulation model. Two water vapor variables, the standard active one and an additional passive one (i.e., no latent heat released when condensation occurs), are advected by the resolved circulation. The passive water vapor is thermodynamically perturbed by modifying the saturation specific humidity used in the calculation of its condensation tendency and surface evaporation. We can obtain the thermodynamic component of precipitation change evaluated for the entire distribution. Here, we present results for wet and dry extremes. Our simulations have zonal-mean tropical increase and higher latitude decrease of dry spells' length (defined as the maximum consecutive dry days), as found in comprehensive models. This simulated thermodynamic-induced intensification of dry spells in the tropics arises with the upper-troposphere amplification of warming. Our simulations also have the expected increase in heavy daily rainfall (e.g., the 99.9th percentile of daily precipitation distribution) at all latitudes. Outside of the tropics, there are modest differences between the simulated increase relative to previous theory that assumes moist adiabatic stratification. The increased atmospheric stability slightly damps the simulated increase for the 99.9th percentile of precipitation by inhibiting condensation in the lower-troposphere.

Session: 814 Atmosphere, Ocean, and Climate Dynamics - Part 5 Dynamique de l’atmosphère, des océans et du climat - Partie 5

07/06/2021 15:30

ID: 11129 Contributed abstract

Poster Order:

Prospect of increased disruption to the QBO in a changing climate

James Anstey [1]

1

Presented by / Présenté par: ***James Anstey***

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The quasi-biennial oscillation (QBO) of tropical stratospheric winds was disrupted during the 2019/20 Northern Hemisphere winter. We show that this latest disruption to the regular QBO cycling was similar in many respects to that

seen in 2016, but initiated by horizontal momentum transport from the Southern Hemisphere. The predictable signal associated with the QBO's quasi-regular phase progression is lost during disruptions and the oscillation reemerges after a few months significantly shifted in phase from what would be expected if it had progressed uninterrupted.We infer from an increased wave-momentum flux into equatorial latitudes seen in climate model projections that disruptions to the QBO are likely to become more common in future. Consequently it is possible that in future the QBO could be a less reliable source of predictability on lead times extending out to several years than it currently is.

Session: 611 Climate Variability and Predictability - Part 2
La variabilité et la prévisibilité du climat - Partie 2 **07/06/2021 14:30**

ID: 11228 Invited session speaker

Poster Order:

Warmer and more volatile; why does summertime temperature variance increase as the climate warms?

Lucas Vargas Zeppetello [1] , *David Battisti* [2]

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Presented by / Présenté par: ***Lucas Vargas Zeppetello***
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The increasing frequency of very high temperatures has motivated growing interest in how the probability distribution of summertime temperatures will change in the future. Climate models forced by increasing CO2 project that temperature variance will increase in many places over the course of the 21stCentury. It is of great interest to understand whether these projections are reliable both because of the societal impacts of extreme temperatures and because temperature variability is linked to a host of processes that are currently poorly constrained in land surface models. This presentation presents a first-principles analytic theory for summertime temperature variance based on the surface energy and water budgets. The theory reproduces the increases in midlatitude summertime monthly averaged temperature variance projected by the climate models extremely well and shows that the increases are primarily due to the warming-induced increase in the climatological vapor pressure deficit. The impacts of local warming on saturation specific and relative humidity are shown to have roughly equal contributions to the increase in summertime temperature variance. The vegetation responses to increasing CO2 and temperature are found to be important contributors to the inter-model spread in

temperature variance change, highlighting the role of plants in shaping the summertime temperature distribution. Our results suggest that the increases in summertime temperature variance projected by the climate models are indeed credible.

Session: 611 Climate Variability and Predictability - Part 2
La variabilité et la prévisibilité du climat - Partie 2 **07/06/2021 15:00**

ID: 11216 Contributed abstract

Poster Order:

Human influence on daily temperature variability over land

Hui Wan [1] , *Megan Kirchmeier-Young* [2] , *Xuebin Zhang* [3]

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[3] Environment and Climate Change Canada

Presented by / Présenté par: ***Megan Kirchmeier-Young***
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Changes in temperature variability have implications for the health of humans and other species and industries such as agriculture. The strongest historical changes in daily temperature variability are decreases in the northern high latitudes annually and in all seasons except summer. Additionally, daily temperature variability has increased in the Northern Hemisphere mid-latitudes during summer and over tropical and Southern Hemisphere land areas. These patterns are projected to continue with additional warming. We conduct a formal optimal-fingerprinting detection and attribution analysis, finding the global spatio-temporal changes in daily temperature variability annually and for all seasons except boreal summer are attributable to anthropogenic forcing. Human influence is also detected in some individual 20 degree latitude bands, including the northern high latitudes. Attribution results are generally robust and this provides confidence in projected changes in daily temperature variance with continued anthropogenic warming.

Session: 611 Climate Variability and Predictability - Part 2
La variabilité et la prévisibilité du climat - Partie 2 **07/06/2021 15:15**

ID: 11217 Contributed abstract

Poster Order:

Comparison of the Atlantic Meridional Overturning Circulation indicators and its impact on regional climate

Jing Zhang [1] , *Cheng Sun* [2] , *Jianping Li* [3] , *Zhanqiu Gong* [4] , *Lifei Zhu* [5] , *Yusen Liu* [6]

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Presented by / Présenté par: ***Jing Zhang***
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The Atlantic Meridional Overturning Circulation (AMOC) plays an important role in the earth's climate system, but it remains unclear how the instrumentally observed multidecadal variability of the Earth’s climate is related to the AMOC. We carried out a comprehensive evaluation of five representative indicators of the AMOC. We analyzed five AMOC indices with regional and hemispheric scale temperature and precipitation, and concluded that :(1) AMOC indicators have significant correlation with regional and hemispheric scale temperature and precipitation at multidecadal scale ;(2) AMOC oceanographic indicators are the response to AMOC multidecadal change, and the relationship with multidecadal climate change is the same period or lag relationship ;(3) The AMOC oceanographic index reflects the forcing effect of atmosphere on AMOC multidecadal change, and the relationship with multidecadal climate change shows a significant advance relationship, which can be used as a predictor of climate change.

Session: 611 Climate Variability and Predictability - Part 2
La variabilité et la prévisibilité du climat - Partie 2 **07/06/2021 15:30**

ID: 11219 Contributed abstract

Poster Order:

Downscaling the Ocean Response to the Madden-Julian Oscillation in the Northwest Atlantic

Christoph Renkl [1] , *Keith R. Thompson* [2]

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Presented by / Présenté par: ***Christoph Renkl***
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Subseasonal-to-seasonal (S2S) prediction is a global effort to forecast the state of the atmosphere and ocean with lead times between two weeks and a season. This study explores the feasibility of S2S prediction of the ocean using a variety of tools including statistical analysis, a statistical-dynamical mixed layer model, and regional, high-resolution ocean circulation models based on physical principles. Ocean predictability on S2S timescales is analyzed by compositing winter sea surface temperature (SST) anomalies in the North Atlantic with respect to the Madden-Julian Oscillation (MJO). It is found that statistically significant, large-scale SST changes, particularly along the eastern seaboard of North America, can be related to the MJO. This signal is shown to be driven by anomalous air-sea heat fluxes caused by atmospheric perturbations in response to the MJO. The high-resolution model of the Gulf of Maine and Scotian Shelf (GoMSS) is used to downscale the mean ocean response to the MJO. The model is able to capture the observed relationship between the MJO and SST in the northwest Atlantic. It is also shown that the anomalous atmospheric circulation in response to the MJO leads to anomalous upwelling on the Scotian Shelf. The implications for the feasibility and value of downscaling S2S prediction of the ocean will be discussed.

Session: 611 Climate Variability and Predictability - Part 2
La variabilité et la prévisibilité du climat - Partie 2 **07/06/2021 15:45**

ID: 11220 Contributed abstract

Poster Order:

Climate change-induced variabilities in climate extremes on the Black Sea region of Turkey

Hakan Aksu [1] , *Mahmut Cetin* [2] , *Hafzullah Aksoy* [3] , *Omar Alsenjar* [4] , *Isilsu Yildirim* [5] , *Sait Genar Yaldiz* [6]

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Presented by / Présenté par: ***Omar alsenjar***
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The changes in climate extremes have intrigued the scientists over the world for a long time. In this context, many studies have been conducted at different scales such as local, regional or global level. One of the major concerns with a potential change in climate is that an increase in extreme climate events of different duration will occur very frequently. The Black Sea Region of Turkey is located in Mediterranean basin which is the most vulnerable region to the negative impacts of climate change. In recent years remarkable climatic extremes have been recorded in the meteorological stations of the region. The aims of this study are two-fold: a) to figure out the potential change in climate extreme indices, b) to compare Spatio-temporal behavior and occurrences in the long term. In line with the objectives, data, containing the period of 1927–2019, of 21 meteorological stations located over the Black Sea region of Turkey were used in the present study. Based on the results, the temperature indices such as (summer days, warm nights, annual warmest daily temperature, annual warmest minimum daily temperature) showed a gradual increasing trend in the most of stations. There was a decreasing behaviour in the number of icy and cool days and cool nights during the same study period. However, precipitation extreme indices showed that there was an increasing trend in the total amount of annual rainfall and maximum monthly 1-day and 5-day rainfall amounts and the annual sum of daily precipitation > 95th percentile. Based on the trend analysis results, it could be concluded that there has been a general increase in temperature extremes towards being warmer. Also, it is concluded that the precipitation extremes have been prone to have higher intensity-rainfalls, indicating the very heavy and showery variety of rainfall events in the region.

Session: 341 The Changing Arctic Atmosphere - Part 2
L'évolution de l'atmosphère arctique - Partie 2 **07/06/2021 14:30**

ID: 10884 Invited session speaker

Poster Order:

The ice-nucleating ability of high-latitude dust from the Copper River, Alaska

Sarah Barr [1] , *Bethany Wyld* [2] , *Natalie Ratcliffe* [3] , *James B. McQuaid* [4] , *Benjamin J. Murray* [5]

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Presented by / Présenté par: ***Sarah Barr***
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Ice-nucleating particles (INPs) play an important role in the climate system by influencing cloud radiative properties, cloud lifetime and precipitation. In the high latitudes the influence of mid- and low-latitude sources of INPs is reduced and local dust sources could be important. However, many of these potential sources have not been quantified. The south coast of Alaska, in particular the Copper River valley, is one such area where there are regular dust storms. These can clearly be seen from satellite imagery, which provides information on the frequency and extent of these outbreaks. In order to investigate the potential importance of the Copper River valley as a source of INPs we undertook a field campaign in October 2019. Size segregated aerosol samples from the near surface were collected on to polycarbonate filter substrates using a multistage cascade impactor during seven dust emission events over a 10 day period. In addition, samples of dry sediment were collected from the surface. We used a cold stage instrument to quantify the ice-nucleating efficacy of these samples. In order to identify what controls the ice-nucleating ability of the samples we determined the mineral composition using x-ray diffraction and heat tests were used to ascertain if there is an active biogenic component. Laboratory results were combined with modelling of the transport and dispersion of the dust, using the FLEXible PARTicle dispersion model (FLEXPART), in order to estimate atmospheric INP concentrations. Initial laboratory results show high ice nucleating activity of the samples, comparable to glacial dust from other regions, and FLEXPART modelling shows dust transported over large areas of the northern hemisphere. We will present these results as well as discussing the potential impact of this dust source on clouds and the relevance of the south coast of Alaska as an important source of ice nucleating particles.

Session: 341 The Changing Arctic Atmosphere - Part 2
L’évolution de l’atmosphère arctique - Partie 2 **07/06/2021 15:00**

ID: 11027 Invited session speaker

Poster Order:

Environmental and climatic impacts of dust emissions from mines in Greenland

Christian Juncher Jørgensen [1] , *Jens Søndergaard* [2] , *Anders Mosbech* [3]

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Presented by / Présenté par: ***Christian Juncher Jørgensen***
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Emission and deposition of mineral dust in the Arctic can have direct and indirect impacts on the environment and climate depending on the chemical composition and size fraction of the dust particles. Large emissions of dust may arise from both natural and anthropogenic sources, such as proglacial deflation areas and mines, respectively. Over the last decades, there has been a growing interest in the extraction of raw materials in the Arctic and High Arctic parts of Greenland with potential impacts on both regional environment and climate. In order to understand the potential cumulative effects of increased mining activities on Arctic ecosystems and climate and to develop a more sustainable mining practice in a changing Arctic, the sources and impact of dust emissions on the ecosystems of the sensitive Arctic areas needs to be evaluated. This include an improved knowledge base of the complex positive and negative feedback mechanisms to ecosystem disturbances and accelerated melting of snow and ice. Our research focuses on addressing knowledge gaps and aims to provide an improved characterization of the spatiotemporal variability in dust emissions from both natural and anthropogenic sources in the Arctic. Further, the chemical composition and size fractionation of emitted/deposited dust will be used to better distinguish between natural and mining related impacts. In 2021, a new monitoring site will be established in West Greenland, with full season dust measurements and sample collection along a transect extending from the Greenland Ice Sheet to the western fjords. Results from the dust monitoring program will subsequently be used as input to atmospheric models to upscale the effects of both natural and mining related dust on a more regional level as well as to assess climate effects.

Session: 341 The Changing Arctic Atmosphere - Part 2
L’évolution de l’atmosphère arctique - Partie 2 **07/06/2021 15:30**

ID: 10688 Contributed abstract

Poster Order:

The Importance of Mineral Dust and Proteinaceous Ice Nucleating Particles in the Canadian High Arctic during the Fall of 2018

Jingwei Yun [1] , *Erin Evoy* [2] , *Soleil Worthy* [3] , *Melody Fraser* [4] , *Daneil Veber* [5] , *Andrew Platt* [6] , *Kevin Rawlings* [7] , *Sangeeta Sharma* [8] , *Richard Leaitch* [9] , *Allan Bertram* [10]

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Presented by / Présenté par: ***Jingwei Yun***
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Ice nucleating particles (INPs) can initiate ice formation in clouds, which has a large impact on the hydrological cycle and radiative budget of the Earth. Constraints on the concentration and composition of INPs are needed to predict ice formation in clouds and hence the climate. Despite previous INP measurements in the Arctic, our understanding of the concentrations, composition, and sources of Arctic INPs is insufficient. Here we report daily concentrations of INPs at Alert, a ground site in the Canadian High Arctic, during October and November of 2018. The contributions of mineral dust and proteinaceous particles to the total INP population were evaluated by testing the responses of the samples to heat and ammonium treatments. Possible source locations of the most effective INPs were investigated using back-trajectory simulations with a Lagrangian particle dispersion model. The results show that the INP concentrations in October were higher than that in November. Combining our results with previous INP measurements at Alert, a seasonal trend was observed for the INP concentrations at -18 °C and -22 °C, with a higher concentration in the late spring, summer and early fall, and a lower concentration in the early spring, late fall, and winter. For the October samples, proteinaceous INPs were detected at T > -21 °C with a fraction of 60% to 100% and mineral dust INPs were detected at T < -21 °C. For the November samples, proteinaceous INPs were only detected at T > -16 °C with a fraction of 88% to 100% and mineral dust INPs were detected at T < -20 °C. The most effective INPs were possibly from South China and California based on 20-day backward simulations using the FLEXible PARTicle dispersion model and the correlations between INP concentrations and Al, Na+, and Cl- measured at the site.

Day 7 – 8 June 2021

Oral

ID: 11103 Contributed abstract

Poster Order:

Decadal observations of internal wave energy and shear in the western Arctic

Elizabeth Fine [1] , *Sylvia Cole* [2]

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Presented by / Présenté par: ***Elizabeth Fine***
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In recent years, ice cover in the western Arctic has declined and ice-free conditions in late summer and early autumn have become increasingly common. Sea ice acts as a barrier to the transfer of momentum and energy from the wind to the ocean, and in its absence there may be increased internal wave energy in the upper ocean. However, observations to date have not found an increase in turbulent dissipation or mixing associated with the sea ice decline. In this study, we investigate the relationship between the ice cover, internal wave energy, and turbulent dissipation over 2003-2018. We use velocity and CTD data from the profiling BGOS moorings to examine near-inertial energy and shear and apply a finescale parameterization to estimate turbulent dissipation rates. Interannual, seasonal, and event-driven variability is evident over this 15 year period. Near-inertial energy between 50-300 m tended to be lowest when ice cover was solid and highest when there was no ice cover. In contrast, the highest rates of turbulent dissipation were associated with partial ice cover. The decoupling of energy and shear results as energy entered the ocean at large vertical length scales in ice-free conditions, and at intermediate vertical scales in partial ice conditions. Energy at these intermediate scales is more readily transported to the small vertical scales associated with turbulent dissipation. These results help to explain apparently contradictory observations that have shown internal wave energy increasing in ice-free waters, with no corresponding increase in turbulent dissipation.

Session: 322 The Changing Arctic Ocean - Part 3
L’évolution de l’océan Arctique - Partie 3 **08/06/2021 12:45**

ID: 11130 Contributed abstract

Poster Order:

Changes in internal wave-driven mixing across the Arctic Ocean

Hayley Dosser [1] , *Melanie Chanona* [2] , *Stephanie Waterman* [3] , *Nicole Shibley* [4] , *Mary-Louise Timmermans* [5]

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Presented by / Présenté par: ***Hayley Dosser***
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The Arctic climate is changing rapidly, with dramatic sea ice declines and increasing upper-ocean heat content. While oceanic heat has historically been isolated from the sea ice by weak vertical mixing, it has been hypothesized that a reduced ice pack will increase energy transfer from the wind into the internal wave (IW) field, enhancing mixing and accelerating ice melt. Evidence both supporting and refuting this `ice/internal-wave feedback' has emerged over the last decade, often restricted to a particular region or season in the Arctic. We evaluate this positive feedback more broadly using a finescale parameterization to estimate dissipation, a proxy for the energy available for IW-driven mixing, from pan-Arctic hydrographic profiles spanning 18 years. We find that dissipation has nearly doubled in summer in the central Arctic Ocean basins while declining in winter; we find no interannual trends in any region. Associated summer heat fluxes in the central Arctic Ocean are found to have risen by an order of magnitude, due to increases in both the strength and prevalence of IW-driven mixing. We estimate that while the ice/internal-wave feedback will likely cause negligible sea-ice melt in the strongly-stratified western Arctic for the foreseeable future, the eastern Arctic is vulnerable to increased heat fluxes and accelerated sea ice-melt as IW-driven mixing increases.

Session: 322 The Changing Arctic Ocean - Part 3
L’évolution de l’océan Arctique - Partie 3 **08/06/2021 13:00**

ID: 11184 Contributed abstract

Poster Order:

Impacts of spatially varied vertical mixing in an Arctic Ocean model

Benjamin O'Connor [1] , *Melanie Chanona* [2] , *Stephanie Waterman* [3] , *Jeffery Scott* [4] , *Shayna MacTaggart* [5]

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Presented by / Présenté par: ***Ben O'Connor***
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Numerical models are integral to our understanding of the rapidly changing and difficult to observe Arctic Ocean. Due to the perceived 'quiescent' nature of Arctic turbulence, modelers often prescribe a single background vertical mixing value uniformly throughout their model domains. However, this practice does not accurately reflect the spatial variability of vertical mixing that has recently been documented in the Arctic Ocean. This then raises the question; how would a general circulation model respond to a realistic representation of vertical mixing? Here, we investigate model response to spatial variance in mixing prescription by performing experiments on an Arctic setup of the MITgcm. We employ theoretical and observationally informed mixing distributions and examine their impacts on water composition, sea ice, large-scale circulation, and export flux to subpolar seas. Our observational mixing distribution is created using a collection of historical CTD and ice-tethered profiler (ITP) data that covers a large portion of the Arctic Ocean. We find that the distribution of salinity and the general circulation patterns are sensitive to basin mixing whereas the distribution of heat is more sensitive to shelf mixing. Furthermore, we find that the observationally informed distribution produces an output that resembles observed temperatures and salinities more closely than any uniform distribution. We discuss implications for model development, modelling studies, and projections of future Arctic Ocean state.

Session: 322 The Changing Arctic Ocean - Part 3
L'évolution de l'océan Arctique - Partie 3 **08/06/2021 13:15**

ID: 10956 Contributed abstract

Poster Order:

Impact of vertical mixing and freshwater input on summertime net community production in Canadian Arctic and Subarctic waters: Insights from in situ measurements and numerical simulations

Robert Izett [1] , *Melanie Chanona* [2] , *Laura Castro de la Guardia* [3] , *Paul Myers* [4] , *Stephanie Waterman* [5] , *Philippe Tortell* [6]

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Presented by / Présenté par: ***Philippe Tortell***
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We present new ΔO2/Ar-based estimates of mixed layer net community production (NCP) from three summertime surveys in the Central and Eastern North American Arctic and Subarctic Ocean. Coupling high resolution ship-based data with in-situ hydrographic measurements and output from a regional circulation model, we correct the NCP estimates for vertical mixing contributions to the surface O2 budget. In regions of strong wind-driven mixing, such as the Labrador Sea, and physically dynamic waters of the northern Canadian Arctic Archipelago (CAA), significant vertical O2 fluxes resulted in large positive NCP corrections. In contrast, corrections were small in the density-stratified Baffin Bay, well-mixed Hudson Strait and river-impacted southern CAA. After accounting for mixing effects on the O2 mass balance, we observed elevated NCP in the southern section of the survey area, and in nearshore regions influenced by glacial meltwater and recent ice retreat. Low NCP values and isolated net heterotrophy were observed throughout Baffin Bay and near strong sources of freshwater and organic matter in Hudson Bay and the Queen Maud Gulf. Our results demonstrate a heterogeneous distribution of NCP across the region, reflecting varying contributions of vertical mixing and freshwater input in controlling the net metabolic state of surface waters. We provide insights into the dominant physical drivers of productivity and potential future oceanic responses to on-going Arctic climate change. This work demonstrates the combined use of ship-board measurements and numerical models to better constrain rates of biological productivity in under-sampled high latitude waters.

Session: 322 The Changing Arctic Ocean - Part 3
L’évolution de l’océan Arctique - Partie 3 **08/06/2021 13:30**

ID: 10991 Contributed abstract

Poster Order:

Responses of Atlantic water inflow through Fram Strait to Arctic storms

Zhenxia Long [1] , *Will Perrie* [2] , *Minghong Zhang* [3] , *Yazhou Liu* [4]

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Presented by / Présenté par: ***Zhenxia Long***
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Atlantic water inflow through Fram Strait is one of the major sources for the Atlantic Water Layer (AWL) in the central Arctic Ocean. Any changes in the inflow can affect the heat balance in the region. To understand the decadal variations of the inflow, NEMO 3.6 is implemented in the Arctic Ocean, forced by PHC temperature (salinity), GLORYS currents and CORE II surface fields. Compared to observations, NEMO can reproduce mean sea ice, water temperature and salinity as well as their variability and capture the two warming events in the early 1990s and 2000s. In addition, the simulations show a decadal variation in the inflow, such as the increased inflows in the 1960s and 1990s. The results also suggest the decadal variation is significantly correlated with the storm density in the northern part of the North Atlantic near Fram Strait. When there are fewer storms near Fram Strait, the northwestern Barents Sea and Eurasian Basin are dominated by northerly wind anomalies, which tend to increase fresher water transport from the central Arctic Ocean to the northern Barents Sea. The freshening can reduce surface mixing and enhance water volume transport through Fram Strait. On the other hand, when there is increased storm activity, the enhanced vertical mixing tends to reduce the Atlantic water inflow through Fram Strait. Therefore, Arctic storms can play an important role in the decadal variation of Atlantic inflow due to their impacts on local stratification.

Session: 642 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 3 Observation de la Terre depuis l'espace : informations essentielles sur notre planète - Partie 3 **08/06/2021 12:30**

ID: 10872 Contributed abstract

Poster Order:

OSIRIS on Odin: Twenty years of Scientific Achievements

Doug Degenstein [1] , *Adam Bourassa* [2] , *Daniel Zawada* [3] , *Chris Roth* [4]

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Presented by / Présenté par: ***Doug Degenstein***
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The Canadian Optical Spectrograph and InfraRed Imaging System (OSIRIS) hit 20 years in orbit on February 21, 2021, the day this abstract was written. This is an amazing testament to the engineers and scientists from the Canadian Space Agency who fund and manage OSIRIS, Routes AstroEngineering who built OSIRIS and academic institutions around the world who proposed the concept and worked hard to make it a reality. This "two year mission" has produced results beyond anybody's wildest dreams and this presentation will address as many highlights as time permits. With almost 20 years of high quality, vertically resolve sulphate aerosol, ozone and nitrogen dioxide profiles, OSIRIS has made substantial contributions to international initiatives like the WMO Ozone Assessment, the Intergovernmental Panel on Climate Change quadrennial report and the WCRP sponsored CMIP 6 and although OSIRIS and Odin are aging, it is anticipated that these contributions will continue for the foreseeable future.

Session: 642 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 3 Observation de la Terre depuis l'espace : informations essentielles sur notre planète - Partie 3 **08/06/2021 12:45**

ID: 10787 Contributed abstract

Poster Order:

Air Emissions from the Canadian Oil Sands as seen from space

Chris McLinden [1] , *Vitali Fioletov* [2] , *Debora Griffin* [3] , *Sarah Toshiko Moser* [4] , *Junhua Zhang* [5] , *Kathy Hayden* [6] , *John Liggio* [7] , *Richard Mittermeier* [8] , *Jeremy JB Wentzell* [9] , *Michael Wheeler* [10] , *Cristen Adams* [11] , *Alba Lorente* [12]

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Presented by / Présenté par: ***Chris McLinden***
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Increasingly, Space-based Earth observations (SBEO) of atmospheric composition are helping to provide a better understanding of emissions of air pollutants and greenhouse gases. One location where SBEO is particularly useful is the Athabasca Oil Sands Region in northeast Alberta, Canada. Here, SBEO, combined with meteorological information, are used to estimate emissions of nitrogen oxides (NOx), sulphur dioxide, and methane based on observations from the Ozone Monitoring Instrument (OMI) and Tropospheric Monitoring Instrument (TROPOMI) space-based sensors. Furthermore, annual emissions of pollutants co-emitted with NOx were also derived through a synergistic combination of aircraft and satellite observations, including black carbon particulate matter, carbon monoxide, and nitrous acid. A survey of satellite-based emissions methodologies will be presented along with oil sands annual emissions for these pollutants.

Session: 642 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 3 Observation de la Terre depuis l'espace : informations essentielles sur notre planète - Partie 3 **08/06/2021 13:00**

ID: 10880 Contributed abstract

Poster Order:

The MAESTRO Spectrophotometer on Canada's SCISAT satellite: Advances in data processing and improved data products

C. Thomas McElroy [1] , *James R. Drummond* [2] , *Jiansheng Zou* [3] , *Zahra Vaziri* [4]

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Presented by / Présenté par: ***C. Thomas McElroy***
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Abstract. The ACE-FTS and MAESTRO instruments have now been operating on the Canadian Space Agency's SCISAT satellite for nearly 18 years. The Measurement of Aerosol in the Stratosphere and Troposphere Retrieved by Occultation (MAESTRO) spectrophotometer continues to measure ozone, water

vapour and aerosol in the stratosphere and upper troposphere. The instrument design and performance will be briefly discussed and the algorithms developed to process the data and deal with peculiarities in the performance of the satellite will be described. Significant progress has been made recently in improving the data quality and automating the data processing. Some interesting data collected by the instrument will be presented. Like the ACE-FTS, MAESTRO delivers results from nearly 30 occultation measurements per day, but with a higher vertical resolution of just over 1 km. It measures from 500 nm to 1000 nm with a resolution of 1 to 2 nm.

Session: 642 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 3 Observation de la Terre depuis l'espace : informations essentielles sur notre planète - Partie 3 **08/06/2021 13:15**

ID: 10952 Contributed abstract

Poster Order:

Assessment of the quality of ACE-FTS stratospheric ozone data

Patrick Sheese [1] , *Kaley Walker* [2] , *Chris Boone* [3] , *Adam Bourassa* [4] , *Doug Degenstein* [5] , *Lucien Froidevaux* [6] , *Thomas McElroy* [7] , *Donal Murtagh* [8] , *James Russell III* [9] , *Jason Zou* [10]

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Presented by / Présenté par: ***Patrick Sheese***
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For the past 17 years, the Atmospheric Chemistry Experiment Fourier Transform Spectrometer (ACE-FTS) instrument on the Canadian SCISAT satellite has been measuring profiles of atmospheric ozone. Currently, there are two operational versions of the level 2 ozone data—versions 3.6 and 4.1. This

study will show how both products compare with correlative data from other limb-sounding satellite instruments, namely MAESTRO, MLS, OSIRIS, SABER, and SMR. In general, v3.6, with respect to the other instruments, exhibits a smaller positive bias (~2-4%) in the middle stratosphere than v4.1 (~2-9%). However, both data sets are biased due to field-of-view modelling errors, and when the data sets are corrected for this bias, the average overall v3.6 bias in the middle stratosphere is within ±4% and v4.1 exhibits a positive bias on the order of 0-5%. The bias exhibited in the v4.1 data tends to be stable to within ±1% dec 1, whereas the v3.6 product tends to exhibit a significant negative trend on the order of 1-3% dec-1.

Session: 642 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 3 Observation de la Terre depuis l'espace : informations essentielles sur notre planète - Partie 3 **08/06/2021 13:30**

ID: 10661 Contributed abstract

Poster Order:

Using the COVID-19 flight disruption to constrain aviation-induced cirrus

Ruth Digby [1] , *Nathan Gillett* [2] , *Adam Monahan* [3] , *Jason Cole* [4]

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Presented by / Présenté par: ***Ruth Digby***
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Aviation is responsible for ~3.5% of anthropogenic radiative forcing, the largest portion of which has been attributed to aviation-induced cirrus (AIC). Despite its importance, the radiative impact of AIC has only been estimated from simulations. This is due in part to the challenge of differentiating between natural and aviation-induced cirrus, and in part to the confounding signals of natural variability and potential climate-change- or aerosol-induced trends, which obscure the effects of increasing aviation. However, the COVID-19 pandemic has provided an unprecedented global experiment from which observational constraints can be derived. Aviation was rapidly reduced in an effort to curb the pandemic's spread, with early April flight numbers falling to less than 40% of their corresponding 2019 levels. Here we show that satellite

observations of cirrus cloud do not exhibit a detectable response to this drastic aviation reduction. Furthermore we show that -- based on a simple projection of simulated contrail cirrus for 2006 -- a signal should have been detectable, and that our observations are consistent with a response no more than 48% of that found in simulations. Subject to our simplifying assumptions, these results indicate that the cirrus-mediated effects of aviation may have previously been overestimated.

Session: 612 Climate Variability and Predictability - Part 3
La variabilité et la prévisibilité du climat - Partie 3 **08/06/2021 12:30**

ID: 11225 Invited session speaker

Poster Order:

Potential impact of preceding Aleutian Low variation on the El Niño-Southern Oscillation during the following winter

Shangfeng Chen [1]

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Presented by / Présenté par: ***Shangfeng Chen***
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The present study reveals a close relation between the interannual variation of Aleutian Low intensity (ALI) in March and the subsequent winter El Niño-Southern Oscillation (ENSO). When March ALI is weaker (stronger) than normal, an El Niño (a La Nina)-like sea surface temperature (SST) warming (cooling) tends to appear in the equatorial central-eastern Pacific during the subsequent winter. The physical process linking March ALI to the following winter ENSO is as follows. When March ALI is below normal, a notable atmospheric dipole pattern develops over the North Pacific, with an anticyclonic anomaly over the Aleutian region and a cyclonic anomaly over the subtropical western-central Pacific. The formation of the anomalous cyclone is attributed to feedback of the synoptic-scale eddy to mean flow energy flux and associated vorticity transportation. Specifically, easterly wind anomalies over the mid-latitudes related to the weakened ALI are accompanied by a decrease in synoptic-scale eddy activity, which forces an anomalous cyclone to its southern flank. The accompanying westerly wind anomalies over the tropical western-central Pacific induce SST warming in the equatorial central-eastern Pacific during the following summer-autumn via triggering eastward propagating warm Kelvin waves, which may sustain and develop into an El Niño event during the following winter via positive air-sea feedback. The relation of March ALI with the following winter ENSO is independent of the preceding tropical Pacific SST, the

preceding winter North Pacific Oscillation, and spring Arctic Oscillation. The results of this analysis may provide an additional source for the prediction of ENSO.

Session: 612 Climate Variability and Predictability - Part 3
La variabilité et la prévisibilité du climat - Partie 3 **08/06/2021 13:00**

ID: 11221 Contributed abstract

Poster Order:

Application of CanESM5 to seasonal and decadal forecasting

William Merryfield [1] , *Reinel Sospedra-Alfonso* [2] , *Slava Kharin* [3] , *Woosung Lee* [4] , *George Boer* [5]

[1] ECCC/CCCma
[2] ECCC/CCCma
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Presented by / Présenté par: ***William Merryfield***
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The Canadian Earth System Model version 5 (CanESM5) is the latest global model from the Canadian Centre for Climate Modelling and Analysis (CCCma), and provides the basis for CCCma’s contributions to the Coupled Model Intercomparison Project phase 6 (CMIP6) and related science applications. As for some other recent CCCma model versions, CanESM5 can be initialized with observational data and applied to produce ensemble climate forecasts for the next season to decade. Of note is that CanESM5 is the first of CCCma’s Earth system models featuring an interactive carbon cycle with land and terrestrial ecosystem components to have such capabilities. Importantly, ensemble size has been increased from the 10 ensemble members used for previous model versions to 40 to improve the detection of predictable climate variations. This presentation will provide an overview of CanESM5 contributions to decadal prediction initiatives including the CMIP6 Decadal Climate Prediction Project (DCPP), and of its experimental application to seasonal forecasting. Predictive skill on both time scales is assessed in comparison with previous model versions, and in relation to CanCM5’s representation of climate variability and long-term change.

Session: 612 Climate Variability and Predictability - Part 3
La variabilité et la prévisibilité du climat - Partie 3 **08/06/2021 13:15**

ID: 11213 Contributed abstract

Poster Order:

Decadal climate predictions with the initialized CanESM5 large ensemble

Reinel Sospedra-Alfonso [1], *William J. Merryfield* [2], *George J. Boer* [3], *Viatsheslav V. Kharin* [4], *Woosung Lee* [5], *Christian Seiler* [6], *James R. Christian* [7]

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[2] ECCC
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Presented by / Présenté par: ***Reinel Sospedra-Alfonso***
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The Canadian Earth System Model version 5 (CanESM5) developed at the Canadian Centre for Climate Modelling and Analysis (CCCma) is participating in phase 6 of the Coupled Model Intercomparison Project (CMIP6). A 40-member ensemble of CanESM5 decadal retrospective forecasts or hindcasts is integrated for ten years from realistic initial states spanning 1961 to present under prescribed external forcing. The results are part of CCCma's contribution to the Decadal Climate Prediction Project (DCPP) component of CMIP6. This presentation provides evaluations of CanESM5 large ensemble decadal hindcasts, including assessments of potential predictability and actual skill of key oceanic and atmospheric fields. The impact of initialization on prediction skill is quantified from the hindcasts decomposition into uninitialized and initialized components. CanESM5 decadal hindcasts skilfully predict upper-ocean states and surface climate with significant impacts from initialization that depend on climate variable, forecast range, and geographic location. Two novelties in CCCma's prediction system relative to previous versions are the use of a larger forecast ensemble and the ability with CanESM5 to predict carbon cycle variables. Larger ensembles are shown to enhance the skill of forecasts, particularly where the predictable climate signal is underestimated. Predictions of carbon cycle variables are shown to be locally skilful on decadal time scales, with a strong long-lasting impact from initialization on skill in the ocean and a moderate shorter-lived impact on land.

Session: 612 Climate Variability and Predictability - Part 3
La variabilité et la prévisibilité du climat - Partie 3 08/06/2021 13:30

ID: 11226 Contributed abstract

Poster Order:

Improving seasonal predictions with GEM5 based coupled model

Hai Lin [1] , *Ryan Muncaster* [2]

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Presented by / Présenté par: ***Hai Lin***
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The new CMC numerical weather prediction model, GEM5, is coupled with the NEMO ocean model. The objective is to improve GEM-NEMO in the operational Canadian Seasonal to Interannual Prediction System version 2 (CanSIPSv2). A set of hindcast experiments are performed starting from the first of November, February, May and August for the past 30 years, with 10 members of 6-month integrations. Seasonal forecast skill is assessed for surface air temperature and precipitation, as well as for the Pacific-North American Pattern (PNA) and the North Atlantic Oscillation (NAO). The forecast skill of the Madden-Julian Oscillation (MJO) is also calculated to evaluate its performance on the subseasonal time scale. It is found that the GEM5 based coupled model outperforms the current GEM-NEMO in many aspects.

Session: 612 Climate Variability and Predictability - Part 3
La variabilité et la prévisibilité du climat - Partie 3 08/06/2021 13:45

ID: 11222 Contributed abstract

Poster Order:

Seasonal Forecast Skill and Potential Predictability of Arctic Sea Ice in Two Versions of a Dynamical Forecast System

Joseph Martin [1] , *Michael Sigmond* [2] , *Adam Monahan* [3]

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[3] University of Victoria

Presented by / Présenté par: ***Joseph Martin***

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We present an assessment of the sea ice forecast skill of versions one and two of the Canadian Seasonal to Interannual Prediction System (CanSIPSv1 and CanSIPSv2). Each version consists of two coupled global climate models. CanSIPSv2 features a different model combination and includes an improved initialization procedure for sea ice concentration and thickness. Forecast skill of detrended late summer anomalies in CanSIPSv1 is, as in other systems, characterized by a spring prediction barrier, with significant skill limited to forecasts initialized after June. Prediction skill in CanSIPSv2 is substantially higher for these lead times, with significant skill of late summer predictions for lead times up to 11 months. Forecast skill in CanSIPSv2 is also found to be higher for detrended winter anomalies. Regionally, the new sea ice thickness initialization is shown to improve sea ice forecast skill in the Central Arctic, Sea of Okhotsk, and Laptev Sea and overall improvement is seen in CanSIPSv2 for the GIN, Barents, Kara, and Chukchi Seas. Our results show improvements which can be attributed to both the new initialization procedure and the change in model combination. Further, these changes did not cause any significant decrease in skill on the pan-Arctic or regional scales. In the second part, we present potential predictability experiments with one of the CanSIPS models, CanCM4. CanCM4's estimate of potential predictability of the real system is found to be lower than that of other models. Especially low potential skill was seen in the seas north of the Eurasian continent with few perfect model forecasts showing significant skill at lead times greater than 11 months. Comparison to actual forecast skill suggests that there is still room for improvements in model physics and initialization to yield addition skill in this model.

Session: 323 The Changing Arctic Ocean - Part 4
L'évolution de l'océan Arctique - Partie 4 **08/06/2021 14:30**

ID: 11009 Contributed abstract

Poster Order:

Developing a large ensemble of Arctic wave projections with neural networks

Mercè Casas Prat [1] , *Shady Mohammed* [2] , *Lluís Castrejón* [3]

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Presented by / Présenté par: ***Mercè Casas Prat***

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The Arctic is a hotspot for climate change. As sea ice retreats due to global warming, larger open water areas favor the development, growth and propagation of ocean waves. Larger waves present a number of challenges: increased coastal erosion and flooding, which threatens coastal communities; infrastructure damage, which can impact current and emerging offshore operations. Wave climate is also a key climate variable for the increasing shipping industry in the Arctic. Numerical simulations forced by five climate model data showed that extreme waves might increase up to 2 to 3 times the current value along the Arctic coastlines by the end of the century. However, the projected changes are affected by a number of uncertainty factors: greenhouse scenario, model parameterization and resolution, etc. The latter is particularly relevant in the Arctic, where strong interactions between atmosphere and ocean processes take place. This, for example, leads to large discrepancies in sea ice coverage among some climate models , which notably affects the resulting wave climate. A large ensemble is needed to better investigate the future changes, and uncertainties, in the Arctic wave climate. Due to the large computational cost of the numerical approach, here we explore the use of neural networks to predict future wave projections. In particular, a 3D convolutional neural network is used to capture the spatiotemporal dependencies of wind-sea states and swell waves.

Session: 323 The Changing Arctic Ocean - Part 4
L'évolution de l'océan Arctique - Partie 4 **08/06/2021 14:45**

ID: 10680 Contributed abstract

Poster Order:

Arctic Amplification of Anthropogenic Forcing: A Vector Autoregressive Analysis

Philippe Goulet Coulombe [1] , *Maximilian Göbel* [2]

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Presented by / Présenté par: ***Maximilian Göbel***
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On September 15th 2020, Arctic sea ice extent (SIE) ranked second-to-lowest in history and keeps trending downward. The understanding of how feedback loops amplify the effects of external CO_2 forcing is still limited. We propose the

VARCTIC, which is a Vector Autoregression (VAR) designed to capture and extrapolate Arctic feedback loops. VARs are dynamic simultaneous systems of equations, routinely estimated to predict and understand the interactions of multiple macroeconomic time series. The VARCTIC is a parsimonious compromise between full-blown climate models and purely statistical approaches that usually offer little explanation of the underlying mechanism. Our completely unconditional forecast has SIE hitting 0 in September by the 2060's. Impulse response functions reveal that anthropogenic CO2 emission shocks have an unusually durable effect on SIE – a property shared by no other shock. We find Albedo- and Thickness-based feedbacks to be the main amplification channels through which CO2 anomalies impact SIE in the short/medium run. Further, conditional forecast analyses reveal that the future path of SIE crucially depends on the evolution of CO2 emissions, with outcomes ranging from recovering SIE to it reaching 0 in the 2050's. Finally, Albedo and Thickness feedbacks are shown to play an important role in accelerating the speed at which predicted SIE is heading towards 0.

Session: 323 The Changing Arctic Ocean - Part 4
L'évolution de l'océan Arctique - Partie 4 **08/06/2021 15:00**

ID: 10707 Contributed abstract

Poster Order:

Contribution of ocean physics and dynamics to Arctic Ocean warming in global AOGCMs

Oleg Saenko [1]

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Presented by / Présenté par: ***Oleg Saenko***
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Using an ensemble of atmosphere-ocean general circulation models (AOGCMs) and a climate change experiment where atmospheric CO2 concentration increases at 1% per year, this presentation focuses on the contributions to the Arctic Ocean warming from ocean physical parameterizations and resolved dynamical processes. Analysis of heat budget diagnostics reveals that in a statistical steady state, the heat is supplied to the Arctic Ocean along the boundary by large-scale circulation. This is balanced by mesoscale and submesoscale eddies (parameterized in these AOGCMs) fluxing heat from the boundary into the Arctic Ocean interior, and also by small-scale vertical mixing. In response to CO2 increase the Arctic Ocean heat content (HC) increases, more in the Eurasian Basin than in the Canadian Basin, although the spread

among the models is large. The pattern of Arctic Ocean HC change is dominated by the super-residual heat transport, representing large-scale ocean dynamics combined with all parameterized mesoscale and submesoscale eddy effects. In particular, while the large-scale heat convergence in the Arctic Ocean interior increases, the eddy heat supply from the boundary regions decreases, with the latter process dominated by changes in isopycnal heat diffusion. There is also a relationship between the net Arctic Ocean warming and changes in the Atlantic meridional overturning circulation.

Session: 323 The Changing Arctic Ocean - Part 4
L'évolution de l'océan Arctique - Partie 4 **08/06/2021 15:15**

ID: 10894 Contributed abstract

Poster Order:

Climate Models Underestimate Arctic Sea Ice Climate Sensitivity

Glenn Rudebusch [1] , *Frank Diebold* [2]

[1]

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Presented by / Présenté par: ***Glenn Rudebusch***
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Arctic conditions are an integral part of the evolution of future climate change, and as greenhouse gas concentrations have risen, Arctic sea ice has rapidly diminished. Indeed, a fairly steep linear relationship between Arctic sea ice coverage and cumulative carbon dioxide emissions is apparent in the data. We estimate this relationship in CMIP5 and CMIP6 climate model simulations and in the observed data from 1979 to 2019. We find that the sensitivity of Arctic sea ice area to cumulative carbon emissions---the Arctic sea ice carbon-climate response---is significantly greater in the real world than exhibited by climate models of either vintage. Furthermore, little progress in closing this gap appears to have made from the CMIP5 to CMIP6 vintage

Session: 323 The Changing Arctic Ocean - Part 4
L'évolution de l'océan Arctique - Partie 4 **08/06/2021 15:30**

ID: 10909 Contributed abstract

Poster Order:

Observationally-constrained projections of Arctic warming

Yongxiao Liang [1] , *Nathan Gillett* [2] , *Adam Monahan* [3]

1

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Presented by / Présenté par: ***Yongxiao Liang***
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Tropical and subtropical low-level cloud properties can well explain the inter-model difference on climate warming projections. We apply multiple physical-meaningful low cloud metrics by climatological variables that are chosen by climate feedback decomposition test, as potential indicators, to constrain future climate warming in Arctic using the latest Sixth Coupled Model Intercomparison Project (CMIP6) multi-model ensemble. To avoid the overfitting of emergent constraint by all candidate metrics, we first build multivariate linear regression models with reduced metrics based on a step-wise selection approach. We find the major improvements of prediction ability contributed by selected low-level cloud metric revealed in cross-validation test come from in Arctic, western Eurasia and northern North America. The linear regression approach with selected low-level cloud metrics estimates robustly on constrained uncertainty with cross-validation evaluation in most Arctic region except Greenland sea and Barent sea. Applying observed low cloud metrics to constrain Arctic warming, we reveal that, for both lower and upper bound with both SSP 5-8.5 and SSP 1-2.6, unconstrained projections may overestimate warming in Artic region compare with constrained projections.

Session: 342 The Changing Arctic Atmosphere - Part 3
L'évolution de l'atmosphère arctique - Partie 3 **08/06/2021 14:30**

ID: 10783 Contributed abstract

Poster Order:

Performance of the Canadian deterministic prediction systems over the Arctic during the winter and summer YOPP Special Observing Periods

Barbara Casati [1] , *Tom Robinson* [2] , *François Lemay* [3] , *Jason Milbrandt* [4] , *Greg Smith* [5] , *Eva Mekis* [6] , *Franck Lespinas* [7] , *Vincent Fortin* [8] , *Morten Køltzow* [9] , *Thomas Haiden* [10]

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Presented by / Présenté par: ***Barbara Casati***
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As contribution to the Year of Polar Prediction (YOPP), Environment and Climate Change Canada has developed the Canadian Arctic Prediction System (CAPS, 3 km grid-spacing), that has been running in experimental mode since February 2018. The Meteorological Service of Canada is also running two other operational systems that cover the Arctic: the Regional Deterministic Prediction System (RDPS, 10 km grid-spacing) and the Global Deterministic Prediction System (GDPS, 25 km grid-spacing). The performance of these three systems over the Arctic has been monitored and routinely compared during 2018, both subjectively and with objective verification scores. This work presents the results of the surface variable objective verification for the Canadian deterministic prediction systems during YOPP, focusing in particular on the Arctic Special Observing Periods (Feb-March and July-Aug-Sept 2018). All three systems exhibit a diurnal cycle in the near- surface temperature biases. All three systems systematically over-predict weak winds and under-predict strong winds; CAPS outperforms RDPS and GDPS in predicting near-surface wind. In order to mitigate representativeness issues, the model tile temperatures are adjusted to the station elevation by applying standard atmosphere lapse rate: the lapse-rate adjustment reduce the temperature cold biases characterizing mountain terrains. Verification of winter precipitation is performed by adjusting solid precipitation measurements from the under-catch in windy conditions: the Canadian NWP systematic over-forecast, which was artificially inflated by the under-catch, is reduced after the adjustment, to attain neuter bias. These YOPP dedicated intense verification activities have identified some strengths, weaknesses and systematic behaviours of the Canadian deterministic prediction systems at high latitudes: these results can serve as a benchmark, for comparison and further development. Moreover, this YOPP verification exercise has revealed some issues related to the verification of surface variables, and has led to the development of better verification practices for the polar regions (and beyond).

Session: 342 The Changing Arctic Atmosphere - Part 3
L’évolution de l’atmosphère arctique - Partie 3 **08/06/2021**
14:45

ID: 10929 Contributed abstract

Poster Order:

Impact of model resolution on the representation of the wind field along Nares Strat

Kent Moore [1]

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Presented by / Présenté par: ***Kent Moore***
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Nares Strait is a major pathway along which multi-year sea ice leaves the Arctic, an ice class that seen a recent dramatic reduction in extent. The winds that blow along the strait play an important role in modulating this ice export as well as in establishing the Arctic’s largest and most productive polynya, the North Water, that forms at its southern terminus. However, its remote location has limited knowledge of the winds along the strait. Here we use automatic weather station from Hans Island, in the middle of the strait, to assess the ability a set of atmospheric analyses with a common lineage but with varying horizontal resolution to represent the variability in the wind field. We find that the flow is highly bidirectional, consistent with topographic channeling, with the highest wind speeds from the north and that a model resolution of ~9km is required to capture the observed variability. The winds at Hans Island are also found to be representative of variability in the flow along much of Nares Strait.

Session: 342 The Changing Arctic Atmosphere - Part 3
L’évolution de l’atmosphère arctique - Partie 3 **08/06/2021**
15:00

ID: 10994 Contributed abstract

Poster Order:

The lagged impact of autumn surface temperature conditions on the wintertime Beaufort High.

Maria-Fernanda Lozano [1] , *G. W. Kent Moore* [2]

[1]

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Presented by / Présenté par: ***Maria-Fernanda Lozano***

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The Arctic has recently been undergoing a period of rapid warming, resulting in important changes to the sea ice cover as well as to the patterns of atmospheric circulation. During the winter of 2017, the Beaufort High collapsed as a result of the anomalous propagation of cyclones westward from the eastern Arctic. It has been suggested that warm conditions during the autumn of 2016 contributed to the winter collapse by limiting ice growth that provided an additional energy source for cyclones allowing them to propagate farther into the Arctic. We explore this hypothesis through the application of seasonally multivariate empirical orthogonal functions (MEOFs). The MEOFs were calculated for the autumn surface air temperature (SAT) field and the winter sea level pressure (SLP) anomaly field for the Arctic region from the ERA5 reanalysis for the period 1979-2020. The leading seasonally lagged MEOF suggests that a positive relationship exists between autumn SATs and the Arctic Oscillation (AO) during the following winter. A complementary relationship is found for autumn sea ice concentration anomalies and the winter AO. These results suggest that a seasonally lagged link exists between surface conditions in the autumn and Arctic cyclone activity in the following winter that can modulate the intensity of the Beaufort High. The implications of this kink on the Arctic climate will be discussed.

Session: 342 The Changing Arctic Atmosphere - Part 3
L'évolution de l'atmosphère arctique - Partie 3 **08/06/2021 15:15**

ID: 11090 Contributed abstract

Poster Order:

The consequences of increased global latent heating for the Arctic Atmosphere

Robert Fajber [1] , *Paul Kushner* [2] , *Kyle Armour* [3] , *Aaron Donohoe* [4]

[1] University of Washington
[2] University of Toronto
[3] University of Washington
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Presented by / Présenté par: ***Robert Fajber***
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Under global warming, atmospheric moisture and latent heating increase; however the impacts of this on Arctic warming are unclear. For instance, increased water vapor transport could create latent heating in the Arctic atmosphere or reduce the effects of longwave cooling. Alternatively, latent heating at remote latitudes could create warm airmasses, which are subsequently transported to the atmosphere. In order to capture this second mechanism, we use heat tags - passive tracers which track the sources of heat from remote latitudes - to attribute the increase in polar heat content between latent heating and other physical processes. The use of heat tags allows us to quantify both the local and remote impacts of the hydrological cycle. In an idealized model, we find that the warm air masses created through latent heating outside the poles contribute between 50% and 70% of the dry static energy (potential temperature) within the polar troposphere. Under a CO_2 doubling, we show that it is the transport of warm air from remote latitudes that dominates the increase in polar heat content in our idealized model, and not the transport of water vapor. The results show the importance of the global hydrological cycle in maintaining the heat content of the polar regions, and the importance of remote latent heating in understanding polar amplification.

Session: 342 The Changing Arctic Atmosphere - Part 3
L'évolution de l'atmosphère arctique - Partie 3 **08/06/2021 15:30**

ID: 11137 Contributed abstract

Poster Order:

Impacts of Arctic climate change on synoptic cyclones

Minghong Zhang [1] , *Will Perrie* [2] , *Zhenxia Long* [3]

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Presented by / Présenté par: ***Minghong Zhang***
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The Arctic has experienced dramatic changes over recent decades, and is projected to have ice-free summers by the 2050s in the IPCC5 future climate scenarios. It has been suggested that these changes in environmental conditions have led to an increase in frequencies and intensities of extreme cyclones and related changes in air-sea interactions. Coarse resolution GCMs tend to underestimate the number and intensities of these small-scale systems, thereby leading to deficiencies in their estimates for the poleward energy transport, and associated surface heat fluxes and radiation associated with clouds, in high latitudes and in the Arctic. In our study, we conducted a simulation of the Arctic climatology using a high-resolution implementation of

the Polar WRF3.6 model, driven by coarse resolution climate model HadGEM-ES2 outputs, following IPCC5 climate scenarios RCP8.5, 4.5 and 2.6. Polar WRF results provide significantly improved simulations of the frequency and intensity of cyclones, compared to the HadGEM2-ES simulations over the historical period. In the RCP8.5 climate scenario, by end-of-the-century, the Arctic is expected to be largely ice-free. Moreover, the surface circulation system the Beaufort High becomes weakening during both winter season (NDJF), when the ice is advancing, and in the ice-free summer season (JASO), which is associated with the increased frequency and intensity of Arctic cyclones. In the RCP4.5 and 2.6 scenarios, these surface systems show consistent but weaker trends. We also discuss the mechanisms for such responses.

Day 8 – 9 June 2021

Oral

Session: 910 Hydrologic Modelling of Floods and Droughts
Modélisation hydrologique des inondations et des sécheresses

09/06/2021 12:30

ID: 10643 Invited session speaker

Poster Order:

Spatial flood coherence needs more attention in hydrologic modeling

Manuela Brunner [1], *Lieke Melsen* [2], *Andrew Wood* [3], *Oldrich Rakovec* [4], *Naoki Mizukami* [5], *Wouter Knoben* [6], *Martyn Clark* [7]

[1] University of Freiburg
[2] Wageningen University
[3] National Center for Atmospheric Research
[4] Helmholtz Centre for Environmental Research
[5] National Center for Atmospheric Research
[6] University of Saskatchewan Coldwater Laboratory
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Presented by / Présenté par: ***Manuela Brunner***
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Floods can have particularly severe impacts if they affect large regions. Such widespread flood events occur in regions where flood occurrence is spatially coherent thanks to shared flood generation processes. These spatial flood dependencies, which vary by region and season, need to be realistically

represented in hydrological models to derive reliable regional flood hazard and risk assessments. However, uncertainties in simulated floods can be considerable, particularly when assessments go beyond the local scale. Here, we evaluate the extent to which an ensemble of different models calibrated according to standard model calibration metrics such as the widely used Kling-Gupta efficiency are able to capture flood spatial coherence. We assess model performance for a large sample of catchments in the United States using four different hydrological models. Our results show that modeling both local and particularly spatial flood characteristics is challenging because models underestimate flood magnitude and might not well represent flood timing. We conclude that local calibration on the integrated Kling-Gupta metric alone is likely to yield a suboptimal representation of spatial flood dependencies, which limits the reliability of hydrological models for regional hazard and risk assessments both under current and future climate. We highlight that such assessments may be improved by developing flood-focused, multi-objective, and spatial calibration metrics and by considering data input uncertainty.

Session: 910 Hydrologic Modelling of Floods and Droughts Modélisation hydrologique des inondations et des sécheresses

09/06/2021 12:48

ID: 10801 Invited session speaker

Poster Order:

One size does not fit all: Leveraging flexibility of hydrological model structure for improved prediction

James Craig [1] , *Genevieve Brown* [2] , *Robert Chlumsky* [3] , *Juliane Mai* [4] , *Niels Schütze* [5] , *Diana Spieler* [6] , *Bryan Tolson* [7]

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[2] Northwest Hydraulics Consultants, Inc.
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[7] University of Waterloo

Presented by / Présenté par: ***James Craig***
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Historically, land surface schemes and hydrological models have used a single fixed set of algorithms for representing the various components of the water cycle, occasionally with a handful of options to adjust equations for PET

estimation or soil characteristics. In the past decade, however, a number of flexible modelling frameworks such as SUPERFLEX, SUMMA, and Raven have emerged which do not constrain the modeler to a given model structure or fixed set of constitutive relations; these models can support tens of thousands of distinct alternative model conceptualizations. This opens up new avenues for improving model prediction of floods and droughts by providing the ability to (1) test various conceptual models of a watershed, (2) independently assess incremental structural model improvements, (3) support stepwise model improvement, (4) vary landscape-specific water cycle representation across a watershed, and (5) simultaneously calibrate model structure and parameters to historical data. Models which benefit from these features, especially when augmented with rigorous treatment of water management and land use change, may be better equipped to support simulation of floods and droughts for risk assessment and planning. This talk provides an overview of recent successes in leveraging model flexibility to improve the accuracy and fidelity of hydrologic models for practical application. Case studies of successful manual structure calibration and assessment for flood and reservoir inflow simulation are presented; some of the first attempts to use automatic calibration to identify model structure are discussed. These include a mixed automatic model structure identification (AMSI) and a novel blended model structure calibration (BMSC) approach which converts the structural optimization problem into continuous state space. Some future challenges associated with leveraging the power of flexible model frameworks are identified.

Session: 910 Hydrologic Modelling of Floods and Droughts Modélisation hydrologique des inondations et des sécheresses

09/06/2021 13:06

ID: 11099 Contributed abstract

Poster Order:

Integrating climate change into present-day engineering design decisions – The City of Grand Forks case study

Lawrence Bird [1]

1

Presented by / Présenté par: ***Lawrence Bird***
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In recent years, the need to consider future climate change has moved to the forefront of present-day engineering design decisions. With flood frequency and magnitude expected to change considerably into the future, there is an ever-

present need for practitioners to integrate future conditions into current flood mitigation design. Understanding changes to the hydrologic regime and flood characteristics of interior British Columbia watersheds presents unique challenges due to their multifaceted flood responses. In response to catastrophic flooding in 2018, and consistent with their commitment to “building back better” and reducing future flood risk, the City of Grand Forks is completing a comprehensive, city-wide, Flood Mitigation Program (FMP). The FMP includes schematic design of the overarching structural and non-structural flood mitigation works on the Kettle and Granby Rivers, two large river systems in interior BC. With a design life of 50-80 years, proposed flood mitigation works must be resilient against future climate change. To support hydraulic modelling and subsequent engineering design, Associated Environmental Consultants Inc, a subsidiary of the Associated Engineering Group of Companies, completed a hydrologic and climate change assessment to determine potential changes to peak flow events into the future. This presentation aims to demonstrate how climate change analysis can be integrated into risk-informed decision making and support engineering design to increase a community’s resilience and reduce disaster risk.

Session: 910 Hydrologic Modelling of Floods and Droughts Modélisation hydrologique des inondations et des sécheresses

09/06/2021 13:24

ID: 10778 Contributed abstract

Poster Order:

A new approach for modelling the spatial extent of agricultural drought

Seoncheol Park [1] , *Francis Zwiers* [2]

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Presented by / Présenté par: ***Seoncheol Park***
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We present a new statistical method for analyzing the extreme drought as indicated by the Standardised Precipitation-Evapotranspiration Index (SPEI). The method takes advantage of a conditional spatial extreme modelling approach, which a spatial extension of recently developed class of conditional multivariate extreme models. The development of such models is an ongoing research topic in statistics. We suggest a new approach by adopting a nonlinear regression method using estimation results from a combination of multiple

pairwise parameter estimation procedure. We apply such models to gridded SPEI datasets for Canada that are derived from observations and CMIP5 climate simulations in order to understand the likely spatial extent of an extreme drought event given that given that an extreme event has been observed at a given location of interest. This application of the modes is illustrated by considering several cases where conditioning is performed on the occurrence of extreme drought at several Canadian locations with different climatic characteristics. The estimation of the joint occurrence of drought at two locations as a function of distance based on the estimation result of the conditional spatial extremes model is also provided.

Session: 910 Hydrologic Modelling of Floods and Droughts Modélisation hydrologique des inondations et des sécheresses

09/06/2021 13:42

ID: 10826 Contributed abstract

Poster Order:

Climatic Changes to Streamflow and Snow Indicators Used in Decision Making in British Columbia

Arelia Schoeneberg [1] , *Markus Schnorbus* [2]

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Presented by / Présenté par: ***Arelia Schoeneberg***
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In British Columbia (BC) streamflow drought dominates operations in many sectors, including water supply, agriculture, oil and gas extraction, and hydropower generation. Therefore, accurate projections of the magnitude and occurrence of future droughts is necessary for effective infrastructure planning and management. Throughout most of BC, changes to snowpack accumulation and melt are expected to be a key driver of changes to late-summer low flows and future loss of snowpack may result in more frequent and intense summer streamflow droughts. By using the Pacific Climate Impacts Consortium’s most recent hydrologic projection results, we evaluated the change in annual maximum snow water equivalent and late-summer (July-August-September) streamflow. Results are based on an upgraded version of the Variable Infiltration Capacity (VIC) model that couples to a dynamic glacier model (RGM) and has been calibrated using observations of streamflow, snow covered area, glacier mass balance and evaporation. The analysis considers snow and streamflow changes under four future warming levels, 1.5°C, 2°C, 3°C and 4°C

in the Peace, Fraser and Columbia River basins, a region stretching from 41°N to 58°N and covering a wide range of hydro-climatic zones. After 2°C of Global Mean Temperature (GMT) increase, sub-basins at lower elevations in the Peace, Fraser and Columbia experience a decline in annual maximum snowpack of 20%-60% and a decline of late-summer streamflow of 7%-71%. Declines are greatest further south. Further north and at higher elevations, basins are buffered to change until 3°C GMT. We present results in metrics used for engineering design, water policy development and water supply forecasts to bridge the gap between climate science and decision making.

Session: 740 Building Climate Resilient Communities - Part 1 Bâtir des communautés à l'épreuve des changements climatiques - Partie 1 **09/06/2021 12:30**

ID: 10860 Contributed abstract

Poster Order:

Building Climate Resilient Communities – International Dimensions

Gordon McBean [1]

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Presented by / Présenté par: ***Gordon McBean***
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In 2015, Canada and almost all other countries agreed to the Global Agenda 2030, consisting of: the Paris Agreement on Climate Change; the Sustainable Development Goals; and the Sendai Framework for Disaster Risk Reduction. Canada responded in 2016 with the Pan-Canadian Framework on Clean Growth and Climate Change which identifies actions to reduce emissions and for adaptation and climate resilience. The Paris Agreement's Article 7 states: "Parties hereby establish the global goal on adaptation." The 17 Sustainable Development Goals include goals on poverty, hunger, health, education, gender equality, decent work and economic growth and on building resilient infrastructure. The Global Commission on Adaptation's recent report states: "Global actions to slow climate change are promising but insufficient. We must invest in a massive effort to adapt to conditions that are now inevitable…" The World Economic Forum's Global Risk Reports rank the global risks for events within the next 10 years. The 2021 Report's Executive Summary states that: "Climate continues to be a looming risk as global cooperation weakens". They further state that "Climate change—to which no one is immune—continues to be a catastrophic risk. Although lockdowns worldwide caused global emissions to fall in the first half of 2020, evidence from the 2008–2009 Financial Crisis warns

that emissions could bounce back. A shift towards greener economies cannot be delayed until the shocks of the pandemic subside" and. "Climate action failure" is the most impactful and second most likely long-term risk identified in the Global Risks Perception Survey (GRPS." Extreme Weather Events are ranked as the most likely high impact risks. This information provides a global dimension to addressing the actions for building climate resilient communities in Canada.

Session: 740 Building Climate Resilient Communities - Part 1 Bâtir des communautés à l'épreuve des changements climatiques - Partie 1

09/06/2021 12:45

ID: 11167 Contributed abstract

Poster Order:

Heat Environments of Canadian Communities

Iain Stewart [1] , *James Voogt* [2]

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[2] Department of Geography and Environment, Western University

Presented by / Présenté par: ***James Voogt***
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Canadian communities need to build resilience to large-scale climate change. In our communities, this change and its associated higher temperatures are worsened by local-scale modifications to the environment brought about by urbanization, which further raises local temperatures. The result is a higher level of risk to the effects of heat on our urban communities. These effects have repercussions on thermal comfort, energy use, air quality and heatwaves experienced by urban residents. This review is part of a larger project examining the resilience of Canadian communities to climate change. Our portion summarizes academic work done in Canadian cities using observational and modeling approaches as well as applied studies that examine the heat environment at the urban scale. Synthesis of this work is intended to provide the state of knowledge on the thermal conditions that exist in Canadian cities, actions that have or are being undertaken towards improved heat adaptation and an identification of knowledge strengths and gaps. Based on this review, we will present several areas of targeted research for building heat resilient communities. These include heat warning systems and heat risk mapping for Canadian communities, heat monitoring at the community scale, nature-based solutions and equity issues related to urban heat exposure. We also examine the transfer of approaches that have been employed in other countries to help

build resilience to urban-scale heat for their likely applicability to Canadian communities.

Session: 740 Building Climate Resilient Communities - Part 1 Bâtir des communautés à l'épreuve des changements climatiques - Partie 1 **09/06/2021 13:00**

ID: 10967 Contributed abstract

Poster Order:

Cities Adapt to Extreme Wildfires

Paul Kovacs [1] , *Sophie Guilbault* [2] , *Esther Lambert* [3] , *Robin Kovacs* [4]

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Presented by / Présenté par: ***Esther Lambert***
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Extreme weather and climate contribute to billions of dollars of insured losses annually in Canada, with significant amounts of additional uninsured losses. Opportunities exist for municipalities to reduce these losses. The Institute for Catastrohphic Loss Reduction (ICLR) celebrates successful municipal adaptation through its "Cities Adapt" series, the latest issue of which focuses on Canadian cities adapting to wildfires. We engaged leaders in municipal governments across Canadian provinces and territories to investigate and document wildfire risk reducing actions taken by 20 communities located in the wildland-urban interface. We found that actions taken were consistent with the Sendai Framework for Disaster Risk Reduction's four priorities for action: building back better in recovery, understanding disaster risk, strengthening disaster risk governance and investing in disaster risk reduction. In this presentation, a selection of case studies is highlighted to demonstrate how local leadership is making a positive impact by heightening the preparedness and climate resilience of communities. For each community, the science, trigger, adaptation approach, and outcomes of these policies, plans and projects were examined to identify key lessons learned and best practice for wildfire risk reduction. These cases highlight the role played by the occurrence of wildfires in or near communities in triggering adaptation actions. Communities can often use the recovery after a wildfire to improve their resilience against future events. Many communities built a stronger understanding of fire risk through formal assessments and developed community wildfire protection plans. The case

studies also highlight the importance of building and maintaining coalitions between different stakeholders, as well as public awareness and engagement, and the value in homeowners adopting best practice protocols like FireSmart®. While local leadership is making a positive difference, we acknowledge the need for more action, particularly in areas where development continues to grow without appropriate risk reduction actions.

Session: 740 Building Climate Resilient Communities - Part 1 Bâtir des communautés à l'épreuve des changements climatiques - Partie 1

09/06/2021 13:15

ID: 10993 Contributed abstract

Poster Order:

Building Climate Resilient Communities and Health Systems

Anna Gunz [1] , *Peter Berry* [2] , *Isaac Luginaah* [3] , *Kristin Clemons* [4] , *Piotr Wilk* [5] , *Brianna McKelvie* [6]

[1] Western University
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Presented by / Présenté par: ***Anna Gunz***
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Climate change is impacting the health of Canadians, their communities and their health systems and risks continue to grow with further warming. Climate resilient communities and health systems have the needed information, tools and capacity to protect the health of individuals from current climate hazards and are prepared to withstand even more severe and frequent events. This session will provide an overview of the health impacts of climate change at the individual and community levels, with special attention to inequitable effects on the disease burden. Growing risks to health care systems in Canada, including special challenges faced in rural, remote, Northern and Indigenous communities are then described along with potential adaptation strategies to improve the resilience of communities and the health care sector to the impacts of climate change. Increasing climate resilience will require that decision makers in the health sector collaborate closely with those in other health-relevant sectors, for example, on the integration of early-warning systems, expansion of large-scale urban cooling strategies, and the support of more resilient urban-design,

including ecosystem-specific greenspace infrastructure. At the level of health care system, increased efforts will be needed to adapt to key health risks facing Canadians including those related to extreme heat, air pollution, extreme weather events, food and water safety and security. Special attention will be required to address the mental health impacts of climate change due to the expected increased burden that psychoterratic disorders and collective grief on the population. Innovative, culturally-, and community-specific approaches should be encouraged that address environmental racism and promote social justice and health. There is also an opportunity and need to build on international efforts to develop more climate resilient and environmentally sustainable facilities and infrastructures, including actions to reduce emissions of GHGs and achieve significant health co-benefits from these actions.

Session: 740 Building Climate Resilient Communities - Part 1 Bâtir des communautés à l'épreuve des changements climatiques - Partie 1 **09/06/2021 13:30**

ID: 11020 Contributed abstract

Poster Order:

Adaptation in Indigenous Communities

Brennan Vogel [1], *Lily Yumagulova* [2]

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Presented by / Présenté par: ***Brennan Vogel***
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Resiliency and adaptation to climate change risks in Indigenous communities encounter unique barriers and opportunities for climate change policy, planning and program implementation. This presentation will offer a knowledge synthesis of key themes related to adaptation and resiliency in Canadian Indigenous communities, as a part of the Climate Change: Risk Resilience Response session to be addressed at CMOS 2021.

Session: 643 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 4 Observation de la Terre depuis l'espace : informations essentielles sur notre planète - Partie 4 **09/06/2021 12:30**

ID: 10665 Contributed abstract

Poster Order:

Satellite Observations of Landfast Ice in the Beaufort Sea Region: Features and Trends in the 21th Century

Alexander Trishchenko [1], *Yi Luo* [2], *Vladimir Kostylev* [3], *Calin Ungureanu* [4], *Dustin Whalen* [5], *Junhua Li* [6]

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[2] Canadian Ice Service (CIS), ECCC
[3] Geological Survey Canada (GSC) – Atlantic, Natural Resources Canada (NRCan)
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[5] Geological Survey Canada (GSC) – Atlantic, Natural Resources Canada (NRCan)
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Presented by / Présenté par: ***Alexander Trishchenko***
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The landfast ice (LFI) in the Beaufort Sea region is a prominent climatological feature. The LFI is generally defined as stable immobile near-shore ice that remains fast along the coast and forms seaward from the land. It affects the coastline dynamics, near-shore ecosystems, wildlife, and human socio-economic activities. Two decades (2000-2019) of the landfast ice properties in the Beaufort Sea region were analyzed at 250-m spatial resolution from two sources: 1) monthly LFI maps derived at the Canada Centre for Remote Sensing (CCRS) from the Moderate Resolution Imaging Spectroradiometer (MODIS) clear-sky satellite image composites; 2) Canadian Ice Service (CIS) charts. Detailed comparisons have been conducted for three LFI parameters: 1) the total area (spatial extent) occupied by LFI; 2) the water depth at the outer seaward LFI edge, and 3) the distance from the coast to the outer seaward LFI edge. Five sub-regions have been selected to study the LFI properties: 1) Alaska coast; 2) Barter Island to Herschel Island stretch; 3) Mackenzie Bay; 4) Richards Island to Cape Bathurst stretch, and 5) Banks Island coast. The CCRS and CIS results demonstrated good agreement in general. We observed around a 7% difference between average LFI extent from CCRS and CIS data with a correlation equal to 0.77. The details of approach, features, statistics, as well as long-term climatic trends for the entire region, and sub-regions will be presented and discussed. This work is supported through the NRCan Climate Change

Records as part of the Cumulative Effects program.

Session: 643 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 4 Observation de la Terre depuis l'espace : informations essentielles sur notre planète - Partie 4 **09/06/2021 12:45**

ID: 10638 Contributed abstract

Poster Order:

Large-scale Arctic sea ice motion from Sentinel-1 and the RADARSAT Constellation Mission

Stephen Howell [1] , *Mike Brady* [2] , *Alexander Komarov* [3]

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[3] Environment and Climate Change Canada

Presented by / Présenté par: ***Stephen Howell***
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Recently, the sea ice community has entered a new era of synthetic aperture radar (SAR) satellites operating at C-band with the launch of Sentinel-1A in 2014, Sentinel-1B in 2016 and the RADARSAT Constellation Mission (RCM) in 2019. These missions represent a collection of 5 spaceborne SAR sensors that together can routinely cover Arctic sea ice with a high spatial resolution (20-90 m) but also with a high temporal resolution (1-7 days) typically associated with passive microwave sensors. Here, we used ~32,000 SAR images from Sentinel-1AB (S1) together with ~29,000 SAR images from RCM to generate large-scale sea ice motion (SIM) estimates across the pan-Arctic domain for 2020. Results indicate that combining S1+RCM provides more SIM estimates in Hudson Bay, Davis Strait, the Beaufort and Bering Seas as well as the over the North Pole compared to S1 alone. Additional SIM vectors provided by combining S1+RCM also results in improved SIM characterization along the marginal ice zone from the Beaufort Sea to the Eastern Siberian Sea. We found the average uncertainty of S1+RCM SIM to be ~0.75 km/day for most regions across the Arctic, but uncertainty increased to upwards of 1.4 km/day, as the marginal ice zone develops in the Chukchi, East Siberian, and Greenland Seas during the melt season. Compared to the National Snow and Ice Data Center (NSIDC) Polar Pathfinder and Ocean and Sea Ice-Satellite Application Facility (OSI-SAF) SIM products, S1+RCM ice speed was found to be over 1 km/day faster attributed to the higher spatial resolution of SAR imagery and the output SAR SIM vector fields. Overall, our results demonstrate that SIM across the

pan-Arctic domain can now be generated from multi-sensor SAR images at both high spatial and temporal resolution.

Session: 643 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 4 Observation de la Terre depuis l’espace : informations essentielles sur notre planète - Partie 4 **09/06/2021 13:00**

ID: 10721 Contributed abstract

Poster Order:

Using CloudSat-CPR estimates of snowfall to constrain gridded snow water equivalent products

Fraser King [1] , *Christopher Fletcher* [2]

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Presented by / Présenté par: ***Fraser King***
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Changes in the quantity of Arctic snow have far-reaching implications to the global water-energy budget, ecosystem development and cold region flooding. Snow water equivalent (SWE) is a useful metric for measuring these changes, however the locations of in situ SWE measurement sites are sparsely distributed at high latitudes due to the cost of maintaining equipment in extremely cold and remote regions. Remote sensing instruments are well positioned to fill these measurement gaps due to their remote orbit and improved spatial coverage. NASA's CloudSat satellite is equipped with a cloud profiling radar (CPR) instrument which is capable of generating vertical reflectivity profiles describing interior cloud structures. These profiles can be used to identify precipitating clouds and derive estimates of surface snowfall rates. Regression analyses examining the relationship between consecutive month-pair estimates of average accumulated SWE from CloudSat, and the positive difference in SWE on ground over the same period in the Blended-4 (B4) gridded SWE product, allows us to identify outlier periods of atypical accumulation. Applying this process to a case study at Resolute Bay in the Canadian high Arctic identified an unphysical January 2008 melt event in B4 which could then be traced back to an assimilated in situ measurement error at the station. Generalizing this technique to a 1\degree~grid from 60\degree~to 82\degree~N, and tallying the total number of outliers per grid-cell, generates a quality flag dataset of 5781 total outliers. This quality flag dataset acts as an additional confidence metric for gridded products to highlight areas and periods

of potentially anomalous accumulation. CloudSat is uniquely positioned as one of the only observational datasets for observing snowfall at high latitudes, and when combined with the methodology developed in this work, its estimates can be used to further enhance the accuracy of current gridded SWE products.

Session: 643 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 4 Observation de la Terre depuis l’espace : informations essentielles sur notre planète - Partie 4 **09/06/2021 13:15**

ID: 10854 Contributed abstract

Poster Order:

Characteristics of the convectively injected moisture plumes in the extratropical lower stratosphere and their observability by satellite instruments

Xun Wang [1] , *Yi Huang* [2] , *Zhipeng Qu* [3]

[1] McGill University
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[3] Environment and Climate Change Canada

Presented by / Présenté par: ***Xun Wang***
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Convective transport is an important source for water vapor in the extra-tropical lowermost stratosphere. There has been observational evidence of elevated water vapor mixing ratio in this region in relation to strong overshooting convections, although it has been a challenge to quantify the convective moistening effect from either in situ or satellite measurements. Previous studies have detected both hydration and dehydration above deep convections and identified mixing between the tropospheric source and stratospheric ambient air to be an important process. It is not well understood, however, how the moisture plumes evolve after they are convectively transported into the stratosphere; it is also unclear whether the plume characteristics during its evolution can be monitored by present satellite sensors. In this study, we use data from a high-resolution numerical weather prediction model, Global Environmental Multiscale, to investigate a simulated convective event over North America in August 2013. We characterize the trajectory, characteristic size and humidity dilution rate of the moisture plumes after entering the stratosphere, when driven by prevailing wind, diabatic heating and mixing processes. In light of the new satellite instruments that are developed to observe the upper troposphere and lower stratosphere region, we test whether the plume features can be properly

observed by these instruments.

Session: 643 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 4 Observation de la Terre depuis l’espace : informations essentielles sur notre planète - Partie 4 **09/06/2021 13:30**

ID: 10767 Contributed abstract

Poster Order:

Satellite observation of thermodynamic conditions in the tropical tropopause layer under the impact of tropical cyclones

Jing Feng [1] , *Yi Huang* [2] , *Zhipeng Qu* [3]

[1]

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Presented by / Présenté par: ***Jing Feng***

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The tropical tropopause layer (TTL) is the transition layer between the troposphere and the stratosphere. Tropical cyclones may impact the TTL by perturbing the vertical distributions of cloud, temperature, and water vapor, although this impact is poorly quantified due to the lack of collocated data. To address this issue, an infrared hyperspectra-based observational dataset of collocated temperature and water vapor profiles above deep convective clouds is developed by implementing a synergetic retrieval method that combines the A-Train satellite observations that overpass tropical cyclone events. This study detects the signature of cyclone impact on the distribution patterns of cloud, water vapor, temperature, and radiation by compositing these thermodynamic fields with respect to cyclone center locations. It is found that tropical cyclone events considerably increase the occurrence of TTL clouds, which mostly dominated by cirrus clouds above a clear troposphere. The major source of TTL cloud ice, however, is found to be overshooting deep convections that penetrate the bottom of TTL. The synergetic retrieval discloses a vertically oscillating pattern of temperature anomalies over tropical cyclones, with warming near the cloud top (around 16 km) and cooling above. The column-integrated water vapor above overshooting deep convections is found to be on average 40 $\%$ higher than the climatology. It is found that tropical cyclones predominantly cool the TTL due to cloud radiative cooling. Furthermore, radiative calculations using retrieved thermodynamic profiles suggest that TTL hydration is usually

associated with radiative cooling of the TTL, which inhibits the diabatic ascent of moist air. The radiative balance of the TTL under the impact of the cyclone, therefore, is not in favor of maintaining the moist anomalies in the TTL or transporting water vertically to the stratosphere.

Session: 230 Atmospheric Rivers and Extratropical Cyclones: Dynamics, Classification, and Prediction - Part 1
Rivières atmosphériques et cyclones extratropicaux : dynamique, classification et prédiction - Partie 1 **09/06/2021 12:30**

ID: 10658 Contributed abstract

Poster Order:

A New Scale to Classify Extratropical Cyclones and Atmospheric Rivers: Recent Case Studies

Rita So [1] , *Matthias Jakob* [2] , *Melinda Brugman* [3] , *Ruping Mo* [4]

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Presented by / Présenté par: ***Rita So***
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A new multi-variate extratropical cyclone–atmospheric river (ECAR) scale is being developed for western Canada to support operational forecasting and warning preparedness to enhance public safety. It is calibrated on the potential hazards scaled to the expected storm impacts. The new scale uses a weighted average to rate storms by considering regionally-significant impacts. The hazard variables include storm characteristics such as integrated vapour transport, total precipitation, precipitation intensity and their respective return periods, the area of the predicted affected region, and total storm runoff. Each rating is linked with the likely consequences based on back-analysis of historical events to improve communication of potential impact severity and risk. A web-based mapping interface was developed to show the forecast ECAR rating, using the operational 10-day forecast from the Global Deterministic Prediction System (GDPS) of Environment and Climate Change Canada for climate stations in British Columbia and Yukon. Currently, the region-specific hazards are estimated for the low elevation locations in North Vancouver, BC and further assessment and calibration are necessary for application to other reasonably homogenous hydroclimatic regions. We applied the ECAR scale to recent case studies using the GDPS forecast and ECMWF Reanalysis v5 data. Through

these case studies, we assess the suitability of the current ECAR scale for the different regions and demonstrate how its ratings compare with that of the existing Atmospheric River Scale used in western United States. Finally, we discuss future scale refinements in the scale based user community consultations to date. We aspire that the proposed scale, once calibrated for specific regions, improves warning preparedness for impactful storms in western Canada.

Session: 230 Atmospheric Rivers and Extratropical Cyclones: Dynamics, Classification, and Prediction - Part 1
Rivières atmosphériques et cyclones extratropicaux : dynamique, classification et prédiction - Partie 1 **09/06/2021 12:45**

ID: 11143 Contributed abstract

Poster Order:

Heavy Precipitation Shifted Downwind by Strong Moist Jets Helped Trigger Major West Coast Landslides During 2020

Melinda Brugman [1] , *Ruping Mo* [2] , *Matthias Jakob* [3] , *Marc Beauchemin* [4] , *Rita So* [5]

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Presented by / Présenté par: ***Melinda Brugman***
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During 2020, multiple strong moist jets, or atmospheric rivers associated with mid latitude cyclones affected the west coast of British Columbia and southeastern Alaska, delivering repeated events of localized heavy precipitation. In this paper, three cases are compared which resulted in landslides causing substantial impacts to roads, infrastructure, homes, forests and, in some cases, loss of life. The three events occurred after large repeated atmospheric rivers delivered heavy precipitation to the BC and southeastern Alaskan regions. All three major landslide slope failure events (Jan 31-Feb 1 at Sasquatch Ski Area; Nov 28 at Bute Inlet area and December 1-2 at Haines Alaska) occurred after very heavy rainfall but were also preceded by snow fall followed by snow melt. Accurate precipitation forecasts are essential for alerting severe storms, and models differ considerably due to variability in model microphysics. Models that included more advanced hydrometeor drift led forecast heavier precipitation amounts in regions where landslides and major road washouts occurred. They also showed precipitation shifts inland and much more precipitation in the regions directly hit by atmospheric rivers, where large landslides occurred. This brought not only heavy snow followed by heavy rain but also strong warming, as the atmospheric river penetrated further inland. Results show that long-range precipitation forecasts would greatly benefit by the inclusion of more advanced hydrometeor schemes and terrain interaction physics, even with coarser gridded models. Accurate long range alerting of heavy precipitation is strongly dependent on model choice and will be improved when CMC operational long range models are upgraded using their new advanced physics which includes hydrometeor drift downwind in strong flows.

Session: 230 Atmospheric Rivers and Extratropical Cyclones: Dynamics, Classification, and Prediction - Part 1
Rivières atmosphériques et cyclones extratropicaux : dynamique, classification et prédiction - Partie 1 **09/06/2021 13:00**

ID: 11045 Contributed abstract

Poster Order:

High-Impact Weather Review: Analysis of a Powerful Atmospheric River System Affecting the South Coast of British Columbia during 29 January–01 February 2020

Matthew MacDonald [1] , *Ruping Mo* [2] , *David Campbell* [3] , *Ashlee Jollymore* [4] , *Matthias Jakob* [5] , *Shunli Zhang* [6] , *Giselle Bramwell* [7] , *Baljit Sekhon* [8]

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Presented by / Présenté par: ***Matthew MacDonald***
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A very strong atmospheric river (AR) system developed over the northeastern Pacific Ocean and made three consecutive landfalls over coastal British Columbia (BC), Canada over a four-day period spanning January 29th to February 1st, 2020. The final landfalling storm (occurring during the last two days of the storm cycle) had the most severe impact, dispensing total precipitation amounts exceeding 370 mm on the west side of Vancouver Island and 160 mm at the north end of Howe Sound on the mainland. The daily precipitation amount observed at one weather station in Metro Vancouver was classified as a 100-year return period event. Numerous impacts were observed, including landslides, extensive flooding and four fatalities attributable to riverbank erosion and road washout. This study focusses on the atmospheric circulation responsible for the setup and maintenance of this powerful AR system, as well as the resulting hydro-meteorological hazards and operational forecast challenges. Our analysis indicates that the observed high-impact weather events were due not only to the intensity and duration of the AR during its last landfall, but also to the high antecedent soil moisture conditions preconditioned by the two previous landfalls of the same AR system. Significant precipitation in January 2020 further contributed to saturated soils leading up to the AR. Overall, the Canadian numerical weather prediction models provided accurate guidance for the AR system, with lead times of up to five days. However, the rainfall amounts and intensities were largely over-forecast for some regions in the Lower Mainland by coarse-resolution models. These models do not consider the hydrometeor drift effect in their quantitative precipitation forecasts (QPFs) and cannot resolve some sub-grid topographic features. High-resolution models, on the other hand, under-forecast the QPFs for these regions mainly because they tend to over-forecast the hydrometeor drift. Orographic over- or under-enhancement issues could also exist with both models. A post-storm simulation using a higher resolution (250 metres), relocatable window system produced a more accurate QPF distribution.

Session: 230 Atmospheric Rivers and Extratropical Cyclones: Dynamics, Classification, and Prediction - Part 1
Rivières atmosphériques et cyclones extratropicaux : dynamique, classification et prédiction - Partie 1 **09/06/2021 13:15**

ID: 11092 Contributed abstract

Poster Order:

A tale of two atmospheric rivers affecting Pacific and Atlantic Canada during 1–2 December 2020

Ruping Mo [1] , *Jim Goosen* [2] , *Melinda M. Brugman* [3] , *Shunli Zhang* [4] , *Marc Beauchemin* [5] , *Rita So* [6] , *Brian Crenna* [7] , *Chris Fogarty* [8]

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Presented by / Présenté par: ***Ruping Mo***
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Through the first two days of December 2020, two powerful atmospheric rivers (ARs) brought heavy precipitation and strong winds to Pacific and Atlantic Canada. This study focuses on the synoptic features and high-impact weather potentials of these ARs. It is shown that both ARs were driven by a cyclone-anticyclone couplet with strong east-west oriented pressure gradients. The associated southerly jet streams brought warm, moist air from the tropical oceans to the extratropical latitudes. The Pacific AR made landfall over the Alaskan Panhandle and was intercepted by the Pacific Coast Range. It generated strong moisture convergence and orographic uplift over the coastal area, and carried some of the condensed water to the leeside of the mountains in southern Yukon and northern British Columbia (BC). There is also evidence of moisture transport through the mountain gaps into the interior. The observed high-impact weather events include heavy snow, heavy rain and strong southerly winds giving blowing snow. The AR on the east coast produced heavy precipitation and some strong winds in the Atlantic Provinces and eastern Quebec through frontal forcing with orographic enhancement. An experimental AR scaling scheme is applied to classify these two systems. The Global Deterministic Prediction System (GDPS, 15-km resolution) of Environment and Climate Change Canada (ECCC) provided a generally good guidance to the AR systems with lead times up to seven days. However, this model failed to predict the heavy precipitation in Yukon and BC because of the lack of hydrometeor drift mechanism in its quantitative precipitation forecast (QPF) scheme and its coarse resolution that cannot resolve some local orographic features. The QPFs from the High-Resolution Deterministic Prediction System (2.5-km resolution) of ECCC are reasonably good. The potential of a higher-resolution model over complex terrain is also explored through a post-storm simulation using a 250-m relocatable window system.

Session: 230 Atmospheric Rivers and Extratropical Cyclones: Dynamics, Classification, and Prediction - Part 1
Rivières atmosphériques et cyclones extratropicaux : dynamique, classification et prédiction - Partie 1 **09/06/2021 13:30**

ID: 11117 Contributed abstract

Poster Order:

Snow and Ice Factors: Including Antecedent Conditions and Sensitivities into Rating Extratropical Cyclones and Atmospheric River Impacts

Melinda M Brugman [1] , *Matthias Jakob* [2] , *Rita So* [3] , *Brian Crenna* [4] , *Gary Geng* [5] , *Alex Cannon* [6] , *Ruping Mo* [7]

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Presented by / Présenté par: ***Melinda M Brugman***
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Antecedent conditions and sensitivities caused by snow and ice play important roles in determining the impacts of intense Extratropical Cyclones (EC) associated with Atmospheric Rivers (AR). The greatest floods on western Canadian river systems in historic times have occurred with deep late snowpacks suddenly transformed by an intense multiday heavy precipitation warming event. Ice (river, lake, sea ice, permafrost or glacier) conditions can further augment storm impacts. In this paper is proposed a new rating ECAR rating scale which includes snow and ice properties so that antecedent conditions and sensitivities are more accurately represented. A cold, dry snowpack or snow that falls ahead of an intense storm may mute the impacts of heavy precipitation on flooding, avalanches and major landslides; however, the passage a warm moist jet may lead to snow level rising above the terrain and rain on snow and ice. If the rain is intense enough, or if it occurs when the snow pack is ready to melt, it may result in an enhancement of storm impacts. In this paper, we demonstrate how the snow factor may be included in antecedent conditions and sensitivity rating factors to improve the reliability of the ECAR rating so that focus can be placed on priority areas where the greatest storm impacts are expected. With global warming, we are expecting a rapid enhancement of the most intense AR storms, and if these arrive coincident with a period of intense snowmelt or ice breakup, they can enhance the level of impacts relative to what we experienced in the past. By including snow and

factors in antecedent conditions and sensitivities related to the Canadian ECAR rating, we are more likely to improve public warnings ahead of the most intense events, even during a time of rapid global warming.

Session: 920 General Session - Hydrology Séance générale — Hydrologie **09/06/2021 14:30**

ID: 11002 Contributed abstract

Poster Order:

Using a Hybrid Optimal Interpolation-Ensemble Kalman Filter approach in the Canadian Precipitation Analysis (CaPA)

Dikra Khedhaouiria [1] , *Stéphane Bélair* [2] , *Vincent Fortin* [3] , *Guy Roy* [4]

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Presented by / Présenté par: ***Dikra Khedhaouiria***
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Several data assimilation (DA) approaches exist to generate consistent and continuous precipitation fields valuable for hydrometeorological applications and land data assimilation. DAs generally use static, dynamic or a combination of both methods. Static approaches, such as Optimal Interpolation (OI), require the a priori estimation of error covariances for both observed and modelled precipitation fields, while dynamic methods rely on ensemble prediction systems to estimate those errors. The linear combination of the two methods, known as the hybrid DA approach, has proven beneficial for different applications because it combines the advantages of both methods. This study aims to explore hybrid approaches in the 6-hour Canadian Precipitation Analysis (CaPA). Currently based OI, CaPA combines deterministic forecasts, surface station observations and radar data to provide precipitation fields over the North American domain. The application of hybrid DA approaches to CaPA has been made possible by the recently operational 20-member Regional Ensemble Forecast System (REPS). The main objective here is to find the optimal weighting between the OI and the REPS-based ensemble Kalman filter (EnKF) to obtain the best CaPA analysis. The results confirmed the findings of the literature with the known efficiency of the hybrid approach when a low observation density is assimilated. Indeed, experiments conducted for the summer without radar and for the winter (characterized by very few observations) showed that assigning a relatively high weight to the REPS (0.5 and 0.7 for summer and winter, respectively) resulted

in better skill scores and a reduction of false alarms. However, a deterioration of the summer bias for medium to high intensity precipitation was also observed. A compromise between bias and analysis skill was nevertheless achieved by reducing the weight to 0.3 for the covariance matrix derived from the EnKF.

Session: 920 General Session - Hydrology Séance générale — Hydrologie **09/06/2021 14:45**

ID: 10808 Contributed abstract

Poster Order:

A Novel Method for Interpolating Daily Station Rainfall Data using a Stochastic Lattice Model

Boualem Khouider [1] , *C.T Sabeerali* [2] , *R. S Ajayamohan* [3] , *A. J Majda* [4] , *D. S. Pai* [5] , *M. Rajeenvan* [6]

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Presented by / Présenté par: ***Boualem Khouider***
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Rain gauge data are routinely recorded and used around the world. However, their sparsity and inhomogeneity make them inadequate for climate model calibration and many other climate change studies. Various algorithms and interpolation techniques have been developed over the years to obtain adequately distributed datasets. Objective interpolation methods such as the inverse distance weighting (IDW) are the most widely used and have been employed to produce some of the most popular gridded daily rainfall datasets (e.g., India Meteorological Department gridded daily rainfall). Unfortunately, the skill of these techniques becomes very limited to nonexistent in areas located far away from existing recording stations. This is problematic as many areas of the world lack adequate rain gauge coverage throughout the recording history. Here, we introduce a new probabilistic interpolation method in an attempt to address this issue. The new algorithm employs a multitype particle interacting stochastic lattice model that assigns a binned rainfall value, from an given number of bins to each lattice site or grid cell, with a certain probability according to the rainfall amounts observed in neighboring sites and a background climatological rain rate distribution, drawn from the available data.

Grid cells containing recording stations are not affected and are being used as ``boundary'' input conditions by the stochastic model. The new stochastic model is successfully tested and compared against two widely-used gridded daily rainfall datasets over the Indian landmass for data from the summer monsoon seasons (June-September) for 1951-1970

Session: 920 General Session - Hydrology Séance générale — Hydrologie **09/06/2021 15:00**

ID: 11066 Contributed abstract

Poster Order:

Effects of Climate Change on Navigability Indicators for the Lower Athabasca River

Daniel Peters [1] , *Joseph Shudian* [2] , *Yonas Dibike* [3] , *Wendy Monk* [4] , *Donald Baird* [5]

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Presented by / Présenté par: ***Daniel Peters***
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Climate change/variability, land and water-use changes, and flow alterations have all affected the quantity and timing of water flowing in North American rivers during the past century. Western Canada is an area of particular concern given historical, recent and projected rates of climate warming, combined with an increasing demand for water from industrial and municipal development. Historical declines have been noted in annual and summer flows emanating from headwater rivers draining the eastern slopes of the Rocky Mountains in Alberta, particularly the Athabasca River that drains into the internationally recognized Peace-Athabasca Delta and Lake Athabasca. Navigability of the lower reaches of the Athabasca River is important for maintaining Indigenous Peoples' traditional activities, barging of goods and general recreational use of the river. Concerns have been raised that water withdrawals combined with climate change may adversely affect navigation during low flow periods. Here, we investigate the potential impacts of future climate change on lower Athabasca River streamflow using flow projections by the VIC hydrological model driven by multiple statistically downscaled GCM outputs. The focus of the study is on navigability indicators proposed by Indigenous Traditional

Knowledge and Western Science including the fall Aboriginal Navigation Index (ANI), Indigenous Navigability Index (INI), percentage of days when flows are above specific thresholds that corresponded to Aboriginal Base Flow (ABF), and Aboriginal Extreme flow (ABF). Preliminary examination reveals that fall ANI and INI generally decrease in value as compared to the baseline period 1981-2010 for the near future climate period (2041-2070), the with more severe decrease for the far future period (2071-2100). The percentage of days above the AXF also decrease during the fall season in the future periods. This climate change study will provide critical information to assessing navigation risk and resilience, and derive potential responses to change.

Session: 920 General Session - Hydrology Séance générale — Hydrologie **09/06/2021 15:15**

ID: 10858 Contributed abstract

Poster Order:

Forecasting categorical ice cover conditions at Lake St. Lawrence and Beauharnois Canal using multinomial logistic regression

Natalie Gervasi [1] , *Jamie Ferguson* [2] , *Yin Fan* [3] , *Jacob Bruxer* [4]

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Presented by / Présenté par: ***Natalie Gervasi***
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During the winter, outflows from Lake Ontario are regulated in consideration of ice conditions at critical locations on the St. Lawrence River. When ice begins to form, outflows are adjusted to ensure safe and stable ice cover on Lake St. Lawrence and the Beauharnois Canal, which helps reduce the risk of ice jams and allow higher outflows later in winter. As spring approaches, outflows can be increased if ice conditions allow or further adjusted as necessary to minimize the risk of ice jamming during breakup. Environment and Climate Change Canada's (ECCC), Great Lakes – St. Lawrence Regulation Office assists decision-makers responsible for regulating outflows by providing weekly forecasts of Lake Ontario water levels and outflows. The hydrologic scenarios used to produce these forecasts also account for the presence of ice based on a reconstructed climatology of ice status indicators (ISI). The current ISI are categorical in nature and describe the stage of ice cover formation at the forebay of the Moses-Saunders Power Dam and within the Beauharnois Canal.

These indicators are used to predict flow adjustments necessary to address fluctuating ice conditions during the winter period. Given the influence of climate change, the timing of formation and break-up of seasonal ice cover in the St. Lawrence River has become increasingly challenging and mid-season, freeze-thaw cycles are becoming more frequent. As such, we have developed a forecasting tool for ISI to complement the existing climatology. Weather data, climate indices, and water level gradients at several locations along the upper St. Lawrence River were analysed for the past twenty seasons of observed ISI. Based on this analysis, a multinomial logistic regression model was derived. We supply this model with two- to four-week ensemble air temperature forecasts from ECCC, monthly values of climate indices, and a climatology of water level gradients to forecast ISI categories. The result is a range of possible ISI scenarios that include an expression of uncertainty based in part on guidance from ensemble meteorological predictions, and which ultimately provide more robust and reliable guidance to decision-makers regulating Lake Ontario outflows.

Session: 920 General Session - Hydrology Séance générale — Hydrologie **09/06/2021 15:30**

ID: 11037 Contributed abstract

Poster Order:

Predictability of sea ice in the Gulf of St. Lawrence on seasonal timescales

David Brickman [1] , *Brendan DeTracey* [2]

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Presented by / Présenté par: ***David Brickman***
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Predictability of sea ice in the Gulf of St. Lawrence (GSL) on a multi-month timescale is investigated using a regional ocean model. The simulation consists of a 1999-2019 hindcast, and a 2016-2019 period in which 12-month-long 20 member ensemble forecasts are performed each month using output from the Canadian Seasonal to Interannual Prediction system (CanSIPS). Ice data for this period is obtained from the Canadian Ice Service. Skill of the model hindcast, forecasts, and data-based climatology (Clm), is computed using contingency table based metrics, with a focus on the Overlap Skill (OS; 0-1) equal to hits/(hits+misses+false positives). Hindcast skill is dominated by a seasonal cycle with high skill (0.7-0.9) during peak ice coverage and low skill

(<0.4) during the ice growth and retreat phases with the model outperforming Clm. The difference between model and Clm shows no seasonality. For the forecast period, the multi-month forecasts exhibit marginally greater skill than Clm, with no clear lead-time effect. It is proposed that this is due to the seasonal cycle dominance of the OS metric. The fact that the Overlap, and other, skill metrics exhibit low skill for the ice growth and retreat phases illustrates the challenges in producing skillful seasonal forecasts of spatially sparse sea-ice fields in the GSL.

Session: 741 Building Climate Resilient Communities - Part 2 Bâtir des communautés à l'épreuve des changements climatiques - Partie 2

09/06/2021 14:30

ID: 11200 Contributed abstract

Poster Order:

Construction Codes – Building Climate Resilient Communities

Gregory Kopp [1] , *Dan Sandink* [2] , *David Sills* [3]

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Presented by / Présenté par: ***Dan Sandink***
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Severe storms, including extreme rainfall and flooding, high wind, and hail, are causing ever increasing damage to homes and property across Canada. Building codes offer minimum requirements for structural performance and have traditionally had the mandate to ensure life safety. In contrast, post-event damage surveys have indicated that the primary issues for severe wind-storms and hail are cladding, fasteners, and small building components. These are the building systems that protect the contents of the building – an aspect which has not been traditionally considered in design standards. In fact, such failures can lead to the write-off of the structure, such that total loss can occur because of a handful of inadequate fasteners (e.g., nails). This greatly increases societal impacts through the disruption caused by displacement of people during re-building. Simply put: resilience to severe convective storms is directly related to the performance of cladding systems and fasteners. The changing climate and increasing losses indicate that resilience and loss reduction need to be considered in building codes, prescriptive requirements, and design practice. Engineering research has identified the solutions to many of these issues, with many being relatively low cost. However, there are still many knowledge gaps,

particularly with respect to severe convective storms. For example, the most recent version of the National Building Code – NBCC 2020 – still utilized backward-facing climate data to prescribe design wind loads, in addition to not explicitly considering thunderstorm winds even though these would be the governing type of wind-storm over much of the country. The presentation will provide details regarding the current state-of-the-art, along with the knowledge gaps, with the goal of enhancing resilience of residential structures.

Session: 741 Building Climate Resilient Communities - Part 2 Bâtir des communautés à l'épreuve des changements climatiques - Partie 2 **09/06/2021 14:45**

ID: 11231 Contributed abstract

Poster Order:

Knowledge Synthesis of the Economics of Adaptation

Bohan Li [1] , *Paul Kovacs* [2] , *Gordon McBean* [3]

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Presented by / Présenté par: ***Bohan Li***
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A broad range of studies find there are climate resilience and adaptation measures with benefits greater than their costs. These measures can include investments in physical structures with various scales (e.g., anything from installing a backwater valve in a private home to building levees to protect against floods), investments in natural infrastructure, provision of information and data (e.g., hazard and risk maps), and changes in policies (e.g., building codes mandating resilient building practices, land-use policies to reduce building in flood plains). While economics cannot recommend a system of normative values, there are several economic decision frameworks which can be used to examine whether a given adaptation project is worth implementing given a set of values. Despite the broad range of climate resilience and adaptation projects with benefits exceeding costs, there is a relatively small amount of investment in such projects. Market, behavioral, and institutional imperfections can prevent the implementation of adaptation measures with benefits greater than costs. Various financial incentives are emerging which can encourage climate adaptation. Financial instruments where the funding must be exclusively directed towards climate change-related projects, such as Green Bonds, are currently relatively small but are growing rapidly in use. Research

shows performance on environmental, social, and governance factors in general and climate adaptation and mitigation specifically can reduce the cost of raising capital for companies. There is less research on their effects for municipalities, but some evidence exists that a similar effect holds.

Session: 741 Building Climate Resilient Communities - Part 2 Bâtir des communautés à l’épreuve des changements climatiques - Partie 2

09/06/2021 15:00

ID: 11178 Contributed abstract

Poster Order:

The local governance approach to resilient communities in Quebec's coastal and littoral communities

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Presented by / Présenté par: ***Sebastian Weissenberger***
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Quebec's coastal and littoral communities are increasingly experiencing negative impacts from erosion, floods, extreme weather events and a change in winter conditions, as a result of climate change. Adaptation has at first been largely reactive and focused on protective measures, but increasingly, communities adopt a longer-term planning strategy and incorporate climate change in their development plans and objectives. However, challenges face communities when devising adaptation plans, since resources available to smaller communities are often insufficient. We will present some examples of communities in Quebec which act as leaders in climate change adaptation, some in the context of the Res'Alliance initiative and highlight the importance of knowledge sharing and establishing networks to promote good adaptation practices and tools.

Session: 741 Building Climate Resilient Communities - Part 2 Bâtir des communautés à l’épreuve des changements climatiques - Partie 2

09/06/2021 15:15

ID: 11110 Contributed abstract

Poster Order:

Utilizing the ENVISION modelling framework to identify risks and evaluate the performance of biomass crops under future climate scenarios in Canada

Brent Coleman [1] , *Salim Silim* [2] , *Dan MacDonald* [3] , *Scott Mitchell* [4] , *Naresh Thevathasan* [5]

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Presented by / Présenté par: ***Brent Coleman***
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Climate change projections predict a rise in average temperatures, as well as increased intensity and frequency of droughts and storms worldwide. These projected changes to climate have the potential to challenge Canadian farmers, especially in relation to field crop production. As droughts and severe precipitation events become more frequent, yields of conventional field crops are predicted to decrease. There is currently interest in investigating the potential of biomass crops as a climate adaptive land-use to help Canadian farmers buffer the effects of climate change. Biomass crops are purpose-grown and typically produced as a feedstock for fibre and energy; These crops are valued for their wide-ranging environmental tolerances and ability to rapidly accumulate large amounts of biomass and carbon. Additionally, these crops are promoted due to their capacity to provision ecosystem services (e.g. erosion control, nutrient leaching reduction) and potential to enhance farm-level productivity. However, their suitability for different agricultural regions across the country (e.g. eastern and southern Ontario) requires further investigation before such options can be widely promoted. To evaluate the potential performance of select biomass crops (hemp, switchgrass and short-rotation willow), biomass crop phenology was reviewed to identify critical growth stages most likely impacted by environmental conditions. Next, environmental thresholds were defined to develop a risk model and allow projections of biomass crop yield reductions. Finally, ENVISION, a geospatial farmscape modelling framework, will couple biomass crop performance and farm management to determine where biomass crops may be introduced across the Canadian landscape under projected climate conditions. This research will enhance our understanding of the performance potentials of biomass crops under future climate conditions,

work will identify how biomass crops may contribute to reduced risk on Canadian farms under future climate conditions through the provisioning of ecosystem services.

Session: 741 Building Climate Resilient Communities - Part 2 Bâtir des communautés à l'épreuve des changements climatiques - Partie 2

09/06/2021 15:30

ID: 11008 Contributed abstract

Poster Order:

Canadian cities resiliency to extreme heat : Numerical scenarios with GEM

Sylvie Leroyer [1] , *Stephane Belair* [2] , *Oumarou Nikiema* [3] , *Nasim Alavi* [4] , *Rodrigo Munoz-Alpizar* [5] , *Ivana Popadic* [6]

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Presented by / Présenté par: ***Sylvie Leroyer***
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Climate projections highlight a significant increase in the intensity and duration of overheating periods. Impact of heat waves in recent years in Canadian cities have already been a challenge for dwellers and public health authorities. Heat effects are exacerbated in urban areas due to the additional radiative trapping and absorbing materials. ECCC is therefore developing numerical tools to assess urban heat mitigation strategies. The so-called numerical platform is developed based on the urban-scale ECCC's Numerical Weather Prediction (NWP) system initially set-up for the 2015 Pan-American and parapan-American games in Toronto. Sub-km grid spacing (down to 250 m) are used in both external urban and land surface modeling (with the Town Energy Balance TEB and the Interactions between the Soil, the Biosphere and the Atmosphere ISBA) and coupled with the Global Environmental Multiscale (GEM) atmospheric model. Such systems are capable of providing detailed forecasts of meteorological conditions in the urban area and advanced thermal stress indices (UTCI, WBGT, as well as the traditional Humidex) at the street level. The summer of 2010 including two heat waves was selected for the large heat-related death rate recorded in Montreal and Toronto. Persistent warm conditions

were found during the night of these periods preventing dwellers from resting. Results are analyzed for scenarios that are divided into the following categories of modification: radiative and materials properties, greening strategies, water management, anthropogenic heat fluxes, and the combination of changes. In general, these countermeasures are found to effectively decrease the impact of extreme heat conditions at pedestrian level, with a different amplitude and behavior during the day and the night. Greening strategies tend to be the more efficient strategies but they highly depend on the soil water availability. Potential side effects of mitigation strategies are explored to provide a comprehensive decision-making guidance.

Session: 741 Building Climate Resilient Communities - Part 2 Bâtir des communautés à l'épreuve des changements climatiques - Partie 2

09/06/2021 15:45

ID: 10971 Contributed abstract

Poster Order:

Addressing Climate Change Impacts on Canada by Building Resilient Communities - Synthesis

Gordon McBean [1] , *Paul Kovacs* [2] , *Greg Kopp* [3] , *James Voogt* [4]

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Presented by / Présenté par: ***Gordon McBean***
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A SSRHC-funded Knowledge Synthesis Project on Building Climate Resilient Communities addressed the framing question: "How can communities across Canada proactively advance climate- resilience to effectively reduce the risk of adverse climate impacts, loss and damage?" The Sendai Framework's pillars of resilience, which recognize the key roles that must be played by multiple stakeholders including the national, provincial and local governments, private stakeholders and others in order to reduce disaster risk and our analytical framework were used as a framework for synthesis. Communities, including Indigenous communities, have different natural, socio-economic, health and geopolitical systems and different strategies are appropriate. The Project connected the processes of knowledge synthesis with those of knowledge mobilization for effective engagement of cross-sectoral stakeholders (academic, public, private and not-for-profit sectors) and communities leading to the

ongoing mobilization of knowledge of the best policies and practices. This presentation will summarize the overall findings of the project (either as a single presentation or a small panel).

Session: 644 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 5 Observation de la Terre depuis l'espace : informations essentielles sur notre planète - Partie 5 **09/06/2021 14:30**

ID: 10824 Contributed abstract

Poster Order:

Progress toward a Canadian-led Arctic Observing Mission (AOM)

Ray Nassar [1] , *Shannon Kaya* [2] , *Matt Arkett* [3] , *Alec Casey* [4] , *Jean-Francois Caron* [5] , *Chris Sioris* [6] , *Chris McLinden* [7] , *Helena van Mierlo* [8] , *Shen-En Qian* [9] , *Isabelle Jean* [10] , *Konstantin Baibakov* [11] , *Ralph Girard* [12]

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Presented by / Présenté par: ***Ray Nassar***
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The Arctic Observing Mission (AOM) is a satellite mission concept that recently completed a Phase 0 (feasibility) study by the Canadian Space Agency (CSA) in partnership with Environment and Climate Change Canada (ECCC). AOM would consist of two satellites in a highly elliptical orbit (HEO) formation to make quasi-geostationary imaging observations of meteorological parameters, greenhouse gases (GHGs), air quality and space weather over northern regions (~45-90°N), addressing the current sparsity in spatial and temporal coverage beyond the viewing range of geostationary satellites. These proposed observations are important for operational mandates, monitoring and scientific research aligned with key Government of Canada priorities. Due to common

Arctic monitoring requirements shared by Canada, the U.S. and Europe, an international partnership on a HEO mission led by Canada is currently being discussed as a potentially cost effective approach to deliver quasi-geostationary northern Earth observation and space weather data. Northern high latitude observations from a HEO meteorological imager that expands upon the current capabilities of the National Oceanic and Atmospheric Administration (NOAA) Advanced Baseline Imager (ABI) would improve Numerical Weather Prediction (NWP) over the Arctic and adjacent northern mid-latitude regions, while also supporting a broad user community for many other environmental and climate applications. Northern GHG observations would improve our ability to detect and monitor changes in the Arctic and boreal carbon cycles, including emissions from permafrost thaw or changes to vegetation carbon fluxes under a changing climate. Air quality observations would enhance our ability to monitor emissions from resource extraction in the North and the transport of pollution from mid-latitudes, which will improve air quality forecasts with implications for human health. Space weather observations would support operational space weather forecasting to protect space-based assets and improve our scientific understanding of solar-terrestrial interactions. The next step for AOM is the “Pre-Formulation Phase”, which will include co-operation with NOAA and other prospective international partners to prepare for a formal project approval to start implementation of the mission. Partners will work together to advance the mission design and define potential roles and contributions in this joint HEO mission to produce quasi-geostationary northern Earth observation and space weather data for the free and open use by the international community.

Session: 644 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 5 Observation de la Terre depuis l’espace : informations essentielles sur notre planète - Partie 5 **09/06/2021 14:45**

ID: 10864 Contributed abstract

Poster Order:

Development of a new Canadian-led satellite mission for seasonal snow mass

Chris Derksen [1] , *Joshua King* [2] , *Vincent Vionnet* [3] , *Camille Garnaud* [4] , *Stephane Belair* [5] , *Vincent Fortin* [6] , *Yves Crevier* [7] , *Patrick Plourde* [8] , *Brian Lawrence* [9] , *Helena van Mierlo* [10]

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Presented by / Présenté par: ***Chris Derksen***
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Freshwater delivered by seasonal snow melt is a commodity of the utmost importance for the health and well-being of Canadians, supports all sectors of the economy, sustains ecosystems, and poses risks through floods or sustained drought events. At present, information on water stored as seasonal snow is poor across Canada. Surface networks are sparse; current satellite observing systems lack the capability to derive terrestrial snow water equivalent (SWE, the amount of liquid water stored in solid form by snow) at the spatial resolution, synoptic sensitivity, global coverage, and accuracy required for environmental monitoring, climate services, and hydrological prediction. The required combination of revisit time, spatial coverage, measurement resolution, and sensitivity to the mass of snow on the ground necessitates a new spaceborne observing concept. To address this observing gap, Environment and Climate Change Canada (ECCC), the Canadian Space Agency (CSA), industrial partners at Airbus, and international scientific collaborators are developing a new Ku-band radar mission primarily focused on seasonal snow, but of high relevance to other variables such as freshwater ice, glaciers, and ocean winds. Following technical trade-off studies, a concept capable of providing dual-polarization (VV/VH), moderate resolution (500 m), wide swath (~250 km), and high duty cycle (~25% SAR-on time) Ku-band radar measurements at two frequencies (13.5; 17.25 GHz) was identified. Ku-band radar is a viable approach for a terrestrial snow mission because these measurements are sensitive to (1) SWE through the volume scattering properties of dry snow and (2) the wet/dry state of snow cover. These two parameters characterize the key aspects of snow relevant to hydro-climatological applications. This presentation will provide an overview of the Ku-band radar technical concept, ongoing activities to advance the scientific readiness, and the programmatic status of the mission.

ID: 10878 Contributed abstract

Poster Order:

The proposed Chemical and Aerosol Sounding Satellite (CASS) Mission

Kaley Walker [1] , *Doug Degenstein* [2] , *the CASS Mission Development Team* [3]

[1] University of Toronto
[2] University of Saskatchewan
[3]

Presented by / Présenté par: ***Kaley Walker***
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The Chemical and Aerosol Sounding Satellite (CASS) is a science mission concept developed and studied by the Canadian Space Agency to provide climate quality atmospheric composition measurements from a low Earth orbit satellite platform. Climate quality satellite observations have become vital to climate research and climate services. CASS is designed to meet user needs on data for atmospheric and climate sciences and services, and to support monitoring of the efficacy of regulatory protocols and polices. Building on the strong Canadian heritage of state-of-the-art optical and infrared space instrumentation, the CASS payload is composed of the next generation Atmospheric Chemistry Experiment Fourier Transform Spectrometer (ACE-FTS), currently on SCISAT, and the next generation of the Optical Spectrograph and InfraRed Imaging System (OSIRIS) instrument, on the Odin satellite. CASS utilizes demonstrated Canadian technologies and strong scientific expertise to address an international need in climate and atmospheric sciences as part of the global effort to provide critical climate-quality measurements.

Session: 644 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 5 Observation de la Terre depuis l'espace : informations essentielles sur notre planète - Partie 5 **09/06/2021 15:15**

ID: 11174 Contributed abstract

Poster Order:

An overview of the NASA A-CCP satellite mission and Canadian participation

Jason Cole [1] , *Thomas Piekutowski* [2] , *Vickie Moran* [3] , *Howard Barker* [4] , *Jean-Pierre Blanchet* [5] , *Adam Bourassa* [6] , *Doug Degenstein* [7] , *Yi Huang* [8] , *Felicia Kolonjari* [9] , *Zen Mariani* [10] , *Landon*

Rieger [11] , *Jeff Langille* [12]

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Presented by / Présenté par: ***Jason Cole***
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The US National Academies' 2017-2027 Decadal Survey for Earth Science and Applications makes recommendations for science priorities including cost-capped satellite missions capable of making essential Earth observations. Two of the designated observables are: 1) aerosols; and 2) clouds, convection and precipitation. Since processes for these two observables are strongly coupled, a single observing system, Aerosol-Clouds, Convection and Precipitation (A-CCP), was proposed for study by NASA which concluded its pre-formulation study in spring 2021. The A-CCP mission, and its pre-formulation study, includes collaborations with international partners in Japan, France, Germany, and Canada. This presentation provides an overview of the A-CCP mission, its main scientific goals, the proposed space-based observing system as recommended by the pre-formulation study, and contributions, including instrumentation, from Canadian government and academic partners.

Session: 644 Space-Based Earth Observation: Providing Critical Information on our Planet - Part 5 Observation de la Terre depuis l'espace : informations essentielles sur notre planète - Partie 5	**09/06/2021 15:30**

ID: 10958 Contributed abstract

Poster Order:

HAWC - a Canadian instrument suite for measurements of clouds, aerosol and water vapour: Simulations and applications

Landon Rieger [1] , *Adam Bourassa* [2] , *Jeff Langille* [3] , *Yann*

Blanchard [4] , *Jean-Pierre Blanchet* [5] , *Doug Degenstein* [6]

[1] University of Saskatchewan
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[3] University of New Brunswick
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Presented by / Présenté par: ***Landon Rieger***
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Clouds, aerosol and water vapour in the upper troposphere and lower stratosphere remain a driving force in climate uncertainty. The NASA decadal survey has identified aerosol and cloud processes as a major challenge and has proposed the Aerosol, Cloud, Condensation and Precipitation (ACCP) mission to help address these questions. Potential Canadian contributions to this mission include the Aerosol Limb Imager (ALI), Spatial Heterodyne Observation of Water (SHOW) and Thin Ice Clouds and Far Infrared Emissions (TICFIRE) instruments. ALI and SHOW measure limb scattered sunlight, with vertical resolution of 500m, and long path lengths that provide excellent sensitivity to levels of aerosol and water vapour not possible from nadir mappers. TICFIRE is an imaging Mid- to Far-IR radiometer sensitive to crystal size, optical depth (water content), liquid-ice mixture and water vapour profiles in the troposphere overlapping with ALI and SHOW. Together, these instruments compose the High altitude Aerosols, Water vapour and Clouds (HAWC) system and provide a strong synergy on aerosol, water, cloud, precipitation, and radiation interaction in the cold regions of the globe and UTLS. This work presents a simulation framework for the three Canadian instruments. Realistic atmospheric scenes based on Canadian Model GEM simulations used in EarthCARE datasets as well as generated from measurements from CALIPSO, OMPS-LP and ERA5 reanalysis are used as inputs to the simulations. Comprehensive instrument models are used to generate simulated measurements from these scenes, and feedback with industry to improve instrument design. These scenes and instrument models are also used to produce synthetic retrieval products. The synergy of which to address aerosol-cloud processes in cold and low water vapour content regions is explored, both in context of a potential HAWC mission, and in the larger scope of ACCP.

ID: 10902 Contributed abstract

Poster Order:

Connecting Seasonal Extratropical Cyclone Variability with Predictor Fields using Self-Organizing Maps

Rebekah Cavanagh [1] , *Eric Oliver* [2]

[1] Dalhousie University
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Presented by / Présenté par: ***Rebekah Cavanagh***
Contact: R.Cavanagh@dal.ca

Winter Extratropical Cyclones (ETCs) are major storms that regularly affect the east coast of North America. High winds and heavy precipitation in the form of rain, snow, and ice are typical features of these storms. Individual ETCs are well predicted by NWPs at lead times of a 3-5 days, however seasonal ETC activity is not well predicted. Seasonal prediction of ETCs depends on a comprehensive understanding of their variability on seasonal time scales and connections with large-scale predictor fields. In this research, an analysis of the climatology, trends, and variability of ETCs on the east coast of North America at 1 degree resolution is discussed using multiple techniques including empirical orthogonal functions analysis and self-organizing maps (SOMs). The SOMs framework reveals that spatiotemporal variability in ETC track density is coincident with spatiotemporal variability of many principal physical drivers of ETCs including marine to continental air temperature gradients, 500 hPa geopotential height patterns, and 250 hPa winds, thus identifying key predictor-predictand relationships. Furthermore, we assess the variability of individual ETC effects including rainfall, snowfall, and severe low-level winds which is compared with the overall variability in track density. The main pattern of variability identified in the ETC track density is an intensification and coastal shift of the primary climatological track from the Carolinas to the Canadian Atlantic Provinces. In seasons when this signature is strong, there is a corresponding decrease in continental air temperature which intensifies the land-sea air temperature gradient. We also observe a decrease in 500 hPa geopotential heights over the continent and an increase in 250 hPa winds which intensifies upper level divergence south and east of the region of storm track intensification. The precipitation pattern during those same seasons shows an increase in snowfall over the Northeastern States and Atlantic Canada.

ID: 10746 Contributed abstract

Poster Order:

Role of Atmospheric Rivers (ARs) and Cyclone Clustering during Winter Extreme Precipitation Regimes (EPRs) in the eastern United States and southeastern Canada

Yeechian Low [1] , *John Gyakum* [2] , *Eyad Atallah* [3]

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Presented by / Présenté par: ***Yeechian Low***
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Extreme precipitation events (EPRs) during winter are often challenging to predict but can have substantial societal and economic impacts through heavy snow and/or rain, flooding, and associated loss of life and property, especially when they persist and affect a large region. We define EPRs based on three criteria of extremes: 1) amount, 2) persistence, and 3) areal coverage of precipitation. We focus on EPRs in the eastern United States and southeastern Canada. Most EPRs are associated with one or more atmospheric rivers (ARs), with the AR frequency during EPRs being higher and the region of highest AR frequency shifted northwestward compared to climatology. During EPRs, there is a preference for long, anticyclonically curved ARs, curving from the subtropical Atlantic northwestward into the eastern United States and then northeastward into southeastern Canada. These ARs are commonly associated with repeated cyclones or an elongated area of low-pressure extending from the central United States northeastward into eastern Canada. This pattern is also associated with a relatively slow eastward-moving 500-hPa trough/ridge in western/eastern North America and anomalously warm and humid lower tropospheric air in eastern North America. A particularly long-duration EPR is studied in further detail. During this EPR, episodes of large-scale, heavy snow/rain in the northern/southern regions and associated flooding in the south ensued. This EPR was associated with one long-lived, anticyclonically curving AR with a series of cyclones to the northwest of the AR.

ID: 10644 Contributed abstract

Poster Order:

Reanalysis of a historical atmospheric river affecting the west coast of North America in January 1896

Ruping Mo [1] , *Mark Barton* [2] , *Giselle Bramwell* [3] , *Judy Kwan* [4]

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Presented by / Présenté par: ***Ruping Mo***
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Atmospheric Rivers (ARs) are long, narrow, and transient corridors of strong horizontal water vapour transport concentrated in the lower atmosphere. Landfalling ARs can produce extremely heavy rainfalls when and where they are forced upward. It would be very difficult to identify and analyse ARs in the nineteenth century because of the lack of upper-air meteorological observations. In this study, we examine a historical AR event that made landfall and produced some torrential rains over the coastal areas of southern British Columbia, Washington, and northern Oregon during 4–5 January 1896. This AR event was identified using the Twentieth Century Reanalysis data, which were generated from a state-of-the-art data assimilation system based only on the surface-based observations. The structure and evolution of this system is in line with the modern conceptual model of AR. Its hydro-meteorological impacts are analysed in detail based on available weather observations, media and archived reports. Our study confirms the possibility of using the reanalysis data to investigate historical high-impact weather events that were poorly understood due to the lack of observational data.

ID: 10774 Invited session speaker

Poster Order:

Future intensification of high-impact storms associated with extreme atmospheric moisture transport over North America

Alex Cannon [1]

[1] ECCC

Presented by / Présenté par: ***Alex Cannon***

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Future projections from two large climate model ensembles -- the 50 member CanRCM4 regional model and the 35 member CESM1 global model -- are used to assess the impact of global warming on intensification of high-impact storms with extreme atmospheric moisture transport (e.g., associated with atmospheric rivers) over North America. The frequency, duration, and magnitude of potentially hazardous storms is projected to increase with warming. Increases are not confined to coastal regions -- storms penetrate further inland and further north, reaching communities that have previously not routinely experienced these kinds of storms.

Day 9 – 10 June 2021

Oral

Session: 650 Collaborative Earth System Modelling in Canada - Part 1 Modélisation collaborative du système terrestre au Canada - Partie 1

10/06/2021 12:30

ID: 11155 Contributed abstract

Poster Order:

Atmospheric radiative transfer in the Canadian Earth System Model

Jason Cole [1] , *Jiangnan Li* [2]

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Presented by / Présenté par: ***Jason Cole***

Contact: Jason.Cole@canada.ca

The transfer and interaction of solar and thermal radiative energy with the atmosphere and surface is a critical process in the Earth system. In CanESM, these processes are modeled using parameterizations of the surface and atmospheric constituents (gases, aerosols and clouds) which are used as input for solar and thermal radiative transfer models. The current state of the radiative transfer model in CanESM will be discussed, including treatment of subgrid-scale variability of clouds and surfaces. To support collaborative development, testing and application of the CanESM radiative transfer model a single column version was developed which can use as input user specified atmospheric profiles and surface information. Inputs from the Radiative Forcing Model Intercomparison Project (RFMIP) are used to evaluate clear-sky fluxes computed by the model against reference line-by-line radiative transfer model calculations. To demonstrate the use of the single column model for collaborative development and testing implementation of a 4-stream solver into the radiative transfer model will be described.

Session: 650 Collaborative Earth System Modelling in Canada - Part 1 Modélisation collaborative du système terrestre au Canada - Partie 1

10/06/2021 12:48

ID: 10897 Contributed abstract

Poster Order:

Oceananigans.ShallowWaterModel: a fast and friendly solver for a shallow water fluid on CPUs and GPUs

Francis Poulin [1] , *Gregory Wagner* [2] , *Ali Ramadhan* [3]

[1]
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[3] MIT

Presented by / Présenté par: ***Francis Poulin***
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There is much work being done by the climate community to develop state-of-the-art software to simulate climate related systems. One such project by the Climate Modeling Alliance is the Climate Machine (CliMA), which is written in the Julia Language. Some members of the Climate Modeling Alliance have helped to create Oceananigans, “A fast and friendly incompressible fluid solver in Julia that can run in 1-3 dimensions on CPUs and GPUs”, which is also entirely written in Julia. Oceananigans can simulate idealized oceanographic flows with a variety of different features, both in terms of the physics that it can

include and the numerical methods that can used to solve those problems. The simplicity of this model allows for quick and easy explorations of different phenomena including, advection schemes, parameterizations of sub-grid scale process, as well as how to model biogeochemical species. Moreover, being able to do these simulations on GPUs can often be much faster in comparison to the more standard CPUs. Oceananigans is a great resource in which one can test different features of an oceanographic model before using it in more expensive in GCM. This seminar will review some of the recent advances of Oceananigans and in particular will focus on the ShallowWaterModel component that has been recently developed. This can serve both as a valuable tool both for education and research.

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10/06/2021 13:06

ID: 10856 Contributed abstract

Poster Order:

Enabling portability and collaborative development of the Canadian Earth System Model (CanESM)

Neil Swart [1] , *Clint Seinen* [2] , *Jason Cole* [3] , *Viatcheslav Kharin* [4] , *Andrew Shao* [5] , *John Scinocca* [6] , *Mike Lazare* [7]

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Presented by / Présenté par: ***Neil Swart***
Contact: neil.swart@canada.ca

The Canadian Earth System Model (CanESM) is globally recognized tool used for understanding the past and projecting the future of climate change. CanESM contributes to major climate science activities, including the Coupled Model Intercomparison Project, producing petabyte scale climate data which is published openly for community benefit. The model has been developed over the past 40 years within the Canadian Centre for Climate Modelling and Analysis (CCCma), a section of Environment and Climate Change Canada (ECCC). Collaboration within the Government of Canada, and with external

university researchers has been key for developing specific sub-components and configurations of CanESM. However, an increasing impediment to effective collaboration of has been the fact that CanESM was only usable on restricted ECCC high performance computing systems. A new philosophy at CCCma for embracing open standards and collaboration with the community is detailed in our recently published strategic plan. We are working towards a more portable, collaborative Canadian Earth System Model. We believe this approach will increase the efficiency of CCCma's internal operations; ensure the sustainability of the model; help to accelerate improvements and lead to broader scale application of CanESM. All these factors will ultimately improve climate information available to Canadians, advancing the key mandate of CanESM. Here we outline CCCma's long term strategic plan. We will describe the recent innovations designed to allow portability and enable collaborative development and application of CanESM. We will highlight examples of porting CanESM to the commercial cloud and to Compute Canada platforms, and validate control simulations against reference runs. Despite the progress so far, many challenges remain for seamless collaboration and the ultimate usability of CanESM, and we summarize these. There are also promising areas of opportunity for future development and application of CanESM within the broader community that we will describe.

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10/06/2021 13:24

ID: 10898 Contributed abstract

Poster Order:

Community perspective and use cases for collaborative development with CanESM

Paul Kushner [1] , *Julie Thériault* [2] , *Ellie Farahani* [3] , *Nathan Gillett* [4] , *Shawn Marshall* [5] , *Neil Swart* [6] , *Kirsten Zickfeld* [7]

[1] University of Toronto
[2] UQAM
[3] ECCC/CCCma
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[7] Simon Fraser University

Presented by / Présenté par: ***Paul Kushner***
Contact: paul.kushner@utoronto.ca

The Canadian Earth System Model (CanESM) is a comprehensive, internationally recognized coupled model, developed by the Canadian Centre for Climate Modelling and Analysis (CCCma) of Environment and Climate Change Canada (ECCC), for the purposes of climate projection and seasonal to decadal prediction. While development and application of CanESM has been carried out in collaboration with the Canadian academic community, these collaborations have been constrained by the fact that CanESM could only be used on ECCC's internal advanced research computing systems. In accordance with its new strategic plan, CCCma is working towards the development of a collaborative version of CanESM, based on the existing open-source codebase. It will include pre-set model configurations, forcing data, model documentation, contributor guides, and a reproducible runtime environment ("container") that enables the model to be run on a wide range of ARC systems, including those from Compute Canada. Although direct system-level support to individual users will not be provided by ECCC, this development has the potential to create a healthy Canadian community of users of CanESM in a manner similar to other international community modelling projects. We here review the results, discussion, and use cases that have arisen from a community survey and workshop sponsored by the CMOS special interest group on atmosphere-related research in Canadian universities (ARRCU), in consultation with ECCC/CCCma. This initiative has been well received by the Canadian academic research community, owing to CanESM's record of international-profile science; relatively low computational cost; extensive list of included forcings, processes, and feedbacks; the extant database of large initial condition ensembles; and its potential for being foundational infrastructure for collaborative projects between ECCC and academia. The user community seeks clarity on the long-term intention of ECCC to maintaining this modelling framework, and to broaden the discussion beyond global climate applications towards other areas of weather and environmental prediction.

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10/06/2021 13:35

ID: 10708 Contributed abstract

Poster Order:

From Global Data Processing and Forecasting Systems to Earth Systems Prediction: A World Meteorological Organisation Perspective

Michel Jean [1] , *David Richardson* [2] , *Yuki Honda* [3] , *Anthony Rea* [4] , *Lars-Peter Riishojgaard* [5] , *Eunha Lim* [6] , *Michel Béland* [7]

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[3] Japan Meteorological Agency
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Presented by / Présenté par: ***Michel Jean***
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The Global Data-Processing and Forecasting System (GDPFS) has traditionally been the network of Global, Regional and National Centres that ensures essential meteorological analyses and forecast products are available to all WMO Members. However, the recent progress towards a unified or seamless earth system modelling approach, based on coupling between atmosphere, ocean, sea-ice, land, hydrology and socio-economic models now opens the door for forecasts and scenarios from minutes to seasonal, annual, decadal and longer time scales. This brings the potential for integrated prediction and analysis products and services for much more accurate and useful applications related to weather, climate, water and the environment. The Global community will leverage high performance computing technologies (e.g. exascale computing capabilities),cloud-based input and output access, open modelling and Artificial (or Augmented) Intelligence to achieve those goals. Ensemble methods and forecast validation from short to longer time scales will become essential to represent and propagate quantitative uncertainty information through the value chain, thus meeting an important and often neglected and identified need from both decision and policy makers. The GDPFS will evolve to exploit this unprecedented potential for the benefit of all Members. It is a high priority that the future Seamless GDPFS will assist Developing and Least Developed Countries to make significant progress towards community resilience and reaching United Nations Sustainable Development Goals by 2030. Significant progress has already been made towards this overarching goal: • New designations for GDPFS centres for nowcasting, sub-seasonal and interannual to decadal forecasts extend the current capabilities across temporal scales • Designation criteria for ocean waves, ocean prediction, sand/dust storms, integrated major ecosystems state and impacts from environmental changes, will extend the range of earth system components beyond the traditional atmospheric weather products • Guidelines for the use and post-processing of ensemble predictions facilitate the exploitation of this data by Members for their own applications Essential future developments include: • the incorporation of additional earth system components (hydrology, atmospheric composition) • monitoring of the earth system (reanalyses) • facilitating access to all required data to all Members, exploiting the potential of cloud services • planning for the exploitation of the detailed temporal and spatial scale earth-system predictions from the exascale computing environment that can be

expected in the coming years Pilot projects to evaluate and incorporate these new components and technologies, the roadmap for the development of the S/GDPFS and a rolling review of user requirements are all under development to ensure the successful evolution of the GDPFS to meet the challenge and exploit the potential of earth system modelling over the coming decade for the benefit of all WMO Members.

Session: 830 Coastal ocean modelling: processes and applications - Part 1 Modélisation des eaux côtières : processus et applications - Partie 1 **10/06/2021 12:30**

ID: 10733 Invited session speaker

Poster Order:

Coastal Modelling into the Future and into the Past

Susan Allen [1]

[1] University of British Columbia

Presented by / Présenté par: ***Susan Allen***

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Accurate coastal modelling requires high temporal and spatial resolution models with good high resolution forcing fields: atmosphere, rivers and boundary conditions. Our models are now capable of nowcasting and forecasting into the near future (hours to days) for storm surge, drift, oxygen, ocean acidification and biological production. We can hindcast the interannual variability of the last decade or more. In regions with good historical forcing one can go further back than in regions with poor historical forcing. In the Salish Sea good high resolution winds limit us to last couple of decades. However, many large changes in the ecosystem happened further back. How do we take our models back? and can we use the same mechanisms to go forward? In this talk I will explore the benefits and limitations of several methods including: using an understanding of the underlying dynamics, informed partial manipulations of the forcing and climate downscaling, all with examples using SalishSeaCast, a coupled coastal model of the Salish Sea.

Session: 830 Coastal ocean modelling: processes and applications - Part 1 Modélisation des eaux côtières : processus et applications - Partie 1 **10/06/2021 13:00**

ID: 11089 Contributed abstract

Poster Order:

Coastal Ice-Ocean Prediction System for the East Coast of Canada (CIOPS-E) version 2: Updates and improvements

Jean-Philippe Paquin [1] , *François Roy* [2] , *Gregory C. Smith* [3] , *Maria Gheta* [4] , *Sarah MacDermid* [5] , *Frédéric Dupont* [6] , *Ji Lei* [7] , *Oleksandr Huziy* [8]

[1] Division de la recherche en météorologie (ECCC)
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[3] Division de la recherche en météorologie (ECCC)
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Presented by / Présenté par: ***Gregory C. Smith***
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As part of Canada’s Oceans Protection Plan, a new version of the Coastal Ice-Ocean Prediction System for the East Coast of Canada (CIOPS-E) will be implemented in operations at Environment and Climate Change Canada in support of the aquatic emergency response and electronic navigation. The system uses a 1/36° resolution (~2km) configuration of the NEMO model with a spectral nudging method applied offshore to down-scale the ocean analysis from the Regional Ice Ocean Prediction System (RIOPS). This presentation will show the improvements to the model’s physics and parameters to address limitations noted in the first version of the system. Changes in the model configuration and physics mainly focused on improving the representation of tides, particularly in the St Lawrence Estuary, correcting a summertime cold sea surface temperature bias and improving the Gulf of Saint Lawrence cold intermediate layer formation.

Session: 830 Coastal ocean modelling: processes and applications - Part 1 Modélisation des eaux côtières : processus et applications - Partie 1 **10/06/2021 13:15**

ID: 11086 Contributed abstract

Poster Order:

Operationalisation of Canada's OPP Port Ocean Prediction Systems (POPS) by CHS and ECCC for E-Navigation Dynamic Hydrographic Products delivery

Ji Lei [1] , *Fraser Davidson* [2] , *Gilles Mercier* [3] , *Frédéric Dupont* [4] , *Benoit Archambault* [5] , *Claude Tremblay* [6]

[1] ECCC & CHS
[2] CHS
[3] CHS
[4] ECCC
[5] ECCC
[6] CHS

Presented by / Présenté par: ***Ji Lei***
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Under Canada's Ocean Protection Plan (OPP), the Canadian Hydrographic Service is developing production and delivery capacity for dynamic hydrographic products that can be used by electronic chart displays on ship navigation bridges. These E-navigation products, including forecasted water depth and surface currents, are depending on operational ocean prediction systems that feed them. DFO Science has been working on researching and prototyping of prediction systems for 6 Canadian ports. To ensure this research effort can be applied to operations, CHS is building a development team for these port systems to enable operational implementation and support for these systems in an operational setting. With decades of experience on operation prediction systems, ECCC, more particularly Canadian Centre for Meteorological and Environmental Prediction (CCMEP) has the best capacities for ultimately running the port operations in the long term. This talk covers the role of an ocean prediction development group that enables research (DFO) to be implemented in operations (CCMEP). Additionally as these prediction systems are new, these port prediction systems will be run routinely on science infrastructure, until resources permit full transfer and operations at ECCC CCMEP's operational center. The main tasks for a ocean prediction group are: 1. Model development from researching mode to operational mode 2. Model testing following the upstream cycles (atmospheric forcing, boundary conditions, etc.) 3. Model migration following upgrades to HPC (high-performance computation) resources 4. Developing customized modules following CHS needs 5. Host routine pre-ops POPS on available computing platform

ID: 11158 Contributed abstract

Poster Order:

Deriving E-Navigation products from coastal and port prediction systems

Fraser Davidson [1] , *Gilles Mercier* [2] , *Maxime Carre* [3] , *Jessica Morena* [4] , *Ji Lei* [5] , *Phillip MacAulay* [6] , *Lanli Guo* [7] , *Louis Maltais* [8] , *Claude Tremblay* [9]

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Presented by / Présenté par: ***Fraser Davidson***
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We present the Canadian Hydrographic Services Dynamic Hydrographic Product approach to transforming routine ocean prediction systems into useful E-Navigation products at sea. The new international S-100 standards for E-NAV are enabling significant advances in enabling mariners to readily exploit ocean and atmospheric prediction systems in the marine environment. Ocean Prediction systems in Canada, particularly with the investments under the GoC Ocean Protection Plan are now reaching a maturity on which standardized products for navigation can be built and supplied to the ships bridge in electronic format. Two E-NAV products described here are the S-104 sea surface height and the S-111 sea surface current product. The E-NAV file standards enable transmission of the latest observations and prediction system output to be communicated to the mariner at sea. Here we describe the systematic approach in developing the various E-NAV products from pan Canadian ocean ice prediction systems down to port prediction systems for Saint John NB and five other Canadian ports. Details of how the ocean model output is transformed and organized into electronic charts with a chart datum vertical reference. The talk finishes with an outlook on future E-NAV development, and it’s importance for a sustainable Blue Economy.

Session: 710 Advances in process-based land surface modelling - Part 1 Progrès dans la modélisation de la surface terrestre basée sur les processus - Partie 1

10/06/2021 12:30

ID: 10718 Contributed abstract

Poster Order:

Performance of CLASSIC In the Earth System Model - Snow Model Intercomparison Project (ESM-SnowMIP)

Paul Bartlett [1] , *Libo Wang* [2] , *Chris Derksen* [3] , *Cecile Menard* [4] , *Richard Essery* [5] , *Gerhard Krinner* [6]

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Presented by / Présenté par: ***Paul Bartlett***
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The site level component of ESM-SnowMIP has 28 participating models, including snowpack models and land surface schemes employed in Earth system models. The Canadian LAnd Surface Scheme Including biogeochemical Cycles (CLASSIC) is participating in this MIP but with biogeochemistry turned off. Simulations were conducted at ten open sites and three boreal forest sites, Old Aspen, Old Black Spruce and Old Jack Pine for which results are highlighted. At the open sites (led by Cecile Menard), CLASSIC had the second smallest RMSE and little bias in snow water equivalent (SWE) and albedo. CLASSIC had one of the smallest soil temperature biases but the coldest snowpack surface. At forest sites, CLASSIC (ensemble average) simulated bias in SWE and depth were -9.1 (-10.0) kg/m² and -0.09 (-0.10) m. Supplied plant functional type and leaf area index values were not implemented in few models, but many show a positive albedo bias >0.1. A large positive albedo bias at Old Aspen by some models suggests that snow masking by leafless trees requires attention. Most models, including CLASSIC, show a cold soil bias but CLASSIC is among the better models. Cold winter soils may be related to the parameterization of turbulent exchanges, especially under stable conditions when surface-atmosphere decoupling may exist. Models employing simplified parameterizations tend to show stronger cold biases. Models employing a multi-layer snowpack showed smaller average biases in snowpack properties and soil temperature than single-layer models. Multi-layer snow models tend not to employ simplified parameterizations used in some single-layer models (e.g.

no explicit canopy, soil water does not freeze). Some single-layer models show performance comparable to multi-layer models. Cold snowpack and soil temperature biases are associated with specific thermal conductivity parameterizations, as well as biases in SWE and depth.

Session: 710 Advances in process-based land surface modelling - Part 1 Progrès dans la modélisation de la surface terrestre basée sur les processus - Partie 1

10/06/2021 12:45

ID: 10711 Contributed abstract

Poster Order:

Why do land surface models overestimate evaporation?

Gesa Meyer [1] , *Joe R. Melton* [2] , *Elyn R. Humphreys* [3]

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Presented by / Présenté par: ***Gesa Meyer***
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Shrub plant functional types (PFTs), in addition to trees, crops, and grasses, are now represented in the Canadian Land Surface Scheme Including biogeochemical Cycles (CLASSIC). This enables better representation of carbon and energy fluxes in Arctic tundra and other shrub ecosystems. However, at both high-latitude and lower-latitude semi-arid shrub sites, CLASSIC tends to overestimate evaporation (E) during periods of high soil moisture. This E bias leads to difficulties in realistically simulating plant productivity, transpiration (T) and total evapotranspiration (ET) once soils become dry. For example, high ground E after snowmelt at a northern shrub site led to a drawdown in soil moisture, which limited photosynthesis, vegetation growth and ET in summer. Globally, CLASSIC represents ET quite well, however, its partitioning into E and T can be improved. The issue of excessive E while underestimating T has also been encountered in other land surface and Earth system models (ESMs). Possible ways to address this bias include parameterization of a dry surface layer (DSL) or litter layer, which increases surface resistance to water vapour and heat fluxes, or reducing interception of water by the canopy, which would lower E from the vegetation making more of the precipitation available for infiltration into the soil, ground E and T. In CLASSIC, a DSL parameterization has been implemented with a surface soil

moisture dependent DSL thickness. Ground E is determined by water vapour diffusion through this thin layer, resulting in higher resistance to E than from the 10 cm thick top soil layer generally used in CLASSIC. This prevents excessive ground E and allows soils to stay moist below the surface. Our study addresses a high ground E bias and examines the effects of an improved ground E parameterization on all three components of ET in CLASSIC at the site-level as well as globally.

Session: 710 Advances in process-based land surface modelling - Part 1 Progrès dans la modélisation de la surface terrestre basée sur les processus - Partie 1

10/06/2021 13:00

ID: 10738 Contributed abstract

Poster Order:

Fire effects on forest-atmosphere interactions in Amazonia

Gabriel de Oliveira [1] , *Jing Chen* [2]

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Presented by / Présenté par: ***Gabriel de Oliveira***
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Recently intensified forest fires in the Amazon region have led to large-scale forest losses, particularly in Brazil, after more than a decade of effective forest conservation policy. Analysis of the time course of fire impacts on radiation, water and carbon cycling is required for accurate measurement of changes in the forest-atmosphere interactions. Moreover, measurements must also account for natural variations associated with vegetation phenology, and generally direct and indirect effects of environmental changes at annual, seasonal and sub-annual time scales. Here, we show a study on the recovery of Amazonian forests affected by fire in terms of radiation, water and carbon fluxes utilizing remote sensing (Moderate Resolution Imaging Spectroradiometer, MODIS) and climate reanalysis data (Global Land Data Assimilation System, GLDAS). Our results showed that fires significantly increased land surface temperature and air temperature by ~1 °C in the forests over a three-year interval. However, the forests showed an ability to recover their original states in terms of coupling between the carbon and water cycles based on the comparison of the three-year periods before and after the fires. Results from a wavelet analysis showed an intensification in annual and seasonal fluctuations, and in some cases (e.g., daily net radiation (Rn24h) and evapotranspiration (ET)) sub-annual fluctuations. Understanding the mechanisms controlling the forest-atmosphere

interactions are essential for assessing how forest fires will influence the exchanges of energy, water and carbon in the future. Improving data and theory about the impacts of fire and other disturbances on the energy balance is essential to improve earth systems models for forecasting the role of tropical forest fires in climate change. Within this context, our approach and, consequently, the results obtained here will help improve the understanding of how forest fires in the Amazon impact land-atmosphere coupling at different spatial and temporal scales.

Session: 710 Advances in process-based land surface modelling - Part 1 Progrès dans la modélisation de la surface terrestre basée sur les processus - Partie 1 **10/06/2021 13:15**

ID: 10660 Contributed abstract

Poster Order:

Benchmarking TRENDY land surface models: How to account for observational uncertainties

Christian Seiler [1]

1

Presented by / Présenté par: ***Christian Seiler***
Contact: christian.seiler@canada.ca

The Global Carbon Project estimates that the terrestrial biosphere has absorbed about 30% of anthropogenic greenhouse gas emissions during the 1959-2019 period. This result is produced by an ensemble of 17 land surface models collectively referred to as the TRENDY ensemble. Given the pivotal role of the terrestrial biosphere in the global climate system, it is important to understand how well TRENDY models reproduce the processes that drive the terrestrial carbon cycle. This presentation compares carbon, energy, and water fluxes simulated by TRENDY models against a wide range of observation-based data sets. Special attention is paid to how observational uncertainties affect benchmarking results. The first part of the presentation demonstrates that observational uncertainties are much larger than anticipated. The second part shows how observation-based benchmark scores provide effective means to separate poor model performance from observational uncertainties. The third part focuses on net ecosystem exchange, which is a key variable that is both, challenging to simulate and measure. The presented results underline that knowledge of observational uncertainty is crucial for a meaningful interpretation of model skill.

Session: 860 Developing Ocean Modelling Capacity in Canada - Part 1 Renforcer la capacité de modélisation des océans au Canada - Partie 1

10/06/2021 12:30

ID: 10948 Contributed abstract

Poster Order:

The Copernicus global 1/12° oceanic and sea ice reanalysis

Jean-Michel lellouche [1] , *Romain Bourdallé-Badie* [2] , *Clément Bricaud* [3] , *Angélique Melet* [4] , *Gilles Garric* [5]

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Presented by / Présenté par: ***Gilles Garric***
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The GLORYS12V1 system is a global eddy-resolving physical ocean and sea ice reanalysis at 1/12° resolution covering the 1993-present altimetry period, designed and implemented in the framework of the Copernicus Marine Environment Monitoring Service (CMEMS). All the essential ocean physical variables from this reanalysis are available with free access through the CMEMS data portal. The GLORYS12V1 reanalysis is based on the current CMEMS global real-time forecasting system, apart from a few specificities that are detailed in this manuscript. The model component is the NEMO platform driven at the surface by atmospheric conditions from the ECMWF ERA-Interim reanalysis. Ocean observations are assimilated by means of a reduced-order Kalman filter. Along track altimeter sea level anomaly, satellite sea surface temperature and sea ice concentration data and in situ temperature and salinity (T/S) vertical profiles are jointly assimilated. A 3D-VAR scheme provides an additional correction for the slowly-evolving large-scale biases in temperature and salinity. The performance of the reanalysis is first addressed in the space of the assimilated observations and shows a clear dependency on the time-dependent in situ observation system, which is intrinsic to most reanalyses. The general assessment of GLORYS12V1 highlights a level of performance at the state-of-the-art and the reliability of the system to correctly capture the main expected climatic interannual variability signals for ocean and sea ice, the general circulation and the inter-basins exchanges. In terms of trends, GLORYS12V1 shows a higher than observed warming trend together with a lower than observed global mean sea level rise. Comparisons made with an experiment carried out on the same platform without assimilation show the benefit of data assimilation in controlling water masses properties and their low

frequency variability. Examination of the deep signals below 2000 m depth shows that the reanalysis does not suffer from artificial signals even in the pre-Argo period. Moreover, GLORYS12V1 represents particularly well the small-scale variability of surface dynamics and compares well with independent (non-assimilated) data. Comparisons made with a twin experiment carried out at ¼° resolution allows characterizing and quantifying the strengthened contribution of the 1/12° resolution onto the downscaled dynamics. In conclusion, GLORYS12V1 provides a reliable physical ocean state for climate variability and supports applications such as seasonal forecasts. In addition, this reanalysis has strong assets to serve regional applications and should provide relevant physical conditions for applications such as marine biogeochemistry. In a near future, GLORYS12V1 will be maintained to be as close as possible to real time and could therefore provide a relevant reference statistical framework for many operational applications.

Session: 860 Developing Ocean Modelling Capacity in Canada - Part 1 Renforcer la capacité de modélisation des océans au Canada - Partie 1

10/06/2021 12:45

ID: 11095 Contributed abstract

Poster Order:

CanTODS: A new pan-Canadian ocean downscaling system for climate and seasonal predictions

Nadja Steiner [1] , *Jim Christian* [2] , *Amber Holdsworth* [3] , *Han Guoqi* [4] , *Diane Lavoie* [5] , *Youyu Lu* [6] , *Oleg Saenko* [7] , *Neil Swart* [8]

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Presented by / Présenté par: ***Nadja Steiner***
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In early February a scoping workshop was held discussing a new system for consistent downscaling of climate projections and seasonal forecasts across Canada’s three oceans named the Canadian Three Oceans Downscaling System (CanTODS). CanTODS aims at providing consistent, high quality,

actionable information on physical and biogeochemical changes in Canada’s marine environment, to aide coastal communities, resource managers and policy makers in their decision making. Canada's marine environment is experiencing significant impacts as a result of climate change, and is also subject to large, natural variability. Currently, information of these changes is produced by coarse resolution global climate models (GCMs). Various groups across Canada downscale these coarse GCM results to obtain higher resolution information relevant to local stakeholders, however, these downscaling systems have piecemeal coverage along the coast, and vary widely in their approach. Many of these regional systems also suffer from a very large step in resolution from the parent GCMs, which is sub-optimal. CanTODS can fill an important gap by providing medium to high resolution projections across all three of Canada's oceans. This will provide consistent information for assessing changes in different coastal areas. It will also provide a much needed intermediate resolution between coarse GCMs and high resolution regional models,building from and adding value to existing modelling systems. CanTODS is envisioned as a collaboration across Environment and Climate Change Canada (ECCC), Department of Fisheries and Oceans Canada (DFO) and academic partners, and we are actively seeking engagement of the community. In this way CanTODS could enable multiple end user-based products, such as operational downscaling of seasonal forecasts, and downscaling of multi-decadal climate projections. The presentation will outline the CanTODS vision and highlight the outcomes from the scoping workshop.

Session: 860 Developing Ocean Modelling Capacity in Canada - Part 1 Renforcer la capacité de modélisation des océans au Canada - Partie 1 **10/06/2021 13:00**

ID: 10631 Contributed abstract

Poster Order:

A 30-year historical ocean and sea ice simulation with a medium-resolution model for Canada’s 3 Oceans

Xianmin Hu [1] , *Eric Oliver* [2] , *Youyu Lu* [3]

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Presented by / Présenté par: ***Xianmin Hu***
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Sea ice plays a crucial role in the exchanges of heat, moment, and freshwater

at the air-ice-ocean interfaces and biogeochemical cycles in the Arctic and subarctic seas. As a part of the ArcticNet project “Downscaling future oceanography projections in the Canadian Arctic and Subarctic", we plan to carry out future climate projection simulations using a coupled ocean and sea-ice model covering the “3 Oceans” around Canada (North Atlantic, Arctic and North Pacific). The model is based on NEMO 3.6 (stable, r13528) with the sea ice module LIM3, at a nominal horizontal resolution of 1/4° in latitude/longitude. In order to provide a baseline reference for future climate change experiments, the model is first used to carry out a historical hindcast simulation over the satellite era. The model is integrated from January 1980 to December 2015, and the first six years are regarded as model adjustment period. The model is forced by the atmospheric forcing from DFS5.2 and open boundaries conditions from SODA3, respectively. No temperature or salinity restoring is applied in the simulation. In this talk, we will present and evaluate the simulated basin-scale sea ice (area and volume) in various subregions. We will also outline plans for a suite of future projection simulations.

Session: 860 Developing Ocean Modelling Capacity in Canada - Part 1 Renforcer la capacité de modélisation des océans au Canada - Partie 1

10/06/2021 13:15

ID: 10728 Contributed abstract

Poster Order:

Improvement in watermass and monitoring in the Pan-Canadian Operational Regional Ocean Data Assimilation System

Audrey-Anne Gauthier [1] , *Yimin Liu* [2] , *Gregory C. Smith* [3] , *Kamel Chikhar* [4] , *Dorina Surcel-Colan* [5]

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Presented by / Présenté par: ***Audrey-Anne Gauthier***
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In order to provide Canada with short-term ice-ocean predictions and hazard warnings in ice-infested regions the Government of Canada CONCEPTS initiative (Canadian Operational Network of Coupled Environmental Prediction Systems) has developed a Regional Ice-Ocean Prediction System (RIOPS). The domain covers the North Pacific, Arctic and North Atlantic regions at

roughly 5km resolution. RIOPS uses the NEMO-CICE ice-ocean model and includes explicit tides, a landfast ice parametrization based on the effect of grounded ice ridges (for improved representation over shallow waters), and an increased resistance to tension and shear in the ice rheology (for improved representation in land-locked areas). The ocean analysis component is based on a multivariate reduced-order Kalman filter that assimilates sea level anomaly, sea surface temperature and in situ profiles of temperature and salinity. The ocean analysis is blended with a 3DVar ice analysis that assimilates SSM/I, SSMIS, AMSR2, ASCAT, as well as manual analyses from the Canadian Ice Service (daily and regional ice charts, and Radarsat image analyses). Here we demonstrate the improvements in the analysis system from a 3DVar bias correction approach. We find this scheme reduces salinity biases considerably in upper 500 m of the Pacific Ocean, eroding errors of up to 0.5 psu in the Northern Pacific region. We also show a demonstration of a new monitoring system.

Session: 860 Developing Ocean Modelling Capacity in Canada - Part 1 Renforcer la capacité de modélisation des océans au Canada - Partie 1

10/06/2021 13:30

ID: 11063 Contributed abstract

Poster Order:

Ocean data assimilation in the Canadian Center for Meteorological and Environmental Prediction

kchikhar Chikhar [1] , *Gregory C. Smith* [2] , *Dorina Dorina Surcel-Colan* [3] , *Audrey-Anne Gauthier* [4] , *Yimin Liu* [5]

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Presented by / Présenté par: ***kchikhar Chikhar***
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Ocean data assimilation systems are used at the Canadian Center for Meteorological and Environmental Prediction (CCMEP) to initialize a suite of coupled environmental prediction systems. These include coupled medium-range deterministic forecasts, coupled ensemble monthly forecasts and seasonal forecasts. They are also used for regional applications including search and rescue, support for the Canadian Ice Service, and oil spill response.

Marine data assimilation at CCMEP involves coupling of different analysis systems (OI SST, 3DVAR sea ice concentration, Singular Evolutive Extended Kalman (SEEK) filter 3D ocean and 3DVAR T/S bias correction). Two ocean data assimilation systems are currently used at CCMEP. The first one is used as part of the Global Ice Ocean Prediction System (GIOPS) running in operations since 2011. It is based on the "Système d'Assimilation Mercator" version 2 (SAM2) and uses a global 1/4° ORCA grid. The second application is within the Regional Ice Ocean Prediction System (RIOPS). It is also based on SAM2 and the domain covers the the North Pacific, the Arctic and the North Atlantic Oceans on a 1/12° CREG12 grid. This presentation focuses on the global GIOPS configuration and reviews the assimilation method and performance.

Session: 831 Coastal ocean modelling: processes and applications - Part 2 Modélisation des eaux côtières : processus et applications - Partie 2

10/06/2021 14:30

ID: 10832 Contributed abstract

Poster Order:

Upwelling and daily sea breeze impacts on inlets along the central west coast of Vancouver Island

Michael Foreman [1] , *Peter Chandler* [2] , *Glenn Cooper* [3] , *Di Wan* [4] , *Maxim Krassovski* [5] , *Laura Bianucci* [6] , *Pramod Thupaki* [7]

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Presented by / Présenté par: ***Michael Foreman***
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Over the past five years, physical oceanographic and weather observations have been taken and an ocean circulation model has been developed to help address aquaculture issues in Esperanza Inlet, Nootka Sound, and Clayoquot Sound. An overview of this project will be presented along with insight gained from the observations and model results on two important inlet processes: i) density intrusions arising when there is upwelling along the coast and, ii) near-surface water property oscillations arising from a persistent daily sea breeze.

Session: 831 Coastal ocean modelling: processes and applications - Part 2 Modélisation des eaux côtières : processus et applications - Partie 2

10/06/2021 14:45

ID: 10702 Contributed abstract

Poster Order:

The Ocean Circulation in Queen Charlotte Strait, British Columbia: Results from an Unstructured-Grid Numerical Model

Andy (Yuehua) Lin [1] , *Laura Bianucci* [2] , *Mike G. G. Foreman* [3]

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Presented by / Présenté par: ***Andy (Yuehua) Lin***
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Queen Charlotte Strait (QCS) is a large marine area separating northern Vancouver Island from the mainland. It is an important waterway connecting Queen Charlotte Sound at the north of Vancouver Island, with Johnstone Strait and eventually to the Strait of Georgia. A better understanding of the ocean circulation in QCS is required to assist the aquaculture industry and its regulators. As part of a Program for Aquaculture Regulatory Research (PARR) project, a high-resolution model for QCS has been developed. The model is an application of the unstructured grid, Finite-Volume, primitive equation Community Ocean Model (FVCOM). The horizontal resolution of the model grid ranges from 50 m at the southern QCS region to 2 km at the open ocean (Queen Charlotte Sound and northwest shelf of Vancouver Island). At the open ocean boundary, the model is one-way nested within the operational largescale Coastal Ice Ocean Prediction System for the West coast (CIOPS-W) with 1/36° horizontal resolution (~2.0 to 2.5km). At the surface, the FVCOM model is forced by the operational High-Resolution Deterministic Prediction System (HRDPS) from Environment and Climate Change Canada (ECCC), which provides surface winds and heat flux with 2.5 km spatial resolutions. Model simulations were created for the winter and summer of 2019, when ADCP and CTD oceanographic data were collected within QCS and used to evaluate model performance. The model demonstrates a promising capacity to reproduce the ocean circulation regime within QCS. The role of nesting with CIOPS-W, as well as the tidal and wind-driven currents in the stratified waters of QCS, have been investigated. This numerical study shows that QCS should be considered a complex system in itself, rather than just a simple conduit between

Queen Charlotte Sound and the Strait of Georgia.

Session: 831 Coastal ocean modelling: processes and applications - Part 2 Modélisation des eaux côtières : processus et applications - Partie 2

10/06/2021 15:00

ID: 11241 Contributed abstract

Poster Order:

Tidal impacts on seasonal circulation and hydrographic variability over the eastern Canadian shelf

Yuan Wang [1] , *Jinyu Sheng* [2] , *Youyu Lu* [3]

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[3] Bedford Institute of Oceanography, Fisheries and Oceans Canada, Dartmouth, NS, Canada

Presented by / Présenté par: ***Yuan Wang***
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A coupled circulation and sea ice model is used to examine the tidal impacts on the seasonal variability of circulation, hydrography and sea ice over the eastern Canadian shelf (ECS). The model performance is assessed using in-situ and satellite remote sensing observations. The tidal impacts have significant spatial variability, which are relatively small over the Labrador and Newfoundland Shelves, moderate over the Scotian Shelf (ScS), and significant over the St. Lawrence River Estuary (SLRE), northwestern Gulf of St. Lawrence (GSL), southwestern ScS, Gulf of Maine (GoM), Bay of Fundy (BoF), and the northern flank of Georges Bank (GeB). The tidal impacts on the seasonal mean circulation are greater in winter than in summer in the SLRE, while greater in summer than in winter over several other areas in the GSL, the GoM-BoF and the southwest ScS. The tidal impacts on temperature and salinity are the most significant near fronts, where both tidal mixing and frontal circulation play important roles. The tidal residual circulation, especially that due to tidal rectification in the GSL and GoM-BoF, spreads the large tidal impacts generated near fronts into broader areas. The changes in circulation and stratification also account for the reduced sea ice concentrations in the GSL.

Session: 831 Coastal ocean modelling: processes and applications - Part 2 Modélisation des eaux côtières : processus et applications - Partie 2

10/06/2021 15:15

ID: 11119 Contributed abstract

Poster Order:

Modeling the variability of sea level in the Coast of Bays region of Newfoundland

andry ratsimandresy [1] , *sebastien donnet* [2]

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Presented by / Présenté par: ***andry ratsimandresy***
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The Coast of Bays in the south coast of Newfoundland is the main region used to host finfish aquaculture in the province. It includes various fjord-like bays of different widths and lengths. In comparison to other Canadian aquaculture regions, the knowledge of the oceanography of this area is relatively limited as only recently did comprehensive oceanographic research take place as a result of the growth of the aquaculture activity. In this work, we investigate the characteristics of the sea level variability within the bays by means of circulation model and compare it with observation. A barotropic run based on the unstructured coastal model FVCOM was used to simulate the variability. The model reproduces the tidal variability and can provide a high resolution map of tidal constituents inside the bays. Simulation of surges as a result of the passage of hurricanes in the region shows the necessity for a good boundary conditions in order to efficiently reproduce the non-tidal sea level variability near the coast. The study will help in the development of a 3-D circulation model that can be used for aquaculture application.

Session: 831 Coastal ocean modelling: processes and applications - Part 2 Modélisation des eaux côtières : processus et applications - Partie 2

10/06/2021 15:30

ID: 11116 Contributed abstract

Poster Order:

Coastally Trapped Waves in a broad, mid-latitude fjord

Sebastien Donnet [1] , *Pascal Lazure* [2] , *Andry Ratsimandresy* [3] , *Guoqi*

Han [4]

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Presented by / Présenté par: ***Sebastien Donnet***
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Fortune Bay is a long (~130 km), wide (~20 km) and deep (~600 m, maximum) fjord located on the southern shore of Newfoundland. Due to its sheer size, volume and to the general lack of tidal amplification around Newfoundland, tidal ranges are small (~2m) and tidal currents are weak (generally <10-20% of the total variance of observed currents). Wind, as opposed to the tide, appears to be a major force affecting the oceanographic conditions observed. Oceanographic response from this forcing is mainly expressed as spatial and temporal variations of the thermocline, i.e., as upwelling and downwelling events associated with surface and sub-surface currents. Driven by the need to understand and reproduce (model) the ocean dynamics to respond to aquaculture related issues, Fisheries and Oceans has initiated a project based on comprehensive observations and numerical modeling. Latest results of this program will be presented and discussed with focus on the modelling component.

Session: 711 Advances in process-based land surface modelling - Part 2 Progrès dans la modélisation de la surface terrestre basée sur les processus - Patire 2

10/06/2021 14:30

ID: 10814 Contributed abstract

Poster Order:

Evaluation of CLASSIC version 1.1 at a diverse collection of FLUXNET2015 eddy covariance sites

Joe Melton [1] , *Vivek Arora* [2] , *Gesa Meyer* [3] , *Christian Seiler* [4]

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Presented by / Présenté par: ***Joe Melton***
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Eddy covariance (EC) towers are an excellent testing ground for process-based models such as the Canadian Land Surface Scheme including Biogeochemical Cycles (CLASSIC) as they measure exchanges of energy and carbon on appropriate temporal and spatial scales. The FLUXNET2015 dataset contains over 200 EC sites whose data has been harmonized and made publicly available. Thirty-one sites from FLUXNET2015 were used to benchmark CLASSIC version 1.0 where the model was set up to match site-level conditions as closely as possible and run with the observed meteorology at each site. Here, we revisit the model benchmarking by comparing CLASSIC version 1.1, which includes the introduction of 1) the nitrogen cycle, 2) non-structural carbohydrates, and 3) new shrub plant functional types, against CLASSIC version 1.0 and the site-level observations. Our analysis is the first to report on these model enhancements collectively. We also expand the number and diversity of sites in our benchmarking suite to offer a more comprehensive view of the model and its performance in different biomes.

Session: 711 Advances in process-based land surface modelling - Part 2 Progrès dans la modélisation de la surface terrestre basée sur les processus - Patire 2

10/06/2021 14:45

ID: 11107 Contributed abstract

Poster Order:

The potential significance of ericoid mycorrhizal fungi in ombrotrophic peatlands: a modeling study

Siya Shao [1] , *Nigel Roulet* [2] , *Jianghua Wu* [3]

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Presented by / Présenté par: ***Siya Shao***
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Ombrotrophic peatlands (bogs) have acted as carbon sinks for millennia, which is in part attributed to their nutrient scarcity. Ericaceous shrubs, a dominant species in bogs, adapt to this nutrient-poor condition by developing organic nutrient acquisition strategies, possibly mediated by ericoid mycorrhizal fungi (ErM). Greater availability of inorganic nutrients, induced either by increased nutrient deposition or greater mineralization brought by climate change, may alter the established nutrient uptake strategies, and enable more assimilated

carbon to be allocated to plant growth. Thus, mycorrhizal activities, which have been overlooked in past peatland studies, could play a significant role in understanding how peatlands respond to environmental changes in the future. Here we incorporated nitrogen and phosphorus cycle with mycorrhiza controls into the McGill Wetland Model (MWM) and simulated the response of ombrotrophic peatlands to environmental changes to investigate these potential microbial controls.

Session: 711 Advances in process-based land surface modelling - Part 2 Progrès dans la modélisation de la surface terrestre basée sur les processus - Patire 2 **10/06/2021 15:00**

ID: 10951 Contributed abstract

Poster Order:

Biogenic soil NOx emissions in a global air quality model

Diane Pendlebury [1] , *Jack Chen* [2] , *Sylvie Gravel* [3]

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[3] Environment and Climate Change Canada

Presented by / Présenté par: ***Diane Pendlebury***
Contact: diane.pendlebury@canada.ca

A global version of ECCC's operational air quality model (GEM-MACH) provides a tool to study air quality and climate change interactions. As anthropogenic emissions of nitrous oxides (NOx) decrease due to cleaner technologies, the role of natural emissions due to soil and farming practices becomes relatively more important. Recently, a mechanistic soil NOx emission parameterization based on Hudman et al. (2012) has been implemented in GEM-MACH. Such a scheme will allow for more physically-based studies of future climate, since it does not rely on pre-calculated emissions data sets. Results from GEM-MACH using this scheme will be presented, with comparisons with other emissions data sets and the impact on tropospheric NOx. The Hudman scheme uses a pulsing of NOx emissions due to drought conditions based on available soil moisture. The effect of this term in drought-prone regions will be of particular focus.

Session: 711 Advances in process-based land surface **10/06/2021**

ID: 10978 Contributed abstract

Poster Order:

Optimization of maximum photosynthetic carboxylation rate (Vc,max) in CLASSIC for North America's boreal forests using eddy covariance data

Bo Qu [1] , *Oliver Sonnentag* [2] , *Alexandre Roy* [3] , *Joe Melton* [4] , *T. Andrew Black* [5] , *Eugenie Euskirchen* [6] , *Masahito Ueyama* [7] , *Hideki Kobayashi* [8] , *Brian Amiro* [9] , *Hank Margolis* [10]

[1] Department of Geography & Center for Northern Studies, University of Montreal
[2] Department of Geography & Center for Northern Studies, University of Montreal
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[5] Biometeorology and Soil Physics Group, University of British Columbia
[6] Institute of Arctic Biology, University of Alaska Fairbanks
[7] Graduate School of Life and Environmental Sciences, Osaka Prefecture University
[8] Department of Environmental Geochemical Cycle Research, Japan Agency for Marine-Earth Science and Technology
[9] Department of Soil Science, University of Manitoba
[10] Département des sciences du bois et de la forêt, Université Laval

Presented by / Présenté par: ***Bo Qu***
Contact: geo_qb@163.com

The maximum rate of photosynthetic carboxylation (Vc,max) is a key parameter in photosynthesis models for estimating gross primary productivity (GPP) of vegetation. Vc,max varies in space as a consequence of plant traits and environmental conditions, posing a challenge to accurately estimate GPP across North America's boreal biome and its forest ecosystems. The Bayesian optimization is an effective approach to optimize model parameters and characterize their spatial variations. Here, we implemented a comprehensive Vc,max optimization scheme for North America's boreal forests in the Canadian Land Surface Scheme including Biogeochemical Cycles (CLASSIC) using eddy covariance observations made at nine forest stands in different climate and permafrost zones. The Tree-structure Parzen Estimators (TPE), a hyper-parameter searching algorithm based on Bayesian optimization, was employed over each forest stand for global Vc,max optimization at the dominating overstory, understory, and ground cover plant functional types (PFTs). We

investigated PFT-level GPP estimates obtained by the optimized photosynthesis model. Our findings suggest that Vc,max varied significantly across climate and permafrost zones. Carefully characterized stand-level variations in Vc,max provide an opportunity to improve regional GPP estimates and their partitioning into overstory, understory, and ground cover contributions in North America’s boreal forests.

Session: 711 Advances in process-based land surface modelling - Part 2 Progrès dans la modélisation de la surface terrestre basée sur les processus - Patire 2

10/06/2021 15:30

ID: 10681 Contributed abstract

Poster Order:

Uncertainty in global land surface energy, water, and CO2 fluxes due to model structure, driving meteorological data, and land cover characterization

Vivek Arora [1]

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Presented by / Présenté par: ***Vivek Arora***
Contact: vivek.arora@canada.ca

Land surface models (LSMs) explicitly simulate the exchange of energy, water, and CO2 fluxes at the land-atmosphere boundary. Quantification of the uncertainty in fluxes simulated by LSMs remains a challenge. Primary sources of uncertainty in fluxes simulated by LSMs include differences, 1) in their model structure, 2) in driving meteorological data, and 3) in specified geophysical data used to characterize the land surface. Every year participating LSM groups contribute results from a historical simulation to the Global Carbon Project (GCP). The results from this S3 simulation quantify the model mean atmosphere-land CO2 fluxes as part of the global carbon budget but also its inter-model range that is an important measure of uncertainty. The GCP protocol, however, requires that all models are driven with a specified single meteorological data set and a single land cover reconstruction. Uncertainty related to differences in meteorological data and land cover is therefore not addressed. The Canadian LAnd Surface Scheme Including biogeochemical Cycles (CLASSIC) has regularly contributed results from a single S3 simulation to the GCP effort since 2016. Here, using the CLASSIC model we attempt to quantify the uncertainty in simulated results associated with driving meteorological data, land cover characterization, and its model structure. We use two data sets each of meteorological data and historical land cover

reconstruction, as well as two model structures (with and without coupling of carbon and nitrogen cycles) to perform the historical S3 simulation. The resulting spread across the eight (2 x 2 x 2) equally probable model simulations illustrates the uncertainty owing to differences in meteorological forcing, specified land cover, and model structure. In addition to quantification of uncertainty, these results indicate that comparison of model results to observations, which forms the basis to tune models, provides a better context when multiple 'realizations' of model results are considered.

Session: 861 Developing Ocean Modelling Capacity in Canada - Part 2 Renforcer la capacité de modélisation des océans au Canada - Partie 2

10/06/2021 14:30

ID: 10664 Invited session speaker

Poster Order:

Iceberg modelling with NEMO

Juliana Marson [1], *Paul Myers* [2]

[1] University of Manitoba
[2] University of Alberta

Presented by / Présenté par: ***Juliana Marson***
Contact: Juliana.MariniMarson@umanitoba.ca

Icebergs represent around half of the yearly mass discharge from the Greenland Ice Sheet. They are not only important freshwater sources, but also pose a threat to navigation and other offshore activities. Since monitoring individual icebergs in large numbers is unfeasible, numerical models are great tools to evaluate their role in freshwater distribution and their general trajectory patterns. We use the Nucleus for European Modelling of the Ocean (NEMO) coupled with an iceberg module to show the differences between explicitly representing Greenland's solid discharge versus inserting it in the model as liquid runoff from the coast. Additionally, we will present recent improvements done in NEMO's iceberg module. Among those, we highlight a newly implemented iceberg-sea ice dynamic, where icebergs are locked in concentrated and strong sea ice packs, so they will move with sea ice instead of across it. Additionally, recent code modifications allow the user to choose if the iceberg melt plume is inserted in the ocean's first model layer or distributed along the iceberg draft. Results will show if these code upgrades change the way freshwater is distributed in the ocean and if they better represent iceberg trajectories in Baffin Bay.

Session: 861 Developing Ocean Modelling Capacity in Canada - Part 2 Renforcer la capacité de modélisation des océans au Canada - Partie 2

10/06/2021 15:00

ID: 11166 Contributed abstract

Poster Order:

Sensitivity Experiments with the Louvain-la-Neuve (LIM3) Sea-Ice Model

Liam Buchart [1] , *Paul Myers* [2]

[1] University of Alberta
[2] University of Alberta

Presented by / Présenté par: ***Liam Buchart***
Contact: lbuchart@ualberta.ca

The Louvain-la-Neuve (LIM3) sea-ice model is a dynamic-thermodynamic model which represents the ice pack as a series of ice categories to simulate heterogeneous ice cover more accurately. In the Arctic there are numerous factors which impact the state of sea, modelling these features is often difficult. In order to gain insight towards the relative impact of different components on the simulated ice pack, sensitivity experiments are run to analyze changes in key model output variables, as well as to gain insight into the improvements and shortcomings of the LIM3 model compared to the previous LIM2 model. Analysis is focuses on two regions, pan-Arctic and then a closer look at the Pikialasorsuaq (North Water Polynya region). Key variables, sea-ice thickness and concentration are looked at more closely and compared to observations; CryoSat thickness and AMSR2 concentration as well as changes to ice volume, extent, salinity, and thickness distribution. Further, the relative sensitivity to changes in sea-ice physics to ocean properties are analyzed, including sea-ice transport through the Canadian Arctic Archipelago. On a pan-Arctic scale, LIM3 has a thinner ice pack than LIM2 and better matches CryoSat observed thicknesses. As well, LIM3 has a greater seasonality in ice concentration with slightly greater winter values and lower summer concentrations than LIM2 and better matches AMSR2 ice concentration observations. Including tides is found to further decrease mean ice thickness and increase the seasonality of thickness. Lowering the ice salinity acts to thin ice slightly. Increasing the ice shear strength increases ice thickness, while changing the ice density produces minimal changes. On a pan-Arctic scale sensitivity experiments only produce small discrepancies in ice concentration compared to the change from LIM2 to LIM3.

Session: 861 Developing Ocean Modelling Capacity in Canada - Part 2 Renforcer la capacité de modélisation des océans au Canada - Partie 2 **10/06/2021 15:15**

ID: 11021 Contributed abstract

Poster Order:

Online Tidal Harmonic Analysis

Yimin Liu [1] , *Gregory Smith* [2]

[1] Meteorological Research Division, Environment and Climate Change Canada
[2] Meteorological Research Division, Environment and Climate Change Canada

Presented by / Présenté par: ***Yimin Liu***
Contact: yimin.liu@canada.ca

In order to assimilate satellite observations of sea level anomaly in an ocean model that contains explicit tides, the tidal variability must first be filtered. Here we present a novel online tidal harmonic analysis method that has been developed and implemented in the NEMO ocean model as part of the Regional Ice Ocean Prediction System version 2 (RIOPSv2) running operationally at the Canadian Centre for Meteorological and Environmental Prediction. This method uses a sliding-window approach in time and a spectral-space rotation operator to provide an accurate estimate of tidal variability at a low numerical cost. Moreover, this approach allows harmonic constants to vary in time, which is necessary in seasonally ice-infested waters where the additional surface stress from sea ice has been shown to affect tidal amplitudes and phases. The sliding-window tidal harmonic filter is compared using both an online version as part of NEMO as well as an offline calculation to the well-known T_tide harmonic analysis package. The sliding window approach is shown to capture a larger portion of the tidal variance even in complex regions such as Ungava Bay. Finally, the filter is demonstrated as part of a multivariate ocean data assimilation system and shown to adequately remove the surface tidal signal allowing the assimilation of satellite altimetry. In particular, this method is shown to work effectively and efficiently in a multi-year reanalysis of RIOPSv2.

Session: 861 Developing Ocean Modelling Capacity in Canada - Part 2 Renforcer la capacité de modélisation des océans au Canada - Partie 2

10/06/2021 15:30

ID: 11071 Contributed abstract

Poster Order:

AtaaMap v1.0: a new high-resolution bed map of the Canadian Arctic

Andrew Hamilton [1], *Gabriel Joyal* [2], *Luke Copland* [3], *Paul G. Myers* [4]

[1] University of Alberta
[2] Centre de Geomatique du Quebec
[3] University of Ottawa
[4] University of Alberta

Presented by / Présenté par: ***Andrew Hamilton***
Contact: akhamilt@ualberta.ca

Seabed bathymetry and subglacial bed topography are essential boundary conditions for modelling the dynamics of the ocean, glaciers and climate. To accurately model processes such as ocean circulation and mixing, glacier velocity and mass loss, sea level rise, and marine biogeochemical cycling requires knowledge of the shape and elevation of the bed below the ocean and glaciers. However, existing digital elevation models, such as the International Bathymetric Chart of the Arctic Ocean (IBCAO v4), lack any glacier ice thickness information and poorly represent the actual elevations in the Canadian Arctic due to a combination of sparse underlying measurements and generalized interpolation techniques, leading to elevation errors of several hundred meters in nearshore regions. Here, we present an effort to create a new high-resolution (50 x 50 m), gridded, continuous digital elevation model of seafloor bathymetry, subglacial topography, and glacier ice thickness for the Canadian Arctic north of 60 oN called AtaaMap v1.0, where ‘ataa’ means ‘bottom’ or ‘below’ in Inuktitut, referring to a map of the bottom of the ocean and the land below glaciers. The map will compile a substantial amount of previously un-utilized bathymetric soundings, extensive ground and aerial radar glacier ice thickness datasets, a new high-resolution coastline, and employ enhanced interpolation techniques to produce a greatly improved representation of bed elevations for the Canadian Arctic. AtaaMap v1.0 will be utilized in high-resolution ocean circulation and climate models, enable calculation of total glacier ice volume in the Canadian Arctic, and allow researchers to better constrain Canadian contributions to global sea level rise.

Day 10 – 11 June 2021

Oral

ID: 11196 Contributed abstract

Poster Order:

Historical Snow Measurement over Canada and Data Quality Control

Hong Lin [1] , *Chris Hampel* [2] , *Lee Cudlip* [3] , *Daniel Duklas* [4] , *Ayan Gedleh* [5] , *Hannah Fong* [6]

[1] Environment and Climate Change Canada
[2] Environment and Climate Change Canada
[3] Environment and Climate Change Canada
[4] Environment and Climate Change Canada
[5] Environment and Climate Change Canada
[6] Environment and Climate Change Canada

Presented by / Présenté par: ***Hong Lin***
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Snow is an important weather element for regional climate and hydrological applications in Canada. Environment and Climate Change Canada (ECCC) has been collecting and archiving snow data since 1954. This study investigates the characteristic of historical snow on the ground measurement across Canada. Data from ECCC's national archive in the period from 1981 to 2010 are used in the analysis including the extreme and mean daily snow depth measurements. Detailed seasonal snow depth distributions from each Canadian provinces and territories were analyzed. The analysis were further grouped into about 100 smaller climate zones across Canada, the results will be presented and discussed. In this presentation, we will also provide a brief introduction on Meteorological Service of Canada's Data Management System and the real time snow depth data quality assessment for this system.

Session: 750 General Session - Climate change Séance générale — Changement climatique **11/06/2021 11:15**

ID: 10737 Contributed abstract

Poster Order:

Could agriculture be replaced? Evaluating the potential climate impacts of an emerging technology

Andrew MacDougall [1]

[1]

Presented by / Présenté par: ***Andrew MacDougall***
Contact: amacdoug@stfx.ca

Global agriculture is the second largest contributor to anthropogenic climate change after the burning of fossil fuels. However the potential to mitigate the agricultural contribution is limited by the imperative to supply food for the global population. Advances in microbial biomass cultivation technology have recently opened a pathway to growing substantial amounts of food for humans or livestock, by fuelling microbial growth with hydrogen produced from electrolysis powered by renewable energy. This method of food production would use a small fraction of the land presently used for agriculture. Here we investigate the potential climate change impacts of the end of agriculture as the primary human food production system. We find that microbial biomass cultivation technology has both the potential to exacerbate climate change by out-competing economic decarbonization for renewable energy and the potential to mitigate climate change if deployed following economic decarbonization. A duality which originates from the contrast between the reversibility of agricultural driven climate change and the irreversibility of fossil-fuel CO2 driven climate change. The range of reduced warming from the replacement of agriculture ranges from -0.22 [-0.29 to -0.04]ºC for Shared Socioeconomic Pathway (SSP) 1-1.9 to -0.85 [-0.99 to -0.39]ºC for SSP4-6.0. For limited temperature target overshoot scenarios, replacement of agriculture could eliminate or reduce the need for active atmospheric CO2 removal to achieve the necessary peak and decline in global warming. Given current societal barriers to switching to a microbial-based diet, deep near-term emissions reductions in CO2 and agricultural emissions remain necessary steps to keep warming within the bounds set by the Paris Agreement.

Session: 750 General Session - Climate change Séance générale — Changement climatique **11/06/2021 11:30**

ID: 11132 Contributed abstract

Poster Order:

Projected Changes to Temperature, Sea Level Rise and Storms for the Gulf of Maine region in 2050

Lucy Chisholm [1] , *Tracey Talbot* [2] , *William Appleby* [3] , *Benita Tam* [4] , *Robin Rong* [5]

[1] ECCC
[2] ECCC
[3] ECCC
[4] ECCC

[5] ECCC

Presented by / Présenté par: ***Lucy Chisholm***
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A scientific scenario paper was prepared ahead of the Gulf of Maine (GOM) 2050 International Symposium to review and summarize possible weather-related and sea level changes within the GOM as a result of climate change. It is projected that the GOM will experience warming temperatures, continued sea level rise, as well as changes to storm characteristics and related elements such as precipitation and waves in the intermediate term, by approximately 2050. Coastal communities within the GOM region are particularly vulnerable to the anticipated impacts of climate change. This presentation will summarize the review paper, to provide context on some of the consequential impacts that may occur from the changes projected within the area.

Session: 750 General Session - Climate change Séance générale — Changement climatique **11/06/2021 11:45**

ID: 10715 Contributed abstract

Poster Order:

Canada's Net Zero challenge: Action by concerned citizens

Charles Lin [1] , *James Lin* [2] , *Stephen Phoon* [3] , *Shu Yi Chu* [4]

[1] Retired scientist
[2] University of Alberta (Alumni)
[3] Seneca College of Applied Arts & Technology
[4] University of Oxford (Alumni), McGill University (Alumni)

Presented by / Présenté par: ***Charles Lin***
Contact: charles.augustin.lin@gmail.com

The Canadian federal government has committed the country to reach "Net Zero" anthropogenic CO2 emissions by 2050 in accord with the Paris Agreement, where emissions by sources are balanced by removals by sinks in the second half of this century. Governments, corporations and citizens have a role in this commitment, and the pathways to reach Net Zero have not been fully defined. There are different pathways to reach Net Zero, with varying technological, economic, and political uncertainties and risks. The federal government has recently published a climate plan, "A Healthy Environment and a Healthy Economy", which is a step in determining how Canada would reach

Net Zero. Recent polls also show over 80% of Canadians would like to be seen as “determined to help combat climate change”; this opinion toward a willingness to act is consistent across generations, regions of the country, and political affiliation. A challenge is to transform a citizen’s willingness to act, to achieve collective impact to help Canada reach Net Zero. At the individual level, actions such as driving less or eating less red meat, no matter how worthwhile, are not sufficient. These actions must be transformed to realize collective impact through mobilization, to influence governments, politicians, and corporations. We, a group of four concerned Canadians, review aspects of this challenge, and present an internet and social media-based approach that aims to engage and empower Canadians to help our country reach its Net Zero goal.

Session: 750 General Session - Climate change Séance générale — Changement climatique **11/06/2021 12:00**

ID: 11245 Contributed abstract

Poster Order:

Interdisciplinary Climate Science Advocacy

Geoff Strong [1], *Garth Mihalcheon* [2]

[1] A retired atmospheric/climate scientist in Cowichan Bay, BC
[2] A retired health management expert consultant in Duncan, BC

Presented by / Présenté par: ***Geoff Strong***
Contact: geoff.strong@shaw.ca

Scientists are sometimes warned to “stay in their own lane,” because they risk getting embroiled in partisan politics or other controversy. How can we avoid those pitfalls and still share our science with the public and media, and help influence government policy? One approach is to consider interdisciplinary networking to achieve objectives difficult to reach individually. Networks can work together to advocate for an effective, balanced strategy across many disciplines and decision-makers. Two examples where climate science could effectively network are international aid organizations, and locally with our healthcare sector. International aid organizations have become hard-pressed to respond to huge demands for aid in developing countries of the subtropics, where the great bulk of aid goes, and where climate impacts have been most severe. For example, desertification and drought caused by global warming and expanding deserts are having horrendous impacts on millions of people across the African Sahel, east Africa, southern Africa, and the Middle East. Millions of climate refugees have been relegated to crowded migrant camps, where tents are plagued by rats, contaminated water sources, and inhabitants diagnosed

with tuberculosis, scabies, other diseases, and post-traumatic stress. In Canada, our healthcare sector is increasingly concerned about the health impacts of climate change and pollution, both caused by the burning of fossil fuels. These disciplines need the expertise of climate science, while we require their networking to allow us to explain climate change impacts and necessary solutions and actions to those who need the information. Interdisciplinary advocacy allows for buffered explanations to media and the public, and can better influence government policy for the daunting battles on climate change, international aid, healthcare, and other disciplines.

Session: 651 Collaborative Earth System Modelling in Canada - Part 2 Modélisation collaborative du système terrestre au Canada - Partie 2

11/06/2021 12:30

ID: 10905 Contributed abstract

Poster Order:

Quantifying changes in the marine carbon sink in Canadian Waters and its future trajectory

Parsa Gooya [1] , *Neil Swart* [2] , *Roberta C. Hamme* [3]

[1] School of Earth and Ocean Sciences, University of Victoria
[2] Environment and Climate Change Canada
[3] School of Earth and Ocean Sciences, University of Victoria

Presented by / Présenté par: ***Parsa Gooya***
Contact: parsa.g76@gmail.com

As a major sink for anthropogenic carbon, the oceans slow the increase of CO2 in the atmosphere and regulate climate change. However, warming and ocean acidification, as well as changing productivity, stratification, and sea ice conditions induced by climate change are reducing the oceans' ability to absorb carbon from the atmosphere. Despite the importance of the marine carbon sink, its trend and magnitude have mainly been analyzed on a global basis. Regional estimates and projections are necessary to evaluate whether and how this valuable sink is changing, what the driving forces are, and what the future trajectory is. Here, we will report a regional multimodal analysis focusing on Canadian waters using output data from the Coupled Model Intercomparison Project phase 6 (CMIP6). We will show where there are robust signals across models, indicate regions of unexpected anomalies in the present and future ocean carbon sink, and identify some potential driving processes behind these changes. Such information is highly relevant to Canada because a weakened marine carbon sink would require appropriate adjustments in emission reduction

targets to meet the commitments to stabilize the global climate as part of the 2015 Paris agreement.

Session: 651 Collaborative Earth System Modelling in Canada - Part 2 Modélisation collaborative du système terrestre au Canada - Partie 2

11/06/2021 12:48

ID: 11175 Contributed abstract

Poster Order:

Transition from land carbon sink to land carbon source in temperature overshoot scenarios

Sabine Mathesius [1] , *Kirsten Zickfeld* [2]

[1]

[2] Simon Fraser University

Presented by / Présenté par: ***Sabine Mathesius***

Contact: sabine_mathesius@sfu.ca

Since the industrial revolution, a substantial fraction of anthropogenic carbon dioxide (CO2) has been taken up by terrestrial vegetation and stored in soil and vegetation. This natural land carbon sink has been counteracted by deforestation, resulting in a net carbon flux close to zero for most of the historical period. In recent decades, the net atmosphere-to-land carbon flux became positive (i.e., net carbon uptake). The future of the terrestrial carbon sink is uncertain, due to the complex interplay of factors such as changing vegetation growth due to CO2 fertilisation, changes in soil respiration induced by climate change, and anthropogenic land-use change. Here, we analyse potential future developments of the terrestrial carbon cycle under several Shared Socioeconomic Pathways (SSP) overshoot scenarios (SSP1-1.9, SSP1-2.6, SSP4-3.4, SSP5-3.4). Overshoot scenarios are scenarios in which a given temperature target is temporarily exceeded and later achieved by deploying negative CO2 emission technologies. We used the community-developed Earth system model of intermediate complexity UVic ESCM 2.10 (University of Victoria Earth System Climate Model) for extended simulations until the year 2500. In all scenarios we find a sink-to-source transition of the net atmosphere-land carbon flux during the 21st century. The timing of the transition is scenario-dependent and heavily influenced by the scenarios’ prescribed land-use change. In our simulations, the natural land sink remains a sink on global average for the whole simulation period, but becomes a source in some regions, especially in the Northern high latitudes. Furthermore, we compare our results of the UVic ESCM to results of the Canadian Earth System Model version 5

(CanESM5), which has a different representation of the terrestrial carbon cycle. A better understanding of the future development of the terrestrial carbon sink is important to improve estimates of the remaining carbon budget for the well-below 2°C temperature target of the Paris Agreement.

Session: 651 Collaborative Earth System Modelling in Canada - Part 2 Modélisation collaborative du système terrestre au Canada - Partie 2 **11/06/2021 13:06**

ID: 11156 Contributed abstract

Poster Order:

Isolating the Climate-driven and CO₂-driven Components of the Zero Emissions Commitment

Rachel Chimuka [1] , *Kirsten Zickfeld* [2]

[1] Simon Fraser University
[2] Simon Fraser University

Presented by / Présenté par: ***Rachel Chimuka***
Contact: rchimuka@sfu.ca

The zero emissions commitment (ZEC) refers to the change in global average temperature following a cessation of emissions. The ZEC is important for the quantification of carbon budgets consistent with temperature targets. It is determined by inertia in both physical and biogeochemical components of the climate system. The ZEC is commonly quantified from fully coupled model simulations in which the land and ocean respond to changes in both climate and atmospheric CO₂ concentration. However, the CO₂ and climate effects on the ZEC are difficult to isolate in this simulation mode. This study uses a community-developed Earth system model of intermediate complexity to isolate and independently analyze the climate and CO₂ effects on the ZEC. To this end, climate model simulations with a prescribed increase in atmospheric CO₂ concentration at 1% per year from preindustrial levels until it quadruples, followed by an emissions-driven simulation with zero CO₂ emissions are run in fully coupled, biogeochemically coupled and radiatively coupled modes. When the CO₂ effect is isolated, the atmospheric CO₂ concentration declines more rapidly than in the fully coupled mode due to continued land and ocean uptake. However, isolating the climate effect results in a continued increase in the atmospheric CO₂ concentration, as the land and ocean continue to lose carbon. The climate-driven component of the ZEC is much larger than the CO₂-driven component, and the

two components do not combine linearly to the ZEC in the fully coupled simulation. This study is part of a larger project to quantify climate-carbon cycle feedbacks under negative CO₂ emissions, and results could inform the design of experiments with complex ESMs seeking to quantify this feedback.

Session: 651 Collaborative Earth System Modelling in Canada - Part 2 Modélisation collaborative du système terrestre au Canada - Partie 2

11/06/2021 13:24

ID: 11088 Contributed abstract

Poster Order:

Quantifying the effectiveness of deliberate carbon dioxide removal from the atmosphere

Kirsten Zickfeld [1]

[1] Simon Fraser University

Presented by / Présenté par: ***Kirsten Zickfeld***
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Carbon dioxide removal (CDR) refers to the deliberate removal of CO2 from the atmosphere by enhanced biological processes on land and in the ocean or by chemical methods, and permanent storage. It is a key mitigation measure in scenarios consistent with meeting stringent climate targets, such as the 1.5°C and 2°C targets adopted in the Paris Agreement. Quantifying the extent to which application of CDR results in a decline in atmospheric CO2 and surface air temperature is crucial for designing effective credit systems for CDR projects. The amount of CO2 sequestered by CDR does not result in an equivalent reduction in atmospheric CO2 because of CO2 outgassing from land and ocean reservoirs, which is controlled by a range of factors (e.g. rate and amount of removal, climate state from which CO2 is removed). Here we use idealized model simulations with a community-developed Earth System Model of intermediate complexity (UVic ESCM) to explore the advantages and disadvantages of different approaches to quantifying the effectiveness of CDR, defined as the amount of sequestered CO2 remaining out of the atmosphere. These approaches include: i) CDR applied from a transient model state, ii) CDR applied from a model state in equilibrium with a given atmospheric CO2 level, and iii) the difference between a transient model simulation and a simulation with zero CO2 emissions. While closest to the “real-world” situation, applying CDR from a transient model state makes it difficult to isolate the Earth system response to CDR from the response to the prior CO2 emission trajectory.

Quantifying the effectiveness by removing the lagged response through an additional zero emission simulation appears to be the most promising approach. Insights from this work inform the design of simulations with complex ESMs and Model Intercomparison Projects aimed at quantifying the effectiveness of CDR.

Session: 651 Collaborative Earth System Modelling in Canada - Part 2 Modélisation collaborative du système terrestre au Canada - Partie 2

11/06/2021 13:35

ID: 10830 Contributed abstract

Poster Order:

Investigating the Dependence of the Effectiveness of Carbon Dioxide Removal on the Amount and Rate of Removal

Chloe Papalazarou [1] , *Kirsten Zickfeld* [2]

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Presented by / Présenté par: ***Chloe Papalazarou***
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To stay within the carbon budget consistent with the 1.5°C-2°C warming limits set by the Paris Agreement, strong mitigation of our CO2 emissions must take place. In most future climate scenarios consistent with these limits, the use of negative emissions, or carbon dioxide removal (CDR) is used to offset positive CO2 emissions or recover a carbon budget after overshoot. It has been shown that only a fraction of CO2 removed from the atmosphere remains out of the atmosphere but the effectiveness of CDR at drawing down atmospheric CO2 and temperature based on the amount and rate of CDR is not well quantified. Using an Earth System Model of Intermediate Complexity, a systematic investigation of the Earth system response to CDR is performed, and the dependence of the effectiveness of CDR based on the amount and rate of atmospheric CO2 removal is quantified. Three different amounts ranging from100GtC to 500GtC and five different rates of removal ranging from 1GtC/year to 10GtC/year within these cumulative amounts are investigated in this research. The processes that determine the coupled climate-carbon cycle response to different rates and amounts of CDR at global and continental scales

are investigated. We show that the effectiveness of CDR decreases as the magnitude of CO_2 removed increases, and that the effectiveness of CDR at reducing surface air temperature does not depend on the level or rate of removal on century timescales. This research provides a systematic understanding of CDR as it pertains to different magnitudes and rates of removal. The quantification of the effectiveness of CDR at reducing the carbon burden and temperature in the atmosphere will allow insights into the optimal timing of implementing CDR to ensure the maximum effectiveness of carbon sequestration.

Session: 210 In situ measurement of precipitation and snow cover: advances, challenges, and ongoing issues - Part 1
Mesure in situ des précipitations et de la couverture de neige : progrès, défis et situations actuelles - Partie 1 **11/06/2021 12:30**

ID: 11013 Contributed abstract

Poster Order:

Data hiding in plain sight: retrieving historical snow depth measurements in northern Canada through staffed airport Meteorological Aerodrome Reports (METAR)

Andrew C.W. Leung [1] , *Samantha Yuen* [2]

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Presented by / Présenté par: ***Andrew C.W. Leung***
Contact: andrew.leung@canada.ca

Snow depth measurements are often used in climatological studies to monitor climatological changes in the environment. Yet few weather stations in northern Canada measure snow depth and they are prone to animal disturbance. METAR is a highly standardized format to transmit weather observations from airports around the world. Due to the current infrastructure of the archive and variations in observation hours, these data cannot be stored in the ECCC historical climate archive database. We developed a novel approach to retrieve snow depth records by manually parsing airport METARs with partial hourly observing program through the METAR codes or remarks for the winters of 2015 to 2021 in northern Canada (Yukon, Northwest Territories, Nunavut and northern Quebec). We identified 32 candidate locations with snow depth measurements in the METAR messages. Twelve of the airport measurements provided substantial added-value to climatological research as there were no

snow depth measurements by Environment and Climate Change Canada (ECCC) automatic weather stations in those communities. Many of these airport locations were located more than 100 km away from the nearest weather station with snow depth measurements. The remaining 20 airports also provided complimentary snow depth data for comparison and validation on the ECCC stations for quality control purposes. Data completeness varied between these airports. Some data gaps were attributed to the lack of snow cover for parts of the winter and winter storms forcing early airport closures. These additional snow depth values enhanced the spatial resolution of snow depth analysis in the data-sparse region by providing additional on-site measurements, leading to improved understanding of the snow conditions in the Arctic and potentially a new source of information for forecasters for severe weather warnings. An automated parsing functionality can lead to more timely retrieval and storage of these values in the future.

Session: 210 In situ measurement of precipitation and snow cover: advances, challenges, and ongoing issues - Part 1
Mesure in situ des précipitations et de la couverture de neige : progrès, défis et situations actuelles - Partie 1 **11/06/2021 12:45**

ID: 10968 Contributed abstract

Poster Order:

Deep-learning-based precipitation observation quality control

Yingkai Sha [1] , *David John Gagne II* [2] , *Gregory West* [3] , *Roland Stull* [4]

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Presented by / Présenté par: ***Yingkai Sha***
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We present a novel approach for the automated quality control (QC) of precipitation for a sparse precipitation observation network within the complex terrain of British Columbia, Canada. Our QC approach uses Convolutional Neural Networks (CNNs) to classify bad observation values, incorporating a multi-classifier ensemble to achieve better QC performance. We train CNNs using human QC'd labels from 2016 to 2017 with gridded precipitation and elevation analyses as inputs. Based on the classification evaluation metrics, our QC approach shows reliable and robust performance across different geographical environments (e.g., coastal and inland mountains), with 0.927

Area Under Curve (AUC) and type I/type II error lower than 15\%. Based on the saliency-map-based interpretation studies, we explain the success of CNN-based QC by showing that it can capture the precipitation patterns around, and upstream of the station locations. This automated QC approach is flexible to the input data, and does not require the information of other stations neighboured to the QC'd station. Thus, it can be an option of automated QC for various applications, including the pre-processing of near-real-time observational values and cleaning/filtering a historical database.

Session: 210 In situ measurement of precipitation and snow cover: advances, challenges, and ongoing issues - Part 1
Mesure in situ des précipitations et de la couverture de neige : progrès, défis et situations actuelles - Partie 1 **11/06/2021 13:00**

ID: 10696 Contributed abstract

Poster Order:

The hourly wind-bias adjusted precipitation data set from the ECCC automated surface observation network (2001-2019)

Craig Smith [1] , *Eva Mekis* [2] , *Megan Hartwell* [3] , *Amber Ross* [4]

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Presented by / Présenté par: ***Craig Smith***
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The measurement of precipitation in the ECCC surface network is a crucial component for climate and weather monitoring, flood and water resource forecasting, numerical weather prediction and many other applications that impact the health and safety of Canadians. Through the late 1990s and early 2000s, ECCC surface network modernization led to a shift from manual to automated precipitation measurements. Increased reliance on automated precipitation gauges has resulted in additional challenges with both data quality and homogenization. The automated weighing precipitation gauges used in the operational network have an increased propensity for wind-induced under-catch of solid precipitation, but also increase the frequency of available measurements. One outcome of the WMO Solid Precipitation Inter-Comparison Experiment (SPICE) was the development of transfer functions for the adjustment of high frequency solid precipitation measurements made with gauge/wind shield configurations used in the ECCC surface network. Using the

SPICE universal transfer function, hourly precipitation measurements from 397 ECCC automated climate stations were retroactively adjusted for wind under-catch. The new adjusted hourly data set (2001-2019) and impacts of adjustments on total measured precipitation will be presented and future improvements to the adjustment procedure will be discussed.

Session: 210 In situ measurement of precipitation and snow cover: advances, challenges, and ongoing issues - Part 1
Mesure in situ des précipitations et de la couverture de neige : progrès, défis et situations actuelles - Partie 1 **11/06/2021 13:15**

ID: 10940 Contributed abstract

Poster Order:

Development of a New Transfer Function Using the Iqaluit Supersite for Adjusting Arctic Precipitation Measurements

Eva Mekis [1] , *Craig D. Smith* [2] , *Amber Ross* [3] , *Michael Earle* [4]

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[4] Transformation, Innovation and Engineering Division, Environment and Climate Change Canada

Presented by / Présenté par: ***Eva Mekis***
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Good quality precipitation observation is a critical element of the water cycle and is fundamental for streamflow, climate and weather forecasting. However, it is one of the most difficult variables to measure accurately. Key users, such as Numerical Weather Prediction (NWP) and Canadian Precipitation Analysis (CaPA), identified the need to develop and apply transfer functions for precipitation gauge wind bias adjustments applicable for diverse Canadian climates. The quality control verification systems often flag and disqualify solid precipitation measurements in windy conditions because measurements are known to be significantly underestimated. This is a severe problem for weather forecast verification, especially in winter at high latitudes, where the selective quality control systems systematically eliminate most snow events. The WMO Solid Precipitation Inter-Comparison Experiment (SPICE) developed site-specific and universal transfer functions for the adjustment of snowfall measurements using data from eight supersites representing different climate conditions. Given the geographical span and climate diversity of Canada, the additional characterization of important regions such as the Canadian Arctic is

still required. Development and testing of climate-dependent transfer function is possible using Canadian research supersites equipped with integrated measurement systems collecting core meteorological data as well as precipitation observations via several automatic gauge configurations, including the Double Fence Automated Reference (DFAR) WMO standard configuration. The presentation will focus on the major steps, difficulties, requirements, and preliminary results of the new Iqaluit transfer function development and discuss a decision process for applying climate dependent transfer functions across the Canadian networks.

Session: 210 In situ measurement of precipitation and snow cover: advances, challenges, and ongoing issues - Part 1
Mesure in situ des précipitations et de la couverture de neige : progrès, défis et situations actuelles - Partie 1 **11/06/2021 13:30**

ID: 10779 Contributed abstract

Poster Order:

Precipitation gauge collection efficiency with wind speed and hydrometeor fall velocity

Jeffery Hoover [1] , *Michael Earle* [2] , *Paul Joe* [3] , *Pierre Sullivan* [4]

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Presented by / Présenté par: ***Jeffery Hoover***
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Automated catchment-type precipitation gauge measurements are critical for weather, climate, hydrology, transportation, and validation of remote sensing products. The systematic bias and uncertainty of these catchment gauges due to wind-induced undercatch is a major challenge, particularly with respect to the measurement of solid precipitation. Transfer functions developed through the World Meteorological Organization Solid Precipitation Intercomparison Experiment (WMO-SPICE) have demonstrated reductions in the systematic bias of solid precipitation measurements; however, large uncertainty in measured values relative to reference Double Fence Automated Reference (DFAR) measurements persists. One avenue for improvement is the ability of transfer functions to distinguish among different precipitation types and their aerodynamic properties. In this study, Environment Canada’s Precipitation Occurrence Sensor System (POSS), which is an upward pointing mini Doppler

Radar, is used to characterize precipitation by its fall velocity. Measurements were conducted at the Centre for Atmospheric Research Experiments (CARE) test site in Egbert, Ontario, during WMO-SPICE. New transfer functions are developed using numerical and experimental approaches that incorporate both the effects of wind speed and hydrometeor fall velocity on the catch efficiency of automated precipitation gauges. The application of these functions results in significant improvements in the uncertainty of adjusted precipitation accumulation values relative to other transfer functions. These results suggest that incorporating measurements of hydrometeor fall velocity could improve operational precipitation accumulation estimates and warrants further study.

Session: 832 Coastal ocean modelling: processes and applications - Part 3 Modélisation des eaux côtières : processus et applications - Partie 3

11/06/2021 12:30

ID: 10692 Contributed abstract

Poster Order:

Development and implementation of an operational capacity for aquatic oil spill dispersion modelling at the Canadian Centre for Meteorological and Environmental Prediction

Yves Pelletier [1]

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Presented by / Présenté par: ***Yves Pelletier***
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The Environmental Emergency Response Section (EERS) of the Canadian Centre for Meteorological and Environmental Prediction develops, deploys and uses atmospheric dispersion and transport modelling in support of national and international emergency response mandates and other applications. Beginning with the World Class Tanker Safety System, and more recently in the framework of the federal Ocean Protection Plan, the EERS was given the mandate to expand its capabilities to include the dispersion modelling of hydrocarbons on bodies of water. In accordance with this, the EERS developed and deployed the Canadian Oil Spill Modelling Suite (COSMoS). COSMoS extends the EERS's existing Lagrangian atmospheric dispersion modelling capabilities to the aquatic domain and adds treatment of aquatic environmental parameters as well as fate and behaviour of hydrocarbons in water. We present an overview of COSMoS, examples of simulations and products, and discuss current and potential applications.

Session: 832 Coastal ocean modelling: processes and applications - Part 3 Modélisation des eaux côtières : processus et applications - Partie 3

11/06/2021 12:45

ID: 10785 Contributed abstract

Poster Order:

Influence of climate variability and hydroelectric development on oceanography and sea ice in a subarctic fjord

Eric Oliver [1], *Breanna Bishop* [2], *Claudio Aporta* [3], *Kyoko Ohashi* [4], *Jinyu Sheng* [5]

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Presented by / Présenté par: ***Eric Oliver***
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Hamilton Inlet, also known as Aiviktuk, is a subarctic fjord along the central Labrador coast stretching 200 km from the boreal forest of the Labrador interior to the coastal barrens along the Labrador Sea. The Rigolet Narrows divides Hamilton Inlet into Lake Melville to the west and Groswater Bay to the east. The Narrows exhibits strong tidal currents as well as a mean outflow from river discharge into Lake Melville. This leads the Narrows to be predominantly open water during the sea ice season while Lake Melville is covered by fast ice and the Labrador coast is choked with a high concentration of pack ice. The tidal and ice-free nature of the Narrows is an important feature - for travel, culture and food security - for local communities, notably the Inuit community of Rigolet. The tidal currents and ice conditions in the Narrows as well as the salinity in Lake Melville have changed since the mid-twentieth century and local Inuit knowledge attributes much of this change to the modified discharge of the Churchill River after the Upper Churchill hydroelectric development in 1971. Here we present a numerical ocean-ice model to simulate the ocean circulation, hydrography, and ice conditions in Hamilton Inlet. The model is based on ROMS for the ocean component coupled to CICE for the sea ice component. We first validate the model simulations of tidal currents and ice features by comparison with mapped Inuit knowledge from the region. We then show how changes in seasonal runoff and atmospheric forcing, representative of pre- and post-Churchill hydro development conditions as well as different climate periods, affect the tidal currents and ice patterns in the Narrows. We conclude with speculation as to the potential influence of contemporary hydroelectric development on the Lower Churchill (Muskrat Falls).

Session: 832 Coastal ocean modelling: processes and applications - Part 3 Modélisation des eaux côtières : processus et applications - Partie 3

11/06/2021 13:00

ID: 10784 Contributed abstract

Poster Order:

Modelling oxygen dynamics in Discovery Islands, B.C.

Laura Bianucci [1] , *Mike Foreman* [2] , *Maxim Krassovski* [3] , *Peter Chandler* [4] , *Jennifer Jackson* [5]

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[5] Hakai Institute

Presented by / Présenté par: ***Laura Bianucci***
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The Discovery Islands region is a network of deep fjords and narrow channels north of the Strait of Georgia, between Vancouver Island and British Columbia’s mainland. The complex interaction of fresh water inputs, bathymetry, and marine and atmospheric forcing leads to rich marine ecosystems, which sustain wild salmon during their migration as well as orcas and other species. Furthermore, the region was used for aquaculture farming for many years, which led to the development of a circulation model to use as a tool for the aquaculture industry and its management (e.g., to assist in farm siting decisions, assess the connectivity between farms, evaluate the risk of spread of disease onto wild fish populations, etc.). However, the region is also interesting from a biogeochemical point of view, since a recent study has shown that deep waters in Bute Inlet display warming and deoxygenation trends in the last 70 years (as well as other fjords in BC). Therefore, we have now coupled the physical model (an application of the Finite Volume Community Ocean Model that extends from the northern tip of Texada Island to Johnstone Strait) to the biogeochemical module FVCOM-ICM in order to study nutrient and oxygen dynamics in the region. In particular, we are interested in understanding what are the key processes dominating the distribution of dissolved oxygen concentrations and whether these processes could change along with climate. In this presentation, we discuss our latest results and future plans.

Session: 832 Coastal ocean modelling: processes and applications - Part 3 Modélisation des eaux côtières : processus et applications - Partie 3

11/06/2021 13:15

ID: 10705 Contributed abstract

Poster Order:

Coupled hydro-biogeochemical modelling to support shellfish aquaculture management in Baynes Sound (British Columbia)

Thomas Guyondet [1] , *Maxim Krassovski* [2] , *Terri Sutherland* [3] , *Michael Foreman* [4] , *Ramon Filgueira* [5]

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Presented by / Présenté par: ***Thomas Guyondet***
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Baynes Sound is considered one of the most prolific production sites for bivalve culture in British Columbia. Bivalve production is influenced by a balance of water quality, hydrodynamics (bay flushing), and food supply (plankton). An ecological carrying capacity assessment is required to assess this balance, where mathematical models can integrate these complex interactions using a high-resolution spatially-explicit model. The Finite Volume Community Ocean Model (FVCOM) was coupled with a Bivalve Culture Ecosystem Model (BiCEM) resorting to the Dynamic Energy Budget (DEB) to simulate bivalve physiology and their interactions with the ecosystem. The physical oceanographic conditions gathered through observations and simulated using FVCOM show a characteristic two-layered estuarine circulation over Baynes Sound. This estuarine circulation coupled with wind and tidal mixing contribute to the regular nutrient replenishment from the deep waters of the Strait of Georgia, leading to high levels of pelagic primary productivity. In turn, this phytoplankton productivity supports the potential for secondary production, in particular cultivated bivalves, and provides a high carrying capacity to the Sound. This study provides an example of how coupled hydrodynamic-biogeochemical models can be relevant to an ecosystem-based management of coastal activities and resources with the flexibility to inform on both changing aquaculture intensity and climate scenarios.

Session: 832 Coastal ocean modelling: processes and applications - Part 3 Modélisation des eaux côtières : processus et applications - Partie 3

11/06/2021
13:30

ID: 10821 Contributed abstract

Poster Order:

Using coastal circulation models to assess connectivity among regions with aquaculture interests

Wendy Callendar [1] , *Laura Bianucci* [2] , *Mike Foreman* [3] , *Peter Chandler* [4]

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Presented by / Présenté par: ***Wendy Callendar***
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Fisheries and Oceans Canada (DFO) is responsible for regulating and managing the aquaculture industry in British Columbia. To inform and support regulatory and management decisions, previous work has developed hydrodynamic coastal ocean models in several regions with aquaculture operations (Broughton Archipelago, Discovery Islands, and the west coast of Vancouver Island), as well as particle tracking models to study the dispersion of particles released from finfish farms. In the present study, we have standardized the approach to the release of passive, buoyant particles from farm locations in the three mentioned model domains. Within each region, we analyze how many particles released from a given farm reach any of the other farms after 24hr, 48hr, … and up to 14 days after release. In this way, we assess how the different areas within each region are connected and also how the three regions compare to each other. The information generated should ultimately support the definition of meaningful boundaries/areas within each region, supporting DFO’s move towards an Area Based Management approach for aquaculture in British Columbia.

Session: 862 Developing Ocean Modelling Capacity in Canada - Part 3 Renforcer la capacité de modélisation des océans au Canada - Partie 3

11/06/2021
12:30

ID: 11023 Contributed abstract

Poster Order:

The Balance Between Atmospheric and Lateral Buoyancy Fluxes in Labrador Sea Water Formation

Laura Gillard [1] , *Helen Johnson* [2] , *Clark Pennelly* [3] , *Paul Myers* [4]

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Presented by / Présenté par: ***Laura Gillard***
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Labrador Sea Water formation is a balance between atmospheric buoyancy loss and lateral buoyancy exchange, via the ocean. This formation is notoriously difficult to represent accurately in ocean and climate models. The ocean's lateral exchanges of heat and salt between the shelf and the interior of the Labrador Sea are smaller in a regional coupled ocean-sea ice model at higher vertical resolution (75 levels compared with 50 levels), due in part to altered bathymetry along the west Greenland shelf. Reduced lateral exchange results in a stronger stratification and convective resistance in the interior of the Labrador Sea, resulting in unrealistically shallow mixed layers. Westward fluxes of heat and salt at Cape Farewell, associated with Irminger Water, are 50 % and 33 % lower, respectively, with higher vertical resolution. Exchanges south of the Labrador Sea from the North Atlantic Current are also smaller, contributing to the reduction in salt and heat import into the Labrador Sea interior. When the high-resolution model is forced with a stronger wintertime buoyancy loss at the ocean surface, the Labrador Sea's stratification weakens, allowing the surface forcing to break through the freshwater cap and increasing convection, bringing mixed layer depths back to observed values. A strong atmospheric forcing can therefore compensate for a reduction in lateral advection. Therefore, this presentation will show that convection and Labrador Sea Water formation is a complex interplay of surface and lateral fluxes.

Session: 862 Developing Ocean Modelling Capacity in Canada - Part 3 Renforcer la capacité de modélisation des océans au Canada - Partie 3 **11/06/2021 12:45**

ID: 11047 Contributed abstract

Poster Order:

Variability on the Scotian Shelf: Insight From Both Models and Observations

Michael Casey [1] , *Youyu Lu* [2] , *Keith Thompson* [3]

[1] Bedford Institute of Oceanography, Department of Fisheries and Oceans, Government of Canada
[2] Bedford Institute of Oceanography, Department of Fisheries and Oceans, Government of Canada
[3] Department of Oceanography, Dalhousie University

Presented by / Présenté par: ***Michael Casey***
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Conditions on Atlantic Canada's Scotian Shelf (SS) are influenced by a complex combination of atmospheric forcing, variations in up-stream water sources, such as the Gulf of St. Lawrence and Newfoundland Shelf, and by eddy intrusions of Scotian-Slope water, an admixture of both Gulf Stream and Labrador Sea waters. Here we use both high-resolution models and observations of various types and sources (e.g. autonomous gliders, ADCP, surface radar) to study the variability on the SS on time scales ranging from hours to seasons. We observe such phenomena as near-inertial oscillations (and how they might change from one season to the next), and seasonal and interannual variability of currents and water-mass properties. For example, spectral analysis of the currents from ADCP measurements reveal an interesting vertical coherence structure of near-inertial oscillations at a particular location off Halifax (Station 2) on the Scotian Shelf. We also assess the skill of several ocean models by comparing the model results to the observations, and offer insight as to how these models could be improved.

Session: 862 Developing Ocean Modelling Capacity in Canada - Part 3 Renforcer la capacité de modélisation des océans au Canada - Partie 3

11/06/2021 13:00

ID: 11029 Contributed abstract

Poster Order:

Evaluation of eddy-properties in operational oceanographic analysis systems

Gregory Smith [1] , *Anne-Sophie Fortin* [2]

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Presented by / Présenté par: ***Gregory Smith***
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Recent studies have shown that the presence of oceanic eddies affects the intensification of high-impact tropical cyclones. Many operational weather prediction systems (e.g. in Canada, UK and Europe) have now moved to using fully-coupled atmosphere-ocean prediction models. As a result, the accuracy with which ocean analysis systems are able to constrain the presence and properties of oceanic eddies may affect tropical cyclone forecast skill. While numerous eddy identification and tracking methods have been developed for oceanic eddies, specific methods and metrics tailored to verifying the skill of ocean analyses and forecasts in capturing these features are lacking. Here we apply an open-source eddy-tracking software and adapt it for the purpose of matching eddies between gridded observational analyses and two ocean analysis products of different resolution (1/4° and 1/12°). The ocean analysis products are the Global and Regional Ice Ocean Prediction Systems run operationally at Environment and Climate Change Canada. The systems share a common data assimilation approach with the main difference between them being the model resolution and the inclusion on tides in the regional system. A contingency table approach is taken to identify hits, misses and false alarms to provide statistics on the probability of detection and false alarm ratio. These statistics are investigated in terms of their sensitivity to eddy properties (radius, amplitude). The results clearly demonstrate the added value of higher resolution in accurately representing eddy features. The higher resolution analyses provide a higher probability of detection with a lower false alarm rate. Errors in eddy radii are also improved in the 1/12° analyses.

Session: 862 Developing Ocean Modelling Capacity in Canada - Part 3 Renforcer la capacité de modélisation des océans au Canada - Partie 3

11/06/2021 13:15

ID: 11169 Contributed abstract

Poster Order:

A North Atlantic ocean-ice downscaling system for hindcasts and climate change projections

Guoqi Han [1] , *Joel Chasse* [2] , *Nicolas Lambert* [3] , *Zhiming Ma* [4] , *Zeliang Wang* [5] , *Dave Brickman* [6]

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Presented by / Présenté par: ***Guoqi Han***
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A North Atlantic Ocean-ice Downscaling System (NAODS) has been developed, which consists of an eddy-resolving model for the northwest Atlantic region two-way nested to an eddy-permitting model for the North Atlantic. The models are forced by the European Centre for Median Weather Forecasts Reanalysis Interim product, tides and runoff. The simulation was carried out for the period from 1980 to 2018. The northwest Atlantic model results are evaluated for ocean temperature and salinity, winter convection in the Labrador Sea and dominant shelf-scale currents, as well as winter sea ice extents. The model results are in good qualitative agreement with observations in terms of dominant features and in approximate quantitative agreement with observations at various locations. The equatorward shelf-edge current transport show strong interannual and decadal variations closely related to the winter North Atlantic Oscillation index, nearly out of phase between the Labrador Slope and the Scotian Slope.

Session: 862 Developing Ocean Modelling Capacity in Canada - Part 3 Renforcer la capacité de modélisation des océans au Canada - Partie 3 **11/06/2021 13:30**

ID: 11230 Contributed abstract

Poster Order:

Variations of marine heat waves from the analysis of a high-resolution ocean model

Li Zhai [1] , *Haiyan Wang* [2] , *Youyu Lu* [3]

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Presented by / Présenté par: ***Li Zhai***
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Marine heat waves (MHWs) are defined as persistent extremely warm ocean temperature. MHWs are an important aspect of ocean variability and are amplified by climate changes. Intensified MHWs, in terms of strength, duration and frequency, are increasingly being considered as an important environmental stressor for ecosystem and fishery applications. Currently, in most studies the spatial and temporal variations of the MHWs are being

estimated based on satellite-derived and also model simulated sea surface temperature (SST). However, MHWs for temperature at depth are also important, e.g., for the habitat of ground fish such as lobster and sea scallop. Furthermore, there are needs to understand the forcing mechanisms of the MHWs for future prediction. In this study, we aim to study the 3D variations of MHWs through analyzing the 3D fields of ocean models. Preliminary analysis has been applied to the solution of an 1/12 degree hindcast for the Northwest Pacific from 1993-2019. Progresses are being made to extend the analysis to model solutions in both the west and east coasts of Canada.

Session: 343 The Changing Arctic Atmosphere - Part 4
L'évolution de l'atmosphère arctique - Partie 4 **11/06/2021 12:30**

ID: 11144 Contributed abstract

Poster Order:

Retrieving arctic ice clouds optical properties using a far-infrared radiometer

Ludovick Pelletier [1] , *Zen Mariani* [2] , *Jean-Pierre Blanchet* [3]

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Presented by / Présenté par: ***Ludovick Pelletier***
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In the cold region of the atmosphere, most of the radiative emission to space occurs at longer wavelengths in the Far InfraRed (FIR) ranging between 15 and 100 µm.The atmospheric radiative cooling rate in this spectral region is very sensitive to the cloud microphysical properties.While theoretical work has shown the added value of FIR measurements for the retrieval of the ice clouds' microphysical properties and water vapour profiles, there is currently no spaceborne instrument performing spectrally resolved measurements in the FIR domain. The Thin Ice Cloud Far Infrared Experiment (TICFIRE) instrument developed by the Canadian Space Agency is currently under study as a proposed architecture for NASA's Aerosol-Cloud Convection Precipitation (A-CCP) satellite mission. In this presentation, multiple dataset from the ground-based version of TICFIRE, the Far InfraRed Radiometer (FIRR) are combined with collocated ceilometers and lidars to retrieve cloud microphysics properties. The FIRR measures downwelling radiances in 8 spectral channels spanning from 8 – 50 µm with a radiometric resolution of 0.02 [W m-2 sr -1]. Two versions of the instrument have already been deployed in the Canadian Arctic. The first

one was tested during winter 2016 at the ØPAL (zero altitude Pearl Auxiliary Laboratory) lab in Eureka, NU (80 N, 85.9 W) in collaboration with Canadian Network for Detection of Atmospheric Change (CANDAC). The second instrument has been operating since September 2018 in Iqaluit, NU (63.75 N,68.52 W), at the Environment and Climate Change Canada Canadian Arctic Weather Science (CAWS) supersite. The purpose is to evaluate the minimum a priori knowledge obtained from the collocated instruments and the required number of FIR channels to retrieve the cloud properties accurately. Preliminary results showed that the combination of the FIRR and a ceilometer is able to retrieve the optical depth and the effective diameter of ice clouds.

Session: 343 The Changing Arctic Atmosphere - Part 4
L'évolution de l'atmosphère arctique - Partie 4 **11/06/2021 12:45**

ID: 11154 Contributed abstract

Poster Order:

Infrared remote sensing of Arctic cloud microphysical properties: Preliminary results from Eureka, Nunavut

Joseph Hung [1] , *Penny Rowe* [2] , *Lei Liu* [3] , *Kimberly Strong* [4]

[1] University of Toronto Dept. Physics
[2] NorthWest Research Associates
[3] University of Toronto Dept. Physics
[4] University of Toronto Dept. Physics

Presented by / Présenté par: ***Joseph Hung***
Contact: joseph.hung@mail.utoronto.ca

The presence of clouds in the High Arctic plays a fundamental role in the energy balance of the region, particularly in relation to the seasonal prolonged periods of darkness and daylight. To investigate the properties of Arctic clouds, an Extended-range Atmospheric Emitted Radiance Interferometer (E-AERI) was installed at the Polar Environment Atmospheric Research Labratory (PEARL) at Eureka, Canada (80°N, 86°W) in October 2008. The E-AERI is a moderate resolution (1 cm^{-1}) Fourier Transform Infrared Spectrometer that measures the absolute downwelling infrared spectral radiance from the atmosphere between 400 and 3000 cm^{-1}. Spectra are recorded every 7 minutes, year-round, including during the polar night. Using observations from the E-AERI, an iterative optimal nonlinear inverse method based on the Levenberg–Marquardt algorithm, the CLoud and Atmospheric Radiation Retrieval Algorithm (CLARRA) is used to retrieve cloud properties. This retrieval uses radiances within selected microwindows in the E-AERI observation spectrum, particularly the 400-600 and

750-1300 cm-1 regions, which are optically sensitive to the retrieved variables. A preliminary compilation of the retrieved microphysical properties (cloud height, temperature, optical depth, phase, and particle effective radii), and climatology of Arctic cloud properties at Eureka will be presented.

Session: 343 The Changing Arctic Atmosphere - Part 4
L'évolution de l'atmosphère arctique - Partie 4 **11/06/2021 13:15**

ID: 10976 Contributed abstract

Poster Order:

Gravity wave measurements from two lidars at Eureka, Nunavut during a winter with exceptionally low stratospheric ozone

Emily McCullough [1] , *Robin Wing* [2] , *Alexey Tikhomirov* [3] , *Ali Jalali* [4] , *J. R. Drummond* [5] , *Tom Duck* [6] , *R. J. Sica* [7]

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Presented by / Présenté par: ***Emily McCullough***
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The chemical composition and dynamical variations of the Arctic atmosphere are intricately linked, in part by perturbations and mixing due to waves. The Canadian Network for the Detection of Atmospheric Change (CANDAC) Polar Environment Atmospheric Research Laboratory (PEARL) operates several lidar systems at Eureka, Nunavut (80°N, 86°W): SOLID, the Stratospheric Ozone Lidar; CRL, the CANDAC Rayleigh-Mie-Raman Lidar; and a soon-to-be-installed MPLCAN network mini-MicroPulse Lidar. Together, these lidars investigate chemical composition (ozone and water vapour), physical composition (temperature, clouds, aerosols), and dynamics, from the lower troposphere through the mesosphere. Periodically from 1993 - 2009, SOLID measurements have been used to study gravity waves. Stratospheric and mesospheric gravity wave power spectral densities (PSD) determined the distribution of wave energy as a function of each of the vertical wavelengths present during the measurements from 30 - 45 km altitude. In contrast to mid-latitude locations where one or two waves tend to dominate the energy budget, a superposition of numerous wavelengths often coexisted at Eureka. Potential energy per unit mass (PE), carried by the waves, was calculated for 30-35 km altitude, and was highly influenced by the location of the polar vortex. Now, we apply similar analysis methods to SOLID measurements from 2017-2020 made since its recent refurbishment. Small deviations (+/-1.5%) in temperature and relative density from nightly mean profiles reveal the gravity wave activity between 15 - 50 km. PSD and PE are calculated for the full altitude range, as well as for subsets applicable to comparison with the 1990s results. Further, we attempt CRL's first gravity wave analyses in the lower stratosphere. We examine the gravity waves in the context of the exceptionally low stratospheric ozone values of the 2020 winter and spring season.

Session: 343 The Changing Arctic Atmosphere - Part 4
L'évolution de l'atmosphère arctique - Partie 4 **11/06/2021 13:30**

ID: 11139 Contributed abstract

Poster Order:

Detection and ray tracing of gravity waves in the Arctic upper atmosphere

Dustin Fraser [1] , *William Ward* [2] , *Peter Preusse* [3] , *Samuel Kristoffersen* [4] , *Cornelia Strube* [5] , *Dustin Gamblin* [6]

[1] University of New Brunswick
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Presented by / Présenté par: ***Dustin Fraser***
Contact: dustin.fraser111@unb.ca

Internal gravity waves (GWs) contribute significantly to the energetics of the atmosphere. GW representation in global models must be improved to evolve the state of the atmosphere more accurately. It is therefore essential to determine GW spectra and sources. In this study, ray tracing is applied to GWs to diagnose their potential sources. GWs are observed in the mesosphere and lower thermosphere (MLT) through perturbations to airglow layers above Eureka, NU (80°N, 86°W). Data from the All-Sky Imager (ASI) and E-Region

Wind Interferometer (ERWIN) at the Polar Environment Atmospheric Research Laboratory (PEARL) are analysed for probing waves. The Gravity-wave Regional Or Global Ray Tracer (GROGRAT), developed by Marks and Eckermann (1995), is used for evolving the waves backwards in time to their possible origins. The background atmosphere acquired for ray tracing is extracted from the extended Canadian Middle Atmosphere Climate (CMAM-Ext) model. Various case studies are presented, and limitations described. Small-scale waves with horizontal wavelengths less than 100 km are found to commence near the surface around Eureka. Some large-scale, inertia GWs travel longer distances and are traced back to the mid-latitudes, one to a rapidly intensifying low pressure system approaching Greenland. This work investigates wave sources, examines trajectory sensitivity to various initial conditions, and advances the fields of internal GW detection and propagation in the Arctic upper atmosphere.

Session: 211 In situ measurement of precipitation and snow cover: advances, challenges, and ongoing issues - Part 2
Mesure in situ des précipitations et de la couverture de neige : progrès, défis et situations actuelles - Partie 2 **11/06/2021 14:30**

ID: 11035 Contributed abstract

Poster Order:

The Evolution of Automatic Snow Depth Measurements and the status of Snowfall mesurements.

Claude Labine [1]

[1] Campbell Scientific (Canada)

Presented by / Présenté par: ***Claude Labine***
Contact: claude@campbellsci.ca

This presentation will use the history of the SR50A sensor and how research has guided it's evolution. The focus will be on the contribution of this automatic snow depth sensor to the needs of the Snow Operations community. Initially simple practical improvements were done based on feedback from researchers and operators. A review of Snowfall measurements by various countries and agencies will be presented with the objective of showing what problems exist not necessarily with measurement itself but rather with the use or interpratation of the data.

Session: 211 In situ measurement of precipitation and snow cover: advances, challenges, and ongoing issues - Part 2
Mesure in situ des précipitations et de la couverture de neige : progrès, défis et situations actuelles - Partie 2 **11/06/2021 14:45**

ID: 10935 Contributed abstract

Poster Order:

Using optical disdrometers to complement automated precipitation gauges in observing networks

Michael Earle [1] , *Jeffery Hoover* [2] , *Hagop Mouradian* [3]

[1] Transformation, Innovation, and Engineering Division, Meteorological Service of Canada, Environment and Climate Change Canada
[2] Transformation, Innovation, and Engineering Division, Meteorological Service of Canada, Environment and Climate Change Canada
[3] Transformation, Innovation, and Engineering Division, Meteorological Service of Canada, Environment and Climate Change Canada

Presented by / Présenté par: ***Michael Earle***
Contact: michael.earle@canada.ca

Automated precipitation gauges are used broadly in meteorological and hydrological observing networks to provide measurements for weather forecasting, climate modelling, flood warnings, and other applications. To determine the suitability of precipitation measurements for a given application, it is important to assess and quantify gauge performance, and to understand how it can be impacted by environmental conditions. A seemingly simple question is raised when undertaking such an assessment: how does one know when it is precipitating and when it isn't? The World Meteorological Organization Solid Precipitation Intercomparison Experiment (WMO-SPICE) addressed this question by including an optical disdrometer alongside a weighing gauge in the automated field reference configuration for precipitation measurements. The disdrometer provided independent verification of precipitation occurrence, allowing precipitating and non-precipitating periods to be identified with a higher degree of confidence than configurations employing precipitation gauges, exclusively. This approach has recently been extended to develop a methodology for identifying, characterizing, and quantifying false precipitation reports from automated weighing gauges. False precipitation can be reported when specific environmental conditions are present during non-precipitating periods. This has the potential to artificially increase precipitation totals in operational and climate datasets and to impact downstream data users. This work demonstrates further the utility of optical disdrometers as complementary instruments to automated precipitation gauges, with direct applicability to installations in operational networks. Disdrometers can also provide information

regarding precipitation type, size distribution, and fall velocity, presenting additional opportunities for prospective applications and data users.

Session: 211 In situ measurement of precipitation and snow cover: advances, challenges, and ongoing issues - Part 2
Mesure in situ des précipitations et de la couverture de neige : progrès, défis et situations actuelles - Partie 2 **11/06/2021 15:00**

ID: 10722 Contributed abstract

Poster Order:

Evaluation of LiDAR snow depth estimates from portable consumer devices and their application towards advancing citizen science

Fraser King [1], *Richard Kelly* [2]

[1] University of Waterloo
[2] University of Waterloo

Presented by / Présenté par: ***Fraser King***
Contact: fdmking@uwaterloo.ca

Snow is a critical contributor to the regional water-energy budget with impacts to springtime flooding and water resource management practices. In situ snow depth measurements are incredibly useful reference observations as inputs to hydrologic models and reanalysis. However Canadian measurement station counts have declined by over 70% since 1990, and the current observational network is sparsely distributed with large unobserved gaps. Laser altimetry (LiDAR-Light Detection and Ranging) is a remote sensing technique that has demonstrated promising results at mapping changes in snow depth, but the expense of purchasing and transporting traditional LiDAR equipment has generally limited their use to large institutions. We demonstrate that the combination of vertical cavity surface-emitting lasers (VCSELs) and single-photon avalanche diodes (SPADs) installed on the iPhone 12 Pro comprise a portable LiDAR sensor that acts as a real-time, handheld measurement instrument for accurately observing changes in snow depth. Two independent field experiments in southern Ontario found that the iPhone LiDAR measurements were able to accurately capture daily changes in snow depth when compared to in situ snow ruler measurements. In situ and LiDAR comparisons of $n=50$ days at measurement site 1 exhibit a correlation of $r=0.98$, mean absolute bias less than 1 mm, and an RMSE of approximately 5 mm. Similar positive agreement was also noted at the second field study site for $n=10$ measurements over the same period. As LiDAR sensors become ubiquitous components of future smartphones, their capabilities as portable

snow depth measurement instruments cannot be understated. The high accuracy of the LiDAR sensor suggests that a mobile application could be developed which allows users to quickly scan a snow-covered area before and after a snowfall event and consequently use this data to aid in filling current observational gaps through a citizen-science based-approach of measuring local-scale changes in snow depth.

Session: 211 In situ measurement of precipitation and snow cover: advances, challenges, and ongoing issues - Part 2
Mesure in situ des précipitations et de la couverture de neige : progrès, défis et situations actuelles - Partie 2 **11/06/2021 15:15**

ID: 10852 Contributed abstract

Poster Order:

Which snow water equivalent manual measurement method should be used as the reference of the true SWE?

Maxime Beaudoin-Galaise [1] , *Sylvain Jutras* [2]

[1] Université Laval
[2] Université Laval

Presented by / Présenté par: ***Maxime Beaudoin-Galaise***
Contact: maxime.beaudoin-galaise.1@ulaval.ca

Manual snow water equivalent (SWE) measurements are still needed today for calibration of hydrological models or automatic SWE sensors. The most frequently used measurement methods are based either on snowpits or snow tube samplers, the later being made of different materials and sizes. Although the snowpit-derived SWE measurement methods involve a lot of handling, which is generating multiple sources of errors, the comprehensive uncertainty evaluation of such method has never been thoroughly documented. The objective of this study is to estimate the uncertainty and the accuracy of numerous snowpit and snow tube sampling methods in order to identify which would represent the most appropriate method of reference of the “true” SWE. For 5 winters from 2016 to 2020, manual SWE measurements of the snow cover has been done on a two-weeks or weekly basis on the NEIGE site, at the Forêt Montmorency. Multiple methods were used simultaneously and repetitively during each visit: a snowpit and three snow samplers, i.e. Standard Federal sampler (SFS), the Hydro-Québec sampler (HQS) and the Université Laval sampler (ULS). For the snowpit, different calculation methods were used to estimate the SWE, based on an average snowpack density or a cumulative snow layers density. The two largest samplers (HQS and ULS) showed the

lowest uncertainty, possibly due to the large volume of snow collected. The snowpit methods, when compared to large size tube samplers, showed significantly higher uncertainty and lower accuracy. Theses results are therefore questioning the use of snowpits methods as reference of true SWE estimation.

Session: 211 In situ measurement of precipitation and snow cover: advances, challenges, and ongoing issues - Part 2
Mesure in situ des précipitations et de la couverture de neige : progrès, défis et situations actuelles - Partie 2

11/06/2021
15:30

ID: 11128 Contributed abstract

Poster Order:

On the Optimal Network Design of the Surface Precipitation Network in Canada

Dominique Brunet [1] , *Daniel Michelson* [2]

[1] Environment and Climate Change Canada
[2] Environment and Climate Change Canada

Presented by / Présenté par: ***Dominique Brunet***
Contact: Dominique.Brunet@canada.ca

Optimal network design seeks to find the best spatial configuration of sensors to meet pre-defined scientific or operational objectives within budget constraints. In this talk, we introduce a model of uncertainty for gridded quantitative precipitation estimates (QPE) derived from surface precipitation stations. This statistical model can identify locations with the greatest needs for additional observations or be combined with a station denial experiment to select which station to potentially move or remove. To account for the intermittent and skewed distribution of precipitation, a precipitation occurrence model is combined with a log-normal precipitation amount model. These statistical models represent spatially varying statistics using Gaussian Processes with the prior spatial covariance structure estimated from ERA5-Land model re-analysis. By simulating observations from ERA5-Land, the impact of adding a station at a new location can be estimated, and the location with maximum uncertainty can be selected. We conducted network design experiments for each Canadian province and territory, starting either from the current network or from blank slate. The station network design under each weather radar coverage was also studied to assess if the needs for reference observations are met when statistically adjusting and validating radar QPE. Results indicate that adding only a few stations can dramatically reduce the uncertainty in QPE. Moreover, an optimal network design from blank slate would only need a small fraction of

the current number of stations to lower the overall uncertainty of the QPE.

Session: 652 Collaborative Earth System Modelling in Canada - Part 3 Modélisation collaborative du système terrestre au Canada - Partie 3

11/06/2021 14:30

ID: 11034 Contributed abstract

Poster Order:

The role of the basic state in the CanESM5 response to future sea ice loss

Michael Sigmond [1]

[1]

Presented by / Présenté par: ***Michael Sigmond***
Contact: Michael.Sigmond@canada.ca

There is great uncertainty in the atmospheric circulation response to future sea ice, with some models predicting a circulation response that is characterized by a shift toward the negative phase of the North Atlantic Oscillation (NAO), while others predict a more neutral NAM response. Using 300 member ensemble experiments with two versions of the CanESM5 model we investigate the role of the basic state and internal variability in this spread. Consistent with a previous study, we find large differences in the circulation response between three 100 ensemble member means, highlighting the important role of internal variability. In addition, we find a robust dependency of the atmospheric circulation response to the basic state, with a strong negative NAO response in the standard version of CanESM5, and a neutral NAO response in a version of CanESM5 with a modified basic state. We show that this difference is associated with the presence or absence of the stratospheric pathway, and present a mechanism on how this is linked to differences in the basic state. Our results suggest that differences in the models' basic states could significantly contribute to model spread in the simulated atmospheric circulation response to sea ice loss.

Session: 652 Collaborative Earth System Modelling in Canada - Part 3 Modélisation collaborative du système terrestre au Canada - Partie 3

11/06/2021 14:45

ID: 11191 Contributed abstract

Poster Order:

Design and execution of the long coupled simulations of PAMIP Tier 3

Alexandre Audette [1] , *Paul Kushner* [2] , *Gudrun Magnusdottir* [3] , *Yannick Peings* [4]

[1] University of Toronto
[2] University of Toronto
[3] University of California Irvine
[4] University of California Irvine

Presented by / Présenté par: ***Alexandre Audette***
Contact: alexandre.audette@utoronto.ca

To assess the effect of ocean-atmosphere coupling in the climate response to forced sea ice loss, the PAMIP (Polar Amplification Model Intercomparison Project) protocol includes centennial coupled AOGCM simulations with imposed sea ice loss. The protocol, which includes specific sea ice concentration and thickness distribution targets, does not prescribe a specific method for achieving the target. Several different methods for imposing sea ice loss (or growth) in models have been documented in previous literature and testing of the method-dependence of the resulting climate responses has been limited (Sun et al. 2020). We will report on several attempts to achieve the sea ice targets in PAMIP. This has proven to be challenging to implement using methods based on the longwave nudging from McCusker et al. (2017), which induces ice melt from below. We have attempted to implement the PAMIP protocol by nudging the sea ice of coupled AOGCM CESM1.2-WACCM4-SC to the PAMIP “present day” and “Future” states. Despite considerable experimentation with the strength of the nudging, it has proven challenging to reproduce both states in sea ice concentration and thickness. Progress on alternate methods will be reported, such as simultaneous lateral and bottom melting, simultaneous bottom and top melting, top melting only, non-conservative nudging, enthalpy nudging. Tests have been implemented in both CESM sea ice model CICE standalone as well as within the fully coupled AOGCM. This work could be undertaken with CanESM as well and would be an interesting use case for the Canadian model. It is arguably important for the community to develop a common protocol for targeted sea ice loss in these types of simulations that is straightforward to implement, given the computational expense involved. We seek to encourage a discussion that will lead to a common methodological protocol for these simulations.

ID: 11056 Contributed abstract

Poster Order:

Missing Freshwater Found at Depth in the Canada Basin of the CESM Climate Model

Erica Rosenblum [1] , *Robert Fajber* [2] , *Julienne Stroeve* [3] , *Bruno Tremblay* [4] , *Sarah Gille* [5] , *Eddy Carmack* [6]

[1]
[2] University of Washington
[3] University of Manitoba
[4] McGill University
[5] Scripps Institution of Oceanography
[6] Fisheries and Oceans

Presented by / Présenté par: ***Erica Rosenblum***
Contact: erica.j.rosenblum@gmail.com

The Canada Basin, a region of rapid sea ice retreat, has been observed and modelled extensively over the past several decades. Observations indicate a significant trend toward a fresher surface layer and, therefore, a more stratified upper ocean. Here, we explore the extent to which a climate model accurately simulates the observed surface freshening and the seasonal surface processes that contribute to the freshening. We examine 30 simulations from the Community Earth System Model (CESM) 1.1, a climate model used in the IPCC AR5, 3 simulations from CESM 2, a climate model that will be used in the upcoming IPCC AR6, and observations from the Ice Tethered Profilers (ITPs) and the Arctic Ice Dynamics Joint Experiment (AIDJEX). In stark contrast to the observations, the model simulates salinity profiles that show relatively little variation between 1975 and 2012. We demonstrate that, during the spring and summer months, this bias can be partly attributed to the model’s tendency to unrealistically spread the freshwater from sea ice melt over a deeper mixed layer, contributing to a surface layer that is saltier than observed. This finding may have wide-reaching implications because upper ocean stratification influences the vertical transport of heat and nutrients, and the model parametrizations for upper ocean physics may be similar between multiple models. We suggest that these results may provide guidance for climate model improvement, and suggest several future experiments within the setting of collaborative earth systems modelling in Canada that would lend insight into this question.

ID: 10863 Contributed abstract

Poster Order:

Cloud Feedbacks from CanSESM2 to CanESM5 and their influence on Climate Sensitivity

John Virgin [1] , *Christopher Fletcher* [2] , *Jason Cole* [3] , *Knut Von Salzen* [4] , *Toni Mitovski* [5]

[1] University of Waterloo
[2] University of Waterloo
[3] Canadian Centre for Climate Change Modelling and Analysis
[4] Canadian Centre for Climate Change Modelling and Analysis
[5] Ministry of Health, Government of British Columbia

Presented by / Présenté par: ***John Virgin***
Contact: jgvirgin@uwaterloo.ca

The newest iteration of the Canadian Earth System Model (CanESM5.0.3) has an Effective Climate Sensitivity (ECS) of 5.65 kelvin, which is a 54% increase relative to the model's previous version (CanESM2 - 3.67 K), and the highest sensitivity of all current models participating in the sixth phase of the coupled model inter-comparison project (CMIP6). Here, we explore the underlying causes behind CanESM5's increased ECS via comparison of forcing and feedbacks between CanESM2 and CanESM5. We find only modest differences in radiative forcing as a response to CO2 between model versions. Through the use of cloud area fraction output and radiative kernels, we find that more positive shortwave cloud feedbacks— particularly with regards to low clouds across the equatorial pacific, as well as sub/extratropical free troposphere cloud optical depth—are the dominant contributors to CanESM5's increased climate sensitivity. Additional simulations with prescribed sea surface temperatures reveal that the spatial pattern of surface temperature change explains the pattern of change in low cloud fraction, but does not fully explain the increased ECS in CanESM5. The results from CanESM5 are consistent with increased ECS in several other CMIP6 models, which has been primarily attributed to changes in shortwave cloud feedbacks.

Session: 652 Collaborative Earth System Modelling in Canada - Part 3 Modélisation collaborative du système terrestre au Canada - Partie 3 **11/06/2021 15:15**

ID: 10863 Contributed abstract

Poster Order:

Cloud Feedbacks from CanSESM2 to CanESM5 and their influence on Climate Sensitivity

John Virgin [1] , *Christopher Fletcher* [2] , *Jason Cole* [3] , *Knut Von Salzen* [4] , *Toni Mitovski* [5]

[1] University of Waterloo
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[3] Canadian Centre for Climate Change Modelling and Analysis
[4] Canadian Centre for Climate Change Modelling and Analysis
[5] Ministry of Health, Government of British Columbia

Presented by / Présenté par: ***John Virgin***
Contact: jgvirgin@uwaterloo.ca

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Session: 652 Collaborative Earth System Modelling in Canada - Part 3 Modélisation collaborative du système terrestre au Canada - Partie 3

11/06/2021 15:45

ID: 11022 Contributed abstract

Poster Order:

Is warming proportional to cumulative carbon emissions because heat and carbon are mixed into the ocean by the same processes?

Nathan Gillett [1]

[1] Canadian Centre for Climate Modelling and Analysis, ECCC

Presented by / Présenté par: ***Nathan Gillett***
Contact: nathan.gillett@canada.ca

Climate models consistently show that global mean warming is closely proportional to cumulative CO2 emissions, with little sensitivity to emissions pathway. This result was a high profile assessment finding of the IPCC Fifth Assessment Report, and leads directly to the concept of cumulative emissions budgets for CO2 to which emissions must be limited in order to avoid exceeding a particular temperature threshold. This proportionality requires two distinct properties of the climate system. The first is that the global mean temperature response to a pulse emission of CO2 is independent of the background CO2 concentration or emissions scenario. This property is well known, and has been explained by the balance between an approximately logarithmic dependence of radiative forcing on changes in CO2 concentration, balanced by an increasing airborne fraction of emissions at higher ambient CO2, owing to a saturation of CO2 sinks. The second distinct property required is that temperatures are proportional to cumulative CO2 emissions over time in an instantaneous CO2 quadrupling experiment, or equivalently under any other arbitrary type of scenario. The first property implies that if proportionality of warming to emissions occurs for one type of scenario, it will occur in all others. It has been argued that the second property arises because heat and carbon are mixed into the ocean by the same physical processes. Here we show that this hypothesis is not generally true based on an analytical model. We further demonstrate that this hypothesis does not explain the proportionality of warming to cumulative emissions in the CO2 quadrupling experiment of the Canadian Earth System Model, since atmosphere-ocean heat and carbon fluxes are not proportional to one another, and the ratio of global mean warming to cumulative ocean carbon uptake is not constant.

Session: 863 Developing Ocean Modelling Capacity in Canada - Part 4 Renforcer la capacité de modélisation des océans au Canada - Partie 4

11/06/2021 14:30

ID: 10932 Contributed abstract

Poster Order:

Ocean model derived vs <i>in situ</i> sound speed profiles and sonar performance prediction in the Forecasting Acoustic VAriability 2020 (FAVA 2020) experiment

Cristina Tollefsen [1]

[1]

Presented by / Présenté par: ***Cristina Tollefsen***
Contact: cristina.tollefsen@gmail.com

Navies worldwide use the output of sonar performance prediction models to make tactical decisions while operations are underway. All sonar performance models require environmental inputs including the ocean bottom depth and composition, the sound speed profile (SSP) in the water column, and wave or wind conditions. The Forecasting Acoustic VAriability 2020 (FAVA 2020) experiment was a combined environmental and acoustic experiment carried out on 09 Oct 2020 in 4000 m water depth, 315 km SE of Halifax, NS, with the assistance of a Royal Canadian Air Force CP-140 aircraft. Bathythermograph (BT) buoys were dropped at 9.3-km spacing in a 28 km x 28 km grid covering an area near the Gulf Stream north wall. An acoustic source was deployed at the centre of the grid, with one receiver deployed at each corner of the grid (i.e., 20 km from the source). Over the course of two hours, 1-s 1800-Hz tones were transmitted at 30 s intervals and recorded on the receivers. Operational ocean model forecasts and analyses for the experiment time and location were available from Canada's Global Ice-Ocean Prediction System (GIOPS) and Regional Ice-Ocean Prediction System (RIOPS). SSPs calculated from BT measurements as well as GIOPS and RIOPS temperature and salinity outputs were used as inputs to an acoustic transmission loss (TL) model. On the west side of the experimental grid, a sound channel at 50 m depth was observed when using BT SSPs that was not observed using GIOPS or RIOPS SSPs, while on the east side, all three SSP types resulted in similar TL predictions. Measured and modelled TL are compared and the operational impact of using ocean forecasts instead of <i>in situ</i> measurements to calculate sonar performance is discussed.

Session: 863 Developing Ocean Modelling Capacity in Canada - Part 4 Renforcer la capacité de modélisation des océans au Canada - Partie 4 **11/06/2021 14:45**

ID: 11186 Contributed abstract

Poster Order:

Understanding Sources of Uncertainty and Forecast Error in a Medium

Range Coupled Ensemble Sea Ice Prediction System

K Andrew Peterson [1]

[1] Environment and Climate Change Canada

Presented by / Présenté par: ***K Andrew Peterson***
Contact: andrew.peterson@canada.ca

The Global Ensemble Prediction System (GEPS) of Environment and Climate Change Canada (ECCC) was recently upgraded to a coupled atmosphere, ocean and sea ice version from an uncoupled atmosphere only system. This has been operational since July 2019, with over a year and a half of forecasts now available to evaluate the system throughout all seasons. Using the Spatial Probability Score (SPS) and Integrated Ice Edge Error (IIEE), we investigate the spread-error relationship in probabilistic Arctic sea ice forecasts from the system, along with finding the skill of the system relative to persistence and a companion Global Deterministic Prediction System (GDPS). Within this ensemble framework we explore the advantages of having a probabilistic forecast and probe its usefulness for addressing the errors in the system. Both the Ensemble GEPS and the deterministic GDPS systems show enhanced sea ice prediction over persistence in all months except May and June, when heavy biases exist in the systems in shallow sea and shelf regions. The lowest errors in the systems are found during September, and then continue at reasonably low levels through much of the boreal winter. The minimum and maximum extent periods, along with the early freeze-up period are shown to be good periods for which the ensemble system offers enhanced benefits over a single deterministic forecast as both the errors are low, with the ensemble spread showing close spatial similarities to the errors, along with an amplitude more closely representing the error. Nevertheless, we find the ensemble system would likely still benefit from further improving the spread error relationship in the system, currently hampered due to ensemble perturbations that are solely produced in the atmospheric component.

Session: 863 Developing Ocean Modelling Capacity in Canada - Part 4 Renforcer la capacité de modélisation des océans au Canada - Partie 4

11/06/2021 15:00

ID: 10892 Contributed abstract

Poster Order:

Wave-current interactions during Hurricanes Earl and Igor over the northwest Atlantic

Shangfei Lin [1] , *Jinyu Sheng* [2]

1
2

Presented by / Présenté par: ***Shangfei Lin***
Contact: Shangfei.Lin@dal.ca

A coupled wave-circulation model was developed and validated for the northwest Atlantic based on the Regional Ocean Modeling System (ROMS) and Simulating Waves Nearshore model (SWAN). The interactions between ocean surface gravity waves and tidal currents, hurricane-driven currents, and large-scale circulations during Hurricanes Earl and Igor (2010) are investigated using observational data and numerical model results. Our results demonstrate that the inclusion of wave-current interactions (WCIs) in the coupled model significantly improves the model performance in simulating the surface waves, sea level, temperature and salinity under different environmental conditions. In comparison with results produced by the wave-only model, the maximum significant wave heights (SWHs) produced by the coupled wave-circulation model during hurricanes are reduced about more than 10% along the storm track and more than 20% over the eddies associated with the Gulf Stream to the WCIs. The simulated SWHs and peak wave periods are also modulated by strong tidal currents in the Gulf of Maine (GoM). Surface waves reduce the semidiurnal tidal amplitudes in the GoM by up to 8.6% and cause the phase lag mainly due to the wave-induced bottom stress. The peak storm surge can be increased by surface waves up to ~19.4%. Wave effects on the storm surge are mostly attributed to additional wave forces but compensated by the wave-induced bottom stress. Surface waves also affect hurricane-driven currents, tidal currents and the large-scale circulations. Surface waves have additional forces on currents and enhance the upper layer mixing, which results in higher surface salinity and stronger surface cooling induced by hurricanes.

Session: 344 The Changing Arctic Atmosphere - Part 5
L’évolution de l’atmosphère arctique - Partie 5 **11/06/2021 14:30**

ID: 10986 Invited session speaker

Poster Order:

The Exceptional 2019/2020 Arctic Stratospheric Vortex: Stratospheric Ozone Loss and Transport, and Links to the Troposphere

glmanney Manney [1]

[1] NorthWest Research Associates / New Mexico Tech

Presented by / Présenté par: ***Gloria Manney***
Contact: manney@nwra.com

The Arctic stratospheric vortex in 2019/2020 was extremely strong, cold, and long-lasting. Approximately 16-year records from the Aura Microwave Limb Sounder (MLS) and the Atmospheric Chemistry Experiment - Fourier Transform Spectrometer (ACE-FTS) provide measurements of numerous trace gases that give a comprehensive picture of transport and processes involved in stratospheric chemical processing. These measurements, along with other satellite and ground-based observations, have been used to show that chemical processing was critical to the observed record-low Arctic stratospheric ozone in spring 2020. Chlorine activation and ozone depletion began earlier in 2019/2020 than in any previously observed winter, with evidence of chemical ozone loss starting in November; active chlorine then persisted as late into spring as it did in 2011 (the year with the most ozone loss previously observed in the Arctic). Chlorine deactivation followed a much more Antarctic-like pattern than is typical in the Arctic. Satellite long-lived trace gas data also show unusual distributions, which appears to arise from a combination of descent of anomalous values entrained into the middle stratospheric vortex during formation and anomalously weak mixing. Links of the exceptionally strong Arctic stratospheric vortex to surface conditions, including temperature and rainfall anomalies, will also be briefly discussed.

Session: 344 The Changing Arctic Atmosphere - Part 5
L'évolution de l'atmosphère arctique - Partie 5 **11/06/2021 15:00**

ID: 10825 Contributed abstract

Poster Order:

Unprecedented spring 2020 ozone depletion in the context of 20 years of measurements at Eureka, Canada

Kristof Bognar [1] , *Ramina Alwarda* [2] , *Kimberly Strong* [3] , *Martyn P. Chipperfield* [4] , *Sandip S. Dhomse* [5] , *James R. Drummond* [6] , *Wuhu Feng* [7] , *Vitali Fioletov* [8] , *Florence Goutail* [9] , *Beatriz Herrera* [10] , *Gloria L. Manney* [11] , *Et al.* [12]

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[10] Department of Physics, University of Toronto, Toronto, ON, Canada
[11] NorthWest Research Associates, Socorro, NM, USA
[12]

Presented by / Présenté par: ***Kristof Bognar***
Contact: kbognar@physics.utoronto.ca

In the winter and spring of 2019/2020, the unusually cold, strong, and stable polar vortex created favorable conditions for ozone depletion in the Arctic. Chemical ozone loss started earlier than in any previous year in the satellite era, and continued until late March, resulting in the unprecedented reduction of the ozone column. The vortex was located above the Polar Environment Atmospheric Research Laboratory in Eureka, Canada (80°N, 86°W) from late February to the end of April, presenting an excellent opportunity to examine ozone loss from a single ground station. Measurements from a suite of instruments show that total column ozone was at an all-time low in the 20-year dataset, 22 to 102 DU below previous records set in 2011. Ozone minima (<200 DU), enhanced OClO and BrO slant columns, and unusually low HCl, ClONO2, and HNO3 columns were observed in March. Polar stratospheric clouds were present as late as 20 March, and ozonesondes show unprecedented depletion in the March and April profiles (to <0.2 ppmv). While both chemical and dynamical factors lead to reduced ozone when the vortex is cold, the contribution of chemical depletion (based on the variable correlation of ozone and temperature) was exceptional in spring 2020 when compared to typical Arctic winters. Mean chemical ozone loss over Eureka was estimated to be 111-126 DU (27-31%) using April measurements and passive ozone from the SLIMCAT chemical transport model. While absolute ozone loss was generally smaller in 2020 than in 2011, percentage ozone loss was greater in 2020.

Session: 344 The Changing Arctic Atmosphere - Part 5
L’évolution de l’atmosphère arctique - Partie 5 **11/06/2021 15:15**

ID: 11171 Contributed abstract

Poster Order:

Sudden Stratospheric Warmings Signatures in the Polar Mesopause Region

Samuel Kristoffersen [1] , *Dustin Gamblin* [2] , *Dustin Fraser* [3]

[1] University of New Brunswick
[2] University of New Brunswick
[3] University of New Brunswick

Presented by / Présenté par: ***William Ward***
Contact: wward@unb.ca

Sudden stratospheric warmings are among the most significant dynamical events affecting the middle atmosphere. It is now known that their impact entends upward into mesosphere and upper atmosphere where their effects are global. Observations of wind and airglow irradiance in the mesopause region taken over the past decade at the Polar Environment Atmospheric Research Laboratory (PEARL) in Eureka, Nu. (80N) provide a means to identify the signature of these warmings at these heights. It is known that during warmings the large scale meridional circulation is reversed and the airglow volume emission rate is perturbed. In this paper, warming events over the past decade are summarized and this general behaviour confirmed. It is also found that there are differences in the details of each warming with the scale of the perturbation in the mesopause region appearing to be independent of the warming strength in the stratosphere. This paper summarizes the characteristics of warmings observed at PEARL over the past decade.

Session: 344 The Changing Arctic Atmosphere - Part 5
L'évolution de l'atmosphère arctique - Partie 5 **11/06/2021 15:30**

ID: 10753 Contributed abstract

Poster Order:

Radiative and Dynamical Heating Rate Trends in the Polar Winter Atmosphere

Kevin Bloxam [1] , *Yi Huang* [2]

[1] McGill University
[2] McGill University

Presented by / Présenté par: ***Kevin Bloxam***
Contact: kevin.bloxam@mail.mcgill.ca

The Arctic has been experiencing unprecedented changes in recent years due to anthropogenic greenhouse gas emissions leading to what is known as polar amplification, whereby the Arctic is warming faster than any other area of the

planet. While the majority of research has focused on the near-surface level heating and radiative forcing, one underexplored area of research is the temperature and heating rate changes in the stratosphere and upper troposphere particularly during the winter months (December – February). For instance, reanalysis data has revealed that this region of the polar winter atmosphere has been warming at a rate of approximately 0.5 K/decade over the 1979-2019 period. To understand what is driving this nonnegligible temperature trend this work investigates the underlying dynamical and radiative heating rates trends over the same 41-year period. Using a radiative transfer model, we also examine how the longwave radiative heating rates have in turn been impacted by changes in surface temperature, ozone, water vapour, and carbon dioxide concentrations. This work will highlight our results and what conclusions can be made about the impact changes in dynamics and radiation have on the heating rates and temperature in the Arctic atmosphere. We will also discuss the influence sudden stratospheric warmings are having on the observed temperature trends, particularly in the stratosphere.

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