2022 CMOS-CGU-ESC Joint Congress
Virtual from Saskatoon SK, June 1-3 and 6-8, 2022

Contents

SCIENCE SERVING SOCIETY

June 1-3 & 6-8, 2022

CONGRESS 2022

VIRTUAL CONFERENCE

SASKATOON

Presented by:

CMOS SCMO

Canadian Geophysical Union
Union Géophysique Canadienne

Eastern Snow Conference

LA SCIENCE AU SERVICE DE LA SOCIÉTÉ

1 à 3 et 6 à 8 Juin 2022

CONFÉRENCE VIRTUEL

CONGRÈS 2022

Présenté par:

CMOS SCMO

Canadian Geophysical Union
Union Géophysique Canadienne

Eastern Snow Conference

SASKATOON


Iviit Nunaat
Kalaallit Nunaat
Ungazigmit
(Chaplino) Yupik
Inupiat
Inuvialuit
Inuit
Dënéndeh
Holikachuk
Tanana
K'asho Got'ine
Yup'ik/Cup'ik
Hän
Sahtú Got'ine
Inuit
Inuit
Nunatsiavut
Upper Tanana
Shita Got'ine
Tłįchǫ Ndè
Nitassinan (Innu)
Beothuk
White River-Kluane
Alutiiq (Sugpiaq)
NWT Métis Nation
Carcross/Tagish
First Nation (Yukon)
Denendeh
(Dënësųłıné Nëné)
Lingít Aaní (Tlingit)
Dene Tha'
Wabanaki (Dawnland
Confederacy)
Penobscot
Gitanyow Lax'yip
Beaver
Moose Cree
Cree
Oji-Cree
Arosaguntacook
Beaver Lake Cree
Cree
x̣à'isla w̓áwis (Haisla)
Pawtucket
Nuxalk
Quinnipiac
Tsuu T'ina
Anishinabewaki
Quatsino
Susquehannock
Odawa
Sisseton
Hupacasath
Okanagan
Assiniboine
Meškwahki·
aša·hina (Fox)
Pamunkey
Hunkpapa
Twana/Skokomish
Wahpekute
Skilloot
Salish
Sihapsa

GatherTown Icebreaker

Wednesday, June 1

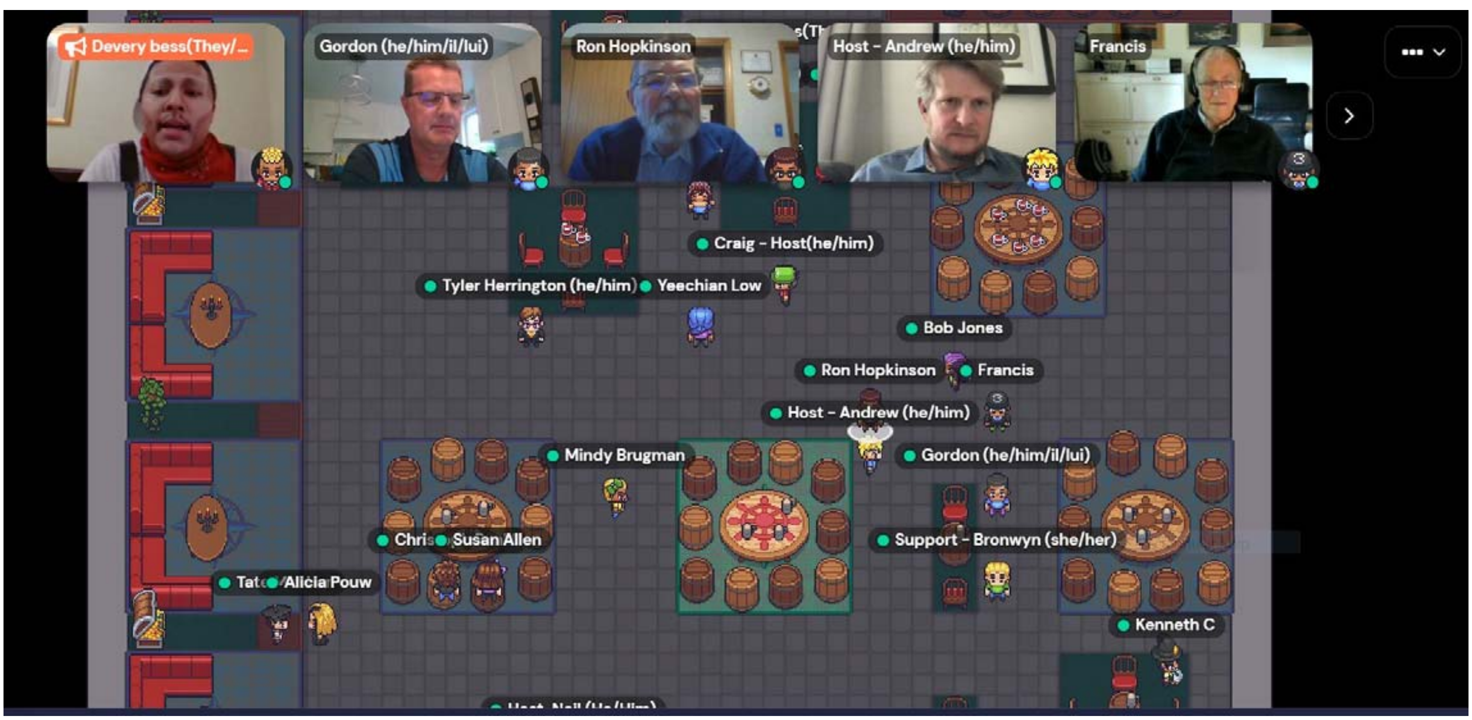
7:00pm - 8:30pm EDT

Breaking the ice with DeVery Best!

Come and catch up with friends and colleagues in our virtual Icebreaker. Click on the link, create your avatar, explore and network. Check out the entertainment provided by the Fabulous Drag artist DeVery Best in the Lounge and have some great fun!

The virtual Icebreaker is being hosted in the GatherTown platform which will open a new window outside of the conference platform.

Scene from the Icebreaker



CMOS/CGU/ESC Joint 2022 Congress

Updated 30 May 2022

01-Jun

**Time - CST	A	B	C	D	E	F
8:10-8:15						
8:15-8:30	Opening Ceremony					
8:30-9:30	Plenary Amanda Lynch *Sea Ice Retreat and Navigation:* *Implications from Climate Scenarios for Arctic Geopolitics*					
9:30-9:55						
9:55-11:35	2010 Air Quality General Session	5020 Canada's renewed weather radar network	9010 General Hydrology - I	14010 Eastern Snow Conference General Session - I	7020 BC Extreme Events I: Atmospheric Rivers and Associated Impacts Part 1	
11:35-11:45						
11:45-12:45	Posters and Exhibits				Young Hydrologist's worksop (Registration required) *From failure to progress: lessons learned in hydrology*	
12:45-12:55						
12:55-14:35	2020 Air Quality and Linkages to Weather and Climate	4040 Atmosphere, Ocean and Climate Dynamics and Modelling - I	9011 General Hydrology - II	14011 Eastern Snow Conference General Session - II	7021 BC Extreme Events I: Atmospheric Rivers and Associated Impacts Part 2	6010 Climate change and variation general session
14:35-14:55						
14:55-16:35	2030 Air Quality Science Serving Society	4041 Atmosphere, Ocean and Climate Dynamics and Modelling - II	9012 General Hydrology - III	14050 Observation and modelling of snow processes	7022 BC Extreme Events II: Heatwaves and Associated Impacts	5010 General Session on Monitoring
16:35-17:00						
17:00-18:30	Ice Breaker					

02-Jun

Time - CST	A	B	C	D	E
8:10-8:25					
8:25-10:05	3030 Changing Arctic: Science and Policy Studies	5050 Climatic Data Rescue in Canada	9013 General Hydrology - IV	14030 Monitoring and Modelling Cryospheric Change - I	7023 BC Extreme Events I: Atmospheric Rivers and Associated Impacts Part 3
10:05-10:30					
10:30-11:30	Plenary *Integrated Canadian Science Addressing Global Agenda 2030* (panel discussion)				Young Hydrologist's worksop (Registration required) Hands on hydrology: exploring methods and techniques
11:30-11:45					
11:45-12:45	Posters and Exhibits			Poster Discussion 4040, 9010, 9020, 14010	
12:45-12:55					
12:55-14:35	3020 Advancing our understanding of the Arctic atmosphere - I	4042 Atmosphere, Ocean and Climate Dynamics and Modelling - III	9020 Advances in forest hydrology - I	14031 Monitoring and Modelling Cryospheric Change - II	7024 Responding to the BC Extreme Events – A Panel Discussion
14:35-14:55					
14:55-16:35	3021 Advancing our understanding of the Arctic atmosphere - II	4043 Atmosphere, Ocean and Climate Dynamics and Modelling - IV	9021 Advances in forest hydrology - II	14032 Monitoring and Modelling Cryospheric Change - III 14020 In situ measurement of snow and solid precip.	11020 CSAFM: Observational studies - I
16:35-17:00					
17:00-18:30	Public Lecture Eric Oliver *Bridging knowledge systems:* *Scientific and Inuit knowledge of the ocean and sea ice*				

03-Jun

Time - CST	A	B	C	D	E
8:10-8:25					
8:25-10:05	2040 Air Quality Studies in the Alberta Oil Sands Region	4060 Developing Ocean Modelling Capacity in Canada - I	10030 Boreal Land Surface Processes - I	14040 Seasonal Snow - I	11020 CSAFM: Observational studies - II
10:05-10:30					
10:30-11:30	Plenary Michelle Walvoord *Woo Distingused Lecture in Hydrology* *Observing and Modeling the Expansion of Lateral Talik Development in Permafrost Landscapes*				
11:30-11:45					
11:45-12:45	Posters and Exhibits			Poster Discussion 3030, 4060, 10050, 11020	Poster Discussion 14020, 14030, 14040
12:45-12:55					
12:55-14:35	3022 Advancing our understanding of the Arctic atmosphere - III	4061 Developing Ocean Modelling Capacity in Canada - II	10031 Boreal Land Surface Processes - II	14041 Seasonal Snow - II	11030 CSAFM: Climate Impacts - I
14:35-14:55					
14:55-16:35	3023 Advancing our understanding of the Arctic atmosphere - IV	6030 Probabilistic climate risk assessments	10050 Linking hydrological and biogeochemical processes in disturbed ecosystems	14042 Seasonal Snow - III	11031 CSAFM: Climate Impacts - II
16:35-17:00					
17:00-18:30	Posters and Exhibits			CGU Section AGMs	

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Updated 30 May 2022

06-Jun

**Time - CST	A	B	C	D	E
8:10-8:25					
8:25-10:05	8010* Solid Earth Geophysics, Geodesy and Seismology	5030 Space-Based Earth Observation - I	7040 Extreme Precipitation and Flooding I: Continental & Global Scale	12020 Dynamical processes in the upper ocean - I	13010 Services, Impacts and Adaptation General Session
10:05-10:30					
10:30-11:30	Plenary Debra Wunch *Using atmospheric measurements to examine the Earth's carbon cycle*				
11:30-11:45					
11:45-12:45	Posters and Exhibits			NSERC Information Session	
12:45-12:55					
12:55-14:35	8030 Geodesy and the United Nations Sustainability Goals	5031 Space-Based Earth Observation - II	7041 Extreme Precipitation and Flooding II: Local & Regional Scale	12021 Dynamical processes in the upper ocean - II	13020 Computational Methods, Machine Learning, and Model Development
14:35-14:55					
14:55-16:35	4020 Dynamics and chemistry of the upper troposphere and stratosphere (UTS)	5032 Space-Based Earth Observation - III	13080 Electronic delivery of geophysical science services	12030 Fjord systems	13040 Collaborative Weather, Water, Ice and Climate Data Inventory Development
16:35-17:00					
17:00-18:30	Students Social Event				

* Poster discussion for session 8010 occurs within the session

07-Jun

Time - CST	A	B	C	D	E
8:10-8:25					
8:25-10:05	7010 Extremes General Session	5040 The 2030 mitigation challenge: Tracking of Canada's methane emissions - I	4050 Collaborative Earth System Modelling in Canada - I	12040 Physical Oceanography	13030 Climate/engineering studies to support adaptation and mitigation - I
10:05-10:30					
10:30-11:30	Plenary Karen Kohfeld *Evidence-based approaches to understanding blue carbon dynamics on the Pacific Coast of Canada*				
11:30-11:45					
11:45-12:45	Posters and Exhibits			Poster Discussion 4050, 12020, 12030, 12040	Poster Discussion 5040, 7040. 13010, 13020, 13030
12:45-12:55					
12:55-14:35	4030 Assessing the Canadian and global terrestrial carbon cycle - I	5041 The 2030 mitigation challenge: Tracking of Canada's methane emissions - II	7060 Severe and Extreme Convective Storms - I	12050 Arctic Ocean Climate and Climate Change	13031 Climate/engineering studies to support adaptation and mitigation - II
14:35-14:55					
14:55-16:35	4031 Assessing the Canadian and global terrestrial carbon cycle - II	5042 The 2030 mitigation challenge: Tracking of Canada's methane emissions - III	7061 Severe and Extreme Convective Storms - II	12070 Integrating ocean-atmosphere data and models	13032 Climate/engineering studies to support adaptation and mitigation - III
16:35-17:00					
17:00-18:30	Awards Ceremonies				

08-Jun

Time - CST	A	B	C	D	E
8:10-8:25					
8:25-10:05	4051 Collaborative Earth System Modelling in Canada - II	6020 Climate change and variation - I: Arctic and tropical-extratropical interaction	12060 Coastal Oceanography and Inland Waters - I	13060 Applied climate change science amidst large data and contingent futures	13100 Science Serving Societies to Become Climate Resilient - I
10:05-10:30					
10:30-11:30	Plenary Sonia Seneviratne *Science serving society: The way forward*				
11:30-11:45					
11:45-12:45	Posters and Exhibits		CGU Union AGM		Poster Discussion 4030, 7060, 12050, 12060, 12070, 13070
12:45-12:55					
12:55-14:35	4052 Collaborative Earth System Modelling in Canada - III 8050 Tectonics and Dynamics of the Earth's Interior - I	6021 Climate change and variation - II: Large-scale circulation and climate anomalies	12061 Coastal Oceanography and Inland Waters - II	13070 Developing Actionable Canadian Climate Information - I	13101 Science Serving Societies to Become Climate Resilient - II
14:35-14:55					
14:55-16:35	8051 Tectonics and Dynamics of the Earth's Interior - II	6022 Climate change and variation - III: Climate prediction	12062 Coastal Oceanography and Inland Waters - III	13071 Developing Actionable Canadian Climate Information - II	13102 Science Serving Societies to Become Climate Resilient - III
16:35-16:45					
16:45-17:00	Closing				

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TIME	ROOM	SESSION	CHAIR
June 01, 2022	**Wednesday - Day 1**		
08:15 - 08:30 CST	Room A	OPENING SESSION	Francis Zwiers Jim Abraham
08:30 - 09:30 CST	Room A	1010 Plenary - Amanda Lynch - Sea Ice Retreat and Navigation: Implications from Climate Scenarios for Arctic Geopolitics	Jim Abraham
09:55 - 11:35 CST	Room A	2010 Air Quality General Session	Yongsheng Chen Mark Gordon
09:55 - 11:35 CST	Room B	5020 Canada’s renewed weather radar network	Frédéric Fabry Daniel Michelson
09:55 - 11:35 CST	Room C	9010 General Hydrology - Part 1	Pete Whittington Barret Kurylyk
09:55 - 11:35 CST	Room D	14010 Eastern Snow Conference General Session – Part 1	Craig Smith Krystopher Chutko
09:55 - 11:35 CST	Room E	7020 BC Extreme Events I: Atmospheric Rivers and Associated impacts - Part 1	Ashlee Jollymore
11:45 - 12:45 CST		POSTERS / EXHIBITS	
11:45 - 12:45 CST	Room E	15020 Young Hydrologist's workshop - From failure to progress: lessons learned in hydrology	
12:55 - 14:35 CST	Room A	2020 Air Quality and Linkages to Weather and Climate	Mark Gordon Paul Makar
12:55 - 14:35 CST	Room B	4040 Atmosphere, Ocean, and Climate Dynamics - Part 1	Adam Monahan
12:55 - 14:35 CST	Room C	9011 General Hydrology - Part 2	Pete Whittington Barret Kurylyk
12:55 - 14:35 CST	Room D	14011 Eastern Snow Conference General Session - Part 2	Craig Smith Krystopher Chutko
12:55 - 14:35 CST	Room E	7021 BC Extreme Events I: Atmospheric Rivers and Associated impacts - Part 2	Melinda Brugman
12:55 - 14:35 CST	Room F	6010 Climate change and variation general session	Charles Curry
14:55 -	Room A	2030 Air Quality Science Serving Society	Yongsheng

16:35 CST			Chen Mark Gordon
14:55 - 16:35 CST	Room B	4041 Atmosphere, Ocean, and Climate Dynamics - Part 2	Marek Stastna
14:55 - 16:35 CST	Room C	9012 General Hydrology - Part 3	Pete Whittington Barret Kurylyk
14:55 - 16:35 CST	Room D	14050 Observation and modelling of snow processes: integrating legacy and new tools to advance snow science	Christopher Marsh
14:55 - 16:35 CST	Room E	7022 BC Extreme Events II: Heatwaves and Associated Impacts	Nathan Gillett
14:55 - 16:35 CST	Room F	5010 General Session on Monitoring	Markus Schnorbus
17:00 - 18:30 CST		ICEBREAKER	
June 02, 2022	**Thursday - Day 2**		
08:25 - 10:05 CST	Room A	3030 Changing Arctic: Science and Policy Studies	Helen Joseph David Fissel
08:25 - 10:05 CST	Room B	5050 Climatic Data Rescue in Canada	Victoria Slonosky
08:25 - 10:35 CST	Room C	9013 General Hydrology - Part 4	Pete Whittington Barret Kurylyk
08:25 - 10:05 CST	Room D	14030 Monitoring and Modelling Cryospheric Change - Part 1	Shawn Marshall Homa Kheyrollah Pour
08:25 - 10:05 CST	Room E	7023 BC Extreme Events I: Atmospheric Rivers and Associated impacts - Part 3	Matthias Jakob
10:30 - 11:30 CST	Room A	1011 Plenary - Integrated Canadian Science Addressing Global Agenda 2030 (panel discussion)	Gordon McBean
10:30 - 12:45 CST	Room E	15021 Young Hydrologist's workshop - Hands on hydrology: exploring methods and techniques	
11:45 - 12:45 CST		POSTERS / EXHIBITS	
11:45 - 12:45 CST	Room D	15010 Poster Discussion - Session ID 4040, 9010, 9020, 14010	Marek Stastna Markus Schnorbus
12:55 - 14:35 CST	Room A	3020 Advancing our understanding of the Arctic atmosphere - Part 1	Robert Sica William Ward Rachel

			Chang
12:55 - 14:35 CST	Room B	4042 Atmosphere, Ocean, and Climate Dynamics - Part 3	Michael Waite
12:55 - 14:35 CST	Room C	9020 Advances in forest hydrology - Part 1	Magali Nehemy
12:55 - 14:35 CST	Room D	14031 Monitoring and Modelling Cryospheric Change - Part 2	Shawn Marshall Homa Kheyrollah Pour
12:55 - 14:35 CST	Room E	7024 Responding to the BC Extreme Events – A Panel Discussion	Francis Zwiers Jim Abraham
14:55 - 16:35 CST	Room A	3021 Advancing our understanding of the Arctic atmosphere - Part 2	Robert Sica William Ward Rachel Chang
14:55 - 16:35 CST	Room B	4043 Atmosphere, Ocean, and Climate Dynamics - Part 4	Ron McTaggart-Cowan
14:55 - 16:35 CST	Room C	9021 Advances in forest hydrology - Part 2	Sheena Spencer
14:55 - 15:40 CST	Room D	14032 Monitoring and Modelling Cryospheric Change - Part 3	Shawn Marshall Homa Kheyrollah Pour
14:55 - 16:35 CST	Room E	11020 CSAFM 1: Observational studies of land-atmosphere interactions - Part 1	Sara Knox
15:40 - 16:35 CST	Room D	14020 In situ measurement of snow and solid precipitation: advances, challenges, and ongoing issues	Craig Smith Eva Mekis
17:00 - 18:30 CST	Room A	Public Lecture - Eric Oliver - Bridging knowledge systems: Scientific and Inuit knowledge of the ocean and sea ice	Jim Abraham Douglas Clark
June 03, 2022	**Friday - Day 3**		
08:25 - 10:05 CST	Room A	2040 Air Quality Studies in the Alberta Oil Sands Region	Mark Gordon Paul Makar
08:25 - 10:05 CST	Room B	4060 Developing Ocean Modelling Capacity in Canada - Part 1	Frederic Dupont David Greenberg Gregory Smith
08:25 - 10:05 CST	Room C	10030 Advances in boreal disturbance research - Part 1	Miranda Hunter Rebecca Frei

08:25 - 10:05 CST	Room D	14040 Novel Approach in Seasonal Snow: Field Measurements, Remote Sensing, Modeling, and Data Assimilation & Analytics - Part 1	Eunsang Cho Elias Deeb
08:25 - 10:05 CST	Room E	11021 CSAFM 1: Observational studies of land-atmosphere interactions - Part 2	Shannon Brown
10:30 - 11:30 CST	Room A	1012 Plenary - Michelle Walvoord - Woo Distingused Lecture in Hydrology - Observing and Modeling the Expansion of Lateral Talik Development in Permafrost Landscapes	Pete Whittington Barret Kurylyk
11:45 - 12:45 CST		POSTERS / EXHIBITS	
11:45 - 12:45 CST	Room D	15011 Poster Discussion - Session ID 3030, 4060, 10050, 11020	Helen Joseph Shannon Brown
11:45 - 12:45 CST	Room E	15012 Poster Discussion - Session ID 14020, 14030, 14040	Krystopher Chutko Eunsang Cho
12:55 - 14:35 CST	Room A	3022 Advancing our understanding of the Arctic atmosphere - Part 3	Robert Sica William Ward Rachel Chang
12:55 - 14:35 CST	Room B	4061 Developing Ocean Modelling Capacity in Canada - Part 2	Susan Allen Paul Myers
12:55 - 14:35 CST	Room C	10031 Advances in boreal disturbance research - Part 2	Miranda Hunter Rebecca Frei
12:55 - 14:35 CST	Room D	14041 Novel Approach in Seasonal Snow: Field Measurements, Remote Sensing, Modeling, and Data Assimilation & Analytics - Part 2	Eunsang Cho Melissa Wrzesien
12:55 - 14:35 CST	Room E	11030 CSAFM 2: Understanding past, present and future effects of climate on agriculture, forestry and water resources. - Part 1	Emmanuel Ojo Yinsuo Zhang
14:55 - 16:35 CST	Room A	3023 Advancing our understanding of the Arctic atmosphere - Part 4	Robert Sica William Ward Rachel Chang
14:55 - 16:35 CST	Room B	6030 Probabilistic climate risk assessments	David Huard Martin Leduc
14:55 - 16:35 CST	Room C	10050 Linking hydrological and biogeochemical processes in disturbed ecosystems: Implications for watershed management	David McLagan Wai Ying Lam
14:55 - 16:35 CST	Room D	14042 Novel Approach in Seasonal Snow: Field Measurements, Remote Sensing, Modeling, and Data Assimilation & Analytics - Part 3	Eunsang Cho Melissa Wrzesien

14:55 - 16:35 CST	Room E	11031 CSAFM 2: Understanding past, present and future effects of climate on agriculture, forestry and water resources - Part 2	Catherine Champagne Yinsuo Zhang
17:00 - 18:00 CST		POSTERS / EXHIBITS	
17:00 - 18:00 CST	ROOM E	CGU Section AGMs	
June 06, 2022	**Monday - Day 4**		
08:25 - 10:05 CST	Room A	8010 General Contributions to Solid Earth Geophysics	Fiona Darbyshire
08:25 - 10:05 CST	Room B	5030 Space-Based Earth Observation: Climate Information for Society - Part 1	Adam Bourassa Kaley Walker
08:25 - 10:05 CST	Room C	7040 Extreme Precipitation: Past, Present, Future – Part 1	Neil Tandon Xander Wang
08:25 - 10:05 CST	Room D	12020 Dynamical processes in the upper ocean related to surface currents and dispersion - Part 1	Nancy Soontiens Graigory Sutherland
08:25 - 10:05 CST	Room E	13010 Services, Impacts and Adaptation General Session	Francis Zwiers
10:30 - 11:30 CST	Room A	1013 Plenary - Debra Wunch - Using atmospheric measurements to examine the Earth's carbon cycle	Paul Kushner
11:45 - 12:45 CST		POSTERS / EXHIBITS	
11:45 - 12:45 CST	ROOM E	NSERC Information Session	Fiona Darbyshire
12:55 - 14:35 CST	Room A	8030 Geodesy and the United Nations Sustainability Goals	Georgia Fotopoulos
12:55 - 14:35 CST	Room B	5031 Space-Based Earth Observation: Climate Information for Society - Part 2	Kaley Walker Adam Bourassa
12:55 - 14:35 CST	Room C	7041 Extreme Precipitation: Past, Present, Future - Part 2	John Gyakum Megan Kirchmeier-Young
12:55 - 14:35 CST	Room D	12021 Dynamical processes in the upper ocean related to surface currents and dispersion - Part 2	Dany Dumont Cédric Chavanne
12:55 - 14:35 CST	Room E	13020 Computational Methods, Machine Learning, and Model Development	Christopher Subich
14:55 -	Room A	4020 Dynamics and chemistry of the upper troposphere	Susann

16:35 CST		and stratosphere (UTS)	Tegtmeier
14:55 - 16:35 CST	Room B	5032 Space-Based Earth Observation: Climate Information for Society - Part 3	Adam Bourassa Kaley Walker
14:55 - 16:35 CST	Room C	13080 Electronic delivery of geophysical science services	David Huard Martin Leduc
14:55 - 16:35 CST	Room D	12030 Advancing our understanding of fjord systems	Laura Bianucci
14:55 - 16:35 CST	Room E	13040 Collaborative Weather, Water, Ice and Climate Data Inventory Development in Canada	Paul Kushner
17:00 - 18:30 CST	ROOM A	STUDENT RECEPTION	
June 07, 2022	**Tuesday - Day 5**		
08:25 - 10:05 CST	Room A	7010 Extremes General Session	Stephen Sobie
08:25 - 10:05 CST	Room B	5040 The 2030 mitigation challenge: Science-based tracking of Canada's methane emissions to support policy - Part 1	David Risk Felix Vogel
08:25 - 10:05 CST	Room C	4050 Collaborative Earth System Modelling in Canada - Part 1	Rachel Chimuka
08:25 - 10:05 CST	Room D	12040 Physical Oceanography	David Straub
08:25 - 10:05 CST	Room E	13030 Emerging methods, strategies and frameworks in climate/engineering system interaction studies to support climate change adaptation and mitigation - Part 1	Bernardo Stephan Teufel Laxmi Sushama
10:30 - 11:30 CST	Room A	1014 Plenary - Karen Kohfeld - Evidence-based approaches to understanding blue carbon dynamics on the Pacific Coast of Canada	Sybil Seitzinger
11:45 - 12:45 CST		POSTERS / EXHIBITS	
11:45 - 12:45 CST	Room D	15013 Poster Discussion - Session ID 4020 4050, 12020 - 12040	Yanping Li Laura Bianucci
11:45 - 12:45 CST	Room E	15014 Poster Discussion - Session ID 5040, 7040, 13010 - 13030	Stephen Sobie Dave Risk
12:55 - 14:35 CST	Room A	4030 Assessing the Canadian and global terrestrial carbon cycle - Part 1	Joe Melton Elyn Humphreys Salvatore Curasi

12:55 - 14:35 CST	Room B	5041 The 2030 mitigation challenge: Science-based tracking of Canada's methane emissions to support policy - Part 2	David Risk Felix Vogel
12:55 - 14:35 CST	Room C	7060 Severe and Extreme Convective Storms - Part 1	David Sills
12:55 - 14:35 CST	Room D	12050 Arctic Ocean Climate and Climate Change	Zhenxia Long Will Perrie
12:55 - 14:35 CST	Room E	13031 Emerging methods, strategies and frameworks in climate/engineering system interaction studies to support climate change adaptation and mitigation - Part 2	Bernardo Stephan Teufel Laxmi Sushama
14:55 - 16:35 CST	Room A	4031 Assessing the Canadian and global terrestrial carbon cycle - Part 2	Joe Melton Elyn Humphreys Salvatore Curasi
14:55 - 16:35 CST	Room B	5042 The 2030 mitigation challenge: Science-based tracking of Canada's methane emissions to support policy - Part 3	David Risk Felix Vogel
14:55 - 16:35 CST	Room C	7061 Severe and Extreme Convective Storms - Part 2	David Sills
14:55 - 16:35 CST	Room D	12070 Integrating ocean-atmosphere data and models to support environmental response operations in the marine environment	Youyu Lu
14:55 - 16:35 CST	Room E	13032 Emerging methods, strategies and frameworks in climate/engineering system interaction studies to support climate change adaptation and mitigation - Part 3	Bernardo Stephan Teufel Laxmi Sushama
17:00 - 18:30 CST		Awards Ceremonies	
June 08, 2022	**Wednesday - Day 6**		
08:25 - 10:05 CST	Room A	4051 Collaborative Earth System Modelling in Canada - Part 2	Paul Kushner
08:25 - 10:05 CST	Room B	6020 Climate Variability and Predictability - Part 1	Hai Lin Bin Yu
08:25 - 10:05 CST	Room C	12060 Coastal Oceanography and Inland waters - Part 1	Jinyu Sheng
08:25 - 10:05 CST	Room D	13060 Delivering applied climate change science amidst large data and contingent futures	Markus Schnorbus
08:25 - 10:05 CST	Room E	13100 Science Serving Societies to Become Climate Resilient - Part 1	Gordon McBean
10:30 -	Room A	1015 Plenary - Sonia Seneviratne - Science serving	Francis

11:30 CST		society: The way forward	Zwiers
11:45 - 12:45 CST		POSTERs / EXHIBITS	
11:45 - 12:45 CST	ROOM C	CGU Union AGM	
11:45 - 12:45 CST	Room E	15015 Poster Discussion - Session ID 4030 7060, 12050 - 12070, 13070	Paul Kushner Youyu Lu
12:55 - 13:40 CST	Room A	4052 Collaborative Earth System Modelling in Canada - Part 3	Paul Kushner
12:55 - 14:35 CST	Room B	6021 Climate Variability and Predictability - Part 2	Hai Lin Bin Yu
12:55 - 14:35 CST	Room C	12061 Coastal Oceanography and Inland waters - Part 2	Guoqi Han
12:55 - 14:35 CST	Room D	13070 Developing Actionable Canadian Climate Information - Part 1	Elaine Barrow Carrington Pomeroy
12:55 - 14:35 CST	Room E	13101 Science Serving Societies to Become Climate Resilient - Part 2	Gordon McBean
13:50 - 14:35 CST	Room A	8050 Tectonics and Dynamics of the Earth’s Interior - Part 1	Russell Pysklywec Erkan Gün
14:55 - 16:35 CST	Room A	8051 Tectonics and Dynamics of the Earth’s Interior - Part 2	Russell Pysklywec Erkan Gün
14:55 - 16:35 CST	Room B	6022 Climate Variability and Predictability - Part 3	Hai Lin Bin Yu
14:55 - 16:35 CST	Room C	12062 Coastal Oceanography and Inland waters - Part 3	Shiliang Shan
14:55 - 16:35 CST	Room D	13071 Developing Actionable Canadian Climate Information - Part 2	Louis-Philippe Caron
14:55 - 16:35 CST	Room E	13102 Science Serving Societies to Become Climate Resilient - Part 3	Gordon McBean
16:45 - 17:00 CST		CLOSING SESSION	

Day 1 – 1 June 2022

Convenor: Yongsheng Chen

This session invites contributions from all aspects of air quality science, in particular those not covered by an other session.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
09:55	Satellite-derived Ammonia Observations: Improvements and Applications	Sean Ford		
10:10	Ozone vegetation exposure modelling for impact assessment over an industrializing region of northern British Columbia	Chibuike Onwukwe		
10:25	Three-dimensional regional model simulation of dry and wet deposition fluxes of inorganic mercury species in the springtime Arctic	Kenjiro Toyota		
10:50	Satellite Monitoring for Temperature-Based Prediction of Springtime Ammonia from Agricultural Practices	Andrew Kovachik		
11:05	Cloud Base Height Correlation between a Co-located Micro-Pulse Lidar and a CHM15k Lufft Ceilometer	Victoria Pinnegar		

Convenors:

Daniel Michelson (Environment and Climate Change Canada),
Frédéric Fabry (McGill University)

In 2022-23, Canada's weather radar network will be in its final years of hardware replacement by the Canadian Weather Radar Replacement Program (CWRRP). According to plan, by March 31, 2023, there will be 33 new Leonardo S-band polarimetric radars replacing the legacy network of 30 C-band Doppler radars that included data from the McGill S-band polarimetric radar. Radar replacement represents a generational change, with a new (to ECCC) vendor, new wavelength, new transmitter type, and new systems and data to understand and champion, all of which have implications on the radar network's ability to provide information uniquely valuable to identifying and predicting high-impact weather, and to issuing warnings. Radar replacement also marks a transition of how data from the network are used: from mainly qualitative to both qualitative and quantitative.

This session will provide the opportunity to inform the community and provide updates on the following topics:
• Status of the deployment of the new radars
• S-band radar configuration and scan strategy
• Data quality
• Exploitation of polarimetric moments in new/improved radar-based products and services

• Case studies using new S-band data in high-impact weather
• What happens beyond radar replacement?

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
09:55	Replacement of the Canadian Weather Radar Network – an Update	Qian Li		
10:10	Improving the Canadian S-band weather radar scan strategy	Daniel Michelson		
10:25	An Update of Operational Radar Processing Improvements under the Canadian Weather Radar Replacement Program	Janti Reid		
10:50	Polarimetric radar observations of the 2021 Mascouche Québec EF2 tornadic event	Sudesh Boodoo		
11:05	Evaluation of WRF Microphysics Schemes during Atmospheric River Events using Polarimetric Radar Data	Anthony Di Stefano		
11:20	Dual-polarization radar data at vertical incidence, and what it teaches us	Frederic Fabry		

Convenors:

Pete Whittington (Brandon University),
Barret Kurylyk (Dalhousie University)

This session invites contributions from all aspects of hydrology, in particular those not covered by an other session.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
09:55	The drying of the Arctic and future changes: a case study from the Western Canadian Arctic	Brampton Dakin		
10:10	Why are Perched Basins in the Peace-Athabasca Delta in Northwestern Canada Drying? Revisiting the Water Balance	Daniel Peters		
10:25	Effect of regulation on peak open-water flows: lower Peace River, Canada	Spyros Beltaos		

10:40	The effects of climate warming on the McKenzie Creek streamflow in Southern Ontario	Tariq Deen	Poster-9010
10:40	Estimating soil moisture storage using a Geological Weighing Lysimeter	Morgan Braaten	Poster-9010
10:50	Historic and Future Post-Retreat Land-Cover Evolution at Bridge Glacier, Canada	Ben Pelto	
10:50	Using automatic optimization method to calibrate irrigation parameters in Noah-MP model in North China Plain with census irrigation amount	danqiong dai	
10:55	Challenges in hydrologic-land surface modelling of permafrost dynamics - Impacts of parameterization on model fidelity	Mohamed Abdelhamed	

Convenors:

Krystopher J Chutko (University of Saskatchewan),
Craig Smith (Environment and Climate Change Canada),
Elias J Deeb, (Cold Region Research and Engineering Laboratory, Hanover, NH, USA)

The Eastern Snow Conference is a joint United States and Canada forum for discussing recent work on operational, applied, and scientific issues related to snow and ice. Research topics range widely and include in situ and remote sensing of seasonal and long-lasting snow and ice cover, the development of new techniques and/or sensor technology for the measurement of snow and ice extent and properties, and the impact of changing snow and ice conditions on the physical environment and on human/animal communities. For this session, we invite contributions from the snow and ice community who would like to share their research across this wide spectrum of snow and ice science. All aspects of snow and ice research, as well as from all regions of the planet, are welcome.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
09:55	Enabling Low Latency Snow Pit data	Puneeth Yogananda		
10:10	DeepPrecip: A deep neural network for retrievals of precipitation	Fraser King		
10:25	Development of Snow Wetness In-situ Data Distribution Survey	Mahboubeh Boueshagh		
10:40	VIIRS Snow-Cover Frequency Map of North America	Dorothy Hall	Poster-14010	

10:40	Monitoring Freshwater Lake Ice Thickness and Ice Bottom Roughness in Central Ontario	Noah Bacal	Poster-14010
10:40	Remote sensing of snowscapes and caribou (Rangifer tarandus) movement in the Northwest Territories of Canada	Mariah Matias	Poster-14010
10:50	Global transferability of temperature index snowmelt model	Achut Parajuli	
11:05	The relationship between Arctic Oscillation and intense cyclone patterns, and their impacts on summer precipitation distribution in the Canadian Arctic	Xiaomeng Zuo	
11:20	Remote Sensing Methods for Quantifying Snow Water Equivalent at the Bay of Quinte (Ontario) and for Lake Erie Watershed (Ontario)	Felix Ouellet	

Convenors:

Nathan Gillett (Environment and Climate Change Canada)
Matthias Jakob (BGC Engineering)
Melinda Brugman (Environment and Climate Change Canada)
Ashlee Jollymore (BC River Forecast Centre)

An intense atmospheric river made landfall in southwestern B.C. on 14th November 2021, bringing two days of intense precipitation, and rapidly rising temperatures which led to substantial snowmelt at higher elevations. This caused numerous landslides, highway washouts and severe flooding which led to the loss of at least five lives, severed all transportation links between Vancouver and the rest of Canada for days to weeks, and flooded numerous farms and properties in the Fraser Valley, making this event the costliest natural disaster in British Columbia history. Recent work has shown that climate change may increase the intensity and/or frequency of landfalling atmospheric rivers, increasing both the risk associated with these potentially devastating storms and the need for accurate, advanced forecasting of such systems. In this session we invite papers related to the understanding of all aspects of this event, including the atmospheric river, the associated rainfall and snowmelt, and their hydrological effects. We invite submissions on forecasting such events, including storm-rating systems aimed at forecasting their perspective impacts, as well as studies of climate change influence on such events, including event attribution studies. We also welcome papers aimed at improving understandings of atmospheric river disaster response (including forecaster training and risk communication), and papers that address various atmospheric river consequences within a rapidly warming world (including but not limited to flooding, landslides, and washouts) in conjunction with landscape-scale stressors such as wildfires.

It is intended that this session, and its companion session "BC Extreme Events II", will be followed by a third session consisting of a panel discussion involving stakeholders, scientists and communicators.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
09:55	Climate change, atmospheric rivers and the November 14/15 2021 Pacific Northwest	Kent Moore		

	extreme rainfall event			
10:25	Water management at BC Hydro generation facilities during the November 2021 atmospheric river events	Tim Ashman		
10:50	A&P in Action: Involvement of the Analysis and Prognosis section with respect to the November, 2021 Atmospheric River event over southwestern British Columbia	Alissa Steeves		
11:05	Antecedent Conditions and Impacts from the Atmospheric Rivers Over Southwestern British Columbia in November 2021	Baljit (Bobby) Sekhon		
11:20	ECAR - A Multivariate Atmospheric River Scale for Canada	Melinda M Brugman		

Convenors:

Marek Stastna (University of Waterloo)
Mike Waite (University of Waterloo)
Adam Monahan (University of Victoria)
Ron McTaggart-Cowan (Environment and Climate Change Canada)

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
12:55	Transmission and Reflection of Three-Dimensional Internal Gravity Wave Packets in Non-uniform Retrograde Shear Flow	Alain Gervais		
13:10	The sensitivity of internal solitary waves to localized patches of mixing	Nicolas Castro-Folker		
13:25	A data centric look at internal waves in late winter lakes	Marek Stastna		
13:40	Numerical investigation of diapycnal mixing in the Kitikmeot Sea	Yasaman Afsharipour	Poster-4040	

13:50	Constant flux layers with gravitational settling: deposition velocity implications.	Peter Taylor
14:05	Turbulence dynamics in a stably stratified wall-bounded flow	Amir Atoufi
14:20	Kinetic Energy Spectra and Energy Cascade Analysis of Radiative-Convective Equilibrium	Kwan tsaan (Donald) Lai

Convenors:

Mark Gordon (York University)
Yongsheng Chen (York University)
Paul Makar (Environment and Climate Change Canada)

This session invites topics related to air-quality and it linkages to weather and climate. There is an emphasis on efforts to improve regional-scale modelling of air-quality and demonstration of how these improvements are linked to changes in weather and climate. This can include direct feedback mechanisms to weather such as aerosols and cloud formation, or more broad linkages to climate such as greenhouse gas emission modelling.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
12:55	Satellite-based methane emission estimates for western Canada using a mass balance method, and quantification of the oil and gas sector contribution	Nazrul Islam		
13:10	Sensitivity of Air Pollution in Quebec to Regional Emissions and Meteorology	Robin Stevens		
13:25	Representation of Precipitation Phases and a New Parameterization for Below-Cloud Scavenging	Roya Ghahreman		
13:50	An Analysis of the Global Distribution of Aerosol Direct Radiative Forcing and Its Implications for Meridional Energy Transport	Qiurun Yu		
14:05	Aerosol chemical and physical properties during the Halifax Fog and Air Quality Study	Rachel Chang		
14:20	Recent research on Canada’s FireWork wildfire air quality forecast system and the 2021	Jack Chen		

fire season impacts on weather

Convenors:

Pete Whittington (Brandon University),
Barret Kurylyk (Dalhousie University)

This session invites contributions from all aspects of hydrology, in particular those not covered by an other session.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
12:55	Evaluation of Soil Erosion Models for Application in the Canadian Prairie Environment	Peter Lawford		
13:10	Impacts of climate change and anthropogenic activities on the hydrology of British Columbia's Nechako River Basin	Rajtantra Lilhare		
13:25	Stream temperature response to climate variability in a forested landscape dominated by small lakes	Danielle Hudson		
13:50	Snowmelt water partitioning in Seasonally Frozen Soils: Insights from field observations	Ines Sanchez-Rodriguez		
14:05	Assessing channel geometry in response to land use disturbance in a low-relief, glacially conditioned region	Pamela Tetford		
14:20	Understanding Snow Representation in the Noah-MP Model through a Single Column Experiment	Engela Sthapit		

Convenors:

Krystopher J Chutko (University of Saskatchewan),
Craig Smith (Environment and Climate Change Canada),
Elias J Deeb, (Cold Region Research and Engineering Laboratory, Hanover, NH, USA)

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Time	Abstract Title	Presenter	Poster	Add to

		Order	Calendar
12:55	Overview of SnowEx field campaign in Northern Alaska, U.S.	Carrie Vuyovich	
13:10	Observationally constraining a snow-on-sea-ice model to estimate Arctic snow and sea ice thickness with associated uncertainties	Alex Cabaj	
13:25	Evaluating Fourteen Gridded SWE products using Airborne Gamma Radiation SWE and Snow Courses Transacts	Eunsang Cho	
13:40	Local scale soil-snow interaction and the impacts of soil on snow characteristics	Mahsa Moradi	Poster-14011
13:40	Using Unpiloted Aerial Systems Structure From Motion Photogrammetry for Avalanches in Mount Washington, NH	Cameron Wagner	Poster-14011
13:40	Conductive Heat Flow Through Temperate Region Lake Ice	Laura Alvarez Salinas	Poster-14011
13:50	Tundra snow depth retrievals from wideband radar observations in Trail Valley Creek	Wei Wang	
14:05	How Do Microwaves Interact with Freshwater Ice, and Why Is It So Important?	Grant Gunn	
14:20	Snow depth on sea ice record from 1955-2019 in the Canadian Arctic and development plans for multi-satellite snow depth retrieval	Hoi Ming Lam	

Convenors:

Nathan Gillett (Environment and Climate Change Canada)
Matthias Jakob (BGC Engineering)
Melinda Brugman (Environment and Climate Change Canada)
Ashlee Jollymore (BC River Forecast Centre)

An intense atmospheric river made landfall in southwestern B.C. on 14th November 2021, bringing two days of intense precipitation, and rapidly rising temperatures which led to substantial snowmelt at higher elevations. This caused numerous landslides, highway washouts and severe flooding which led to the loss of at least five lives, severed all transportation links between Vancouver and the rest of Canada for days to weeks, and flooded numerous farms and properties in the Fraser Valley, making this event the costliest natural disaster in British Columbia history. Recent work has shown that climate change may increase the intensity and/or frequency of landfalling atmospheric rivers, increasing both the risk associated with these potentially devastating storms and the need for accurate, advanced forecasting of such systems. In this session we invite papers related to the understanding of all aspects of this event, including the atmospheric river, the associated rainfall and snowmelt, and their hydrological effects. We invite submissions on forecasting such events, including storm-rating systems aimed at forecasting their perspective impacts, as well as studies of climate change influence on such events, including event attribution studies. We also welcome papers aimed at improving understandings of atmospheric river disaster response (including forecaster training and risk communication), and papers that address various atmospheric river consequences within a rapidly warming world (including but not limited to flooding, landslides, and washouts) in conjunction with landscape-scale stressors such as wildfires.

It is intended that this session, and its companion session "BC Extreme Events II", will be followed by a third session consisting of a panel discussion involving stakeholders, scientists and communicators.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
12:55	The climatological context of the mid-November 2021 floods in BC	Tamar Richards-Thomas		
13:10	Atmospheric Rivers Leading to the Catastrophic Flooding in Western Canada in November 2021: A Comprehensive Study	Ruping Mo		
13:25	Big Storms, Landslides & Worker Safety	Matt Sakals		
13:50	Using projections of extremes to reduce future risks: lessons learned from a 2010 climate risk assessment on the Coquihalla	Trevor Murdock		
14:05	The Tahtsa Ranges Atmospheric River Experiment (TRARE)	Stephen Dery		

Convenor:

Charles Curry

This session invites contributions from all aspects of the study of climate change and variability, in particular those not covered by an other session.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
12:55	A multi-algorithm analysis of projected changes to freezing rain over North America in an ensemble of regional climate model simulations	Christopher McCray		
13:10	The Canadian Ice Service Sea and Lake Ice Climate Normals	Scott Weese		

	for 1991-2020			
13:25	Tropospheric warming drives the rise of the tropopause in the Northern Hemisphere in recent decades	Jane Liu		
13:50	Detection of climate change in terrestrial water storage from global weather patterns	Fei Huo		
14:05	Mitigation of Methane Emission from Municipal Solid Waste Landfill using Engineered Biocovers	Mohammad Rayhani		
14:20	The Futility of Countering Carbon Emissions with Tree Planting	Geoff Strong		

Convenors:

Marek Stastna (University of Waterloo)
Mike Waite (University of Waterloo)
Adam Monahan (University of Victoria)
Ron McTaggart-Cowan (Environment and Climate Change Canada)

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
14:55	Sensitivity of convective overturning and turbulent mixing of dissolved gases in the Labrador Sea to atmospheric forcing	Romina Piunno		
15:10	Modelling the Atlantic Water along its poleward pathway into and through the Arctic Ocean	Adam Fu		
15:25	Effects of currents, winds, river flows and tides on salinity in James Bay	MANFRED DESIRE BONGA NYETEM		
15:40	The Impact of Land on the Fog over Sable Island	Zheqi Chen	Poster-4041	
15:50	Lagrangian analysis of seasonal and interannual	Rebecca Beutel		

	trends in estuarine flow composition and path within Juan De Fuca Strait			
16:05	ENSO influence on Bay of Bengal cyclogenesis confined to low latitudes	Ajaya Mohan Ravindran		
16:20	What limits the robustness of the separate ocean-atmosphere responses to sea ice loss and greenhouse forcing?	Paul Kushner		

Convenors:

Mark Gordon (York University)
Yongsheng Chen (York University)

This session will demonstrate air-quality measurements and related modelling work that has direct societal benefit. Presentations on any general topics related to air quality are invited with emphasis on end users and stakeholders. This can include measurement campaigns or modelling work that provides information for the general public, government, or industry.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
14:55	AQMAP: A real-time interactive map of PM2.5 in Canada from low-cost and regulatory monitors	Brayden Nilson		
15:10	Modelling the atmospheric transport of microplastics	Eric Ward		
15:25	Non-Exhaust Particle Emission Factor of Vehicular Traffic in an Urban Canopy.	Rhythm Reet		
15:50	Impact of deep basin terrain on PM2.5 distribution and its seasonality over the Sichuan Basin, Southwest China	Zhuozhi Shu		
16:05	A New Plume Rise Algorithm - The Thermodynamic Effects of Combustion Water in Buoyant Stack Plumes	Sepehr Fathi		
16:20	Automated Plume Rise Measurements based on Deep Neural Networks using Video Images	Mohammad Koushafar		

Convenors:

Pete Whittington (Brandon University),

Barret Kurylyk (Dalhousie University)

This session invites contributions from all aspects of hydrology, in particular those not covered by an other session.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
14:55	Post-processing Sub-Daily Precipitation Forecasts With Analog Ensembles in Southwest BC	Julia Jeworrek		
15:10	Using glaciers to interpret deep learning hydrological models	Sam Anderson		
15:25	Spatiotemporal Changes of Hydrologic Drought and Flood Swings in Western North America Under Climate Change	Reza Rezvani		
15:50	Projecting impacts of climate change on interlink between green and blue water resources in Canadian Prairies	Pouya Khalili		
16:05	THE DOMINANT ROLE OF SALT EXCLUSION ON THE FREEZING CHARACTERISTIC CURVE OF SOILS	Seth Kwaku Amankwah		

Convenors:

Christopher Marsh (University of Saskatchewan),
Phillip Harder (University of Saskatchewan),
Vincent Vionnet (Environment and Climate Change Canada)

Seasonal snowpacks influence many aspects of cold-regions meteorology and hydrology such as surface-atmosphere energy exchanges, frozen soil dynamics, and storage of substantial volumes of water. The melt of these snowcovers provides fresh water supplies resources to local as well as downstream communities and ecosystems. Globally, these snowcovers are estimated to provide essential flows for about one-sixth of the world's population. Ongoing anthropogenic climate and land use change are dramatically impacting the snowpacks driving these critical flows. There are significant incentives to provide better estimates of these snowpacks and their physical processes through improved observations, analysis, and modelling.

In this session, we invite contributions from the broader snow science community who are interested in observations, analysis, and/or modelling to share their experiences, insights, and advances in utilizing existing and next-generation tools. Contributions are particularly encouraged that explore the possibilities and strategies to overcome the significant challenges of the increasingly complex and large datasets now available from big data and advances in remote sensing from UAVs, satellite and airborne systems, and high-performance computing opportunities. Research spanning snow processes across all climate zones is encouraged to be a part of the discussion. Canada boasts impressive snow science capabilities, and we envision this session to be a forum to highlight and discuss areas of recent progress and collective gaps.

Time	Abstract Title	Presenter	Poster	Add to

14:55	Improving Snow Analyses for Hydrological Forecasting at Environment and Climate Change Canada (ECCC)	Camille Garnaud
15:10	Assessing the spatial distribution of snow depth in open and forested environments by UAV lidar	Vasana Dharmadasa
15:25	Complex precipitation phase and impact on snowpack evolution in Eastern Canada.	Nicolas Leroux
15:50	Simulation of cold processes in the CMIP6 land-historical simulations	Lawrence Mudryk
16:05	Simple Snow Temperature Index Models Account for Important Discrepancies between Snow Water Equivalent Products	Aleksandra Elias Chereque
16:20	Operational water forecast assessment of a spatially distributed process-based snow model; a case study in the East River Watershed, Colorado.	Joachim Meyer

Convenors:

Nathan Gillett (Environment and Climate Change Canada)
Matthias Jakob (BGC Engineering)
Melinda Brugman (Environment and Climate Change Canada)
Ashlee Jollymore (BC River Forecast Centre)

Shortly after the 2021 summer solstice, a high amplitude quasi-stationary high pressure ridge formed over western North America, then intensified over five days beginning June 25th before progressing eastward. The attendant heat-wave spanned from 45 °N in Oregon up through southern Northwest Territories covering the entirety of British Columbia’s interior. Daily maximum and overnight minimum near surface air temperatures rose until the evening of the 28th or the next day further inland. The final days produced widespread all-time-high temperatures that exceeded previous values by several °C at long-record locations including a new Canada-wide record of 49.6 °C in Lytton, BC. The event had severe impacts on human health including heat-related illness and death, ecological damage, burdened or destroyed infrastructure and diverse economic losses. Unfortunately, in almost any future emissions scenario, events like this one will become more likely in this region and globally.

In this multidisciplinary session, we seek papers that explore the past/present/future climatology and climate attribution of western North America heatwaves; the meteorological dynamics (i.e. meso-scale meteorological factors, importance of teleconnections, wave amplification and stationarity, atmospheric and surface energy budget); the potential for forecasting or early-warnings (i.e. antecedent conditions, importance of Pacific sea surface temperature, skill of S2S forecasts); and the unique impacts of the occurrence of such an early season, widespread and extremely large record break (i.e. human well-being, cryospheric, land and aquatic ecosystem responses, agricultural adaptation). Papers from severe heatwaves in other locations will be considered to aid in exploration of the factors that contribute to extreme heat in our warming climate and strategies for adaptation.

It is intended that this session, and its companion session "BC Extreme Events I", will be followed by a third session consisting of a panel discussion involving stakeholders, scientists and communicators.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
14:55	The 2021 western North American heatwave: mechanisms and subseasonal predictions	Hai Lin		
15:25	Future heat stress and its impact on labor capacity in North America	Guilong Li		
15:50	An anomalous atmospheric river linked to the late June 2021 western North America heatwave	Ruping Mo		
16:05	Attribution of the 2021 heat wave in British Columbia	Elizaveta Malinina		

Convenor:

Marcus Schnorbus

This session invites contributions from all aspects of atmospheric, hydrometric and climate monitoring, in particular those not covered by another session.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
14:55	Scale separation diagnostics and the Symmetric Bounded Efficiency for the inter-comparison of precipitation reanalyses	Barbara Casati		
15:10	Investigating precipitation trends in the Central and Southern Ontario	Daniel Serrano		

Day 2 – 2 June 2022

Convenors:

David Fissel, Helen Joseph
(CMOS Arctic Special Interest Group)

This interdisciplinary session will present emerging scientific results on the rapidly changing physical environment of the Canadian Marine Arctic. 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 marine 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. The importance of Arctic research and its consequences in looking ahead is very timely and pertinent for policy and decision-makers ranging from the community to international scales. Scientific papers will be solicited from a wide range of sectors including academia, government research agencies, the private sector, environmental non-governmental groups, communities and Indigenous organizations. Papers are sought from research and science activities that are nearing completion, updates on research that is underway and the plans for research and science activities that is planned or just getting underway. This session will seek papers 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
08:25	Policies to limit air pollution are key for successfully mitigating Arctic warming	Knut von Salzen		
08:55	The Role of Wind in the Dynamics of Reduced Sea Ice Motion in Winter and Early Spring on the Canadian Beaufort Sea Continental Shelf	David Fissel		
09:10	The Impact of the Decoupling of Wind and Sea Level Pressure on Sea Ice Motion in the Nares Strait	Kaitlin McNeil	Poster-3030	
09:10	Watershed Sensitivity to Glacier Hypsometry and Rising Equilibrium Line Altitudes in the Canadian Arctic	Madeline Myers	Poster-3030	
09:20	Thin and thick ice in the Beaufort Sea: A new regime with enhanced mobility	Kent Moore		
09:35	Atmospheric Forcing of Wind-Driven Regional Sea Ice Motion In Winter and Early Spring in the Canadian Beaufort Sea	Matthew Asplin		
09:50	Seasonal predictions of the open-water season in the Baffin Bay region	Minghong Zhang		

Convenor:

Charles K Paterson (Environment and Climate Change Canada)

Changing technology and changing methods of observation often leave past observed data hidden and very difficult to access, as we have seen with data stranded on paper, in punch-card formats, or on magnetic tape in the last few decades. Since 2017, the MSC has been working in some specific projects of data rescue and recovery; namely the recovery of large volumes of past daily data observation forms to scanned copies, the recovery of automated tipping rain gauge data from past bulletins to use in creating IDF curves, and the continuing generation of IDF curve data from the older manual tipping bucket rain gauges and older loggers. Other organisations such as DRAW McGill (Data Rescue: Archives and Weather) have also been recovering past data from paper in order to use it for research.

These activities link well to international efforts at the WMO level such as I-DARE (International Data Rescue https://www.idare-portal.org/) and ACRE (Atmospheric Circulation Reconstructions over the Earth https://www.met-acre.net/data%20rescue.htm). What has been done so far in Canada has barely scratched the surface; much data remains to be discovered, such as automated station hourly data before the 1990s, hourly observations before the 1960s, solar radiation from auto-stations, and other such data. The aim of this session is to open the floor to presentations on accomplishments and future opportunities in data recovery in all observed weather and climate data.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
08:25	The recent evolution of historical weather data rescue in Canada: ACRE-Canada, DRAW and Open Data Rescue	Victoria Slonosky		
08:40	A guideline for AI-augmented data rescue workflow tested by DRAW dataset	Yumeng Zhang		
08:55	Rescuing Metadata to Improve the Usability of Orphan Historical Climate Data	Camille Brais		
09:20	Evaluating characteristics of historical cloud cover in Quebec using station based observations, reanalysis, satellite products and model simulations	Rashed Mahmood		
09:35	Early surface auto-station history and data in MSC	Charles Paterson		
09:50	Representativeness of the precipitation observing network for monitoring precipitation change and variability in Canada	Hui Wan		

Convenors:

Pete Whittington (Brandon University),
Barret Kurylyk (Dalhousie University)

This session invites contributions from all aspects of hydrology, in particular those not covered by an other session.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
08:25	Drivers of hydrological response for distinct wetland complexes in a high latitude alpine watershed.	Lauren Bourke		

08:40	Hydrological Controls on the water balance of thermokarst lakes between Inuvik and Tuktoyaktuk, Northwest Territories, Canada	Evan Wilcox
08:55	Plant water uptake is distinct, opportunistic, and controlled by seasonality and precipitation in a subarctic, alpine environment	Erin Nicholls
09:20	Wind effects on rain gauge amount and rainfall isotopic composition	Pedro Hervé-Fernández 1,2
09:35	Ecohydrology of natural and constructed ecotones surrounding peatlands in south eastern Manitoba	Frank Yamoah
09:50	Stream temperature variability and change across Western Canada	Rajesh Shrestha

Convenors:

Shawn Marshall (University of Calgary & Environment and Climate Change Canada),
Homa Kheyrollah Pour (Wilfrid Laurier University)

The cryosphere is transforming in response to global climate change, with widespread impacts on climate, hydrology, landscapes, and northern communities. Snow and ice are defining features of the world's mountain and Arctic regions, but their remoteness also makes them difficult to access for monitoring and process studies. Integrated remote sensing and modelling studies grounded in in-situ field data are greatly needed to improve observational and predictive capacity for monitoring cryospheric response to climate change. We invite contributions that address modelling or monitoring of snow, lake/river ice, sea ice, permafrost, or glaciers and their interaction with the broader Earth system. Studies that integrate observational and modelling studies, introduce new sensor technologies to expand monitoring capacity, or develop new cryospheric observational capacities through community partnerships are of particular interest.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
08:25	Changing Arctic Snow and Ice: in situ monitoring using digital camera imagery	Brianna Lane		
08:40	Comparaison de la performance de modèles empiriques de bilan de masse glaciologique en réponse au changement climatique.	Lisa Michaud		
08:55	Comparison and calibration of a temperature-index based coupled glacier mass balance dynamic evolution model and applications in regional melt projections	Amanda Kotila		

09:10	Diagnosing the Future Hydrology of a Central Asian Glacierized Basin using a Hydrological-Glaciological Land Surface Model	Okan Aygün	Poster-14030	
09:20	Heat wave impacts on glacier mass balance, glacier runoff and salmon in Nooksack River, Washington	Mauri Pelto		
09:35	Multi-method approach to inventorying rock glaciers and features of interest in Banff and Jasper National Parks, Alberta, Canada	Mishelle Wehbe		
09:50	Cryospheric Observation and Modelling for improved Adaptation in Central Asia (CROMO-ADAPT)	Martin Hoelzle		

Convenors:

Nathan Gillett (Environment and Climate Change Canada)
Matthias Jakob (BGC Engineering)
Melinda Brugman (Environment and Climate Change Canada)
Ashlee Jollymore (BC River Forecast Centre)

An intense atmospheric river made landfall in southwestern B.C. on 14th November 2021, bringing two days of intense precipitation, and rapidly rising temperatures which led to substantial snowmelt at higher elevations. This caused numerous landslides, highway washouts and severe flooding which led to the loss of at least five lives, severed all transportation links between Vancouver and the rest of Canada for days to weeks, and flooded numerous farms and properties in the Fraser Valley, making this event the costliest natural disaster in British Columbia history. Recent work has shown that climate change may increase the intensity and/or frequency of landfalling atmospheric rivers, increasing both the risk associated with these potentially devastating storms and the need for accurate, advanced forecasting of such systems. In this session we invite papers related to the understanding of all aspects of this event, including the atmospheric river, the associated rainfall and snowmelt, and their hydrological effects. We invite submissions on forecasting such events, including storm-rating systems aimed at forecasting their perspective impacts, as well as studies of climate change influence on such events, including event attribution studies. We also welcome papers aimed at improving understandings of atmospheric river disaster response (including forecaster training and risk communication), and papers that address various atmospheric river consequences within a rapidly warming world (including but not limited to flooding, landslides, and washouts) in conjunction with landscape-scale stressors such as wildfires.

It is intended that this session, and its companion session "BC Extreme Events II", will be followed by a third session consisting of a panel discussion involving stakeholders, scientists and communicators.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
08:25	Human influence on 2021 British Columbia floods: attribution of extreme precipitation	Elizaveta Malinina		
08:40	Reconciling the discrepancy between rarity of the	Alex Cannon		

	atmospheric river and rainfall associated with the November 2021 flooding in southwestern B.C.			
08:55	Extreme Streamflow Associated with the 2021 British Columbia Atmospheric River Event	Markus Schnorbus		
09:20	Quantifying the human influence on extreme streamflow in 2021 British Columbia flood event	Qiaohong Sun		
09:35	Human influence on the 2021 British Columbia floods	Nathan Gillett		

Convenors:

Rachel Chang (Dalhousie University)
Robert Sica (The University of Western Ontario)
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, which means that 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 describing advances in all aspects of the Arctic atmosphere are welcomed, including new and updated data sets, methodologies, campaigns, instruments, and modeling efforts, with an emphasis on advances in 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
12:55	The role of the polar vortex in whole atmosphere coupling	V Lynn Harvey		
13:25	Past and Predicted Temperature Trends in the Winter Arctic Stratosphere and the Role of Sudden Stratospheric Warmings	Kevin Bloxam		
13:50	Impact of Resolution on the Representation of the Mean and Extreme Winds along Nares Strait	Kent Moore		
14:05	Assessing Pan-Arctic	Stephen Beagley		

	atmospheric Ozone simulation capability within the GEM-MACH air quality modelling system	
14:20	Observations of Extreme Wildfire VOC Enhancements over the Canadian High Arctic	Tyler Wizenberg

Convenors:

Marek Stastna (University of Waterloo)
Mike Waite (University of Waterloo)
Adam Monahan (University of Victoria)
Ron McTaggart-Cowan (Environment and Climate Change Canada)

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
12:55	Impact of land-ocean contrasts in cumulus entrainment on the current climate	Meera Mohan		
13:10	Variability of Biomass Burning Emissions Impacts the Hydrologic Cycle in Earth System Models	Kyle Heyblom		
13:25	The Impact of Major North American Lakes in WRF for Regional Climate Applications	Mani Mahdinia		
13:50	Investigation of the climatology of low-level jets over North America in a high-resolution WRF simulation	Xiao Ma		
14:05	Seasonal Forecasting of Winter Extratropical Cyclones in Nova Scotia	Rebekah Cavanagh		
14:20	Mesoscale Wind and Temperature Changes over Peatlands of the Hudson Bay Lowlands and their Impact on the Surface Energy Balance	Olalekan Balogun		

Convenors:

Jason Leach (Canadian Forest Service),
Sheena Spencer (BC Ministry of Forests),
Magali Nehemy (University of Saskatchewan)

Forests dominate much of Canada's landscape and are a critical source of freshwater resources, provide natural infrastructure for flood protection and drinking water supply, and support habitat for culturally and economically important aquatic species. Climate and land cover changes are altering forest-water relationships in complex and unprecedented ways across a range of spatial and temporal scales. This session will feature research conducted on forest-water relationships and how changes in climate and forest cover impact water, from plot to watershed scales. We invite both empirical and modelling studies, and contributions that provide new theoretical understanding and perspectives on hydrological and biogeochemical processes within forested ecosystems.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
12:55	Climate change increases the severity and duration of soil water stress in the temperate forest of eastern North America	Audrey Maheu		
13:25	Forest use of bedrock water in droughts past, present and future: implications for ecosystem resilience	W. Jesse Hahm		
13:40	Quantifying Evapotranspiration in Seasonally Frozen Forests	Sujan Basnet	Poster-9020	
13:50	The Effects of Spruce Budworm Defoliation on Catchment Hydrology in Hilly Spruce and Fir-Dominated Forests in Gaspé, Québec	Harvinder Sidhu		
14:05	Event-scale hydrologic responses in a hardwood dominated headwater catchment 25 years following clearcut harvesting	Annie Gray		
14:20	Characterizing the effects of climate change, land cover change, and internal climate variability on the hydrology of a forested watershed	Mohammad Fereshtehpour		

Convenors:

Shawn Marshall (University of Calgary & Environment and Climate Change Canada),
Homa Kheyrollah Pour (Wilfrid Laurier University)

The cryosphere is transforming in response to global climate change, with widespread impacts on climate, hydrology, landscapes, and northern communities. Snow and ice are defining features of the world’s mountain and Arctic regions, but their remoteness also makes them difficult to access for monitoring and process studies. Integrated remote sensing and modelling studies grounded in in-situ field data are greatly needed to improve observational and predictive capacity for monitoring cryospheric response to climate change. We invite contributions that address modelling or monitoring of snow, lake/river ice, sea ice, permafrost, or glaciers and their interaction with the broader Earth system. Studies that integrate observational and modelling studies, introduce new sensor technologies to expand monitoring capacity, or develop new cryospheric observational capacities through community partnerships are of particular interest.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
12:55	Forward Modelling of SAR Backscatter during Lake Ice Melt Conditions using the Snow Microwave Radiative Transfer (SMRT) Model	Justin Murfitt		
13:10	Spatial Variability of Lake Ice Thickness and Phenology on Sub-Arctic Lakes in Yellowknife, Northwest Territories.	Gifty Attiah		
13:25	Improving lake ice simulations in Canada based on lake size	Alexis Robinson		
13:40	Meltwater Refreezing and Retention on the Greenland Ice Sheet in a Changing Climate	Shawn Marshall	Poster-14031	
13:50	Evaluation of Snow Depth Derived from Ground Penetrating Radar on Canadian Subarctic Lakes.	Alicia Pouw		
14:05	Variability in thermokarst lake size, elevation, and connectivity in the western Canadian Arctic	Rosamond Tutton		
14:20	Why do simulated trends of Arctic sea ice drift speed go from positive in the 20th century to negative in the 21st century?	Jamie Ward		

In June of 2021 an extraordinary “Heat Dome” with record breaking temperatures resulted in almost 600 deaths over southwestern British Columbia. This is the greatest weather-related loss of life in Canada’s history. This was followed by wildfires, one of which destroyed the community of Lytton. Less than five months later, extreme rainfall from a persistent “atmospheric river” event, resulted in historic flooding with damages likely to exceed one billion dollars.

Several scientific sessions at the 2022 Congress hosted jointly by the Canadian Meteorological and Oceanographic Society, the Canadian Geophysical Union, and the Eastern Snow Conference, are dedicated to the 2021 extreme events. The theme of the Congress is “Science Serving Society”.

Impressive scientific advances have been made in the observing, understanding and prediction of changes in weather, water and climate. Since the unprecedented events of 2021 in British Columbia are a harbinger of climate-driven extremes that will more frequently impact society, the Panel will discuss steps that are, or should, be taken.

Panelists include:
• Russ White, Director General Prediction & Services, Environment and Climate Change Canada
• Matt Godsoe, Director of the Resilience and Economics Integration Division, Public Safety Canada
• Jason Thistlewaite, Professor in the School of Environment, Enterprise and Development at the University of Waterloo
• David Campbell, Head, River Forecast Centre, British Columbia Ministry of Forests

Each Panelist will offer a 10-minute perspective, followed by a 40-minute discussion/Q&A

Convenors:
Rachel Chang (Dalhousie University)
Robert Sica (The University of Western Ontario)
William Ward (University of New Brunswick)

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Time	Abstract Title	Presenter	Poster Order	Add to Calendar
14:55	Canadian Atmospheric Science Space Missions and Recent Polar Science Results	Cassandra Bolduc		
15:10	Remote Sensing analysis of Kluane Lake dust plumes: automated dust classification scheme using optical and microphysical correlation analyses	Seyedali Sayedain		
15:25	Ice nucleating properties of airborne dust from an actively retreating glacier in Yukon, Canada	Yu Xi		
15:50	Characterizing the hygroscopicty of growing particles in the Canadian Arctic summer	Rachel Chang		

Convenors:

Jason Leach (Canadian Forest Service),
Sheena Spencer (BC Ministry of Forests),

Magali Nehemy (University of Saskatchewan)

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Time	Abstract Title	Presenter	Poster Order	Add to Calendar
14:55	The effects of forest disturbance on water quality in the Algoma region, central Ontario	Matthew Watkins		
15:10	Immediate and Legacy Impacts of Different Harvesting Strategies on Phosphorus Yield in Upland Hardwood Forested Watersheds	Robert Fines		

Convenors:

Shawn Marshall (University of Calgary & Environment and Climate Change Canada),
Homa Kheyrollah Pour (Wilfrid Laurier University)

The cryosphere is transforming in response to global climate change, with widespread impacts on climate, hydrology, landscapes, and northern communities. Snow and ice are defining features of the world's mountain and Arctic regions, but their remoteness also makes them difficult to access for monitoring and process studies. Integrated remote sensing and modelling studies grounded in in-situ field data are greatly needed to improve observational and predictive capacity for monitoring cryospheric response to climate change. We invite contributions that address modelling or monitoring of snow, lake/river ice, sea ice, permafrost, or glaciers and their interaction with the broader Earth system. Studies that integrate observational and modelling studies, introduce new sensor technologies to expand monitoring capacity, or develop new cryospheric observational capacities through community partnerships are of particular interest.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
14:55	Recommendations to enhance hydrological models for improved estimates of climate impacts on northern waters	Robin Thorne		
15:10	Projection of Lake ice thickness and Phenology under Representative Concentration Pathways (RCP) Scenarios: Great Slave and Great Bear Lake, Northwest Territories	Ariana Mansingh		
15:25	Investigating the Impact of Snow Cover on Permafrost Soil Temperatures in Modern	Tyler Herrington		

Reanalysis and Data
Assimilation Systems

Convenors:

Shannon E. Brown (University of Guelph),
Sara Knox (University of British Columbia),
Elyn Humphreys (Carleton University)

Physical and biological land surface characteristics affect how energy, water, aerosols, and greenhouse gases are exchanged with the atmosphere. Thus, interactions between the land surface and the atmosphere represent a key component of the climate system. To improve predictions of global and regional climates, a better understanding of the tight coupling between land and atmosphere is needed. Observational and experimental studies can improve our understanding of land-atmosphere interactions. For example, eddy covariance measurements of fluxes of energy and matter help constrain flux dynamics across multiple time scales from hours to years and create large, long-term datasets to examine variability in land-atmosphere interactions. This data provides base data for ecosystem models. Chamber studies have provided the information needed to investigate process-based dynamics of GHG emissions. New technologies are expanding measurements to all landscapes across Canada – i.e., agricultural, forest, and peatland sites. These studies provide powerful tools to explore biophysical and biogeochemical processes underlying land-atmosphere interactions. This session highlights innovative research of all aspects of field campaigns observing land-atmosphere interactions.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
14:55	CARBON DIOXIDE NET ECOSYSTEM EXCHANGE ALTERED BY CROP ROTATION DIVERSIFICATION AND USE OF COVER CROPS	Jacob Evans		
15:10	Mitigating nitrous oxide emissions from corn using nitrification and urease inhibitors following cover crop adoption	Nicole Menheere		
15:25	Wind-Profiler Identification of Gravity wave Hotspots and Importance for Meteorological Modelling.	Wayne Hocking		
15:40	Controls of Differing Non-Growing Season Cover Crops On Winter Soil Temperatures	Kayla Wicks	Poster-11020	
15:40	Net ecosystem greenhouse gas budget of corn determined using long term flux measurements	Sibley Duckert	Poster-11020	
15:50	Coupling crop-growth and cold regions hydrology with observations and modelling on the Canadian Prairies	Phillip Harder		
16:05	Winter Water Budgets under Enhanced Freeze Thaw	Ryan Lafleur		

	Cycles: A Lysimeter Study in a Humid Continental Climate		
16:20	Comparison of nitrous oxide flux measurements from low power and multi-plot flux-gradient systems against eddy covariance measurements	Shannon Brown	

Convenors:

Craig D. Smith, Eva Mekis, Joshua King
(Climate Research Division, Environment and Climate Change Canada)

The measurement of snow and solid precipitation are fundamental observations of the cryosphere and are critical for identifying and characterizing the impacts of climate change, monitoring and forecasting water resources (both floods and droughts), and improving our understanding of dynamics. In situ measurements are also crucial for developing, assessing, and improving products derived from remote sensing missions. Exacerbated by automation, inhomogeneity, and sparsity, measurements of snow and solid precipitation are often difficult to obtain with any known level of uncertainty. This session will solicit submissions on the in situ measurement of snow and solid precipitation, including but not limited to: 1) challenges and solutions for existing observing networks; 2) instrument performance issues; 3) post-measurement data processing and quality control; 4) precipitation gauge transfer function development and application; 5) emerging observation techniques (such as non-catchment precipitation measurements and low cost snow cover monitoring); and 6) future opportunities.

Time	Abstract Title	Presenter	Poster Order	Add to Calendar
15:40	Traceability and catch-efficiency of the Lambrecht rain[e]H3 automated precipitation gauge for measuring precipitation in Canadian operational networks	Amber Ross	Poster-14020	
15:40	Snow Specific Surface Area: Margins of Error and Best Methods for the IceCube by A2 Photonic Sensors	Kaitlin Meyer	Poster-14020	
15:50	What if you put a phone on a drone?	Fraser King		
16:05	Assessing the impact of transition from single Alter-shielded Geonor T-200B to double Alter-shielded Pluvio2L gauges on winter precipitation measurements in the ECCC operational network	Craig Smith		
16:20	Transfer Function development for adjusting precipitation observations in Arctic and Maritime climate conditions	Eva Mekis		

14020 - In Situ Measurement of Snow and Solid Precipitation: Advances, Challenges, and Ongoing Issues

Convenors:

Craig Smith
Eva Mekis

Amber Ross
PRESENTATION DATE AND TIME: JUNE 02, 2022 15:40
Traceability and catch-efficiency of the Lambrecht rain[e]H3 automated precipitation gauge for measuring precipitation in Canadian operational networks

Kaitlin Meyer
PRESENTATION DATE AND TIME: JUNE 02, 2022 15:45
Snow Specific Surface Area: Margins of Error and Best Methods for the IceCube by A2 Photonic Sensors

Fraser King
PRESENTATION DATE AND TIME: JUNE 01, 2022 10:10: DEEPPRECIP: A DEEP NEURAL NETWORK FOR RETRIEVALS OF PRECIPITATION
PRESENTATION DATE AND TIME: June 02, 2022 15:50: What if you put a phone on a drone?

Craig Smith
PRESENTATION DATE AND TIME: JUNE 02, 2022 16:05
Assessing the impact of transition from single Alter-shielded Geonor T-200B to double Alter-shielded Pluvio2L gauges on winter precipitation measurements in the ECCC operational network

Eva Mekis
PRESENTATION DATE AND TIME: JUNE 02, 2022 16:20
Transfer Function development for adjusting precipitation observations in Arctic and Maritime climate conditions

Day 3 – 3 June 2022

Convenors:

Mark Gordon

Paul Makar

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
08:25	GEM-MACH Simulations for the Oil Sands Area – An Overview	Paul Makar		
08:40	Contribution of emissions from the oil sands activities to atmospheric concentration and deposition of nitrogen and sulphur species at a downwind site	Yuan You		
08:55	Modeling trace elements over Athabasca oil sands region in Alberta, Canada using WRF-Chem	Jingliang Hao		
09:20	Understanding Emissions of Hydrogen Sulphide in Athabasca Oil Sands Region	Colin Lee		

09:35	HETV2: An update to the vectorized inorganic chemistry solver in GEM-MACH based on ISORROPIA II algorithms	Stefan Miller		
09:50	Merging aircraft and satellite observations to derive emissions of pollutants co-emitted with nitrogen oxides: Application to the Canadian oil sands	Debora Griffin		

Convenors:

Paul Myers (University of Alberta),
Youyu Lu (Bedford Institute of Oceanography),
Susan Allen (University of British Columbia),
Greg Smith (Environment and Climate Change Canada),
David Greenberg (Bedford Institute of Oceanography),
Frederic Dupont (Environment and Climate Change Canada),
Juliana Marson (University of Manitoba)

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
08:25	Improving ocean and sea-ice model hindcast simulations for Canada's Three Oceans: Present and ongoing work	Youyu Lu		
08:40	Development of an advanced coupled modelling system to study interactions among physical and biogeochemical processes in the northwest Atlantic Ocean	Kyoko Ohashi		
08:55	Bias Correction and Spatiotemporal Scales for Downscaling Future	Christoph Renkl		

	Projections of Northwest Atlantic Circulation and Sea Ice		
09:10	Classification of Lagrangian trajectories in the Labrador Current with a Machine Learning algorithm	Mathilde Jutras	Poster-4060
09:10	Towards creating an ensemble of global ocean analysis: Ensemble GIOPS	Andrew Peterson	Poster-4060
09:20	NEMO Model developments at the University of Alberta	Clark Pennelly	
09:35	Iceberg-associated freshwater transport across Davis Strait	Juliana Marson	
09:50	Impact of Model Resolution on the simulated MOC across OSNAP West Section	Pouneh Hoshyar	

Convenors:

Miranda L Hunter (University of Waterloo),
Rebecca J Frei (University of Alberta)

Disturbance in the boreal zone is increasing due to widespread direct and indirect anthropogenic actions that alter ecosystem structure and function. Together, direct (e.g., forestry and resource extraction and exploration) and indirect disturbances (e.g., wildfires and permafrost thaw) impair ecosystems through diverse and interconnected ways. For example, disturbances may alter ecohydrology, greenhouse gas exchange, nutrient cycling, storage and transport of heavy metals, habitat availability, species richness and diversity, and cultural connections (or a combination of the above) at multiple temporal and spatial scales. In this session, we invite researchers studying the effects of disturbance in boreal ecosystems, such as in wetlands, forests, uplands, and inland waters. Research can be conducted both at the source of disturbance or downstream (or downwind, down commercial chains, etc.). We welcome research from a variety of disciplines and methodologies, including in situ measurements, lab experiments, modeling, and remote sensing. We hope this session will facilitate knowledge exchange to inform restoration, emission inventories, and production of regulatory policies that will serve society."

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
08:25	Are restored seismic lines heading in the right direction? Comparing taxonomic, phylogenetic and functional plant diversity in boreal peatlands.	Ellie Goud		
08:40	Combined impacts of soil salinity and water-table on Juncus balticus growth in a constructed fen in the Alberta oil sands	Tianshi Wang		

08:55	Boreal peatland reclamation through partial well pad removal: Understanding biogeochemical dynamics supporting fen moss initiation	Murdoch McKinnon		
09:20	Restoration of oil sands well-pads to peatlands: Evaluating the return of carbon sink function to inform restoration practice	Maria Strack		
09:35	Impacts of Wildfire on Greenhouse Gas Dynamics in a Bog Peatland in Central Alberta	Abigail Shingler		
09:50	Carbon Production and Transport: Impact of Water Table Fluctuations in Bare Peat Column Experiment	Miranda Hunter		

Convenors:

Eunsang Cho (NASA Goddard Space Flight Center),
Melissa Wrzesien (NASA Goddard Space Flight Center),
Elias Deeb (U.S. Army Cold Regions Research and Engineering Laboratory),
Carrie Vuyovich (NASA Goddard Space Flight Center)

Seasonal snow plays a critical role in the Earth's water and energy cycles, and its role is rapidly changing under a warming climate. However, a lack of reliable, high-resolution, global observations has limited our understanding of its role in Earth's systems and human society. Advances in field measurements, remote sensing, modeling, and data fusion & analytics are essential for linking snow information to natural and human systems and improving our understanding of snow dynamics in a changing climate.

This session invites research on novel and advanced approaches in seasonal snow including field measurements (campaigns and instruments), unpiloted aerial system (UAS), airborne, and satellite remote sensing, physical and data-driven simulations, and emerging data assimilation & analytics along with machine and deep learning (ML/DL). Efforts that identify and overcome gaps in the current knowledge of snow observations and modeling are particularly encouraged. We also welcome submissions connecting snow to society for water resources, agriculture, ecology, infrastructure, and extremes (e.g., floods, drought, and wildfire) around the globe.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
08:25	Advances in X- and Ku- Band Radar Algorithms for SWE Retrieval by Future Satellite Missions	Edward Kim		
08:40	An Analysis of Snowpack Temperature, Density, and Cold Content across the US West from the Repurposed	Jeffrey Schmidt		

	USGS RMS Dataset		
08:55	Retrieval of snow water equivalent from SWESARR measurements in Grand Mesa Colorado, SnowEx 2020	Michael Durand	
09:10	Evaluating Passive Microwave Snowmelt Detection Methods with Ground Snow Observations	Angela Rienzo	Poster-14040
09:10	Modelling snowpack bulk density using snow depth, cumulative degree days, and climatological predictor variables.	Andras Szeitz	Poster-14040
09:20	Using machine learning to estimate snow cover from ground surface temperature measurements.	Anika Forget	
09:35	Characterizing the Role of Snow for Liquid Water Storage and Transmission: A Ground-Based Remote Sensing and Modeling Sensitivity Analysis	Ryan Webb	
09:50	The Airborne Cryosphere-Observing Synthetic Aperture Radar System (CryoSAR): A Snow, Soil, Sea Ice and Lake Ice Observing System	Richard Kelly	

Convenors:

Shannon E. Brown (University of Guelph),
Sara Knox (University of British Columbia),
Elyn Humphreys (Carleton University)

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Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar

08:25	FLUXNET-CH4 – a global database of eddy covariance methane flux measurements	Sara Knox	
08:40	Interannual Variability of Carbon Dioxide and Methane Fluxes in a Temperate Bog over a 6-Year Period	Tin Satriawan	
08:55	The UHI and thermally forced circulations events of the Valley of Mexico as revealed by a historical analysis in a dry period of simulated intense events.	Lourdes Aquino	
09:10	Exploring extreme weather events adaptation measures of spring wheat based on AquaCropOS in Saskatchewan	Qi Zhao	Poster-11030
09:20	The relevance of energy partitioning and vegetation water use to Taiga Shield water budgets in a warming climate	Christopher Spence	
09:35	Climate Response to Severe Changes in Forestation: An Intercomparison Study	Olivier Asselin	

Convenors:

Rachel Chang (Dalhousie University)
Robert Sica (The University of Western Ontario)
William Ward (University of New Brunswick)

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Time	*Abstract Title*	Presenter	Poster	Add to

			Order	Calendar
12:55	Arctic Cirrus Cloud Radiative Forcing: Observational Challenges and Regional Climate Impacts	James Campbell		
13:25	The Critical Role of Polar Cold Clouds: Simulation, Analysis and Observations	Jean-Pierre Blanchet		
13:50	Cloud microphysical properties at Eureka, Nunavut from 2016 to 2020.	Joseph Hung		
14:05	Detailed investigation of possible mechanisms driving recent Arctic PSC and ozone hole events	Liviu Ivanescu		

Convenors:

Paul Myers (University of Alberta),
Youyu Lu (Bedford Institute of Oceanography),
Susan Allen (University of British Columbia),
Greg Smith (Environment and Climate Change Canada),
David Greenberg (Bedford Institute of Oceanography),
Frederic Dupont (Environment and Climate Change Canada),
Juliana Marson (University of Manitoba)

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
12:55	Nitrous oxide production in the global ocean: Control by nitrification and denitrification pathways	Rebecca Pierce		
13:10	Assessment of sea ice with NEMO 4.2 / SI3 coupled model for operational purpose.	Gilles Garric		

13:25	Development of a Relocatable Ocean Model System for the West Coast of Canada	Yuehua (Andy) Lin
13:50	Port modelling on the west coast under the Oceans Protection Plan	Michael Dunphy
14:05	Port Modelling on the east coast under the Oceans Protection Plan	Rachel Horwitz
14:20	Enabling Ocean Modelling with CIOOS Data	James Munroe

Convenors:

Miranda L Hunter (University of Waterloo),
Rebecca J Frei (University of Alberta)

Disturbance in the boreal zone is increasing due to widespread direct and indirect anthropogenic actions that alter ecosystem structure and function. Together, direct (e.g., forestry and resource extraction and exploration) and indirect disturbances (e.g., wildfires and permafrost thaw) impair ecosystems through diverse and interconnected ways. For example, disturbances may alter ecohydrology, greenhouse gas exchange, nutrient cycling, storage and transport of heavy metals, habitat availability, species richness and diversity, and cultural connections (or a combination of the above) at multiple temporal and spatial scales. In this session, we invite researchers studying the effects of disturbance in boreal ecosystems, such as in wetlands, forests, uplands, and inland waters. Research can be conducted both at the source of disturbance or downstream (or downwind, down commercial chains, etc.). We welcome research from a variety of disciplines and methodologies, including in situ measurements, lab experiments, modeling, and remote sensing. We hope this session will facilitate knowledge exchange to inform restoration, emission inventories, and production of regulatory policies that will serve society."

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:55	High rates of methane oxidation in tropical peatland drainage canals moderate methane emissions	Lauren Somers		
13:10	Horticultural Additives influence soil biogeochemistry and increase CO2 emissions from peat	Bidhya Sharma		
13:25	Vulnerability of peatland complexes in the Hudson Plains to permafrost-thaw-driven landcover and hydrological change	Mikhail Mack		
13:50	Ecohydrological implications of the variability of soil hydrophysical properties between two Sphagnum moss	Pete Whittington		

	microforms and the impact of different sample heights			
14:05	Prairie Potholes as Transformers on the Landscape: Exploring the Rates of Planktonic Nitrogen Uptake, DNRA, and Denitrification	Amy Hergott		
14:20	Disentangling multiple drivers of dissolved organic matter concentration in a prairie drinking water reservoir	Anthony Baron		

Convenors:

Eunsang Cho (NASA Goddard Space Flight Center),
Melissa Wrzesien (NASA Goddard Space Flight Center),
Elias Deeb (U.S. Army Cold Regions Research and Engineering Laboratory),
Carrie Vuyovich (NASA Goddard Space Flight Center)

Seasonal snow plays a critical role in the Earth's water and energy cycles, and its role is rapidly changing under a warming climate. However, a lack of reliable, high-resolution, global observations has limited our understanding of its role in Earth's systems and human society. Advances in field measurements, remote sensing, modeling, and data fusion & analytics are essential for linking snow information to natural and human systems and improving our understanding of snow dynamics in a changing climate.

This session invites research on novel and advanced approaches in seasonal snow including field measurements (campaigns and instruments), unpiloted aerial system (UAS), airborne, and satellite remote sensing, physical and data-driven simulations, and emerging data assimilation & analytics along with machine and deep learning (ML/DL). Efforts that identify and overcome gaps in the current knowledge of snow observations and modeling are particularly encouraged. We also welcome submissions connecting snow to society for water resources, agriculture, ecology, infrastructure, and extremes (e.g., floods, drought, and wildfire) around the globe.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:55	Fine scale characterization of snowpack evolution using unpiloted aerial system lidar and SfM photogrammetry	Megan Verfaillie		
13:10	Estimating Snow Water Equivalent at the watershed scale using drones across in the Arctic shrub-tundra	Branden Walker		
13:25	Quantifying volumetric scattering bias in ICESat-2 altimetry over snow-covered surfaces	Zachary Fair		
13:40	Leveraging adaptive viewing to improve the	Colin McLaughlin	Poster-14041	

	efficacy of space-borne satellite retrievals of terrestrial snow.		
13:40	Soil freeze-thaw detection using Sentinel-1 SAR data in agricultural fields	Shahabeddin Taghipourjavi	Poster-14041
13:50	Precipitation phase from atmospheric model improves snowfall estimates across Canada	Vincent Vionnet	
14:05	DLR Global SnowPack - possible applications of the near real-time product	Sebastian Rößler	
14:20	An accurate global daily snow cover and albedo product from MODIS and VIIRS	Karl Rittger	

Convenors:

Catherine Champagne (Agriculture and Agri-Food Canada) ,
Timi Ojo (Manitoba Agriculture and Resource Develpoment),
Yinsuo Zhang (Agriculture and Agri-Food Canada)

This session focuses on understanding relationships between climate and land based resource sectors such as agriculture, forestry and water in order to ensure the resiliency of these sectors. We invite contributions that expand our knowledge base on how we can use past, present and future climates to better adapt and reduce costs associated with climate change, variability and extreme events. We encourage submissions related (but not limited to) any of the following sub-themes:

1. Exploring productivity limitations under different climatic regimes.
2. Integrating climate extremes in ecosystem models.
3. Mainstreaming climate information in resource based sectors.
4. Trend, magnitude, frequency and severity analysis of sector-specific climate indices under the past, present and future climate scenarios.
5. Empirical/process-based methods for estimating climate variability impacts on ecosystems across multiple spatio-temporal scales.
6. Translating weather forecasts into useful decision support tools for natural resource managers.
7. Remote sensing applications in land surface meteorology, agriculture and forestry.

Modelling or measurement-based studies from the following sciences and fields are encouraged: agriculture, forestry, remote sensing, hydrology, climatology, geography, insurance, transportation, energy, actuary and media.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:55	Climate and Prairie Crop Production: Historical and Future Perspectives	Paul Bullock		

13:25	Effects of Delayed Harvest Dates on Gluten Strength of Canada Western Red Spring Wheat	Manasah Mkhabela		
13:50	Developing Fusarium head blight risk models for western Canadian cereals using weather data and logistic regression analysis	Taurai Matengu		
14:05	Feeding Models of Food Production: Scaling Meteorological and Biophysical Data Sets for Agroecosystem Modelling	Catherine Champagne		
14:20	Exploring the crop yield forecast skill in climate extreme years by alternative treatment of technology induced yield trends in the Canadian Prairies	Yinsuo Zhang		

Convenors:

Rachel Chang (Dalhousie University)

Robert Sica (The University of Western Ontario)

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, which means that 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 describing advances in all aspects of the Arctic atmosphere are welcomed, including new and updated data sets, methodologies, campaigns, instruments, and modeling efforts, with an emphasis on advances in 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
14:55	Atmospheric impact of carbon fluxes of Arctic ecosystems on local and regional scales	Roisin Commane		
15:25	Characterization of atmospheric	Daniel Wesley		

	methane release at hotspots in the outer Mackenzie River Delta.	
15:50	Using Ground-Based Fourier Transform Infrared Spectroscopy to Evaluate Model Concentrations of Short-Lived Climate Forcers	Victoria Flood
16:05	Old air trapped in polar ice cap helps reconstruct recent trace gas histories	Anais Orsi
16:20	Validation of Short-Lived Climate Forcer Modelling by Ground-Based Near-Infrared Fourier Transform Spectroscopy	Erin McGee

Convenors:

Martin Leduc (Ouranos),
David Huard (Ouranos)

Climate change adaptation measures strive in part to reduce risks from climate hazards. Despite the fact that the concept of risk combines the vulnerability and exposure of a system with the probability of a hazard, there are notorious barriers to the assessment of the latter probabilistic component. For one, no probabilities are assigned to the scenarios of future increase in atmospheric greenhouse gases concentrations typically used to simulate future climate conditions and hazards. Climate impact assessments are thus conditional on the emission or concentration scenario imposed to climate models. This leaves decision-makers in the delicate position of having to make judgment calls regarding future greenhouse gases concentrations. Second, there is no community consensus on model weighting schemes that would translate an ensemble of model projections into a probability distribution. Model structural uncertainty is often described as the spread of an ensemble of model projections with “one model, one vote” weights. This however neglects known similarities and dependencies in model structure, which tends to bias results toward popular model architectures. It also ignores known differences in the skill of models to reproduce past climate observations, which may provide important information about models reliability to simulate future climate change. These model weighting issues are compounded for hybrid ensembles of opportunity formed by multiple global (GCM) and/or regional (RCM) climate models, and increasingly for regional assessments where large internal climate variability often restricts climate models evaluation.

This session seeks contributions that feed the development of fully probabilistic climate risk assessments.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:55	Estimating the likelihood of GHG concentration scenarios from probabilistic IAM simulations	David Huard		
15:10	Addressing the “Which	Jeremy Fyke		

	scenario should I use?" question: a demonstration of probabilistic emission projections for real-world risk-based decision making			
15:25	Observationally constrained projections of regional warming	yongxiao liang		
15:50	Sensitivity of regional climate projections to differences in model weighting techniques	Martin Leduc		

Convenors:

Wai Ying Lam, Vaughn Mangal, David McLagan, Sayuri Sagisaka, Planck Huang
(Department of Physical and Environmental Sciences, University of Toronto)

Natural and anthropogenic disturbances in ecosystems can have substantial impacts on hydrological and biogeochemical processes at both local and regional scales. It is critical that we understand the practical implications of disturbances such as anthropogenic contamination, land use change, wildfires, forestry activities, major storms, and climate change, on the hydrological and biogeochemical processes of these systems. Additionally, recognizing the importance of interconnected hydrological and biogeochemical processes, the watershed science community seeks to advance our understanding of the specific biotic and abiotic changes in these linked cycles following disturbance. This will enable us to improve management practices for water quality and availability and contamination mitigation and remediation strategies in terrestrial watersheds. This session welcomes quantitative and qualitative contributions from field, experimental, and modelling studies, particularly those regarding carbon and nutrient cycling, contaminant fate and transport, that are as a result of natural and anthropogenic disturbances.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:55	Forest Harvesting Impacts on the Chemical Composition of Dissolved Organic Matter in Boreal Streams	Vaughn Mangal		
15:10	A history of eating garbage and getting gas	Daniel Grégoire		
15:25	Effects of beaver impoundments on surface water mercury concentrations in boreal watersheds along a gradient of forest harvest disturbance	Wai Ying Lam		
15:40	Effects of forest harvesting on mercury concentration, methylation and demethylation in soils and sediment in Canadian boreal forests	Haiyong (Planck) Huang	Poster-10050	
15:50	From road to stream: A process-based integrated watershed model for stream chloride from road salts	Bhaswati Mazumder		

	using SWMM	
16:05	Demystifying mercury geochemistry in contaminated soil–groundwater systems with complementary mercury stable isotope, concentration, and speciation analyses	David McLagan
16:20	Modelling the effects of cover cropping on water quality and crop production in agricultural watersheds of Canadian Prairies	Sepideh Kheirkhah

Convenors:

Eunsang Cho (NASA Goddard Space Flight Center),
Melissa Wrzesien (NASA Goddard Space Flight Center),
Elias Deeb (U.S. Army Cold Regions Research and Engineering Laboratory),
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Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:55	Merging models with observations to support open science, NASA SnowEx, and snow satellite missions	Melissa Wrzesien		
15:25	Climate driven changes in snowpack: simulations (1970s to 2020) for the Bay of Quinte, Ontario, Canada	Félix Ouellet		
15:40	Assimilation of GRACE / GRACE-FO Terrestrial Water Storage Retrievals to Improve Snow Mass Estimates across North America	Alireza Moghaddasi	Poster-14042	

15:45	Evaluation of three different machine learning algorithms for snow mass estimation over the Colorado Rockies using space-based passive microwave brightness temperatures	Bincheng Yu	Poster-14042
15:50	An Observing Simulation System Experiment (OSSE) for Snow Mass Estimation over Western Colorado Using Adaptive Viewing from Space	Lizhao Wang	
16:05	Predicting Surface Density using Snow Models and Assimilation for Wildlife Applications	Michael Druand	
16:20	Spatiotemporal assessment of snow density and Snow Water Equivalent (SWE) using the Cone Penetration Test (CPT) and/or Ground Penetrating Radar (GPR)	Adrian McCallum	

Convenors:

Catherine Champagne (Agriculture and Agri-Food Canada) ,
Timi Ojo (Manitoba Agriculture and Resource Develpoment),
Yinsuo Zhang (Agriculture and Agri-Food Canada)

This session focuses on understanding relationships between climate and land based resource sectors such as agriculture, forestry and water in order to ensure the resiliency of these sectors. We invite contributions that expand our knowledge base on how we can use past, present and future climates to better adapt and reduce costs associated with climate change, variability and extreme events. We encourage submissions related (but not limited to) any of the following sub-themes:

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7. Remote sensing applications in land surface meteorology, agriculture and forestry.

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Time	*Abstract Title*	Presenter	Poster	Add to

			Order	Calendar
14:55	Interpreting Drought in the Canadian Prairies Using Machine Learning and SHAP Values	Jacob Mardian		
15:10	Projected changes in the hotspots of agriculturally relevant compound events in Western Canada cropping regions under the RCP8.5 scenario	Richard Agyeman		
15:25	Integrating climate change research into forest and natural resource management, northern British Columbia	Vanessa Foord		
15:50	The Severe Drought of 2021 over Prairies: La Nina provides the forcing mechanism	Ray Garnett		
16:05	Land hydroclimatology of the Laurentian Great Lakes region in changing climate	Narayan Shrestha		
16:20	Future water levels for the Great Lakes under 1.5°C to 3°C warmer climates	Frank Seglenieks		

Day 4 – 6 June 2022

Convenors:

Fiona Darbyshire (Université du Quebec à Montréal)
Clément Estève (McGill University)

This session invites the presentation of research investigating all aspects of Solid Earth geophysics. Topics will range in scope, including, but not limited to: application of field and laboratory techniques, diverse geophysical methods and observations, data analyses from the field and from modelling studies, studies of structure, studies of Solid Earth processes. Also encouraged are submissions describing analyses of the Solid Earth and other planets as obtained by remote sensing techniques, or data collected by landers.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
08:25	Canada's National Quantum Strategy: A role for Geophysics?	Calvin Klatt		
08:40	Seismic structure of the lithosphere in eastern Canada using earthquake and ambient noise seismology	Omid Bagherpur Mojaver		
08:55	Investigating how the accelerometer measurements of the GRACE C satellite are affected by geomagnetic	Myrto Tzamali		

	disturbances.		
09:10	Shear-velocity and anisotropic model of the Alaskan lithosphere obtained by full-waveform joint inversion of ambient noise and local earthquake data	Tianshi Liu	Poster-8010
09:10	Seismic network development and updated ground motion prediction equations for Georgia, Caucasus	Nato Jorjiashvili	Poster-8010
09:10	Intrinsic and Scattering Attenuation in the lithosphere of the Racha Region, Georgia	Ia Shengelia	Poster-8010
09:35	Heuristic Measures as a Prospect for Data-Driven Discovery: Application to Observations of Relative Paleointensity During Transitions of the Geomagnetic Field	L. Ian Lumb	
09:50	Application of geophysical techniques to supplement geotechnical analysis of slope stability problems	Mark Lepitzki	

Convenors:

Kaley A. Walker (University of Toronto),
Adam Bourassa (University of Saskatchewan)

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 in US, Europe and Japan have provided and will provide a wealth of new information about the Earth system and can be used to investigate a wide range of environmental and scientific questions. 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
12:55	Satellite Earth Observation in Canada – A Strategy in Action Commentary and Q&A	David Harper		
13:10	Satellite Earth Observation in Canada – A Strategy in Action	David Harper		
13:50	Development of Composite Data Products at the	Alexander Trishchenko		

	Canada Centre for Remote Sensing from Visible Infrared Imaging Radiometer Suite Imagery for Climate and Environmental Applications			
14:05	A Neural Network Approach to Arctic Microwave Surface Property Retrievals	Colleen Henschel		
14:20	Extending aerial surveys with LANDSAT-based canopy cover: A case study in Montreal	Marsha Akkerhuis		

Convenors:

Neil Tandon (York University),

John Gyakum (McGill University),

Megan Kirchmeier-Young (Environment and Climate Change Canada)

As we have seen repeatedly in the news, extreme precipitation events are impacting many regions across Canada and around the globe, often contributing to devastating floods. The atmospheric rivers that hit British Columbia last fall are just some of the countless examples. Understanding extreme precipitation events is imperative for improved climate change projections and climate change adaptation. This session welcomes contributions addressing the range of topics relevant to extreme precipitation, including long-term changes, variability, physical drivers, climate change attribution, prediction, observing methods, modelling and impacts. These studies might examine events in the distant past, more recent events or projected future events. We encourage submissions of theoretical modelling studies as well as analyses of observations and model output. Regional case studies are welcomed, as well as studies examining extreme precipitation characteristics and mechanisms aggregated over larger spatial scales and longer temporal scales.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
08:25	Multi-model evidence for the “intense gets intenser” pattern of extreme precipitation in a warmer climate	Chao Li		
08:40	Influence of Horizontal Model Resolution on the Spatial Scale of Extreme Precipitation Events	Syed Muhammad Anas Ali		
08:55	Using a model comparison to support the interpretation of event attribution for extreme precipitation	Megan Kirchmeier-Young		
09:10	Impact of Future Climate on Extreme Precipitation: A Case Study of the 2013 Alberta Flooding Event	Xiaohui Zhao	Poster-7040	
09:20	A new concept of max-stable vector to analyze and predict	Mohamed Ali Ben Alaya		

	the probability of precipitation extremes			
09:35	Compound flooding analysis over the Canadian coastal zones	Farshad Jalili Pirani		
09:50	An assessment of open versus ice-affected high water levels in Canadian rivers	Yonas Dibike		

Convenors:

Graigory Sutherland (Environment and Climate Change Canada),
Nancy Soontiens (Fisheries and Oceans Canada),
Dany Dumont (Université du Québec à Rimouski),
Cédric Chavanne (Université du Québec à Rimouski)

Accurate knowledge of surface currents is important for most human activities on the ocean. Surface currents control the transport and dispersion of physical, chemical and biological tracers, including pollutants, in the upper ocean. These processes are affected by the complex interaction between surface waves, mean currents and turbulence. Ocean circulation models do not account for many of these processes so they must be parameterized in order to provide accurate predictions of transport and dispersion. In this session we welcome theoretical, numerical, and experimental studies of surface currents, dispersion and other related dynamical processes in the upper ocean. Field observations of surface currents and dispersion using methods such as high-frequency radar, drifting buoys, and dye-release experiments are also welcome.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
08:25	Surface currents in and around an atoll in the South China Sea	Rich Pawlowicz		
08:40	Towards an operational drift prediction at sea: verification with drift of containers from the Zim Kingston	Kuo-Hsien Chang		
08:55	Assessment of drift prediction in ocean models using Finite Scale Lyapunov Exponents	Donovan Allum		
09:10	Surface drift and dispersion in the Laurentian Channel during the passage of Hurricane Dorian	Graigory Sutherland	Poster-12020	
09:20	LES simulation of dye dispersion in the Gulf of St. Lawrence	Anneke ten Doeschate		
09:35	Using drifters to understand the dynamics of the Labrador Current System over the shelf	Taylor Davies		
09:50	The impact of ocean model	Nancy Soontiens		

resolution on the accuracy of drift predictions

Convenor:

Francis Zwiers

This session invites contributions from all aspects of the development and delivery of user services and all aspects of impacts and adaptation research, in particular those not covered by another session.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
08:25	Summary of the largest innovation cycle ever at the Meteorological Service of Canada: a journey into Innovation Cycle 3	Normand Gagnon		
08:55	Water level prediction: products and services provided by Environment and Climate Change Canada	Oleksandr Huziy		
09:10	Visualizing Canada's Daily Climate Records in 2021: Placing High Impact Weather within a Historical Climatological Context	Judy Kwan	Poster-13010	
09:20	On the development of Canada's homogenized precipitation monthly dataset	Xiaolan Wang		
09:35	A preliminary look at a machine-learning model for the improvement of quality control of MSC's surface observation data	Jim M.C. Young		
09:50	RADASAT-2 AND SENTINEL-1 FOR ASSESSING GROUND DISPLACEMENTS AT THE HAY RIVER AIRPORT, NWT, CANADA	Nanar Jacobs		

Convenors:

Georgia Fotopoulos (Queen's University),
Calvin Klatt (Canadian Geodetic Survey, Natural Resources Canada)

In 2015 all United Nations (UN) Member States adopted the 2030 Agenda for Sustainable Development. In all, there are 17 Sustainable Development Goals (SDGs) that highlight the urgent need for all countries to partner towards providing peace and prosperity for our global future. Geodesy plays a key role in all of these goals. This session will explore the interconnected aspects of geodesy and the UN SDGs. All research applications and topics where geodetic tools directly and indirectly help further our understanding of the Earth and the Earth System from monitoring to mitigation are welcome. Theoretical developments involving geodetic infrastructure, payloads and observations will also be a key part of this session. The session will involve research on various spatial scales and highlight geodesy's contributions for a sustainable future.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:55	Sea-level Change, Geodesy, and the United Nations Sustainable Development Goals	Thomas James		
13:25	Supporting the UN Sustainable Development goals through UN Geospatial and Geodetic Expert Committee Activities	Calvin Klatt		
13:50	Progress of the North American-Pacific Geopotential Datum of 2022	Jianliang Huang		
14:05	How knowledge of terrestrial water storage derived from GRACE/GRACE-FO can lead Canada towards a sustainable future	Stephanie Bringeland		

Convenors:

Kaley A. Walker (University of Toronto),
Adam Bourassa (University of Saskatchewan)

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 in US, Europe and Japan have provided and will provide a wealth of new information about the Earth system and can be used to investigate a wide range of environmental and scientific questions. 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.

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14:05	A Neural Network Approach to Arctic Microwave Surface Property Retrievals	Colleen Henschel
14:20	Extending aerial surveys with LANDSAT-based canopy cover: A case study in Montreal	Marsha Akkerhuis

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Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:55	High Resolution Climatological Simulations for South and Southeast Asia and the Tibetan Plateau: Mean and Extreme Precipitation Changes	Yiling Huo		
13:10	Climate attribution study of a deep moist convection: the Copenhagen case of July 2011	Dominic Matte		
13:25	PRECIPITATION EXTREMES AND THEIR LINKS WITH REGIONAL AND LOCAL TEMPERATURES: A CASE STUDY OVER THE OTTAWA RIVER BASIN, CANADA	Ana LLerena		
13:50	Winter Extreme Precipitation Regimes (EPRs) in eastern North America: Synoptic-Scale Environments and Categorization	Yeechian Low		

14:05	Overview of the Saint John River Experiment on Cold Season Storms (SAJESS)	Julie Thériault		
14:20	Assessing Wastewater Flooding Risk for the City of Charlottetown	Farhan Aziz		

Convenors:

Graigory Sutherland (Environment and Climate Change Canada),
Nancy Soontiens (Fisheries and Oceans Canada),
Dany Dumont (Université du Québec à Rimouski),
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12:55	Surface Waves Effects on Momentum Fluxes to the Upper-Ocean Currents under a Storm Track	Guoqiang Liu		
13:10	Altimetric Indices of Whale Habitat in the western Gulf of St. Lawrence	Jing Tao		
13:25	Estimation of the Stokes drift based on wind field retrieved by single high frequency radar	Abïgaëlle Dussol		
13:50	Effect of surface gravity waves on the upper ocean circulation and hydrography over the northwestern Atlantic during Hurricane Arthur	Colin Hughes		
14:05	Variability of oxygen saturation in the subsurface waters of the Northwest Pacific from Argo-O_2 data	Mohamed Ahmed		
14:20	Exploring the forcing behind the productivity of the Hudson Bay Complex	Inge Deschepper		

Convenors:

Christopher Subich (Environment and Climate Change Canada),
Michael Dunphy (Fisheries and Oceans Canada)

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
12:55	Generative Adversarial Networks for Extreme Super-Resolution and Downscaling of Wind Fields at Convection-Permitting Scales	Nic Annau		
13:10	Data efficient statistical post-processing of weather forecasts using neural networks	David Landry		
13:25	A framework for exploring a complete measurement model	Rick Danielson		
13:40	Experimental development for AI in weather using Hydra	Geneviève Chafouleas	Poster-13020	
13:50	Robustness of the parameterization of sub-grid scale wind variability on sea-surface fluxes	Kota Endo		
14:05	Evaluation of Optical Flow Methods for Radar Precipitation Extrapolation	Norbert Driedger		
14:20	On preconditioning a discontinuous Galerkin solver for the shallow water equations	Christopher Subich		

Convenors:

Susann Tegtmeier (University of Saskatchewan),
David Plummer (Environment and Climate Change Canada),
James Anstey (Environment and Climate Change Canada),

The chemical composition of the upper troposphere and stratosphere (UTS) plays a key role in the climate system as this region is coupled to the surface both dynamically and radiatively. Variability and long-term changes of dynamical UTS processes are important for many phenomena including the transport of trace gases via the stratospheric circulation or the connection between the Quasi-Biennial Oscillation of the tropical stratosphere and the Madden-Julian Oscillation. Our understanding of the interactions between dynamics, chemistry and climate in this region is rapidly advancing thanks to both observational and modelling studies.

In this session we welcome abstracts of chemical, dynamical and transport processes in the UTS region. This includes studies of variability and long-term trends in the UTS composition, causes and consequences of UTS dynamical variability, and feedbacks between the two. We encourage abstracts bringing together recent remote sensing or in-situ observations and model simulations of different complexity.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:55	Ozone-depleting substances: a major contributor late 20th century global warming	Michael Sigmond		
15:10	How Does Coupled Tropospheric Chemistry Influence Ozone in the Upper Troposphere and Stratosphere?	Noah Stanton		
15:25	Tropopause-level NOx in the Asian Summer Monsoon	Kimberlee Dube		
15:40	Variability and long-term changes of the tropical cold point temperature	Mona Zolghadrshojaee		
15:50	Convectively injected moisture plumes in the extratropical lower stratosphere: their characteristics, fate, and detectability by satellite instruments	Xun Wang		
16:05	Development of a Long-Term Relative Humidity Climatology Directly from Simultaneous Vibrational-Rotational Raman Lidar Measurements	Vasura Jayaweera		
16:20	On the Contribution of Thin Ice Clouds to Radiative Forcing and Dynamics of the UTLS	Jean-Pierre Blanchet		

Convenors:

Kaley A. Walker (University of Toronto),
Adam Bourassa (University of Saskatchewan)

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 in US, Europe and Japan have provided and will provide a wealth of new information about the Earth system and can be used to investigate a wide range of environmental and scientific questions. 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
14:55	Canadian Operational Atmospheric Science Space Missions and Recent Results	Cassandra Bolduc		
15:10	Comparison of carbon monoxide variability over North America using IASI and MOPITT satellite sensors	Heba Marey		
15:25	OSIRIS on Odin: Twenty One Years and Counting	Doug Degenstein		
15:50	Validation and Science Results from the Canadian Atmospheric Chemistry Experiment	Kaley Walker		
16:05	Results from the 2016 Canadian Space Agency Data Analysis Grants Program	Cassandra Bolduc		
16:20	A Portrait of Canadian Science & Applications Activities in Preparation for Data from the SWOT Mission	Jean Bergeron		

Convenors:

James Hiebert (PCIC, University of Victoria),
David Huard (Ouranos)

In recent years, it has come to be an expectation of contemporary climate researchers that climate services and data can and should be delivered electronically over the Internet. This presents interesting challenges in that the spatiotemporal nature of the climate, earth and ocean sciences, with their significant computational and storage requirements, posing significant provisioning barriers across all types of computational and network infrastructure. This session welcomes submissions describing novel methods, strategies, visualizations, user interfaces or implementations for any electronic delivery of geophysical (climate, water, weather, oceanic) services to a community of engaged stakeholders.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:55	Visualization of wind energy icing maps and wind time series using MSC's GeoMet API for geospatial web services	Simon-Philippe Breton		
15:10	PAVICS-GIS : Integrating online climate data services with Geographic Information Systems	Travis Logan		
15:25	ClimateData.ca: a modern interface for climate information delivery	Carrington Pomeroy		

Convenors:

Laura Bianucci (Fisheries and Oceans Canada)
Jennifer Jackson (The Hakai Institute)
Andry Ratsimandresy (Fisheries and Oceans Canada),
Daniel Bourgault (Université du Québec à Rimouski),

The Canadian coastline is comprised of innumerable fjords, reminiscent of the glacial era. The importance of these coastal geomorphological features extend into many realms: they provide habitats for multiple species, they receive inputs from both the watersheds and the neighbouring ocean (e.g. freshwater runoff with large amounts of organic matter; upwelling of shelf waters into the fjord), and they offer protected waters for transportation, aquaculture, fisheries, and many other human activities. They are also important sites for indigenous cultures. Furthermore, fjords in general, but particularly silled-fjords, are great environments to address fundamental questions related to ocean turbulent mixing such as internal hydraulic jumps, shear instabilities, gravity currents, internal waves (from generation to dissipation), eddies, water mass modifications, and deep water renewals. Fjords properties have been changing in the past (showing for instance warming and deoxygenation), and while further changes are to be expected in the future, it is still uncertain how climate change will affect current fjord ecosystems. This session invites contributions related to any aspect of fjord oceanography (from physics to biology, including biogeochemistry and diagenesis), on timescales from minutes (i.e. buoyancy period) to decades or longer, in the past, present, or future. Both observational and modelling studies are welcome.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:55	Three-dimensional nature of flow near a sill in the Saguenay Fjord	Jérôme Lemelin		
15:10	WINTER OUTFLOW (GAP) WINDS CAUSE COOLING AND REOXYGENATION IN BUTE INLET, BRITISH	Jennifer Jackson		

	COLUMBIA		
15:25	A persistent mid-water column hypoxic zone with low pH and CaCO3 saturation state in Toba Inlet	Alex Hare	
15:40	Towards a mechanistic understanding of physical transport in Quatsino Sound, B.C.: An FVCOM modeling study	Krysten Rutherford	Poster-12030
15:40	Sill Processes in the Saguenay Fjord	Jérôme Guay	Poster-12030
15:50	Understanding oxygen dynamics in two nearby Canadian fjords with different oxygen characteristics (oxic vs. hypoxic subsurface waters)	Laura Bianucci	
16:05	Tidal Influence on the Fraser River Plume in the Strait of Georgia.	Shumin Li	
16:20	Dynamics of Renewal Events in Seasonally Anoxic Saanich Inlet	Roberta Hamme	

Convenors:

Paul Kushner (University of Toronto),
Silvie Harder (Canadian Centre for Climate Services),
Emilia Diaconescu (Canadian Centre for Climate Services),
Lindsay Matthews (Canadian Centre for Climate Services)

Weather, water, ice and climate (WWIC) data inventories are valuable tools for the advancement of climate science, climate-change prediction, and for the timely development of climate services to address user needs. Whether available as an informal gathering point for local and/or traditional knowledge; as crowdsourced environmental information gathered via social media; as collections of documents focused on a particular region, set of climate variables, or application; or as a formal relational database, climate data inventories can serve a variety of short- and long-term needs for a wide range of applications. However, the potential for equitable, well-informed, and effective use of climate data is often limited by technical and historical barriers that undermine the so-called 'interoperability' of climate data. These barriers range from limited documentation, to inconsistent formatting, to unfamiliar standards of practice for valid application and interpretation, to proprietary requirements of data holders. Such barriers stand in the way of taking full advantage of WWIC data and the potential for scientific and applied insight from it.

This session seeks contributions to address the state of climate data inventories for climate analysis and climate-services development in Canada and internationally. Contributions are invited across the full range of inventory formats, communities of practice, spatial and temporal scales, geographic locales, and internationally coordinated efforts. Community initiatives, federal/provincial/municipal/academic/private-sector WWIC data inventory projects, international initiatives, and case studies involving novel development strategies and applications are encouraged. The conveners seek to build support for a broad collaborative Canadian effort in this area that will take advantage of best international practices and help synthesize efforts across institutional and disciplinary boundaries.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:55	Collaborative Permafrost Data Inventory Development in Canada	Nicholas Brown		
15:25	Establishing what weather, water, ice, and climate (WWIC) information users need for safe vessel operation in the Canadian Arctic	Jean Holloway		
15:50	Summer Minimum Snow and Ice Cover over the Northern Latitudes: Long-term Variations since 2000 and Consistency among Various Definitions	Alexander Trishchenko		
16:05	Improving Crisis Management by Inventorying Social Media Responses to Canadian Extreme Weather	Renee Sieber		
16:20	An inventory of historical climate data and climate projections for the Canadian North	Emilia Paula Diaconescu		

Day 5 – 7 June 2022

Convenors:

Salvatore R. Curasi (Carleton university & Environment and Climate Change Canada),
Elyn R. Humphreys (Carleton university),
Joe R. Melton (Environment and Climate Change Canada)

Climate change impacts the terrestrial carbon cycle with important feedback effects on the global climate system. To best understand how to adapt to current and future climate change, we require skilful projections of the terrestrial carbon cycles response to a warmer climate, increased atmospheric CO2 concentrations, land-use change, disturbances, vegetation change, accelerated nutrient cycling, and other perturbations. We also need to better understand the carbon budgets of critical ecosystems including boreal forests, peatlands, and Arctic ecosystems. Process-based models, inventory-based estimates, atmospheric inversion, remote sensing, and data-driven approaches provide an array of methods each with its own strengths for exploring the terrestrial carbon cycle. This session will showcase research focused on improving our understanding of the Canadian and global terrestrial carbon cycle. The diverse perspectives offered in this session provide insights into how best to represent these complex systems and reduce uncertainties. We encourage submissions that explore the terrestrial carbon cycle with a focus on informing the development of process-based models. We especially encourage studies that utilized the Canadian Land Surface Scheme including Biogeochemical Cycles (CLASSIC). 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.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:55	The sensitivity of future carbon dynamics to model biases, vegetation dynamics, and wildfires	Christian Seiler		
13:10	Optimizing the Soil Carbon Module of CLASSIC using Soil Carbon Bulk Pools and Fluxes Datasets	Charles Gauthier		
13:25	Global sensitivity analysis applied to the CLASSIC model for a single site.	Raj Deepak Suruli Nagarajan		
13:40	Plant functional type mapping from ESA CCI land cover data for use in CLASSIC	Libo Wang	Poster-4031	
13:40	Implementation of plant hydraulics in the Canadian Land Surface Scheme Including Biogeochemical Cycles (CLASSIC)	Muhammad Umair	Poster-4031	
13:40	Winter carbon fluxes measurements in Arctic tundra and Boreal forest using the snowpack gas diffusion method	Alex Mavrovic	Poster-4031	
13:50	Calibrating land models to reproduce the historical terrestrial carbon sink in the	Sian Kou-Giesbrecht		

	absence of nitrogen cycling compromises future projections			
14:05	Increased productivity in arid/semi-arid regions due to modified ET partitioning in CLASSIC	Gesa Meyer		
14:20	Carbon cycle feedbacks in an idealized and a scenario simulation of carbon dioxide removal in CMIP6 Earth system models	Ali Asaadi		

Convenors:

Dave Risk (St. Francis Xavier University),
Felix Vogel (Environment and Climate Change Canada)

As the second most important anthropogenic greenhouse gas, methane has been a focus of the atmospheric research community for many years. The recent COP26 in Glasgow has moved methane into the spotlight, with over 100 countries signing the Global Methane Pledge aiming at reducing anthropogenic methane by 30% over the coming decade. The Canadian Government also announced an ambitious goal of reducing oil and gas associated methane emissions by 75%.

Science-based information will be crucial in designing effective policies and identifying untapped mitigation potentials. This session intends to bring together experts working on understanding Canada's anthropogenic methane emissions using cutting-edge atmospheric monitoring techniques, process-studies, modelling, or novel (data-driven) inventory approaches and showcase their results to scientists and policymakers.

Many studies have highlighted the importance of super-emitters, regional and industry-specific differences in emission intensities and the potential for improved monitoring from the provincial to the component scale using novel measurement techniques.

The session invites research related to all anthropogenic methane sources.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
08:25	Field deployment of multiple top-down approaches to investigate	Sebastien Ars		

	methane emissions from two municipal solid waste landfills in Ontario, Canada		
08:40	Satellite-Based Tracking of Global Methane Emissions to Support Policy and Mitigation	Eric Choi	
08:55	A lightweight open-cell sensor for methane based on mid-infrared tunable diode laser absorption spectroscopy	Jalal Norooz Oliaee	
09:10	Detecting and quantifying methane emissions with the high-resolution GHGSat satellite constellation	Jean-Philippe MacLean	Poster-5040
09:10	Estimating Methane Emissions Using an Instrument-Specific Gaussian Plume Inversion Model	Lawson Gillespie	Poster-5040
09:20	A preliminary evaluation of GHGSat for methane emissions monitoring over Canada	Chris McLinden	
09:35	Using carbon-14 and carbon-13 measurements for source attribution of atmospheric methane in the Athabasca oil sands region	Regina Gonzalez Moguel	
09:50	Soil surface flux measurements of fugitive gas migration across	Mark Argento	

soils and seasons

Convenors:

Paul Kushner (University of Toronto),
Neil Swart (Environment and Climate Change Canada),
Yanping Li (University of Saskatchewan),
Paul Myers (University of Alberta),
Ivy Tan (McGill University),
Kirsten Zickfeld (Simon Fraser University),

Earth System Models (ESMs) are the principal tools used to understand and attribute past climate changes, to make projections of future climate, and to carry out near-term environmental predictions. The Canadian research community pursues collaborative research with ESMs across many domains, from the perspective of atmosphere/ocean science, cryospheric science, carbon-cycle science, and research related to land surface and hydrological processes. This collaborative research occurs within Canada and internationally, within government and academic settings, and within academic-government partnerships. Whatever the setting, the complexity and technical challenges associated with ESMs can pose barriers to their development, application, and analysis in the absence of formal collaborative structures and advanced technical tools to facilitate their use. New technologies, including machine-learning and novel data-science approaches, advanced version control systems, reproducible runtime environments (containers), community analysis packages, and common computing resources are affording new collaborative opportunities from development to analysis to application.

This session invites the CMOS community to submit papers on Earth System Models and modelling applications taking place in Canada, ranging from model descriptions through to applications and analysis procedures, across many earth-system science domains that are unified by their use of ESMs and could be enhanced by stronger collaborative partnerships. Initiatives of interest include atmospheric/ocean model process and parameterization development, activities in carbon cycle modelling (including climate change mitigation such as atmospheric carbon dioxide removal), land-surface model development and application, and sea-ice/land-ice modelling. We invite submissions focused on the modelling environment within Canada (including CanESM, the UVic ESM, GEM-NEMO, CanRCM, CRCM, etc.) and internationally (including CESM, WRF, CliMA, etc.). We seek to engage in a discussion concerning challenges and opportunities for collaboration between universities, government laboratories, and the private sector; and the scientific results emerging from such collaborations.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
08:25	Developing the Collaborative Platform for CanESM (CP4C)	Paul Kushner		
08:40	Analysis in support of CanESM development	Michael Sigmond		
08:55	Verification of	Haruki Hirasawa		

	CanESM porting on Compute Canada Supercomputers using Ensemble Consistency Testing		
09:10	Quantifying the Asymmetry in Land Carbon Cycle Feedbacks under Positive and Negative CO2 Emissions	Rachel Chimuka	Poster-4050
09:20	Coupling a wildfire model to an Earth System Climate Model of intermediate complexity	Étienne Guertin	
09:35	Land Surface Modeling of Wheat Growth in the Canadian Prairies – Current Representation and Potential Future Climate Change	Zhe Zhang	
09:50	Optimizing spring maize yield and water productivity in an arid irrigation area by using deficit irrigation strategies at different plant growth stages	Ya Huang	

Convenors:

David Straub (McGill University),
Francis Poulin (University of Waterloo),
Louis-Philippe Nadeau (Université du Québec à Rimouski)

Advances in Physical Oceanography benefit from observational data, detailed modelling studies, and theory describing fundamental processes occurring over a large range of spatial and temporal scales. The range of length scales is vast, including micro- and fine-structure, sub-mesoscale, mesoscale, and basin-scale flows. Ocean forcing fields and boundary conditions are also strongly modified by sea ice and surface wave effects. We welcome contributions on these and other related topics and will work with The organizers of closely related sessions to minimize scheduling overlaps.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
08:25	The Nonlinear	Bruce Sutherland		

	Evolution of Internal Tides: The Superharmonic Cascade		
08:40	Gulf Stream: Skewed Jet Dynamics	Jonathan Tessier	
08:55	Energy Cascades in a Two-Layer Shallow Water Ocean Model	Francis Poulin	
09:10	Observations of upwellings and downwellings on the edge of the Gaspé Current	Théau Leclercq	Poster-12040
09:20	Dynamic response characterization of the RBRArgo3 CTD from numerical modeling and laboratory experiments	Clark Richards	
09:35	Numerical study of tidal amplification in the Sable Gully of the Scotian Shelf	Shengmu Yang	
09:50	An Intermittent Gravity Current in Deep Water of the Strait of Georgia	Mina Masoud	

Convenors:

B. Teufel (McGill University),

L. Sushama (McGill University),

G. Bitsuamlak (Western University),

A. Shamseldin (University of Auckland),

J. Vaze (CSIRO Land and Water) ,

D. Nagesh Kumar (Indian Institute of Science, Bangalore)

Climate change impacts the operation and performance of a wide range of engineering systems, demanding new design approaches, adaptation in management strategies, and new technologies. While engineering systems in Canada’s densely populated southerly urban regions have developed into complex interconnected systems, those in the North are less developed and challenges are further compounded by the remoteness and harsh surface and sub-surface climate of the region. Therefore, the challenges that Arctic engineering systems will be subject to will be very different to those of the southern urban regions and need to be addressed uniquely. Multi-scale climate modelling and advanced integrated investigations encompassing interdisciplinary topics are required to develop new sustainable solutions that maximize the performance and co-benefits of climate-ready, and socially acceptable, engineering systems. We invite contributions on all aspects of climate/engineering system interaction studies aimed at climate change adaptation and mitigation, including observational, experimental, and numerical modelling studies, such as:

1) Development of climate change information using conventional and emerging approaches (physical, statistical and machine learning and/or hybrid models) at engineering scales; 2) Multi-scale climate/micro-climate modelling as it relates to engineering systems in different climatic zones (e.g., Urban and Arctic regions); 3) Emerging data-driven methods/frameworks at the engineering-climate interface; 4) Climate change adaptation and mitigation through nature-based solutions, and their feedback on the regional climate system; 5) Land dynamics-engineering coupled studies; 6) Urban climate modelling and urban resiliency studies; 7) Flash flood modelling and mitigation studies in relation to various engineering sectors such as transportation and infrastructure; 8) Coastal flooding and related adaptation/mitigation strategies for coastal infrastructure; and 9) Emerging experimental methods to assess micro-climate-engineering systems interactions.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
08:25	Urban Water Infrastructure Design in the Climate Change Context: Recent Advances and Shortcomings in Modeling of Extreme Rainfall Processes	Van-Thanh-Van Nguyen		
08:40	High-Resolution Modelling of Climatic Hazards Relevant for the Canadian Northern Transportation Sector	Laxmi Sushama		
08:55	Evaluating Climate Change Adaptation Policies for Urban Transportation in India	Ashish Verma		
09:10	Evaluation of River Flows and Stages Variability Considering Impacts of Climate Change	Asaad Y. Shamseldin	Poster-13030	
09:10	Centre for Climate Science and Engineering	Daniela A. Bodden	Poster-13030	

	(CSE)			
09:20	Flash flood-traffic interaction studies for the City of Ottawa	Keihan Kouroshnejad		
09:35	The Effects of Climate and Climate Change on Electric Vehicle Charging Demand	I. Daniel Posen		
09:50	Cold temperature limits to biodiesel use under present and future climates in North America	I. Daniel Posen		

Convenors:

Salvatore R. Curasi (Carleton university & Environment and Climate Change Canada),
Elyn R. Humphreys (Carleton university),
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The session invites research related to all anthropogenic methane sources.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:55	Improving the detection accuracy for fugitive methane emissions from petroleum storage tanks	Alex Pletnyov		
13:10	A statistical framework for uncertainty estimation when quantifying methane emissions from Canada's oil and gas sector	Paule Lapeyre		

13:25	METHANE VENTING RELATED TO PETROLEUM WELL INTEGRITY ISSUES IN ALBERTA: CHARACTERISTICS, MAGNITUDES AND IMPACTS	KIRK OSADETZ	
13:40	Methane inventories, but not regulatory submissions, show major variations in methane intensity for Canadian oil and gas producers	Martin Lavoie	Poster-5041
13:40	Spatial variation and magnitude of methane emissions from inactive oil and gas infrastructure in Western Canada	Gilles Perrine	Poster-5041
13:50	Characterization of methane and hydrogen sulfide emissions from oil and gas wells in Ontario	Khalil El Hachem	
14:05	Do underground leaks from abandoned hydrocarbon wells and through shallow aquifers significantly contribute to methane emissions?	Geneviève Bordeleau	
14:20	Differentiating and mitigating methane emissions from natural gas distribution, historic landfills, and manholes in Montréal, Canada	Philip James Williams	

Convenors:

David Sills (Western University)

The majority of Canada’s most costly natural disasters were caused by convective storms. Increasingly, the losses from these storms can reach over a billion dollars. Anthropogenic climate change may significantly alter the probability of such disasters occurring in the future.

This session will be dedicated to the study of severe and extreme convective storms and their associated hazards in Canada and abroad over all seasons. It is therefore open to a wide range of topics from thunderstorm case studies to summer severe weather climatologies, but could also include the influence of climate change on winter snow squalls. The goal of the session is to highlight new insights that improve our physical understanding and detection / prediction capabilities for such events.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:55	Global Perspectives on Hail and Severe Storms	John Allen		
13:25	The Correlation of Radar-Derived Hail Data and Reported Insured Losses in Canada: An Investigation	Caroline Floyd		
13:40	A Study of the Favorable Locations and Patterns of Squall Lines in BC	Quanzhen (Gary) Geng	Poster-7060	
13:50	SEASONAL AND SPATIAL ORGANIZATION OF CHANGES IN HAIL FREQUENCY AND THERMODYNAMIC MECHANISMS WITHIN WRF-HAILCAST SIMULATIONS	Daniel Betancourt		
14:05	Assessing gaps in hail reports in Canada using a lightning proxy	Dominique Brunet		
14:20	Large hail in weakly sheared environments in Alberta	Daniel Brown		

Convenors:

Zhenxia Long, William Perrie
(Bedford Institute of Oceanography)

The Arctic Ocean can be characterized as having a deep basin with several subsurface ridges, and shallow shelf areas. There are neighboring high-latitude seas and waterways with linked passageways and straits. Large-scale climate changes are impacting sea ice, ocean currents, mixing, eddies, Atlantic water, and Pacific water etc. These changes and processes are the focus of recent multidisciplinary measurement programs and numerical modeling simulations. The latter include global programs like the Coupled Modelling Intercomparison Project (CMIP5 and CMIP6), as well as regional efforts using high-resolution ice-ocean simulations. These have investigated climate variability and change on a large range of temporal and spatial scales.

In this session, we welcome presentations based on recent field efforts, for example MOSAIC (the Multidisciplinary drifting Observatory for the Study of Arctic Climate) etc., and also on analysis of the long-term datasets of key environmental factors, like sea ice concentration, thickness, freshwater, nutrients, carbon and ocean acidification. Modeling studies are welcome on CMIP-type models as well as regional high-resolution simulations, in addition to efforts that combine models with observations. Studies that focus on Arctic Ocean processes, linkages to atmosphere dynamics in the Arctic as well as lower latitudes, coupled feedbacks between ice, snow, atmosphere of biogeochemical processes are also encouraged.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:55	Impact of runoff forcing on ocean model simulations in the Pan-Arctic region	Tahya Weiss-Gibbons		
13:10	Response of the upper Arctic Ocean to marine heatwaves for regionally differing ice-ocean regimes	Benjamin Richaud		
13:25	Accelerated sea ice loss along Nares Strait during the summers 2017-2019 leads to an unprecedented ocean surface warming.	Yarisbel Garcia Quintana		
13:40	Decadal simulations of ocean temperature and salinity in the eastern	Zhenxia Long	Poster-12050	

	Beaufort Sea	
13:50	Multiyear evolution of surface roughness and radar backscatter of the Nansen Sound sea ice plug, 2016-2019	Mara Neudert

Convenors:

B. Teufel (McGill University),
L. Sushama (McGill University),
G. Bitsuamlak (Western University),
A. Shamseldin (University of Auckland),
J. Vaze (CSIRO Land and Water) ,
D. Nagesh Kumar (Indian Institute of Science, Bangalore)

Climate change impacts the operation and performance of a wide range of engineering systems, demanding new design approaches, adaptation in management strategies, and new technologies. While engineering systems in Canada's densely populated southerly urban regions have developed into complex interconnected systems, those in the North are less developed and challenges are further compounded by the remoteness and harsh surface and sub-surface climate of the region. Therefore, the challenges that Arctic engineering systems will be subject to will be very different to those of the southern urban regions and need to be addressed uniquely. Multi-scale climate modelling and advanced integrated investigations encompassing interdisciplinary topics are required to develop new sustainable solutions that maximize the performance and co-benefits of climate-ready, and socially acceptable, engineering systems. We invite contributions on all aspects of climate/engineering system interaction studies aimed at climate change adaptation and mitigation, including observational, experimental, and numerical modelling studies, such as:
1) Development of climate change information using conventional and emerging approaches (physical, statistical and machine learning and/or hybrid models) at engineering scales; 2) Multi-scale climate/micro-climate modelling as it relates to engineering systems in different climatic zones (e.g., Urban and Arctic regions); 3) Emerging data-driven methods/frameworks at the engineering-climate interface; 4) Climate change adaptation and mitigation through nature-based solutions, and their feedback on the regional climate system; 5) Land dynamics-engineering coupled studies; 6) Urban climate modelling and urban resiliency studies; 7) Flash flood modelling and mitigation studies in relation to various engineering sectors such as transportation and infrastructure; 8) Coastal flooding and related adaptation/mitigation strategies for coastal infrastructure; and 9) Emerging experimental methods to assess micro-climate-engineering systems interactions.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar

12:55	Meteorologically-driven complementarity between daily renewable energy resources at one location and demand at another	Frédéric Fabry
13:10	An innovative methodology to understand the real cost of climate change on public sector infrastructure	Charles-Antoine Gosselin
13:25	Regional-scale investigation of pile bearing capacity for Canadian permafrost regions in a warmer climate	Amro Faki
13:50	Building-climate interaction modeling for permafrost regions to inform climate-responsive designs in a changing climate	Muna Younis
14:05	Cold energy storage as a solution for year-round renewable artificial ground freezing: Case study of the Giant Mine Remediation Project	Ahmad Zueter
14:20	Climate-resilience of dams and levees: Perspectives from the literature	Md Robiul Islam

Convenors:

Salvatore R. Curasi (Carleton university & Environment and Climate Change Canada),
Elyn R. Humphreys (Carleton university),
Joe R. Melton (Environment and Climate Change Canada)

Climate change impacts the terrestrial carbon cycle with important feedback effects on the global climate system. To best understand how to adapt to current and future climate change, we require skilful projections of the terrestrial carbon cycles response to a warmer climate, increased atmospheric CO2 concentrations, land-use change, disturbances, vegetation change, accelerated nutrient cycling, and other perturbations. We also need to better understand the carbon budgets of critical ecosystems including boreal forests, peatlands, and Arctic ecosystems. Process-based models, inventory-based estimates, atmospheric inversion, remote sensing, and data-driven approaches provide an array of methods each with its own strengths for exploring the terrestrial carbon cycle. This session will showcase research focused on improving our understanding of the Canadian and global terrestrial carbon cycle. The diverse perspectives offered in this session provide insights into how best to represent these complex systems and reduce uncertainties. We encourage submissions that explore the terrestrial carbon cycle with a focus on informing the development of process-based models. We especially encourage studies that utilized the Canadian Land Surface Scheme including Biogeochemical Cycles (CLASSIC). 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.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:55	Impact of seismic lines on peatland plant productivity and carbon exchange	Percy Korsah		
15:10	Modeling soil respiration and its influencing factors for an ongoing peat extraction site	Hongxing He		
15:25	A boreal forest model benchmarking dataset for North America: a case study with the Canadian Land Surface Scheme including Biogeochemical Cycles (CLASSIC)	Bo Qu		
15:40	Better than butter tarts: Benchmarking a Canadian terrestrial ecosystem model with Canadian eddy covariance sites	Joe Melton	Poster-4031	
15:40	Long-term carbon and water cycle variability in Canadian watersheds using coupled MESH-CLASSIC	Daniel Mutton	Poster-4031	

	model			
15:50	Evaluating the performance of the Canadian Land Surface Scheme Including Biogeochemical Cycles (CLASSIC) tailored to the pan-Canadian domain	Salvatore Curasi		
16:05	Combined inventory and model based assessments of the carbon balance of Canada’s managed forests	Werner Kurz		

Convenors:

Dave Risk (St. Francis Xavier University),
Felix Vogel (Environment and Climate Change Canada)

As the second most important anthropogenic greenhouse gas, methane has been a focus of the atmospheric research community for many years. The recent COP26 in Glasgow has moved methane into the spotlight, with over 100 countries signing the Global Methane Pledge aiming at reducing anthropogenic methane by 30% over the coming decade. The Canadian Government also announced an ambitious goal of reducing oil and gas associated methane emissions by 75%.

Science-based information will be crucial in designing effective policies and identifying untapped mitigation potentials. This session intends to bring together experts working on understanding Canada’s anthropogenic methane emissions using cutting-edge atmospheric monitoring techniques, process-studies, modelling, or novel (data-driven) inventory approaches and showcase their results to scientists and policymakers.

Many studies have highlighted the importance of super-emitters, regional and industry-specific differences in emission intensities and the potential for improved monitoring from the provincial to the component scale using novel measurement techniques.

The session invites research related to all anthropogenic methane sources.

Time	***Abstract Title***	Presenter	Poster Order	Add to Calendar
14:55	Aerial mass balance measurements of methane emissions in 11 oil and gas	Hugh Li		

	production regions and 15 facilities in Alberta, Canada	
15:10	Stationary sensing of temporal emissions from natural gas infrastructures using a Back-trajectory Lagrangian Stochastic model	Afshan Khaleghi
15:25	Quantification of anthropogenic methane emissions in four different regions of western Canada	Judith Vogt
15:50	Methane emissions from upstream oil and gas production in Canada are underestimated	David Risk
16:05	Aircraft-based measurements of methane emissions from Canada's offshore oil industry	Katlyn MacKay
16:20	Canada's Methane Emissions from Oil & Gas: Sources of Claimed Emissions Reductions	Scott Seymour

Convenors:

David Sills (Western University)

The majority of Canada's most costly natural disasters were caused by convective storms. Increasingly, the losses from these storms can reach over a billion dollars. Anthropogenic climate change may significantly alter the probability of such disasters occurring in the future.

This session will be dedicated to the study of severe and extreme convective storms and their associated hazards in Canada and abroad over all seasons. It is therefore open to a wide range of topics from thunderstorm case studies to summer severe weather climatologies, but could also include the influence of climate change on winter snow squalls. The goal of the session is to highlight new insights that improve our physical understanding and detection / prediction capabilities for such events.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:55	S-Band Dual-Polarization Radar Evaluation of the Barrie, Ontario Tornado of July 15 2021.	Arnold Ashton		
15:10	Are Significant Tornadoes Occurring Later in the Year in Southern Ontario?	David Sills		
15:25	Updating Canada’s National Tornado Climatology	Francis Lavigne-Theriault		
15:50	Canada’s First and Only F5/EF5 Tornado: Observational and Modelling Analysis	Wang Chun-Chih		
16:05	Exploring the Meteorological Conditions Associated with Classic Type Supercell Thunderstorms - in the Canadian Prairies	Mostofa Kamal		

Convenors:

Kenneth Lee (Fisheries and Oceans Canada) ,
Youyu Lu (Fisheries and Oceans Canada),
Zhi Chen (Concordia University),
Gregory Smith (Environment and Climate Change Canada),
Susan Allen (University of British Columbia),
Haibo Niu (Dalhousie University),
Fraser Davidson (Fisheries and Oceans Canada),
Sophia Johannessen (Fisheries and Oceans Canada),
Feiyue Wang (University of Manitoba)

Marine pollutants such as crude oil and its refined products, plastics and various chemicals pose a significant threat to the health and sustainability of both coastal seas and the open ocean. New scientific knowledge and novel technologies have been developed to assess potential environmental impacts, design management policies and response strategies, and monitor recovery. For example, a five-year (2017-2022) Multi-Partner Research Initiative (MPRI) led by Fisheries and Oceans Canada has supported an international network of researchers to advance science and technology related to marine oil spills.

Research approaches include field sampling, ground truth observations and remote sensing, laboratory and field experiments, and numerical modelling. Besides the significant achievements related to chemical and biological processes, many studies have addressed the influence of ocean-atmosphere dynamic processes (e.g., waves, circulation, sea ice, mixing, winds, temperature and salinity). Data from ocean-atmosphere observations and models are being integrated into advisory and response systems.

Through a combination of contributed and invited presentations, this session aims to bring together national and international researchers: 1) to review the recent achievements from research programs focused on the improvement of our understanding of ocean-atmosphere dynamic processes on marine oil spills and other pollutants; 2) to update the status of integration of ocean-atmosphere data and models into the marine environmental advisory and response systems; and 3) to discuss a roadmap for enhancing collaboration between the marine environmental and ocean-atmosphere communities.

Time	***Abstract Title***	**Presenter**	**Poster Order**	**Add to Calendar**
14:55	The Multi-Partner Research Initiative: A Scientific Research Network to Support Decision Making in Oil Spill Response	Kenneth Lee		
15:10	Developments in ECCC Oil Spill and drift modelling	Paul Pestieau		
15:25	Long-term multi-species consequences of an oil spill in the Salish Sea using an Atlantis model	Raisha Lovindeer		
15:40	Development and testing of an offshore oil spill trajectory modeling tool	Zhaoyang Yang	Poster-12070	
15:50	Ocean feature extraction from Radarsat-2 synthetic aperture radar, with a view to monitoring right whale habitat in the Gulf of St. Lawrence	Rick Danielson		
16:05	Beyond Scenarios: A statistical representation of	Susan Allen		

	oil spills in the Salish Sea	
16:20	Space-time variations of ocean circulation and hydrography in coastal and deep oceans off Canada’s east coast: Analysis and verification of high-resolution model simulations	Youyu Lu

Convenors:

B. Teufel (McGill University),

L. Sushama (McGill University),

G. Bitsuamlak (Western University),

A. Shamseldin (University of Auckland),

J. Vaze (CSIRO Land and Water) ,

D. Nagesh Kumar (Indian Institute of Science, Bangalore)

Climate change impacts the operation and performance of a wide range of engineering systems, demanding new design approaches, adaptation in management strategies, and new technologies. While engineering systems in Canada’s densely populated southerly urban regions have developed into complex interconnected systems, those in the North are less developed and challenges are further compounded by the remoteness and harsh surface and sub-surface climate of the region. Therefore, the challenges that Arctic engineering systems will be subject to will be very different to those of the southern urban regions and need to be addressed uniquely. Multi-scale climate modelling and advanced integrated investigations encompassing interdisciplinary topics are required to develop new sustainable solutions that maximize the performance and co-benefits of climate-ready, and socially acceptable, engineering systems. We invite contributions on all aspects of climate/engineering system interaction studies aimed at climate change adaptation and mitigation, including observational, experimental, and numerical modelling studies, such as:
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Time	*Abstract*	Presenter	Poster	Add to Calendar

	Title	Order
14:55	Physically Based Deep Learning Framework to Model Intense Precipitation Events at Engineering Scales	Bernardo Teufel
15:10	Machine learning framework to aid climate model assessment and improvements	Francisco Andree Ramirez Casas
15:25	Exploring machine learning frameworks to fill the spatial and temporal gaps in satellite-based soil moisture and freeze-thaw data over Canada	Arun Kuttiyanikudiyil Sasidharan
15:50	Super-resolution climate and tailings pond modelling for the Mont-Wright mine	Khalil Hashem
16:05	Nature-Based Solutions for Urban Flood Mitigation: Perspectives on Emerging Techniques	Yeowon Kim
16:20	City-level modelling of the thermal and hydrologic regimes of road network to inform long-term management strategies	Hang YIn

Day 6 – 8 June 2022

Convenors:

Paul Kushner (University of Toronto),
Neil Swart (Environment and Climate Change Canada),
Yanping Li (University of Saskatchewan),
Paul Myers (University of Alberta),
Ivy Tan (McGill University),
Kirsten Zickfeld (Simon Fraser University),

Earth System Models (ESMs) are the principal tools used to understand and attribute past climate changes, to make projections of future climate, and to carry out near-term environmental predictions. The Canadian research community pursues collaborative research with ESMs across many domains, from the perspective of atmosphere/ocean science, cryospheric science, carbon-cycle science, and research related to land surface and hydrological processes. This collaborative research occurs within Canada and internationally, within government and academic settings, and within academic-government partnerships. Whatever the setting, the complexity and technical challenges associated with ESMs can pose barriers to their development, application, and analysis in the absence of formal collaborative structures and advanced technical tools to facilitate their use. New technologies, including machine-learning and novel data-science approaches, advanced version control systems, reproducible runtime environments (containers), community analysis packages, and common computing resources are affording new collaborative opportunities from development to analysis to application.

This session invites the CMOS community to submit papers on Earth System Models and modelling applications taking place in Canada, ranging from model descriptions through to applications and analysis procedures, across many earth-system science domains that are unified by their use of ESMs and could be enhanced by stronger collaborative partnerships. Initiatives of interest include atmospheric/ocean model process and parameterization development, activities in carbon cycle modelling (including climate change mitigation such as atmospheric carbon dioxide removal), land-surface model development and application, and sea-ice/land-ice modelling. We invite submissions focused on the modelling environment within Canada (including CanESM, the UVic ESM, GEM-NEMO, CanRCM, CRCM, etc.) and internationally (including CESM, WRF, CliMA, etc.). We seek to engage in a discussion concerning challenges and opportunities for collaboration between universities, government laboratories, and the private sector; and the scientific results emerging from such collaborations.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
08:25	High-Resolution Regional Climate Modeling and Projection over Western Canada using a Weather Research Forecasting Model with a Pseudo-Global Warming Approach	Yanping Li		
08:40	Sensitivity of sea-ice and AMOC to snow conductivity in NEMO4	Duo Yang		
08:55	Simulating COVID-19: How well do CMIP6 models capture the response of aerosol optical depth to a sudden reduction in emissions?	Ruth Digby		

09:20	Storm-track weakening in response to Arctic sea ice loss arises with ocean coupling	Alexandre Audette		
09:35	A Novel Bias-Correction Method for High-Resolution Regional Climate Model	Zhenhua Li		
09:50	Biogeophysical responses to forest cover change under different climate baselines	Alexander Koch		

Convenors:

Bin Yu (Environment and Climate Change Canada),
Hai Lin (Environment and Climate Change Canada)

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
08:25	Linking Arctic variability and change with extreme winter weather in the US including the Texas Freeze of February 2021	Judah Cohen		
08:55	Interannual variability of the warm Arctic-cold North American pattern	Bin Yu		
09:20	Stratosphere-Troposphere Coupling Leading to Extended Seasonal Predictability of Summer North Atlantic Oscillation and Boreal Climate	Lei Wang		
09:35	Role of Diurnal Cycle in the Maritime Continent Barrier Effect on MJO Propagation in an AGCM	Ajaya Mohan Ravindran		

Convenors:

Jinyu Sheng (Dalhousie University) ,
Guoqi Han (Institute of Ocean Sciences),

Dan (Shiliang) Shan (Royal Military College of Canada)

This session will focus on all aspects of monitoring and modelling of 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. We also invite contributions related to both observational and modelling aspects of biogeochemistry in coastal and inland waters.

We expect that papers submitted to this session will be in two main types. The first type will focus on improving our limited knowledge of physical and biogeochemical conditions over coastal and inland waters in the past and present climate. The second type will focus on predictions and examinations of changes and extremes in marine conditions over coastal and inland waters, including the Canadian Arctic waters, due to the climate change.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
08:25	Response of the Gulf of St. Lawrence circulation to atmospheric forcing in the operational Canadian coastal ice-ocean prediction system	Gregory Smith		
08:55	Circulation and Inflow within Emerald and LeHave Basins and surrounding areas on the Scotian Shelf	Michael Casey		
09:10	Trends in Coastal Upwelling on the Scotian Shelf over the Past Two Decades	Shiliang Shan	Poster-12060	
09:20	Hydrodynamics and sediment transport in the submarine canyons of Pointe-des-Monts	Khouloud Baccara		
09:35	Numerical Study of Topographic Effects on Wind-driven Coastal Upwelling on the Scotian Shelf	Shiliang Shan		
09:50	Improving extreme sea level estimates along the Pacific coast of Canada	Jing Lu		

Convenors:

Markus Schnorbus (PCIC, University of Victoria),
Charles Curry (PCIC, University of Victoria)

Applied science is the process of using knowledge derived from the scientific method to attain practical goals. It often generates new knowledge that is best suited for a specific, user-driven purpose. Applied climate science, specifically, aims to identify the physical variables in the Earth system that are the drivers of climate impacts, and quantify their changes, providing stakeholders and decision makers with the information they need to develop plans for reducing the risks associated with climate change. However, the conceptual framework for studying the impacts of climate change provides a unique set of constraints that can defy easy interpretation of climate risk. Namely, (1) the future trajectory of climate is unknowable; hence the process is a scenario-driven exercise that spans a range of possible futures; (2) the future climate along a given scenario is uncertain, particularly for far-future projections; and (3) due to points (1) and (2), a model ensemble-based approach is often used, which can generate massive amounts of data that span a wide range of outcomes. These are challenges that many stakeholders are unaccustomed to dealing with.

In this session, we invite abstracts that demonstrate the use of applied research that directly addresses climate change adaptation or mitigation requirements. We are particularly interested in presentations that discuss novel methodology to deal with real-world problems, explore approaches to reducing apparent uncertainty in future climate projections and the resultant impacts, and/or address the challenges associated with communicating and interpreting climate change impact data and results. We welcome presentations from all areas of Earth system science touching on century-scale climate change.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
08:25	A narrative approach to building computational capacity for climate change impact assessment in professional graduate students	Conor Anderson		
08:55	Climate model projections for Canada: A comparison of CMIP5 and CMIP6	Stephen Sobie		
09:20	Selecting a representative climate model subset considering both model spread and central tendency	Charles Curry		
09:35	Communicating Change in Peak Flow Design Values using Temperature Scaling	Markus Schnorbus		
09:50	Warming water temperature in the coastal rivers of British Columbia due to climate change	Md. Shahabul Alam		

Convenors:

Gordon McBean (Western University)

In 2021, the number of climate-related disastrous events rose again with floods, fires, extreme winds, hail and others. In 2021, the Report on Building Climate Resilient Communities (McBean et al) was completed and result presented at CMOS 2021. The Council of Canadian Academies report on Disaster Resilience in a Changing Climate will be released early in 2022. This session will bring together the expertise and wisdom of these and other reports and the analysis of recent events to provide an overall review and synthesis of strategies and the most effective approaches - for Science Serving Societies to become more resilient. The session will include presentations across the disciplines and the weather-climate-governance-societal-health issues that will most effectively motivate actions and lead to action by all levels of governance and by individuals to become resilient and reduce the impacts of climate-related extremes.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
08:25	Integration of disaster risk and climate adaption as key driver to enhance disaster resilience in Canada.	Scott Vaughan		
08:55	Building Infrastructure Resilience to Address the Climate Emergency	John Stone		
09:20	Indigenous-led nature-based solutions for climate crisis: Insights from Canada	Brennan Vogel		
09:35	Maximizing place-based potential: translating interdisciplinary knowledge into climate change action in Gros Morne National Park enclave communities	Camille Ouellet Dallaire		
09:50	Understanding and Responding to Changing Sea Ice and Weather Conditions in Northern Communities	Armel Castellan		

Convenors:

Paul Kushner (University of Toronto),
Neil Swart (Environment and Climate Change Canada),
Yanping Li (University of Saskatchewan),
Paul Myers (University of Alberta),
Ivy Tan (McGill University),
Kirsten Zickfeld (Simon Fraser University),

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Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:55	Linking cumulative carbon emissions with observable climate impacts	Claude-Michel Nzotungicimpaye		
13:10	The implications of Earth system feedbacks from using reforestation to stabilize the climate in net-zero pathways	Alexander MacIsaac		
13:25	Discussion Period	Discussion		

Convenors:

Bin Yu (Environment and Climate Change Canada),
Hai Lin (Environment and Climate Change Canada)

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
12:55	Enhanced jet stream waviness induced by suppressed tropical Pacific convection during boreal summer	qinghua ding		
13:25	Origin of the warm Arctic – cold North American pattern on the intraseasonal time scale	Hai Lin		

13:50	Large-scale atmospheric and marine features connected to interannual and interdecadal fog variability in Atlantic Canada	Patrick Duplessis		
14:05	The North Pacific Blob acts to increase the predictability of the Atlantic Warm Pool	Yusen Liu		

Convenors:

Jinyu Sheng (Dalhousie University) ,
Guoqi Han (Institute of Ocean Sciences),
Dan (Shiliang) Shan (Royal Military College of Canada)

This session will focus on all aspects of monitoring and modelling of 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. We also invite contributions related to both observational and modelling aspects of biogeochemistry in coastal and inland waters.

We expect that papers submitted to this session will be in two main types. The first type will focus on improving our limited knowledge of physical and biogeochemical conditions over coastal and inland waters in the past and present climate. The second type will focus on predictions and examinations of changes and extremes in marine conditions over coastal and inland waters, including the Canadian Arctic waters, due to the climate change.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:55	Interactions between Surface Waves, Tides and Storm-Induced Currents over Shelf Waters of the Northwest Atlantic during Hurricane Earl	Shangfei Lin		
13:25	Numerical Study of Circulation, Hydrography and Dissolved Oxygen Concentration over the Scotian Shelf Using a Nested-grid Coupled Circulation-oxygen Model	Qiantong Pei		
13:50	Overview of the changes to the Canadian Water Cycle Prediction System v3.1.0	Frederic Dupont		
14:05	Where terrestrial carbon goes when it mixes with coastal waters	Celine Gueguen		
14:20	A framework for estimating river tides and estuarine discharges from the SWOT satellite mission	Pascal Matte		

Convenors:

Elaine Barrow (Environment and Climate Change Canada),
Carrington Pomeroy (Environment and Climate Change Canada),
Louis-Philippe Caron (Ouranos),
Lindsay Matthews (Environment and Climate Change Canada),
Trevor Murdock (Environment and Climate Change Canada)

Climate services help form a two-way bridge between climate science and real-world decision-making, opening the door for communication between all parties. The distribution of reliable and usable climate information and guidance is crucial to the identification and anticipation of climate impacts, vulnerability and risk. However, this information is not always “one size fits all” and tailored information is often required. In order to ensure the usefulness of the climate information and its uptake by stakeholders, the communication between climate scientists, service providers and practitioners must flow smoothly.

Although climate services have greatly improved in terms of coverage, availability and accessibility, barriers associated with developing and tailoring information remain. The goal of this session is to encourage those in the climate field to share their experiences in creating robust, tailored climate information, and guidance, for delivery to practitioners.

Relevant topics for this session could include:
- Climate information development
- User needs engagement and analysis
- Deployment of platforms providing climate information
- Co-production of datasets and tools with practitioners
- Translation of technical climate information into a usable format
- Examples of successful application of climate information

Time	***Abstract Title***	**Presenter**	**Poster Order**	**Add to Calendar**
12:55	Climate services promise better decisions but mainly focus on better data	Kieran Findlater		
13:25	Developing tailored climate information for various audiences with varied needs	Dominique Paquin		
13:40	Building Resilient Communities with Confidence: The Risk and Return on Investment Tool	Christine Zimmer	Poster-13070	
13:50	The role of climate services in connecting practitioners and scientists: an example using IDF curves	Maginda Magendrathajan		
14:05	Application of Climate Information to assess the impacts of climate change on Ontario's municipal and provincial infrastructure	Kenneth Kin Cheung Chow		

	budgets			
14:20	Applying a Multi-Factor Vulnerability Approach to the Development of the City of Calgary's Community Climate Risk Index	Christina Schwantes		

Convenors:

Gordon McBean (Western University)

In 2021, the number of climate-related disastrous events rose again with floods, fires, extreme winds, hail and others. In 2021, the Report on Building Climate Resilient Communities (McBean et al) was completed and result presented at CMOS 2021. The Council of Canadian Academies report on Disaster Resilience in a Changing Climate will be released early in 2022. This session will bring together the expertise and wisdom of these and other reports and the analysis of recent events to provide an overall review and synthesis of strategies and the most effective approaches - for Science Serving Societies to become more resilient. The session will include presentations across the disciplines and the weather-climate-governance-societal-health issues that will most effectively motivate actions and lead to action by all levels of governance and by individuals to become resilient and reduce the impacts of climate-related extremes.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
12:55	Resilience in Recovery: Achieving transformative improvement in climate resilience following major loss events	Paul Kovacs		
13:25	Flood emergency response and preparedness in New Brunswick – an empirical study on the spring floods in 2019	Sebastian Weissenberger		
13:50	Building Resilient Communities KSG Report - Synthesis	Gordon McBean		
14:05	Designing a vulnerability indicator for climate change impacts in coastal communities in Senegal and Benin	Émilie Gauthier		
14:20	The Water-Energy-Food (WEF) Nexus: a Potential Framework for using Earth Science and Observations to Benefit Society	Richard Lawford		

Convenors:

Erkan Gün (University of Toronto),
Russell N. Pysklywec (University of Toronto),
Claire Currie (University of Alberta)

This session aims to explore broadly aspects of the tectonics of the Earth—looking at aspects of the structure and evolution of the Earth's lithosphere and mantle. As the outermost solid layer of the planet, the lithosphere is a structurally and compositionally complex region that experiences a range of tectonic behaviours from large-scale plate motions to intraplate deformation to local plate boundary tectonics. The mantle is the thermal engine of the planet, transporting heat from the deep interior to the surface through processes of convection and conduction in high-pressure mineral/rock environments. The dynamics and the nature of these regions are studied with a variety of observational, experimental, and numerical tools, in a host of tectonic settings and on a variety of length- and time-scales. In this cross-disciplinary session, we welcome contributions from fields of research that investigate these mantle and lithosphere dynamics, and surface tectonics.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
13:50	Reconstructing the southern North Atlantic Ocean back through time using deformable plate tectonic models	Michael King		
14:05	Seismic evidence for crustal thickening controlling aseismic deformation at the Beaufort Sea continental margin	Clément Estève		
14:20	Surface expressions of lithospheric delamination	Tai-Chieh Yu		

Convenors:

Erkan Gün (University of Toronto),
Russell N. Pysklywec (University of Toronto),
Claire Currie (University of Alberta)

This session aims to explore broadly aspects of the tectonics of the Earth—looking at aspects of the structure and evolution of the Earth's lithosphere and mantle. As the outermost solid layer of the planet, the lithosphere is a structurally and compositionally complex region that experiences a range of tectonic behaviours from large-scale plate motions to intraplate deformation to local plate boundary tectonics. The mantle is the thermal engine of the planet, transporting heat from the deep interior to the surface through processes of convection and conduction in high-pressure mineral/rock environments. The dynamics and the nature of these regions are studied with a variety of observational, experimental, and numerical tools, in a host of tectonic settings and on a variety of length- and time-scales. In this cross-disciplinary session, we welcome contributions from fields of research that investigate these mantle and lithosphere dynamics, and surface tectonics.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar

14:55	Fundamental differences between lithosphere drips in 2D and 3D	David Quiroga		
15:10	Generating exact solutions for 2D thermochemical mantle convection models	Sean Trim		
15:25	"It's not the heat, it's the humidity": The impact of planetary climate on tectonic regime stability in numerical mantle convection models	Rob McGrory		
15:50	Stranding of continental crustal fragments during continental break-up: mantle suture reactivation in the Nain province of Eastern Canada	Phil Heron		
16:05	Slab-Pull vs. Plate Flexure: Syn-Drift Extension of Oceanic Plateaus	Erkan Gün		
16:20	The influence of deep lithosphere dynamics on crustal deformation in the Central Andes: Insights from 2D numerical models	Zhihong Pan		

Convenors:

Bin Yu (Environment and Climate Change Canada),
Hai Lin (Environment and Climate Change Canada)

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
14:55	The Canadian Seasonal to Interannual Prediction System Version 2.1 (CanSIPSv2.1)	Ryan Muncaster		
15:25	Impact of improved land initialization of ECCC's seasonal prediction system on the skill of summer 2021 forecast	Gulilat T. Diro		
15:50	Influences of atmospheric blocking on North American winter cold spells and summer	Dae Jeong		

	heatwaves in a changing climate: CanESM2 and CanESM5 large ensembles			
16:05	Seasonal Predictability of Regional and Pan-Antarctic Sea Ice Extent with the Canadian Seasonal to Interannual Prediction System V2	Robert Payne		

Convenors:

Jinyu Sheng (Dalhousie University) ,
Guoqi Han (Institute of Ocean Sciences),
Dan (Shiliang) Shan (Royal Military College of Canada)

This session will focus on all aspects of monitoring and modelling of 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. We also invite contributions related to both observational and modelling aspects of biogeochemistry in coastal and inland waters.

We expect that papers submitted to this session will be in two main types. The first type will focus on improving our limited knowledge of physical and biogeochemical conditions over coastal and inland waters in the past and present climate. The second type will focus on predictions and examinations of changes and extremes in marine conditions over coastal and inland waters, including the Canadian Arctic waters, due to the climate change.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:55	Seasonal and interannual variations in the shelf circulation off the west coast of Canada	Guoqi Han		
15:25	Characterizing extremes in temperature, ocean acidification, and deoxygenation along the Canadian North Pacific continental margin	Amber Holdsworth		
15:50	Future Climate Simulations for the Salish Sea Using a High Resolution Ocean Model with Biogeochemistry	Natasha Ridenour		
16:05	The Southern expansion of the La Grande river plume	Christopher Peck		
16:20	Influence of seasonal freshwater dynamics on nutrient distributions in the region of freshwater influence of the La Grande River, northeastern James Bay.	Alessia Guzzi		

Convenors:

Elaine Barrow (Environment and Climate Change Canada),
Carrington Pomeroy (Environment and Climate Change Canada),
Louis-Philippe Caron (Ouranos),
Lindsay Matthews (Environment and Climate Change Canada),
Trevor Murdock (Environment and Climate Change Canada)

Climate services help form a two-way bridge between climate science and real-world decision-making, opening the door for communication between all parties. The distribution of reliable and usable climate information and guidance is crucial to the identification and anticipation of climate impacts, vulnerability and risk. However, this information is not always “one size fits all” and tailored information is often required. In order to ensure the usefulness of the climate information and its uptake by stakeholders, the communication between climate scientists, service providers and practitioners must flow smoothly.

Although climate services have greatly improved in terms of coverage, availability and accessibility, barriers associated with developing and tailoring information remain. The goal of this session is to encourage those in the climate field to share their experiences in creating robust, tailored climate information, and guidance, for delivery to practitioners.

Relevant topics for this session could include:
- Climate information development
- User needs engagement and analysis
- Deployment of platforms providing climate information
- Co-production of datasets and tools with practitioners
- Translation of technical climate information into a usable format
- Examples of successful application of climate information

Time	***Abstract Title***	**Presenter**	**Poster Order**	**Add to Calendar**
14:55	Heat Stress Indices - Estimating historical and projected values of Humidex-based indices	Kenneth Kin Cheung Chow		
15:10	Application of Future Weather Files in Building Performance Simulation	Pouriya Jafarpur		
15:25	Using Ensemble Weather Forecast and Climate Data to Study Over-Heating and Over-Shadowing in Canadian Urban Fabric	Mojtaba Samimi		
15:50	Delivering user-relevant projections of future fire weather for Canada	Laura Van Vliet		
16:05	Worth the Risk? How Large Outdoor Event Attendees Obtain, Perceive, and Respond	Kyle Woods		

	to Severe Thunderstorm Information in a Southwestern Ontario County			
16:20	Tool support and User Engagement: Lessons Learned from the Climate Change Vulnerability Assessment Tool for Drinking Water Source Quality	Deborah Balika		

Convenors:

Gordon McBean (Western University)

In 2021, the number of climate-related disastrous events rose again with floods, fires, extreme winds, hail and others. In 2021, the Report on Building Climate Resilient Communities (McBean et al) was completed and result presented at CMOS 2021. The Council of Canadian Academies report on Disaster Resilience in a Changing Climate will be released early in 2022. This session will bring together the expertise and wisdom of these and other reports and the analysis of recent events to provide an overall review and synthesis of strategies and the most effective approaches - for Science Serving Societies to become more resilient. The session will include presentations across the disciplines and the weather-climate-governance-societal-health issues that will most effectively motivate actions and lead to action by all levels of governance and by individuals to become resilient and reduce the impacts of climate-related extremes.

Time	*Abstract Title*	Presenter	Poster Order	Add to Calendar
14:55	Canada’s Net Zero challenge: Concerned citizens making impact	Charles Lin		
15:10	Building Climate Resilient Communities – International Dimensions	Gordon McBean		

Plenary Speakers

June 1, 2022, 08:30-09:30 CST

Dr. Amanda H. Lynch, Lindemann Distinguished Professor

Institute at Brown for Environment and Society

Department of Earth, Environmental and Planetary Sciences

Brown University

Sea Ice Retreat and Navigation: Implications from Climate Scenarios for Arctic Geopolitics

In the context of retreating sea ice, the Northern Sea Route (NSR) is thought to present an attractive alternative to the longer Suez Canal route for global trade, despite ongoing issues of satellite navigation coverage, emergency response, expenses associated with Polar Code compliance, and more. This already complex context is likely to be impacted by the recent invasion by Russia into Ukraine, with the accompanying widespread condemnation and the imposition of sanctions on Russian goods and services. Indeed, it is possible that Russia will close the NSR for strategic reasons. CMIP6 scenarios are characterized by uncertainties associated with emissions pathway and model performance, but provide a source of rich and detailed information on the timing and distribution of navigable seas. Here we elucidate their potential to provide insights into sea ice retreat and its implications for economic, regulatory and geopolitical friction in this system.

Biography: Amanda Lynch, Lindeman Distinguished Professor of Earth, Environmental and Planetary Sciences at Brown University, obtained her Ph.D. in Atmospheric Science from the University of Melbourne. Amanda developed the first Arctic regional climate system model in 1993, won the Priestly Medal in 2008, and is a Fellow of the American Meteorological Society, the Australian Academy of Technological Sciences and Engineering, the Norwegian Scientific Academy for Polar Research, and the World Academy of Art and Science. She was President of the American Society of Policy Scientists, and founding director of the Institute at Brown for Environment and Society. Her research focuses on the intersection between atmospheric science and environmental governance, with particular interest in the Arctic as a place that expresses convergences of rapid change in natural and human systems. At present, Amanda Lynch is chair of the Research Board at the World Meteorological Organization.

June 2, 2022, 10:30-11:30 CST

Integrated Canadian Science Addressing Global Agenda 2030

Moderator: Gordon McBean, Professor Emeritus, Western University

Speakers:

G. Brunet, Chief Scientist, Australian Bureau of Meteorology, Chair, WMO Scientific Advisory Panel;

E. Ubalijoro, Future Earth Global Hub Director, Canada;

M. Jean, President, WMO Commission for Observation, Infrastructure and Information Systems;

K. Dodds, Chair, MEOPAR Board, former ADM, S&T, Environment Canada

Global Agenda 2030 - Sustainable Development Goals, Climate Change, Disaster Risk Reduction, Oceans and related issues – addresses important and complex intersecting issues with a wide range of scientific issues. There are global programs (WCRP, WWRP, Future Earth, IRDR – Integrated Research on Disaster Risk, and UHWB – Urban Health and Well Being) and coordination of infrastructure on global observational, prediction and data exchange programs. This session will have presentations on and discussions of nationally coordinated scientific programs and their contributions to the related assessment processes (IPCC, IPBES, etc…) and how the Canadian science community can more effectively work together, addressing these policy issues and bring together science, globally and across the disciplines, to have Canada as a leader.

June 3, 2022, 10:30-11:30 CST

The Woo Distinguished Lecture in Hydrology

Dr. Michelle Walvoord

U.S. Geological Survey

Earth System Processes Division

Observing and Modeling the Expansion of Lateral Talik Development in Permafrost Landscapes

The spatial footprint of supra-permafrost taliks in Arctic and boreal regions is growing in response to gradual surface warming and superimposed punctuated disturbance, such as wildfire and flooding. Talik formation and expansion can substantially influence geomorphic, hydrologic, and biogeochemical processes in permafrost landscapes, thus motivating efforts to understand current distribution and provide constraints on future evolution at local to pan-Arctic scales. Discerning the presence and movement of water (or lack thereof) and determining lateral connectivity in these actively thawing zones are critical, yet challenging elements to characterize, particularly at large scales. These characteristics affect water and biogeochemical cycling and the potential for lateral groundwater transport of dissolved constituents, including organic carbon, released from permafrost. This presentation highlights recent geophysical characterization and modeling efforts aimed at constraining current and projected talik distribution. Field investigations show localized examples of rapid talik development that outpace current coarse scale talik projections by ~ 100 years even under the most extreme greenhouse gas emission scenario. Coupled field and cryohydrogeologic modeling investigations allow for exploration into complex and interrelated factors that influence thaw rate, susceptibility, and hydrologic impact. Presented examples provide context for discussing broad implications of talik development on groundwater flow paths and fluxes in high-latitude geologic settings that include upland, lowland, and coastal systems.

Biography: Dr. Michelle Walvoord is a research hydrologist with the United States Geological Survey's Earth System Processes Division in Denver, Colorado. She holds a B.A. from Hamilton College and M.S. and Ph.D. degrees in Earth Sciences from New Mexico Tech. Dr. Walvoord's expertise in non-isothermal, multiphase subsurface flow and transport has led to a variety of hydrogeological studies at sites stretching from the desert southwestern US to boreal Alaska. Among these, a common tie is toward understanding hydrologic response to climate and disturbance. Her research relies on a blend of field, statistical, and process-based modeling approaches and typically intersects with multiple disciplines including biogeochemistry, ecology, and geophysics. Dr. Walvoord currently serves as an Associate Editor for Water Resources Research and as a board member for the US Permafrost Association. She is an adjunct faculty member at Colorado School of Mines, Université Laval, and University of Colorado, Boulder.

June 6, 2022, 10:30-11:30 CST

Dr. Debra Wunch

Department of Physics and School of the Environment

University of Toronto.

Using atmospheric measurements to examine the Earth's carbon cycle

The Earth's carbon cycle describes the flow of carbon between the land, oceans and atmosphere. Measurements of the atmosphere are key to understanding these flows: they constrain the sources and sinks of carbon dioxide and methane and help determine the impacts of increasing fossil fuel emissions into our atmosphere. In this talk, I will describe some of the ongoing work that uses satellite and ground-based measurements of the Earth's atmosphere to quantify global and local sources and sinks of carbon dioxide and methane.

Biography: Dr. Debra Wunch is an Assistant Professor at the University of Toronto, cross-appointed between the Department of Physics and the School of the Environment. Her research focuses on making precise and accurate atmospheric measurements and using these measurements to improve understanding of the carbon cycle, including the role of urban regions and boreal forests.

June 7, 2022, 10:30-11:30 CST

Dr. Karen E Kohfeld, Simon Fraser University

Evidence-based approaches to understanding blue carbon dynamics on the Pacific Coast of Canada

Karen E Kohfeld[1,2], Marlow G Pellatt[3,1], Hasini Basnayake[1], and Stephen Chastain[1]

[1]School of Resource and Environmental Management, Simon Fraser University, Burnaby, BC. Coast Salish Territories, xʷməθkʷəy̓əm (Musqueam), Skwxwú7mesh (Squamish) & səl̓ilwətaʔɬ (Tsleil-Waututh)

[2]School of Environmental Science, Simon Fraser University, Burnaby, BC. Coast Salish Territories, xʷməθkʷəy̓əm (Musqueam), Skwxwú7mesh (Squamish) & səl̓ilwətaʔɬ (Tsleil-Waututh)

[3]Parks Canada, Office of the Chief Ecosystem Scientist, Vancouver, BC.

Vegetated coastal ecosystems have been proposed as possible nature-based climate solutions (NBCS) because of their potential to sequester significant amounts of “blue carbon” while also providing co-benefits for biodiversity and shoreline protection. Global assessments frequently use broad generalizations to estimate the global potential of blue carbon. However, incorporating blue carbon as a NBCS requires detailed understanding of regionally-specific processes governing blue carbon storage. Our research goal is to understand controls on salt marsh and eelgrass ecosystems on the Pacific Coast of Canada focussing on the Pacific Rim and Gulf Islands National Park Reserves, and urban salt marshes near Vancouver, Canada. Through field, laboratory, and remote sensing efforts, we have documented areal extent, C stocks, C accumulation rates, and how these have changed through time. Our work indicates that C stocks and C accumulation rates in eelgrass systems along the Pacific coast are 10 times lower than the global averages. In Pacific coast salt marshes, C stocks are lower than global averages, but C accumulation rates are comparable to other areas of the Pacific coast of North America and eastern Canada. These results imply that salt marsh and eelgrass ecosystems exhibit highly regional carbon dynamics, making broad generalizations challenging, both globally and within Canada. Even within each system, carbon dynamics can be highly variable, and characterization of each system requires careful sampling to capture this variability. Importantly, our knowledge of the areal extent of these ecosystems remains poor, with global datasets overestimating Pacific salt marsh area by factors of 2 to 5. Our future work aims to provide a holistic understanding of the carbon budgets of these marshes, through estimation of greenhouse gas emissions and better quantification of in-situ and ex-situ carbon contributions. Ultimately, implementation of blue carbon as a NBCS requires understanding the physical processes influencing long-term carbon sequestration.

Biography: Dr. Karen Kohfeld is professor and former Tier-2 Canada Research Chair in Climate, Resources, and Global Change in the School of Resource and Environmental Management and the School of Environmental Science at Simon Fraser University. Internationally, Karen is known for her work on past climates and the global carbon cycle, specifically using of global datasets to understand the roles of atmospheric dust, ocean productivity, and ocean circulation in modulating long-term changes in climate and the global carbon cycle. In 2006, Karen formed the Climate, Oceans, and Paleo- Environments (COPE) laboratory at Simon Fraser University where she also focuses on regional changes in climate and the carbon cycle. Through collaborations with Metro Vancouver, Fisheries and Oceans Canada, and Parks Canada, she involves students in research on changes in ocean acidification, past climate and fire behavior in western Canada, and understanding carbon storage dynamics in coastal wetlands and lacustrine environments. A 2022 recipient of an honorary Ph.D. degree from Stockholm University, Dr. Kohfeld currently serves on the External Advisory Group for the Bolin Centre for Climate Research at Stockholm University and as a member of the Canadian Council of Academies' Panel on Canada's Carbon Sink Potential.

June 8, 2022, 10:30-11:30 CST

Sonia I. Seneviratne

ETH Zurich, Zurich, Switzerland

Science serving society: The way forward

How do we ensure that science can play its role in a state of climate crisis?

I will highlight four main avenues to achieve this aim:

- First, by tirelessly repeating the established scientific facts. In a world in which fake news is a daily grind, truth needs to be reinstated. Key facts from IPCC reports need to be repeated until they sink in, namely that a) the current global warming is without precedent in more than 100,000 years; b) the burning of fossil fuels is the main source of present-day CO_2 emissions; c) that emissions need to be halved by 2030 and reach zero before mid-century; and d) that solutions exist.

- Second, science is needed more than ever as we push the climate outside the realms of past variability. Remaining uncertainty is not something that can soothe our concerns. To the contrary, climate models are found to be very linear in their behavior and may not capture tipping elements. Some examples are found in the representation of the carbon cycle and drought-vegetation feedbacks.

Furthermore, impact science is only starting now to unravel the implications of compound extreme events for society.

- Third, a transdisciplinary revolution is needed. We should reach out beyond our comfort zone to design pathways for the needed transition phase. None of us has all answers to this crisis: natural and physical scientists should work with social scientists, engineers, lawyers, and artists to design resilient solutions and new narratives that can allow us to overcome inertia.

- Fourth, we have a duty to lead by example. Can we ensure that climate conferences will be organized from now on in hybrid form, so that travel and its resulting CO_2 footprint can be minimized? And how do we make our research institutions halve their emissions in less than eight years and become CO_2 neutral shortly thereafter?

This presentation will provide examples and suggestions for how to advance on these fronts. This is no small challenge, but one we must and can take on!

Biography: Sonia Seneviratne is Professor at the Institute for Atmospheric and Climate Science at ETH Zurich since 2007. She studied environmental physics and biology at ETH Zurich and the University of Lausanne. She was awarded her PhD thesis in 2003 at ETH Zurich and was a Postdoctoral scientist at NASA/Goddard Space Flight Center in 2003-2004. Her research addresses climate change and extreme events, land-climate interactions, and terrestrial water processes. She has served as a Coordinating Lead Author and Lead Author on several IPCC reports, including the *IPCC Special Report on Extreme events* (SREX, 2012), the *IPCC Special Report on 1.5°C Global warming* (2018), and the *IPCC 6th Assessment report* (2021), on which she was a coordinating lead author of the weather and climate extremes chapter.

Sonia Seneviratne is one of the most cited scientists in her field (https://recognition.webofscience.com/awards/highly-cited/2021/). She has received several awards for her research, including a Consolidator Grant from the European Research Council (2014), the Macelwane Medal from the American Geophysical Union (2013), and the Hans Oeschger Medal from the European Geosciences Union (2021: https://www.egu.eu/news/701/egu-announces-its-2021-awards-and-medals/).

Special Sessions

Day 1 Wednesday, June 1 10:15am - 10:30am EDT

Opening Ceremony

Convenor: Francis Zwiers, chair of the Scientific Program Committee

Welcome message and opening remarks from CMOS, CGU, and ESC.

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Day 1 (11:45 - 12:45 CST) and Day 2 (10:30 - 12:45 CST) – June1 and 2, 2022

Young Hydrologist's workshop - Hands on hydrology: exploring methods and techniques

Day 1: Young Hydrologist's Workshop - From Failure to Progress: Lessons Learned in Hydrology

Day 2: Young Hydrologist's Workshop - Hands on Hydrology: Exploring Methods and Techniques

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Day 2 (11:45 - 12:45 CST) – June 2, 2022

Natural Science and Engineering Research Council (NSERC) staff will be holding an information session to provide an update on what is new at NSERC.

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Day 6 Wednesday, June 8 (4:45pm - 5:00pm CST)

Closing Ceremony

Thank You

Thursday

June 2, 2022

4 pm - 5:30pm PDT
5 pm - 6:30pm CST
7 pm - 8:30pm EDT
8 pm - 9:30pm ADT

Bridging knowledge systems: Scientific and Inuit knowledge of the ocean and sea ice

Speaker: Dr. Eric Oliver, Ph.D.
Dalhousie University

Le jeudi

2 juin 2022

16h - 17h30 HAP
17h - 18h30 HNC
19h - 20h30 HAE
20h - 21h30 HAA

Rapprocher les systèmes de connaissances : Connaissances scientifiques et inuites de l’océan et de la glace de mer

Conférencier: Eric Oliver, Ph.D.
L’Université Dalhousie

PUBLIC LECTURE

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

Date: Thursday, June 2, 2022

Time: 17:00 – 18:30 CST (19:00 - 20:30 EDT, 20:00 - 21:30 ADT)

The Public Speaker: Dr. Eric Oliver, Dalhousie University

Bridging knowledge systems: Scientific and Inuit knowledge of the ocean and sea ice

Science and Inuit both have ways of knowing with a rich understanding of climate, the ocean and sea ice. These understandings are distinct and independent, yet complementary. Is it possible to bridge these two knowledge systems so as to inform each from the other? Is it even desirable? As a Labrador Inuk working in the scientific field of oceanography, I have spent the four years exploring these questions. While they cannot be answered simply, I will provide my perspective and experience working at the interface between scientific and Inuit knowledge of the ocean. My research team and collaborators in the Nunatsiavut Government and in Inuit communities in the region have been undertaking a number of related project and activities along these lines. Inuit knowledge of the coastal ocean and sea ice is being documented using participatory mapping and interview methods. We are developing ways recording Inuit observations of the environment, rooted in and referencing local traditional knowledge and focusing on that which Inuit consider important and of value. Scientific measurements of coastal ocean temperature, salinity, and ocean currents are being made through community-based monitoring programmes with representation in most communities in Nunatsiavut who are providing their expertise in choosing locations, times, and methods of accessing field sites. Finally, we are developing numerical ocean models for the region with Inuit Knowledge providing both ground-truths against which we can validate the model as well as informing hypothesis and model experiments. We have also been exploring the role that land-based activities, including research workshops, can play in this process. We are encouraged by the points of contact between science and Inuit knowledge that have emerged – such as maps, conceptual models, hypotheses – and that these can play the role of boundary objects to facilitate dialogue between these two knowledge systems.

Biography: Dr. Eric Oliver is an Assistant Professor of Physical Oceanography in the Department of Oceanography, Dalhousie University, Halifax, Nova Scotia, Canada. His research interests involve ocean and climate variability across a range of time and space scales including extreme events, the predictability of climate variations, the influence of modes of variability on the ocean, and the role of climate change on the mean state, variability and extremes of the climate system. He is of Inuit descent with roots in Nunatsiavut (northern Labrador) and is interested in Indigenous perspectives on climate, weather and oceans and understanding both Indigenous and scientific knowledge of these systems.

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CONFÉRENCE PUBLIQUE

L'évènement est gratuit, et aucune pré-inscription n'est requise.

Date: le jeudi 2 juin 2022

Heure: 17h00 – 18h30 HNC (19h00 - 20h30 HAE, 20h00 - 21h30 HAA)

Orateur : Eric Oliver, Ph. D., l'Université Dalhousie

Rapprocher les systèmes de connaissances: Connaissances scientifiques et inuites de l'océan et de la glace de mer

La science et les Inuits ont tous deux des modes de connaissance avec une riche compréhension du climat, de l'océan et de la glace de mer. Ces connaissances sont distinctes et indépendantes, mais complémentaires. Est-il possible de jeter un pont entre ces deux systèmes de connaissances afin de les informer l'un de l'autre ? Est-ce même souhaitable ? En tant qu'Inuk du Labrador travaillant dans le domaine scientifique de l'océanographie, j'ai passé les quatre dernières années à explorer ces questions. Bien qu'il soit impossible d'y répondre simplement, je vais vous faire part de mon point de vue et de mon expérience de travail à l'interface entre les connaissances scientifiques et inuites de l'océan. Mon équipe de recherche et mes collaborateurs du gouvernement du Nunatsiavut et des communautés inuites de la région ont entrepris un certain nombre de projets et d'activités connexes dans ce domaine. Les connaissances des Inuits sur l'océan côtier et la glace de mer sont documentées à l'aide de méthodes de cartographie et d'entretiens participatifs. Nous développons des moyens d'enregistrer les observations inuites de l'environnement, en nous appuyant sur les connaissances traditionnelles locales et en nous concentrant sur ce que les Inuits considèrent comme important et de valeur. Les mesures scientifiques de la température de l'océan côtier, de la salinité et des courants océaniques sont effectuées par le biais de programmes de surveillance communautaires. La plupart des communautés du Nunatsiavut sont représentées et apportent leur expertise dans le choix des lieux, des horaires et des méthodes d'accès aux sites de terrain. Enfin, nous développons des modèles numériques d'océan pour la région, les connaissances inuites fournissant à la fois des vérités de terrain par rapport auxquelles nous pouvons valider le modèle et des informations sur les hypothèses et les expériences de modèle. Nous avons également exploré le rôle que les activités terrestres, notamment les ateliers de recherche, peuvent jouer dans ce processus. Nous sommes encouragés par les points de contact entre la science et le savoir inuit qui ont émergé - comme les cartes, les modèles conceptuels, les hypothèses - et par le fait que ceux-ci peuvent jouer le rôle d'objets limites pour faciliter le dialogue entre ces deux systèmes de connaissances.

Biographie: Eric Oliver est professeur assistant d'océanographie physique dans le département de l'océanographie, de l'Université Dalhousie, Halifax, en Nouvelle-Écosse, Canada. Ses recherches participent à la variabilité océanique et climatique dans une gamme de temps et d'échelles spatiales, notamment des événements extrêmes, la prévisibilité des variations climatiques, l'influence des modes de variabilité sur l'océan et le rôle du changement climatique sur l'état moyen, la variabilité et les extrêmes du système climatique. Il est d'une descente inuite avec des racines à Nunatsiavut (Nord de Labrador) et s'intéresse aux perspectives autochtones sur le climat, la météo et les océans et la compréhension des connaissances autochtones et scientifiques de ces systèmes.

Session: 2010 Air Quality General Session Séance générale - La qualité de l'air **01/06/2022 09:55**

ID: 11602 Contributed abstract

Poster Order:

Satellite-derived Ammonia Observations: Improvements and Applications

Sean Ford [1] , *Mark Shephard* [2] , *Evan White* [3] , *Enrico Dammers* [4] , *Karen Cady-Pereira* [5] , *Shailesh Kharol* [6] , *Evan Chow* [7] , *David Tobin* [8] , *Greg Quinn* [9] , *Jason O'Brien* [10] , *Jesse Bash* [11]

[1] Environment and Climate Change Canada
[2] Environment and Climate Change Canada
[3] Environment and Climate Change Canada
[4] Netherlands Organization for Applied Scientific Research
[5] Atmospheric and Environmental Research
[6] AtmoAnalytics Inc.
[7] University of Waterloo
[8] Space Science and Engineering Center
[9] Space Science and Engineering Center
[10] Environment and Climate Change Canada
[11] US Environmental Protection Agency

Presented by / Présenté par: ***Sean Ford***
Contact: Sean.Ford@ec.gc.ca

The CrIS Fast Physical Retrieval ammonia product (CFPR) utilizes the Cross-track Infrared Sounder (CrIS) instrument aboard both Suomi NPP and NOAA-20 satellites to provide global ammonia measurements from May 2012. Satellite retrievals of ammonia are being continually improved to provide valuable information on the spatial and temporal variations of the short-lived boundary layer ammonia, and supplementing observations from traditional in-situ observations. One recent algorithm update is the ability to account for conditions that are below the detection limit of the sensor. Previously, pixels with an ammonia signal below the detection limit of the sensor were skipped, which can create a high bias in averaged values in regions without large continuous sources of ammonia. Accounting for non-detects provides better representative gridded and averaged values in more background non-continuous source regions, where non-detects can comprise 60% of the values with a relative reduction of 70% in the surface small concentration (<1 ppbv) values. In addition to the implementation of non-detects, details on the comparison and inclusion of data from the second CrIS on NOAA-20 satellite with the first CrIS on SNPP are provided, with the goal of continuing the CFPR ammonia dataset from May 2021 into the future. Also presented are applications of the CFPR retrievals such as satellite-derived ammonia emission estimates on a "county"-level scale across Canada and around the world.

Session: 2010 Air Quality General Session Séance générale - La qualité de l'air **01/06/2022 09:55**

ID: 11602 Contributed abstract

Poster Order:

Satellite-derived Ammonia Observations: Improvements and Applications

Sean Ford [1] , *Mark Shephard* [2] , *Evan White* [3] , *Enrico Dammers* [4] , *Karen Cady-Pereira* [5] , *Shailesh Kharol* [6] , *Evan Chow* [7] , *David Tobin* [8] , *Greg Quinn* [9] , *Jason O'Brien* [10] , *Jesse Bash* [11]

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Presented by / Présenté par: ***Sean Ford***
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The CrIS Fast Physical Retrieval ammonia product (CFPR) utilizes the Cross-track Infrared Sounder (CrIS) instrument aboard both Suomi NPP and NOAA-20 satellites to provide global ammonia measurements from May 2012. Satellite retrievals of ammonia are being continually improved to provide valuable information on the spatial and temporal variations of the short-lived boundary layer ammonia, and supplementing observations from traditional in-situ observations. One recent algorithm update is the ability to account for conditions that are below the detection limit of the sensor. Previously, pixels with an ammonia signal below the detection limit of the sensor were skipped, which can create a high bias in averaged values in regions without large continuous sources of ammonia. Accounting for non-detects provides better representative gridded and averaged values in more background non-continuous source regions, where non-detects can comprise 60% of the values with a relative reduction of 70% in the surface small concentration (<1 ppbv) values. In addition to the implementation of non-detects, details on the comparison and inclusion of data from the second CrIS on NOAA-20 satellite with the first CrIS on SNPP are provided, with the goal of continuing the CFPR ammonia dataset from May 2021 into the future. Also presented are applications of the CFPR retrievals such as satellite-derived ammonia emission estimates on a “county”-level scale across Canada and around the world.

Session: 2010 Air Quality General Session Séance générale - La qualité de l’air **01/06/2022 10:25**

ID: 11758 Contributed abstract

Poster Order:

Three-dimensional regional model simulation of dry and wet deposition fluxes of inorganic mercury species in the springtime Arctic

Kenjiro Toyota [1] , *Andrei Ryzhkov* [2] , *Ashu Dastoor* [3] , *Jack Chen* [4] , *Craig Stroud* [5] , *Alexandru Lupu* [6] , *Junhua Zhang* [7] , *Verica Savic-Jovcic* [8] , *Qiong Zheng* [9] , *Michael Moran* [10] , *Ralf Staebler* [11] , *Alexandra Steffen* [12]

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Presented by / Présenté par: ***Kenjiro Toyota***
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Gas-phase bromine radical chemistry is the main driver for the frequent and concurrent depletion of ozone and mercury in the polar boundary layer during the spring. Snow on sea ice and coastal snow cover are the key elements in the production of reactive bromine in the polar spring. Within Environment and Climate Change Canada's air quality model, GEM-MACH, we have developed a process-oriented representation of atmospheric chemistry and a semi-empirical parameterization of snowpack chemistry to simulate the coupled bromine-ozone-mercury chemistry in the atmospheric boundary layer and the underlying snow surface. The model is run at 15-km resolution in a limited-area domain of the Arctic and is capable of capturing the evolution of high BrO column densities associated with synoptic weather disturbances measured from satellite and from the surface. Gaseous elemental mercury is oxidized via bromine chemistry and then undergoes rapid dry and wet deposition. Together with the inflow from rivers surrounding the Arctic Ocean, the atmospheric deposition contributes substantially to the input of mercury to the marine ecosystem in the high Arctic. However, a notable fraction of deposited oxidized mercury is subject to re-volatilization to the atmosphere after photochemical reduction within the snowpack. The representation of wet scavenging processes involving solid and mixed-phase clouds and aerodynamic mass transfer associated with dry deposition over sea ice with sub-grid scale open leads also poses a challenge for the model-based assessment of mercury fluxes. Using observational data from two Arctic sites (Utqiagvik, Alaska and Alert, Nunavut) for surface-air oxidized mercury concentrations, micrometeorological momentum and sensible heat fluxes and snowfall mercury concentrations, we discuss the strength and limitation of our revised model representation of processes unique to the Arctic environment for simulating the dry and wet deposition of gaseous and particulate oxidized mercury species.

ID: 11678 Contributed abstract

Poster Order:

Satellite Monitoring for Temperature-Based Prediction of Springtime Ammonia from Agricultural Practices

Andrew Kovachik [1] , *Olga Bashalkhanova* [2] , *Mark Shephard* [3] , *Enrico Dammers* [4] , *Roy Wichink Kruit* [5] , *Xinrui Ge* [6]

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Presented by / Présenté par: ***Andrew Kovachik***
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Satellite observations have great potential for monitoring emissions and concentrations of atmospheric species. This is especially true for atmospheric ammonia (NH_3), which varies greatly in space and time and is difficult to measure with in-situ instruments due to its sticky nature. Measurements of ammonia are important as it is a significant contributor to the secondary production of aerosols (PM2.5) and can add excessive reactive nitrogen to the environment. In a previous investigation we examined the capability to predict ammonia concentrations based on farming practices and found that these closely align with ground based measurements and atmospheric measurements from Cross-Track Infrared Sounder (CrIS) satellite data. In this study we have adapted the previous method to provide the potential to make predictions in any region. As the collection of data on farming practices is a difficult process that changes with each region of interest, it is not feasible on a larger scale. However, as farming practices are largely associated with the start of growing seasons, we found that similar predictions of springtime ammonia exist from historical data and the cumulative temperature to the given time of year.

Session: 2010 Air Quality General Session Séance générale - La qualité de l'air **01/06/2022 11:05**

ID: 11773 Contributed abstract

Poster Order:

Cloud Base Height Correlation between a Co-located Micro-Pulse Lidar and a CHM15k Lufft Ceilometer

Victoria Pinnegar [1] , *Paul Christiaans* [2] , *Joe Clarke* [3] , *Alexander Haefele* [4] , *Ellsworth J. Welton* [5] , *Robert Sica* [6]

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Presented by / Présenté par: ***Victoria Pinnegar***

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MPLCAN is a network of Micro-Pulse Lidars (MPLs) across Canadian sites in Eureka NU, Halifax NS, London ON, Toronto ON and Sherbrooke QC. MPLCAN is part of NASA's global MPLNET. The MPLs have the ability to detect clouds, aerosols and the planetary boundary layer, as well as to differentiate between water and ice in clouds via polarization measurements. The London (Ontario) MPL site operates a Lufft CHM15k ceilometer, which is part of the European Meteorological Network's E-PROFILE project. E-PROFILE makes available measurements from over 280 stations. Common to both MPLNET and E-PROFILE is the determination of the base height of clouds.

Cloud Base height is a data product which in principle should be the same for each instruments, despite the MPL transmitter wavelength at 532 nm as compared to the ceilometer's 1.064 nm wavelength..Using the MPLNET data product compared to the Lufft for the first year of operation (Jan 2021-Dec 2021), the monthly correlation coefficient between cloud base heights varies between 0.78 and 0.95. Below 1 km altitude, the comparison is poor, in part due to aerosol layers and in part due to uncertainties in the instruments' overlap functions. Above this altitude the comparisons are generally good. The overall agreement is improved by using the MPL's ability to detect aerosols using polarization to mask out layers misidentified as aerosols or clouds by the ceilometer. To further improve the comparison an algorithm based on MPLNET's Version 2 Cloud Base product was written and applied to both datasets. It accurately represents low level clouds (<5 km) , and for optically thick clouds when compared to the initial results. However, it is less effective when signal to noise gets too low, as is typical for cirrus clouds. The impact of these results on interpreting lidar cloud base heights will be discussed.

Session: 5020 Canada's renewed weather radar network Le réseau renouvelé de radars météorologiques du Canada **01/06/2022 09:55**

ID: 11549 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] , *Sorin Pinzariu* [6] , *Todd Benko* [7] , *Michael Romaniuk* [8] , *Hamid Nasr* [9] , *Rick Czepita* [10] , *Alvin Au Duong* [11] , *Miguel DeVera* [12]

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Presented by / Présenté par: ***Qian Li***
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The Canadian Weather Radar Replacement Program (CWRRP) is entering into the final years of the project phase. The pandemic continued to add challenges and complexities to the project. In particular, for radars located in high population centres such Toronto, Ottawa, Edmonton, Vancouver, and Halifax, which draw significant public attention. Despite the COVID-19 challenge, the CWRRP team worked with the vendor and other enablers and successfully replaced 7 radars: King City ON, Frankton ON, Gore NS, Aldergrove BC, Cold Lake AB, Britt ON and Carvel AB. By the end of the year, 26 new S-Band radars were completed across the country spanning from the west coast to eastern Newfoundland.

To mitigate radar coverage gaps during the construction period, many factors were considered, including significant schedule adjustments, severe weather exceptions, and high resolution modelling approach. The team also worked with scientists and data processing team to test and implement a 400km long-range scan strategy. This extended coverage from surrounding radars provides some high elevation data as a gap filler for our meteorologists to gain upstream information of weather systems and overlapping coverage of the area of concern during the radar outage period.

The project remains on schedule for the delivery of at least 6 radars in 2022, and continues to be within our budget parameters.

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 discussion.

Session: 5020 Canada's renewed weather radar network Le réseau renouvelé de radars météorologiques du Canada **01/06/2022 10:10**

ID: 11703 Contributed abstract

Poster Order:

Improving the Canadian S-band weather radar scan strategy

Daniel Michelson [1] , *Lubna Bitar* [2] , *Norman Donaldson* [3] , *Stephen Holden* [4] , *Qian Li* [5] , *Janti Reid* [6]

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Presented by / Présenté par: ***Daniel Michelson***
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The Canadian weather radar network is undergoing a generational renewal, with the replacement of legacy C-band radars with new S-band systems. 2022-

23 is the final season, and will see the deployment of the last seven radars in the network. With radar renewal come many significant changes, one of which is the way the radars are configured to collect basic data: the so-called scan strategy.

The new Canadian weather radar scan strategy, called PVOL6S, attempts to balance legacy requirements with increased quantitative application of the data. Seventeen sweeps of data at and above 0.4° are acquired in top-down order every six minutes, containing dual-polarization, Doppler and conventional moments. As of 2020, there is a mountain version with a lowest sweep of -0.3° and a few other tweaks. During 2021, a long-range sweep at 0.3° out to 400 km was introduced on several radars, with the intent to cover gaps introduced while some sites were being replaced. This contingency measure has proven to be very popular among severe weather forecasters, despite several weaknesses.

ECCC continues to devote significant effort to improving the quality of basic acquired data and balancing goals of different users. User feedback has helped us prioritize improvements to specific issues like coverage, clutter suppression, second-trip echoes, radio frequency interference, and data dropouts. We have addressed several potential revisions to PVOL6S aimed at introducing overall improvement. These include:
• Adjustments to elevation angles
• Extending coverage to 330 km with the same timing and data quality as with PVOL6S
• Replicating the 0.4° sweep every three minutes, with options for removing other sweeps to stay within the six-minute acquisition period
• Signal processing changes aimed at improving data quality, e.g. reducing second-trip echoes

These potential revisions will be presented, with the goal of soliciting feedback from users of the data and products.

Session: 5020 Canada’s renewed weather radar network Le réseau renouvelé de radars météorologiques du Canada **01/06/2022 10:25**

ID: 11752 Contributed abstract

Poster Order:

An Update of Operational Radar Processing Improvements under the Canadian Weather Radar Replacement Program

Janti Reid [1] , *Sudesh Boodoo* [2] , *Norman Donaldson* [3] , *David Hudak* [4] , *Emma Hung* [5] , *Ahmed Mahidjiba* [6] , *Daniel Michelson* [7] , *Wendy Yuen* [8]

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Presented by / Présenté par: ***Janti Reid***
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In the next year, Environment and Climate Change Canada's (ECCC) Meteorological Service of Canada (MSC) will be poised to complete the revitalization of Canada's radar infrastructure. This will be achieved through the replacement of MSC's existing C-band Doppler radar network with 32 new dual-polarization (DP) S-band radars as part of the Canadian Weather Radar Replacement Program (CWRRP). One of the key goals of the CWRRP project is to modernize operational radar processing applications to ensure the continuity of ECCC radar products using data acquired by these new radar systems. This past year, work has continued to introduce and enhance radar algorithms and products using new dual polarization parameters and science. These include DP quantitative estimations for snow, a surface precipitation type product (which will be available to public), and a number of radar data and product quality improvements. The latter includes the introduction of differential reflectivity (ZDR) bias corrections, addressing gaps left by ground clutter removal, and enhancements to melting layer determination as used by the DP particle classification algorithm. The provision of new and improved products has benefitted internal ECCC forecast offices and recently DP quantitative precipitation estimation (DP QPE) products have been successfully tested and evaluated for assimilation into operational precipitation analysis products. The Government of Canada's website (Weather Office) and mobile app (WeatherCAN) platforms, as well as many other external and private users, have also benefitted from these enhancements. An overview of these improvements to ECCC operational radar processing will be presented.

Session: 5020 Canada's renewed weather radar network Le réseau renouvelé de radars météorologiques du Canada **01/06/2022 10:50**

ID: 11628 Contributed abstract

Poster Order:

Polarimetric radar observations of the 2021 Mascouche Québec EF2 tornadic event

Sudesh Boodoo [1], *Norman Donaldson* [2], *Daniel Michelson* [3], *David Sills* [4], *Julian Brimelow* [5]

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Presented by / Présenté par: ***Sudesh Boodoo***
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In the afternoon of June 21, 2021, a series of severe thunderstorms developed over southern Quebec. The storms formed as part of a frontal boundary ahead of a cold front. A storm cell just north of Montreal, produced an EF2 tornado over Mascouche, causing significant damage and one fatality. There were reports of three additional tornadoes in the surrounding areas. Northern Tornadoes Project (NTP) performed damage surveys and confirmed the location and observation time of the Mascouche EF2. Estimated wind speed was in excess of 180 km/h, damage track length of about 7.0 km, with approximately 250 m path width. Observations from Environment and Climate Change Canada's (ECCC) Blainville S-band radar shows the cell developing

rapidly, and the tornado produced from it was within 20 km of the radar. Hook reflectivity signature was clearly visible; however, well-defined rotation was not as evident. Low-level velocity signatures of rotation were contaminated by non-meteorological targets; however velocity couplets were better defined in the upper scans. Dual-polarization measurements shows the presence of a ZDR arc and nearby KDP footprints in areas of heavy precipitation in several radar scans. A tornadic debris ball signature was also evident in the polarimetric measurements, and the hydrometeor classes were consistent with expectations for the thunderstorm cell. The presentation will additionally describe some of the vertical features exhibited in the supercell, for example regions of updrafts as indicated by ZDR and KDP columns, and the tornadic cell ranking by operational software compared to storm cells nearby under the radar coverage will also be discussed.

Session: 5020 Canada's renewed weather radar network Le réseau renouvelé de radars météorologiques du Canada **01/06/2022 11:05**

ID: 11623 Contributed abstract

Poster Order:

Evaluation of WRF Microphysics Schemes during Atmospheric River Events using Polarimetric Radar Data

Anthony Di Stefano [1] , *Gregory West* [2] , *Philip H. Austin* [3] , *Brenda Dolan* [4] , *Toshihisa Matsui* [5] , *Henryk Modzelewski* [6] , *Roland Stull* [7]

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Presented by / Présenté par: ***Anthony Di Stefano***
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Bulk microphysical parameterizations (BMPs) are ideal for representing clouds, hydrometeors and precipitation in numerical weather prediction (NWP) models at low computational expense. Despite their wide application, BMPs are limited by knowledge gaps of various microphysical processes, uncertainties in empirically-derived process equations, and challenges in observing the evolutions of different hydrometeors across space and time. One pathway to optimizing BMPs is to validate them for different locations, weather regimes and forecast horizons using a robust observational dataset.

Polarimetric radars across southern Canada and the United States provide a reliable means of observing clouds and hydrometeors. Moreover, the recent emergence of comprehensive radar simulators, such as the Polarimetric Radar Retrieval and Instrument Simulator (POLARRIS), allows NWP modelers to directly verify BMPs against polarimetric radar observations. These provide a unique opportunity to compare polarimetric radars to other observation sources, and to identify deficiencies in BMPs that contribute uncertainty in NWP models.

The Weather Research and Forecasting (WRF) model is run with five BMP configurations to simulate two atmospheric river events. The first was observed

during the OLYMPEX project in Washington state, USA, on 3-4 December 2015. The second was observed over southwestern British Columbia (BC), Canada, on 14-15 November 2021, and led to the costliest flooding in BC history. Each BMP is then verified against polarimetric radar data from nearby radar stations (KLGX and OLYMPEX-NPOL for the first case, and CASAG and KATX for the second case) using POLARRIS. This new approach to BMP evaluation allows users to study the spatiotemporal performance of BMPs and further improve the representation of clouds, hydrometeors and precipitation in NWP models.

Session: 5020 Canada's renewed weather radar network Le réseau renouvelé de radars météorologiques du Canada **01/06/2022 11:20**

ID: 11493 Contributed abstract

Poster Order:

Dual-polarization radar data at vertical incidence, and what it teaches us

Frederic Fabry [1] , *Veronique Meunier* [2]

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Presented by / Présenté par: ***Frederic Fabry***
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For the past few years, McGill has operated one of its X-band vertically pointing radars (VertiX) in dual-polarization mode. Like the Canadian radars, the dual-polarization VertiX simultaneously transmits and receives signals at two orthogonal channels, except of course that the traditional "horizontal" and "vertical" polarization naming convention makes little sense at vertical incidence. As such, differential reflectivity data are not very interesting except for biological echoes, but very precise measurement of copolar correlation coefficients are being made in precipitation. Furthermore, VertiXDP can also make spectral measurements of correlation in parallel to the more usual spectral measurements of echo power. These are used to get new insights on microphysical phenomena such as the melting layer, the growth of snow,, and the refreezing of ice pellets, providing useful context for understanding their signature in scanning radars.
VertiXDP can also transmit signals in one channel and receive them in orthogonal channels, but we have not found that data to be particularly interesting or of good enough quality to get insightful Ldr measurements.

Session: 7020 BC Extreme Events I: Atmospheric Rivers and Associated impacts - Part 1 Événements extrêmes de la Colombie-Britannique I: Rivières atmosphériques et les impacts associés - Partie 1 **01/06/2022 09:55**

ID: 11385 Contributed abstract

Poster Order:

Climate change, atmospheric rivers and the November 14/15 2021 Pacific Northwest extreme rainfall event

Kent Moore [1]

1

Presented by / Présenté par: ***Kent Moore***
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In mid-November 2021, an extreme rainfall event severely impacted all aspects of society throughout southern British Columbia and northern Washington State. The event was associated with an atmospheric river, a filamentary region of enhanced water vapour transport, and it has been suggested that climate change contributed to extreme nature of the event. Here we show that the observed monthly mean November rainfall in the region has also increased by over 40% since the late 1930s. In addition, the event's precipitation exceeded the 99th percentile for November and that over the past 70 years, this threshold has increased by over 30%. We furthermore show that this increase has been associated with northward shift as well as a more perpendicular orientation at landfall of the atmospheric rivers associated with extreme events that allows for a more direct route for moisture to reach southern British Columbia. Climate models suggest that there will an intensification of these atmospheric rivers this century that will be associated with more intense rainfall in southern British Columbia. The results presented suggest that we are already dealing with this consequence of a changing climate.

Session: 7020 BC Extreme Events I: Atmospheric Rivers and Associated impacts - Part 1 Événements extrêmes de la Colombie-Britannique I: Rivières atmosphériques et les impacts associés - Partie 1 **01/06/2022 10:25**

ID: 11462 Contributed abstract

Poster Order:

Water management at BC Hydro generation facilities during the November 2021 atmospheric river events

Tim Ashman [1], *Helen Hamilton Harding* [2], *Georg Jost* [3], *Wolf Read* [4], *Frank Weber* [5], *Greg West* [6]

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Presented by / Présenté par: ***Tim Ashman***
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The atmospheric river events of November 2021 brought challenging water management conditions to BC Hydro's hydroelectric generation facilities in southwestern British Columbia. The November 14-15 event produced extreme inflows and required timely flood routing operations to manage reservoir levels and downstream river flows. Examples will be given of how water was stored in reservoirs and released during the event and to what extent system operations were able to mitigate downstream flows above flood thresholds. These operational plans were informed by hydroclimatic observations, and weather and inflow forecasts leading up to and during the event. A high-level look at hydroclimatic monitoring challenges during extreme precipitation events, the

weather and inflow forecasts, the general messaging, and shortcomings in the forecasts will be presented here along with lessons learned. The extent to which snowmelt at mid- and high-elevations contributed to inflows will also be discussed. The November 14-15 event also impacted BC Hydro’s transmission, distribution, and logistics, requiring the activation of a corporate level emergency coordination centre. This elevated level of coordination continued during the subsequent atmospheric river events later in the month.

Session: 7020 BC Extreme Events I: Atmospheric Rivers and Associated impacts - Part 1 Événements extrêmes de la Colombie-Britannique I: Rivières atmosphériques et les impacts associés - Partie 1 **01/06/2022 10:50**

ID: 11568 Contributed abstract

Poster Order:

A&P in Action: Involvement of the Analysis and Prognosis section with respect to the November, 2021 Atmospheric River event over southwestern British Columbia

Alissa Steeves [1] , *Dragana Kornic* [2] , *Amin Erfani* [3] , *Jeff Miller* [4] , *Jean-Philippe Morin* [5] , *Alex Donaldson* [6]

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Presented by / Présenté par: ***Alissa Steeves***
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Atmospheric rivers, characterized by heavy moisture transport, can create extreme rainfall upon confronting a mountain barrier, causing potentially catastrophic impact on infrastructure and lives. The Analysis and Prognosis (A&P) section of the National Prediction Operations Division at the Canadian Centre for Meteorological and Environmental Prediction (CCMEP) is responsible for monitoring meteorological phenomena at the synoptic scale with the goal of serving their Environment and Climate Change Canada (ECCC) clients and other federal departments as part of its mandate. A&P is also the authority for the National Meteorological and Environmental Forecasting System (NMEFS) performance verification for the Canadian models. Here we will cover critical A&P activities in the days leading up to the catastrophic November 13-15 Atmospheric River event that affected southwestern British Columbia, and will present some of the key findings from A&P in its subjective verification of Canadian weather model performance with respect to forecast lead time, precipitation amounts, and precipitation distribution.

Session: 7020 BC Extreme Events I: Atmospheric Rivers and Associated impacts - Part 1 Événements extrêmes de la Colombie-Britannique I: Rivières atmosphériques et les impacts associés - Partie 1 **01/06/2022 11:05**

ID: 11730 Contributed abstract

Poster Order:

Antecedent Conditions and Impacts from the Atmospheric Rivers Over Southwestern British Columbia in November 2021

Baljit (Bobby) Sekhon [1] , *Giselle Bramwell* [2]

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Presented by / Présenté par: ***Baljit (Bobby) Sekhon***
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The flooding and landslides that occurred over southwestern British Columbia in mid-November 2021 were catastrophic and life-changing. This was not a standalone event; rather it was months in the making. Multiple atmospheric river (AR) events occurred on the coast in the fall of 2021. November saw approximately seven ARs including the strongest one from November 13-15, 2021 followed by three consecutive ARs at the end of November. ARs are challenging to forecast and the impacts that might occur even more so. The mid-November AR aligned in such a way that copious precipitation fell in 48 hours. This heavy precipitation combined with snowmelt from rising freezing levels and wet antecedent conditions contributed to catastrophic flooding and landslides. Lives were lost on the highways from bridge collapses, landslides and washouts. Livestock was lost due to the vast flooding in the Sumas Prairie and Abbotsford in the Fraser Valley. Some farms will be recovering from damaged crops for several years. The economic impact was severe too. The South Coast was cut off by road and rail from the rest of Canada, crippling the supply chain between these regions for months and weeks. Agricultural and personal property losses were well over 100 million dollars. Meteorologists worked extremely closely with emergency management personnel around the clock to try and prevent further losses and keep those crews safe who were trying to rescue and repair. This historic and devastating event brought to light the value of having close working relationships with clients and partners to have a coordinated response to a catastrophic event.

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ID: 11791 Contributed abstract

Poster Order:

ECAR - A Multivariate Atmospheric River Scale for Canada

Melinda M Brugman [1] , *Ruping Mo* [2] , *Matthias Jakob* [3] , *Alex Cannon* [4] , *Ashlee Jollymore* [5] , *Jonathan Boyd* [6] , *Juris Almonte* [7] , *Ka Hing Yau* [8] , *Phillip Jarrett* [9] , *Anthony Liu* [10] , *Roxanne Vingarzan* [11] , *Armel Castellan* [12]

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Atmospheric Rivers worldwide are responsible for a disproportionate amount of flood damage. This realization has led to focused research efforts on various aspects of these phenomena. Environment and Climate Change Canada is collaborating with others to develop a 5-level ECAR scale that combines predicted Integrated Vapour Transport, various storm (Extratropical Cyclone) characteristics and predicted streamflow by return periods. To separate the worst storms possible, the highest level in the tool is expanded into three more levels for experts to separately identify 1:1000 (1/k) year storms, and greater estimated maximums determined from historical data and climate warming projections. ECAR ratings include AR, Storm RP, Weighted and MaxIDF versions. The weighted multi-variate scale is linked to specific expected first-order hydroclimatic responses such as river flooding, debris flooding, debris flows, bank erosion, channel avulsions and landsliding. In addition, the system includes qualitative and quantitative second-order consequences associated with each category including the area affected by an AR, the likely population size affected, economic losses, number of potential fatalities, recovery time and ecological consequences. A prototype system has been developed. It is currently being calibrated by historic ARs in which the relevant hydroclimatic variables are compared to the documented damages of those storms. This new Canadian ECAR storm rating scale has shown promise for experimental alerting of recent AR storms affecting British Columbia, including the catastrophic November 13-16, 2021 event. This multi-hazard ECAR rating tool prototype for atmospheric rivers addresses the need in Canada for identifying the worst expected storms based on impacts now and in the future

Session: 9010 General Hydrology - Part 1 Hydrologie générale - Partie 1 **01/06/2022 09:55**

ID: 11603 Contributed abstract

Poster Order:

The drying of the Arctic and future changes: a case study from the Western Canadian Arctic

Brampton Dakin [1] , *David Rudolph* [2] , *Philip Marsh* [3] , *Fereidoun Reza Nezhad* [4]

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Presented by / Présenté par: ***Brampton Dakin***
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The summer of 2021 in Inuvik, NWT was warm and dry with the 7th warmest summer and driest July recorded to date (Environment and Climate Change Canada). This presented a unique opportunity to study the drying phenomena of Arctic ecosystems and what this could mean for the thawing of Arctic permafrost. Field data was collected from May 25th to August 29th at Siksik Creek, a sub-catchment of Trail Valley Creek, located 50km north-east of Inuvik, NWT. These data were along 15 transects measured on a weekly basis. These transects covered the entirety of the watershed and crossed a variety of terrain and vegetation types. The data collected included: frost table depths; water table depths; and stratigraphy and soil thicknesses across mineral earth hummocks and their inter-hummock zones that are typical of this region. In addition to analyzing the 2021 field data, we will use the GEOtop permafrost hydrology model to explore the processes controlling frost table depths over the summer. GEOtop is a physically based model designed to handle micro topographies, such as the hummocks that are ubiquitous in Siksik Creek. Specifically, we are: using the 2021 field data to validate GEOtop, and once validated to simulate frost table depths as well as end of summer thaw depths under these dry and warm conditions. In particular we will consider how the movement of water impacts thaw depths in these landscapes. This is pertinent within the discussion of the drying of the arctic and how changing hydrological conditions impact this.

Session: 9010 General Hydrology - Part 1 Hydrologie générale - Partie 1 **01/06/2022 10:10**

ID: 11789 Contributed abstract

Poster Order:

Why are Perched Basins in the Peace-Athabasca Delta in Northwestern Canada Drying? Revisiting the Water Balance

Daniel Peters [1] , *Donald Baird* [2] , *Spyros Beltaos* [3] , *Barrie Bonsal* [4] , *Yonas Dibike* [5] , *Wendy Monk* [6] , *Rajesh Shrestha* [7]

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Presented by / Présenté par: ***Daniel Peters***
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The Peace-Athabasca Delta (PAD) is a freshwater deltaic ecosystem formed at the confluence of the Peace, Athabasca and Birch rivers with Lake Athabasca in northwestern Canada. The biologically and culturally rich delta is a Ramsar Convention wetland site of international importance, and is located within the Wood Buffalo National Park (WBNP) listed as a UNESCO World Heritage Site. The deltaic floodplains contain >1000 lake and wetland basins with varying connectivity to the main flow system. Influenced by a semi-arid climate (evapotranspiration > precipitation), ponded water is influenced by and in many cases is dependent on periodic recharge via ice-jam and open-water flood events.

The PAD ecosystem is influenced by local and upstream pressures from flow regulation (eg, hydroelectric dams), water and land use (eg, oil sands mining) and climate change. In response to Indigenous Peoples' concerns regarding cumulative effects on the PAD ecosystem and the broad ecosystem services the delta provides, the WBNP World Heritage Action Plan was developed to address a suite of UNESCO World Heritage Committee recommendations to ensure the maintenance of Outstanding Universal Values of the Park. A key recommendation from this report is to conduct environmental flows assessments, to the highest international standard, in order to identify water flows needed to sustain the ecological functioning of the PAD under current and projected development and climate change.

An important first endeavour in addressing the ecological functioning of the PAD is to address the question “Why are perched basins in the PAD drying? The goal of this presentation is thus threefold: i) Revisit the water balance modelling of perched basins under various historical hydroclimatic scenarios, ii) Revisit water surface extent obtained via remote sensing methods, and iii) combine these two approaches to arrive at an enhanced understanding of spatio-temporal changes in perched basin hydrology that influences aquatic habitat.

Session: 9010 General Hydrology - Part 1 Hydrologie générale - Partie 1 **01/06/2022 10:25**

ID: 11336 Contributed abstract

Poster Order:

Effect of regulation on peak open-water flows: lower Peace River, Canada

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Presented by / Présenté par: ***Spyros Beltaos***
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Downstream impacts of large hydropower dams are not as well understood as upstream impacts, especially in areas situated at long distances from a dam. Naturalization of the flow hydrograph is an important step in assessment of ecological and socioeconomic impacts of regulation. Using reservoir inflows, a recently developed, lagged-flow naturalization method is applied to the lower portion of the regulated Peace River, which forms the northern boundary of the Peace-Athabasca Delta (PAD). The PAD is a Ramsar wetland of international importance that depends on overbank flooding for recharge of its high-elevation, or “perched” basins. Such flooding can be caused by ice jams during the spring breakup of the ice cover or by exceptionally high runoff during open-water flow conditions. Herein, the focus is on the latter type of event and the resulting recharge of basins located within the Peace Sector of the PAD. Flooding potential is indexed by the peak value of the lower Peace River flow hydrograph and assessed for both regulated and naturalized open-water flow conditions during the period 1972-2016. The results indicate that regulation has reduced open-water peaks by about 4200 m3/s on average, while severely limiting the possibility of overbank flooding from the Peace River throughout the examined time interval. Consistent with earlier findings on spring breakup flows, naturalized open-water peaks do not exhibit a temporal trend. Future work will

examine naturalized values of additional flow-related indices that are also important to the ecological sustenance of PAD basins.

Session: 9010 General Hydrology - Part 1 Hydrologie générale - Partie 1 **01/06/2022 10:40**

ID: 11432 Contributed abstract

Poster Order: Poster-9010

Estimating soil moisture storage using a Geological Weighing Lysimeter

Morgan Braaten [1] , *Andrew Ireson* [2]

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Presented by / Présenté par: ***Morgan Braaten***

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Soil moisture plays a crucial role in the exchange and partitioning of water and energy fluxes at the land surface. Representative measurements of soil moisture are needed to characterize hydrological processes, and to calibrate and constrain weather and climate predictions. Agriculture practices also rely heavily on accurate measurement of soil moisture storage for crop health and vegetation productivity. However, accurately measuring soil moisture proves difficult as it varies spatially, as a function of heterogeneity of the land-surface, and temporally, as a function of dynamic drivers of precipitation, melt and evapotranspiration. Traditional point-scale measurement techniques provide high resolution information but rely on upscaling and large observation networks to accurately represent field-scale (104 m2) soil moisture. Large-scale continental measurements provide coarse spatial averages making it difficult to extract smaller scales of soil moisture. Geological weighing lysimeters (GWL) provide a mechanism to measure total terrestrial water storage at field-scale. GWLs use pore pressure response within deep saturated formations to estimate mechanical loading from accumulation and depletion of moisture on the surface, effectively acting as a giant weighing lysimeter. In this study we investigate the use of a piezometer within confined aquifer as a GWL, at a field site in Duck Lake, Saskatchewan. We critically assess the performance of the GWL estimate of total storage, in conjunction with other local observations of snow, surface water and groundwater storage, to estimate field-scale soil moisture storage.

Session: 9010 General Hydrology - Part 1 Hydrologie générale - Partie 1 **01/06/2022 10:40**

ID: 11709 Contributed abstract

Poster Order: Poster-9010

The effects of climate warming on the McKenzie Creek streamflow in Southern Ontario

Tariq Deen [1] , *Altaf Arain* [2] , *Olivier Champagne* [3] , *Patricia Chow-Fraser* [4] , *Dawn Martin-Hill* [5]

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Presented by / Présenté par: ***Tariq Deen***
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The McKenzie Creek is an intermediate size tributary within the southern portion of the Grand River in the Great Lakes Basin. The Creek is an important ecosystem service provider, supplying water for agricultural irrigation to the rural communities within the sub-watershed as well as the Six Nations of the Grand River reserve, the largest First Nations community by population in Canada. It is understood that lakes, river, and streams will be impacted by temperature increases and changes in precipitation patterns. Climate change projections for the McKenzie Creek sub-watershed indicate that the region will experience a 3-6°C increase in annual average temperature and increase in winter and early spring precipitation; understanding how these changes will impact the McKenzie Creek will provide water managers and users within the sub-watershed with important information. This study explores the affect climate change will have on the hydrology of the McKenzie Creek. The Coupled Groundwater and Surface-Water Flow Model (GSFLOW) was used to simulate changes in streamflow within the sub-watershed from 1951 to 2099. GSFLOW was run using observed NRCANmet gridded data, and 11 downscaled Coupled Model Intercomparison Project 5 (CMIP5) Global Climate Models (GCM) under Representative Concentration Pathways (RCP) 4.5 and 8.5 scenarios. Findings suggest future McKenzie Creek streamflow will be most affected during winter months with streamflow projected to increase while spring streamflow is expected to decrease and summer and fall streamflow will experience little to no change. These changes may lead to more winter-early spring flooding while summer low flows may result in drought events within the sub-watershed.

Session: 9010 General Hydrology - Part 1 Hydrologie générale - Partie 1 **01/06/2022 10:50**

ID: 11822 Contributed abstract

Poster Order:

Using automatic optimization method to calibrate irrigation parameters in Noah-MP model in North China Plain with census irrigation amount

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Presented by / Présenté par: ***danqiong dai***
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Humans directly change the dynamics of the water cycle through water storage and water withdrawals for agricultural, industrial or domestic purposes. The intensive irrigation-linked groundwater abstraction in North China Plain (NCP) especially affects water supply and demand. The observed groundwater table depth declines in North China Plain. To investigate observed groundwater decline in NCP, a new groundwater-fed irrigation module considering specific irrigation method was developed in Noah-MP land surface model to simulate groundwater irrigation demands in NCP. In this study, we first calibrated model parameters to simulate irrigation amount in NCP according to census data and then found the uncertainties in irrigation amount due to different irrigation maps. Compared with GRACE observations, the groundwater depletion trend caused by irrigation demand was captured in our simulated total water storage (TWS). This study could provide valuable insights for policy makers to develop more sustainable groundwater management in North China Plain.

Session: 9010 General Hydrology - Part 1 Hydrologie générale - Partie 1 **01/06/2022 10:50**

ID: 11593 Contributed abstract

Poster Order:

Historic and Future Post-Retreat Land-Cover Evolution at Bridge Glacier, Canada

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The downstream effects of shrinking glaciers on water supply and water quality have received substantial attention using both empirical analysis of historic data and computer modelling to make future projections under climate-change scenarios. Most modelling studies replaced glacier cover with open or alpine land cover following retreat and have not accounted for vegetation or soil development on deglaciated areas or formation of proglacial lakes. The objective of this project is to use field observations and remotely sensed data to document glacial retreat and the ongoing evolution of deglaciated forelands and valley walls. These data will then be used to model vegetation expansion in the watershed. The study focused on the catchment area for Bridge River in the southern Coast Mountains of British Columbia, which contains Bridge Glacier, a lake-terminating valley glacier.

Since 1980, the Bridge Glacier terminus has retreated 4.75 km, while the proglacial lake grew from 2 to 7.6 km2. The valley sidewalls have exhibited substantial expansion of shrubby vegetation, especially in areas where soil moisture is supported by topographic convergence. Scattered coniferous trees have established in the upper portions of the deglaciated valley wall downslope of subalpine forest above the Little Ice Age trimline. Using satellite-based vegetation indices, field surveys of vegetation, mapped surface exposure ages, and topographic data, we are developing an auto-logistic spatiotemporal model of vegetation expansion. This model will be combined with existing projections of future glacier extent to represent future land cover change within the catchment.

Ongoing work is using these observations and projected land cover evolution to support the development and application of a hydrologic model that can account for the cumulative effects of climate change, glacier retreat, lake formation and vegetation succession on catchment hydrology.

Session: 9010 General Hydrology - Part 1 Hydrologie générale - Partie 1 **01/06/2022 10:55**

ID: 11841 Contributed abstract

Poster Order:

Challenges in hydrologic-land surface modelling of permafrost dynamics - Impacts of parameterization on model fidelity

Mohamed Abdelhamed [1] , *Mohamed Elshamy* [2] , *Saman Razavi* [3] , *Howard Wheater* [4]

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Presented by / Présenté par: ***Mohamed Abdelhamed***
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Permafrost is a critical feature in cold regions that significantly impacts hydrological processes, energy flux partitioning, plant communities, and carbon dynamics. Permafrost thaw has been observed in recent decades in the Northern Hemisphere and is expected to accelerate with continued global warming. Predicting climate warming implications in these regions requires proper representation of the surface/subsurface thermal and hydrologic regimes. Land surface models (LSMs) are well suited for such predictions, as they couple heat and water interactions across soil-vegetation-atmosphere interfaces. However, modelling permafrost dynamics is challenged by several issues, including the large number of model parameters (and their interactions), complex memory of state variables, and scarcity of permafrost observations (thermal/hydraulic regimes). In this study, we investigate several permafrost-related challenges for LSM application by evaluating the uncertainty due to meteorological forcing, assessing the sensitivity of permafrost simulation to LSM parameters, and highlighting issues of parameter identifiability. We report model experiments conducted with the Modélisation Environmentale Communautaire – Surface and Hydrology (MESH) modelling framework and its embedded Canadian Land Surface Scheme (CLASS) for three permafrost regions within the Mackenzie River Basin. Results highlight that modelers may encounter significant trade-offs when selecting a forcing dataset as some datasets enable the representation of some aspects of permafrost dynamics but are inadequate for others. The results also highlight the high sensitivity of various aspects of permafrost simulation to parameters controlling surface insulation and soil texture. Identifiability analysis reveals that many of the most influential parameters for permafrost simulation are unidentifiable. These conclusions could guide future efforts in data collection and model parametrization.

Session: 14010 Eastern Snow Conference General Session - Part 1 Session générale de la conférence de l'est sur la neige - Partie 1 **01/06/2022 09:55**

ID: 11610 Contributed abstract

Poster Order:

Enabling Low Latency Snow Pit data

Puneeth Yogananda [1] , *Roger De Roo* [2] , *Ruzbeh Akbar* [3] , *Agnelo Silva* [4]

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Presented by / Présenté par: ***Puneeth Yogananda***
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Current methods of monitoring snow water equivalent (SWE) from space, such as measuring the differential scatter darkening in the radio brightness at 19 and 37 GHz, rely on snow microphysical properties, such as grain size, in addition to the snow macroscopic properties like snow depth. The algorithms to invert the observations to SWE or snow depth are region-specific and require substantial ground truth.
The research addresses this concern by automating the collection of snow ground truth. We will do this by integrating two technologies that already exist: 1. the SoilSCAPE system enables the collection of low-latency soil moisture data from areas that are large enough to be representative of a passive microwave footprint. 2. The University of Michigan snow sensor is a small, easily replicated device that logs snow's temperature, density, and grain size, moisture and ambient light levels. The bulk of the effort is on implementing the software needed allow the two systems to communicate, and thereby turn the SoilSCAPE system into one that can also monitor snow over a wide area. Advantages of merging the two systems include giving to the snow sensor the intelligence of the SoilSCAPE system. Power management of a device embedded in the snowpack is important to preserving the snowpack properties. Judicious alterations of the measurement schedule, possible with the SoilSCAPE system, will enable rapid measurements of the snowpack when the snow changes, and sparse sampling of the snowpack when excess power dissipation is undesired.
The recent work includes successful data transmission of snow data from one snow sensor to the SoilSCAPE’s End Device (ED) over UART, and the ED sending the data to a Local Coordinator (LC) wirelessly in a lab setting. The near future work involves expanding the network by connecting four snow sensors to the ED. This will enable space-time sampling of snow.

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01/06/2022 10:10

ID: 11322 Contributed abstract

Poster Order:

DeepPrecip: A deep neural network for retrievals of precipitation

Fraser King [1] , *George Duffy* [2] , *Lisa Milani* [3] , *Christopher Fletcher* [4] , *Claire Pettersen* [5] , *Kerstin Ebell* [6]

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Presented by / Présenté par: ***Fraser King***
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Remotely-sensed vertical radar reflectivity profiles of the lower atmosphere can be linked to precipitation through empirical power-law relationships at high spatiotemporal frequency. These relationships are tightly coupled to particle phase, shape, size and density, which contributes to uncertainty and error when applied to unseen data. In this work, we develop an alternative precipitation retrieval using a deep convolutional multilayer perceptron (DeepPrecip), to estimate surface precipitation from eight measurement sites across the northern hemisphere. Using a combination of K-band micro-rain radar (MRR) retrievals up to 3 km, surface meteorology observations, and ERA-5 atmospheric data, a total of N=(60307 x 45) data points spanning 2012 to 2020 are used to train DeepPrecip against collocated 20-minute-average in situ precipitation accumulation records. DeepPrecip displays strong predictive skill on unseen data and is able to accurately model snowfall with a mean square error (MSE) of 1.3 x 10^-4 mm, rainfall with a MSE of 1.2 x 10^-4 mm, and displays positive Pearson correlations of r = 0.64. These MSE values are approx. 170% lower, on average, than current commonly used methods. We find that both near-surface and top-of-profile radar observations provide the most important information contributing to model skill. These results highlight the value of the relative structure of the full vertical column in contributing to improved retrieval accuracy. DeepPrecip also displays skill in capturing changes in precipitation magnitude across different sites/climates, and over multiple seasons; without explicit descriptions of precipitating particle microphysics or geospatial covariates being provided to the model. This research reveals the important role for deep learning in extracting predictive information about precipitation from radar retrievals.

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ID: 11664 Contributed abstract

Poster Order:

Development of Snow Wetness In-situ Data Distribution Survey

Vicki Jagdeo [1] , *Mahboubeh Boueshagh* [2] , *Joan Ramage* [3] , *Mary Brodzik* [4] , *Elias Deeb* [5]

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Presented by / Présenté par: ***Mahboubeh Boueshagh***
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Snow wetness is the amount of liquid water present in a snowpack and is an important physical parameter of snow. Snowmelt timing is vital for water storage and resource management, and possible environmental hazards such as flooding. However, snowmelt timing is ephemeral, spatially variable, and difficult

to estimate because of the inaccessibility and lack of field observations in many regions. In situ measurements of snow wetness are critical for documenting snow hydrology, including seasonal snow changes that affect runoff timing and discharge. Understanding these changes has important implications in regional climate variability and vehicle mobility. Therefore, ground-based observations are essential for researchers and scientists to develop improved remote sensing and modeling approaches to snowmelt processes in remote and vast areas. We are developing a community survey to collect information about existing ground-based snow wetness data. The survey will serve to organize information about the data, like measurement type, technology and tools used, date and location, altitude, elevation, frequency, data accessibility, and references. We will organize the information by region, communicate additional needs from individuals, and make the collection available to others. Once collected, the compiled responses will be shared with the snow community. We hope for broad community engagement and a range of dataset date, location, and scope. This work will address the need for collecting and sharing existing ground-based data on snow wetness and assess data gaps. Since existing data sets include variable intervals with different collection methods and locations, this survey will benefit the community to have a searchable list of existing datasets and sampling approaches. Contributors will retain their own datasets. The development of this resource provides a collective space for community knowledge of existing in-situ observations and their application in snow science.

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ID: 11546 Contributed abstract

Poster Order: Poster-14010

VIIRS Snow-Cover Frequency Map of North America

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Presented by / Présenté par: ***Dorothy Hall***
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There is a large amount of variability in the month-to-month and interannual extent of snow-cover extent (SCE) in the Northern Hemisphere where ~98 percent of the Earth’s seasonal SCE is located. The mean winter maximum SCE is reported to be ~47 million km2 [https://nsidc.org/cryosphere/sotc/snow_extent.html]. To improve our understanding of SCE variability, we have developed a daily time series of SCE frequency. We use eight years of the Suomi National Polar-orbiting Partnership (S-NPP) Visible Infrared Imaging Radiometer Suite (VIIRS) daily cloud-gap filled standard 375-m resolution snow-cover maps derived from the VNP10A1F NASA standard data snow-cover product. After applying filters to remove cloud/snow confusion, the VIIRS snow-frequency time series, described in this work, shows snow-cover variability at both the continental and basin scales.

While there is no fully-validated SCE extent product available with which to compare and thus determine absolute errors of the VIIRS maps, we can increase our confidence in the VIIRS SCE record through comparisons with other hemispheric-scale SCE maps such as from the 24-km resolution National Ice Center (NIC) Interactive Multisensor Snow and Ice Mapping System (IMS) snow output, processed and quality-controlled at Rutgers University. Preliminary comparisons for North America indicate excellent correspondence in total SCE for three months in 2019, ranging from 88.0 – 99.3 percent agreement. Regions in which the maps do not agree may be studied in detail using higher-resolution satellite data such as from the Landsat series. A map showing eight-year maximum SCE of North America was derived from the daily VIIRS SCE maps.

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01/06/2022 10:40

ID: 11811 Contributed abstract

Poster Order: Poster-14010

Monitoring Freshwater Lake Ice Thickness and Ice Bottom Roughness in Central Ontario

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Presented by / Présenté par: ***Noah Bacal***
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Lake ice thickness is an important parameter for understanding hydrological changes and implications in the Northern Hemisphere, yet there is a stark lack of ground-based lake ice data across Canada. Remote sensing techniques are increasingly used to address this void. Satellite-based ice thickness retrievals are becoming more reliable and widely used for Arctic sea ice, however, these methods are not yet viable for most freshwater lakes. Currently, satellite-based lake ice thickness can only be retrieved for very large lakes or small lakes where the ice freezes to the lakebed. Current approaches of lake ice thickness retrieval on other lakes, including those in the mid-latitudes, focus on RADAR backscatter analysis and are working towards accounting for the distortion of the backscatter signal at the ice-water interface, caused by roughness on the underside of the ice layer. To date, there is no field-based method to quantify the roughness of the ice bottom surface in deeper freshwater lakes. Using in-situ measurements of lake ice thickness, and by measuring roughness from physical imprints of the ice bottom surface, this project aims to identify a correlation between these two characteristics that will better inform how ice bottom roughness impacts total ice thickness on mid-latitude freshwater lakes. Preliminary results from measurements of early-season roughness indicate ice bottom features ranging from 0.010 mm to 2.071 mm in height protruding from the ice bottom surface. Measurements of the total imprint depth per unit area of the ice bottom surface range from 0.198 mm/cm2 to 1.323 mm/cm2. Further sampling of ice bottom roughness characteristics is planned to better relate observed roughness characteristics with airborne ice thickness retrievals using Ku-band and L-band RADAR backscatter analysis, towards developing space-based ice thickness retrievals in the future.

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01/06/2022 10:40

ID: 11673 Contributed abstract

Poster Order: Poster-14010

Remote sensing of snowscapes and caribou (Rangifer tarandus) movement in the Northwest Territories of Canada

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Presented by / Présenté par: ***Mariah Matias***
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Caribou play a crucial role in nutrient cycling and turnover, and they are an essential herbivore and prey animal in northern ecosystems. This keystone species undergoes exceptionally large, annual synchronized migrations on the order of thousands of kilometers, triggered by shared environmental stimuli. Relationships between climate factors and caribou populations and their migration patterns remain ambiguous. Recent studies suggest that snow characteristics may be primary drivers of migration, largely due to caribou's high level of mobility and their dependence on landscape conditions for locomotion. We use three datasets to explore the spatial and temporal relationships between landscape-scale caribou movement and snowpack characteristics in the Northwest Territories, Canada, over two decades. We use GPS (Global Positioning System) tracking collar data of barren-ground caribou provided by the Government of the Northwest Territories' Department of Environment and Natural Resources to identify individual animal location and migration patterns, with a focus on the Bathurst herd. We derive environmental factors from Calibrated, Enhanced-Resolution Brightness Temperatures (CETB) at 3.125 km resolution and Moderate Resolution Imaging Spectroradiometer (MODIS) data at 500 m resolution. The GPS collar data provides the location of >200 animals (1996-2017) at multiple pre-determined (but varied) time intervals daily. These datasets allow us to further understand whether and how snow characteristics such as melt/refreeze status and the presence of ice are related to caribou movement. Do migration patterns align with snowscape characteristics, possibly indicating a preference for conditions that increase mobility? Do changes in snow factors influence the timing or duration of their movement? A strong relationship between snow melt onset, refreeze cycles, or rain-on-snow events would suggest that expected changes in snowpack variability could lead to range shifts and changes in the overall timing, duration, and synchrony of movement.

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01/06/2022 10:50

ID: 11601 Contributed abstract

Poster Order:

Global transferability of temperature index snowmelt model

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Presented by / Présenté par: ***Achut Parajuli***
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Snowmelt models are frequently applied tools that contributes to simplification of meltwater dynamics within snow-fed catchments. Among the different snowmelt models, temperature index (TI) model is the simplest model that uses positive air temperature and melt factor to simulate snow and ice melt. Due to limited data requirement and parameterization ease, TI is therefore a popular model and often implemented in remote locations. However, some recent studies point out that the calibration reliant model like the TI is unable to describe the site-specific variability thereby limiting the transferability to other sites. Therefore, our study uses hourly ERA5-Land reanalysis dataset (air temperature and snowmelt) from 1981 to 2020, first to calibrate the melt factor or the degree day factor and to test the global transferability of simple TI model. Furthermore, this study aims to identify the role of biophysical variables (canopy coverage, turbulent and radiative fluxes and relative humidity) in relation to performance of simple TI model. Based on our findings, except for the Tibetan plateau and the Atacama region, the calibrated TI model (1981 -1999) was able to simulate reasonable snowmelt estimation. Relative humidity appeared to influence the efficiency of the simple TI model where humid region showcased better outcome while performance in drier regions were least efficient. Similar to calibrated output, the validation dataset (2000 - 2020) for drier region showcased poor outcome. With some exception, it is also worth pointing out that there was reduced performance throughout the world when comparing the validation output with the calibrated TI model. It was expected that simple TI model will have limited transferability but the model has room for improvement given the addition of pertinent inputs.

Session: 14010 Eastern Snow Conference General Session - Part 1 Session générale de la conférence de l'est sur la neige - Partie 1 **01/06/2022 11:05**

ID: 11521 Contributed abstract

Poster Order:

The relationship between Arctic Oscillation and intense cyclone patterns, and their impacts on summer precipitation distribution in the Canadian Arctic

Xiaomeng Zuo [1] , *Laura Brown* [2]

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Presented by / Présenté par: ***Xiaomeng Zuo***
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A trend analysis of the Arctic System Reanalysis Version 2 (ASRv2) data from 2000 to 2015 showed that changes occurring with summer rainfall and snowfall are synchronized in the Canadian Arctic, rather than changing between forms. The precipitation in July showed a significant decreasing trend between 75°N and 80°N, while a significant increasing trend was found in September between 70°N and 80°N. Comparing the precipitation distribution in the Canadian Arctic with low-pressure system (center pressure < 1000hpa) frequency and intensity patterns in the same study period showed high consistency, while the strength of the Arctic Oscillation (AO) also showed varying degrees of correlation with the frequency and intensity of the cyclones in the study area, thus affecting the distribution of precipitation. Visualizing the wind speed reanalysis data for each summer month showed that the distribution of intense cyclones is related to the positive or negative AO. The negative AO index in July in the 16 years corresponds to a southern movement of the jet stream, thus higher intensity cyclones, with local Laplacian over 15 mPa/km-2, are mostly observed in the areas around 60°N and further south, resulting in less precipitation in the northern high latitudes. On the contrary, the positive AO index in September corresponds to the northward shift in the jet stream, and more intense cyclones are observed between 70°N and 80°N, which brought more precipitation to the high latitude area in Canadian Arctic in the summertime. Meanwhile, strong positive AO index months are found to have more snow than negative AO index months in the higher latitudes. Finally, along the eastern coast of the Canadian Arctic, higher snow amounts, corresponding with more intense cyclones, are often found in positive AO index months, while this pattern is not evident for rain.

Session: 14010 Eastern Snow Conference General Session - Part 1 Session générale de la conférence de l'est sur la neige - Partie 1 **01/06/2022 11:20**

ID: 11654 Contributed abstract

Poster Order:

Remote Sensing Methods for Quantifying Snow Water Equivalent at the Bay of Quinte (Ontario) and for Lake Erie Watershed (Ontario)

Felix Ouellet [1] , *Agnes Richards* [2]

1

2

Presented by / Présenté par: ***Felix Ouellet***

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Remote sensing methods used to quantify snow water equivalent in two key priority areas: the Bay of Quinte and the Lake Erie watershed, will be presented. Different remote sensing products and methods have been used to map and identify snow cover. This remote sensing information is cross-referenced with field data and used in running our SNOWPACK model, which uses the following meteorology inputs: precipitation, humidity, wind, and solar radiations. The GIS aspect of the data acquisition and manipulation will also be discussed: spatial references, bandwidth operations, and data format conversions.

Session: 2020 Air Quality and Linkages to Weather and **01/06/2022**

Climate Qualité de l'air et liens avec la météo et le climat **12:55**

ID: 11677 Contributed abstract

Poster Order:

Satellite-based methane emission estimates for western Canada using a mass balance method, and quantification of the oil and gas sector contribution

Nazrul Islam [1] , *Peter Jackson* [2]

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Presented by / Présenté par: ***Nazrul Islam***
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Preliminary analysis of Greenhouse Gases Observing Satellite (GOSAT) based column-averaged dry-air mole fractions of atmospheric methane (XCH4) data products (2009-2019) in the three western-most Canadian provinces and a portion of northwestern North Dakota, consistently shows four source regions with elevated XCH4 coinciding with locations of existing oil and gas industries. We quantified total methane (CH4) emissions in these source regions using a simple mass balance method, and subsequently subtracted wetland and other non-oil and gas sector anthropogenic CH4 emissions from the satellite-based total CH4 emissions to estimate the oil and gas emissions. Although our satellite-based estimates have large uncertainties, the estimated emissions in all source regions are in reasonable agreement with independently derived estimates by other groups. Therefore, we conclude that satellite XCH4 data products are suitable for quick and reasonably accurate detection of CH4 emissions from oil and gas industries in western Canada, while other traditional methods are more labor intensive.

Session: 2020 Air Quality and Linkages to Weather and Climate Qualité de l'air et liens avec la météo et le climat **01/06/2022 13:10**

ID: 11382 Contributed abstract

Poster Order:

Sensitivity of Air Pollution in Quebec to Regional Emissions and Meteorology

Robin Stevens [1] , *Nicole Trieu* [2] , *Henry Rodriguez* [3] , *Patrick Hayes* [4]

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Presented by / Présenté par: ***Robin Stevens***
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Particulate matter, NO_{<small>X</small>} (nitrogen oxide (NO) + nitrogen dioxide (NO_{<small>2</small>})), and ozone (O_{<small>3</small>}) are known to be associated with adverse

health outcomes in humans. It is important to better understand the sources of air pollution in order to craft policies that allow for economic growth while also reducing the impacts on populations of poor air quality.
We perform simulations using the GEOS-Chem chemical transport model with 0.5° x 0.625° resolution to determine the regional contributions to air pollution in Quebec. Specifically, we perform sensitivity studies to determine the contributions due to anthropogenic emissions from three different regions: from within Quebec, from the rest of Canada (excluding Quebec), and from the United States. We find that emissions from each of these three source regions make a significant contribution to the surface concentrations of all three pollutants in Quebec, with variations depending on location. For example, we find that anthropogenic emissions from Quebec, the rest of Canada, and the United States contribute up to 80%, 30%, and 50% of NO_{<small>X</small>} concentrations in Quebec, respectively, depending on location within the province.
For each of these sensitivity simulations, we then create a statistical model to link air pollutant concentrations to local and regional meteorology. We do this by performing a linear regression of the pollutant concentrations against common meteorological variables as well as a singular value decomposition of the regional meteorology to capture synoptic factors. We perform the analysis independently for each horizontal grid cell and each month to isolate geographical and seasonal patterns. We plan to use these statistical models to make predictions of how pollution transport into Quebec may change in the future as a result of climate change.

Session: 2020 Air Quality and Linkages to Weather and Climate Qualité de l'air et liens avec la météo et le climat **01/06/2022 13:25**

ID: 11579 Contributed abstract

Poster Order:

Representation of Precipitation Phases and a New Parameterization for Below-Cloud Scavenging

Roya Ghahreman [1] , *Wanmin Gong* [2] , *Paul Makar* [3]

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Presented by / Présenté par: ***Roya Ghahreman***
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Below-cloud scavenging is the process of aerosol removal from the atmosphere between cloud-base and the ground by precipitation (e.g. rain or snow), and affects aerosol number/mass concentrations, lifetime and distributions. An accurate representation of precipitation phases is important in treating below-cloud scavenging as the efficiency of aerosol scavenging differs significantly between liquid and solid precipitation. To study cloud processes and precipitation chemistry, we examined representation of below-cloud aerosol scavenging of in the current GEM-MACH model, including implementing a new aerosol below-cloud scavenging scheme (from Wang et al., 2014) and comparing with the GEM-MACH’s existing scavenging scheme, based on Slinn (1984).
GEM-MACH considers a single-phase precipitation for below-cloud scavenging: total precipitation is treated as either liquid or solid depending on a fixed

environment temperature threshold. Here, we consider co-existing liquid and solid precipitation as they are predicted by the GEM microphysics. GEM-MACH simulations are compared with the observed precipitation samples, with a focus on the particulate base cation NH4+ and acidic anions NO3-, SO4-2 and HSO3- in precipitation, and ambient particulate sulfate, ammonium and nitrate. Overall, the precipitation-phase partitioning improves model results. Including partitioning results in SO42- scavenging decreases, while the impact on wet deposition of NO3- and NH4+ varies, with both increases and decreases in wet scavenging. As for the new Wang's scavenging scheme vs. the existing Slinn's scheme, in the case of liquid precipitation, the two schemes differ for the aerosol with the size of 0.1-1 μm, mostly at high precipitation intensity. For the solid precipitation at lower intensity (R=0.01 mm/h), the two schemes diverge for aerosols smaller than 1 μm, while at higher precipitation intensities (R=10 mm/h), the two schemes show larger differences for aerosols larger than 1 μm. The impact of the two scavenging schemes relative to the previous methodology used in GEM-MACH will be discussed.

Session: 2020 Air Quality and Linkages to Weather and Climate Qualité de l'air et liens avec la météo et le climat **01/06/2022 13:50**

ID: 11420 Contributed abstract

Poster Order:

An Analysis of the Global Distribution of Aerosol Direct Radiative Forcing and Its Implications for Meridional Energy Transport

Qiurun Yu [1]

[1]

Presented by / Présenté par: ***Qiurun Yu***

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Aerosols can interact with radiation via scattering and absorption. This effect is geographically heterogeneous due to aerosol-related and environment-related factors (e.g., aerosol optical depth and surface albedo, respectively), making it difficult to quantify the impact on the global radiative budget. Based on 5 years of reanalysis data, we find that the distribution of the aerosol direct radiative forcing (DRF) can be well explained by a multivariate regression model, based on which the relative contributions from aerosol optical properties and meteorological conditions are separated. This multiple regression model can explain 95% of the spatial inhomogeneity in clear-sky DRF over the globe, to which the aerosol optical depth, solar angle, aerosol-surface interaction, surface reflection, and aerosol single scattering albedo contribute on average 44%, 25%, 16%, 15%, and 0.09%, respectively. These results help improve the understanding of the spatial inhomogeneity in DRF and suggest that DRF cannot be parameterized by AOD alone as suggested by some studies. Moreover, we analyze the zonal pattern of the aerosol DRF and the meridional energy transport it potentially drives. We find that the heterogenous DRF spatial distribution leads to a northward cross-equator energy transport, which is mainly contributed by sulfate and dust aerosols.

Session: 2020 Air Quality and Linkages to Weather and Climate Qualité de l'air et liens avec la météo et le climat **01/06/2022 14:05**

ID: 11590 Contributed abstract

Poster Order:

Aerosol chemical and physical properties during the Halifax Fog and Air Quality Study

Rachel Chang [1] , *Baban Nagare* [2] , *Joelle Dionne* [3] , *Aldona Wiacek* [4] , *Cameron Power* [5] , *Cora Young* [6] , *Teles Furlani* [7] , *Alexander Moravek* [8] , *Ye Tao* [9]

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Presented by / Présenté par: ***Rachel Chang***
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Port settlements have unique atmospheric chemistry due to the confluence of emissions associated with anthropogenic marine traffic, such as ships and trucks, as well as natural marine sources. Port settlements are also often frequently influenced by low visibility events due to fog advected from nearby bodies of water. This study presents measurements conducted as part of the Halifax Fog and Air Quality Study (HaliFAQS) which took place in Halifax during summer 2019. Aerosol mass loadings, size distributions, hygroscopicity and chemical composition will be presented as well as their relationship to criteria air pollutants and fog events. These results provide insight on secondary aerosol processes that occur in coastal cities across Canada.

Session: 2020 Air Quality and Linkages to Weather and Climate Qualité de l'air et liens avec la météo et le climat **01/06/2022 14:20**

ID: 11826 Contributed abstract

Poster Order:

Recent research on Canada’s FireWork wildfire air quality forecast system and the 2021 fire season impacts on weather

Jack Chen [1] , *Paul Makar* [2] , *Wanmin Gong* [3] , *Ayodeji Akingunola* [4] , *Konstantinos Menelaou* [5] , *Dragana Kornic* [6] , *Sylvain Menard* [7] , *Melissa Cholette* [8] , *Paul Vaillancourt* [9]

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Presented by / Présenté par: ***Jack Chen***
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Despite an unusually quiet 2020 wildfire activity in Canada, the 2021 fire season was one of the worst in the previous 10 years. More than 4 million hectares of forests in Canada were consumed by fire during the fire season (Apr-Oct), and resulted in significant amount of wildfire smoke, fine particles, and poor air quality conditions over a large regional environment.
Several episodes of extremely high PM2.5 concentrations were observed over several cities in the central and eastern provinces. The high atmospheric loading of fine particles from smoke may have influenced surface radiation budgets, cloud formation, and surface temperatures in some areas. The extent to which the forest fire pollutants may influence weather, and the potential to predict these influences in weather forecasts, is the focus of the project discussed here.
In the recent development of the FireWork wildfire air quality forecast system, we are experimenting with the on-line implementation of the Canadian Forest Fire Emissions Prediction System (CFFEPS) within the fully-coupled research GEM-MACH air quality model, to determine our capability to predict the influence of forest fire emissions on weather. The system links emitted particles, particles created through secondary chemistry, and the effects of these particles on radiative transfer and cloud microphysics. We have used this system to study these direct and indirect feedbacks of air quality on weather. We are also designing prototypes forecast products for potential future implementation which make use of forest fire pollutant emissions and chemistry to predict their impacts on forecasted weather. We will present an analysis of FireWork model forecast for the 2021 fire season, discuss recent research applications and results on accounting the forest fire impacts on both regional air quality and weather parameters, and the potential path forward for these applications.

Session: 4040 Atmosphere, Ocean, and Climate Dynamics - Part 1 La dynamique de l'atmosphère, de l'océan et du climat - Partie 1

01/06/2022 12:55

ID: 11461 Contributed abstract

Poster Order:

Transmission and Reflection of Three-Dimensional Internal Gravity Wave Packets in Non-uniform Retrograde Shear Flow

Alain Gervais [1] , *Bruce Sutherland* [2]

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Presented by / Présenté par: ***Alain Gervais***
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Internal gravity waves (IGWs) propagate horizontally and vertically within stably stratified fluids. Linear theory predicts that a small amplitude IGW packet propagating upward against a retrograde background shear flow will be Doppler-shifted until its Doppler-shifted frequency is equal to the background buoyancy frequency. The `reflection level' at which this occurs is the height at which the incident wave packet reflects, resulting in a downward-propagating wave packet. Moderately large amplitude IGW packets evolve subject to

additional nonlinear dynamics: wave-wave interactions on the scale of the wave packet induce an order amplitude-squared mean flow that locally accelerates the ambient fluid. Simulated 1-D IGW packets (Sutherland, QJRMS, 2000) have been shown to transmit partially above the reflection level predicted by linear theory, provided the magnitude of the vertical shear associated with their wave-induced mean flow was locally greater than that of the background shear. We study numerically the evolution of a moderately large amplitude 3-D IGW packet initialized with its predicted induced mean flow superimposed as it propagates upward into a non-uniform retrograde background shear flow. Simulations are initialized with a range of amplitudes and relative vertical wavenumbers. We quantify the resulting wave transmission using the ratio of upward-propagating pseudomomentum above the reflection level to the total (conserved) pseudomomentum in the simulation domain. Transmission above the predicted reflection level is transient and its maximum value in time tends to decrease with increasing initial amplitude for all but the most strongly nonhydrostatic wave packets.

Session: 4040 Atmosphere, Ocean, and Climate Dynamics - Part 1 La dynamique de l'atmosphère, de l'océan et du climat - Partie 1 **01/06/2022 13:10**

ID: 11369 Contributed abstract

Poster Order:

The sensitivity of internal solitary waves to localized patches of mixing

Nicolas Castro-Folker [1] , *Marek Stastna* [2]

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Presented by / Présenté par: ***Nicolas Castro-Folker***
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While most theoretical work idealizes the stratification which forms the wave guide for internal solitary waves using combinations of smooth analytical functions (i.e. hyperbolic tangent functions), in the field the stratification is typically much more complicated. The general question of how any stratification is affected by any perturbation is typical of calculus of variations, but difficult to study analytically . Instead, we build on recent work on nearly linear stratifications by adopting perturbations that take the form of a localized patch of mixing. We present a data-centric framework that seeks to identify which locations of a mixing patch yield the largest effect on ISW structure, and conclude the talk with a discussion of implications for time dependent simulations.

Session: 4040 Atmosphere, Ocean, and Climate Dynamics - Part 1 La dynamique de l'atmosphère, de l'océan et du climat - Partie 1 **01/06/2022 13:25**

ID: 11374 Contributed abstract

Poster Order:

A data centric look at internal waves in late winter lakes

Marek Stastna [1]

Presented by / Présenté par: ***Marek Stastna***
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In late winter/early spring temperate and northern lakes often experience a so-called weak, inverse stratification. Such a stratification occurs when the water temperature falls below the temperature of maximum density (typically around 4 degrees) This classical scenario fits some lakes, but the small density differences due to the thermal forcing also imply that very small amounts of dissolved salts could create a more complex, combined solute-thermal stratification. We explore the behaviour of nonlinear internal waves for one such stratification measure in an Arctic lake. In contrast to the classical description of internal waves that builds up theory from linearization, we adopt a data centric approach. We first demonstrate that by an appropriate choice of moving frame mode-2 waves manifest differently in the upper and lower half of the water column. We subsequently extend the fairly standard EOF analysis to demonstrate that the variability can be captured by a two EOF reconstruction.

Session: 4040 Atmosphere, Ocean, and Climate Dynamics - Part 1 La dynamique de l'atmosphère, de l'océan et du climat - Partie 1 **01/06/2022 13:40**

ID: 11343 Contributed abstract

Poster Order: Poster-4040

Numerical investigation of diapycnal mixing in the Kitikmeot Sea

Yasaman Afsharipour [1] , *Chengzhu Xu* [2] , *Paul G. Myers* [3] , *Qi Zhou* [4]

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Presented by / Présenté par: ***Yasaman Afsharipour***
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The Kitikmeot Sea is a semi-enclosed basin located in the Southern Canadian Arctic Archipelago (CAA). Oceanographic characteristics of the Kitikmeot Sea are different from the northern sections of the CAA due to the particular features of this sea, such as massive freshwater input from rivers, shallow surrounding sills that limit water exchange, and a substantial ice-free period each year. We have studied this region’s physical oceanography, particularly diapycnal mixing, using a 1/12-degree resolution simulation based on the Nucleus for European Modeling of the Ocean (NEMO v3.4). Diapycnal mixing is quantified in terms of diapycnal diffusivities (calculated at each isopycnal surface) and then used to investigate temporal and spatial variabilities in mixing. In addition, preliminary analysis of the energetics of a number of mixing mechanisms has been carried out based on the model output data. Results suggest considerable seasonal variabilities in stratification and mixing, mainly due to the variations in sea-ice coverage.

Session: 4040 Atmosphere, Ocean, and Climate Dynamics - **01/06/2022**

ID: 11779 Contributed abstract

Poster Order:

Constant flux layers with gravitational settling: deposition velocity implications.

Peter Taylor [1]

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Presented by / Présenté par: ***Peter Taylor***
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Turbulent boundary layer concepts of constant flux layers and surface roughness lengths are extended to include aerosols and the effects of gravitational settling. Interactions between aerosols and the Earth’s surface are represented via a roughness length for aerosol which will generally be different from the roughness lengths
for momentum, heat or water vapor. Gravitational settling will impact vertical profiles and the surface deposition of aerosols, including fog droplets. Simple profile solutions are possible in neutral and stably stratified atmospheric surface boundary layers. These profiles can be used to predict deposition velocities and to illustrate
the dependence of deposition velocity on reference height, friction velocity and gravitational settling velocity.

Session: 4040 Atmosphere, Ocean, and Climate Dynamics - Part 1 La dynamique de l'atmosphère, de l'océan et du climat - Partie 1

01/06/2022 14:05

ID: 11646 Contributed abstract

Poster Order:

Turbulence dynamics in a stably stratified wall-bounded flow

Amir Atoufi [1], *Andrea K. Scott* [2], *Michael L. Waite* [3], *Fazle Hussain* [4]

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Presented by / Présenté par: ***Amir Atoufi***
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This work addresses turbulence dynamics in a stably stratified open-channel flow based on direct numerical simulations. The concept of Lamb vector divergence is first extended to stratified cases. Then, the response of wall turbulence to the introduction of stable stratification is examined through the concept of Lamb vector divergence. It is shown that the flexion product (the dot product of vorticity curl and velocity), without a need to introduce a mean state, remarkably resembles turbulence production even for strongly stratified cases in which the flow becomes intermittent.

The self-sustaining process (SSP) of near-wall turbulence production is assessed through investigating mechanisms involved in the evolution of streamwise vorticity fluctuations. The strong relation between streaky base flow and the streamwise meandering features of the streaks is shown. It is also demonstrated that stratification does not change self-sustaining mechanisms qualitatively as long as turbulence is at quasi-stationarity. It is argued that there is a preferred direction in self-sustaining mechanisms based on the distance from the wall. It is also discussed that streak formation and the meandering feature of the streaks naturally appear in high Reynolds number flows. Thus, the transient growth mechanism as a precursor mechanism for meandering streaks is insightful primarily for low Reynolds number flows. The energy cascade mechanisms with a full band of horizontal and vertical scales are then investigated in detail. It is shown that energetic vertical scales of size $r_z^+ \gtrsim 10$ in the logarithmic layer are larger than the Ozmidov scale and thus strongly affected by the presence of stable stratification. However, the most productive vertical scales, although of the size $r_z^+ \gtrsim 10$, are located in the lower buffer layer where the stratification at quasi-stationary state has minimal effects.
A new measure to predict turbulence collapse for strongly stable wall-bounded stratified flows is introduced based on near-wall quantities.

Session: 4040 Atmosphere, Ocean, and Climate Dynamics - Part 1 La dynamique de l'atmosphère, de l'océan et du climat - Partie 1 **01/06/2022 14:20**

ID: 11636 Contributed abstract

Poster Order:

Kinetic Energy Spectra and Energy Cascade Analysis of Radiative-Convective Equilibrium

Kwan tsaan (Donald) Lai [1], *Michael Waite* [2]

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Presented by / Présenté par: ***Kwan tsaan (Donald) Lai***
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In this talk, radiative-convective equilibrium (RCE) is used to investigate atmospheric kinetic energy spectrum and energy cascade in idealised simulations. WRF is used to perform cloud resolving simulation of an idealized RCE with dx=4 km. The effect of aggregation of RCE on the kinetic energy spectrum will be investigated. The horizontal kinetic energy (HKE) spectrum resembles the -5/3 spectrum from 30 to 150 km in the aggregated simulation. The HKE spectrum for the non-aggregated simulation in the upper troposhere (UT) and the lower stratosphere (LS) are much shallower than the -5/3 spectrum. In the UT, the divergent kinetic energy (DKE) has a similar magnitude to the rotational kinetic energy (RKE) in the non-aggregated simulation and the DKE is marginally larger than the RKE in the aggregated simulation. The spectral budgets are similar for both the aggregated and non-aggregated simulations for scales larger than 20 km, but different in magnitude. Energy is mainly gained from the buoyancy and mainly lost from the vertical energy flux for scales larger than 20 km. There is energy transfer from large scales to small scales for both simulations, which corresponds to a direct energy cascade. Dissipation is the main source of energy loss at small scales. For scale smaller

than 20 km, the spectral budget are different between the aggregated simulation and non-aggregated simulation. In the LS, the DKE dominates the HKE spectrum in both aggregated and non-aggregated simulation. The overall spectral budgets are similar for both the aggregated and non-aggregated simulations at all scales, but different in magnitude. Energy is mainly gained from the vertical energy flux and is balanced by the loss from the buoyancy term, transfer term and dissipation. The transfer term transfer energy from small scales to the mean flow, which corresponds to an inverse cascade. We believe the eddy-mean flow interaction between gravity waves and the mean flow is responsible for the inverse cascade. Note that upscale flux happens in the LS but not the UT. We will compare upscale flux to other reported inverse cascade in the literature.

Session: 6010 Climate change and variation general session Séance générale - Les changements climatiques et la variabilité climatique **01/06/2022 12:55**

ID: 11349 Contributed abstract

Poster Order:

A multi-algorithm analysis of projected changes to freezing rain over North America in an ensemble of regional climate model simulations

Christopher McCray [1], *Dominique Paquin* [2], *Julie Thériault* [3], *Émilie Bresson* [4]

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Presented by / Présenté par: ***Christopher McCray***
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Freezing rain events have caused severe socioeconomic and ecosystem impacts. An understanding of how these events may evolve as the earth warms is necessary to adequately adapt infrastructure to these changes. We present an analysis of projected changes to freezing rain events over North America relative to the 1980-2009 recent past climate for the periods during which +2, +3, and +4˚C of global warming is attained. We diagnose freezing rain using four precipitation-type algorithms (Cantin and Bachand, Bourgouin, Ramer, and Baldwin) applied to four simulations of the fifth-generation Canadian Regional Climate Model (CRCM5) driven by four global climate models (GCMs). We find that the choice of driving GCM strongly influences the spatial pattern of projected change. The choice of algorithm has a comparatively smaller impact, and primarily affects the magnitude but not the sign of projected change. We identify several regions where all simulations and algorithms agree on the sign of change, with increases projected over portions of western Canada and decreases over the central, eastern, and southern United States. However, we also find large regions of disagreement on the sign of change depending on driving GCM, highlighting the importance of examining freezing rain events in an ensemble of simulations driven by multiple GCMs to sufficiently account for model uncertainty in projections of these hazardous events.

Session: 6010 Climate change and variation general session **01/06/2022**

ID: 11843 Contributed abstract

Poster Order:

The Canadian Ice Service Sea and Lake Ice Climate Normals for 1991-2020

Adrienne Tivy [1] , *Angela Cheng* [2] , *Trudy Wohlleben* [3] , *Scott Weese* [4]

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Presented by / Présenté par: ***Scott Weese***
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The Canadian Ice Service (CIS) has been analyzing sea and lake ice in Canadian waters for more than 50 years. This year, the CIS will be releasing the Canadian Ice Climate Normals for the 1991 to 2020 period. In accordance with World Meteorological Organization (WMO) guidelines, every ten years an update to the official Ice Climate Normals are generated to reflect the most recent 30-year reference period. Week by week climate maps will be available for the East Coast of Canada (Atlantic Canada); the Great Lakes (including Lake Michigan); the Western Canadian Arctic, the Eastern Canadian Arctic and Hudson Bay. These sea ice climate maps provide a depiction of normal ice conditions throughout the year: its location, distribution, extent, thickness, and variability. This atlas will feature additional new products pertaining to land fast ice that are intended to support navigators, researchers and northern communities. An important consideration is that these will be the first normals to be created using vastly improved technologies, including Geographic Information System (GIS) software and high-resolution satellite imagery. Digitization of charts replaced hand-drawn products and synthetic aperture radar (SAR) imagery became concurrently available to the CIS in the mid 1990s, thereby enhancing the quality and reliability of the data presented in this atlas. Notable changes in multi-year ice distribution, reduced ice thickness, diminished seasonal ice coverage, delays in ice freeze-up and earlier onset of break-up are generally observed in the updated ice climate normals when compared against previous normals (i.e. the 1981-2010 reference period). Important regional variability is present across the Canadian domain and exhibited in the 1991-2020 ice atlas.

Session: 6010 Climate change and variation general session
Séance générale - Les changements climatiques et la variabilité climatique **01/06/2022 13:25**

ID: 11492 Contributed abstract

Poster Order:

Tropospheric warming drives the rise of the tropopause in the Northern Hemisphere in recent decades

Jane Liu [1] , *Lingyun Meng* [2] , *David Tarasick* [3] , *William Randel* [4] , *Andrea Steiner* [5] , *Hallgeir Wilhelmsen* [6] , *Lei Wang* [7] , *Leopold Haimberger* [8]

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Presented by / Présenté par: ***Jane Liu***
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The tropopause marks the boundary between the troposphere and stratosphere, and tropopause height (H) is a sensitive diagnostic for greenhouse gas (GHG) induced climate change. Here we use dense radiosonde balloon observations over the Northern Hemisphere (NH) to show a continuous rise of H at 50-60 m per decade over the last two decades (2001-2020), comparable to that observed over 1980-2000. Results using space-borne GPS radio occultation measurements and homogenized radiosonde data are in good agreement with those from radiosonde balloon observations. Under the combined influence of GHG emissions and stratospheric ozone changes, it is challenging to assess the relative importance of tropospheric warming and stratospheric cooling to the change in H. We develop a robust statistical method to quantify the relative importance of the two factors to the rise of H, before and after 2000. We find that the continuous rise of H over the NH from 2001 to 2020 is primarily driven by ongoing warming of the troposphere, while in the earlier period, 1980-2000, tropospheric warming and stratospheric cooling contribute almost equally to the rise of H.

Session: 6010 Climate change and variation general session
Séance générale - Les changements climatiques et la variabilité climatique

01/06/2022
13:50

ID: 11693 Contributed abstract

Poster Order:

Detection of climate change in terrestrial water storage from global weather patterns

Fei Huo [1] , *Li Xu* [2] , *Yanping Li* [3] , *Zhenhua Li* [4]

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Presented by / Présenté par: ***Fei Huo***
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Climatologists identify externally forced signals in the observed climate record. This can be difficult when one tries to detect climate change in terrestrial water storage (TWS) at global scale due to the brevity of freshwater observations. In this study, we applied a novel method to identify relationship between annual global mean TWS and global weather patterns (i.e., surface air temperature and humidity fields) using hydrological simulations from ISIMIP2b, yielding

fingerprints of anthropogenically forced change. Reanalysis datasets are projected onto the fingerprints to detect climate change. It is found that approximately 80% of days for most years since 2016 have informed climate change signals, with high inter-annual variability. While strong signals of forced climate change in global mean TWS could not be uniformly detected from each day during the studied period, the fraction of days detected started to surge from the mid-1970s. Climate change signals in global mean TWS have been accumulated over the last few decades and will likely emerge from the back ground of natural climate variability in the future.

Session: 6010 Climate change and variation general session
Séance générale - Les changements climatiques et la variabilité climatique

01/06/2022 14:05

ID: 11444 Contributed abstract

Poster Order:

Mitigation of Methane Emission from Municipal Solid Waste Landfill using Engineered Biocovers

Mohammad Rayhani [1]

[1]

Presented by / Présenté par: ***Mohammad Rayhani***
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Municipal solid waste (MSW) landfills are considered as one of the main sources for anthropogenic methane emissions around the world. According to Environment and Climate Change Canada, emissions from Canadian landfills account for 20% of national methane emissions. Estimates have shown that approximately 27 Megatonnes (Mt) of carbon dioxide equivalent (eCO2) are generated annually from Canadian landfills, of which 20 Mt eCO2 are being emitted annually. Many of these landfills are equipped with active landfill gas (LFG) collection system where a considerable portion of the LFG is collected and managed. However, potential for gaseous emissions still exists where a gas collection system is not operational, and from fugitive emissions not captured by the system. Many landfills, especially in cold regions, do not produce enough gas to support conventional gas collection and treatment system. For example, the City of Ottawa has over 80 closed landfills, without any LFG collection system, ranging from small demolition sites to municipal solid waste landfills. These landfills still generate methane and other greenhouse gases, which contribute to climate change and also pose potential health and safety concerns. Methane emissions from MSW landfills can be reduced by means of methane oxidation enhanced in composted-based landfill biocovers. Biocovers are defined as biological surface layers containing methane oxidizing bacteria and nutrients that enhance the biodegradation of methane. This paper presents results of a pilot experimental research on performance of biocovers in mitigating methane emissions from landfills in cold climate.

Session: 6010 Climate change and variation general session
Séance générale - Les changements climatiques et la variabilité climatique

01/06/2022 14:20

ID: 11785 Contributed abstract

Poster Order:

The Futility of Countering Carbon Emissions with Tree Planting

Geoff Strong [1] , *Brian Barge* [2]

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Presented by / Présenté par: ***Geoff Strong***
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Most countries acknowledge the need to significantly reduce carbon emissions to slow down climate change. However, there is no universal agreement on how best to accomplish this. Annual global carbon emissions now exceed 35 GT, while Canada's annual share hovers around 730 MT. Many climate plans, including Canada's, include an emphasis on the sequestration of carbon dioxide (CO2) by trees, but is this a valid approach?

The carbon cycle and photosynthesis are well understood, where CO2 is taken from the air and combined with nutrients and water from soils to produce plant growth, while oxygen is released for use by animals and humans. Many climate plans have therefore assumed that planting millions more trees is a viable means to counter annual carbon emissions, without actual major reductions in emissions. But none of the plans, to our knowledge, reveal the amount of carbon sequestered by trees. Using Douglas Fir and Sugar Maple trees as examples, we show that planting trees to counter annual emissions are a waste of time and effort in the time span of a couple of decades that we have left to solve the climate crisis. We discuss this insight in the context of Canada's climate plan and the best path forward to reduce carbon emissions.

Session: 7021 BC Extreme Events I: Atmospheric Rivers and Associated impacts - Part 2 Événements extrêmes de la Colombie-Britannique I: Rivières atmosphériques et les impacts associés - Partie 2 **01/06/2022 12:55**

ID: 11849 Contributed abstract

Poster Order:

The climatological context of the mid-November 2021 floods in BC

Tamar Richards-Thomas [1] , *Stephen Déry* [2] , *Ronald Stewart* [3] , *Julie Thériault* [4]

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Presented by / Présenté par: ***Tamar Richards-Thomas***
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In recent years, British Columbia (BC) has experienced several large-scale, destructive flood events that caused significant economic and social effects on many communities. Several of these floods were driven by atmospheric rivers (ARs) and their associated heavy rainfall. The most dramatic of these ARs affected southern BC in mid-November 2021 and it caused catastrophic flooding that triggered immediate evacuations and the displacement of up to 20,000 residences. This event is BC's costliest natural disaster, but it needs to be placed into a historical context. This will help decision-makers to develop flood resilient communities.

This study included over 20 extreme flood events over the last 21 years in BC, inclusive of the mid-November 2021 flood event. A map of these flood events showed that rainfall and snow-related events dominated the southwest and southeast (and eastern) regions of BC, respectively, but a mixture of both in the northeast and central regions. The dates of occurrence of the flood events showed a bi-modal structure with a dominant peak in spring to early summer and a secondary peak in fall, where two of the seven flood events occurred in November. The spring-summer and fall are dominated by snowmelt and rainfall-related events, respectively, suggesting that spring annual peak flow may be triggered by substantial snowmelt and either intense or prolonged rainfall increases flow rates to nearby streams.

A focus on the mid-November 2021 flood event showed that several factors led to the catastrophic flooding. These included a spike in temperature, which was interlinked with intense precipitation, strong AR winds, and rapid snowmelt at higher elevations. The previous development of a deep snowpack surrounding flood plains furthermore contributed to the magnitude of the flood.

Session: 7021 BC Extreme Events I: Atmospheric Rivers and Associated impacts - Part 2 Événements extrêmes de la Colombie-Britannique I: Rivières atmosphériques et les impacts associés - Partie 2 **01/06/2022 13:10**

ID: 11732 Contributed abstract

Poster Order:

Atmospheric Rivers Leading to the Catastrophic Flooding in Western Canada in November 2021: A Comprehensive Study

Ruping Mo [1] , *Melinda Brugman* [2] , *Gary Geng* [3] , *Anthony Liu* [4] , *Hai Lin* [5] , *Shunli Zhang* [6] , *Manon Faucher* [7] , *Radenko Pavlovic* [8]

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Presented by / Présenté par: ***Ruping Mo***
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The landfall of a strong atmospheric river (AR) over the south coast of British Columbia (BC) during 13–15 November 2021 triggered one of the most destructive and expensive weather disasters in Canadian history. The extremely heavy and prolonged precipitation gave rise to a catastrophic flooding situation with multiple mudslides, debris flows, and highway washouts. Here we perform a comprehensive analysis of the important hydro-meteorological factors and forecast challenges related to this high-impact storm. It is shown that a North Pacific short-wave train was responsible for pushing two consecutive ARs onto southern BC within a 5-day period. The first AR, which had a connection with moisture sources in the tropical western Pacific, made landfall on the BC south coast around 0000 UTC 12 November and spread heavy rainfall into the Lower Mainland with snow over the mountains. The second AR was a typical Pineapple Express that brought warm, moist air from the Hawaii and made landfall around 0000 UTC 14 November. The pressure pattern forced the AR to penetrate into the Lower Fraser Valley, where the orographic convergence led to extremely heavy precipitation. The warm advection with the AR led to the rapid snowmelt over the mountains, leading to the disastrous flooding. Our analysis suggests that the short-wave train could be linked to the Madden-Julian Oscillation in phase 4, and the warm anomalies of sea surface temperature in the subtropical North Pacific could be a crucial factor for the AR developments. Overall, these two ARs were well forecast by the numerical weather prediction (NWP) models of Environment and Climate Change Canada (ECCC). The Global Deterministic Prediction System was capable of providing guidance for the first and second ARs with useful lead times up to five and three days, respectively. The forecast skills of higher-resolution models of ECCC are also investigated.

Session: 7021 BC Extreme Events I: Atmospheric Rivers and Associated impacts - Part 2 Événements extrêmes de la Colombie-Britannique I: Rivières atmosphériques et les impacts associés - Partie 2 **01/06/2022 13:25**

ID: 11767 Contributed abstract

Poster Order:

Big Storms, Landslides & Worker Safety

Matt Sakals [1] , *Ben Kerr* [2] , *Sina Shabani* [3]

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Presented by / Présenté par: ***Matt Sakals***
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Worker safety can be strongly affected by wet weather conditions on coastal British Columbia. High magnitude hydrometeorological storm events combined

with steep and potentially unstable terrain can cause significant landslide risk in areas of active timber harvest and road construction. Although in most cases, the actual storm totals associated with specific landslides are not known, here a relation is sought between previously recorded hydrogeomorphic events (landslides, debris flows, and erosion events) and archived forecasts of hydrometeorological factors. Classification of hydrogeomorphic event type is expected to lead to better characterization of influencing storms as the hydrogeomorphic processes have different responses to various hydrometeorological drivers. Ultimately, a forecasting system is sought that would link assessments of terrain stability hazard with specific threshold hydrometeorological events. Such a development would allow information regarding the occurrence and magnitude of storms impacting remote worksites to be used to schedule high risk work during benign weather periods and result in a reduction of the exposure of workers to hazardous conditions.

Session: 7021 BC Extreme Events I: Atmospheric Rivers and Associated impacts - Part 2 Événements extrêmes de la Colombie-Britannique I: Rivières atmosphériques et les impacts associés - Partie 2 **01/06/2022 13:50**

ID: 11727 Contributed abstract

Poster Order:

Using projections of extremes to reduce future risks: lessons learned from a 2010 climate risk assessment on the Coquihalla

Zane Sloan [1] , *Trevor Murdock* [2]

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Presented by / Présenté par: ***Trevor Murdock***
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Extreme weather has caused service disruptions and catastrophic failure to highway infrastructure for as long as there has been highway infrastructure. It was for this reason that the BC Ministry of Transportation and Infrastructure (BC MoTI) was one of the very first active users of regional climate services when the Pacific Climate Impacts Consortium was formed in 2005. To understand what risks climate change might pose to highways, a series of case studies was undertaken using a climate risk assessment methodology called the PIEVC Protocol. One of those case studies was for a 45 km section of the Coquihalla Highway 5, between Hope and Merritt, BC, which revealed 14 highway infrastructure categories at high risk from extreme precipitation including atmospheric rivers. Each disruption and catastrophic failure during the November 2021 flood disaster was among the high risk categories identified in the risk assessment published over a decade ago.

This presentation will briefly describe the processes used by planners and engineers in BC to identify highway infrastructure at high risk to climate change, and how future climate projections are used in these processes. A critical reflection will be provided on what can be learned from this experience and some ways that risk assessments may be improved to better identify specific locations where infrastructure may fail in a changing climate will be described. This will include both different types of risk assessments as well as development of climate projections such as multi-variate indices and sequential

events.

Session: 7021 BC Extreme Events I: Atmospheric Rivers and Associated impacts - Part 2 Événements extrêmes de la Colombie-Britannique I: Rivières atmosphériques et les impacts associés - Partie 2 **01/06/2022 14:05**

ID: 11499 Contributed abstract

Poster Order:

The Tahtsa Ranges Atmospheric River Experiment (TRARE)

Kelly Hurley [1] , *Jeremy Morris* [2] , *Emile Cardinal* [3] , *Derek Gilbert* [4] , *Anna Kaveney* [5] , *Bruno Sobral* [6] , *Julie Theriault* [7] , *Hadleigh Thompson* [8] , *Stephen Dery* [9]

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Presented by / Présenté par: ***Stephen Dery***
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In September and October 2021, the Tahtsa Ranges Atmospheric River Experiment (TRARE) was held to collect detailed hydrometeorological data on atmospheric rivers and other mid-latitude storms impacting British Columbia’s upper Nechako Watershed and surrounding regions. A total of 11 precipitation events, including three atmospheric rivers, yielded a cumulative precipitation total of 250 mm at Huckleberry Mine, the primary field site. This presentation will review the TRARE experimental setup that comprised six principal field sites, along with 14 secondary ones where high-frequency (up to the minute-scale) hydrometeorological data were collected. The setup included an array of four micro rain radars, four laser disdrometers, four meteorological stations, Hotplate and weighing precipitation gauges, plus a network of tipping bucket rain gauges. Water measurements, including temperatures, levels and flows for two alpine creeks and one lake, were also collected. Additional measurements of vertical atmospheric profiles from radiosondes, supplemented by in situ visual observations at two sites, provide a comprehensive database to characterize storm evolution and precipitation distribution in the area. The presentation will highlight data from two case studies, including an intense atmospheric river that made landfall in the vicinity of the study area. A brief discussion on training and outreach opportunities during TRARE will close the presentation.

Session: 9011 General Hydrology - Part 2 Hydrologie générale - Partie 2 **01/06/2022 12:55**

ID: 11806 Contributed abstract

Poster Order:

Evaluation of Soil Erosion Models for Application in the Canadian Prairie

Environment
Peter Lawford [1] , *John Pomeroy* [2]

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Presented by / Présenté par: ***Peter Lawford***
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Soil erosion and sediment transport in runoff is an important factor in transport of phosphorous from agricultural fields to waterways. It can be affected by agricultural land use practices, geomorphology, soil texture and climate. In the Canadian Prairies, the role of snowmelt runoff over partially frozen soils and post-melt rainfall-runoff events as well as variable contributing areas adds considerable complexity and uncertainty to estimating sediment loads. In this work a selection of soil erosion models is evaluated for suitability on the Canadian Prairies by evaluation in the agriculture-dominated South Tobacco Creek Basin (STC), Manitoba. STC has been well studied for monitoring agricultural land management and relationships to streamflow and water quality metrics. Models considered include a chemostatic approach, modified universal soil loss equation (MUSLE), and an approach from Cold Regions Hydrological Model with Water Quality (CRHM-WQ).
Evaluation is based on qualitative factors such as configuration requirements and quantitative metrics such as sensitivity to limitations in precipitation and streamflow availability, with consideration for the different dynamics of spring thaw and summer storm periods. The capacity for each model to capture variations from changing land management practices is also considered. It is expected that such an evaluation will provide an impetus for further advances in modeling soil erosion and pollutant transport on the Canadian Prairies.

Session: 9011 General Hydrology - Part 2 Hydrologie générale - Partie 2 **01/06/2022 13:10**

ID: 11790 Contributed abstract

Poster Order:

Impacts of climate change and anthropogenic activities on the hydrology of British Columbia's Nechako River Basin

Rajtantra Lilhare [1] , *Stephen Dery* [2]

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Presented by / Présenté par: ***Rajtantra Lilhare***
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In this study, we simulate hydrological processes over the Nechako River Basin (NRB), which is the second largest sub-watershed of British Columbia's Fraser River Basin. The NRB is heavily regulated after the development of Kemano project in the mid-1950s, which created the 922 km2 Nechako Reservoir while diverting ~50% of the upper Nechako's flows to produce hydroelectricity at the Kemano Powerhouse. In this research, we utilize the Variable Infiltration Capacity model (version 5.0.1) (VIC5) forced by the European Centre for Medium-Range Weather Forecasts (ECMWF) Re-Analysis (ERA)5-Land at high

spatial (~5 km) and temporal resolutions. We applied VIC5 over the entire NRB for 1950–2019 after model calibration and evaluation over unregulated sub-basins (i.e., Stuart and Nautley). We have incorporated the upper Nechako (Nechako Reservoir catchment) in calibration and validation processes under naturalized flow conditions. Further, we compare these naturalized VIC5 simulated flows against observations to quantify streamflow regulation vs climate change effects across the reservoir. Moreover, this study also evaluates impacts of landcover changes (e.g., forest fires, deforestation, pest infestations, etc.) and its cumulative effects with climate change and regulation on the hydrology of the NRB and its tributaries. Simulations reveal overall increasing trends (although not significant) in annual water balance components (i.e., evapotranspiration, surface runoff and baseflow) due to warmer and wetter climatic conditions across the Nechako Reservoir for 1981–2019. Further, sensitivity simulations (1981-2019), in which we alter landcover inputs (grasslands replacing forests) reveal increasing trends in annual surface runoff and baseflow coupled with decreasing trends in evapotranspiration. Outcomes from this research will provide crucial information on the potential impacts of land cover changes and wildfires on the hydrology of western Canada and similar hydro-climatic regimes. Additionally, this research will also benefit with planning and management of future infrastructure development and flow regulation within the watershed as anticipated future warming necessitate an increased focus on the NRB's long term water security.

Session: 9011 General Hydrology - Part 2 Hydrologie générale - Partie 2 **01/06/2022 13:25**

ID: 11400 Contributed abstract

Poster Order:

Stream temperature response to climate variability in a forested landscape dominated by small lakes

Danielle Hudson [1] , *Jason Leach* [2] , *Daniel Houle* [3]

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Presented by / Présenté par: ***Danielle Hudson***
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Stream temperature is an important driver of aquatic ecosystems. There are concerns that environmental changes, such as climate variability and forest harvesting, are altering stream thermal regimes with potentially negative impacts on cold-water fish. In many northern landscapes, small lakes are abundant within stream networks and yet we know little about how these lakes influence downstream thermal regimes, particularly within the context of climate change. To address this knowledge gap, we used a 35 year record of routine spot measurements collected at nine sites distributed along a stream-lake network within the Turkey Lakes Watershed near Sault Ste. Marie, Ontario. Despite increases in summer air temperature (0.2 °C/decade), streams did not appear to warm at the same rate (mean increase in summer stream temperature of 0.06 °C/decade across all sites) and some sites even exhibited decreasing trends in summer water temperatures. In contrast, most streams exhibited warming trends in the autumn (0.39 to 0.73 °C/decade) that exceeded increases in autumn air temperature (0.34 °C/decade). Streams located

downstream of lakes had higher autumn warming trends (mean of 0.54 °C/decade) than streams without lakes (mean of 0.28 °C/decade). This study highlights that a focus on summer stream temperatures may mask important responses to climate change in other seasons. In addition, small lakes distributed throughout stream networks can influence stream temperature response to climate variation.

Session: 9011 General Hydrology - Part 2 Hydrologie générale - Partie 2 **01/06/2022 13:50**

ID: 11407 Contributed abstract

Poster Order:

Snowmelt water partitioning in Seasonally Frozen Soils: Insights from field observations

Ines Sanchez-Rodriguez [1] , *Andrew Ireson* [2]

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Presented by / Présenté par: ***Ines Sanchez-Rodriguez***
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A better understanding of the snowmelt water partitioning between runoff and infiltration might improve the water management practices in cold regions during spring melt. In the Canadian prairies, snowmelt is the dominant water input to the soil, streams and groundwater. Historically, the worst floods in this region have been driven by snowmelt runoff. Water for crops, taking up 80% of the agricultural land in Canada, heavily relies on snowmelt infiltration. The objective of this study was to use field observations from St. Denis, Saskatchewan, to describe: a) how snowmelt and spring rainfall over seasonally frozen soils are partitioned between infiltration and runoff; b) what happened to infiltration water within the frozen soils, and c) how groundwater recharge is generated during the spring thaw period.

Session: 9011 General Hydrology - Part 2 Hydrologie générale - Partie 2 **01/06/2022 14:05**

ID: 11472 Contributed abstract

Poster Order:

Assessing channel geometry in response to land use disturbance in a low-relief, glacially conditioned region

Pamela Tetford [1] , *Joseph Desloges* [2]

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Presented by / Présenté par: ***Pamela Tetford***
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Bankfull flow represents the highest elevation at which a river channel contains its flow before overbank flooding occurs. At bankfull stage, the channel boundary experiences the highest shear stress producing somewhat predictable

hydraulic relationships and channel cross-sectional form. However, research suggests that land use affecting flow has a profound impact on a channel's 'natural' hydrogeomorphic response. There are two common approaches to identifying bankfull flow: using flow frequency estimates from long-term historical flow data and using stream morphology or channel form. In this study, flood frequency is assessed from 207 hydrometric gauge records and compared to field-measured channel cross-sectional form of 140 alluvial river reaches in southern Ontario. The objective is to develop a reliable downstream hydraulic geometry relationship in terms of flood frequency and magnitude, derive bankfull flow estimates based on channel morphological criteria, and compare hydrologically derived discharge estimates to a channel's morphological capacity while considering the influence of upstream land use. Goodness-of-fit tests determine varying optimal probabilistic distributions (i.e., log-Normal, Gumbel, log-Pearson Type-III, or Generalized Extreme Value) when modelling annual maxima series (AMS) flood data whereas the log-Pearson Type-III distribution is optimal for partial duration series (PDS) flood data. An analysis of variance indicates no statistically significant difference between the 2-year discharge, Q2, estimates using AMS or PDS data when applied to an accepted discharge-drainage area relationship. Survey derived estimates of Q2 are found to be greater than gauge derived Q2 values for smaller drainage areas (<100 km2). Channels impacted by low levels of anthropogenic disturbance demonstrate a near constant and higher width to depth ratio (w/d). Reaches impacted by moderate to high levels of anthropogenic disturbance demonstrate an increase in w/d with upstream drainage area. Channels impacted by high levels of disturbance show statistically significant lower w/d values among the three disturbance levels ($p<0.001$).

Session: 9011 General Hydrology - Part 2 Hydrologie générale - Partie 2 **01/06/2022 14:20**

ID: 11660 Contributed abstract

Poster Order:

Understanding Snow Representation in the Noah-MP Model through a Single Column Experiment

Engela Sthapit [1] , *Mimi Hughes* [2] , *Tarendra Lakhankar* [3] , *Reza Khanbilvardi* [4] , *Robert Cifelli* [5] , *Kelly Mahoney* [6] , *William Currier* [7]

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Presented by / Présenté par: ***Engela Sthapit***
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Accurate prediction of land-surface and hydrological processes is a challenging task for numerical water prediction models due to uncertainties in both meteorological forcing variables, and in what parameterizations are most appropriate to accurately reproduce small-scale land and atmospheric processes of the area. Snow influences land-atmosphere interactions but the snowpack properties such as snow water equivalent (SWE) and snow depth

(SD) are difficult to estimate in land surface models. This study focuses on understanding snow representation in the Noah-MP land surface model, through a single column experiment, based on a location in Caribou, Maine. First, Noah-MP-simulated SWE and SD were compared using meteorological forcing from two datasets -- the North American Land Data Assimilation System version 2 (NLDAS-2) and in-situ station observations (Station) – for water years 2014-2019. Simulated SWE and SD from NLDAS2-Noah-MP were consistently higher than those estimated from the Station-Noah-MP simulation. This difference was linked to a low bias in 2 m air surface temperature in NLDAS-2, which affected the precipitation partitioning to rain and snow, as parameterized in Noah-MP. Second, the simulated SWE and SD were compared to the observed values during water year 2019. Observed SWE and SD were both higher than the simulated values from both models. This difference could be due the differences in scales in the model grid versus the in-situ point measurement. In addition, wind transport of snow could be another factor effecting the observed values, as the wind-blown snow re-deposition is an active process in the observed but not accounted for by the Noah-MP.

Session: 14011 Eastern Snow Conference General Session - Part 2 Session générale de la conférence de l'est sur la neige - Partie 2 **01/06/2022 12:55**

ID: 11722 Contributed abstract

Poster Order:

Overview of SnowEx field campaign in Northern Alaska, U.S.

Carrie Vuyovich [1] , *Svetlana Stuefer* [2] , *Hans Peter Marshall* [3] , *Michael Durand* [4] , *Kelly Elder* [5] , *Dragos Vas* [6] , *Arthur Gelvin* [7] , *Batuhan Osmanoglu* [8] , *Christopher Larsen* [9] , *Stine Pedersen* [10] , *Daniel Hodkinson* [11] , *Elias Deeb* [12]

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[9] University of Alaska - Fairbanks
[10] Colorado State University
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Presented by / Présenté par: ***Carrie Vuyovich***
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Snow Experiment (SnowEx) was initiated by NASA’s Terrestrial Hydrology Program in 2017 to "enable trade studies for a snow satellite mission design." The specific focus of SnowEx is on testing and maturing technology for satellite remote sensing of global snow water equivalent (SWE). Currently, the SnowEx team is planning an airborne and ground-based snow campaign in Alaska in 2022–2023 to address SWE and snow depth measurement questions unique to taiga and tundra snowpacks. Three SnowEx sites are selected in Interior Alaska, a boreal forest environment with discontinuous permafrost and seasonal

taiga snowpack. Two SnowEx sites are located on the North Slope of Alaska, a region dominated by low-stature land cover, tundra snowpack, and continuous permafrost. A suite of airborne and ground-based validation activities will take place in fall 2022 and spring 2023 to quantify and compare the capabilities of radar and altimetry sensors to measure differences in SWE and snow depth accumulation during one winter season. The same set of sensors was tested by the SnowEx team in mountain ranges and temperate forests of the Western U.S. in 2017─2021. When taken together, the SnowEx field campaigns provide snow datasets in support of testing and advancement of remote sensing, modeling, and measurements techniques needed for the development of global SWE products. This presentation focuses on the objectives of the boreal forest and tundra SnowEx campaign and presents an overview of upcoming field activities in Alaska.

Session: 14011 Eastern Snow Conference General Session - Part 2 Session générale de la conférence de l'est sur la neige - Partie 2 **01/06/2022 13:10**

ID: 11657 Contributed abstract

Poster Order:

Observationally constraining a snow-on-sea-ice model to estimate Arctic snow and sea ice thickness with associated uncertainties

Alex Cabaj [1], *Paul Kushner* [2], *Alek Petty* [3]

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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. Snow depth is also a key input for sea ice thickness derived from ice altimetry measurements, such as satellite lidar observations from ICESat-2. Making direct snow measurements is logistically challenging in the Arctic due to the remoteness of the region, so basin-wide snow depth on sea ice is difficult to observationally constrain. Likewise, uncertainties in snow on sea ice and in derived sea ice thickness are challenging to quantify.

Snow-on-sea-ice models, such as the NASA Eulerian Snow On Sea Ice Model (NESOSIM), can provide basin-wide snow depth and density estimates over Arctic sea ice. NESOSIM includes free parameters which dictate the strength of snow densification and loss processes, but these parameters are not directly observationally well-constrained. We present a calibration of NESOSIM to snow depth and density observations using a Metropolis Markov Chain Monte Carlo method. This method provides estimates of the model free parameters and their uncertainty distributions. We propagate the parameter uncertainty estimates through NESOSIM to produce uncertainty estimates for model-output snow depth and density. Finally, we estimate the resulting sea ice thickness using NESOSIM snow output and ICESat-2 altimetry measurements, and quantify the contribution of snow uncertainty to uncertainty in sea ice thickness.

Session: 14011 Eastern Snow Conference General Session - **01/06/2022**

ID: 11808 Contributed abstract

Poster Order:

Evaluating Fourteen Gridded SWE products using Airborne Gamma Radiation SWE and Snow Courses Transacts

Eunsang Cho [1] , *Colleen Mortimer* [2] , *Lawrence Mudryk* [3] , *Chris Derksen* [4] , *Carrie Vuyovich* [5] , *Mike Brady* [6]

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Presented by / Présenté par: ***Eunsang Cho***
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Snow-related research in hydrological and climate sciences at continental and global scale typically rely on spatially distributed snow water equivalent (SWE) products. Recently, many gridded SWE datasets have been developed from climate, snow, hydrological sciences community, which must be validated with independent and reliable observations in various environments. Such validation is challenging due to limited spatial coverage of available reference data (e.g. snow course transects, and airborne flight lines) particularly in complex terrains, thus validation with multiple sources of reference data is required. In this study, we quantify 1) the spatial representativeness of SWE estimates from airborne gamma radiation measurements through comparisons at different distances from snow course transects and 2) the performance of fourteen gridded SWE products using gamma and snow course reference datasets over the continental U.S. and southern Canada.
Results show strong agreement between the gamma measurements and snow course transects at distances up to at least 50 km in the northeastern U.S. However, there is limited agreement beyond 5 km in the western U.S. likely due to more limited spatial representativeness of the gamma observations in complex topography. Among fourteen gridded SWE products, ERA5-Land and University of Arizona SWE showed the best performance with both reference SWE observations. This work supports global SWE evaluation efforts within the European Space Agency (ESA) Satellite Snow Product Intercomparison and Evaluation Exercise (SnowPEx), by providing guidance on integrating different sources of reference data.

Session: 14011 Eastern Snow Conference General Session - Part 2 Session générale de la conférence de l'est sur la neige - Partie 2 **01/06/2022 13:40**

ID: 11824 Contributed abstract

Poster Order: Poster-14011

Local scale soil-snow interaction and the impacts of soil on snow characteristics

Mahsa Moradi [1] , *Jennifer Jacobs* [2] , *Adam Hunsaker* [3]

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Presented by / Présenté par: ***Mahsa Moradi***
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The complex interaction between soil and snowpack via energy and mass exchange processes is a critical component of winter at cold regions and has significant consequences for hydrological and ecological cycles. While the impacts of snowpack on the underlying soil and its thermodynamic processes have been widely studied, there are limited studies on soil contributions to the temporal evolution and spatial distribution of snowpack characteristics. The goal of this study is to understand if and how soil exerts controls on snowpack evolution over the course of winter at local scale. The hypothesis is that the soil layers with different physical properties have different thermal and hydrological regimes which impact some characteristics of their overlying snowpack such as its temperature profile. Using observational data at three sites, this study investigates a) if observed depth, temperature, and albedo of snowpacks over different soil layers evolve differently during accumulation and ablation periods and b) how soil physical properties contribute to the temporal evolution of the snowpack characteristics. The study sites, located at the University of New Hampshire Thompson Farm Research Station, Durham, New Hampshire, USA, are selected to represent spatial variability of soil properties and snow depth over the study region. Detailed and continuous observations of meteorological variables, ground heat flux, soil states and snow characteristics including temperature, depth and albedo are collected at these sites to investigate the role of soil layer on snowpack development.

Session: 14011 Eastern Snow Conference General Session - Part 2 Session générale de la conférence de l'est sur la neige - Partie 2 **01/06/2022 13:40**

ID: 11776 Contributed abstract

Poster Order: Poster-14011

Conductive Heat Flow Through Temperate Region Lake Ice

Laura Alvarez Salinas [1] , *Laura Brown* [2]

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Presented by / Présenté par: ***Laura Alvarez Salinas***
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Understanding the conductive heat flow through lake ice is important to understanding the future of lake ice in a changing climate. Temperate lake ice has a different composition compared to arctic lake ice due to the warmer and wetter climate experienced in more southern latitudes. With limited research, there is a need to study how conductive heat flow travels through the ice layers in temperate regions. Consequently, this research focuses on expanding research in temperate lake ice by providing the first in-depth look at heat flux through the predominantly white ice layers found in the temperate region. This

research investigates the temperature gradients within both black and white ice, and the snowpack on top of the ice, while also looking at lake ice thickness over the span of six years from 2017 to 2022. The area of study consists of two lakes in Central Ontario: Macdonald Lake and Clear Lake. Snow and ice measurements have been collected along 4 sampling transects (snow depth, density, temperature, grain type, albedo, ice thickness, ice type) while heat flow was measured through the ice using thermistors at a single location. Data collected has shown climate variability throughout the collection period, with thicker white ice in the most recent years compared to earlier years. Moreover, the data collected from the thermistors allows an insight on how conductive heat flow occurs through both the black and white ice. Furthermore, snowpack data also reflects climate variability by exhibiting different patterns in the temperature profile which has reflected variations in degrees of annual slushing. This research aids to show how heat transfers through the ice layers and allow for a more thorough understanding of the effect that heat flow has on temperate region lake ice, greatly expanding the field.

Session: 14011 Eastern Snow Conference General Session - Part 2 Session générale de la conférence de l'est sur la neige - Partie 2

01/06/2022 13:40

ID: 11837 Contributed abstract

Poster Order: Poster-14011

Using Unpiloted Aerial Systems Structure From Motion Photogrammetry for Avalanches in Mount Washington, NH

Cameron Wagner [1], *Adam Hunsaker* [2], *Tim Hoheneder* [3], *Jennifer Jacobs* [4]

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Presented by / Présenté par: ***Cameron Wagner***
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Unpiloted Aerial Systems (UAS) collected structure from motion (SfM) photogrammetry is a proven effective high resolution snow depth measurement technique with a potential for avalanche forecasting. In winter 2021/2022, a series of flights were conducted in Tuckerman Ravine and Boott Spur Gullies avalanche zones on Mount Washington, NH, USA. The goal of these flights was to: (1) quantify wind slab depth across varying aspect terrain, (2) model wind slab distribution over the same terrain given actual meteorological conditions, and (3) engage with the Mount Washington Avalanche forecasters and backcountry skiers. Mount Washington east aspect glacial cirques were chosen for this project due to their predominant wind slab avalanche problem attributed to common hurricane force winds and ample snowfall in fetch areas above the cirques. Ground truthing was conducted to quantify the SfM effectiveness in measuring snow depth in this hostile mountain environment. It is found that UAS collected SfM photogrammetry is effective in quantifying wind slab depth with a 5 cm spatial resolution. Qualitative methods and results from stakeholder engagement will also be presented.

Session: 14011 Eastern Snow Conference General Session - Part 2 Session générale de la conférence de l'est sur la neige - Partie 2

01/06/2022 13:50

ID: 11485 Contributed abstract

Poster Order:

Tundra snow depth retrievals from wideband radar observations in Trail Valley Creek

Wei Wang [1] , *Kelly Richard* [2] , *Joshua King* [3]

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Presented by / Présenté par: ***Wei Wang***
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Recent experiments have explored the potential of using airborne wide-band snow radar observations to estimate snow accumulation. Most if not all experiments have focused on sea ice applications with a series of campaigns conducted by Operation Ice Bridge (OIB) successfully demonstrating the applicability of wideband observations (2-8 GHz) to estimate snow on sea ice. Most applications of the wideband approach for terrestrial snow applications have been conducted using ground-based systems. However, in 2019 a wideband radar system (2-18 GHz) was flown over Trail Valley Creek in the North West Territories, Canada coinciding with ground-based field measurements of snow depth and SWE properties from a range of measurement systems. This paper describes the application of the using the interface-based pulse peakiness snow depth retrieval method to estimate snow on land. The approach was tested on the six major vegetation types present at the study area (white and black spruce trees, tall shrub, riparian shrub, dwarf shrub, tussock, and lichen). Snow depth derived from Airborne Laser Scanner (ALS) point clouds was used as the reference for snow depth retrieval. To address the differences between snow on land and on sea ice, a recalibration of the algorithm parameters was completed as well as introducing additional measures to screen abnormal observations with a low Signal to Noise Ratio. It was concluded that the principles behind the pulse peakiness approach was generally valid for tundra snow depth estimates at study sites characterized by smooth and low slope surfaces and with low stand vegetation. The presence of surface vegetation and increased surface roughness led to increased complexity of radar waveforms, which resulted in increased snow depth retrieval uncertainty.

Session: 14011 Eastern Snow Conference General Session - Part 2 Session générale de la conférence de l'est sur la neige - Partie 2

01/06/2022 14:05

ID: 11446 Contributed abstract

Poster Order:

How Do Microwaves Interact with Freshwater Ice, and Why Is It So Important?

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Presented by / Présenté par: ***Grant Gunn***
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We present the history of literature's understanding of microwave interactions with freshwater ice, and the potential that the current generation of spaceborne SAR sensors present for ice property retrieval. In the 1970s, Side Looking Airborne Radar (SLAR) imaged frozen thermokarst lakes on the coast of the Alaskan north coast as a byproduct of observing sea ice features. Elongated lakes were bright in the imagery compared to the dark tundra, which was hypothesized to be the result of long cylindrical bubble inclusions within the ice column causing a double bounce of the incident signal (scattered by the bubble, reflected off the ice-water interface and back to the sensor).
The double-bounce hypothesis was pervasive into the 2010s, until fully polarimetric acquisitions (quad-pol, HH/VV/VH/HV) became accessible over northern lakes. Quad-pol SAR data allowed for the application of polarimetric decomposition algorithms (e.g. Freeman-Durden) which provide a measure of the relative contribution of surface, double-bounce, and volume scatter interactions with targets based on the covariance matrix. Recent publications and the results presented in this study indicate that lakes, regardless of frequency (L- to X-band), incidence angle, ice structure, or morphometry overwhelmingly display odd-bounce surface interactions from the ice-water interface as the dominant scattering mechanism (as opposed to double-bounce). With the understanding that the dominant source of scatter occurs at the ice-water interface, the direct retrieval of changes in ice thickness highlight the potential ice properties that can be obtained using the current generation of SAR satellite constellations. This study presents preliminary analysis of ice thicknesses directly measured from TanDEM-X using repeat-pass interferometry for multiple regions in northern Canada and Alaska.

Session: 14011 Eastern Snow Conference General Session - Part 2 Session générale de la conférence de l'est sur la neige - Partie 2 **01/06/2022 14:20**

ID: 11412 Contributed abstract

Poster Order:

Snow depth on sea ice record from 1955-2019 in the Canadian Arctic and development plans for multi-satellite snow depth retrieval

Hoi Ming Lam [1], *Torsten Geldsetzer* [2], *Stephen Howell* [3], *John Yackel* [4]

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[3] Environment Canada and Climate Change
[4] University of Calgary

Presented by / Présenté par: ***Hoi Ming Lam***
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Using in situ snow depth measurements at 11 Canadian study sites from the period 1955-2019, we study the intra-annual and decadal trends in snow accumulation on landfast sea ice and on terrestrial ground within the Canadian

Arctic. Ice chart data acquired via the Canadian Ice Service are used to establish sea ice break-up and freeze-up dates and assess their impact on snow depth evolution. We find that on-ice and on-land snow accumulation in autumn differ due to the lag between the freeze-up and the first snow of the season. Once sea ice consolidates, on-ice and on-land snow depth become positively correlated in winter ($p<0.05$). The mean seasonal rate of snow accumulation on sea ice from September to April is 3.2 ± 0.6 cm per month across the Canadian Arctic. Snow depth on terrestrial land is generally higher than on sea ice in the southern Canadian Arctic by up to 20 to 30 cm; but snow depth on sea ice tends to exceed that on land in the northern Canadian Arctic from winter to spring. Results have been submitted for publication in a peer-reviewed journal (in print).
As a follow-up study, a machine learning (ML) algorithm is being developed to estimate winter snow depth on landfast sea ice in the Canadian Arctic using measurements from satellite altimeters (ICESat-2 and CryoSat-2) and radar scatterometers (Sentinel-1 and RADARSAT-CM), under the first-order assumption that rougher sea ice, which is signified by higher SAR backscatter, would entrap thicker snow. Preliminary results indicate some correspondence between the altimetric surface heights and SAR backscatter coefficient (sigma-nought). Our proposed approach can provide greater spatial and temporal coverages for snow depth estimates on Arctic landfast sea ice. A field campaign is planned in April 2022 to sample snow on sea ice at near-coincident CRYO2ICE tracks to provide validation datasets.

Session: 2030 Air Quality Science Serving Society Société au service de la science de la qualité de l'air **01/06/2022 14:55**

ID: 11456 Contributed abstract

Poster Order:

AQMAP: A real-time interactive map of PM2.5 in Canada from low-cost and regulatory monitors

Brayden Nilson [1] , *Peter Jackson* [2] , *Corinne Schiller* [3] , *Matthew Parsons* [4]

[1] University of Northern British Columbia | Environment and Climate Change Canada
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[3] Environment and Climate Change Canada | University of Northern British Columbia
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Presented by / Présenté par: ***Brayden Nilson***
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Fine particulate matter (PM2.5) is a primary pollutant of concern in many Canadian cities, especially with the increasing severity and duration of wildfire smoke impacts across the country in recent years. Both acute and chronic exposure to elevated concentrations of PM2.5 have been linked to a myriad of serious health problems including respiratory and heart diseases, lung cancer, diabetes, stroke, and adverse birth effects. Monitoring of PM2.5 in Canada historically has focused on using Federal Equivalent Method (FEM) monitors which are relatively expensive, large, standardized, well-maintained, and provide accurate real-time observations in most Canadian cities for regulatory purposes. Recently, however, a wave of low-cost “small sensors” has spread across Canada (and elsewhere) with over 1000 small sensors currently installed

in Canada alone. Additional small sensors continue to be installed in locations across Canada that lack adequate PM2.5 observations. These sensors are smaller, much lower cost, and require little to no maintenance; many of which provide reasonably correlated data with the FEM monitors at concentrations typical in Canada. In order to support the Canadian public as well as air quality forecasters, we developed a web-mapping tool to display data from some of these small sensors alongside the FEM monitors across Canada, plus other contextual and forecast layers (https://cyclone.unbc.ca/aqmap). We also developed and evaluated a correction algorithm for improving the small sensor performance in comparison with the standardized monitors. This correction is applied by default to the small sensor observations we display and can be evaluated in real-time using our tool. This tool and the additional small sensor observations has proven valuable for forecasters in the 2021 wildfire smoke season for understanding where the smoke is touching the surface and impacting human health.

Session: 2030 Air Quality Science Serving Society Société au service de la science de la qualité de l'air **01/06/2022 15:10**

ID: 11371 Contributed abstract

Poster Order:

Modelling the atmospheric transport of microplastics

Eric Ward [1] , *Mark Gordon* [2] , *Ronald Hanson* [3]

[1] York University
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Presented by / Présenté par: ***Eric Ward***
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In recent years microplastics have been found in various regions around the world, including remote areas, raising questions about the extent of atmospheric transport of microplastic particles. To improve understanding of atmospheric pathways, various size and shape parameters were applied within the HYSPLIT model to simulate microplastic particles and determine the reach of atmospheric microplastic transport and deposition within the North American domain. Tire wear was investigated as a primary emission type for these microplastics, with emissions assumed to be proportional to vehicle kilometres travelled (VKT). The top 100 most populated cities within the continental United States and Canada were chosen for source locations. When modelled for the entire month of July 2021, the size and shape of the microplastics had a significant effect on the overall distance travelled from the source cities. Spherical particles over 5 μm in diameter showed significantly reduced transport distance compared to longer cylindrical particles, or fibres, of the same diameter. In fibres with a sphericity of 0.5 or an aspect ratio L/D of 16.4, the maximum transport distance was up to 30% further compared to equal diameter spherical microplastics. For particles with a diameter between 3 and 5 μm, the difference in transport distance between spherical and elongated fibrous particles was still significant; however, the shape dependence on the distance transported was greatly reduced. At diameters less than 3 μm, there was a negligible difference in the transport distance based on the shape of the microplastic. The results demonstrate the extent of long-range atmospheric transport of microplastics to remote regions of the planet and quantify the influence of shape on the range of the microplastic

particle transports.

Session: 2030 Air Quality Science Serving Society Société au service de la science de la qualité de l'air **01/06/2022 15:25**

ID: 11383 Contributed abstract

Poster Order:

Non-Exhaust Particle Emission Factor of Vehicular Traffic in an Urban Canopy.

Rhythm Reet [1] , *Mark Gordon* [2]

[1] York University
[2] York University

Presented by / Présenté par: ***Rhythm Reet***
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Road traffic emissions are a major contributor to pollution in urban cities. The emissions produced by vehicles can be categorized into two categories: exhaust emissions (30 nm to 500 nm) which form in the engine during the combustion event, and non-exhaust emissions (>500 nm), which originate from brake wear, road abrasion, and road dust resuspension. The type of vehicle, speed, and braking pattern play a role in the type and amount of emissions released. This work investigates the effects of non-exhaust emissions from urban fleets (light-duty vehicles or heavy-duty vehicles), with a focus on the 500 to 1000 nm range. Roadside aerosol concentration and flux measurements were made in Toronto, Ontario using an anemometer to collect turbulent flux data and an Ultra High-Sensitivity Spectrometer (UHSAS), which measured size-resolved particles (50 – 1000 nm). We compare aerosol concentrations between weekends and weekdays. Roadside aerosol fluxes are determined by eddy covariance and footprint analysis and are used to determine the source of the aerosols. The roadside aerosol flux-measurement installation includes a video camera from which the footage was analyzed to differentiate the vehicle type and speed to correlate with size-resolved particles simultaneously. Preliminary results have demonstrated that a higher number of heavy-duty vehicles resulted in higher concentrations of larger particles (>500 nm). Increased traffic congestion, which leads to more frequent acceleration and deceleration, also contributes to higher non-exhaust emissions (> 500 nm). By comparing roadside aerosol fluxes and the analysis of video imaging, this work will demonstrate relationships between vehicle speed and emissions. These results can determine whether lowering speed limits in urban areas can directly improve air quality within the city.

Session: 2030 Air Quality Science Serving Society Société au service de la science de la qualité de l'air **01/06/2022 15:50**

ID: 11487 Contributed abstract

Poster Order:

Impact of deep basin terrain on PM2.5 distribution and its seasonality over the Sichuan Basin, Southwest China

Zhuozhi Shu [1] , *Yongsheng Chen* [2] , *Tianliang Zhao* [3]

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Presented by / Présenté par: ***Zhuozhi Shu***
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The terrain effect on atmospheric environment is poorly understood in particular for the polluted region with underlying complex topography. Therefore, this study targeted the Sichuan Basin (SCB), a deep basin with severe PM2.5 pollution enclosed by the eastern Tibetan Plateau (TP), Yunnan-Guizhou Plateaus (YGP) and mountains over Southwest China, and we investigated the terrain effect on seasonal PM2.5 distribution and the meteorological mechanism based on the WRF-Chem simulation with stuffing the basin topography. It is characterized that the three-dimensional distribution of topography-induced PM2.5 concentrations over the SCB with the seasonal shift of regional PM2.5 averages from approximately 30 μg m-3 in summer to 90 μg m-3 in winter at surface layer and from summertime 10 μg m-3 to wintertime 30 μg m-3 in the lower free troposphere. Such basin-forced PM2.5 changes presented the vertically monotonical declines concentrated within the lower troposphere below 3.6 km in spring, 2.3 km in summer, 2.6 km in autumn and 4.8 km in winter. Impacts of deep basin aggravated PM2.5 accumulation within the SCB and transport toward the surrounding plateaus contributing approximately 50–90 % to PM2.5 levels over the regions of eastern TP and northern YGP. In the SCB, atmospheric thermal structure in the lower troposphere could build a vertical convergence layer between the boundary layer and free troposphere, acting as a lid inhibiting air diffusion, which was regulated by the terrain effects on interactions of westerlies and Asian monsoons, especially the wintertime strong warm lid deteriorating air pollution in the SCB. Furthermore, warm and humid air conditions within the basin prompted sulfur oxidation ratio by +0.02 and nitrogen oxidation ratio by +0.22 effectively producing the secondary PM2.5 in atmospheric environment.

Session: 2030 Air Quality Science Serving Society Société au service de la science de la qualité de l'air **01/06/2022 16:05**

ID: 11536 Contributed abstract

Poster Order:

A New Plume Rise Algorithm - The Thermodynamic Effects of Combustion Water in Buoyant Stack Plumes

Sepehr Fathi [1] , *Paul Makar* [2] , *Wanmin Gong* [3] , *Mark Gordon* [4] , *Junhua Zhang* [5] , *Katherine Hayden* [6]

[1] Air Quality Research Division, Environment and Climate Change Canada, Toronto, Canada; Physics and Astronomy, York University, Toronto, Canada
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[4] Earth and Space Science, York University, Toronto, Canada
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[6] Air Quality Research Division, Environment and Climate Change Canada, Toronto, Canada

Presented by / Présenté par: ***Sepehr Fathi***
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Plume rise estimation from large industrial stacks is parameterized using atmospheric conditions and stack parameters (e.g. effluent temperature and exit momentum), with some form of Briggs parameterizations being employed in large-scale air-quality models (e.g. Environment and Climate Change Canada's GEM-MACH model), evaluated against observed plume heights emitted from industrial sources (e.g., Canadian oil sands). Initial predicted/observed height discrepancies were attributed to meteorological spatial variability between observation and stack locations; stack-location-specific meteorology and plume rise calculations conducted between atmospheric layers improved predicted plume heights. However, more recent observations have shown that predicted plume heights remain biased low, particularly under colder winter conditions, and demonstrate the need for further improvements to plume height calculation algorithms.
We introduce a new algorithm for plume rise calculation, which incorporates thermodynamic effects of the emitted water vapor from industrial stack combustion sources for the first time. High temperature emissions from these stacks usually contain significant amounts of combustion-generated water. As the plume rises and cools, this condenses, increasing plume temperature and buoyancy through the release of latent heat, resulting in additional plume rise. We have developed a revised plume rise algorithm for implementation with GEM-MACH model simulations, by combining the Briggs' parameterizations with thermodynamics of water vapour. Our preliminary results show significant improvement in model plume rise performance, through evaluation against observed plumes in the Canadian Oil Sands. We present initial results from long-term (15 month duration) model simulations with the new versus the original algorithm, along with evaluations against aircraft-based observations of plume height. The potential impact of the condensed in-plume liquid water on aqueous phase processing of emissions will also be discussed. This work is the first plume rise algorithm to incorporate the effects of latent heat release of both combustion-emitted and in-plume ambient-entrained water, for use in air quality models.

Session: 2030 Air Quality Science Serving Society Société au service de la science de la qualité de l'air **01/06/2022 16:05**

ID: 11536 Contributed abstract

Poster Order:

A New Plume Rise Algorithm - The Thermodynamic Effects of Combustion Water in Buoyant Stack Plumes

Sepehr Fathi [1] , *Paul Makar* [2] , *Wanmin Gong* [3] , *Mark Gordon* [4] , *Junhua Zhang* [5] , *Katherine Hayden* [6]

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Presented by / Présenté par: ***Sepehr Fathi***
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Plume rise estimation from large industrial stacks is parameterized using atmospheric conditions and stack parameters (e.g. effluent temperature and exit momentum), with some form of Briggs parameterizations being employed in large-scale air-quality models (e.g. Environment and Climate Change Canada's GEM-MACH model), evaluated against observed plume heights emitted from industrial sources (e.g., Canadian oil sands). Initial predicted/observed height discrepancies were attributed to meteorological spatial variability between observation and stack locations; stack-location-specific meteorology and plume rise calculations conducted between atmospheric layers improved predicted plume heights. However, more recent observations have shown that predicted plume heights remain biased low, particularly under colder winter conditions, and demonstrate the need for further improvements to plume height calculation algorithms.
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Session: 2030 Air Quality Science Serving Society Société au service de la science de la qualité de l'air **01/06/2022 16:20**

ID: 11795 Contributed abstract

Poster Order:

Automated Plume Rise Measurements based on Deep Neural Networks using Video Images

Mohammad Koushafar [1] , *Mark Gordon* [2] , *Gunho Sohn* [3]

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Presented by / Présenté par: ***Mohammad Koushafar***
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When pollutants are released from smokestacks, they rise due to buoyancy and momentum. This plume rise affects how far pollutants are carried downwind, their deposition to the environment, as well as the amount of greenhouse gases mixed into the upper troposphere. Therefore, correctly calculating plume rise for the modelled dispersion of pollutants is of concern in air-quality transport models and local environment assessment cases. Recent studies have shown that the Briggs equations as a popular form of parameterizations in models, significantly underpredict the plume rise. Modern computer vision methods allow the possibility of measuring plume rise under varied atmospheric conditions using video images. Most existing computer vision methods detect smoke clouds by using an estimated bounding box without performing a segmentation down to the pixels level. Our proposed method can accurately detect and segment a plume cloud exiting from a smokestack and consider a hypothetical plume centerline based on an improved DCNN (Deep Convolutional Neural Network). We propose a Mask R-CNN model which can be applied for extracting the region of the plume cloud area of interest. Then, the proposed network is modified with our training dataset and used for detecting the hypothetical centerlines of plume cloud. Therefore, the generated model produces two outputs. First, the plume cloud foreground segments in pixel level and second, multiple lines for representing the central lines from the segmented region. Initial tests have confirmed an underestimation of plume rise using a test smokestack in Northern Alberta. Using our model, conventional plume rise model validation methods and new physical models can be developed.

Session: 4041 Atmosphere, Ocean, and Climate Dynamics - Part 2 La dynamique de l'atmosphère, de l'océan et du climat - Partie 2 **01/06/2022 14:55**

ID: 11463 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

2

Presented by / Présenté par: ***Romina Piunno***

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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, 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.
The large temperature gradients and strong winds during the winter months favour turbulent fluxes of heat. In addition to the model, we investigate the impact of large-scale atmospheric circulation patterns such as the North Atlantic Oscillation, and Icelandic Low on air-sea fluxes over the Labrador Sea, and thus convective overturning.

Session: 4041 Atmosphere, Ocean, and Climate Dynamics - Part 2 La dynamique de l'atmosphère, de l'océan et du climat - Partie 2

01/06/2022 15:10

ID: 11482 Contributed abstract

Poster Order:

Modelling the Atlantic Water along its poleward pathway into and through the Arctic Ocean

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Presented by / Présenté par: ***Adam Fu***
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The thermohaline intrusion of the warm and saline Atlantic Water (AW) into the Arctic Ocean, referred to as “Arctic Atlantification”, has significant implications and feedback to the {thermo}dynamics of the Arctic Ocean. The AW enters the Arctic Ocean through two gateways: Fram Strait and the Barents Sea Opening (BSO), and the relative strength of these two AW branches dominates the oceanic heat contribution to the Arctic Ocean. Numerical modelling is an effective tool to simulate the AW based on its thermohaline properties. The simulations are carried out using the regional configuration Arctic and North Hemispheric Atlantic (ANHA) of the ocean/sea-ice model NEMO run at 1/4° and 1/12° high resolutions. Online passive tracers from both model configurations are used to trace the pathways of the AW inflow in the Arctic Ocean.
We first evaluate the interannual and seasonal variability of the AW thermohaline structure at these two gateways, then quantify the AW volume and heat transport on the interannual and seasonal timescales. We also compare long-term transport means with the available observations to test the model's performance. In our study, we discover two strong Cold AW anomaly events along the rim of the eastern Eurasian Basin during 2013 and 2014, overturning our understanding that the AW is always warm and saline. The dominant contributor to the Cold AW formation is the intense surface sea cooling at the Barents Sea for two consecutive years. By releasing the particles at the Barents Sea Opening and the Fram Strait using an offline Lagrangian product Ariane, we find that the source of the Cold AW is primarily from the Barents Sea Branch Water (BSBW), and it also has some contributions from the Fram Strait Branch Water (FSBW). The Cold AW signals progress along the typical AW poleward pathway and eventually result in the heat content reduction in the AW layer of the eastern Arctic Basin.

Session: 4041 Atmosphere, Ocean, and Climate Dynamics - Part 2 La dynamique de l'atmosphère, de l'océan et du climat - Partie 2

01/06/2022 15:25

ID: 11544 Contributed abstract

Poster Order:

Effects of currents, winds, river flows and tides on salinity in James Bay

MANFRED DESIRE BONGA NYETEM [1], *Cédric Chavanne* [2], *Urs Neumeier* [3]

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Presented by / Présenté par: ***MANFRED DESIRE BONGA NYETEM***

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The salinity of the eastern James Bay is controlled by several large rivers, which discharge patterns were strongly modified by the hydroelectric James Bay Project. We studied salinity variations in James Bay in 2018, 2019, and 2021, as well as the effect of currents, winds, river flows, and tides on these variations. Moorings with tide gauges, acoustic Doppler current profiler (ADCPs), and salinity and temperature loggers were installed for 1-2 months in summer. Salinity and temperature profiles (CTDs) were recorded in summer and winter. Wind data from the ERA5 reanalysis model and river discharge data were also used for the analysis. The results show that the increase in the flow of the Grande Rivière in winter (due to hydroelectric production) produced a 5-m layer of freshwater at the mouth of la Grande Rivière. That layer thickness decreases to 1-3m in summer. The river discharge significantly influences the salinity variations in winter ($p=0.01$). Wavelet analysis showed that salinity and currents were correlated at semidiurnal tidal frequencies ($p<0.05$). In these stratified waters, currents have different effects on salinity depending on the depth. In front of the mouth of the Grande Rivière, dominant bottom currents impact salinity variations on time scales of 2 to 8 days, while surface currents affect salinity over periods of 3 to 4 days at the beginning of summer (June-July). There is a significant effect of prevailing northwest/southeast winds on salinity ($p=0.002$), which is more marked during storms at the summer beginning and the summer end over periods of 3 to 4 days. These results allowed us to describe the salinity variation and quantify the effect of these forcings on seasonal salinity variations in James Bay.

Session: 4041 Atmosphere, Ocean, and Climate Dynamics - Part 2 La dynamique de l'atmosphère, de l'océan et du climat - Partie 2

01/06/2022 15:40

ID: 11845 Contributed abstract

Poster Order: Poster-4041

The Impact of Land on the Fog over Sable Island

Zheqi Chen [1], *Li Cheng* [2]

[1] York University

Presented by / Présenté par: ***Zheqi Chen***
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Marine fog occurs frequently offshore from Atlantic Canada. For flights to coastal locations along the East Coast, including Sable Island, and for helicopter flights to the offshore sites, it can be a problem. From the Climate Normals (1971-2000) of Environment and Climate Change Canada (ECCC), Sable Island has an average of 200 hours (out of 720 or 744) of fog in June and July. It is believed that the marine fog over Sable Island occurs due to warm moist air advected over colder water. Since Sable Island is a long and narrow crescent-shape sand bar, the impact of its land is usually neglected. However, the ECCC hourly reports at the Sable Island A site, about 400 m inland from the South shoreline, show that fog occurrence has a clear diurnal cycle along with the temperature, which is not found in reports over the Grand Banks. It shows that the land has an impact on the fog.

The Weather Research and Forecasting (WRF) model is used to see such impact with different grid point resolutions. With the resolution of 10 km, the grid point at Sable Island is still treated as a water surface, but it can be manually set as a land surface. The two cases of with and without the land surface are simulated for a three-month period from June to August, 2018. A very high resolution of 1.1 km where the land can be seen in detail, is also used in a short period case study on May 31, 2021. The results of 10 km resolution show that having the land surface does not necessarily improve the forecast, since more fogs are missed compared to a water surface. The results of 1.1 km resolution show that the WRF model is able to simulate good details of fog.

Session: 4041 Atmosphere, Ocean, and Climate Dynamics - Part 2 La dynamique de l'atmosphère, de l'océan et du climat - Partie 2

01/06/2022 15:50

ID: 11741 Contributed abstract

Poster Order:

Lagrangian analysis of seasonal and interannual trends in estuarine flow composition and path within Juan De Fuca Strait

Rebecca Beutel [1], *Susan Allen* [2]

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Presented by / Présenté par: ***Rebecca Beutel***
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The deep estuarine flow within Juan de Fuca Strait (JdF) accounts for the majority of the water entering and leaving the Salish Sea, an inland sea between southern Vancouver Island and the coast of British Columbia and Washington State. The health of the Sea’s physically and biologically diverse basins is strongly impacted by the composition of the water within this strait, and the accuracy of models in the region is strongly impacted by our understanding of it. Complex flow at the mouth of JdF means that a catalogue of Pacific currents may play a role. The physical and chemical characteristics of these

currents, and how they are likely to change due to human influence, has been well studied; however, a quantification of their contributions to the composition of JdF flow is a challenge. Within the Salish Sea variable river discharge and wind driven upwelling within the basins adds to the uncertainty. This work aims to provide a comprehensive evaluation of how the source, and thus the chemical and physical composition, of water entering and leaving the Salish Sea varies seasonally and interannually in present day. To do this, we applied Lagrangian tracking to a three-dimensional physical-biological-chemical ocean circulation model of the region, SalishSeaCast, looking at both water parcel trajectories and the volumetric flow of biogeochemical tracers (silicon, nitrate, carbon, temperature, salinity) through the Sea. Five years of simulated flow and tracer flux into and out of the Strait of Georgia and Puget Sound are analyzed, highlighting the distinct difference between summer and winter, and interannual trends. What this tells us about the likely contributions of each Pacific source, and the variability therein, and what this means for the sensitivity of the of the Salish Sea to human influence and climate change will be discussed.

Session: 4041 Atmosphere, Ocean, and Climate Dynamics - Part 2 La dynamique de l'atmosphère, de l'océan et du climat - Partie 2 **01/06/2022 16:05**

ID: 11348 Contributed abstract

Poster Order:

ENSO influence on Bay of Bengal cyclogenesis confined to low latitudes

Ajaya Mohan Ravindran [1] , *Shinto Roose* [2] , *Pallav Ray* [3] , *Reshmi Mohan* [4] , *Kesavapillai Mohanakumar* [5]

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Presented by / Présenté par: ***Ajaya Mohan Ravindran***
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The low latitudinal cyclones (LLCs, originating between 5N and 10N) constitute about 40% of tropical cyclones (TCs) formed in the Bay of Bengal (BoB) with a peak in the post-monsoon season (October to December). We investigate the interannual variability of post-monsoonal BoB LLCs and their teleconnection with El Nino Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD). It is found that the years with the fewer number of BoB LLCs are associated with anomalous equatorial easterlies that are largely connected with the El Nino and positive IOD. Likewise, equatorial westerly phases often associated with the La Nina and negative IOD years favour the LLC formation by providing the initial spin-up required for TC genesis. It is found that the teleconnection between ENSO and BoB TC frequency is significant only if the genesis occurs in the low-latitudinal region. However, the frequency of TCs originating north of 10N during different ENSO and IOD phases does not vary much, except during negative IOD. These results may help extend the lead time and improve the seasonal prediction of BoB TCs, especially those that form at the low latitudes.

Session: 4041 Atmosphere, Ocean, and Climate Dynamics - **01/06/2022**

ID: 11792 Contributed abstract

Poster Order:

What limits the robustness of the separate ocean-atmosphere responses to sea ice loss and greenhouse forcing?

Paul Kushner [1] , *Stephanie Hay* [2] , *Alexandre Audette* [3] , *James Screen* [4]

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Presented by / Présenté par: ***Paul Kushner***
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Experimental protocols with earth system models developed in the last five years allow separation of the effects of greenhouse radiative forcing from greenhouse-forced sea-ice loss on the coupled ocean-atmosphere system. Such experiments provide mechanistic insight, suggest observational tests for finding teleconnected effects of sea-ice loss, and yield clues into how model errors bias teleconnected climate responses. We here explore a tiered assessment of whether responses to greenhouse forcing with constrained Arctic sea ice, versus Arctic sea-ice loss with fixed greenhouse forcing, are additive, in which case a given climate response can be attributed to sea-ice loss or GHGs in isolation; are separable (as quantified by the smallness of the magnitude of spatial pattern correlation between responses), suggesting unique fingerprints to seek in observations; and are robust, i.e. similar and physically plausible in different model-experiments, which adds confidence to model prediction. Model experiments of CNRM-CM5, ECCC CanESM2, and NCAR WACCM4, with forcing protocols for sea-ice loss and greenhouse forcing with constrained sea ice, are assessed. Additivity holds very well, and separability and robustness hold fairly well, for the responses of the atmospheric circulation and for the near-surface response of the North Pacific ocean to Arctic sea-ice loss and greenhouse forcing with constrained sea ice. In the subpolar-to-midlatitude North Atlantic, on the other hand, models are challenged to produce additive signals in the presence of a diversity of oceanic circulation and convective responses, which limits separability and robust attribution of, e.g. regional storm-track and jet-stream changes to sea ice loss. The analysis further suggests that projects like PAMIP need to develop precise coupled sea-ice forcing protocols to obtain consistent responses in regions dominated by oceanic convection and strong atmosphere-ocean coupling.

Session: 5010 General Session on Monitoring Séance générale - Surveillance 01/06/2022 14:55

ID: 11390 Contributed abstract

Poster Order:

Scale separation diagnostics and the Symmetric Bounded Efficiency for the inter-comparison of precipitation reanalyses

Barbara Casati [1] , *Cristian Lussana* [2] , *Alice Crespi* [3]

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Presented by / Présenté par: ***Barbara Casati***
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The ERA5 global reanalysis has been compared against a high-resolution regional reanalysis (COSMO-REA6) by means of scale-separation diagnostics based on 2d Haar discrete wavelet transforms. The presented method builds upon existing methods and enables the assessment of bias, error and skill for individual spatial scales, separately. A new skill score (evaluated against random chance) and the Symmetric Bounded Efficiency are introduced. These are compared to the Nash-Sutcliffe and the Kling-Gupta Efficiencies, evaluated on different scales, and the benefits of symmetric statistics are illustrated. As expected, the wavelet statistics show that the coarser resolution ERA5 products under-estimate small-to-medium scale precipitation compared to COSMO-REA6. The newly introduced skill score enables to show that the ERA5 control member (EA-HRES), despite its higher variability, exhibits better skill in representing small-to-medium scales with respect to the smoother ensemble members. The Symmetric Bounded Efficiency reveals suitable for the inter-comparison of reanalyses, since invariant with respect to the order of comparison.

Session: 5010 General Session on Monitoring Séance générale - Surveillance **01/06/2022 15:10**

ID: 11786 Contributed abstract

Poster Order:

Investigating precipitation trends in the Central and Southern Ontario

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Presented by / Présenté par: ***Daniel Serrano***
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Changes in Lake Ice thickness are closely linked with regional climate variability, mainly temperature and precipitation. Most of the research on lake ice focuses on high latitude lakes which are characterized by thick cold ice and low precipitation amounts (especially rain) relative to the mid-latitudes. This research analyses mid-latitude winter precipitation trends in the Algonquin Lake Nipissing and the Manitoulin-Lake Simcoe ecoregions. Initially winter precipitation trends were analyzed from 1900 - 2019 in Haliburton, Ontario. Rainfall increased by 13.32 mm/decade ($p<0.05$) and snow by 7.11 mm/decade ($p<0.05$). Rain comprised most of the precipitation in early winter, 52%, and late winter, 67%. Early winter saw the greatest increase in rain (Nov, Dec), while late winter saw the least increase (Feb – April). Snow on the other hand showed the greatest increases in the middle of winter (Dec and Jan). Focusing on the period of 1990-2019 and expanding this analysis to the rest of the study locations reveals significantly decreasing rain trends in November only at Trenton, Chalk

River, Centerville, Shanty Bay and Udora (-17.3, -9.62, -20.2, -8.38, -7.88 mm/decade respectively, p ≤ 0.1). While snow trends were significant (p≤0.1) in a mix of directions. Positive trends were evident mostly in February months at the southern extent of the BSE with values ranging to 11.6mm/decade. On the other hand, negative trends were present mostly in March at the southeastern extent of the BSE and ranged down to -10.3cm/decade. No significant temperature trends were observed for any of the sites. Incorporating the effects of mid-winter rain into lake ice models will facilitate the study of lakes across the mid-latitudes. Global lake abundance is highest at these latitudes and many of the lakes are of recreational and economic importance.

Session: 7022 BC Extreme Events II: Heatwaves and Associated Impacts Événements extrêmes de la Colombie-Britannique II: Vagues de chaleur et impacts associés **01/06/2022 14:55**

ID: 11337 Contributed abstract

Poster Order:

The 2021 western North American heatwave: mechanisms and subseasonal predictions

Hai Lin [1] , *Ruping Mo* [2] , *Frederic Vitart* [3]

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Presented by / Présenté par: ***Hai Lin***
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Record-breaking above-normal temperatures were observed across western North America in June-July 2021. In this study, our ability to predict this heatwave 2-3 weeks in advance is assessed based on 10 Subseasonal-to-Seasonal prediction models. It is found that the above normal temperature in Western Canada during June 28-July 4 was predicted by most models as early as June 10. However, for the forecasts initialized earlier than June 17, not a single ensemble member of all the models was able to capture the magnitude of the observed temperature anomaly. We identify two important processes for this heatwave: an upper tropospheric wave train associated with the boreal summer intraseasonal oscillation in Southeast Asia and an anomalous North Pacific atmospheric river leading to high moisture conditions. Most models were able to predict the wave train across the North Pacific. A realistic representation of moisture transport and its pattern appears crucial for the extended-range forecast of this heatwave.

Session: 7022 BC Extreme Events II: Heatwaves and Associated Impacts Événements extrêmes de la Colombie-Britannique II: Vagues de chaleur et impacts associés **01/06/2022 15:25**

ID: 11331 Contributed abstract

Poster Order:

Future heat stress and its impact on labor capacity in North America

Guilong Li [1] , *Xuebin Zhang* [2]

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Presented by / Présenté par: ***Guilong Li***
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Warming increases heat stress. Heat stress exceeding human body's coping capacity will have negative effect on human health and reduce the amount of time that an outdoor worker such as farmers and construction workers can perform. This study provides future projection of heat stress and its possible effect on labor capacity in North America. Here we use 3-hourly output of the Canadian Regional Climate Model version 4 (CanRCM4) large ensemble simulation under the RCP8.5 emission scenario to compute the wet bulb globe temperature (WBGT), a heat stress indicator that combines the effects of both temperature and humidity. We then bias correct the model simulations to match the heat stress climatology based on NCEP North American Regional Reanalysis (NARR). The bias corrected WBGT is finally used to evaluate projected impact on the labor capacity for conducting light, moderate, and heavy outdoor work. The results show that WBGT is projected to increase more in Canada because of larger temperature increase, but the occurrence and duration of severe heat stress that can limit outdoor activities increase more in southern United States because of warmer climate there. For example, labor capacity for heavy workload in regions of hot climate such as Florida, Louisiana, and southern Texas is only about 50% during summer in the historical period and this will be further reduced to only about 10% by the end of this century under the RCM8.5 scenario. Areas with reduced labor capacity expands northward. Additionally, severity of labor capacity increase with warming. Areas that experience labor capacity loss only for heavy workload in historical climate will experience labor capacity loss for moderate workload by the middle of the 21st century and labor capacity loss for even light workload by the end of the century under the RCP8.5 scenarios.

Session: 7022 BC Extreme Events II: Heatwaves and Associated Impacts Événements extrêmes de la Colombie-Britannique II: Vagues de chaleur et impacts associés **01/06/2022 15:50**

ID: 11726 Contributed abstract

Poster Order:

An anomalous atmospheric river linked to the late June 2021 western North America heatwave

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Presented by / Présenté par: ***Ruping Mo***
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Atmospheric rivers (ARs) are long and narrow bands of enhanced water vapour flux concentrated in the lower troposphere. Many studies have documented the important role of cold-season ARs in producing heavy precipitation and

triggering extreme flooding in many parts of the world. However, relatively little research has been conducted on the warm-season ARs and their impacts on extreme heatwave development. Here we show an anomalous warm-season AR moving across the North Pacific and its interaction with the western North American heatwave in late June 2021. We call it an "oriental express'' to highlight its capability to transport tropical moisture and sensible heat to the west coast of North America from sources in Southeast Asia. Its landfall over the Alaska Panhandle lasted for more than two days and resulted in significant spillover of moisture and sensible heat into western Canada. We provide evidence that the injected water vapour and sensible heat were trapped under the heat dome and formed a positive feedback mechanism to regulate the heatwave development in western North America.

Session: 7022 BC Extreme Events II: Heatwaves and Associated Impacts Événements extrêmes de la Colombie-Britannique II: Vagues de chaleur et impacts associés **01/06/2022 16:05**

ID: 11467 Contributed abstract

Poster Order:

Attribution of the 2021 heat wave in British Columbia

Elizaveta Malinina [1], *Nathan Gillett* [2], *Megan Kirchmeier-Young* [3], *Xuebin Zhang* [4]

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Presented by / Présenté par: ***Elizaveta Malinina***
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In late June 2021, record-high temperatures were observed across British Columbia and the Pacific North-West in general. This heat wave made worldwide media headlines and claimed several hundred lives. In this study, we present an attribution of that event, including an analysis of annual maximum daily maximum temperature (TXx). Using data from ERA5 reanalysis and output from CMIP6 models, we conclude that the temperatures observed in 2021 were virtually impossible in the pre-industrial climate, while in the current climate the return period of such an event is about 1400 years. By the end of the century (2081-2100) the TXx observed in 2021 will occur about once in 20 years, under SSP2-4.5.

Session: 9012 General Hydrology - Part 3 Hydrologie générale - Partie 3 **01/06/2022 14:55**

ID: 11692 Contributed abstract

Poster Order:

Post-processing Sub-Daily Precipitation Forecasts With Analog Ensembles in Southwest BC

Julia Jeworrek [1], *Gregory West* [2], *Roland Stull* [3]

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Presented by / Présenté par: ***Julia Jeworrek***
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Following a paper that investigated precipitation predictability in southwest British Columbia (BC) with systematically varied Weather Research and Forecasting (WRF) model configurations (Jeworrek et al. 2021), the three best performing physics configurations, each with three grid spacings (27-9-3 km), are post-processed using analog ensembles. We created a 5.5-year archive of past model runs with these nine total configurations. For each target model forecast, a set of “analog” past model forecasts is selected depending on the similarity in key predictor variables. The corresponding past verifying observations are used to generate the analog ensemble forecast for the target time. This technique is sensitive to several tuning parameters, such as the choice of predictors, similarity measure, and ensemble size.
Our research seeks an analog post-processing methodology for sub-daily precipitation forecasts optimized over the complex terrain of southwest BC. Using the hindcast dataset from 2016 to 2021, forecasts are trained over 4.5 years and verified over one year across 46 stations. Our predictor investigation reveals that forecasted precipitation and integrated vapor transport are among the best predictor variables. However other variables, like 70-hPa geopotential height, add value to the prediction of warm-season precipitation. We test various ensemble generation techniques: utilizing (1) a range of fixed (“static”) ensemble sizes, and (2) a variable (“dynamic”) ensemble size resulting from the available analogs within a defined similarity threshold; in combination with (a) using the verifying observations as ensemble members, and (b) applying the past forecast errors of each selected analog to the corresponding target forecast.

Jeworrek, J., West, G., & Stull, R. (2021). WRF Precipitation Performance and Predictability for Systematically Varied Parameterizations over Complex Terrain, Weather and Forecasting, 36(3), 893-913.
https://journals.ametsoc.org/view/journals/wefo/36/3/WAF-D-20-0195.1.xml

Session: 9012 General Hydrology - Part 3 Hydrologie générale - Partie 3 **01/06/2022 15:10**

ID: 11733 Contributed abstract

Poster Order:

Using glaciers to interpret deep learning hydrological models

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Presented by / Présenté par: ***Sam Anderson***
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Deep learning (DL) based hydrological models have been found to be successful for streamflow prediction, often outperforming traditional modelling approaches. However, model interpretability remains a nearly ubiquitous challenge in machine learning approaches and there is a need to understand

why DL models make their predictions and how physical processes are represented. We want to know: are DL models making the right decisions for the right reasons?

For this study, we use an ensemble of convolutional long short-term memory neural networks that can predict streamflow throughout British Columbia and Alberta. We demonstrate that the models have automatically learned that the meteorological drivers of streamflow vary by streamflow regime in physically consistent ways. Importantly, we determine that the DL models' decision-making for streamflow prediction in glacierized basins is different than its decision-making for non-glacierized basins, indicating that the models learn to represent glacier contributions to streamflow despite the models having no knowledge of basin glacier coverage. We explain this finding by discovering that glacier runoff is represented as a temperature-controlled streamflow source term that the model learns is important for making predictions at glacierized basins, but not at non-glacierized basins.

Overall, we make progress towards interpreting DL hydrological models by conducting a series of tests to understand what drives model decision making, and we investigate how decision making varies as a function of known geophysical controls. Our results suggest that the CNN-LSTM models can learn to represent important physical drivers of streamflow in addition to making accurate streamflow predictions.

Session: 9012 General Hydrology - Part 3 Hydrologie générale - Partie 3 **01/06/2022 15:25**

ID: 11718 Contributed abstract

Poster Order:

Spatiotemporal Changes of Hydrologic Drought and Flood Swings in Western North America Under Climate Change

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Presented by / Présenté par: ***Reza Rezvani***
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In recent years, an upsurge in the occurrence of hydrometeorological extremes and their temporal swings, including floods and droughts, is observed in many regions around the world. The intensification of the global hydrological cycle associated with climate change can further alter the drivers of such extremes and their interactions. Consecutive flood and drought events can undermine the safety and functionality of communities and infrastructure systems, therefore it is important to understand their characteristics, including their spatiotemporal frequency and magnitude, in a changing climate. In this study, different

scenarios for flood and drought swings along with changes in the corresponding mechanisms are investigated based on streamflow data in Western North America (WNA). Further, future projections of consecutive floods and droughts are assessed using Variable Infiltration Capacity (VIC) simulations driven by six downscaled Global Climate Models (GCM) of the 5th phase of the Coupled Model Intercomparison Project (CMIP5) for 1.5°C-4 °C global warming levels. Preliminary results suggest that headwaters are susceptible to swings on a seasonal timescale. Besides, areas in lower latitudes are expected to experience abrupt swings more frequently under climate change. Our findings assert the necessity of integrating mitigation measures targeting such compound events into Disaster Risk Reduction strategies at the identified hotspots.

Session: 9012 General Hydrology - Part 3 Hydrologie générale - Partie 3 **01/06/2022 15:50**

ID: 11747 Contributed abstract

Poster Order:

Projecting impacts of climate change on interlink between green and blue water resources in Canadian Prairies

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Presented by / Présenté par: ***Pouya Khalili***
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Green water (evapotranspiration) and blue water (water yields) play a critical role in the terrestrial ecosystem, especially in arid and semi-arid regions. Green and blue water resources are interlinked through terrestrial processes and human activities. Assessment of these linkages and projections of their future changes are crucial for water and crop management and planning. The Canadian Prairies (CP) supply crops and other foods to over 170 countries worldwide and rely on green and blue water resources that are affected by climate variability and linked by land management practices. Few studies indicated that climate change might reduce blue water by enhancing evapotranspiration in semi-arid regions, especially during extreme warm seasons. Given that the CP have historically been exposed to frequent droughts, e.g., 1988-1989 and 2000-2003, understanding the interchange and variability of both green and blue water is of great significance.

We have developed an agro-hydrologic model of the Nelson River Basin (NRB), a dominant agricultural watershed with an area of about 1 million km2. The Soil and Water Assessment Tool was calibrated and validated using measured monthly streamflow data from 84 hydrometric stations and annual wheat yields

(WY) from 50 counties in the region. Future climate scenarios were generated from an ensemble of downscaled CMIP6 GCMs for the SSP126 and SSP585 scenarios to analyze green and blue water anomalies based on historical (1987-2016) and future (2030-2099) projections. The overall model performance for streamflow across the NRB was assessed through bR2, with values from 0.1 to 0.96, and WY, with MSE values of 0.05 to 0.35. In our presentation, we will show how prediction uncertainty based on optimized parameter ranges in our calibrated agro-hydrologic model can be useful in simulating regional changes in green and blue water anomalies during extreme warm seasons and for the projection of their future changes.

Session: 9012 General Hydrology - Part 3 Hydrologie générale - Partie 3 **01/06/2022 16:05**

ID: 11408 Contributed abstract

Poster Order:

THE DOMINANT ROLE OF SALT EXCLUSION ON THE FREEZING CHARACTERISTIC CURVE OF SOILS

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Presented by / Présenté par: ***Seth Kwaku Amankwah***
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During freezing and thawing of pure free water, phase transition occurs at zero degree centigrade. In soil pore water, due to salts and capillary attraction/adsorption forces, the phase transition occurs over a range of subzero temperature - a phenomenon called freezing point depression (FPD). FPD results in the co-existence of ice with liquid water at subzero temperature. The relationship between liquid water and temperature, the soil freezing characteristic curve (SFC), is an important hydraulic property in frozen soils. In most hydrological models, the SFC is predicted from the Generalized Clapeyron Equation using information from the moisture characteristic curve of unfrozen soils, without accounting for the effect of salt on FPD. In this study, we developed a salt model to quantify the SFC and tested it with the GCE-based model and a combined capillary salt exclusion model. The models were validated with results from laboratory and field experiments. We were able to match the observations with the salt exclusion model and the combined model, suggesting that salinity is a dominant control on the SFC in real soils that always contain solutes. In modeling applications where the salinity is unknown, the soil bulk solute concentration can be treated as a single fitting parameter. Improved characterization of the SFC may result in improvements in coupled mass-heat transport models for simulating hydrological processes in cold regions.

Session: 14050 Observation and modelling of snow processes: integrating legacy and new tools to advance snow science Observation et modélisation des processus de la neige : l'intégration des outils existants et nouveaux pour faire progresser la science de la neige **01/06/2022 14:55**

ID: 11330 Contributed abstract

Poster Order:

Improving Snow Analyses for Hydrological Forecasting at Environment and Climate Change Canada (ECCC)

Camille Garnaud [1] , *Vincent Vionnet* [2] , *Étienne Gaborit* [3] , *Vincent Fortin* [4] , *Marco Carrera* [5] , *Bernard Bilodeau* [6] , *Dorothy Durnford* [7]

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Presented by / Présenté par: ***Camille Garnaud***
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As part of the National Hydrological Services Transformation Initiative, Environment and Climate Change Canada (ECCC) designed and implemented the National Surface and River Prediction System (NSRPS) to provide surface and river flow analysis and forecast products across Canada. Within NSRPS, the Canadian Land Data Assimilation System (CaLDAS) produces snow analyses that are used to initialise the land surface model, which in turn is used to force the river routing component. Originally, CaLDAS was designed to improve atmospheric forecasts with less focus on hydrological processes. When snow data assimilation occurs, the related increments remove/add water from/to the system, which can sometimes be problematic for streamflow forecasting, in particular during the snowmelt period. Recent modifications to the snow analysis method introduce multiple innovations that respond to the need for higher quality snow analyses for hydrological purposes, including the use of IMS snow cover extent data instead of in situ snow depth observations. Results show that the new snow assimilation methodology brings an overall improvement to snow analyses and substantially enhances water conservation, which is reflected in the generally improved streamflow simulations. This work represents a first step towards a new snow data assimilation process in CaLDAS, with the final objective of producing a reliable snow analysis to initialise and improve NWP as well as environmental predictions, including flood and drought forecasts.

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ID: 11413 Contributed abstract

Poster Order:

Assessing the spatial distribution of snow depth in open and forested environments by UAV lidar

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Presented by / Présenté par: ***Vasana Dharmadasa***
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Spatial distribution of the snow depth in two agro-forested sites and one coniferous site in eastern Canada was analyzed for topographic and vegetation effects on snow accumulation. Spatially distributed snow depth retrievals were obtained by Unmanned Aerial Vehicle Light Detection and Ranging (UAV lidar) measurements in 2019 and 2020. Lidar-derived snow depths showed distinct patterns of snow accumulation and erosion in open areas/fields versus adjacent forested areas across all sites. Omnidirectional semi-variogram analysis of snow depths showed the existence of a scale break distance less than 10 m in the forested area at all three sites whereas open areas showed scale invariance or comparatively larger scale break distances (i.e., 18 m). To investigate the effect of vegetation and topographic variables on the spatial variability of the snow depth, random forest models were employed. Our results showed that including wind-related forest edge effects improved the model accuracy by more than 50% in agro-forested sites whereas incorporating canopy characteristics improved the model accuracy by more than 60% in the coniferous site. This implies the importance of including and better representing these processes in process-based models for accurate estimates of snowpack dynamics. As well, within agro-forested sites, it is rather the underlying topography and/or the wind-redistribution of snow along forest edges that govern the snow depth variability, while within the coniferous environment, it is the forest structure variability. The findings of this study could be applied/extrapolated to similar landscapes in the region and any similar environment that addresses the relevant processes.

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ID: 11464 Contributed abstract

Poster Order:

Complex precipitation phase and impact on snowpack evolution in Eastern Canada.

Nicolas Leroux [1] , *Vincent Vionnet* [2] , *Julie Thériault* [3] , *Hadleigh Thompson* [4] , *Dominique Boisvert* [5] , *Lisa Rickard* [6] , *Stephen Déry* [7] , *Ronald Stewart* [8]

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Presented by / Présenté par: ***Nicolas Leroux***

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Accurate estimation of precipitation phase at the surface is critical for hydrological modelling in cold regions. Different precipitation phase partioning methods (PPM) exist and were developed with local data; however, their application across a variety of climatic regions in numerical snow models is often limited. In particular, PPMs used in hydrological and land surface models struggle to represent near-0 C complex precipitation phase, such as freezing rain and wet snow, and their impact on snowpack simulations. The goal of this study is to evaluate PPMs of varying complexity using high-quality observations of precipitation phase and to assess the impact on simulated snowpack evolution over a winter season. To do so, we use meteorological data including air temperature, relative humidity, wind speed, and precipitation amount collected at Edmundston, New Brunswick, during the Saint John River Experiment on Cold Season Storms field campaign. These data are combined with observations of snow on the ground, such as snow depth, snow surface temperature, and snow water equivalent. The reference precipitation phase is derived from measurements from a laser-optical disdrometer, micro-rain-radars (MRR), and a Multi-Angle Snowflake Camera (MASC) operating during SAJESS. The snowpack evolution during the 2020-2021 winter was simulated using the model Crocus and the impact of the different PPMs on simulated snowcover dynamics was evaluated across the winter season. The results show that commonly used PPM are limited when representing wet snow and freezing rain events, which mostly impacted the snowpack evolution in spring due to a succession of storms associated with complex precipitation phase. Overall, this study highlights the difficulty in estimating precipitation phase at the surface during near 0oC conditions and its impact on snow modelling.

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ID: 11509 Contributed abstract

Poster Order:

Simulation of cold processes in the CMIP6 land-historical simulations

Lawrence Mudryk [1] , *Eleanor Burke* [2] , *Gerhard Krinner* [3] , *Nate Collier* [4] , *Chris Derksen* [5] , *David Lawrence* [6]

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Presented by / Présenté par: ***Lawrence Mudryk***
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Model evaluation is a necessary component of climate research. While the snow and soil components of land-surface models have been previously evaluated using standalone simulations (Dirmeyer et al., 1999; Slater et al.,

2001; Dirmeyer, 2011), the Land Surface, Snow and Soil moisture Model Intercomparison Project (LS3MIP; van den Hurk et al., 2016) is the first CMIP framework that coordinates both components and integrates them into the larger suite of CMIP experiments. Here we analyze output from the “land-hist” global land surface simulations, forced by historically observed meteorological conditions, and compare them to the fully coupled and AMIP historical CMIP6 simulations.

We focus on high-latitude processes and variables, in particular snow and permafrost. For both snow and permafrost there is better representation of trends and historical variability in the 'land-hist' simulations. NH snow mass and snow extent variability and trends correlate better with observations in the historically forced simulations. Likewise, these simulations better represent historical permafrost loss rates for nearly all analyzed models.

However there remain residual structural and parametrization errors in both variables. While for alpine snow mass, the 'land-hist' ensemble mean shows better agreement with observations and smaller errors for individual models (reduced spread about the observations) this is not the case for nonalpine snow, which has larger systematic errors relative to the observations. We analyze these differences in terms of the balance of accumulation and ablation across both regions. Similarly for permafrost, errors in the functional relationships that control permafrost extent and soil temperature are large and result in limited to no improvement in climatological permafrost extent in the historically forced simulations. These results suggest that the added value of standalone land model simulations in the suite of CMIP6 experiments may depend on both the variable and region of interest.

Dirmeyer (2011), https://doi.org/10.1175/JHM-D-10-05010.1
Dirmeyer et al. (1999), https://doi.org/10.1175/1520-0477(1999)080<0851:TPPOTG>2.0.CO;2
Slater et al. (2001), https://doi.org/10.1175/1525-7541(2001)002<0007:TROSIL>2.0.CO;2
van den Hurk et al. (2016), https://doi.org/10.5194/gmd-9-2809-2016

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ID: 11555 Contributed abstract

Poster Order:

Simple Snow Temperature Index Models Account for Important Discrepancies between Snow Water Equivalent Products

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Presented by / Présenté par: ***Aleksandra Elias Chereque***
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Snow water equivalent (SWE) is a routine output from reanalysis systems and offline land-surface schemes, but documented discrepancies among the resulting SWE products impede the assessment of hemispheric-scale snow mass variability and trends. These discrepancies may stem from differing meteorological fields between reanalysis products or different surface observation sources, data assimilation schemes, snow model structure, and parameterizations used.
In this work, we investigate SWE differences between three modern reanalysis products (ERA5, JRA-55, and MERRA-2) from 1980-2020. We force the recently updated “B-TIM”, a simplified, single-layer temperature index snow model based on Brown et al., (2003), with their respective temperature and precipitation fields. B-TIM captures the most important features of snow evolution, whereby precipitation amount and phase mainly influence the resulting snow depth, while temperature influences the snowpack density, but it does not attempt to represent humidity-, radiative-, or wind-related processes. Nonetheless, by “standardizing” the snow model physics used, we primarily isolate biases in the precipitation and temperature fields as sources of spread. We identify and correct first-order biases between the JRA-55 and ERA5 forcing data to bring the two B-TIM reconstructed datasets, “ERA5rec” and “JRArec”, into closer agreement. This reduces the climatological mean wintertime bias by 50%, indicating the propagation of forcing biases into SWE uncertainty. Through several SWE metrics at the continental scale (e.g. mean SWE, max SWE), we find strong correlations in the range 0.84 to 0.96 between all the reconstructed datasets. This is not observed between the native SWE products, which have correlations below 0.4, suggesting that snow model and data assimilation differences affect the interannual variability of a given product more than relative forcing biases do. We conclude that comparison to a temperature index model helps diagnose some inconsistencies between snow products and help assess the impact of changes in data assimilation schemes and input data.

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ID: 11774 Contributed abstract

Poster Order:

Operational water forecast assessment of a spatially distributed process-based snow model; a case study in the East River Watershed, Colorado.

Joachim Meyer [1] , *McKenzie Skiles* [2] , *Patrick Kormos* [3] , *Andrew Hedrick* [4] , *Ernesto Trujillo* [5] , *Scott Havens* [6]

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Presented by / Présenté par: ***Joachim Meyer***
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Operational water-resource planning faces an increased challenge with a changing seasonal snowpack in mountain watersheds due to global and regional climatological factors. An example region is the Western United States, where there is a demonstrated decline in extent and amount of seasonal snow in mountain ranges such as the Sierra Nevada, California, or the Rocky Mountains, Colorado. Causes for the shift include precipitation phase changes or increased amounts of dust on snow. Like the Colorado Basin River Forecast Center (CBRFC), regional forecasters cannot currently account for these factors when their prediction method relies on an empirical snow model based on historic calibration records. To evaluate the options and supplement the current method of the CBRFC, we run a physical-based snow energy balance model for past water years in a subset region; the East River Watershed, Colorado. The results are compared with in-situ measurements, remote sensing observations, and the predictions by the current model. This assessment is an effort to include the process based model in day-to-day CBRFC operations and to create a foundation to expand to larger domains. This project also bridges the gap between scientific advancements and benefits for society with more accurate water resource forecasting.

Session: 3030 Changing Arctic: Science and Policy Studies
l'Arctique changant : Études scientifiques et politiques **02/06/2022 08:25**

ID: 11332 Contributed abstract

Poster Order:

Policies to limit air pollution are key for successfully mitigating Arctic warming

Knut von Salzen [1] , *Cynthia Whaley* [2] , *Susan Anenberg* [3] , *Rita Van Dingenen* [4] , *Zbigniew Klimont* [5] , *Mark Flanner* [6] , *Rashed Mahmood* [7]

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Presented by / Présenté par: ***Knut von Salzen***
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Reducing air pollutants, driven by human health and environmental concerns, can have profound consequences for climate. We used Shared Socioeconomic Pathways and newly developed emission scenarios to assess atmospheric changes from 2015 to 2050. Global air quality would improve under most of the scenarios. Regardless of air quality benefits, the air pollutant changes act to enhance Arctic warming under all scenarios. Unlocking identified mitigation potential for carbon particulate matter and methane would result in Arctic climate and human health co-benefits well before 2050, with Arctic climate benefits comparable to those from CO2 reductions. Synergistic and competing impacts of air pollutants on Arctic climate and global human health are substantial and should be considered for climate and air pollution policy development.

Session: 3030 Changing Arctic: Science and Policy Studies
l'Arctique changant : Études scientifiques et politiques **02/06/2022 08:55**

ID: 11325 Contributed abstract

Poster Order:

The Role of Wind in the Dynamics of Reduced Sea Ice Motion in Winter and Early Spring on the Canadian Beaufort Sea Continental Shelf

David Fissel [1] , *Matthew Asplin* [2] , *Keath Borg* [3] , *Alex Graham* [4] , *Humfrey Melling* [5]

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Presented by / Présenté par: ***David Fissel***
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Sea-ice velocity data sets have been obtained at a mid- and outer-shelf location in the eastern Canadian Beaufort Sea using subsurface continuous upward looking sonar instruments. Previous analyses of these 1999-2019 data sets reveal a large seasonal cycle to small ice velocities in winter, and a trend to increased ice velocities, especially in late winter and early spring.
To investigate the underlying dynamics of the sea ice motion response to wind forcing and internal ice forces, detailed analyses of two mid-record ice seasons (2009-2011) were conducted. The event response factor, computed as the ratio of the ice-to-wind speeds over each event, falls into three categories: (1) high response factors exceeding 1.8% ("free drift") of the ice to wind forcing; (2) "reduced response" of 0.02% to 1.8% and (3) "zero-response" with all of the ice speeds exhibiting "no motion" (< 0.5 cm/s), which occur for both easterly and westerly winds.
Free drift wind events occur from fall to early winter and resume in early May, with typical response factors of 2.4 to 5.0%. The response factors are similar for easterly and westerly wind events.
During winter and early spring, about 85% of wind events are in the reduced response category with nearly all events including at least some "no-motion" ice speeds. The average ice motion for reduced response events is somewhat larger, on average, for easterly than westerly wind events (1.1% vs. 0.8% respectively). Also noted is a distinct pattern of no-motion developing at the end of most of the westerly events vs. some easterly wind events which exhibit a delay in the resumption of ice motion. These patterns demonstrate that westerly wind events are often associated with larger internal ice forces than for easterly winds. The analysis is being extended to additional years within the full 20 year data set.

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l'Arctique changant : Études scientifiques et politiques **02/06/2022 09:10**

ID: 11700 Contributed abstract

Poster Order: Poster-3030

Watershed Sensitivity to Glacier Hypsometry and Rising Equilibrium Line Altitudes in the Canadian Arctic

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Presented by / Présenté par: ***Madeline Myers***
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The importance of the spatial distribution of glacier melt is often overshadowed by the volume of glacier melt as it relates to global sea level rise. In the North Canadian Arctic Archipelago (NCAA), the spatiality of glacier melt production and flux to the Arctic Ocean is important to global thermohaline circulation and local ecosystem dynamics. Here, we present hydrologically-corrected glacier outlines from the Randolph Glacier Inventory and hypsometries derived from a high-resolution digital elevation model. We then artificially increase the equilibrium line altitude (ELA) to show the distribution of total melt potential

across the NCAA and within newly defined watersheds. Accumulation area ratio (AAR) is treated as a proxy of glacier mass budget and is used to assess watershed sensitivity to glacier hypsometry and variations of the ELA. Broadly, the degree of ELA change across the region is unknown. We therefore impose different magnitudes of ELA change to simulate the spatial variability of AARs across NCAA watersheds. Changes to the AAR have direct implications for glacier mass budget and reveal possible climate change refugia. AAR variability is used to assess the likely (re)distribution of glacier melt across the NCAA with warming temperatures and rising ELAs. Our results offer a first order understanding of the probabilistic redistribution of melt in the NCAA given different climate (and therefore ELA) scenarios.

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l'Arctique changant : Études scientifiques et politiques **02/06/2022 09:10**

ID: 11717 Contributed abstract

Poster Order: Poster-3030

The Impact of the Decoupling of Wind and Sea Level Pressure on Sea Ice Motion in the Nares Strait

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Presented by / Présenté par: ***Kaitlin McNeil***
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The Nares Strait is a narrow waterway connecting the Arctic Ocean's Lincoln Sea to the North Atlantic's Baffin Bay. The prevailing northerly winds along the Nares Strait drive sea ice motion and contribute to the loss of thick multiyear ice from the Arctic. Furthermore, they influence the formation of the ice arch and modulate the sea ice motion within the strait. Historically, ice arches have formed annually blocking the strait preventing the transport of sea ice from the Arctic into Baffin Bay. Over the past 20 years, the ice arch has seen a decrease in duration and a corresponding increase in sea ice volume flux down the strait. The prevailing winds along the strait are from the north and have been shown to be a contributing factor to the formation of the ice bridges with extreme events being linked to the early collapse of arches. Previous work has shown that the pressure gradient between Baffin Bay and the Lincoln Sea is primarily responsible for the variability in the winds and ice motion along the strait. Here we use the ERA5 reanalysis as well as the recently completed Copernicus Arctic Regional Reanalysis to identify months in which there is a decoupling of the wind and pressure fields along the strait. Specifically, the winds are from the south over the northern section of the strait and from the north over the southern section of the strait. The impact of this decoupling on ice motion along the strait will be discussed including a potential to replenish the thick multiyear ice that is present in the Lincoln Sea.

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l'Arctique changant : Études scientifiques et politiques **02/06/2022 09:20**

ID: 11641 Contributed abstract

Poster Order:

Thin and thick ice in the Beaufort Sea: A new regime with enhanced mobility

Kent Moore [1] , *Michael Steele* [2] , *Axel Schweiger* [3] , *Jinlun Zhang* [4] , *Kristin Laidre* [5]

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Presented by / Présenté par: ***Kent Moore***
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The Arctic Ocean has seen a remarkable reduction in sea ice coverage, thickness and age since the 1980s. These changes are most pronounced in the Beaufort Sea, with a transition around 2007 from a regime dominated by multi-year sea ice to one with large expanses of open water during the summer. Here we show that during the summers of 2020 and 2021, the Beaufort Sea hosted anomalously large concentrations of thick and old ice. We show that ice advection contributed to these anomalies, with 2020 dominated by eastward transport from the Chukchi Sea, and 2021 dominated by transport from the Last Ice Area to the north of Canada and Greenland. Since 2007, cool season (fall, winter, and spring) ice volume transport into the Beaufort Sea accounts for ~45 % of the variability in early summer ice volume - a threefold increase from that associated with conditions prior to 2007. This variability is likely to impact marine infrastructure and ecosystems including ice-dependent species.

Session: 3030 Changing Arctic: Science and Policy Studies
l'Arctique changant : Études scientifiques et politiques **02/06/2022 09:35**

ID: 11625 Contributed abstract

Poster Order:

Atmospheric Forcing of Wind-Driven Regional Sea Ice Motion In Winter and Early Spring in the Canadian Beaufort Sea

Matthew Asplin [1] , *David Fissel* [2] , *Keath Borg* [3] , *Alex Graham* [4]

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Presented by / Présenté par: ***Matthew Asplin***
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Synoptic-scale wind forcing is a key physical forcing mechanism for sea ice dynamic processes in Arctic Sea ice. This is particularly true in the Canadian Beaufort Sea, characterized by the offshore anti-cyclonic Beaufort Gyre regional circulation, sea ice lead formation, and dynamic thickening of sea ice throughout the winter. To investigate the underlying dynamics of the sea ice motion response to synoptic-scale wind forcing and internal ice forces, detailed analyses of two ice seasons (2009 - 2011) were conducted. Sea ice velocity was collected at two sites on the continental shelf in the eastern Canadian

Beaufort Sea using subsurface upward looking ADCP sonars. Event response factors were calculated, computed as the ratio of the ice-to-wind speeds for easterly and westerly wind forcing events. Three categories of responses were identified: (1) high response factors exceeding 1.8% (“free drift”) of the ice to wind forcing; (2) “zero-response” with all the ice speeds exhibiting “no motion” (< 0.5 cm/s), and (3) an intermediate “reduced response” case.

Identification of synoptic meteorological drivers for wind-forcing events were assessed using a synoptic climatology based upon principal components analysis (PCA) and k-means clustering of gridded NCEP-NCAR II mean sea level pressure data (Asplin et al., 2015). High resolution gridded wind-wave reanalysis data from the MSC Beaufort Sea Wind and Wave Reanalysis (Swail et al., 2007) was retrieved and is available at a 2.5 km resolution (0.1°) for the continental shelf area near Tuktoyaktuk, NT. Wind data were processed to determine the characteristics of wind divergence and convergence associated with each synoptic type and are used to further understand the response factors observed in the sea ice cover, on regional as well as local scales, for easterly and westerly wind events throughout the annual cycle, and with respect to sea ice concentration and movement within the Beaufort Sea.

Session: 3030 Changing Arctic: Science and Policy Studies
l'Arctique changant : Études scientifiques et politiques **02/06/2022 09:50**

ID: 11679 Contributed abstract

Poster Order:

Seasonal predictions of the open-water season in the Baffin Bay region

Minghong Zhang [1] , *William Perrie* [2] , *Zhenxia Long* [3]

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Presented by / Présenté par: ***Minghong Zhang***

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The Arctic has had rapidly decreased summer sea ice and increasingly thin sea ice for the last several decades. Significant increases in the ice-free season duration have direct impacts on the ecosystem and socio-economic fabric of the Canadian Arctic. For example, from the practical viewpoint, longer open-water seasons bring greater marine access and increased marine vessel traffic. Therefore, prediction of the occurrence and duration of the ice free season has become increasingly important in the warming Arctic. In this study, we investigate seasonal predictabilities of sea ice conditions in July over the Baffin Bay region, with a focus on the atmospheric forcing and the pre-conditions of the preceding winter sea ice. We find a significant correlation between the winter North Atlantic Oscillation (NAO) and the East Atlantic Pattern (EAP), by a “two-winter lead-time”, with the summer sea ice, as well as robust connections to the preceding spring circulation mode. For example, for sea ice in July in 2020, the “two-winter lead-time” consists of November-December in 2018 and January-February-March in 2019. We explore the forecast ability of an empirical multiple linear regression model, using these atmospheric circulation modes. For detrended data, using the two-winter leading NAO and EAP, the multiple linear regression model accounts for 25% of the internal variance of sea ice area. When we use NAO, EAP and the preceding spring circulation mode, this

becomes 43.6%. When we use the above three atmospheric modes and the linear trend of sea ice, this forecast skill goes to 63%. Independent predictor data is used to assess the forecast skill of the procedure in making predictions for 2021. In the presentation, we discuss the mechanisms of the leading connections and processes, including the oceanic sub-polar gyre, convection, arctic outflows and surface heat fluxes and winds due to the atmospheric forcing.

Session: 5050 Climatic Data Rescue in Canada Sauvetage des données climatiques au Canada **02/06/2022 08:25**

ID: 11368 Contributed abstract

Poster Order:

The recent evolution of historical weather data rescue in Canada: ACRE-Canada, DRAW and Open Data Rescue

Victoria Slonosky [1] , *Renee Sieber* [2] , *Frederic Fabry* [3] , *Lori Podolsky* [4] , *Rachel Black* [5] , *Gordon Burr* [6] , *Robert Smith* [7]

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Presented by / Présenté par: ***Victoria Slonosky***
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The process of rescuing historical weather data has evolved over the course of a decade, from sharing pdf files and open source spreadsheets with volunteers using tools such as DropBox to the development of an open source software platform allowing transcribers to type in data directly to an online database over the internet. The involvement of a multidisciplinary team and knowledge sharing both nationally and internationally has led to the discovery of new sources, the development of metadata standards, and file sharing protocols to enable transcribed information to be shared across disciplines, across formats and across nations. Making the information recorded centuries ago with paper and ink machine readable is only the first step: post processing, unit, transformation, quality control and exchange standards that will continue to make the information useable into the future remain formidable challenges.

We report on the processes that drive the evolution and progress of three projects over the course of the past decade: the citizen science component of ACRE-Canada, the citizen science driven McGill DRAW project, and the Open Data Rescue partnership with Environment and Climate Change Canada (ECCC). Together these projects have tens of thousands of images of historical weather journals and over a million unique observations from around Canada.

Canadian weather observations date back to the eighteenth century, with some of the oldest weather observations in Canada taking place in the Hudson Bay, St Lawrence Valley and Atlantic coast regions. Efforts to trace early Canadian records started with the work of Morley Thomas in the second half of the 20th century. National and international projects to make the historical (pre-1870),

archival, non-governmental records machine readable in the early 21st century combined efforts from volunteer citizen science projects and work by ECCC which together formed ACRE-Canada.

Session: 5050 Climatic Data Rescue in Canada Sauvetage des données climatiques au Canada **02/06/2022 08:40**

ID: 11377 Contributed abstract

Poster Order:

A guideline for AI-augmented data rescue workflow tested by DRAW dataset

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Millions of valuable historical weather records exist in paper formats, such as logbooks, diaries and newspapers. Those historical records are gold mines that contain much valuable information. Data rescue initiatives worldwide have been working hard trying to retrieve those records, preserve them, and transcribe them into a machine readable format for easier storage and analysis. Currently, most of the historical records are being keyed in manually as a great portion of the records are written by hand and using an OCR (Optical Character Recognition) to transcribe handwritten records is complicated. Keying in is a time-consuming and labor-intensive approach while an automated approach can optimize the transcription process to be efficient and automatic.

I propose a workflow for handwritten weather information that uses artificial intelligence to automate the transcription process. This workflow translates the generics of how to automated a data rescue project with the help of AI. It is composed of five steps including image-preprocessing, layout analysis and character recognition with the EAST algorithm (Efficient and Accurate Scene Test Detector) and Tesseract OCR embedded. The algorithm automatically detects the table layout, slices the tabular data into rectangles, and transcribes them into digital format. The resulting transcription can be fitted into a pre-formatted Excel spreadsheet for research analysis. The workflow is tested using the historical climate records from the DRAW (Data Rescue: Archives and Weather) project, and it can be adapted to other handwritten dataset with proper setup as well. The workflow proposed can serve as a first step for future data rescue projects given that it is replicable and can be easily adapted to other transcription projects. Currently, there are still challenges, such as a lack of cursive handwriting training datasets and an intuitive UI (User Interface). Further endeavors need to be made to optimize the automation processes and results.

Session: 5050 Climatic Data Rescue in Canada Sauvetage des données climatiques au Canada **02/06/2022 08:55**

ID: 11518 Contributed abstract

Poster Order:

Rescuing Metadata to Improve the Usability of Orphan Historical Climate Data

Camille Brais [1] , *Lucy Wilkie* [2] , *Adrita Khan* [3] , *Juliette Goulette* [4] , *Eidan Willis* [5] , *Ngan Pham* [6] , *Mailys Laprevotte* [7] , *Victoria Slonosky* [8] , *Kevin Wood* [9]

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Presented by / Présenté par: ***Camille Brais***
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Our ability to understand, detect, predict, and respond to local and regional climate change and variability is contingent upon digitized historical climate observations. Such records can be highly fragmented, which is in part due to the widespread presence of orphan historical climate data. Orphan data are data that are missing important metadata, i.e., data that lack the contextual information necessary to make them useful in research. Such missing metadata can be rescued to situate orphan data in their context and open them to analysis. We investigated how this can be done through a case study of WWII-era land station climate data collected by the US navy. This set contains over 800,000 observations of pressure, temperature and relative humidity. These data were missing station names and geographical coordinates and presented a number of skewed values. We found the missing locations could be retrieved by cross referencing with historical documents and comparing with preexisting assimilated climate data. The stations we have identified are scattered over four continents and numerous islands in the Pacific and Atlantic, including a station in Nova Scotia. Our results suggest some of the data have not been previously assimilated into existing data sets, and are thus “new” data. We also elaborated methods to correct the skewed values by identifying patterns in their distribution. We present tools and methods used in this case study and suggest how they can be applied for We also present results from surveys and interviews with climate data experts which highlighted both methods for and challenges surrounding metadata rescue. We consider our methodology for rescuing orphan data can be applied to other data sets, making them of more general use. This can help contribute additional historical data to analyses and further our understanding of past, current and future climate trends.

Session: 5050 Climatic Data Rescue in Canada Sauvetage des données climatiques au Canada **02/06/2022 09:20**

ID: 11608 Contributed abstract

Poster Order:

Evaluating characteristics of historical cloud cover in Quebec using station based observations, reanalysis, satellite products and model simulations

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Presented by / Présenté par: ***Rashed Mahmood***
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Clouds play an important role in modulating the regional and global climate through their influence on Earth's energy budget. On regional scales, snow and clouds play an important role in the seasonal transitioning of the climate and modulating the hydrological cycle. Despite their importance especially for regional climate systems of cold environments, the station based analysis of local cloud characteristics including daily and seasonal cycles, long-term trends, and their linkages to regional physical processes over Quebec, remain largely unknown. In an ongoing project of the le Ministère de l'Environnement et de la Lutte contre les Changements Climatiques (MELCC), we aim to fill some of the knowledge gaps in the Quebec region by evaluating major characteristics of the local cloud cover by first analyzing long-term (i.e. 1953-2020) station based observations in conjunction with other observational products (e.g. reanalysis and satellite products) and climate model simulations. For the observational record, we use hourly station data obtained from Environment and Climate Change Canada (ECCC) for more than 80 stations across the Quebec province. After harmonizing the station data through quality controls, only about a third of the stations are retained for further analyses. This study presents our findings related to major characteristics of station based observed total cloud fraction and their representation in reanalysis and satellite products. In general, at most station locations the reanalysis and satellite products compare well in the summer season while in the winter season these products show an increased bias.
We plan on further extending these analyses to model simulations and the processes contributing to cloud formation such as energy and water cycles to better understand the cloud fraction biases among different observational and simulated data sets.

Session: 5050 Climatic Data Rescue in Canada Sauvetage des données climatiques au Canada **02/06/2022 09:35**

ID: 11361 Contributed abstract

Poster Order:

Early surface auto-station history and data in MSC

Charles Paterson [1]

[1]

Presented by / Présenté par: ***Charles Paterson***
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This presentation will illustrate the development of the automatic weather stations in the MSC and will point out that some of this data produced in earlier years is still not available to the general public. Analysis of tables in the MSC Archives database, MSC newsletters, Morley Thomas publications, station change notices, and other sources have revealed hourly data not otherwise available, along with appropriate metadata. Data extracted from these tables has been analysed preliminarily as to the weather elements observed and the gaps in the record. Taken in the light of MSC and MSC archives history, this

data has been left behind by changes in archival procedures being years behind the changes in the data-producing networks and their data.

What was found has been about 2200 station-years of data coming from records of 250 stations, in whole or in part. Most of this hourly data includes temperature, wind, and pressure, and a few stations' records include visibility, ceiling heights, and three-season precipitation. Some sites' data can augment other longer-term climate sites' records, some other sites' data fill in gaps where there is no other data. Some of this data may be capable of enhancing the record of observed climate data in climate models. Analysis of this data will also improve the quality of observational metadata from the 1970s to 2000s.

Session: 5050 Climatic Data Rescue in Canada Sauvetage des données climatiques au Canada **02/06/2022 09:50**

ID: 11591 Contributed abstract

Poster Order:

Representativeness of the precipitation observing network for monitoring precipitation change and variability in Canada

Hui Wan [1] , *Xuebin Zhang* [2] , *Megan Kirchmeier-Young* [3]

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Presented by / Présenté par: ***Hui Wan***
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While there are thousands of precipitation stations in the Canadian climate archive, it has been challenging to estimate regional and national averages of precipitation for the purpose of monitoring climate change and variability, because of evolution of the monitoring network and generally sparse network density, in particular in the north. Changes in the observing network have resulted in segmentation and inhomogeneities in precipitation records. We used monthly precipitation from the CanRCM4 large ensemble simulations as a proxy of observations with complete spatial and temporal coverage. By comparing results from the complete-coverage dataset with versions masked by observational coverage, we examined the representativeness of two long-term precipitation datasets for the estimation of annual mean precipitation at regional and national levels for the purpose of monitoring precipitation change and variability in Canada. We also analyzed the implications of changes in the network and the possible added value of data processing such as in-filling through interpolating station records. We find that at the best coverage of approximately 450 precipitation stations in the Adjusted and Homogenized Canadian Climate Data dataset, station coverage is, in general, adequate for the purpose of monitoring precipitation trends. However, this capability is severely compromised as station density changes (reduces) with time. The addition of station records in regions already better represented (i.e., regions with more population) does not provide significant improvement. In-filling over space through spatial interpolation does add value, provided that there is sufficient information in the station network. Our analysis shows the utmost importance of maintaining a consistent long-term network with sufficient station density for the purpose of monitoring climate change and variability.

Session: 7023 BC Extreme Events I: Atmospheric Rivers and Associated impacts - Part 3 Événements extrêmes de la Colombie-Britannique I: Rivières atmosphériques et les impacts associés - Partie 3 **02/06/2022 08:25**

ID: 11466 Contributed abstract

Poster Order:

Human influence on 2021 British Columbia floods: attribution of extreme precipitation

Elizaveta Malinina [1] , *Nathan Gillett* [2] , *Markus Schnorbus* [3] , *Faron Anslow* [4] , *Francis Zwiers* [5]

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Presented by / Présenté par: ***Elizaveta Malinina***
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In November 2021, a series of atmospheric rivers made landfall on the coast of British Columbia. The most destructive was the atmospheric river event of the 14th and 15th of November, which resulted in life and property losses and severe damage to surface transportation infrastructure caused by extreme precipitation, flooding and mudslides. In this study, we look in more detail at the precipitation aspect of this event. Using ERA5 and CaPA reanalysis data, we analyze two-day cumulative precipitation associated with the event, as well as an antecedent precipitation index. Using results from CMIP6 models, we also carry out an attribution study to quantify the impact of human induced climate change on those two variables. We estimate a risk ratio for an event at least as strong as that observed in 2021 relative to pre-industrial climate to be 1.45 for two-day consecutive precipitation and 1.26 for the antecedent precipitation index. We also provide estimates for the end of the century using precipitation data under the SSP2-4.5 scenario.

Session: 7023 BC Extreme Events I: Atmospheric Rivers and Associated impacts - Part 3 Événements extrêmes de la Colombie-Britannique I: Rivières atmosphériques et les impacts associés - Partie 3 **02/06/2022 08:40**

ID: 11393 Contributed abstract

Poster Order:

Reconciling the discrepancy between rarity of the atmospheric river and rainfall associated with the November 2021 flooding in southwestern B.C.

Alex Cannon [1]

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On 14th November 2021, a strong landfalling atmospheric river (AR) brought two days of intense rainfall to southwestern British Columbia. This led to landslides, extensive flooding, and loss of life and property. A rapid event attribution study conducted after the event found 1) that AR storms with similar characteristics (i.e., with event total integrated vapour transport, TIVT, of the same magnitude and trajectory) are approximately one in 10 year events in the current climate of this region, 2) that such events have been made at least 60% more likely by the effects of human-induced climate change, and 3) that further warming will lead to increased frequency of such events in the future. However, when the storm was characterized in terms of the associated 2-day precipitation (RX2day) over the region, the event was found to have a rarity of 1 in 50 to 100 years in the current climate — substantially more rare than the AR itself. To account for this discrepancy, an expanded analysis of the AR storm in terms of its horizontal moisture convergence (HMC), column relative humidity (CRH), and principal condensation (PCR) rate has been conducted. While the AR storm was strong, but not unprecedented, in terms of IVT and TIVT, its HMC and PCR, which are more highly correlated with rainfall, were substantially more rare and consistent with RX2day. This result has implications for the use of variables like IVT and TIVT that have traditionally been used to diagnose ARs and their potential impacts.

Session: 7023 BC Extreme Events I: Atmospheric Rivers and Associated impacts - Part 3 Événements extrêmes de la Colombie-Britannique I: Rivières atmosphériques et les impacts associés - Partie 3 **02/06/2022 08:55**

ID: 11483 Contributed abstract

Poster Order:

Extreme Streamflow Associated with the 2021 British Columbia Atmospheric River Event

Markus Schnorbus [1] , *Faron Anslow* [2] , *Faron Anslow* [3]

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Presented by / Présenté par: ***Markus Schnorbus***
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A strong atmospheric river made landfall in southwestern British Columbia, Canada on 14th November 2021, bringing two days of intense precipitation to the region. The resulting floods and landslides made this the costliest natural disaster in the province's history. There is a close link between landfalling atmospheric rivers and extreme discharge. Compared to other winter storms, atmospheric river storms typically transport relatively warm, moist air that raises the altitude of the 0°C isotherm, or freezing level. Therefore, more precipitation falls as rain (instead of snow) at high elevations and there is opportunity for increased snowmelt. These rain-on-snow conditions often lead to runoff over a much larger catchment area than during a typical storm. The effects of precipitation on streamflow can also be exacerbated by wet conditions preceding the event. This combination of effects can increase extreme runoff and streamflow and lead to increased flood hazard. In this presentation we will characterise the hydro-meteorological conditions specific to the 2021 event and

discuss the mechanisms that likely led to streamflow maxima exceeding estimated one in a hundred-year events at several locations in the region.

Session: 7023 BC Extreme Events I: Atmospheric Rivers and Associated impacts - Part 3 Événements extrêmes de la Colombie-Britannique I: Rivières atmosphériques et les impacts associés - Partie 3 **02/06/2022 09:20**

ID: 11454 Contributed abstract

Poster Order:

Quantifying the human influence on extreme streamflow in 2021 British Columbia flood event

Qiaohong Sun [1] , *Markus Schnorbus* [2] , *Megan Kirchmeier-Young* [3] , *Francis Zwiers* [4] , *Xuebin Zhang* [5]

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Presented by / Présenté par: ***Qiaohong Sun***
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In November 2021, a powerful atmospheric river made landfall and brought two days of drenching rain that led to floods and landslides in southwestern British Columbia. To assess the role of human influence on the occurrence of events like the November 15th extreme streamflow, we compared the magnitudes of different return period events for the 1950-1969 and 2011-2030 climate states using hydrologic simulations driven by the CanESM2 large ensemble. Daily temperature and precipitation data from the CanESM2 large ensemble simulations was statistically downscaled and bias corrected to high-resolution (0.0625°) and used to drive the VIC-GL hydrologic model to produce a large ensemble hydrologic simulation of the Fraser River basin. We present the flood frequency results from these simulations for seven locations in the Coldwater, Coquihalla, Chehalis, Chilliwack, and Stave River basins, focusing on peak flows in October-November-December (OND) during the earlier 20-year period (1950-1969) and current (2011-2030) periods. Results show that simulated flood magnitudes for all return periods in the current climate are larger than in the 1950-1969 climate at all seven locations. The best estimates of the 100-year OND peak flow in the current climate are 13-55% larger than those over the 1950-1969 period, depending on location. For an event with the magnitude of the 100-year OND peak flow in the 1950-1969 climate, the ratio of its probability in the current climate compared to the 1950-1969 period, or risk ratio, is 2.2 - 4.0, depending on location. Results therefore suggest that the probability of extreme streamflow events such as those that caused damage in multiple BC communities in November 2021 has been increased by human-induced climate change to between two and four times their probability in the 1950s, which has important implications for infrastructure design and climate change adaptation policy.

Session: 7023 BC Extreme Events I: Atmospheric Rivers and Associated impacts - Part 3 Événements extrêmes de la **02/06/2022 09:35**

ID: 11350 Contributed abstract

Poster Order:

Human influence on the 2021 British Columbia floods

Nathan Gillett [1], *Alex Cannon* [2], *Elizaveta Malinina* [3], *Markus Schnorbus* [4], *Faron Anslow* [5], *Qiaohong Sun* [6], *Megan Kirchmeier-Young* [7], *Francis Zwiers* [8], *Christian Seiler* [9], *Xuebin Zhang* [10], *Greg Flato* [11], *Hui Wan, Guilong Li, Armel Castellan* [12]

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Presented by / Présenté par: ***Nathan Gillett***
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A strong atmospheric river made landfall in southwestern British Columbia, Canada on 14th November 2021, bringing two days of intense precipitation to the region. The resulting floods and landslides led to the loss of at least five lives, cut Vancouver off entirely from the rest of Canada by road and rail, and made this the costliest natural disaster in the province's history. This talk describes a rapid attribution study of this event, carried out as a collaboration between Environment and Climate Change Canada and the Pacific Climate Impacts Consortium. We show that westerly atmospheric river events of this magnitude are approximately one in ten year events in the current climate of this region, and that such events have been made at least 60% more likely by the effects of human-induced climate change. Characterised in terms of the associated two-day precipitation, the event is approximately a one in 50-100 year event, and the probability of events at least this large has been increased by a best estimate of 45% by human-induced climate change. The effects of this precipitation on streamflow were exacerbated by already wet conditions preceding the event, and by rising temperatures during the event that led to significant snowmelt, which led to streamflow maxima exceeding estimated one in a hundred year events in several basins in the region. Based on a large ensemble of simulations with a hydrological model which integrates the effects of multiple climatic drivers, we find that the probability of such extreme streamflow events has been increased by human-induced climate change by a best estimate of 100-300%. Together these results demonstrate the substantial human influence on this compound extreme event, and help motivate efforts to increase resiliency in the face of more frequent events of this kind in the future.

ID: 11526 Contributed abstract

Poster Order:

Drivers of hydrological response for distinct wetland complexes in a high latitude alpine watershed.

Lauren Bourke [1] , *Sean Carey* [2]

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Presented by / Présenté par: ***Lauren Bourke***
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Alpine wetlands in northern landscapes are abundant and critical for runoff regulation and seasonal water storage. Although extensive work has been conducted on water table dynamics in temperate wetlands, little has been conducted on the hydrology and heterogeneity of water table responses of high latitude alpine wetlands. This research aims to compare the hydrological response of two distinct subarctic alpine wetland types near Whitehorse, YT; a valley bottom wetland and a perched wetland system. Each wetland was instrumented with a series of well nests and pressure transducers to evaluate hydrological gradients and water table changes. Weekly isotopic samples of hydrogen (δ2H) and oxygen (δ18O) were taken to identify source waters for the wetlands and evaluate their degree of evaporative fractionation. As the perched wetland dried early in the season, both δ18O and δ^2H increased, while in the valley bottom δ18O and δ2H values remained consistent. The deviation from the local Meteoric Water Line was calculated using line-condition excess (lc-excess), and the perched wetland had greater kinetic fractionation (mean lc-excess = -13.2 ‰), compared to the valley bottom (-3.6 ‰). After snowmelt, water tables dropped consistently at both wetlands, leading to rapid drying of the perched ponds, however, the valley bottom wetland remained wet throughout the summer as it was sustained by flow from adjacent hillslopes. During rain events, water level response at the perched wetland was relatively consistent with comparable magnitudes between each well. In the valley bottom wetland, the lower elevation wells showed a greater sensitivity to rain events. These results suggest that the position of wetlands in the landscape plays a critical role in how wetlands store and cycle water; valley bottom wetlands remain wet and serve as an important dry season reservoir of water, while perched wetlands rapidly go dry after initial snowmelt contributions.

Session: 9013 General Hydrology - Part 4 Hydrologie générale - Partie 4 **02/06/2022 08:40**

ID: 11558 Contributed abstract

Poster Order:

Hydrological Controls on the water balance of thermokarst lakes between Inuvik and Tuktoyaktuk, Northwest Territories, Canada

Evan Wilcox [1] , *Brent Wolfe* [2] , *Philip Marsh* [3]

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Presented by / Présenté par: ***Evan Wilcox***
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The water balance of thermokarst lakes are shifting, as arctic warming causes precipitation to shift from snowfall to rainfall, permafrost thaw alters the hydrological connectivity of lake watersheds, longer ice-free periods increase evaporation, and increased vegetation growth changes snow redistribution and snowmelt timing. To predict the response of thermokarst lake water balances to climate change, knowledge of how meteorological, lake and watershed characteristics influence lake water balance is required. We used water isotope (18O and 2H) samples collected from 25 thermokarst lakes along the Inuvik-Tuktoyaktuk Highway, Northwest Territories from May-September 2018 to estimate the average isotope composition of input waters (δI), and the ratio of evaporation to inflow (E/I). Samples were collected at five points during the year to capture the response of δI and E/I to meteorological conditions, while lake and watershed attributes were also tested for their association with δI and E/I. After experiencing initial recharge from freshet runoff, lakes experienced increasing E/I ratios until the end of July, when air temperatures cooled, and rainfall increased to lower E/I ratios by September. Isotope data revealed that lakes experienced minimal impact from the first rainfall after a warm and dry spell in July, highlighting the importance of antecedent moisture conditions for conveying lateral flow in this environment. The large variability in E/I, which ranged from 0.00 to 0.43, was well explained by the relative area of a lake's watershed (watershed area/lake area, $r^2 = 0.74$), where lakes with relatively smaller watersheds experienced increased E/I ratios. The δI of lakes was steadily rainfall-like throughout the study period, indicating the presence of snowmelt bypass during the freshet period and the strong mixing of soil water in the soil column.

Session: 9013 General Hydrology - Part 4 Hydrologie générale - Partie 4 **02/06/2022 08:55**

ID: 11329 Contributed abstract

Poster Order:

Plant water uptake is distinct, opportunistic, and controlled by seasonality and precipitation in a subarctic, alpine environment

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Presented by / Présenté par: ***Erin Nicholls***
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As northern ecosystems warm, precipitation regimes change and vegetation shifts, there is limited knowledge of how changing species composition and density will affect critical zone water fluxes across vegetation types underlain with seasonally frozen soils and permafrost. Here, we use stable water isotopes to assess the role of soil moisture, frozen ground status, precipitation dynamics and plant species on the timing, magnitude, and sources of plant water uptake at three sites across a subarctic, alpine catchment in Yukon, Canada. The sites represent a space-for-time analogy and include a low-elevation boreal forest, a

mid-elevation subalpine taiga comprised of tall, dense willow and birch shrubs and a high-elevation subalpine taiga with shorter, sparse shrubs. We sampled soil and xylem water every 3 weeks from pre-leaf out to post-senescence over 2 hydrologically distinct years. Isotopic data was supplemented with sap flow and eddy covariance measurements of ecosystem evapotranspiration (ET). We answer the questions: 1) What sources of water, and where in the profile, do subarctic plants access water within and among seasons? and 2) How does soil moisture and the seasonal nature of frozen ground influence plant sources? Plant water uptake was more reliant on snow water at the forest site than both shrub sites. Near-surface bulk soil water had more negative lc-excess at the forest throughout the season and with depth, highlighting increased contributions from soil evaporation. Willow and birch shrubs had distinct lc-excess values, and indicate shallower, more evaporatively enriched sources for birch. Mixing analyses reveals that subarctic plants were opportunistic, using both meltwater and rain dependent upon season. This study provides new details on multi-year plant-soil-water dynamics and water cycling in seasonally frozen soils, which have not previously been reported in this environment. Results imply that rapid changes in vegetation will have considerable impact on future blue/green water fluxes.

Session: 9013 General Hydrology - Part 4 Hydrologie générale - Partie 4 **02/06/2022 09:20**

ID: 11862 Contributed abstract

Poster Order:

Wind effects on rain gauge amount and rainfall isotopic composition

Pedro Hervé-Fernández 1,2 [1] , *Jeffrey McDonnell 1* [2]

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Presented by / Présenté par: ***Pedro Hervé-Fernández 1,2***
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The effect of wind speed (WS) on rainfall measurement is well documented in hydrology. However, it is unknown how the latter translates into differences in the isotope composition of rainfall within and between events. Here we report a field study of precipitation from our site in Punta Arenas, Chile (average windspeed 12 ± 5.6 m·s-1). We hypothesised that gauge undercatch would increase with gauge height (as seen in other studies) and that isotopic effects would follow this trend whereby an evaporative fraction of rainfall and isotopic “amount-effects” would also follow trends in physical totals, both within and between events. We measured rainfall using three co-located pluviometers at heights of 0.05, at 0.5, and 1.2 m above ground level. A passive sequential water collector was attached to each pluviometer to collect samples for δ2H, δ17O and δ18O. Deuterium-excess and Δ’17O were calculated as proxies for precipitation evaporative enrichment at 1 to 3 mm volume increments. We measured WS at a nearby meteorological station. We examined 36 individual rainfall events with event rainfall totals ranging from 0.3 to 23 mm. Yearly total rainfall ranged from 446.1 – 515.8 mm. Individual storm totals were statistically

different for 19 events. Within-storm WS for sampled events ranged from 0 to 10.5 m·s-1. Overall, our results showed more complex patterns than simple trends with height above ground. In general, gauge undercatch varied due to a combination of wind speed and direction. The consequences of these differences on an event basis were complex, reflected in the measured isotopic variability. Overall, the δ2H and δ18O data (the standard hydrological tracers) were in equilibrium and plotted along the Local Meteoric Water Line for Punta Arenas. More advanced analysis of δ'18O/Δ'17O suggests that wind may be enhancing kinetic fractionation of rainfall. We are exploring this now with air mass trajectory analysis.

Session: 9013 General Hydrology - Part 4 Hydrologie générale - Partie 4 **02/06/2022 09:35**

ID: 11649 Contributed abstract

Poster Order:

Ecohydrology of natural and constructed ecotones surrounding peatlands in south eastern Manitoba

Frank Yamoah [1] , *Pete Whittington* [2]

[1]

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Presented by / Présenté par: ***Frank Yamoah***

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Ecotones are dynamic communities between two ecosystems that ensure the exchange of water, energy and nutrients and are typically between natural bogs and fens. Integrating this concept during the restoration of extracted peatlands and their natural surrounding is not common practice, in part to not being well understood. One recent approach to restore ecotone function is to create slopes on the periphery of the extracted peatland and compare to ecotones found along natural bog-to-fen transitions. Water table, surface elevation, peat depth and moisture content (5 m interval) were determined across 8 identified transects on an extracted peatland in South-eastern Manitoba in 2019 (pre-restoration) and re-established in 2020 (post-restoration). Water retention strategies (5-Pond, 3-Pond, Berm and Control) were included within the slopes to improve the hydrological connection at three sections (West, Northwest, and South) of the site. Surface elevation across 3 of the 8 transects dropped by ~1 m within 20m of the peripheral ditch. Water tables increased by 29.9 cm on 3 (managed) out of the 8 transects and increased 18.6 cm on the remaining 5 (unmanaged) transects. Comparing managed and unmanaged ecotones, water table was 11.3 cm higher on managed ecotones. Ponds and berms were generally effective at improving hydrological condition on the ecotone slopes. Soil moisture content increased immediately following rain events but declined rapidly in drier periods. Combining the water retention technique used in the study with surface reprofiling along artificial ecotone slopes can be effective at improving hydrological conditions, thus increasing the success of restoration.

Session: 9013 General Hydrology - Part 4 Hydrologie générale - Partie 4 **02/06/2022 09:50**

ID: 11821 Contributed abstract

Poster Order:

Stream temperature variability and change across Western Canada

Rajesh Shrestha [1] , *Jennifer Pesklevits* [2] , *Sydney Hoffman* [3]

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Presented by / Présenté par: ***Rajesh Shrestha***
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There is a growing body of evidence that the warming climate is leading to summer stream temperature increases, with warming air temperatures and declining snowmelt driven and rainfall driven summer flows as the main contributing factors. In this study we analyze historical stream temperature across a network of 44 river stations in Western Canada. Given that most stations have only a few observation records per year, we reconstructed 1960-2012 historical water temperature records using the air2stream hybrid process-based/statistical water temperature model. After validation of the model results, we analyzed relationships of water temperature with air temperature and discharge, which revealed the dominant contribution of air temperature to the explained variance of water temperature. Trend analyses showed increasing summer (July and August) stream temperatures for most stations, with statistical significant increases (at 5% significance level) for stations in the southern basins, and generally smaller water temperature trends compared to air temperature trends. Considering the critical stream temperature of 18°C, we find increases in the occurrences across all rivers in recent decades. Furthermore, while the stream temperatures above the critical threshold are highly synchronous with high air temperatures, there are indications of increasing synchronicity with low flows in the recent years. A sensitivity analysis with 2°C air temperature increase and/or 20% summer discharge decline revealed increasing synchrony of critical water temperatures with both high air temperatures and low flows. Overall, the results contributes to new insights on ongoing and potential future stream temperature change across the Western Canada region.

Session: 14030 Monitoring and Modelling Cryospheric Change - Part 1 Surveillance et modélisation du changement cryosphérique - Partie 1 **02/06/2022 08:25**

ID: 11498 Contributed abstract

Poster Order:

Changing Arctic Snow and Ice: in situ monitoring using digital camera imagery

Brianna Lane [1] , *Laura Brown* [2]

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Presented by / Présenté par: ***Brianna Lane***
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In the Arctic region, a rapid loss of snow and ice cover has been observed in recent years. The effects of this loss have significant impacts on global climate, hydrological events, biological processes and human populations. Previous studies have measured changes in snow and ice cover using satellite imagery and model-based approaches. Novel research is beginning to utilize ground-based automated camera systems for in situ monitoring of lake and river ice. The overall aim of this study is to maximize the usage of field imagery for snow and ice studies within the context of the changing Arctic climate. This study is focused on monitoring lake ice and snow at five study lakes (Resolute Lake, Small Lake, Plateau Lake, North Lake, and Hunting Camp Lake) near Resolute and Nanuit Itillinga, Nunavut in the Central Canadian High Arctic with data available from 2016-2021. The objective of the research is to develop a feasible method for snow and lake ice data quantification from in situ digital imagery and examine the recent variability in snow and ice phenology using the method developed. Preliminary results using image segmentation techniques show promising results for tracking the progression of ice formation and snow redistribution across the lakes. Ongoing work is focused on assessing the most viable method for automation. The significance of this research will work to develop a practical and accessible in situ methodology using automated cameras to assess Arctic climate change through observational science. Ultimately, the results from this study will provide critical insight into the spatial conditions of lake ice and snow in the study region under the current climate regime, which will support better projections under warming climate conditions in the Arctic.

Session: 14030 Monitoring and Modelling Cryospheric Change - Part 1 Surveillance et modélisation du changement cryosphérique - Partie 1 **02/06/2022 08:40**

ID: 11575 Contributed abstract

Poster Order:

Comparaison de la performance de modèles empiriques de bilan de masse glaciologique en réponse au changement climatique.

Lisa Michaud [1] , *Christophe Kinnard* [2]

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Presented by / Présenté par: ***Lisa Michaud***
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La prévision de l’évolution du bilan de masse glaciologique se fait à l’aide de modèles qui reproduisent, à l’aide de données météorologiques, les mesures prises sur le terrain. Les modèles physiques sont efficaces pour faire des prévisions à long terme, mais nécessitent de nombreuses données météorologiques, pas toujours disponibles. Les modèles empiriques, qui nécessitent peu de données météorologiques, sont donc souvent utilisés. Les études comparant la performance des modèles empiriques concluent que ceux qui représentent mieux le bilan de masse des dernières décennies auront également les meilleures projections durant le prochain siècle. Toutefois, les conditions dans lesquelles ces modèles ont été calibrés ne seront plus les mêmes dans les prochaines décennies en raison du changement climatique. Les conclusions de ces études peuvent être erronées puisque les modèles empiriques sont moins performants lorsqu'ils sont utilisés hors de leurs conditions de calibration. Afin d'explorer cette problématique, cette étude compare les résultats de modèles empiriques directement dans les conditions climatiques des prochaines décennies. Les modèles empiriques ont été calibrés en comparant leurs résultats avec ceux du modèle physique de Hock et Holmgren (2005) modifié par Kinnard et al. (2022) pour le glacier Saskatchewan, en Alberta. Les projections du modèle physique sont considérées comme étant les 'valeurs réelles' de bilan de masse des prochaines décennies. Trois méthodes de calibration sont testées afin de voir l'impact du choix de la méthode sur les projections des modèles empiriques. Cet impact est peu mentionné dans les études sur le sujet. Pourtant, cela affecte les valeurs optimales des paramètres des modèles lors de la calibration, ce qui a un impact sur les valeurs de bilan de masse prédites. Nous avons également constaté que la performance des modèles empiriques est plus affectée par les changements de température que par les changements de taux de précipitations dans différents scénarios climatiques.

Session: 14030 Monitoring and Modelling Cryospheric Change - Part 1 Surveillance et modélisation du changement cryosphérique - Partie 1 **02/06/2022 08:55**

ID: 11672 Contributed abstract

Poster Order:

Comparison and calibration of a temperature-index based coupled glacier mass balance dynamic evolution model and applications in regional melt projections

Amanda Kotila [1] , *Andrew Bush* [2] , *Monireh Faramarzi* [3]

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Presented by / Présenté par: ***Amanda Kotila***
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Projection of the changes in the dynamics of glacier accumulation, ablation, and melt runoff is crucial for the management and planning of downstream water use and aquatic ecosystems. The temperature-index models (TIMs) and energy-balanced approaches (EBMs) are widely used to predict glacier changes. In most studies, the TIMs and EBMs are applied with limited or no calibration of model parameters for regional estimates of glacier changes. Hence, they do not account for the spatially variable glacier characteristics for individual glaciers and a group of glaciers at a regional scale. On the other hand, the scarcity of high-resolution measured data at the scale of individual glaciers poses a significant challenge for predicting glacier changes at a regional scale.
This research compared the performance and predicted the uncertainty of a coupled glacier mass balance dynamic evolution model (CGMBDEM) using two TIMs for application in regional studies. The Classical Temperature Index Model (CTIM) and the Pellicciotti Temperature Index Model (PTIM) were examined using the best available data from Athabasca Glacier in Western Canada. The CTIM calculates melt using degree-day factors and a threshold temperature, whereas the PTIM incorporates melt due to radiative forcing. The CGMBDEM was calibrated, and an uncertainty prediction was made based on the optimized

range of physical and meteorological parameters via Latin Hypercube Sampling and 95 Percent Prediction Uncertainty (95PPU). Calibration and uncertainty assessment results indicate that the CGMBDEM simulations using the CTIM tend to have a statistically better (bR2=0.726, p-factor=0.77, r-factor=1.04) performance than those using the PTIM (bR2=0.551, p-factor=0.31, r-factor=1.02). This demonstrates the sensitivity of model performance to TIM choice and associated parameters. We propose that the 95PPU based on optimized parameter ranges in our CTIM-based CGMBDEM can be useful in modelling regional changes in glacier melt runoff, mass-balance, and evolution while balancing errors due to the issue of parameter transferability.

Session: 14030 Monitoring and Modelling Cryospheric Change - Part 1 Surveillance et modélisation du changement cryosphérique - Partie 1 **02/06/2022 09:10**

ID: 11562 Contributed abstract

Poster Order: Poster-14030

Diagnosing the Future Hydrology of a Central Asian Glacierized Basin using a Hydrological-Glaciological Land Surface Model

Okan Aygün [1] , *John W. Pomeroy* [2] , *Martyn P. Clark* [3] , *Alain Pietroniro* [4]

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Presented by / Présenté par: ***Okan Aygün***
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Water resources in high mountain central Asia are strongly dependent on snow and glacier melt which are vulnerable to climate change. How climate change impacts hydrology has not previously been diagnosed in the region using physically based glacio-hydrological models that can resolve mountain snow and glacier hydrology with confidence. This study assesses the impacts of projected climate change on the hydrology of the snow-covered Ala-Archa River Basin in the Tien Shan Mountains of Kyrgyzstan, a mountain headwater basin, 15% covered by glaciers. Current and future hydrological processes and streamflow were diagnosed using MESH, a Canadian physically based hydrological land surface scheme with comprehensive representation of cold regions processes. The MESH Ala-Archa model was forced by the EM-Earth (0.1°) and ERA-5 (0.25°) datasets. Temperature and precipitation forcing data over 1991-2010 were seasonally perturbed using outcomes of CMIP5-AR5 subset for RCP 8.5 for the region over the 2081-2100 period. MESH streamflow prediction was good, with Kling-Gupta Efficiency (KGE) scores above 0.9 and percent bias below ±1% over both calibration and validation periods. Under the climate change scenarios examined, the snowfall ratio declined from 49% to 33%, snowcovered period decreased by two months, and peak SWE declined by 15%. Ice melt and snowmelt presently form 40% and 25% of the total runoff, respectively, but snowmelt became the largest source of runoff with warming and deglaciation. The timing of peak streamflow advanced from mid-July to early June, and both peak discharge and annual streamflow volume decreased by more than 50% for the 2081-2100 period compared to recent conditions. These results underline the need for renewed diagnostic assessments of water supply in high mountain headwaters of Central Asia to inform adaptation to

Session: 14030 Monitoring and Modelling Cryospheric Change - Part 1 Surveillance et modélisation du changement cryosphérique - Partie 1 **02/06/2022 09:20**

ID: 11803 Contributed abstract

Poster Order:

Heat wave impacts on glacier mass balance, glacier runoff and salmon in Nooksack River, Washington

Mauri Pelto [1] , *Mariama Dryak* [2] , *Jill Pelto* [3]

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[3]

Presented by / Présenté par: ***Mauri Pelto***
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In the North Cascade Range, Washington USA, glacier runoff is a major source of streamflow during the summer low-flow season and mitigates both low flow and high-water temperatures, particularly during summer heat waves. A thirty-eight year record (1984-2021) of glacier mass balance and areal extent measurement indicate a significant glacier response to climate change in the North Cascades, Washington that has led to declining glacier runoff. The ameliorating role of glacier runoff on discharge and water temperature is examined during 23 late summer heat wave events from 2010-2021 including the early summer 2021 Pacific Northwest heat wave. The heat waves are characterized by local temperature data. Glacier runoff is determined using synchronous observations of glacier ablation on Sholes Glacier and stream discharge immediately below Sholes Glacier. The observed ablation rate is applied to glaciers across the North Fork Nooksack watershed, providing daily glacier runoff discharge to the North Fork Nooksack River. This is compared to observed daily discharge and temperature data of the North Fork Nooksack River and the unglaciated South Fork Nooksack River from the USGS. During the 23 warm weather events the discharge increased an average of +23% in the North Fork and decreased an average of 20% in the South Fork. For water temperature the mean increase was 0.7o C in the North Fork and 2o C in the South Fork. For the North Fork glacier runoff production was equivalent to 34% of the total discharge during the 23 events. Heat waves that occurred after significant bare firn and ice was exposed on the glacier surface led to peak glacier discharges. Ongoing climate change will cause further decreases in summer baseflow and an increase in water temperature potentially exceeding tolerance levels of several Pacific salmonid species.

Session: 14030 Monitoring and Modelling Cryospheric Change - Part 1 Surveillance et modélisation du changement cryosphérique - Partie 1 **02/06/2022 09:35**

ID: 11778 Contributed abstract

Poster Order:

Multi-method approach to inventorying rock glaciers and features of interest in Banff and Jasper National Parks, Alberta, Canada

Mishelle Wehbe [1] , *Philip Bonnaventure* [2] , *Robert Way* [3]

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[3] Northern Environmental Geoscience Laboratory, Queen's University

Presented by / Présenté par: ***Mishelle Wehbe***
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Rock glaciers are perennially frozen masses of ice and unconsolidated material that creep downslope resultant from internal, cyclic freeze-thaw mechanisms and weight due to gravity. These features are often tongue-shaped, lobate landforms, with lateral and frontal margins, that often contain longitudinal or transverse flow features within their surface consisting of poorly sorted, angular rock debris. Although rock glaciers are abundant geomorphological features in the alpine periglacial environments of the Rocky Mountains, their spatial distribution and characteristics are largely unknown. As rock glaciers contain frozen fresh water and can be potential geohazards, inventories are crucial in the assessment of the activity status and distribution of these landforms. This inventory will also provide an estimate on the potential cubic meters of water equivalent storage within the rock glaciers for cryospheric reserves as freshwater depletes. To date, over 800 intact (active/inactive) rock glaciers were successfully identified within the study areas, as well as over 204 features of interest requiring further validation of surface kinematics and morphometric quantification. Grid-based manual inventorying of these features was completed using high-resolution satellite imagery that is readily available through the ESRI World Imagery Base Layer, then subsequently verified manually with Google Earth Pro. This proved crucial and supports the idea of both multi-temporal and multi-method approaches to the inventorying of rock glaciers and features of interest within the alpine terrains of Canada to ensure high accuracy in inventorying and for long-term monitoring feasibility. This work represents the first component of our rock glacier monitoring network within Canada, as there currently are none to date.

Session: 14030 Monitoring and Modelling Cryospheric Change - Part 1 Surveillance et modélisation du changement cryosphérique - Partie 1 **02/06/2022 09:50**

ID: 11365 Contributed abstract

Poster Order:

Cryospheric Observation and Modelling for improved Adaptation in Central Asia (CROMO-ADAPT)

Martin Hoelzle [1] , *Martina Barandun* [2] , *Christian Hauck* [3] , *Christin Hilbich* [4] , *Joel Fiddes* [5] , *Tamara Mathys* [6] , *Enrico Mattea* [7] , *Rodica Nita* [8] , *Jeannette Noetzli* [9] , *Eric Pohl* [10] , *Tomas Saks* [11]

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Presented by / Présenté par: ***Martin Hoelzle***
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Climate change is a challenge for humanity and the resulting global consequences will influence and endanger economies and livelihoods of coming generations. Strategies to improve climate resilience through adaptation must be based on sound baseline information, such as climate observations, especially on the Essential Climate Variables (ECVs) defined by the Global Climate Observing System (GCOS). Significant gaps exist however in the global climate observing system, particularly in High Mountain Asia This data scarcity results in high uncertainties about the experienced as well as expected consequences of climate change, preventing sound anticipation of future developments and planning corresponding adaptation measures. A region, where climate change is projected to have major impacts on water availability and occurrence of natural hazards is Central Asia’s mountain regions.
A new project, named Cryospheric Observation and Modelling for improved Adaptation in Central Asia (CROMO-ADAPT), will address this gap by strengthening and (re-)establishing cryospheric (snow, glaciers, and permafrost) in-situ monitoring systems in Central Asia. This project continues the improvements of glacier monitoring activities that have been ongoing for more than a decade by complementing it with snow and permafrost monitoring systems and corresponding capacity building in Central Asia. Ultimately, this project aims to develop climate resilience through climate information services and adaptation measures based on sound climate observations. Four watersheds, particularly in the headwater regions of Kyrgyzstan and Tajikistan are selected for a combined cryospheric observation strategy following the guidelines provided by the Global Cryosphere Watch (GCW) of the World Meteorological Organization (WMO) and the Global Framework for Climate Services (GFCS). This includes mainly the application of old and new in situ technology of snow, glacier, and permafrost long-term observations.

Session: 3020 Advancing our understanding of the Arctic atmosphere - Part 1 Faire progresser notre compréhension de l'atmosphère arctique - Partie 1

02/06/2022 12:55

ID: 11834 Invited session speaker

Poster Order:

The role of the polar vortex in whole atmosphere coupling

V Lynn Harvey [1]

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Presented by / Présenté par: ***V Lynn Harvey***
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In the polar regions, the wintertime polar vortices play a critical role in both "bottom-up" atmospheric coupling via its modulation of planetary and gravity waves as well as "top-down" coupling via the transport of nitrogen oxides created by energetic particle precipitation. This talk will present the current state of understanding regarding the role of the polar vortex in coupling different atmospheric layers via both “bottom-up” and “top-down” processes. In particular, for “bottom-up” coupling, the polar vortices acts to vertically coupling the atmosphere from the ground to geospace by shaping the background wind field through which atmospheric waves propagate. For a variety of reasons, the geographic distribution of gravity wave (GW) activity depends on the strength and shape of the polar vortex. In the ionosphere, the frequency of occurrence of traveling ionospheric disturbances is linked to this GW activity and to polar vortex strength. For “top-down” coupling, energetic particle precipitation (EPP) generates nitrogen oxides (NOx=N+NO+NO2) in the mesosphere-lower thermosphere polar regions. In the wintertime, the polar vortices play a key role in downward coupling the thermosphere to the stratosphere by focusing the descent of EPP-NOx within its interior. State-of-the-art global climate models severely underestimate EPP-NOx transport during disturbed Arctic winters. Recent results demonstrate the role of Lagrangian Coherent Structures at mesopause altitudes in focusing the descent of EPP-NOx into the top of the polar vortex. Both upward and downward coupling processes will be elucidated by showing examples in observations and in whole atmosphere models. Finally, we will discuss how disturbances to the polar vortex can be traced all the way to the opposite summer pole and can modulate noctilucent clouds.

Session: 3020 Advancing our understanding of the Arctic atmosphere - Part 1 Faire progresser notre compréhension de l'atmosphère arctique - Partie 1

02/06/2022 13:25

ID: 11370 Contributed abstract

Poster Order:

Past and Predicted Temperature Trends in the Winter Arctic Stratosphere and the Role of Sudden Stratospheric Warmings

Kevin Bloxam [1] , *Yi Huang* [2]

[1] McGill University
[2] McGill University

Presented by / Présenté par: ***Kevin Bloxam***
Contact: kevin.bloxam@mail.mcgill.ca

Arctic amplification has resulted in the Arctic warming at a faster pace than anywhere else on the planet. This amplified warming, predominately studied for its tropospheric and near-surface impacts, however, is not just constrained to the troposphere. In fact, reanalysis data has revealed that the winter (December – February) upper troposphere and lower stratosphere has been warming at a rate of approximately 0.5 K/decade over the 1980-2019 period. Despite the enhanced radiative cooling of the stratosphere, induced by anthropogenic emissions of greenhouse gases, dynamical heating dominates over the temperature trends of the last 40 years resulting in the warming trend found there. It has been further revealed that when this 40-year period is filtered according to years with and without sudden stratospheric warmings (SSWs), it is the SSW-occurring years that are largely dictating the trends. Years without the occurrence of an SSW, on the other hand, show widespread stratospheric cooling, consistent with the expectation of the stratosphere under climate change. Motivated by these results this work uses CMIP6 models to help elucidate future trends of the Arctic winter stratosphere. By first determining which CMIP6 models best represent the current state of the stratosphere and

produce a realistic number of SSWs per year, this work will use these selected models to help predict the future temperature evolution of the stratosphere and determine if these trends will continue in the future.

Session: 3020 Advancing our understanding of the Arctic atmosphere - Part 1 Faire progresser notre compréhension de l'atmosphère arctique - Partie 1 **02/06/2022 13:50**

ID: 11386 Contributed abstract

Poster Order:

Impact of Resolution on the Representation of the Mean and Extreme Winds along Nares Strait

Kent Moore [1]

[1]

Presented by / Présenté par: ***Kent Moore***
Contact: gwk.moore@utoronto.ca

Nares Strait is the long and narrow strait bounded by steep topography that connects the Arctic Ocean's Lincoln Sea to the North Atlantic's Baffin Bay. The winds that blow along the strait play an important role in modulating ice and water exports from the Arctic Ocean as well as in helping to establish the Arctic's largest and most productive polynya that forms at its southern terminus. However, its remote location has limited our knowledge of the winds along the strait. Here we use weather station data from the region as well as 3 numerical models with horizontal resolutions that vary from ~30km to ~2.5 km to characterize the wind field in the vicinity of the strait. The strait has a width that varies from ~40km to ~100 km and as such the wind field is typically ageostrophic and controlled by the pressure gradient in the along-strait direction. We show that model resolution plays a role in the representation of both the mean and extreme winds along the strait through the ability to represent this ageostrophic flow. Higher windspeeds occur in the vicinity of Smith Sound and are the result of a left-hand corner jet. Kane Basin, the widest section of the strait, is characterized by a pronounced zonal windspeed gradient that is the result of the steep topography of the upstream Washington Land peninsula.

Session: 3020 Advancing our understanding of the Arctic atmosphere - Part 1 Faire progresser notre compréhension de l'atmosphère arctique - Partie 1 **02/06/2022 14:05**

ID: 11749 Contributed abstract

Poster Order:

Assessing Pan-Arctic atmospheric Ozone simulation capability within the GEM-MACH air quality modelling system

Stephen Beagley [1] , *Wanmin Gong* [2] , *Roya Ghahreman* [3]

[1] ECCC
[2] ECCC
[3] ECCC

Presented by / Présenté par: ***Stephen Beagley***

Contact: drsrbeagley@gmail.com

In order to assess our current simulation capacity for the Tropospheric Arctic atmosphere, the GEM-MACH air quality model has been adapted to be run on a PAN-Arctic domain. A series of annual simulations for the year 2015 were conducted to assess the model's capability in capturing seasonal variation and geographical distribution of the Arctic surface ozone.
Using surface ozone measurements throughout the PAN-Arctic domain, and by developing observational-model comparative diagnostic capacity, together with an ozone budget diagnostic system, an assessment is being undertaken to identify missing processes and current capabilities in the simulation of surface Arctic ozone, and related chemical species. Initial analyses show and compare: (1) the Impact of biogenic emissions on atmospheric oxidation capacity in the northern boreal region; (2) the Role of iodide-mediated ozone deposition over the ocean, on the regional simulation capacity of the model. Results will be shown from several sensitivity experiments aimed to highlight the significance of the role of these processes.

Session: 3020 Advancing our understanding of the Arctic atmosphere - Part 1 Faire progresser notre compréhension de l'atmosphère arctique - Partie 1 **02/06/2022 14:20**

ID: 11547 Contributed abstract

Poster Order:

Observations of Extreme Wildfire VOC Enhancements over the Canadian High Arctic

Tyler Wizenberg [1] , *Kimberly Strong* [2] , *Dylan Jones* [3] , *Erik Lutsch* [4] , *Emmanuel Mahieu* [5] , *Bruno Franco* [6] , *Lieven Clarisse* [7]

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Presented by / Présenté par: ***Tyler Wizenberg***
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Wildfires are a common occurrence in many parts of the globe and can emit significant quantities of trace gases and particulate matter, negatively impacting air quality on large spatial scales. Among the various trace gases emitted by wildfires are volatile organic compounds (VOCs). Four VOCs that are of particular importance are methanol (CH_3OH), formic acid (HCOOH), peroxyacetyl nitrate (PAN), and ethylene (C_2H_4). These reactive VOCs can have a variety of negative impacts on the atmospheric chemistry and environment of remote regions including influencing trace gas budgets, impacting atmospheric acidity, and contributing to the 'Arctic haze' pollution phenomenon.
During August 2017, two independent large-scale wildfires in British Columbia and the Northwest Territories of Canada generated vast smoke plumes that merged and were subsequently transported to the high Arctic. Simultaneous

observations by a high-resolution ground-based Fourier transform infrared (FTIR) spectrometer at the Polar Environment Research Laboratory (PEARL) in Eureka, Nunavut (80.05°N, 86.42°W), and the Infrared Atmospheric Sounding Interferometer (IASI) satellite instruments display extreme enhancements in these species relative to background concentrations during the fire-affected period in late August 2017, demonstrating the long-range transport and secondary formation of these typically short-lived species. Comparisons of observations with the GEOS-Chem global chemical transport model illustrate that this exceptional wildfire event contributed to a substantial perturbation to the VOC budget of the high-Arctic atmosphere.

Session: 4042 Atmosphere, Ocean, and Climate Dynamics - Part 3 La dynamique de l'atmosphère, de l'océan et du climat - Partie 3

02/06/2022 12:55

ID: 11532 Contributed abstract

Poster Order:

Impact of land-ocean contrasts in cumulus entrainment on the current climate

Meera Mohan [1] , *Daniel Kirshbaum* [2] , *Timothy Merlis* [3]

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Presented by / Présenté par: ***Meera Mohan***
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Cumulus entrainment is the process by which environmental air is ingested into cumulus clouds through the cloud boundaries. Entrainment involves mixing cooler and drier environmental air into cumulus clouds, which reduces the cloud depth, the number of cloud droplets, cloud cover, cloud water concentration etc., thereby affecting the radiation and precipitation fields. Among the processes parameterized in climate models, entrainment rate is found to be the dominant factor affecting climate sensitivity. Despite the significance of entrainment in shaping the climate, there is no agreement among climate models on parameterizing entrainment or a physical basis for its parameterization. In this study, we explore the impact of land-ocean contrasts in cumulus entrainment on the current climate using the High-Resolution Atmospheric Model (HIRAM), a GCM.

A modification of the entrainment parameter over land and ocean affect both the convection patterns and the global circulation systems. The continental precipitation is found to increase upon reducing the entrainment rates over land. An increase in convective precipitation moistens the soil, which increases the latent heat fluxes and further enhances precipitation. This soil moisture feedback is found to contribute to the increased low-level moisture supply over continents. On the other hand, reducing the entrainment rate over oceans has a major impact on changing the convection pattern over the tropical Pacific. Among the global circulation systems, the Hadley circulation does not change significantly upon modification of entrainment rates as the zonal land-ocean contrasts are averaged out in the zonal mean. The Walker circulation, which affects rainfall patterns in different parts of the world, is found to weaken by almost 14 percent when the entrainment rate in oceanic clouds is reduced.

Session: 4042 Atmosphere, Ocean, and Climate Dynamics - Part 3 La dynamique de l'atmosphère, de l'océan et du climat - Partie 3

02/06/2022 13:10

ID: 11706 Contributed abstract

Poster Order:

Variability of Biomass Burning Emissions Impacts the Hydrologic Cycle in Earth System Models

Kyle Heyblom [1] , *Hansi Singh* [2] , *Philip Rasch* [3] , *Patricia DeRepentigny* [4]

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Presented by / Présenté par: ***Kyle Heyblom***
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Historical simulations performed for the Coupled Model Intercomparison Project Phase 6 (CMIP6) used biomass burning (BB) emissions with much higher spatial and temporal variability between 1997-2014, compared to emission inventories specified for earlier years. Using the Community Earth System Model version 2 (CESM2) Large Ensemble, we show that increased BB emissions variability leads to a significant amplification of the hydrologic cycle poleward of 40N. Notably, the high variability of BB emissions leads to increased latent heat fluxes, column-integrated precipitable water, and precipitation. Using a hierarchical model approach, we further explore how the sensitivity of the climate system to BB emissions variability arises from a nonlinear aerosol-climate response. As the interannual variability of BB emissions increases, more downwelling shortwave radiation is absorbed by the climate system, creating a greater effective aerosol forcing due to aerosol-cloud interactions (i.e. the aerosol indirect effect). Therefore, our results suggest that it is not only the total time-integrated amount or secular changes (on multidecadal timescales) of BB emissions that impact the aerosol forcing, but also the shorter timescale variability in emissions. Our results are of importance to users of the CMIP6 ensemble and contributors to future multi-model intercomparison projects, as the choice in the interannual variability of BB emissions can create significant biases in the modeled climate.

Session: 4042 Atmosphere, Ocean, and Climate Dynamics - Part 3 La dynamique de l'atmosphère, de l'océan et du climat - Partie 3

02/06/2022 13:25

ID: 11714 Contributed abstract

Poster Order:

The Impact of Major North American Lakes in WRF for Regional Climate Applications

Mani Mahdinia [1] , *Andre Erler* [2] , *Richard Peltier* [3]

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Presented by / Présenté par: ***Mani Mahdinia***
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In this study, we focus upon the influence of major lakes on the North American climate, and how well different lake models do in achieving realistic simulations. We also investigate the ability of these models to properly represent specific lake effects such as ice-in and -out dates and lake effect precipitation. The study design and domain setup follows CORDEX guidelines for historical regional climate modelling and we employ the recent ERA5 reanalysis product. The lakes of concern to us include the Laurentian Great Lakes, which straddle the US-Canada border; the Great Slave and Great Bear Lakes of the Northwest Territories; and the Lakes Winnipeg and Winnipegosis. These are the largest lake clusters on the Canadian land mass and are characterized by a range of depths and environmental conditions. We employ the WRF model, a widely-used state-of-the-art regional climate model, at 0.11 degree resolution. There have been several previous attempts to implement lake models in WRF (e.g. FLake), but most of these have focused solely upon the Great Lakes. However, when considering the climate across all of Canada, other large lake regions such as Great Slave and Great Bear Lakes or Lakes Winnipeg and Winnipegosis are also of critical importance. Our goals in the current work are, first, to produce a direct comparison of different column lake models (e.g., FLAKE or enhanced versions of CLM/WRF lake model) when applied to the Great Lakes, second, to provide a general assessment of lake effects and perform an assessment of column lake models at high latitudes (for Great Slave and Great Bear Lakes), and third, trend analysis and comparison of lake surface temperatures, ice, and lake-effect precipitation for all the major lakes. The simulations will encompass an extensive historic period during which reanalysis data is available.

Session: 4042 Atmosphere, Ocean, and Climate Dynamics - Part 3 La dynamique de l'atmosphère, de l'océan et du climat - Partie 3

02/06/2022 13:50

ID: 11748 Contributed abstract

Poster Order:

Investigation of the climatology of low-level jets over North America in a high-resolution WRF simulation

Xiao Ma [1] , *Yanping Li* [2] , *Zhenhua Li* [3]

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[3] Global Institute for Water Security

Presented by / Présenté par: ***Xiao Ma***
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The Low-level Jet (LLJ) is an important atmospheric phenomenon over North America and significantly impacts local weather and climate. In this study, we

use a 4-km convection-permitting Weather Research Forecasting (WRF) simulation over 13 years (2000-2013) to investigate the climatological features of LLJs. A high-resolution model better represents orography and the underlying surface that strongly affect winds in the boundary layer. The simulation domain covers the continental US and the neighboring portions of Canada and Mexico. The study characterizes the spatial distribution, seasonal and diurnal fluctuations of northerly/southerly LLJs' frequencies. Our algorithm successfully identified the previously well-known large-scale features of North American LLJs like southerly Great Plain LLJs and summer northerly Pacific Coast LLJs. Besides, the high-resolution simulation also provides new climatic characteristics of weaker and smaller-scale LLJs near complex terrains. Wintertime northerly Rockies LLJs were confined in limited foothill regions. Finally, the different thermal/dynamic processes contributing to the formations of large and small-scale LLJs were investigated.

Session: 4042 Atmosphere, Ocean, and Climate Dynamics - Part 3 La dynamique de l'atmosphère, de l'océan et du climat - Partie 3

02/06/2022 14:05

ID: 11815 Contributed abstract

Poster Order:

Seasonal Forecasting of Winter Extratropical Cyclones in Nova Scotia

Rebekah Cavanagh [1] , *Eric Oliver* [2]

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Presented by / Présenté par: ***Rebekah Cavanagh***
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Winter Extratropical Cyclones (ETCs) are mid-latitude storms that regularly impact the east coast of North America. These storms are characterized by high winds and heavy precipitation of varying types. ETCs are well predicted by NWPs at short- to mid-range forecast lead times however, on seasonal time scales these storms are not well predicted. Winter storm season characteristics vary greatly from year to year, with consecutive winters often being dominated by different storm types. We focus on a particular location (Halifax, NS) and separate winter ETCs that affect this area into subseries based on their impacts in the region. For each storm type subseries, we then develop a multiple linear regression (MLR) model using stepwise regression and cross-validation to select predictors from September mean fields of atmospheric variables that are known drivers of ETCs. The best model is the snow storm MLR which showed a correlation between predicted and observed storm counts of 0.86 and a normalized root mean squared error of 0.58 storms/season. Overall, the results indicate the storm type-specific MLRs have some skill, but still have considerable uncertainty when forecasting an exact number of storms in a given season. Rather than forecast specific storm numbers, we apply the probability density function of the MLR outputs within a probabilistic forecast framework to predict the likelihood of average, below average, or above average activity each season. Validation over the 2019 and 2020 winter storm seasons revealed 9 of 16 forecasts were verified. This seasonal forecast of ETCs in Halifax and the surrounding area has the potential to provide information to government, policy makers, and the general public to allow for adequate preparation and minimization of losses in upcoming winter storm seasons.

Session: 4042 Atmosphere, Ocean, and Climate Dynamics - Part 3 La dynamique de l'atmosphère, de l'océan et du climat - Partie 3

02/06/2022 14:20

ID: 11780 Contributed abstract

Poster Order:

Mesoscale Wind and Temperature Changes over Peatlands of the Hudson Bay Lowlands and their Impact on the Surface Energy Balance

Olalekan Balogun [1] , *Richard Bello* [2] , *Kaz Higuchi* [3]

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Presented by / Présenté par: ***Olalekan Balogun***
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The Hudson Bay exerts a strong advective influence on the surface energy balance in the Hudson Bay Lowlands (HBL) region of Canada. The onshore winds are relatively cold and moist compared to the warm and dry offshore winds. The contrasting thermal and humidity properties of these two wind regimes affect the partitioning of net radiation between the sensible, latent and ground heat fluxes over the HBL. The long-term impact of climate change on the advective role of the Hudson Bay was previously unknown. In this study, we employ NOAA's North American Regional Reanalysis (NARR) dataset to show that global warming has caused significant changes in the advective role of the Hudson Bay and the mesoscale wind regimes of the HBL over the past 40 years. We found a strong increasing trend in onshore wind frequency of about 7% from 1979 to 2018. The most rapid changes occurred in June when the onshore winds have increased by 17%, resulting in a shift from offshore to onshore winds dominance over the region. These changes in June are striking, as it implies that the average difference in frequency between the two wind regimes has decreased by about 35% over the study period. Our results also demonstrate that the offshore wind temperatures are increasing faster than the onshore temperatures, producing positive trends in the surface energy fluxes that are significantly different between the wind regimes. We identify considerable spatial heterogeneity in the magnitude and strength of these climatic trends across the HBL. Our results show that the changes in the mesoscale wind regimes and surface energy balance of the HBL under present and projected climate warming are markedly different than was previously thought.

7024 Responding to the BC Extreme Events – A Panel Discussion

In June of 2021 an extraordinary “Heat Dome” with record breaking temperatures resulted in almost 600 deaths over southwestern British Columbia. This is the greatest weather-related loss of life in Canada's history. This was followed by wildfires, one of which destroyed the community of Lytton. Less than five months later, extreme rainfall from a persistent “atmospheric river” event, resulted in historic flooding with damages likely to exceed one billion dollars.

Several scientific sessions at the 2022 Congress hosted jointly by the Canadian Meteorological and Oceanographic Society, the Canadian Geophysical Union, and the Eastern Snow Conference, are dedicated to the 2021 extreme events.

The theme of the Congress is “Science Serving Society”.

Impressive scientific advances have been made in the observing, understanding and prediction of changes in weather, water and climate. Since the unprecedented events of 2021 in British Columbia are a harbinger of climate-driven extremes that will more frequently impact society, the Panel will discuss steps that are, or should, be taken.

Panelists include:
• Russ White, Director General Prediction & Services, Environment and Climate Change Canada
• Matt Godsoe, Director of the Resilience and Economics Integration Division, Public Safety Canada
• Jason Thistlewaite, Professor in the School of Environment, Enterprise and Development at the University of Waterloo
• David Campbell, Head, River Forecast Centre, British Columbia Ministry of Forests

Each Panelist will offer a 10-minute perspective, followed by a 40-minute discussion/Q&A

Session: 9020 Advances in forest hydrology - Part 1
Avancées en hydrologie forestière - Partie 1 **02/06/2022 12:55**

ID: 11406 Invited session speaker

Poster Order:

Climate change increases the severity and duration of soil water stress in the temperate forest of eastern North America

Audrey Maheu [1] , *Cybèle Cholet* [2] , *Daniel Houle* [3] , *Jean-Daniel Sylvain* [4] , *Frédérik Doyon* [5]

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[2] Université du Québec en Outaouais
[3] Environnement et Changement climatique Canada
[4] Direction de la Recherche Forestière, Ministère des Forêts, de la Faune et des Parcs du Québec
[5] Université du Québec en Outaouais

Presented by / Présenté par: ***Audrey Maheu***
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Under climate change, drought is projected to intensify and soil water stress has been identified as one of the primary drivers of the decline of forests. While there is strong evidence of such disturbance in semi-arid regions, large uncertainty remains in North American temperate forests and fine-scale projections of soil water stress are needed to guide adaptation decisions. The objectives of this study were to i) assess the impact of climate change on the severity and duration of soil water stress in temperate forests of eastern North America and ii) identify drivers of the spatial variability of soil water stress. We modeled current and future soil moisture at a 1 km resolution with the Canadian Land Surface Scheme (CLASS). Despite a slight increase in precipitation during the growing season at the 2080 horizon, the severity (95th percentile of absolute soil water potential) and duration (mean number of days per year

where absolute soil water potential is greater than or equal to 9000 hPa) of soil water stress were projected to increase on average by 1680 hPa and 6.7 days under RCP8.5, which correspond to a 33 % and 158 % increase compared to current levels. The largest increase in severity was projected to occur in areas currently experiencing short periods of soil water stress, while the largest increase in duration is rather likely to occur in areas already experiencing prolonged periods of soil water stress. Soil depth and, to a lesser extent, soil texture, were identified as the main controls of the spatial variability of projected changes in the severity and duration of soil water stress. Overall, these results highlight the need to disentangle impacts associated with an increase in the severity versus in the duration of soil water stress to guide the management of temperate forests under climate change.

Session: 9020 Advances in forest hydrology - Part 1
Avancées en hydrologie forestière - Partie 1 **02/06/2022 13:25**

ID: 11506 Invited session speaker

Poster Order:

Forest use of bedrock water in droughts past, present and future: implications for ecosystem resilience

W. Jesse Hahm [1] , *Dana Lapides* [2] , *David Dralle* [3] , *John Whiting* [4] , *Erica McCormick* [5] , *Daniella Rempe* [6]

[1] Simon Fraser University
[2] ORISE; Simon Fraser University
[3] US Forest Service
[4] US Forest Service
[5] UT Austin
[6] UT Austin

Presented by / Présenté par: ***W. Jesse Hahm***
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Droughts are increasing in frequency and severity, with variable and difficult-to-predict consequences for upland forests and the streams that drain them. When, where, and why do some forests emerge unscathed from extreme reductions in precipitation? Here we explore the interaction between precipitation magnitude and subsurface water storage capacity—including both soil and underlying weathered bedrock—in mediating forest resilience. We combine rare field data sets of bedrock water storage throughout deeply weathered, unsaturated profiles in seasonally dry California with remotely sensed precipitation and evapotranspiration fluxes to identify controls on forest sensitivity to precipitation variability. By synthesizing ongoing work from both rain- and snow-dominated regions (in the Coast Ranges and Sierra Nevada, respectively), we advance a subsurface-centric framework for predicting both streamflow and evapotranspiration sensitivity to increasingly variable seasonal precipitation totals. Insights from seasonally dry California have implications for the economically and culturally significant forests of Southern British Columbia, whose climate is anticipated to become more Mediterranean in the coming century.

Session: 9020 Advances in forest hydrology - Part 1 **02/06/2022**
Avancées en hydrologie forestière - Partie 1 **13:40**

ID: 11430 Contributed abstract

Poster Order: Poster-9020

Quantifying Evapotranspiration in Seasonally Frozen Forests

Sujan Basnet [1] , *Andrew Ireson* [2]

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Presented by / Présenté par: ***Sujan Basnet***
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In seasonally frozen environments, hydrological processes are highly dynamic during and following the melt period in the spring, and this is when most of the runoff and groundwater recharge happens. This is also when evapotranspiration (ET) fluxes start to increase in response to higher solar radiation and a resumption of photosynthesis in evergreen species. This study applies the Canadian Land Surface Scheme (CLASS) to three Boreal Ecosystem Research and Monitoring Sites (BERMS) in the boreal forest in Saskatchewan; Old Jack Pine, Old Black Spruce and Old Aspen. CLASS was used to simulate the energy and water balance of the vegetation, soil and snowpack at the three sites. Consistent with previous studies, it was shown that ET is overestimated in the model during the melt/thaw period. The study explored the model behaviour of the simulated fluxes. The phenomenon of freezing point depression, where water freezes below 0 ℃ in soils, is not represented in the CLASS model. Consequently, the model predicted a significant amount of transpiration to occur during the melt period while the soil was at 0 ℃ and ice was still present in the soil pores. Subtracting the transpiration that occurred from soil layers containing ice improved the simulated ET, compared with flux tower estimates. Therefore, it is suggested that implementing freezing point depression in the model and including a water stress function to shut down transpiration when the soil temperature is 0 ℃ would improve the simulated evapotranspiration during the melt period. The study also showed that calibration of the model parameters is unable to uniquely constrain the infiltration and soil drainage fluxes by either single objective (ET) or multi-objective (soil moisture and ET) calibration. Further process research is needed to understand and quantify root water uptake in soils at and below 0 ℃

Session: 9020 Advances in forest hydrology - Part 1
Avancées en hydrologie forestière - Partie 1 **02/06/2022 13:50**

ID: 11501 Contributed abstract

Poster Order:

The Effects of Spruce Budworm Defoliation on Catchment Hydrology in Hilly Spruce and Fir-Dominated Forests in Gaspé, Québec

Harvinder Sidhu [1] , *Karen Kidd* [2] , *Erik Emilson* [3] , *Brian Kielstra* [4] , *Colin McCarter* [5]

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Presented by / Présenté par: ***Harvinder Sidhu***
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The native North American moth, spruce budworm (SBW), has been linked to significant reductions in forest density and increased tree mortality of spruce and fir trees across the eastern Canadian boreal forest. How such pest-driven modifications to the forest structure impacts catchment-scale hydrological processes remain relatively unknown. Over a three-year period (2019-2021), we measured how the magnitude of SBW defoliation affected streamflow and runoff processes in 12 catchments across the Gaspé Peninsula in Québec, Canada, six of which have been aerially treated with BtK pesticide and the remaining six left untreated; as such, there was a gradient of defoliation intensity. For each catchment, stage-discharge relationships were derived between June and October and used for recession limb analysis and separated into event flow and baseflow, and the runoff ratio was determined. After which, the relationships between defoliation intensity and the hydrological metrics were determined using linear regression analyses. Discharge was shown to significantly increase with increasing defoliation intensity ($R2=0.36$, $p= 0.002$), particularly in third-order streams. The same relationship was observed at the seasonal level during the summer months but was less prominent during the autumn months. Further, there was a significant relationship between catchment elevation and discharge ($R2=0.47$, $p=0.0002$) as high-elevation catchments displayed higher spruce-fir stand compositions and often increased defoliation severity. However, defoliation intensity was shown to have little effect on runoff or runoff ratio. This study strengthens our understanding on the effects of defoliation on freshwater resources and flood management, especially when confronted by other, interactive, disturbances such as climate change.

Session: 9020 Advances in forest hydrology - Part 1
Avancées en hydrologie forestière - Partie 1 **02/06/2022 14:05**

ID: 11460 Contributed abstract

Poster Order:

Event-scale hydrologic responses in a hardwood dominated headwater catchment 25 years following clearcut harvesting

Annie Gray [1] , *Mike Stone* [2] , *Kara Webster* [3] , *Jason Leach* [4] , *Jim Buttle* [5] , *Monica Emelko* [6]

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[4] Natural Resources Canada, Great Lakes Forestry Center, Canadian Forest Service
[5] Trent University School of the Environment
[6] University of Waterloo Department of Civil and Environmental Engineering

Presented by / Présenté par: ***Annie Gray***
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Harvesting practices such as clear-cutting can alter the hydrologic responses of forested landscapes at various timescales and influence the timing and magnitude of nutrient export to receiving streams. While many studies have examined the immediate hydrologic impacts of forest harvesting, much less is known about long-term impacts of harvesting on event-scale hydrologic responses. The present study used high-resolution precipitation, shallow subsurface soil moisture, and stream discharge measurements collected at two hardwood dominated headwater catchments in the Turkey Lakes Watershed near Sault Ste Marie, Ontario. The catchments were part of a forest harvesting experiment initiated in 1997 where one catchment was retained as an unharvested reference and the second catchment was treated with a diameter-limited clearcut. A total of 19 precipitation events between March and October 2021 were analyzed. The mean total event flow across events was (average ± standard deviation) 0.83mm ± 0.99mm in the reference catchment and 0.58mm ± 2.01mm in the clearcut catchment. The reference catchment generally had higher pre-event flows but lower peak event flows relative to the clearcut catchment. The mean runoff ratio was 0.05 ± 0.03 for the reference catchment and 0.05 ± 0.04 for the clearcut catchment. Preliminary results show no significant ($p < 0.05$) legacy effect of clearcut harvesting on the runoff ratios, total flow, or peak flow of the study catchments, regardless of event character or antecedent moisture conditions. These results are comparable to other long-term studies on the effects of post-harvest landscape recovery on stream response and are consistent with evidence of landscape recovery in the clearcut catchment which shows that, 25 years post-harvest, leaf area index and stem stocking density, the latter largely driven by increases in yellow birch, hop-hornbeam and red cherry rather than sugar maple, are about equal between the clearcut and reference catchments.

Session: 9020 Advances in forest hydrology - Part 1
Avancées en hydrologie forestière - Partie 1 **02/06/2022 14:20**

ID: 11720 Contributed abstract

Poster Order:

Characterizing the effects of climate change, land cover change, and internal climate variability on the hydrology of a forested watershed

Vahid Mehdipour [1] , *Mohammad Fereshtehpour* [2] , *Mohammad Reza Najafi* [3] , *Jason Leach* [4]

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Presented by / Présenté par: ***Mohammad Fereshtehpour***
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Hydrological processes of forested watersheds can be influenced by hydroclimate variability and the (in)direct impacts of human activities. In this study, we quantify the influence of three major factors (internal climate variability, climate and land cover change) on the hydrologic components of a forested watershed, including snowpack, mean and extreme river discharge. The study is focused on the Batchawana watershed (catchment area of 1280 km2) located in central Ontario on the eastern shore of Lake Superior. The

watershed is characterized by a gradient of forest types, from deciduous-dominated near the lake to coniferous-dominated further inland, as well as a large number of small lakes and ponds. The hydrological model within the Raven platform was setup and calibrated to determine the hydrological consequences of forest type change and climate change over the watershed, based on land cover scenarios, eight global climate models, and three large ensembles of regional climate models (RCMs). Projected snowpack and streamflow changes are assessed under global mean temperature rises of 1.5-4 °C. The results suggest that shifting from deciduous to coniferous tree cover combined with the impacts of climate change can result in increased streamflow rates in the fall and winter. The study area is projected to experience a warmer and wetter environment with a transition from a nival system to rain-dominated flows, lower annual maximum and higher annual mean streamflow rates. RCMs project higher precipitation compared to GCM simulations, leading to higher mean streamflow. The three LEs indicate a decline in signal-to-noise ratio (SNR) anomalies in the early 21st century and a strong spike in the latter third of this century. LEs consistently show increased external forcing effects compared to internal climate variability beginning in 2010s and rapidly increasing through the 2070s.

Session: 14031 Monitoring and Modelling Cryospheric Change - Part 2 Surveillance et modélisation du changement cryosphérique - Partie 2 **02/06/2022 12:55**

ID: 11644 Contributed abstract

Poster Order:

Forward Modelling of SAR Backscatter during Lake Ice Melt Conditions using the Snow Microwave Radiative Transfer (SMRT) Model

Justin Murfitt [1] , *Claude Duguay* [2] , *Juha Lemmetyinen* [3] , *Ghislain Picard* [4]

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[3] Finnish Meteorological Institute
[4] Institut des Géosciences de l’Environnement, Université Grenoble Alpes

Presented by / Présenté par: ***Justin Murfitt***
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Lake ice is a key component of northern landscapes. It plays a critical role in local energy balances and provides crucial socioeconomic services such as travel between communities and transportation of goods during winter months. However, changing climate is impacting the duration of ice seasons and the thickness of ice covers. Additionally, increasing temperatures lead to an increasing number of melt events throughout the season, resulting in the formation of more snow ice and slush layers. The presence of slush layers can pose challenges for mapping lake ice using active microwave data (i.e., synthetic aperture radar) and be a risk to those who use ice cover as an essential travel route. Using radiative transfer modelling we can better understand the connection between these events, lake ice properties, and remote sensing, however, exploration has been limited. This study will focus on Lake Oulujärvi during the 2020-2021 ice season and use detailed field data collected over three dates. Field data collected in late January and early March are representative of dry conditions, while field data collected in late March shows evidence of increased water content. Snow density, snow depth,

microstructure data, and ice thickness data collected during the field campaign will be used to parameterize the Snow Microwave Radiative Transfer (SMRT) model. SMRT will be used to conduct forward modelling simulations of the ice cover during these dates. The focus of these simulations is to understand how changes in snow and ice properties during melt events impact backscatter and how different conditions impact the dominant scattering interface (i.e., ice-water, snow-ice, and ice-air). The results of this modelling will serve as an important basis for further improving the parameterization of radiative transfer models throughout the ice season.

Session: 14031 Monitoring and Modelling Cryospheric Change - Part 2 Surveillance et modélisation du changement cryosphérique - Partie 2 **02/06/2022 13:10**

ID: 11798 Contributed abstract

Poster Order:

Spatial Variability of Lake Ice Thickness and Phenology on Sub-Arctic Lakes in Yellowknife, Northwest Territories.

Gifty Attiah [1] , *Homa Kheyrollah Pour* [2] , *Andrea Scott* [3]

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Presented by / Présenté par: ***Gifty Attiah***
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Lake ice is a valuable resource to northern communities such as those within the Northwest Territories (NT). Ice roads are constructed on lake ice (e.g., the ice longest road in Yellowknife, (NT), spreading over 80 lakes) during winter to haul goods to and from industrial establishments (e.g., mines) and for travel within communities. A major detriment to the ongoing use of ice roads are the changes in duration and thickness of lake ice due to climate warming. Studies show that a one-degree increase or decrease in air temperature leads to a 6-day almost linear change in ice cover duration making it an essential climate variable to monitor. Crucial knowledge on lake ice and temperature is however limited especially in sub-artic lakes due to logistical difficulties in collecting direct measurements. Methods adopted such as one-dimensional lake ice models rely on weather stations/in-situ data as inputs which are sparse in the NT hence overlook several lakes. To address this limitation, this study uses remote sensing coupled with a thermodynamic lake ice model to monitor the spatial distribution, duration, and thickness of lake ice.
Over 500 small to medium lakes are monitored in this study. To effectively simulate lake ice thickness, an algorithm-based surface temperature for each lake was derived from the thermal bands of Landsat which showed good agreement with in-situ data (1.88°C > RMSE >1.54°C). Lake surface temperatures generated in addition to variables (wind speed (m s-1), relative humidity (%), snowfall (m) and cloud cover (0-1)) and reanalysis (ERA5) data served as major inputs in the spatially distributed thermodynamic model applied. Field work was conducted to collect ice thickness measurements across 10 lake sites in Yellowknife to evaluate model output. Output derived from model simulations not only demonstrate changes in lake ice thickness, but also highlights the spatial variability within lakes.

Session: 14031 Monitoring and Modelling Cryospheric Change - Part 2 Surveillance et modélisation du changement cryosphérique - Partie 2 **02/06/2022 13:25**

ID: 11761 Contributed abstract

Poster Order:

Improving lake ice simulations in Canada based on lake size

Alexis Robinson [1] , *Laura C Brown* [2]

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Presented by / Présenté par: ***Alexis Robinson***
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Lake coverage in Canada is estimated to be between 15-40% depending on location and many experience some form of ice cover throughout the year. Research shows that lake ice duration is shortening in response to a warming climate. Lake ice models are an important tool that can be used to study spatial and temporal changes to lake ice regimes under a changing climate. The Canadian Lake Ice Model (CLIMo) is a well-tested one-dimensional thermodynamic freshwater ice model that has been used to successfully simulate Arctic and sub-Arctic lake ice cover. Research from Central Ontario, Canada, shows that adjusting the albedo parameterization in CLIMo (CLIMo-Temperate) results in a better representation of temperate region lake ice cover. This study uses CLIMo and CLIMo-Temperate to simulate lake ice-on and ice-off dates for 174 lakes across Canada that have historical ice records available. Model inputs include meteorological data obtained from Environment and Climate Change Canada with simulations validated using the historical ice records in the Canadian Ice Database and the Global Lake and River Ice Phenology Database. Results for small (<1 km2) have a mean absolute error (MAE) of 2 to 9 days. For medium (1-100 km 2) and large sized lakes (>100 km2) the MAE ranges from3 to 37 days for ice-off. The results show a satisfactory agreement between field measurements and modelled dates for lakes < 1 km2, however, there is substantial variation in ice-off dates for lakes > 1 km2. The findings show the importance of accounting for lake size and provide a basis to derive a lake size adjustment factor. This size factor will improve the accuracy of one-dimensional lake ice models, which will lead to improvements for global and regional climate models, numerical weather forecasting and future climate projections.

Session: 14031 Monitoring and Modelling Cryospheric Change - Part 2 Surveillance et modélisation du changement cryosphérique - Partie 2 **02/06/2022 13:40**

ID: 11839 Contributed abstract

Poster Order: Poster-14031

Meltwater Refreezing and Retention on the Greenland Ice Sheet in a Changing Climate

Shawn Marshall [1] , *Samira Samimi* [2]

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[2] University of Calgary

Presented by / Présenté par: ***Shawn Marshall***
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We present a novel method to track meltwater infiltration and refreezing in the firn zone of the Greenland Ice Sheet, using vertical transects of TDR probes and thermistors in the upper 4 m of the snow and firn. When installed prior to the onset of the melt season, the instruments permit continuous tracing of surface meltwater infiltration and subsurface latent heat release from meltwater refreezing over the full melt season. This process is of interest because surface meltwater that infiltrates the snow/firn and refreezes internally remains within the glacier system, i.e., is not a source of mass loss, but the extent of meltwater retention through this process is difficult to quantify in mass balance or remote sensing studies. Moreover, increased temperatures and melt extents with a warming climate are expected to decrease the storage capacity of the firn layer, driving a shift from meltwater retention to runoff in polar ice caps and the Greenland Ice Sheets. The observations from our field study are used to constrain a model of the coupled evolution of firn hydrology and thermodynamics which is broadly applicable to the accumulation area of Arctic ice masses. We apply this model to future scenarios for the Greenland Ice Sheet to assess the decadal-scale evolution of the firn layer and the implications for meltwater runoff, ice sheet mass balance, and the long-term thermal and dynamic evolution of the ice sheet.

Session: 14031 Monitoring and Modelling Cryospheric Change - Part 2 Surveillance et modélisation du changement cryosphérique - Partie 2 **02/06/2022 13:50**

ID: 11528 Contributed abstract

Poster Order:

Evaluation of Snow Depth Derived from Ground Penetrating Radar on Canadian Subarctic Lakes.

Alicia Pouw [1] , *Homa Kheyrollah Pour* [2] , *Alex MacLean* [3]

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Presented by / Présenté par: ***Alicia Pouw***
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In subarctic regions, a realistic representation of the snow depth and distribution on lake ice is important for climate change studies and lake ice modeling. Small changes in the surface-atmosphere energy balance could alter snowpack dynamics and can have a profound impact on lake ice thickness and formation. Snow depth observations on lake ice are sparse and mostly restricted to point measurements. Therefore, developing accurate methods of estimating the snow depth and spatial distribution across lake ice is important, but challenging. In this study, we applied an algorithm to estimate snow depths on lake ice using ground penetrating radar (GPR) two-way travel-times (TWT) over four small subarctic freshwater lakes (Landing Lake, Long Lake, Finger Lake, Vee Lake), located north of Yellowknife, Northwest Territories. High spatial resolution (~9

cm) observations along transects totaling ~38km were acquired using a 1000MHz sensor. We derived the snow depth by automatically picking the GPR TWT of the snow-ice interface and combining it with a measured average snow density for each lake. The accuracy of the derived snow depth is assessed using a snow depth GPS magnaprobe. Limited by the spatial accuracy of the snow depth magnaprobe and GPR, a 6m radius was applied around each in-situ snow depth measurement, where it is confirmed the GPR estimated the snow depth with an $R2 = 0.62$, mean bias error of -0.33 cm and root mean square error of 1.72 cm, on average for all four lakes. The results showed that this algorithm can improve the accuracy of snow depth and distribution retrieval data on lake ice which is essential for climate change studies and the lake ice modeling community.

Session: 14031 Monitoring and Modelling Cryospheric Change - Part 2 Surveillance et modélisation du changement cryosphérique - Partie 2 **02/06/2022 14:05**

ID: 11707 Contributed abstract

Poster Order:

Variability in thermokarst lake size, elevation, and connectivity in the western Canadian Arctic

Rosamond Tutton [1] , *Philip Marsh* [2] , *Aaron Berg* [3] , *Roderick Melnik* [4] , *Ben Devries* [5] , *Branden Walker* [6]

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Presented by / Présenté par: ***Rosamond Tutton***
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Large parts of the Arctic are densely covered by vast numbers of thermokarst lakes, ranging in size and stream network connectivity. Such stream-lake networks are poorly studied in the Canadian Arctic. However, a warming climate coupled with permafrost thaw and precipitation change will significantly influence the hydrology of these lakes, including changes in water surface elevation (WSE) and area. Understanding the impact of controls such as climate, snow-cover, vegetation, permafrost thaw, beavers, and hydrological connectivity on WSE requires a combination of field and remote sensing observation and integrated snow, permafrost, runoff, and lake hydrologic models. This paper will present the first step in putting such an observing system in place. We will report on observations of lake WSE across 50 lakes north of Inuvik, NWT. These lakes are located in two contrasting watersheds - Trail Valley Creek (TVC) and Hans Creek (HC). TVC is lake poor while HC is lake rich with a dense network of connected streams and lakes. In addition, HC is dominated by large networks of ice rich polygonal terrain that is prone to thawing with dramatic impacts on these lakes. These thermokarst lakes are important habitats for migratory birds, fish, and mammals and vital to sustaining hunting, fishing, trapping, transportation, freshwater resources, and recreation of those that live in the north. This project will contribute to a Canadian Space Agency project aimed at validation of WSE estimates from the Surface Water

and Ocean Topography (SWOT) mission to be launched later in 2022 and development of integrated lake-stream network models.

Session: 14031 Monitoring and Modelling Cryospheric Change - Part 2 Surveillance et modélisation du changement cryosphérique - Partie 2 **02/06/2022 14:20**

ID: 11835 Contributed abstract

Poster Order:

Why do simulated trends of Arctic sea ice drift speed go from positive in the 20th century to negative in the 21st century?

Jamie Ward [1] , *Neil Tandon* [2]

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Presented by / Présenté par: ***Jamie Ward***
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In addition to its importance for ecosystems and shipping activity, motion of Arctic sea ice might also strongly influence the rate of Arctic sea ice extent decline. Sea ice motion is driven by a combination of wind stress, ocean stress, sea ice internal stress, and sea surface height (SSH) gradients. Buoy observations indicate that sea ice drift speed has been increasing since the 1980s due to increased sea ice deformation associated with reduced sea ice thickness. Modern coupled climate models generally produce similar behaviour during this time period, but puzzlingly, most climate models also project that drift speed will decline over the middle and late 21st century. In this study, we investigate the reasons for this sign change in simulated Arctic drift speed trends using an ensemble of 17 models participating in the Coupled Model Intercomparison Project phase 6 (CMIP6) under the shared socioeconomic pathway (SSP) 585 warming scenario.

We find that, with the exception of one model (NorESM2-MM), all models in our ensemble project decreasing Arctic-average September sea ice drift speeds in the mid-to-late 21st century. Our analysis indicates that these declining drift speeds are primarily due to reduced SSH gradients over the Arctic Ocean. Trends in sea ice internal stress have also been examined, and these do not explain the decline in sea ice drift speed. Analysis of CMIP5 in an earlier study also indicates that changes in wind stress and ocean stress likely do not explain these trends. Altogether, our results suggest that, in addition to understanding sea ice internal stresses, gradients of sea surface height must also be considered in order to accurately project long-term changes in sea ice motion.

Session: 3021 Advancing our understanding of the Arctic atmosphere - Part 2 Faire progresser notre compréhension de l'atmosphère arctique - Partie 2 **02/06/2022 14:55**

ID: 11872 Contributed abstract

Poster Order:

Canadian Atmospheric Science Space Missions and Recent Polar Science Results

Marcus Dejmek [1] , *Wing Wu* [2] , *Cassandra Bolduc* [3]

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Presented by / Présenté par: ***Cassandra Bolduc***
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Current Canadian satellite missions that measure the Earth's atmosphere over the Poles include SCISAT, OSIRIS on Odin, and MOPITT on Terra. These missions continue to measure the Earth's stratospheric ozone layer, a multitude of ozone depleting substances, all major greenhouse gases, and various air quality gases. This presentation will describe these Canadian satellites and instruments, and summarize recent scientific discoveries that use these Canadian space-based datasets to advance Polar science over the past five years. Numerical models that advance Polar science will be presented, along with resulting research collaborations and data comparison activities conducted with other satellite datasets. This body of work helps advance Canada's Polar monitoring efforts related to the UN Montreal Protocol and the Kigali Amendment, along with measurements important for the Paris Climate Agreement.

Session: 3021 Advancing our understanding of the Arctic atmosphere - Part 2 Faire progresser notre compréhension de l'atmosphère arctique - Partie 2 **02/06/2022 15:10**

ID: 11567 Contributed abstract

Poster Order:

Remote Sensing analysis of Kluane Lake dust plumes: automated dust classification scheme using optical and microphysical correlation analyses

Seyedali Sayedain [1] , *Norman T. O'Neill* [2] , *James King* [3] , *Patrick Hayes* [4]

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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. We analyzed ground-based, passive and active remote sensing (RS) techniques in comparison with springtime measurements of microphysical, chemical and meteorological instruments in order to better understand how such plumes could be remotely sensed. This included correlation analyses (R) carried out between ground-based CM (coarse mode) AOD (aerosol optical depth) retrievals from CIMEL (AERONET/AEROCAN) sunphotometry / sky radiometry, CM AODs derived from co-located Doppler lidar profiles and measurements of surface CM particle-volume concentration (vc(0)) and information on dust type.
An automated dust classification scheme, whose goal is to characterize the RS potential of ground-and satellite-based optical measurements was developed. A

class of optically significant dust events (what we labeled as a “D” event) was defined in terms of the correlation, during potential dust events, of the lidar-derived CM AOD and vc(0). A variety of subclasses were then defined in terms of a number of attributes. These included D class events whose lidar-derived CM AOD correlated with CIMEL-derived CM AODs, false positive cloud events for which the lidar-derived CM AOD of a D event indicated the cloud-screening rejection of the CIMEL-derived CM-AODs and D* events for which the D criterion failed while the CIMEL and lidar-derived CM-AODs were well correlated. A variety of illustrations and interpretive analyses of the different types of events will be presented.

Session: 3021 Advancing our understanding of the Arctic atmosphere - Part 2 Faire progresser notre compréhension de l'atmosphère arctique - Partie 2 **02/06/2022 15:25**

ID: 11324 Contributed abstract

Poster Order:

Ice nucleating properties of airborne dust from an actively retreating glacier in Yukon, Canada

Yu Xi [1] , *Cuishan Xu* [2] , *Arnold Downey* [3] , *Robin Stevens* [4] , *Jill Bachelder* [5] , *James King* [6] , *Patrick Hayes* [7] , *Allan Bertram* [8]

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Presented by / Présenté par: ***Yu Xi***
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Airborne dust from glacial outwash sediments may alter properties of clouds and climate at high latitudes by acting as ice nucleating particles (INPs). Nevertheless, the ice nucleating ability of airborne dust from glacial outwash sediments remains uncertain. To address this uncertainty, we measured the ice nucleating ability of airborne dust near an actively retreating glacier in Yukon, Canada during a period when airborne dust concentrations were well above background levels. The airborne dust caused freezing at temperatures from 6 to 23 °C. At temperatures colder than -15 °C, the ice nucleating ability of the airborne dust was similar (within 1 order of magnitude in terms of ice active site density) to that of K-feldspar and Icelandic dust. However, the ice nucleating ability of the airborne dust was significantly worse than the glacial outwash sediments collected in Svalbard by Tobo et al. (2019). Based on a heat assay and an ammonium sulfate assay, the INPs from the airborne dust that caused freezing at temperatures warmer than 15 °C likely contained biological materials. We show that airborne dust from the retreating glacier led to high concentrations of ice nucleating particles at the site for at least most of May 2018, which were two orders of magnitude higher than a prediction using a global chemical transport model that includes low latitude dust sources and anthropogenic dust sources, but not natural high latitude dust sources.

Session: 3021 Advancing our understanding of the Arctic atmosphere - Part 2 Faire progresser notre compréhension de l'atmosphère arctique - Partie 2 **02/06/2022 15:50**

ID: 11594 Contributed abstract

Poster Order:

Characterizing the hygroscopicty of growing particles in the Canadian Arctic summer

Rachel Chang [1] , *Jonathan Abbatt* [2] , *Matthew Boyer* [3] , *Jai Prakash Chaubey* [4] , *Douglas Collins* [5]

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Presented by / Présenté par: ***Rachel Chang***
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New particle formation (NPF) is thought to contribute 40-80% of the global cloud droplet number concentration, although it is extremely difficult to observe an air mass from NPF to cloud formation. NPF and growth occurs frequently in the Canadian Arctic summer atmosphere, although only a few studies have characterized the source and properties of these aerosols. This study presents cloud condensation nuclei (CCN) concentrations measured in the eastern Canadian Arctic Archipelago from 23 July to 23 August 2016 as part of the NETCARE study. The study was dominated by frequent ultrafine particle and/or growth events, and particles smaller than 100 nm dominated the size distribution for 92% of the study period. The mean hygroscopicity parameter calculated for the entire study was 0.12, suggesting that the condensable vapours that led to particle growth were primarily less-hygroscopic, which we infer to be organic. Based on past measurement and modelling studies from NETCARE and the Canadian Arctic, it seems likely that the source of these less-hygroscopic, organic, vapours is the ocean. Examining specific growth events suggests that the mode diameter had to exceed 40 nm before CCN concentrations at 0.99% SS started to increase, although a statistical analysis showed that CCN concentrations increased 13-274/cm3 during all ultrafine particle and/or growth times compared to Background times at SS of 0.26-0.99%. These results support past results from NETCARE by showing that the frequently observed ultrafine particle and growth events are dominated by a less-hygroscopic fraction, which we interpret to be organic vapours originating from the ocean, and that these growing particles can increase the background CCN concentrations at SS as low as 0.26%, thus pointing to their potential contribution to cloud properties and thus climate through the radiation balance.

Session: 4043 Atmosphere, Ocean, and Climate Dynamics - Part 4 La dynamique de l'atmosphère, de l'océan et du climat - Partie 4 **02/06/2022 14:55**

ID: 11796 Contributed abstract

Poster Order:

The Saint Lawrence River Valley Front: Dynamic, thermodynamic, and kinematic structures

John Gyakum [1] , *Juliann Wray* [2]

[1]

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Presented by / Présenté par: ***John Gyakum***
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The Saint Lawrence River Valley (SLRV) front is a commonly observed meteorological feature that functions as a focus for significant precipitation in the populated regions of the Montreal – Quebec City corridor. The associated frontogenesis is typically driven by channeled winds that are relatively warm and southerly from the Champlain Valley, and relatively cold and northeasterly along the SLRV. The conventional network of surface stations provides spatial and temporal resolutions that are too coarse to adequately document the location and strength of the SLRV front. Furthermore, there are no meteorological soundings in the SLRV that would otherwise provide pertinent documentation of the SLRV front's vertical structure.
A recently implemented network of meteorological stations situated throughout the SLRV is providing the spatial and temporal resolution necessary to improve our understanding of the surface frontal kinematics. Additionally, a permanently situated meteorological sounding system, installed at McGill University's Nature Reserve, is providing the infrastructure necessary to document the SLRV front's dynamic and thermodynamic structures. This mesoscale surface network and sounding capability represents a component of a multi-university project, entitled the Adaptable Earth-Observation System (EOS).
The presentation's focus is on the surface frontal characteristics during the most recent 2021-22 winter season. These characteristics include frontal strength, as measured by the temperature breaks during the frontal passage, along with geostrophic and ageostrophic frontogenesis. Additionally, the vertical structure of a recent SLRV front, provided by two-hourly soundings, is documented. The SLRV's frontal slope, strength, and potential vorticity structures will also be discussed.
Finally, the larger-scale synoptic environment facilitating the presence of the SLRV front during the 2021-22 winter will be discussed in the context of the past 40 winter seasons.

Session: 4043 Atmosphere, Ocean, and Climate Dynamics - Part 4 La dynamique de l'atmosphère, de l'océan et du climat - Partie 4

02/06/2022 15:10

ID: 11840 Contributed abstract

Poster Order:

A Case Study of a Foehn Event Over the Alborz Mountains in Iran

Jeff Sepehri [1]

[1] York University (Student)

Presented by / Présenté par: ***Jeff Sepehri***
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The warm and dry foehn wind significantly affects human life in the mountainous regions worldwide, from health to transportation. Foehn features include temperature rising, relative humidity dropping, and high wind commencement with fixed direction. Foehn's beginning and breaking down can easily be determined. Iran, a mountainous country, is affected by foehn wind in many places. Each area has its local name, but they have the same characteristics and behaviour. One-third of Iran is formed by high chain mountains, forming a wall against westerlies blowing moist air from the Mediterranean Sea, with good precipitation on the west side of that mountains. In comparison, the interior part of Iran has a dry climate except around the Caspian Sea, which is moisturized. The southwest part of the Caspian Sea is the are studied here.

In the west part of the Alborz Mountains, foehn's characteristic events have been observed and investigated, as well as simulation data and synoptic analysis. The main reasons for the foehn wind in this area are the lee cyclone over the southern Caspian Sea and the presence of high pressure over the interior regions of Iran. They cause southerly flow with blocking upstream of the Alborz Mountains and strong meridional surface pressure differences. Over the Alborz Mountains, large vertical amplitude mountain waves have occurred. These incidents have caused widespread and severe fires in the Caspian forests.

In this article, we show that, on the synoptic scale, the foehn events occurred due to high pressure over the interior regions of Iran and lee cyclone over the southern Caspian Sea, with a strong south-north pressure gradient across the Alborz Mountains. A typical foehn wind event occurred in the Alborz Mountains on January 15, 2021 and will be used to illustrate the foehn situation.

Session: 4043 Atmosphere, Ocean, and Climate Dynamics - Part 4 La dynamique de l'atmosphère, de l'océan et du climat - Partie 4 **02/06/2022 15:25**

ID: 11863 Contributed abstract

Poster Order:

Mesoscale wind, pressure, temperature and frontal patterns in coastal heatwave events.

Jonathan Buffett [1]

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Presented by / Présenté par: ***Jonathan Buffett***
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Mesoscale meteorology is an increasingly important aspect of weather forecasting, modeling, and analysis – both for extreme and benign events. These seemingly subtle mesoscale influences can play a major role in the outcome of a flood, or conversely, position of a sea breeze front. They're often more pronounced in extreme weather events, such as heatwaves, wind storms, floods, or radiation cooling, which can cause crop damage. Prediction is challenging in areas with variable terrain and multiple bodies of water, such as Nova Scotia, as complex geography enhances local mesoscale patterns. In the past, this would go largely unnoticed. However, with advances in technology for both computer models like the HRDPS, and in situ observations from a dense

network of automated weather stations, they can be verified in case studies. The Cape Breton Mesonet has recorded numerous instances, such as thermal lows, mesoscale areas of high and low pressure, orographic uplift, and much more. Comparing data from the ground with hi res computer models paints a clearer picture into how certain mesoscale patterns are born, and impacts they have on local weather.

Session: 4043 Atmosphere, Ocean, and Climate Dynamics - Part 4 La dynamique de l'atmosphère, de l'océan et du climat - Partie 4 **02/06/2022 15:50**

ID: 11376 Contributed abstract

Poster Order:

Implementation of the soundproof quasi-elastic approximation in the Global Environmental Multiscale model with a height-based terrain-following vertical coordinate

Abdessamad Qaddouri [1] , *Claude Girard* [2]

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Presented by / Présenté par: ***Syed Zahid Husain***
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The “quasi-elastic” (QE) approximation – also referred to as the “unified system” – combines the concepts of the quasi-hydrostatic and anelastic approximations in order to eliminate the vertically-propagating sound waves from the elastic Euler equations. Although the vertically-propagating acoustic modes are insignificant from a meteorological standpoint, their presence in the elastic Euler system imposes severe time-step restrictions for numerical weather prediction (NWP). The foundational assumption of the QE approximation implies that any non-hydrostatic departure in the total density from its hydrostatic counterpart is negligible.

The Global Environmental Multiscale (GEM) model, which is employed operationally by Environment and Climate Change Canada (ECCC), utilizes a log-hydrostatic-pressure-based terrain-following coordinate (TFC) in the vertical. The adoption of the QE approximation within this modelling framework has been found to result in predictions that are meteorologically equivalent to the operational hydrostatic and nonhydrostatic operational dynamical cores. Recently at ECCC, a new dynamical core of the GEM model – namely, GEM-H – has been developed which replaces the pressure-based TFC with a height-based one. A major motivation behind the development of GEM-H is its stability advantage over steeper terrain and is expected to become operational for the different GEM-based operational NWP systems in the near future. Lately, a QE version of GEM-H has been formulated and implemented to study its potential for replacing the two separate dynamical cores for the hydrostatic and nonhydrostatic scenarios with a single QE-based core.

A broad range of tests – involving two-dimensional idealized cases as well as three-dimensional deterministic hydrostatic and nonhydrostatic NWP systems – were carried out to evaluate the skill and performance of the new QE dynamical core. Results show that the new core is capable of predictions that are statistically and meteorologically equivalent to the operational GEM model while

maintaining a comparable computational performance. Details regarding the formulation, implementation and evaluation of the QE model will be presented at the conference.

Session: 4043 Atmosphere, Ocean, and Climate Dynamics - Part 4 La dynamique de l'atmosphère, de l'océan et du climat - Partie 4 **02/06/2022 16:05**

ID: 11394 Contributed abstract

Poster Order:

A Kalman Filter on Grid (KFonG) to improve wind speed Nowcasting on grid

Zhiyong Huang [1] , *Mary Qian* [2] , *Lewis Poulin* [3]

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Presented by / Présenté par: ***Zhiyong Huang***
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The Canadian Meteorological Center's (CMC) Nowcasting of Weather Elements on Grid (NCWEonG) is a project to replace the operational point-based Integrated NowCast System (INCS) with a grid-based application.

For the Nowcasting of wind speeds on CMC's HRDPS 2.5 km grid, a point-based Kalman Filter on Grid (KFonG) using wind direction as a predictor was adapted to function on a grid and tested using 15-and 30-day intervals for training. The performance of KFonG wind speeds is now routinely verified using CMC's in-house EMET verification tool.

Results to date indicate that KFonG wind speeds in central and eastern Canada have a good portion of the HRDPS bias reduced or removed. KFonG wind speed verification scores are better than raw model HRDPS winds, and NCWEonG winds resulting from a meso-analysis process. Also, the performance of KFonG winds can compete with the point-based INCS winds, which are made using UMOS data from the RDPS model.

Further work is needed to adapt this first-generation of KFonG winds to complex topographies such as those found over British Columbia.

The KFonG has the potential to bring significant value to NCWEonG, in this case, for winds speeds. The KFonG infrastructure is modular, uses few CPUs, can be easily adapted to test KFonG for other variables and offers a suitable framework for potential collaborations.

Session: 4043 Atmosphere, Ocean, and Climate Dynamics - Part 4 La dynamique de l'atmosphère, de l'océan et du climat - Partie 4 **02/06/2022 16:20**

ID: 11694 Contributed abstract

Poster Order:

Impact of Land Data Assimilation on Land-Atmosphere Interactions in the

Heihe River Basin, Northwest China

Xinlei He [1] , *Yanping Li* [2] , *Shaomin Liu* [3] , *Fei Chen* [4] , *Tongren Xu* [5]

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Presented by / Présenté par: ***Xinlei He***
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This study investigates the impact of data assimilation (DA) on regional climate in the Heihe River Basin, the second largest inland river basin in northwest China. The DA scheme was developed and incorporated into the Weather Research and Forecasting (WRF) model with the Noah-MP land surface scheme. Remotely sensed leaf area index (LAI) and soil moisture are assimilated into the WRF model within the ensemble Kalman filter (EnKF) framework. The impact on land-atmosphere interactions was assessed by comparing model simulations with and without DA (hereafter, WRF and WRF_DA simulations, respectively) for the growing season (May to September) in 2015. The temperature and humidity of WRF_DA simulation matched well with the observations, whereas WRF simulation overestimated temperature and underestimated humidity in the midstream oasis region. The results show that the cooling and wetting effects have negligible changes in local precipitation in the midstream oasis. However, in the southeast of the Heihe River Basin, the assimilation of LAI and soil moisture may induce water vapor convergence and enhance precipitation.

Session: 9021 Advances in forest hydrology - Part 2
Avancées en hydrologie forestière - Partie 2 **02/06/2022 14:55**

ID: 11581 Contributed abstract

Poster Order:

The effects of forest disturbance on water quality in the Algoma region, central Ontario

Matthew Watkins [1] , *Jim Buttle* [2] , *Jason Leach* [3]

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Presented by / Présenté par: ***Matthew Watkins***
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Canada’s boreal forest is a critical source of drinking water for many communities. Climate change threatens to exacerbate the effects of natural and human-driven disturbances such as wildfire, infestation and harvesting on downstream water quality in this region. These include increasing levels of dissolved organic carbon (DOC) in stream water which can reduce drinking water quality. Moreover, changes in DOC quantity may demand more costly water treatment operations. We present preliminary results of an examination of the implications of recent forest disturbance for downstream drinking water

quality in boreal streams in central Ontario. Streamflow quantity and quality were monitored for 30 catchments (0.17 to 106.7 km^2) to study the relationship between DOC quantity, character and disinfection by-product formation potential at sites with complex disturbance histories. Four distinct patterns of streamflow behaviour were observed across the catchments and there was a wide range in concentrations of dissolved organic carbon (DOC, 3.0 - 22.7 mg L^{-1}) and trihalomethane formation potential (THM-FP, 125 - 2079 µg L^{-1}) for a subset of eight catchments. No discernible difference in [DOC] was observed across treatments whereas [THM-FP] in disturbed catchments was slightly elevated relative to control catchments. In addition, specific ultraviolet absorbance ($SUVA_{254}$) tends to increase in disturbed catchments which suggests DOC is more refractory in nature. Further work, such as mass flux estimation and analysis of landscape characteristics (e.g., slope, wetland coverage), is being completed to examine if there are any differences between treatments.

Session: 9021 Advances in forest hydrology - Part 2
Avancées en hydrologie forestière - Partie 2 **02/06/2022 15:10**

ID: 11620 Contributed abstract

Poster Order:

Immediate and Legacy Impacts of Different Harvesting Strategies on Phosphorus Yield in Upland Hardwood Forested Watersheds

Robert Fines [1] , *Micheal Stone* [2] , *Kara Webster* [3] , *Jason Leach* [4] , *James Buttle* [5] , *Monica Emelko* [6]

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Presented by / Présenté par: ***Robert Fines***
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Forest harvesting can increase phosphorus yields in rivers draining impacted watersheds and lead to eutrophication and elevated potential for harmful algal bloom occurrence in downstream water bodies. While the immediate effects of intensive forest harvesting strategies (e.g., clear cut) have been well documented, the long-term effects of low intensity forest harvesting strategies on phosphorus yield have not been widely investigated. Here, we report the results from a 31-year forest harvesting impacts study on sugar maple (Acer saccharum) dominated uplands within the Turkey Lakes Watershed, Ontario. We evaluated annual and seasonal phosphorus yield response to three forest harvesting strategies (clear cut, shelterwood, and selection harvest) using a before-after control-impact (BACI) study design. Results showed phosphorus yield increased significantly in all harvested catchments with annual treatment effects ranging from -0.51 to 21.47, 0.06 to 14.38, and -3.5 to 20.89 g ha^-1 year^-1 in the clear cut, selection cut, and shelterwood harvested catchments, respectively. Significant seasonal treatment effects were observed in spring for all three harvested catchments with mean treatment effects ranging from 4.14 to 7.46, 3.63 to 6.52, 1.25 to 4.00 g ha^-1 season^-1 for the clear cut, selection, and shelterwood harvested catchments, respectively. The largest treatment

effects were observed 3 to 10 years after harvesting. Increased total phosphorus yields were attributed mainly to increases in stream flow, suggesting that changing hydrological behaviour in response to forest harvesting controls changes in phosphorus yields. While these results are statistically significant, the magnitudes of the treatment effects were relatively small compared to other studies and suggest that lower intensity forest harvesting strategies have minimal impact on total phosphorus yield at Turkey Lakes Watershed. Thus, harvesting in these upland hardwood forests is not likely to influence downstream aquatic phosphorus budgets.

Session: 11020 CSAFM 1: Observational studies of land-atmosphere interactions - Part 1 SCMAF 1 : Etudes observationnelles des interactions terre-atmosphère - Partie 1 **02/06/2022 14:55**

ID: 11666 Contributed abstract

Poster Order:

CARBON DIOXIDE NET ECOSYSTEM EXCHANGE ALTERED BY CROP ROTATION DIVERSIFICATION AND USE OF COVER CROPS

Jacob Evans [1] , *Claudia Wagner-Riddle* [2] , *Scott Krayenhoff* [3] , *Laura Van Eerd* [4] , *Shannon Brown* [5] , *Sean Jordan* [6]

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Presented by / Présenté par: ***Jacob Evans***
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New interest in the potential of agriculture to help mitigate carbon dioxide (CO2) emissions is emerging. Although identification of management practices that foster soil carbon (C) gains on a long-term scale are of interest, short-term changes in terrestrial C dynamics are also regarded as important for predicting and understanding temporal C shifts in agroecosystems. In this study, we used eddy covariance (EC) methods to evaluate the short-term seasonal dynamics of net ecosystem exchange (NEE), ecosystem respiration (Re), gross primary productivity (GPP), and net ecosystem carbon balance (NECB) in corn-soybean rotations and the impact of diversifying this cropping system in Ontario, Canada. The experiment was conducted over two adjacent 8-ha fields for three years. One field was cropped with corn-soybean-soybean (non-diverse) while the other included winter wheat and cover crops (diverse). The diverse rotation significantly enhanced C accumulation (i.e., GPP) when averaged over the study period (–1163±34 g C m-2 vs. –929±45 g C m-2, diverse and non-diverse, respectively¬) compared to the non–diverse rotation, leading to substantial loss of Re in the diverse field compared to the non–diverse field (Re averaged over 3-years: 945±38 g C m-2 vs. 746±54 g C m-2). Taking into consideration C removed via harvest, both corn fields were C sources (NECB: 110±49 g C m-2 vs 64±51 g C m-2, diverse and non–diverse, respectively) in the first year. Soybean varied from being a high source of C for both rotations (NECB: 215±41 g C m-2 vs. 201±38 g C m-2, diverse and non-diverse, respectively) in the second year to a lower source (NECB: 102±32 g C m-2) in the third year. Winter

wheat was a C source for cases where only winter wheat grain is harvested (NECB: –70±43 g C m-2) but acted as source (191±35 g C m-2) owing to a two-fold increase in removed C in harvest when both grain and straw are considered. Additionally, NEE trends in both fields in the second year of this study were identical, indicating good agreement between EC measurements. Results from this study show that management practices such as crop diversification can induce C uptake in cropland but at the cost of also increasing ecosystem respiration.

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ID: 11333 Contributed abstract

Poster Order:

Mitigating nitrous oxide emissions from corn using nitrification and urease inhibitors following cover crop adoption

Nicole Menheere [1] , *John Lauzon* [2] , *Laura Van Eerd* [3] , *Azeem Tariq* [4] , *Claudia Wagner-Ridde* [5]

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Presented by / Présenté par: ***Nicole Menheere***
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Increased N2O emissions have a higher chance of occurring when cover crops are terminated just before fertilizer application to corn. Nitrification and urease inhibitors (NUIs) have been shown to reduce N2O emissions, but their use after cover cropping has not been well studied with year-round studies. The micrometeorological technique used in this study is ideal to capture high temporal variability caused by the episodic nature of N2O emissions. The objective of this study was to evaluate the potential of the nitrification inhibitor (Pronitridine) and the urease inhibitor (N-butyl thiophosphoric triamide) to reduce N2O emissions in corn following cover crop use, in a humid temperate climate in Ontario, Canada. The flux-gradient method was deployed in four 4-ha fields using a tunable diode laser trace gas analyzer. Two 4-ha fields have been managed with a conventional rotation (soybean-soybean-corn) and two 4-ha fields were managed with a diverse rotation (soybean-winter wheat-corn with cover crops) since 2018. Nitrogen starter fertilizer (4.78 kg N/ha) was applied to corn at planting, followed by urea-ammonium-nitrate (UAN) (162 kg N/ha) injected 10 cm below the soil surface at the sixth leaf stage (June 17, 2021). One conventional and one of the diverse rotation fields received NUIs mixed into UAN at the time of fertilization. N2O fluxes were measured from September 1, 2020, to April 30, 2022, with supporting data including soil ammonium and nitrate concentrations, corn yield, and nitrogen uptake. N2O flux measurements indicated the use of NUIs reduced annual cumulative N2O emissions by 13.6% and 20.3% in the conventional and diverse rotations, respectively. NUIs were effective in reducing the N2O emissions associated with fertilizer application in both the conventional and diversely managed fields. These initial results show

the potential of NUIs to reduce N2O emissions associated with cover crop use, but more studies are necessary.

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ID: 11857 Contributed abstract

Poster Order:

Wind-Profiler Identification of Gravity wave Hotspots and Importance for Meteorological Modelling.

Wayne Hocking [1]

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Presented by / Présenté par: ***Wayne Hocking***

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A recent paper has demonstrated the ability of wind-profiler radars in Canada to identify regions of enhanced climatologically significant gravity wave production (Hocking et al., ://rmets.onlinelibrary.wiley.com/doi/10.1002/qj.4152). Such waves are important, as they can force changes to the mean flow though momentum flux transport, which can in turn affect local dynamics and even trigger thunderstorms and severe weather. In this presentation, we discuss the techniques used to identify the hotspots, and the methods used to distinguish areas of large wave activity from regions that are dominated by 2-D quasi-geostrophic turbulence. Regions of high wave production are particularly prevalent in the western regions of Lake Erie, where waves are forced by relatively deep lake-breezes. The importance of applying such knowledge to enhanced meteorological forecast models, and better incorporation of such forcing, will be discussed.

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ID: 11626 Contributed abstract

Poster Order: Poster-11020

Controls of Differing Non-Growing Season Cover Crops On Winter Soil Temperatures

Kayla Wicks [1] , *Jaison Thomas Ambadan* [2] , *Claudia Wagner-Riddle* [3] , *Aaron Berg* [4]

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Presented by / Présenté par: ***Kayla Wicks***

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The largest known anthropogenic source of nitrous oxide (N2O) are cropland soils, and in cold regions a significant component of these emissions are associated with soil freeze-thaw cycles (FTC) throughout the non-growing season (NGS) (November-April). N2O fluxes directly correspond with the Total Number of Frozen soil Days (TNFD) and frequency of FTC. Reductions in soil nitrates which impacts these emissions, are associated with the introduction of cover crops; however, crop covers also influence the variability of soil temperature throughout the NGS. In this study we assess soil temperature variability in NGS under a variety of agricultural management practices including residues and cover crop types. Temperature probes (Thermachron iButtons) were placed in the topsoil at a depth of 5cm below the surface in agricultural plots containing nine different NGS land cover and cover crop alternatives at the Elora Research station in Ontario, Canada. The sensor time series was used to assess the number of soil FTC, TNFD, and the accumulated freezing degree days (AFDD) among the various covers. A photo grid was interpreted for each plot to identify the percentage of bare soil, crop residue, and green cover crop prior to the first snowfall (November 12, 2020). Results indicate strong, statistically significant relationships between the amount of observed bare soil and the FTC, TNFD and AFDD (p-values < 0.01). Most notably, relationships between the bare soil cover and AFDD are most significant suggesting that the extent of soil freezing is strongly influenced by the amount of bare soil. Temperatures observed in cover crop plots (10 and 3 mix and oats) had much lower standard deviations over the NGS and lower correlations to daily diurnal air temperature range. Therefore, implementation of vegetative NGS cover crops have a significant insulating effect on the soil below, reducing the frequency and extent of FTC, TNFD and AFDD.

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ID: 11516 Contributed abstract

Poster Order: Poster-11020

Net ecosystem greenhouse gas budget of corn determined using long term flux measurements

Sibley Duckert [1] , *Shannon Brown* [2] , *Claudia Wagner-Riddle* [3]

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Presented by / Présenté par: ***Sibley Duckert***
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Corn is widely grown across Ontario. Although nitrous oxide (N2O) emissions have been well characterized, net greenhouse gas (GHG) emission associated with corn production is uncertain since annual differences in climatic conditions can affect the uptake and release carbon to and from the atmosphere. Long, multi-season measurements of net GHG emissions considering the net ecosystem carbon budget (NECB) and N2O emissions from corn are needed. The net GHG emissions were evaluated using flux measurements of CO2 and N2O for a field in Elora, Ontario, Canada that was under continuous corn

production from 2012 to 2018. CO_2 fluxes were measured using an eddy covariance system and N_2O emissions were measured using a flux-gradient system. The NECB was calculated as the net ecosystem exchange as measured by the EC system plus the carbon removed via harvest. The total N_2O emitted per season was converted to CO_2 equivalents and added to the NECB to yield net GHG emissions. Aside from one season, the NECBs for each growing year showed that the corn was a carbon source. The degree to which the positive NECBs varied from year to year showed no clear correlation with gross primary productivity, respiration, yields, or climatic conditions. This preliminary analysis indicates that although corn production is likely a carbon source, the causes of the carbon production need to be analyzed on shorter time scales, possibly during key periods of growth or respiration, to fully evaluate the drivers that lead to carbon emissions from corn.

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ID: 11751 Contributed abstract

Poster Order:

Coupling crop-growth and cold regions hydrology with observations and modelling on the Canadian Prairies

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Presented by / Présenté par: ***Phillip Harder***
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Water availability is the major limitation for crop growth on the Canadian Prairies and springtime meltwater infiltration can be an important source of crop available water. Despite its importance, modelling frameworks to couple summertime crop water use with wintertime snow processes and springtime meltwater infiltration are scarce. Field observations of eddy covariance-based energy, water and carbon balances, soil moisture, and crop growth from diverse agricultural fields over 19 site-years near Saskatoon, Saskatchewan were used to develop empirical understandings of the crop water balance and the implications of non-growing season hydrological processes. To further improve this understanding the Cold Regions Hydrological Modeling Platform, a hydrological model with physical process representations of snow dynamics and frozen soil infiltration, was coupled with AquaCrop-OS, a water limited crop growth model. Collected field data was used to drive, parametrize, and validate the coupled modelling framework. Preliminary results quantify and demonstrate the importance of winter season processes upon crop growth, specifically the stubble management practices of the preceding season upon crop water use and yield in the following season. Key sources of uncertainty, frozen soil infiltration and bare soil evaporation snowmelt, are highlighted to articulate future research opportunities. This work improves the representation of agricultural practices and hydrology on the Canadian Prairies to included important, but previously ignored, cold-warm season interactions which are

critical to understand future climate change implications.

Session: 11020 CSAFM 1: Observational studies of land-atmosphere interactions - Part 1 SCMAF 1 : Etudes observationnelles des interactions terre-atmosphère - Partie 1 **02/06/2022 16:05**

ID: 11607 Contributed abstract

Poster Order:

Winter Water Budgets under Enhanced Freeze Thaw Cycles: A Lysimeter Study in a Humid Continental Climate

Ryan Lafleur [1] , *Aaron Berg* [2] , *Asim Biswas* [3] , *Claudia Wagner-Riddle* [4]

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Presented by / Présenté par: ***Ryan Lafleur***
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Climate change is a worldwide phenomenon that has caused temperatures to rise across the planet. An observed consequence of increasing temperatures is a significant decrease in the thickness and duration of winter snow-pack in humid continental climates since the 1970s. Winter snow-pack insulates the soil from sub-freezing temperatures preventing it from experiencing temperature fluctuations. A reduction in snow-pack allows freeze-thaw cycles (FTC) to have a greater influence on soil conditions. To better understand the effects of FTCs on soil hydrology, water budget studies are necessary to assess how hydrological inputs, outputs, and water storage respond to warmer winters. In this study, we conducted a warming experiment using overhead heaters with loamy sand and silty loam soil cores that are held in monolithic weighing lysimeters at the Elora Research Station soil lysimeter facility in Ontario, Canada. A continuous winter warming treatment was applied from December 2017 to May 2018, November 2018 to May 2019, and November 2019 to April 2020 to inhibit FTCs in the soil. An intermittent warming treatment was applied from December 2020 to April 2021 and November 2021 to May 2022 to increase the frequency of FTC. We observed 1.7-2.0 times increase in evapotranspiration and 1.5-1.9 times decrease in water storage for silty loam soil over the three seasons for the continuous warming treatment with negligible effects on infiltrated precipitated water (from either rainfall or snow melt) and drainage. These findings have important implications for soil water availability to crops in the subsequent growing season. The intermittent warming treatment is on-going and preliminary results will be presented. Results will be discussed within a broader context of a soil resiliency assessment for climate variability and land management practices in agriculture and their effects on crop yields under changing climate conditions.

Session: 11020 CSAFM 1: Observational studies of land-atmosphere interactions - Part 1 SCMAF 1 : Etudes observationnelles des interactions terre-atmosphère - Partie 1 **02/06/2022 16:20**

ID: 11533 Contributed abstract

Poster Order:

Comparison of nitrous oxide flux measurements from low power and multi-plot flux-gradient systems against eddy covariance measurements

Shannon Brown [1] , *Ben Conrad* [2] , *Sean Jordan* [3] , *Pedro Vitor Ferrari Machado* [4] , *Claudia Wagner-Riddle* [5]

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Presented by / Présenté par: ***Shannon Brown***
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N2O emissions from agricultural lands occur as pulses with the timing and magnitude dependent on management, soil, and climatic conditions. The flux gradient (FG) and eddy covariance (EC) methods both capture spatially and temporally integrated N2O emissions. FG is less common than EC; however, it has advantages over EC as the instrumentation requirements are more flexible to allow for operation using low power and/or in a multi-plot configuration for side-by-side comparisons of N2O emissions from separate treatments with one gas analyzer. Few comparisons exist to evaluate FG N2O flux measurements against EC. A field study in 2017 compared simultaneous N2O and CO2 flux measurements from a new low power (< 30 W) FG system (LP-FG) and a multi-plot FG system (MP-FG) against those measured by an EC system (N2O-EC). The LP-FG system was co-located on the same tower as the N2O-EC system and the measurement used for the MP-FG comparison was located within the same plot 50 m from the LP-FG/N2O-EC tower. Two post-fertilization emission events occurred, and temporal patterns measured by each method matched. N2O fluxes measured by the LP-FG system correlated well with the EC measurements (r2 = 0.97, slope = 1.05). The MP-FG N2O fluxes were less well correlated with the EC fluxes (r2 = 0.65). The MP-FG system overestimated fluxes during the first flux event (slope = 1.29) and underestimated fluxes in the second event (slope = 0.42). However, MP-FG measured CO2 fluxes corresponded to those of the EC system during the emission time periods (slope = 0.91, r2 = 0.80). The good agreement between the co-located LP-FG and N2O-EC system, as well as that of CO2 for the MP-FG system, indicated that the discrepancy between the MP-FG and EC fluxes are not due to the FG method but were likely due to differences in footprint.

Session: 14032 Monitoring and Modelling Cryospheric Change - Part 3 Surveillance et modélisation du changement cryosphérique - Partie 3 **02/06/2022 14:55**

ID: 11639 Contributed abstract

Poster Order:

Recommendations to enhance hydrological models for improved estimates of climate impacts on northern waters

Robin Thorne [1] , *Philip Marsh* [2] , *David Rudolph* [3] , *Christopher Spence* [4] , *Oliver Sonnentag* [5] , *Jeffrey McKenzie* [6] , *Aaron Berg* [7]

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Presented by / Présenté par: ***Robin Thorne***
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The rapidly changing Arctic climate is impacting the interactions between surface water, supra-permafrost water, snow, vegetation, lakes and streamflow, particularly as ongoing climate warming continues to thaw the permafrost. Across the Northern Water Futures (NWF) study domain, which is a Northwest Territories-focused consortium, spatial and temporal variability in active layer thickness, the occurrence of taliks, soil infiltration, subsidence, and the contribution of groundwater flow to streamflow, are all expected to be enhanced. A key challenge for Arctic models is dealing with freeze/thaw conditions and the high spatial variability in terrain and vegetation. Hydrologic models are being developed in NWF and other research groups around the globe, but there are many difficulties and approaches in developing such models.

Integrated surface and subsurface hydrological models are critical tools to investigate the impacts of warming on Arctic hydrology over the coming decades and centuries. First, we will review a suite of available hydrological models for this purpose, with a focus on interactions between permafrost, groundwater and streamflow. We will consider potential limitations due to the lack of sophisticated 3D permafrost/groundwater model components and limitations in modelling at the high spatial resolution required. Second, we will use a case example in changes to the development of Arctic models using examples from the Trail Valley Creek (TVC) research watershed, north of Inuvik, NWT. Finally, we will make recommendations to enhance model development as needed, such as the inclusion of components from cryohydrogeological and lake process models, to address changes in Arctic hydrology at the scales required to address societal needs.

Session: 14032 Monitoring and Modelling Cryospheric Change - Part 3 Surveillance et modélisation du changement cryosphérique - Partie 3 **02/06/2022 15:10**

ID: 11805 Contributed abstract

Poster Order:

Projection of Lake ice thickness and Phenology under Representative Concentration Pathways (RCP) Scenarios: Great Slave and Great Bear Lake, Northwest Territories

Ariana Mansingh [1] , *Homa Kheyrollah Pour* [2] , *Gifty Attiah* [3]

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Presented by / Présenté par: ***Ariana Mansingh***
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Cold region lakes are key ecosystems acting as sentinels of climate change. The increased severity of climate change is causing a demand for enhanced environmental understanding. Thus, knowledge gaps within the field must be addressed. Currently, the understanding of far future implications of climate change on lake ice thickness and phenology is limited and is challenging in projecting a spatially and temporally extensive lake ice thickness and phenology. This project is taking place on Great Bear Lake and Great Slave Lake, Northwest Territories, to better understand the long-term implications of greenhouse gas emissions and their influence on the future lake ice formation and duration, using a spatially distributed lake ice model, CLIMoGrid. To do so, Representative Concentration Pathways (RCPs) are used, this portrays different scenarios of greenhouse gas concentrations and emissions. Data from a pre-existing model called MRI-CCGM is used based on the different RCPs to force CLIMoGrid, such as cloud cover, air temperature, humidity, snowfall, and wind speed. The model was able to project future ice thickness and phenology based on the future RCPs scenarios with more rapid changes under the 8.5 scenarios by 2085. The overall outcome of this research was to produce a trend analysis of ice thickness and phenology and project future changes that consider different RCPs and climate change's long-term implications. This research provides support to the emerging spectrum of climate change issues throughout cold regions.

Session: 14032 Monitoring and Modelling Cryospheric Change - Part 3 Surveillance et modélisation du changement cryosphérique - Partie 3 **02/06/2022 15:25**

ID: 11497 Contributed abstract

Poster Order:

Investigating the Impact of Snow Cover on Permafrost Soil Temperatures in Modern Reanalysis and Data Assimilation Systems

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Presented by / Présenté par: ***Tyler Herrington***
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Soil temperatures are required as input for hydrological models, and for numerical weather prediction. At high latitudes, accurate permafrost representation is important as soil respiration from melting permafrost may act as a positive feedback on warming. Validation of Arctic soil temperatures in reanalysis and Land Data Assimilation System (LDAS) products (hereafter reanalysis products) has been historically limited because widespread in-situ reference observations have generally been unavailable. Here we validate pan-Arctic soil temperatures from eight reanalysis and Land Data Assimilation System (LDAS) products, at 1-degree spatial resolution, using in situ soil temperature data from diverse measurement networks across Eurasia and North America. We find that most products are biased cold by 2–7 K across the Arctic. Near-surface soil temperature biases and Root Mean Square Error (RMSE) were generally largest in the cold season, and many products

overestimate the observed variability in soil temperatures over the cold season. In addition, preliminary results show that the cold season RMSE in many products was more than 1.5 times as large when snow was present in satellite-based snow cover datasets, though there is substantial variability between products. We attempt to explain the large spread in cold season Arctic soil temperatures by reconciling differences in snow cover between reanalysis products and satellite-based snow cover, and variability in snow cover between reanalysis products. Our hypothesis is that RMSE and bias in soil temperature will be largest when reanalysis products and satellite snow-cover show substantial disagreement; likely when monthly mean air temperatures are close to the freezing point. We also examine a subset of reanalysis products at a higher resolution (0.05 degrees) to test the impact of spatial resolution on soil temperature performance, and preliminary results suggest that small improvements in pan-Arctic soil temperature biases may be achieved by using higher resolution soil temperature data.

Session: 14020 In situ measurement of snow and solid precipitation: advances, challenges, and ongoing issues
Mesure in situ de la neige et des précipitations solides: avancées, défis et enjeux actuels **02/06/2022 15:40**

ID: 11426 Contributed abstract

Poster Order: Poster-14020

Traceability and catch-efficiency of the Lambrecht rain[e]H3 automated precipitation gauge for measuring precipitation in Canadian operational networks

Amber Ross [1] , *Eva Mekis* [2] , *Craig Smith* [3]

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Presented by / Présenté par: ***Amber Ross***
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As organizations are looking to streamline observation networks, many are transitioning to automated gauges for the measurement of precipitation. In order to help ensure homogeneity of precipitation measurements, intercomparisons with reference methods and gauges are acutely important. These studies ultimately lead to better precipitation data with less errors and biases. The key condition of providing these intercomparisons is the availability of overlapping data with reference precipitation observations and the continuous support and maintenance of these research sites. Since climate research and models rely on accurate meteorological measurements, it is important to know the limitations of gauges and methods used to collect long term data.

The aviation weather monitoring network operated by NAV CANADA, in an effort to modernize, is installing Lambrecht rain[e]H3 heated tipping bucket gauges to replace manual (Nipher or Type B gauges or snow ruler) observations of precipitation. This has implications on the accuracy of reporting precipitation, especially solid precipitation events. Collaboration between NAV CANADA and ECCC has provided an opportunity to analyse the existing overlapping measurements at four sites for the 2019 – 2021 period: Dorval, Downsview, Prince George, and Whitehorse. Further to this overlap, a

Lambrecht gauge has been installed at the ECCC Bratt's Lake (SK) supersite for intercomparison with the WMO Double Fence Automated Reference (DFAR) for the 2021 – 2022 winter season. This presentation will share the preliminary results along with future project plans.

Session: 14020 In situ measurement of snow and solid precipitation: advances, challenges, and ongoing issues
Mesure in situ de la neige et des précipitations solides: avancées, défis et enjeux actuels **02/06/2022 15:40**

ID: 11683 Contributed abstract

Poster Order: Poster-14020

Snow Specific Surface Area: Margins of Error and Best Methods for the IceCube by A2 Photonic Sensors

Kaitlin Meyer [1] , *Mike Durand* [2]

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Presented by / Présenté par: ***Kaitlin Meyer***
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Snow specific surface area (SSA) is a minute physical property of snow that governs reflectance and plays an important role in microwave emission modeling and estimations of Earth's energy budget. While SSA is an important measurement, there are many challenges to acquiring in situ measurements. This project works with the IceCube, which measures snow SSA using an optical method in the field. The IceCube is highly desirable for its ability to make in field measurements, although there are some uncertainties about its margin of error. Some studies that have used the IceCube have noted a difference between IceCube SSA and micro-CT SSA up to 25% (Leppänen et al., 2018) and even higher in some cases. This project will take SSA samples using both IceCube and micro-CT from a wide variety of snow packs. Results will be compared and analyzed with the goal of laying out potential sources of error, identifying trends in the SSA differences, giving a better margin of error for the IceCube, and prescribing the best methods for sampling with the IceCube. We hope that this will be useful to those who are not experts in microstructure but need accurate SSA measurements to validate modeling products, remote sensing data, as well as for other areas of study.

Session: 14020 In situ measurement of snow and solid precipitation: advances, challenges, and ongoing issues
Mesure in situ de la neige et des précipitations solides: avancées, défis et enjeux actuels **02/06/2022 15:50**

ID: 11339 Contributed abstract

Poster Order:

What if you put a phone on a drone?

Fraser King [1] , *Richard Kelly* [2] , *Christopher Fletcher* [3]

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Presented by / Présenté par: ***Fraser King***
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Snow has significant impacts to springtime flooding, water resource management practices and the global water-energy budget. In situ observations are considered some of the highest quality measurements of snow depth available, and are useful constraints for climate model and reanalysis system estimates of snow water content. The application of laser altimetry (LiDAR-Light Detection and Ranging) for measuring snow depth has proven an effective method for quickly and accurately observing large areas, however this technique has traditionally been quite expensive to perform in practice due to the high cost of the necessary equipment coupled with required specialized training. In this work, we examine the capabilities of the iPhone 12 Pro LiDAR (iLiDAR) when attached to a consumer-grade DJI Phantom 4 drone (iDrone) in estimating snow depth at two study sites in southern Ontario, Canada. These sites were selected as representative locations of typical snow-covered areas including an open field with low-lying vegetation, as well as a sheltered site with a sloping surface and partial canopy cover. Initial comparisons between iDrone iLiDAR depth estimates and collocated snow ruler measurements demonstrate strong positive agreement with a mean squared error < 4 cm, and low absolute mean bias of approximately 1 cm. Our results suggest that the intersection of these two technologies defines a novel, low-cost alternative to traditional LiDAR-based snow depth measurement systems, while maintaining a high degree of accuracy. Furthermore, the improved accessibility of this method provides new opportunities for citizen science-based snow depth contributions to local weather networks and in turn, the potential for improved regional forecasting of snow melt.

Session: 14020 In situ measurement of snow and solid precipitation: advances, challenges, and ongoing issues
Mesure in situ de la neige et des précipitations solides: avancées, défis et enjeux actuels

02/06/2022
16:05

ID: 11405 Contributed abstract

Poster Order:

Assessing the impact of transition from single Alter-shielded Geonor T-200B to double Alter-shielded Pluvio2L gauges on winter precipitation measurements in the ECCC operational network

Craig Smith [1] , *Amber Ross* [2] , *Eva Mekis* [3]

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Presented by / Présenté par: ***Craig Smith***
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As a key component of network modernization, Environment and Climate Change Canada (ECCC) is replacing single Alter-shielded Geonor T-200B (Geonor-SA) precipitation gauges with double Alter-shielded OTT Pluvio2L (P2L-DA) precipitation gauges. Geonor-SA gauges have been used in the ECCC climate network since the early 2000s. The replacement program with

the P2L-DA configuration began as early as 2016. The number of P2L-DA gauges in the ECCC climate network was approximately 215 at the end of 2021. Following years of precipitation gauge intercomparisons, it is well recognized that more extensive shielding (i.e. double vs. single Alter-shields) results in a higher gauge catch efficiency (CE), especially for solid precipitation, increasing the probability of detection of light events and decreasing the measurement uncertainty. However, introducing this configuration into the network creates a measurement inhomogeneity, especially at cold and windy sites where the double shield will substantially increase the relative amount of observed winter precipitation as compared to the previously installed single shield. A “universal” transfer function (UTF) to adjust wind bias is currently available for single Alter-shielded gauges including the Geonor-SA configuration and has been applied to ECCC network measurements, with adjusted data published in the Government of Canada Open Data Portal. Unfortunately, a similar “universal” transfer function does not yet exist for double Alter-shielded gauges such as the P2L-DA configuration and therefore those measurements are not adjusted.

This analysis assesses the impact of two scenarios that may result in precipitation time series inhomogeneity: 1) transition from the unadjusted Geonor-SA to the unadjusted P2L-DA (realized by using the observations from the ECCC public archive); and 2) transition from the UTF adjusted Geonor-SA to the unadjusted P2L-DA (realized by using the current version of the published bias-adjusted data). The implications and solutions for these scenarios are explored using intercomparison data from the Bratt’s Lake (SK) supersite, including overlapping data with the official ECCC climate station.

Session: 14020 In situ measurement of snow and solid precipitation: advances, challenges, and ongoing issues
Mesure in situ de la neige et des précipitations solides: avancées, défis et enjeux actuels **02/06/2022 16:20**

ID: 11415 Contributed abstract

Poster Order:

Transfer Function development for adjusting precipitation observations in Arctic and Maritime climate conditions

Eva Mekis [1] , *Amber Ross* [2] , *Craig Smith* [3]

1
2
3

Presented by / Présenté par: ***Eva Mekis***
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The replacement of manual rain and snow observations with automated gauges is a difficult challenge for the user community and is leading to extensive research of these new instruments, installations, and measurements with the objective to quantify any underestimation and adjust the measurement bias. Key users, such as Numerical Weather Prediction (NWP) and Canadian Precipitation Analysis (CaPA) have identified the need to develop and apply transfer functions (TF) for precipitation gauge wind bias adjustments applicable for diverse Canadian climates. The WMO Solid Precipitation Inter-Comparison Experiment (SPICE) developed eight site-specific and one universal TF for the

adjustment of solid precipitation measurements using data representing five different climate zones, namely Alpine, Northern Boreal, wet and dry Continental and Maritime climate. Transfer function development requires the availability of a Double-Fence Automated Reference (DFAR) installation for use as the reference precipitation observation in the estimation. Further to the three Canadian supersites that participated in the WMO-SPICE intercomparison experiment, two more locations in Canada with overlapping reference gauge observations are available. The Iqaluit supersite in Nunavut represents a typical Arctic climate with low snowfall amounts, cold temperatures, and blowing snow conditions; while the St John’s site in Newfoundland has a maritime climate with high winds, and frequent light and mixed precipitation conditions.
The focus of this presentation is to estimate the TF for all possible existing configurations [single Alter-shielded / unshielded / Belfort double Alter-shielded Geonor or Pluvio2 gauges] at Iqaluit and St John’s sites. The major steps include 1) process and quality control all precipitation gauge, wind, temperature, and disdrometer data; 2) aggregate high frequency data to 30-minute and 60-minute intervals; 3) estimate transfer function parameters; and 4) validate the results. At the end, the results will be compared to the existing WMO-SPICE transfer functions and the possibility of applying climate dependent transfer functions across the Canadian networks will also be examined.

Session: 2040 Air Quality Studies in the Alberta Oil Sands Region Air Quality Studies in the Alberta Oil Sands Region

03/06/2022 08:25

ID: 11874 Contributed abstract
Poster Order:

GEM-MACH Simulations for the Oil Sands Area – An Overview

Paul Makar [1] , *Colin Lee, Ayodeji Akingunola* [2] , *Roya Ghahreman, Wanmin Gong* [3] , *Craig Stroud, Mahtab Majdzadeh* [4] , *Alex Lupu, Junhua Zhang, Ali Katal,* [5] , *Stefan Miller, Sepehr Fathi* [6] , *John Liggio, Katherine Hayden* [7] , *Ralf Staebler, Samar Moussa* [8] , *Jeremy Wentzell, Sumi Wren* [9] , *Balbir Pabla, Philip Cheung,* [10] , *Eric Edgerton* [11] , *Matthew Landis* [12]

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Presented by / Présenté par: ***Paul Makar***
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The Global Environmental Multiscale – Modelling Air-quality and CHemistry (GEM-MACH) model is Environment and Climate Change Canada's on-line air-quality modelling system. GEM-MACH has been in use to simulate air-quality in Canada's Oil Sands Region since 2012. We will provide a brief historical description of GEM-MACH simulations in the oil sands, and follow with a description of the most recent version of GEM-MACH:
- Expanded particle speciation (sulphate, nitrate, ammonium, secondary organic carbon, primary organic carbon, elemental carbon, crustal material, calcium, magnesium, sodium, potassium, chlorine, iron, manganese) with 12 sectional bins
- Large stack plume rise calculations which include the effects of combustion water latent heat release on plume height
- Improved inorganic heterogeneous chemistry including base cation chemistry
- Improvements to secondary organic aerosol formation processes including from intermediate volatility compounds and to photolysis calculations
- Improvements to cloud scavenging of aerosols, particularly in winter
- Updated particle and gas deposition algorithms, the latter including the explicit dependence of gas deposition on surface pH
- Updated gas-speciation (an expanded version of the Statewide Air Pollution Research Center 2011 (SAPRC11) gas-phase mechanism
- Addition of CO2, reactive CH4, H2S and total hydrocarbon gas species.
- Many emissions inventory updates, via the creation of a hybrid inventory based on data from aircraft, settling pond, National Pollutant Release Inventory

(NPRI) and Alberta Environment and Parks and other sources of information. Two 15 month simulations were evaluated, for the period August 1, 2017 through October 31, 2018 (time period chosen to encapsulate aircraft and surface-based monitoring measurement intensives). We will present the initial evaluation results of these simulations against surface monitoring data as well as measurements from aircraft and settling pond intensive studies. We will also discuss implications for ecosystem impacts, and future plans for GEM-MACH simulations in the region.

Session: 2040 Air Quality Studies in the Alberta Oil Sands Region Air Quality Studies in the Alberta Oil Sands Region

03/06/2022 08:40

ID: 11448 Contributed abstract

Poster Order:

Contribution of emissions from the oil sands activities to atmospheric concentration and deposition of nitrogen and sulphur species at a downwind site

Yuan You [1] , *Jason O'Brien* [2] , *Amanda Cole* [3] , *Leiming Zhang* [4] , *Zhuanshi He* [5] , *Samuel Pearson* [6] , *Jian Feng* [7]

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Presented by / Présenté par: ***Yuan You***
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Oil and gas activities in the Athabasca Oil Sands Region are large sources of atmospheric nitrogen oxides (NOx) and sulphur dioxide (SO2) emissions. Most previous studies on nitrogen and sulphur deposition in this region focused on the area within 50 km of the facilities. This study investigates the atmospheric deposition of nitrogen and sulphur compounds at a downwind site about 350 km away from the oil sands facilities to quantify the impact of emissions from oil sands activities on a wider region. Measurement data in this study are from the Canadian Air and Precipitation Monitoring Network (CAPMoN) from 2015 to 2019. Sector analysis of air mass back trajectories with the Hybrid Single-Particle Lagrangian Integrated Trajectory model (HYSPLIT) is conducted to distinguish measurements with different air mass origins. Preliminary results indicate that the mean atmospheric concentrations of nitrate acid, SO2, particulate nitrate, particulate sulphate, and particulate ammonium in air masses coming from the oil sands sector are significantly greater than those from the background sector by 71 %, 89 %, 48 %, 21 %, and 30 %, respectively. In precipitation samples, the precipitation-weighted mean concentrations of nitrate, sulphate, and ammonium on days where air masses came from the oil sands sector are 59 %, 51 % and 24 % greater than those from the background sector, respectively. Estimated contributions of emissions from oil sands activities to wet depositions of nitrate and sulphate at this site are 10 % and 7 %, respectively. This study is ongoing and the contribution

estimates may change after optimizing the methodology. Quantification of the contribution of oil sands emissions to dry deposition is also underway.

Session: 2040 Air Quality Studies in the Alberta Oil Sands Region Air Quality Studies in the Alberta Oil Sands Region

03/06/2022 08:55

ID: 11474 Contributed abstract

Poster Order:

Modeling trace elements over Athabasca oil sands region in Alberta, Canada using WRF-Chem

Jingliang Hao [1] , *Yongsheng Chen* [2]

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Presented by / Présenté par: ***Jingliang Hao***
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Athabasca oil sands region in Alberta, Canada is one of the largest oil sand bitumen reserves in the world. It benefits Canada financially, but also causes potential environmental impacts on local ecosystem. Bitumen is a form of heavy crude oil, and the extraction and upgrade of bitumen releases various pollutants, including trace elements, into the atmosphere. Eight trace element species, aluminum (Al), calcium (Ca), iron (Fe), manganese (Mn), potassium (K), silicon (Si), titanium (Ti), and zinc (Zn), were added into WRF-Chem, and were simulated in four months (Jan., Apr., Jul., and Oct.) with Environment and Climate Change Canada's emission inventory for Athabasca oil sands region. The simulated trace element concentration was compared with observed concentration at three monitoring sites in Athabasca oil sands region. The mapping of concentration, dry and wet deposition was analysis.

Session: 2040 Air Quality Studies in the Alberta Oil Sands Region Air Quality Studies in the Alberta Oil Sands Region

03/06/2022 09:20

ID: 11538 Contributed abstract

Poster Order:

Understanding Emissions of Hydrogen Sulphide in Athabasca Oil Sands Region

Colin Lee [1] , *Paul Makar* [2] , *Junhua Zhang* [3] , *Ralf Staebler* [4] , *Ali Katal* [5] , *Elisa Boutzis* [6] , *Samar Moussa* [7] , *Meguel Yousif* [8] , *Balbir Pabla* [9]

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Presented by / Présenté par: ***Colin Lee***
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Fort McKay First Nation is located less than 50km from most operations in Canada's Athabasca Oil Sands Region, which results in exposure to downstream air pollutants produced by oil sands operations. As a result of long-term complaints of residents of Fort McKay, the Alberta Energy Regulator created a system for residents to report unusual and unpleasant odours. Analysis has shown that many volatile organic compounds (VOCs) as well as hydrogen sulphide (H2S) are correlated with odour event reports. GEM-MACH is Environment and Climate Change Canada's online meteorology and air quality model. The oil-sands limited area configuration of GEM-MACH runs at 2.5km resolution and has recently received many updates. Included in these is updated emissions using aircraft-derived top-down estimates and the latest National Pollutant Release Inventory (NPRI) estimates, as well as the SAPRC-11 chemistry mechanism with 181 chemical tracers, including many VOCs, and hundreds of reactions. To this state-of-the-science model we added an H2S tracer with a simplified OH-oxidation mechanism. We explore the impacts of different H2S emissions estimates based on both NPRI data as well as another inventory collected by Alberta Environment and Parks, the latter including sub-facility spatial allocations of emissions. This is important at the 2.5km scale, as oil sands facilities span multiple grid cells and the NPRI facility totals can result in spreading sources out in the model, resulting in lower concentration plumes. We explore trajectory analysis with Wood Buffalo Environmental Association monitoring stations as receptors. We also explore the use of facility chemical profiles to improve H2S emissions estimates by tying them to co-emitted species. We will show some case studies of GEM-MACH simulated concentrations at Fort McKay during reported odour events and evaluate the model's ability to capture the sources of these events.

Session: 2040 Air Quality Studies in the Alberta Oil Sands Region Air Quality Studies in the Alberta Oil Sands Region

03/06/2022
09:35

ID: 11537 Contributed abstract
Poster Order:

HETV2: An update to the vectorized inorganic chemistry solver in GEM-MACH based on ISORROPIA II algorithms

Stefan Miller [1] , *Paul Makar* [2] , *Colin Lee* [3]

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Presented by / Présenté par: ***Stefan Miller***
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Inorganic heterogeneous chemistry (the reactions taking place between inorganic components of the gas-particle system) is one of the most complex and computationally demanding parts of atmospheric chemistry models. Accurate and highly computationally efficient algorithms for carrying out these calculations are essential for these models: here we present a revised and updated approach for carrying out these calculations, HETV2.

HETV2 updates the original HETV metastable state subroutines, expanding the aerosol system to include base cations (Mg, K, Ca, Na), and partitioning between chlorine, ammonium, and nitrate ions and gases. HETV2 is based on ISORROPIA II algorithms, but have been improved in several ways. First, inaccuracies in polynomial roots have been removed by using Taylor series expansions (for quadratics) and bisection for cubic polynomials. Second, the new algorithm correctly enforces mass conservation for cases where all species are present and the ratio of total cations to sulfate is between 1.0 and 2.0. Third, the code has been optimized using a “vectorization by gridpoint” approach. Fourth, additional optimizations were used (e.g., removal of function calls in favor of in-lined Taylor series expansions of the same functions). We thus improved both the computational speed and accuracy compared to the original algorithms, for this essential process required in regional and global chemical transport models.

In this talk, we will describe the inorganic heterogeneous chemistry system that is solved, the improvements to the algorithms, and compare the computational speed of ISORROPIA II to the new HETV2 code. As part of this work, we also show the impact of the revised code on high-resolution simulations of the Oil-Sands Region, using Environment and Climate Change Canada’s Global Environmental Multiscale – Modelling Air-quality and CHemistry (GEM-MACH) regional air quality model.

Session: 2040 Air Quality Studies in the Alberta Oil Sands Region Air Quality Studies in the Alberta Oil Sands Region

03/06/2022
09:50

ID: 11479 Contributed abstract

Poster Order:

Merging aircraft and satellite observations to derive emissions of pollutants co-emitted with nitrogen oxides: Application to the Canadian oil sands

Debora Griffin [1] , *Sarah T. Moser* [2] , *Chris McLinden* [3] , *Sumi Wren* [4] , *John Liggio* [5] , *Michael J. Wheeler* [6] , *Jeremy J.B. Wentzell* [7] , *Richard L. Mittermeier* [8] , *Katherine Hayden* [9] , *Andrea Darlington* [10] , *Amy Leithead* [11]

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Presented by / Présenté par: ***Debora Griffin***
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The Athabasca Oil Sands Region (AOSR) in Alberta, Canada is one of the largest unconventional sources of extractable oil in the world. To better understand its impact on air quality, Environment and Climate Change Canada led two intensive measurement campaigns, in 2013 (August to September) and 2018 (April to July). Each included airborne measurements in which roughly 60 species were measured using a variety of in situ instruments. While many of these species are not routinely monitored, nitrogen oxides (NOx; the sum of NO and NO2) are well measured (e.g. CEMS), and these NOx emission rates that can be estimated from independent space-borne observations. In this presentation, a method is described in which these aircraft measurements were examined to find species that were well correlated with NOx, such that pollutant to NOx ratios could be used together with satellite estimates of NOx to derive annual emission rates. Out of the 60 species measured, five air quality pollutants were found to exhibit a robust correlation with NOx, namely: black carbon, CO, HCN, HONO, and SO2. Utilizing NO2 observations from the space-borne TROPOspheric Monitoring Instrument (TROPOMI), facility specific emissions rates can be derived over the AOSR. Details associated with this approach to emissions estimation, its validation and uncertainties, will be discussed.

Session: 4060 Developing Ocean Modelling Capacity in Canada - Part 1 Le développement de la capacité Canadienne de modélisation océanique - Partie 1 **03/06/2022 08:25**

ID: 11744 Contributed abstract

Poster Order:

Improving ocean and sea-ice model hindcast simulations for Canada's Three Oceans: Present and ongoing work

Youyu Lu [1] , *Xianmin Hu* [2] , *Hao Wei* [3] , *Eric Oliver* [4] , *Clark Richards* [5] , *David Brickman* [6]

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Presented by / Présenté par: ***Youyu Lu***
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Several hindcast simulations from 1993 to present have been carried out using two configurations of an ocean and sea-ice model covering Canada's Three Oceans (North Pacific, Arctic and North Atlantic). Currently, the two models configurations are based on version 3.6 of the Nucleus for European Modelling of the Ocean (NEMO), which uses LIM3 for the sea-ice component, with nominal horizontal resolutions of ¼ and 1/12 degree in latitude/longitude, respectively. The results from the ¼-degree version are evaluated with observations of sea-ice concentration from satellite remote sensing, and hydrography and currents form ships and moorings. The evaluation guides model parameter tuning to reduce the model biases identified. Evidence of improved simulation with the 1/12-degree version is presented. Ideas on further improvements for the model, including replacing LIM3 with the CICE sea-ice model modified at Environment and Climate Change Canada, will be discussed

for better coordination with other research initiatives and projects of colleagues in Canada and the international community.

Session: 4060 Developing Ocean Modelling Capacity in Canada - Part 1 Le développement de la capacité Canadienne de modélisation océanique - Partie 1

03/06/2022 08:40

ID: 11397 Contributed abstract
Poster Order:

Development of an advanced coupled modelling system to study interactions among physical and biogeochemical processes in the northwest Atlantic Ocean

Kyoko Ohashi [1] , *Jinyu Sheng* [2]

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Presented by / Présenté par: *Kyoko Ohashi*
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The northwest Atlantic Ocean is characterized by intense air-sea interactions, resulting in processes such as deep convection and biological carbon sequestration that have implications for the global ocean circulation and climate. Changes in the global climate, in turn, are expected to significantly impact the circulation, vertical mixing, sea ice dynamics, and biological productivity in this area. These physical and biological processes as well as their spatiotemporal variabilities are challenging to numerical ocean models, creating a difficulty in projecting future changes. To address this challenge we have developed an advanced coupled circulation-sea ice-biogeochemistry modelling system for the northwest Atlantic Ocean. This modelling system is based on the Regional Ocean Modeling System (ROMS), the Community Sea Ice Model (CICE), and a biogeochemical model including oxygen dynamics and carbon chemistry. The model domain spans the eastern seaboard of North America from Cape Hatteras to southern Baffin Bay and extends offshore to the Flemish Cap. The horizontal grid resolution ranges from ~8 km in the south to ~2 km in the north. The circulation and sea ice models are forced by atmospheric and oceanic reanalysis data at the surface and lateral boundaries, respectively. The circulation model is additionally forced by tides, river discharge, and continental runoff. Preliminary model results are presented and compared to various types of observations, with a focus over coastal waters and the deep convection region of the Labrador Sea.

Session: 4060 Developing Ocean Modelling Capacity in Canada - Part 1 Le développement de la capacité Canadienne de modélisation océanique - Partie 1

03/06/2022 08:55

ID: 11713 Contributed abstract
Poster Order:

Bias Correction and Spatiotemporal Scales for Downscaling Future Projections of Northwest Atlantic Circulation and Sea Ice

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Presented by / Présenté par: ***Christoph Renkl***
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In the Northwest Atlantic (NWA), including the Labrador Sea, interactions between the atmosphere, ocean circulation, and sea ice play a critical role in regulating the global climate system. The ocean and climate in this region observe rapid and unprecedented, anthropogenically forced changes to the physical environment and biosphere. Future projections of NWA circulation and sea ice can help address pressing questions about these changes and mitigate their potential impacts on the global carbon cycle, coastal communities, and transportation. However, the spatial resolution of current climate models is often insufficient to accurately represent important features in the NWA, such as the location and strength of the Gulf Stream and Labrador Current and their dynamical interactions. This can lead to biases in the model's mean state, and a misrepresentation of the temporal and spatial scales of ocean variability, e.g., mesoscale eddies, deep convection. Regional ocean models with grid spacing <10 km, forced by global climate simulations, can be used to improve estimates of historical and future circulation and hydrography. However, given the limited spatial resolution and biases in global climate models, a challenge of downscaling their simulations is the appropriate reconstruction of the forcing fields.

Here, we present preliminary results of downscaled global climate simulations of NWA circulation and sea ice from the Coupled Model Intercomparison Project (CMIP6). The dynamical downscaling is performed using an eddy-resolving, coupled circulation-sea ice model based on the Regional Ocean Modeling System (ROMS) and the Los Alamos Sea Ice Model (CICE). We will focus on the value of correcting biases in the mean and variance of the forcing. We further explore the need of including missing spatial and temporal scales in the atmospheric forcing that are not captured by the global models. Implications for the design of model experiments for future projections will be discussed.

Session: 4060 Developing Ocean Modelling Capacity in Canada - Part 1 Le développement de la capacité Canadienne de modélisation océanique - Partie 1 **03/06/2022 09:10**

ID: 11781 Contributed abstract
Poster Order: Poster-4060

Classification of Lagrangian trajectories in the Labrador Current with a Machine Learning algorithm

Mathilde Jutras [1] , *Noémie Planat* [2] , *Carolina Dufour* [3] , *Alfonso Mucci* [4]

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Presented by / Présenté par: ***Mathilde Jutras***
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The Labrador Current flows south along the coasts of Labrador and

Newfoundland , carrying fresh and cold water from high latitudes. At the tip of the Grand Banks, part of these waters is retroflected eastward into the subpolar North Atlantic, and part follows the continental shelf westward into the Slope Sea. The partition of the waters into these two paths has important implications with respect to the salinity, nutrient, and oxygen inputs to the North Atlantic and to the Slope Sea. To study the variability of the retroflection, we carry virtual Lagrangian particles experiments. Particles are launched in the Labrador Current and advected for three years, using the velocity output of the GLORYS12 ocean reanalysis. These Lagrangian experiments yielded more than a million trajectories. Here, we propose a method to group similar trajectories using an unsupervised machine learning (ML) algorithm. The algorithm is given a subset of trajectories and identifies the main paths taken by the different branches of the Labrador Current. By applying the obtained training to the complete dataset, we classify each trajectory into one of the identified paths and analyze the variability of these paths over time. The algorithm is a simple kernelized k-means++ algorithm with a kernalized principal component analysis (PCA) reduction, ran using the Python package scikit-learn. These results highlight the potential of simple ML algorithms to help deal with large datasets of Lagrangian trajectories. This represents a powerful tool, as that type of data is widely used in oceanography and in atmospheric sciences.

Session: 4060 Developing Ocean Modelling Capacity in Canada - Part 1 Le développement de la capacité Canadienne de modélisation océanique - Partie 1

03/06/2022 09:10

ID: 11582 Contributed abstract

Poster Order: Poster-4060

Towards creating an ensemble of global ocean analysis: Ensemble GIOPS

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Presented by / Présenté par: ***Andrew Peterson***
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Environment and Climate Change Canada’s (ECCC’s) Global Ensemble Prediction System (GEPS) generates an ensemble of atmospheric initial conditions using a sophisticated local ensemble transform Kalman filter (LETKF) approach. Conversely, the ocean and sea ice in this coupled system are initiated with a single analysis, the global ocean and ice prediction system (GIOPS) that also supplies initial conditions for ECCC’s Global Deterministic Prediction System (GDPS). Compared to the atmosphere, therefore, the ocean and sea ice are quite underdispersive, especially at short lead times, and thus fail to accurately represent the large uncertainties in unobserved regions, or the uncertainties in the observations ingested into the assimlation system. As a first step towards rectifying this asymmetry, we have developed a simple ensemble analysis system using the spread in atmospheric forcing available from the ensemble atmospheric initialization system, along with a set of stochastic parametrization approaches available for the NEMO ocean model: stochastic parameter perturbations (SPP), stochastically perturbed parameterization tendencies (SPPT), and stochastic kinetic energy backscatter (SKEB). In this presentation we will detail this ensemble ocean analysis system and investigate, using comparisons with assimilated and non-assimilated observations, how the resulting ensemble of analysis better estimates uncertainties in the best estimate of the ocean state compared to a single ocean analysis. Prospects for future use, particularly in the coupled medium range forecast, will then be explored.

Session: 4060 Developing Ocean Modelling Capacity in Canada - Part 1 Le développement de la capacité Canadienne de modélisation océanique - Partie 1 **03/06/2022 09:20**

ID: 11734 Contributed abstract
Poster Order:

NEMO Model developments at the University of Alberta

Clark Pennelly [1] , *Juliana Marson* [2] , *Laura de la Guardia* [3] , *Paul G. Myers* [4]

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Presented by / Présenté par: ***Clark Pennelly***
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The ocean modeling group at the University of Alberta has multiple goals related to NEMO development, ranging from new model configurations and components of our already-established suite, to improving Canada-wide collaboration and sharing of model output and data in a user-friendly manner. Our group will be carrying our numerical setup into the most recent stable version of NEMO, carrying forth our previous development with both the iceberg and BLING biochemical components. We recently migrated our regional Arctic and Northern Hemisphere Atlantic configuration (ANHA) into a global configuration (eORCA025) and are pleased with the progress.
Our group is also making strides at high resolution modeling. Our previous regional configuration which implements two nests to achieve 1/60° horizontal resolution in the Labrador Sea (LAB60) was successful and computationally cheap enough to afford us a sensitivity study. We are exploring the same simulation with different atmospheric conditions: DFS5.2 versus ERA5. We have spent significant time building a 1/60° configuration over a large portion of the Arctic Ocean. Vastly larger and more complex than LAB60, this configuration will include tides, passive tracers, and icebergs. It is driven by boundary conditions produced from our newly updated 1/12° Arctic and Northern Hemisphere Atlantic configuration. Together, these two configurations will allow further exploration into the mesoscale and subsmesoscale.
Lastly, we are working to improve Canada-wide NEMO collaboration. Between variations in model code, huge amounts of data, and difficulty sharing and

communicating across Canada, we are working towards making this easier for many groups and institutions.

Session: 4060 Developing Ocean Modelling Capacity in Canada - Part 1 Le développement de la capacité Canadienne de modélisation océanique - Partie 1

03/06/2022 09:35

ID: 11447 Contributed abstract
Poster Order:

Iceberg-associated freshwater transport across Davis Strait

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Presented by / Présenté par: ***Juliana Marson***
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The freshwater transport across Davis Strait not only includes Arctic water but also the Greenland Ice Sheet discharge. Part of this discharge is in solid form, i.e., icebergs. While many ocean models parameterize Greenland discharge all in liquid form, icebergs melt slowly and therefore alter when and where this freshwater is delivered. In this study, we analyze the role of icebergs in freshwater transport across Davis Strait. What is its variability and which forcings are most important to this variability? How does it compare to liquid freshwater transports? To answer these questions, we analyze outputs from experiments carried out with the Nucleus for European Modelling of the Ocean (NEMO) and explicit numerical representation of icebergs. We quantify differences in iceberg-related freshwater transport between different sea ice-iceberg forcing parameterizations and the impact of tides on such transports.

Session: 4060 Developing Ocean Modelling Capacity in Canada - Part 1 Le développement de la capacité Canadienne de modélisation océanique - Partie 1

03/06/2022 09:50

ID: 11638 Contributed abstract
Poster Order:

Impact of Model Resolution on the simulated MOC across OSNAP West Section

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Presented by / Présenté par: ***Pouneh Hoshyar***
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The variability of Atlantic Meridional Overturning Circulation (AMOC) is

considered to play an important role in the global redistribution of heat. AMOC variability has traditionally been attributed to the formation of water masses in the Labrador Sea interior. However, several recent studies rebutted the dominant contribution of deep-water masses in this region to the variability of AMOC. Nevertheless, the central Labrador Sea is a significant region to explore because of the occurrence of the Labrador Sea Water formation by deep convection, which is a significant contributor to the deep water masses of North Atlantic including the ventilation of approximately 30% of the subpolar North Atlantic. The focus of the present study is to investigate estimating the MOC using ocean general circulation models across the OSNAP (Overturning in the Subpolar North Atlantic Program) west section, which is stretched from the southeastern Labrador shelf to Greenland's southwestern tip. For this purpose, several experiments with different mesh resolution and configurations (1/4∘,1/12∘,1/60∘) of the NEMO (Nucleus for European Modelling of the Ocean) model are analyzed by investigating the difference of calculated MOC in both density and depth space with the released OSNAP West observational data.

Session: 10030 Advances in boreal disturbance research - Part 1 Avancées dans la recherche sur les perturbations boréales - Patie 1 **03/06/2022 08:25**

ID: 11736 Contributed abstract

Poster Order:

Are restored seismic lines heading in the right direction? Comparing taxonomic, phylogenetic and functional plant diversity in boreal peatlands.

Ellie Goud [1] , *Scott Davidson* [2] , *Anna Dabros* [3] , *Kimberly Kleinke* [4] , *Megan Schmidt* [5] , *Maria Strack* [6]

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Presented by / Présenté par: ***Ellie Goud***
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Land-use changes, including anthropogenic disturbances, are major threats to global biodiversity, with impacts on ecosystem function and post-disturbance recovery. Human activities from petroleum development in boreal Alberta, Canada, have resulted in highly fragmented landscapes, in part due to seismic exploration lines that remove surface vegetation and microtopography. Although forest cover on seismic lines in some uplands appear to recover over time, peatlands do not seem to recover and impacts on wildlife and carbon dynamics remain even decades after seismic line construction. Recent restoration efforts apply silviculture techniques to recreate microtopography and promote tree seedling growth. Whether these restoration treatments are successful in recovering plant diversity in boreal peatlands remains a critical knowledge gap. We compared taxonomic, phylogenetic, and functional diversity of the groundlayer plant community in treed bogs and fens across treated and

untreated seismic lines, and reference sites. We measured relative abundance and evolutionary relationships among species and obtained functional trait data for plant height (H), leaf dry matter content (LDMC), and foliar nitrogen (N) and phosphorus (P) contents. Treated lines differed from untreated lines and reference sites, with shifts towards higher community-weighted H, LDMC, N and P. In bogs, treated lines were more diverse, driven by horsetails, forbs, and graminoids with larger leaf N and P content. In fens, taxonomic and phylogenetic diversity of treated lines differed from reference sites, while functional diversity was similar to reference conditions. Results reveal that bog and fen communities respond differently to seismic line disturbance and restoration, which needs to be considered during management and restoration planning. Changes in plant diversity have implications for ecosystem recovery and functions, especially carbon and nutrient cycling. Although these changes may be temporary as communities continue to undergo succession, long-term monitoring is needed to assess the eventual success of silviculture techniques on boreal peatland recovery.

Session: 10030 Advances in boreal disturbance research - Part 1 Avancées dans la recherche sur les perturbations boréales - Patie 1

03/06/2022 08:40

ID: 11731 Contributed abstract

Poster Order:

Combined impacts of soil salinity and water-table on Juncus balticus growth in a constructed fen in the Alberta oil sands

Tianshi Wang [1] , *Maria Strack* [2] , *Ellie Goud* [3] , *Scott Davidson* [4]

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Presented by / Présenté par: ***Tianshi Wang***
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Oil sands mining destroys wetlands by removing all vegetation on the ground and digging deep to reach the oil. To solve this problem, a fen reclamation project was launched to build a new peatland using salvaged peat according to hydrological design and transplantation. However, salt contamination is a concern for growth and physiology of plants, because mine waste materials are transported into the fen through groundwater. A salinity-tolerant plant community with Baltic rush (Juncus balticus) dominant was planted in 2013 but cover has decreased over time. The response of the plant community to continued salinization under a range of hydrologic conditions remains unclear. This study investigated the combined influence of soil salinity and water availability on J. balticus growth and ecophysiology, which can be used to predict whether this species can survive in the constructed fen in the future. We grew J. balticus seedlings in a factorial greenhouse experiment with seven soil salinity levels and two soil water table levels for fourteen weeks. We measured leaf photosynthesis plant height, above and belowground biomass, and leaf and root sodium (Na) and potassium (K) concentrations. Photosynthesis rates (μmol m^{-2} s^{-1}) decreased when Na concentrations exceeded 2300 mg/L, while this tendency did not show in aboveground or belowground biomass.

Noticeably, biomass and photosynthesis rates were always lower in the wetter treatments, regardless of salinity. Plant height did not have significant relationships with either salinity or water table levels. Leaf and root Na concentrations (mg g-1) increased with salinity but were similar between 2300 and 4600 mg/L in roots. Leaf and root K concentrations (mg g-1) decreased as salinity increased. This indicates that soil Na concentrations affect J. balticus physiological functions in a short period and might harm it in the future. Future field work includes measuring gas exchange, greenness from photographs, biomass, and tissue chemistry.

Session: 10030 Advances in boreal disturbance research - Part 1 Avancées dans la recherche sur les perturbations boréales - Patie 1 **03/06/2022 08:55**

ID: 11745 Contributed abstract

Poster Order:

Boreal peatland reclamation through partial well pad removal: Understanding biogeochemical dynamics supporting fen moss initiation

Murdoch McKinnon [1] , *Felix Nwaishi* [2] , *Bin Xu* [3] , *Richard Petrone* [4]

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Presented by / Présenté par: ***Murdoch McKinnon***
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Boreal peatlands have been disturbed by construction of thousands of oil and gas well pads, which are built by burying peat under upland mineral fill. Accordingly, trials have sought to establish fen mosses directly on remnant mineral substrates following partial removal of well pads. At a small scale, the technique has resulted in biogeochemical conditions which support initiation of fen mosses introduced through the Moss Layer Transfer Technique. It has remained unclear, however, whether these conditions would develop following application of the technique at field scale. Accordingly, our objectives were to characterize the physicochemical properties of a mineral substrate after partial removal of a well pad, and to assess nutrient availability to mosses on that substrate. Monitoring and sample collection were conducted on a partially removed well pad near Slave Lake, Alberta during 2020 and 2021. Pore water on the remnant pad had a similar electrical conductivity and pH as surrounding moderate rich fens and the donor moss collection site, and the substrate was nutrient rich, containing high quantities of total micro and macronutrients. During the first growing season, ammonium became the dominant form of available nitrogen, indicating the development of anoxic wetland biogeochemical processes associated with high measured soil water content. These conditions resulted in decomposition rates across the pad similar to those in adjacent peatlands. Nutrient pore water concentrations and supply rates were also similar to those in adjacent peatlands, though they were more variable and closely controlled by spatial and temporal trends in soil water content. Accordingly, nutrient availability decreased later in both growing seasons in areas of the pad which were hydrologically isolated from adjacent peatlands. While results to date are promising, they highlight the sensitivity of

the technique to water shortages and the resulting need to optimize site hydrology for maintenance of requisite biogeochemical conditions.

Session: 10030 Advances in boreal disturbance research - Part 1 Avancées dans la recherche sur les perturbations boréales - Patie 1 **03/06/2022 09:20**

ID: 11768 Contributed abstract
Poster Order:
Restoration of oil sands well-pads to peatlands: Evaluating the return of carbon sink function to inform restoration practice

Maria Strack [1] , *Meike Lemmer* [2] , *Line Rochefort* [3] , *Melanie Bird* [4] , *Bin Xu* [5]

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Presented by / Présenté par: ***Maria Strack***
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Oil sands deposits in Alberta represent the third largest proven petroleum deposit. Located in the boreal forest where peatland cover is 50–100% in some areas, oil sands exploration and extraction has disturbed large areas of peatland in the province. Over 95% oil sands' area consists of deposits that are too deep to reach with surface mining and are instead extracted using in situ techniques requiring steam injection into the subsurface and pumping bitumen to the surface. In situ techniques require the construction of well pads, 1 to 4 ha areas cleared of vegetation and stabilized with placement of 1 to 4 m thick layer of mineral material. Over 36,000 ha of these well-pads have been constructed on peatlands and provincial policy encourages restoration to a wetland ecosystem once oil extraction has ceased. Several strategies for groundwork, including complete and partial pad removal, and revegetation have been tested. Here we present results on plant community recovery and carbon exchange across restoration projects at four well-pads near Peace River and Cold Lake, Alberta, representing six different restoration strategies and compare results to regional reference ecosystems. All tested restoration methods result in the return of some wetland plant cover, with the distribution of specific plant functional types linked to local hydrologic conditions, chemistry, and adjacent peatland type. Returning the surface level of the well pad as close as possible to the elevation in the adjacent peatland is more conducive to the recovery of plant communities and rates of carbon exchange most like reference peatlands. Restoration strategies that either retain some of the pad material at the surface and those that re-expose peat at the surface can result in ecological function similar to reference ecosystems when hydrologic connection to the adjacent peatland is achieved.

Session: 10030 Advances in boreal disturbance research - Part 1 Avancées dans la recherche sur les perturbations boréales - Patie 1 **03/06/2022 09:35**

ID: 11440 Contributed abstract
Poster Order:
Impacts of Wildfire on Greenhouse Gas Dynamics in a Bog Peatland in Central Alberta
Abigail Shingler [1] , *Maria Strack* [2]

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Presented by / Présenté par: ***Abigail Shingler***
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Peatlands are an important component of the global carbon (C) cycle as they operate as long-term sinks of C. However, they are becoming increasingly vulnerable to disturbances such a wildfire. Understanding the impact of wildfire on greenhouse gas emissions is important as the frequency and severity of these fires continue. This study is unique as field measurements were conducted immediately post-burn, while smouldering was still occurring. The objectives of this study were: 1) to quantify CH_4 and CO_2 emissions in a peatland, post-wildfire, and 2) to determine the impacts of environmental variables such as soil temperature, moisture, and water table position on CH_4 emissions in a peatland, post-wildfire. There are two study sites (an undisturbed reference site and a recently burned site), in Parkland County, Alberta that are comparable due to similar location, vegetation, hydrology, and wetland classification type. In-situ chamber measurements were undertaken to quantify the CH_4 and CO_2 flux at each site. Adjacent to the flux collars measurements for soil temperature, soil moisture, and water table position were also taken to record the environmental conditions at each site. Results suggest that wildfire-generated charcoal has resulted in a decrease of microbial activity and therefore a reduction in CH_4 production and oxidation in comparison to the reference site. Future work will evaluate correlations between phenolics present in the samples and CH_4 cycling as it is hypothesized that that wildfire generated charcoal could provide additional phenolic compounds that may inhibit microbial activity through the enzymic latch mechanism.

Session: 10030 Advances in boreal disturbance research - Part 1 Avancées dans la recherche sur les perturbations boréales - Patie 1

03/06/2022 09:50

ID: 11775 Contributed abstract
Poster Order:
Carbon Production and Transport: Impact of Water Table Fluctuations in Bare Peat Column Experiment
Miranda Hunter [1] , *Ian Strachan* [2] , *Nigel Roulet* [3] , *Maria Strack* [4]

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Presented by / Présenté par: ***Miranda Hunter***
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Vacuum extraction of peatlands is a growing industry within Canada and is an understudied human-caused peatland disturbance. Prior to extraction, the peatland sectors are drained through drainage ditches, and the vegetation and a portion of the acrotelm are removed. The increased specific yield following drainage-induced subsidence has been shown enhance water table (WT) fluctuations in these actively extracted peatlands compared to natural ones. The effect of these fluctuations on carbon dynamics is poorly understood. A column experiment was therefore conducted with 45 cm deep peat cores from an actively extracted peatland to better understand the relationship between hydrologic variables and CO2 and CH4 production and transport. Six cores underwent five to eight successive WT fluctuations, with amplitudes varying from 10 to 30 cm, to mimic the intensity and duration of rain events in central Alberta. Surface emissions of CO2 and CH4 were measured on both the rising and falling limbs of the WT fluctuations. Measurements of WT depth, continuous volumetric water content and soil temperature, and pore gas and dissolved inorganic carbon were also made throughout the experiment.
We observed a positive relationship between CO2 and CH4 emissions and WT depth, and the inverse relationship with soil moisture content. A hysteretic relationship was present in many fluctuation rounds, with greater pore water content on the rising limbs compared to falling ones coinciding with greater carbon dioxide and methane emissions as the WT rose. For CH4, we hypothesize that this positive relationship was due to both a time lag of CH4 production under anoxic conditions, and a forced displacement of CH4 gas by water on the rising limb. These results highlight the importance of considering both biogeochemical conditions for decomposition, and the physical effects of flushing of pore gases in peatland ecosystems with a dynamic WT.

Session: 11021 CSAFM 1: Observational studies of land-atmosphere interactions - Part 2 SCMAF 1 : Etudes observationnelles des interactions terre-atmosphère - Partie 2 **03/06/2022 08:25**

ID: 11445 Contributed abstract

Poster Order:

FLUXNET-CH4 – a global database of eddy covariance methane flux measurements

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[1]

Presented by / Présenté par: ***Sara Knox***

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Uncertainties around global CH4 sources and sinks remain quite large, and much higher than those for CO2, with uncertainties from natural sources exceeding those from anthropogenic emissions. In particular, one of the largest sources of uncertainty in the global CH4 budget is related to emissions from wetlands and inland waters. Direct observations of local CH4 emissions with high measurement frequency are important for constraining CH4 budgets, for understanding the responses of CH4 fluxes to environmental factors and climate, and for creating validation datasets for the land-surface models used to infer global CH4 budgets. However, unlike the well-coordinated efforts for synthesizing CO2 flux measurements, until recently, no parallel initiative was

available for CH4. Here we present a recent FLUXNET coordination network for CH4 organized by the Global Carbon Project in collaboration with regional flux networks. The objectives of the FLUXNET-CH4 activity are described along with an overview of FLUXNET-CH4 Version 1.0 which includes data from 81 sites representing freshwater, coastal, upland, natural, and managed ecosystems. Furthermore, recent work which leverages the FLUXNET-CH4 database will be highlighted. This includes research aimed at providing improved understanding of the controls and timing of wetland CH4 emissions, informing CH4 flux gap-filling and modeling, and generating data-driven CH4 emissions products. The future of FLUXNET-CH4 will also be discussed with an opportunity for a community discussion on the next version of the database.

Session: 11021 CSAFM 1: Observational studies of land-atmosphere interactions - Part 2 SCMAF 1 : Etudes observationnelles des interactions terre-atmosphère - Partie 2 **03/06/2022 08:40**

ID: 11710 Contributed abstract
Poster Order:

Interannual Variability of Carbon Dioxide and Methane Fluxes in a Temperate Bog over a 6-Year Period

Tin W. Satriawan [1] , *Marion Nyberg* [2] , *Sung-Ching Lee* [3] , *Zoran Nesic* [4] , *T. Andrew Black* [5] , *Mark S. Johnson* [6] , *Sara H. Knox* [7]

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Presented by / Présenté par: ***Tin Satriawan***
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Peatland ecosystems are important carbon dioxide (CO2) sinks and methane (CH4) sources. However, changes in climatic conditions and functional responses can shift these ecosystems towards being CO2 sources and weaker or stronger CH4 sources. In peatlands undergoing restoration by rewetting, these responses are often more unpredictable. Here, we evaluated the impact of climate variability and functional change on interannual variability (IAV) of carbon fluxes at Burns Bog, a rewetted bog in Canada, based on six years of continuous eddy-covariance measurements. We found that the study site alternated between being an annual-scale CO2 sink and a source, ranging from -41.7 to 28.9 g CO2-C m-2 year-1, while consistently being a CH4 source, ranging from 12 to 18 g CH4-C m-2 year-1. On average, CH4 emissions (14.4 g CH4-C m-2 year-1) completely offset the CO2 sink (-8.8 g CO2-C m-2 year-1) resulting in the site losing an average of 5.6 g C m-2 year-1. This finding indicates that excluding CH4 flux from the net C budget results in a significant overestimation of this ecosystem's net C uptake. Regardless of the GHG metrics (i.e., GWP and SGWP of 20 and 100-years timeframe) used in annual CO2-eq GHG budget calculation, the bog consistently contributed to climate

warming (i.e., net radiative forcing). Using homogeneity of slopes models, we determined the contribution of functional change and year-to-year climatic variability to C fluxes IAV. The partitioning of variation showed that interannual climatic variability accounted for 12.4% and 0.7% more IAV in CO_2 and CH_4 than functional change, respectively. As indicated by the correlation analysis, growing season soil temperature best explained CO_2 flux components IAV, where warmer summers enhanced gross primary production (r GPP= 0.97) and ecosystem respiration (r= 0.94). Water table depth also exerted a significant control on growing season net ecosystem exchange (r = -0.89), where drier years are associated with less CO_2 uptake during the growing season. Additionally, GPP best explained yearly CH_4 flux (r= 0.85), suggesting that C input is one of the primary drivers of CH_4 IAV.

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ID: 11459 Contributed abstract

Poster Order:

The UHI and thermally forced circulations events of the Valley of Mexico as revealed by a historical analysis in a dry period of simulated intense events.

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Presented by / Présenté par: ***Lourdes Aquino***
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Long-term changes in the intensity of the Urban Heat Island and surface thermally forced circulations (UHIC) in the Valley of Mexico are evaluated through the use of observations, reanalyses, and simulations using a regional model over 30 years (1990-2020). Strong UHIC meteorological events are objectively identified, characterized under conditions of weak synoptic forcing, greater atmospheric stability, high ozone indices, and meteorological criteria. A statistically significant long-term increase in atmospheric stability and sensible heat flux increases is associated with urban area growth in observations and simulations of severe weather events. This corresponds to similar behavior in station-based temperature observations on the surface. UHIC events are becoming more intense in the context of the diurnal cycle. It is concluded that a more favorable thermodynamic environment because of the greater availability of sensible heat on the surface in the Valley of Mexico is facilitating the growth of a better organized and deeper PBL registered in recent years. Findings suggest that events with a more intense UHI can increase their frequency of occurrence when considering changes in Land Use/Land Cover. Higher urban temperatures, although supporting the dilution of pollutants in the PBL, put human health at risk because of a well-linked relationship between heat and mortality and morbidity rates.

Session: 11021 CSAFM 1: Observational studies of land- **03/06/2022**

ID: 11665 Contributed abstract

Poster Order: Poster-11030

Exploring extreme weather events adaptation measures of spring wheat based on AquaCropOS in Saskatchewan

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Presented by / Présenté par: ***Qi Zhao***
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Extreme weather events can cause large-scale crop failures. The increasing frequency and intensity of extreme weather events threaten food security across the globe. Process-based crop model is an indispensable tool to analyze the effects of extreme weather events by simulating the responses of crops at various growth processes. By calibrating crop models with observed meteorological forcing and crop yields, we can confidently compare extreme weather events adaptation measures. We apply a process-based crop model AquaCropOS in Saskatchewan, Canada, to realistically reproduce crop yield before applying the model to evaluate the performance adaptation measures. To force this model, we collected the information of soil and cropland distribution information from Statistics Canada and used WFDEI as the weather input of AquaCropOS. The spring wheat yield data from 295 rural municipalities during 1979-2016 are used in this study. The spatial resolution of WFDEI is 0.25°X0.25° which divides Saskatchewan cropland region into 167 grids. We calibrated AquaCropOS in each grid to find the most suitable parameters for each grid. We used a sensitivity analysis method, VARS (Variogram Analysis of Response Surfaces), to find the most sensitive parameters of AquaCropOS. A global optimization method, SCE-UA (shuffled complex evolution method developed at The University of Arizona), is used to optimize the set of parameters. The NSE (Nash-Sutcliffe efficiency coefficient) and R(Pearson correlation coefficient) are 0.52-0.71 and 0.72-0.91 during the validation period. We evaluated the performances of five adaptation measures: changing sowing date, applying irrigation, increasing fertilizer, applying straw mulching, and variety breeding. The result shows that the efficiencies of these measures are spatially heterogeneous due to climate and soil properties. The results of this study can provide guidance to policymakers on applying adaptation measures according to the region's weather and soil conditions.

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ID: 11391 Contributed abstract

Poster Order:

The relevance of energy partitioning and vegetation water use to Taiga Shield water budgets in a warming climate

Christopher Spence [1] , *Anna Coles* [2] , *Nia* [3] , *Ana Sniderhan* [4] , *Oliver Sonnentag* [5] , *Jennifer Baltzer* [6]

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Presented by / Présenté par: ***Christopher Spence***
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Climate warming and permafrost induced land cover change are well documented in Canada's Southern Arctic, Taiga Cordillera and Taiga Plains ecozones. Vegetation canopies are changing as trees and shrubs expand across the landscape. How this phenomenon is manifesting in the Taiga Shield is less studied, and the different surficial geology could mean results from other regions are not transferable. This is an important knowledge gap because the Shield occupies 60% of Canada's subarctic and a third of its northern ecozones. This study measured energy partitioning and vegetation water use among several land cover types in the Taiga Shield as a means to determine if vegetation canopy change could be a factor controlling water budget response to climate warming. Results indicate that Taiga Shield tree species are all quick to draw water after spring thaw and rainfall and that they tend to draw water from very shallow soil. Over and understory vegetation isotopic signatures are similar. Energy flux measurements imply denser canopies exhibit greater control over canopy conductance than sparse canopies, and these denser canopies are becoming more prevalent on the landscape. This combination of vegetation behaviour would lead to a reduction of inter-annual variability in evapotranspiration rates as tree canopies expand. With this could come a fundamental change in how Taiga Shield catchments divide water with implications for weather, lake levels, and availability of water for chemical transport.

Session: 11021 CSAFM 1: Observational studies of land-atmosphere interactions - Part 2 SCMAF 1 : Etudes observationnelles des interactions terre-atmosphère - Partie 2 **03/06/2022 09:35**

ID: 11342 Contributed abstract

Poster Order:

Climate Response to Severe Changes in Forestation: An Intercomparison Study

Olivier Asselin [1] , *Martin Leduc* [2] , *Dominique Paquin* [3] , *Alejandro Di Luca* [4] , *Katja Winger* [5] , *Melissa Bukovsky* [6]

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Presented by / Présenté par: ***Olivier Asselin***
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Afforestation, reforestation and bioenergy with carbon capture and storage offer a strong technical potential for reducing atmospheric concentration of CO2 (Shukla et al. 2019). However, large-scale implementation of such mitigation strategies would not only impact the chemical composition of the atmosphere, but also the energy and water exchanges between the land and the atmosphere. Replacing grassland with forests, for instance, may lower albedo, increase surface roughness and affect evapotranspiration rates.

The Land-Use and Climate Across Scales (LUCAS) project --- a CORDEX flagship pilot study --- aims to integrate such land-use changes in regional climate models and to quantify their climate impacts. Davin et al. (2020) compared the response of nine combinations of climate and land surface models to severe afforestation and deforestation in Europe. Here, an analog experiment is carried over North America. Three regional climate models were run with two configurations, FOREST and GRASS, representing worlds in which all vegetation is replaced by forests and grasses, respectively. Models respond significantly to such drastic vegetation changes. In wintertime, severe afforestation causes widespread warming in all models, although with different magnitude and distribution. Analysis reveals that the snow-masking albedo effect of needleleaf forests dominates temperature response, when the model represents it. In summertime, there is a large inter-model divergence in the temperature response. The divergence partly stems from differences in the partition between sensible and latent heat fluxes. Implications for the implementation of land-use change in regional climate models will be discussed.

Session: 14040 Novel Approach in Seasonal Snow: Field Measurements, Remote Sensing, Modeling, and Data Assimilation & Analytics - Part 1 Nouvelle approche dans la neige saisonnière: mesures sur le terrain, télédétection, modélisation et assimilation et analyse de données - Partie 1 **03/06/2022 08:25**

ID: 11681 Contributed abstract
Poster Order:

Advances in X- and Ku- Band Radar Algorithms for SWE Retrieval by Future Satellite Missions

Edward Kim [1] , *DK Kang* [2] , *Firoz Borah* [3] , *Leung Tsang* [4]

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Presented by / Présenté par: ***Edward Kim***
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A leading measurement technique for a future SWE satellite mission is radar volume scattering at X and Ku bands (10 and 17 GHz). For example, the European CoReH2O concept was based around this, but unfortunately was not selected. Many key advances have been made since then, both in the theoretical domain as well as in the area of validation against field observations—for example, from SnowEx. Using those advances, there is a NASA mission concept being developed around this technique.
At the core of the current algorithm, and one of the key advances, is a dense media radiative transfer (DMRT) model in a simplified parameterized form. Other advances include subtraction of background scattering, and partitioning by the scattering albedo. The retrieval solution is determined through a cost function minimization approach after accounting for surface scattering from the snow-soil interface, low vegetation, and the scattering albedo.
We will show validation results using both tower and airborne data and discuss the options for obtaining the necessary input parameters.

Session: 14040 Novel Approach in Seasonal Snow: Field Measurements, Remote Sensing, Modeling, and Data Assimilation & Analytics - Part 1 Nouvelle approche dans la neige saisonnière: mesures sur le terrain, télédétection, modélisation et assimilation et analyse de données - Partie 1 **03/06/2022 08:40**

ID: 11355 Contributed abstract
Poster Order:

An Analysis of Snowpack Temperature, Density, and Cold Content across the US West from the Repurposed USGS RMS Dataset

Jeffrey Schmidt [1], *Graham Sexstone* [2], *Mark Serreze* [3]

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[2] USGS Colorado Water Science Center
[3] National Snow and Ice Data Center

Presented by / Présenté par: ***Jeffrey Schmidt***
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Snowpit records provide insight into snowpack conditions and changes, but many existing records are still in paper format, making analysis difficult. Undergraduate students digitized 1,818 historical, hand-written snowpit records from the Western U.S. Rocky Mountains. These unique vertical temperatures and density profiles enable analysis and physical understanding of snowpack cold content (CC) and other snowpack variables. CC represents the energy required to raise the snowpack's temperature to its melting point (related to the snowmelt onset date). It can be an indicator of large-scale climate change and is valuable for assessing the performance of numerical models of the internal snowpack energy and mass flux system. Digging snowpits and recording vertical temperature and density profiles from which temperature, density, and CC can be calculated is laborious and time-consuming. Few campaigns collect snowpit data and even fewer open-source, large geographic scale, high-quality datasets. For 29 years, the USGS Rocky Mountain Regional Snowpack Chemistry Monitoring Study (USGS RMS) has collected snowpit records at a network of 192 sites. At present, the record is updated annually at 60 snowpits.

This thesis describes the compilation of the USGS RMS snowpit records into a quality-controlled dataset of temperature and density profiles followed by a detailed analysis of snowpack CC, temperature, density, and their variability across Rocky Mountain West.
This thesis demonstrates several important aspects of the dataset. First, the manual measurements are high quality and provide useful information to study the Rocky Mountain West snowpack and water resources. Snow water equivalent (SWE) contributes to the CC magnitude, but largely, temperature determines CC variability. CC is useful because it combines temperature and SWE into a single variable. CC reduces the internal snowpack physical system down to MJ m-2, a basic energy term.

Session: 14040 Novel Approach in Seasonal Snow: Field Measurements, Remote Sensing, Modeling, and Data Assimilation & Analytics - Part 1 Nouvelle approche dans la neige saisonnière: mesures sur le terrain, télédétection, modélisation et assimilation et analyse de données - Partie 1 **03/06/2022 08:55**

ID: 11867 Contributed abstract
Poster Order:
Retrieval of snow water equivalent from SWESARR measurements in Grand Mesa Colorado, SnowEx 2020
Michael Durand [1], *Batuhan Osmanoglu* [2]

[1] Ohio State University
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Presented by / Présenté par: ***Michael Durand***
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One critical question in applying radar measurements to estimate SWE is to assess how much prior information is needed to accurately perform the retrieval. We apply retrieval algorithms to SWESARR measurements of radar backscatter made in February 2020, as part of the SnowEx campaign. The algorithm removes background backscatter from a snow off measurement in November. The algorithm uses a physically-based microwave radiative transfer model to relate the snow and backscatter properties, and iteratively computes the optimal estimates. Both one and two layer configurations are explored. The algorithm is Bayesian in that it uses a priori information on SWE, as well as on the microstructure correlation length. We explore three configurations: one in which no a priori information is used, one in which generic prior information is used, and a third where local prior information specific to Grand Mesa is used. We hypothesize that the two layer model with local priors performs best, but that the two layer model with generic priors still performs adequately. Demonstration that generic priors lead to adequate performance would strengthen the case that global SWE can be estimated from satellite measurements of Ku and X band radar.

Session: 14040 Novel Approach in Seasonal Snow: Field Measurements, Remote Sensing, Modeling, and Data Assimilation & Analytics - Part 1 Nouvelle approche dans la neige saisonnière: mesures sur le terrain, télédétection, **03/06/2022 09:10**

ID: 11417 Contributed abstract
Poster Order: Poster-14040
Modelling snowpack bulk density using snow depth, cumulative degree days, and climatological predictor variables.

Andras Szeitz [1] , *Robert Dan Moore* [2]

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Presented by / Présenté par: ***Andras Szeitz***
Contact: aszeitz@gmail.com

Snowpack water equivalent (SWE) is a key variable for water resource management in snow-dominated catchments. While it is not feasible to quantify SWE at the catchment scale using either field surveys or remotely sensed data, technologies such as airborne LiDAR support the mapping of snow depth at scales relevant to operational water management. To convert snow depth to water equivalent, models have been developed to predict SWE or snowpack density based on snow depth and additional predictor variables. This study builds upon previous models that relate snowpack density to snow depth by including additional predictor variables to account for (1) the effect of annually varying meteorological conditions on densification through a cumulative degree-day index derived from North American Regional Reanalysis products, and (2) long-term climatologies that describe the prevailing conditions influencing regional snowpack properties. A non-linear model was fit to 114,506 snow survey measurements spanning 41 years from 1,166 snow courses across western North America. Under spatial cross-validation, the predicted densities had a root-mean-square error of 47.1 kg m^-3, a mean bias of -8x10^-3 kg m^-3, and a Nash-Sutcliffe Efficiency of 0.70. Compared to a similar regression-based model reported in the literature, the two models had similar overall performance, but the model developed in this study had reduced seasonal biases. When applied to predict SWE from simulated depths determined from aerial platforms (LiDAR or Structure-from-Motion), 50% of the SWE estimates for May and June fell within -55 to 59 mm of the observed SWE, representing prediction errors of -15 to 23%.

Session: 14040 Novel Approach in Seasonal Snow: Field Measurements, Remote Sensing, Modeling, and Data Assimilation & Analytics - Part 1 Nouvelle approche dans la neige saisonnière: mesures sur le terrain, télédétection, modélisation et assimilation et analyse de données - Partie 1 **03/06/2022 09:10**

ID: 11534 Contributed abstract
Poster Order: Poster-14040
Evaluating Passive Microwave Snowmelt Detection Methods with Ground Snow Observations

Angela Rienzo [1] , *Sam Tuttle* [2]

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Presented by / Présenté par: ***Angela Rienzo***
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Snowmelt is an important hydrological factor in many areas in North America, especially in regions that rely on seasonal snowmelt to replenish water supply. Rapid spring melt can also lead to destructive river flooding. Because snowpack characteristics can vary significantly in different regions and climates, accurate global snowmelt modeling may require assimilation of both remote sensing and ground observations. The purpose of this investigation is to determine the level of insight that passive microwave remote sensing techniques can provide into complex snowmelt processes. We compare snowmelt events detected from passive microwave brightness temperatures (Tuttle & Jacobs, 2019, Water Resources Research) to daily observed snow water equivalent (SWE) and snow depth data from over 600 SNOTEL stations to determine how much information satellite data can provide about snowmelt processes. Specifically, we evaluate whether the satellite-detected melt events align with SWE decreases (water loss from the snowpack) or snow depth decreases without decreases in SWE (possible midseason melt events in which the melt is refrozen in the snowpack). Comparisons from regional subsets of SNOTEL stations are further analyzed to determine if the satellite snowmelt detection method has a higher accuracy in certain snowpack conditions and climates.

Session: 14040 Novel Approach in Seasonal Snow: Field Measurements, Remote Sensing, Modeling, and Data Assimilation & Analytics - Part 1 Nouvelle approche dans la neige saisonnière: mesures sur le terrain, télédétection, modélisation et assimilation et analyse de données - Partie 1 **03/06/2022 09:20**

ID: 11398 Contributed abstract
Poster Order:

Using machine learning to estimate snow cover from ground surface temperature measurements.

Anika Forget [1] , *Robert Way* [2] , *Rosamond Tutton* [3]

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[3] Wilfred Laurier University

Presented by / Présenté par: ***Anika Forget***
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In Arctic and Subarctic landscapes, snow cover can significantly affect ground temperatures and can lead to changes in permafrost distribution. Snow cover and snow thickness are highly heterogeneous through time and space leading to profound local scale variability and difficulties in representing snow across large areas. Owing to the high cost of snow monitoring equipment, many researchers working in the north use ground surface temperature (GST) loggers distributed across an area to estimate snow characteristics, including snow onset and melt dates. However, existing methods for evaluating snow cover from GST data depend on arbitrary thresholds selected by trial and error.

Such thresholds can vary widely between sites due to snow cover variability, as well as within sites depending on vegetation cover and soil composition. This study established a novel method using supervised machine learning (random forest) to predict daily snow cover from GST data, removing the need for local threshold selection. This random forest method was built using simulations derived from the Northern Ecosystem Soil Temperature model that were calibrated at the Subarctic Pinware River Hills (PRH) research basin in coastal Labrador. Estimates of snow cover derived via application of the machine-learning algorithm to GST data were compared against snow thickness observations at PRH from multiple co-located sources. Our results indicate that this novel method more accurately predicts total snow cover days, snow onset, and melt dates compared to previously used threshold-based approaches. These early results show tremendous potential for reducing error in deriving snow cover information from GST observations and can enable more reliable snow cover estimation across larger areas and differing ecotypes. Insights gained from this research could be applied to the large networks of GST observations currently being assembled for the northern circumpolar regions to improve snow cover modelling.

Session: 14040 Novel Approach in Seasonal Snow: Field Measurements, Remote Sensing, Modeling, and Data Assimilation & Analytics - Part 1 Nouvelle approche dans la neige saisonnière: mesures sur le terrain, télédétection, modélisation et assimilation et analyse de données - Partie 1 **03/06/2022 09:35**

ID: 11427 Contributed abstract

Poster Order:

Characterizing the Role of Snow for Liquid Water Storage and Transmission: A Ground-Based Remote Sensing and Modeling Sensitivity Analysis

Ryan Webb [1] , *Keith Musselman* [2] , *Siobhan Ciafone* [3] , *Katherine Hale* [4] , *Noah Molotch* [5]

[1] University of Wyoming
[2] Institute of Arctic and Alpine Research
[3] Portland State University
[4] University of Colorado Boulder
[5] University of Colorado Boulder

Presented by / Présenté par: ***Ryan Webb***
Contact: ryan.webb@uwyo.edu

Streamflow response in headwater catchments is highly sensitive to the hydrologic connectivity of hillslopes to streams during spring snowmelt. Despite strong evidence at point- to plot-scales of flow paths creating lateral connectivity within an alpine snowpack, meltwater is commonly assumed to infiltrate vertically through the snowpack. Hydrologic models only treat the horizontal (downstream) routing of water once released from the snowpack and/or soil column. This assumption limits our ability to represent the full dynamic nature of hydrologic connections in snow-dominated mountainous headwaters. Thus, the goal of this study is to assess the mechanisms that control the spatiotemporal distribution of liquid water in an alpine snowpack during the spring snowmelt season. We utilize terrestrial laser scanning (TLS), ground penetrating radar (GPR), and manual observations to map the seasonal dynamics of snow depth, snow water equivalent (SWE), and within-snow liquid water content (LWC). We compare these observations to point-scale parameter sensitivity analyses with a modular snow model (SUMMA). The results show high spatial variability of LWC in an alpine snowpack during snowmelt. Statistical analyses show LWC is most highly correlated to snow depth (coefficient of determination = 0.62). However, including the distance to bare soil and topographical slope slightly improved the coefficient of determination (coefficient of determination = 0.67). While hydrologic models have the flexibility to simulate many of the observed dynamics in snowpack liquid water storage, model simulations using previously published parameter ranges always underestimated the high liquid water storage at one of the three sites. This is likely a result of current model structures that lack capabilities for surface ponding of water within a snowpack or surface runoff laterally through a snowpack. Our slope-scale characterization of the spatiotemporal distribution of in-snow LWC, together with a model-based sensitivity assessment, will inform future efforts in hydrologic model development and catchment observations.

Session: 14040 Novel Approach in Seasonal Snow: Field Measurements, Remote Sensing, Modeling, and Data Assimilation & Analytics - Part 1 Nouvelle approche dans la neige saisonnière: mesures sur le terrain, télédétection, modélisation et assimilation et analyse de données - Partie 1 **03/06/2022 09:50**

ID: 11813 Contributed abstract

Poster Order:

The Airborne Cryosphere-Observing Synthetic Aperture Radar System (CryoSAR): A Snow, Soil, Sea Ice and Lake Ice Observing System

Richard Kelly [1] , *Aaron Thompson* [2] , *Adriano Meta* [3] , *Jim Hodgson* [4] , *Alexandre Langlois* [5] , *Alexandre Roy* [6] , *Laura Brown* [7] , *Aaron Berg* [8] , *Chris Derksen* [9]

[1] University of Waterloo
[2] University of Waterloo
[3] Metasensing BV
[4] Lake Central Air Services
[5] University of Sherbrooke
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Presented by / Présenté par: ***Richard Kelly***
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The airborne Cryosphere-Observing SAR (CryoSAR) system is a Ku- and L-band polarimetric synthetic aperture radar (SAR) system designed to conduct observations of snow and ice on land and over water bodies. The CryoSAR system is designed as a fully polarimetric SAR with the capability to conduct single or repeat pass observations for interferometric SAR (InSAR) applications. There is significant interest in the Ku (13.5 GHz) and L-band (1.3

GHz) InSAR measurements of snow on land and water as tools to estimate snow water equivalent, a key variable in water resource management applications and in climate change studies. The CryoSAR radars can be operated independently or together. They can also be deployed on a relatively small aircraft, such as a Cessna 208, which is generally available across North America, Europe and beyond, making the system relatively agile in its deployment. An adjustable mounting system has been designed to enable the instrument to be installed on a 208 platform from inside and at specified look angles. In winter 2022, the first deployment of the system was planned in Ontario as part of a Canadian Space Agency-funded project. Flight paths were identified over the Haliburton Highlands and in Powassan. While Federal certification could not be completed in time, and the aircraft could not be deployed for flight overpasses, this presentation provides a description of the radar operation and what can be achieved. It also describes a snow field campaign that was conducted to support potential aircraft acquisitions. A combination of traditional field observations of snow properties, and detailed state-of-the-art measurements of microstructure properties were made to quantify the snowpack bulk and stratigraphic characteristics of the snow at the different field sites. Once federally-certified, the CryoSAR will be deployed in Ontario and Alberta in the 2022-23 winter season.

Session: 3022 Advancing our understanding of the Arctic atmosphere - Part 3 Faire progresser notre compréhension de l'atmosphère arctique - Partie 3 **03/06/2022 12:55**

ID: 11868 Invited session speaker
Poster Order:

Arctic Cirrus Cloud Radiative Forcing: Observational Challenges and Regional Climate Impacts

James Campbell [1] , *Erica Dolinar* [2] , *Simone Lolli* [3] , *Jasper Lewis* [4] , *Jared Marquis* [5] , *Theodore McHardy* [6] , *G. Javier Fochesatto* [7] , *David Ryglicki* [8] , *E. Judd Welton* [9]

[1] Naval Research Laboratory
[2] American Society for Engineering Education
[3] CNR-IMAA
[4] Univ. Maryland Baltimore County
[5] Univ. North Dakota
[6] American Society for Engineering Education
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[8] Naval Research Laboratory
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Presented by / Présenté par: ***James Campbell***
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Our talk focuses on the top-of-the-atmosphere (TOA) climate radiative forcing effect of cirrus ice-phase clouds in the Arctic upper troposphere, and the challenges in accurately estimating these impacts from limited regional cloud monitoring opportunities. Cirrus clouds, globally, are the most common cloud genus found in the troposphere, exhibiting anywhere from 40-60% instantaneous occurrence rates depending on region. Though they are highly transmissive, and thus the climate forcing effect of a single cloud winds up far less consequential compared with liquid water clouds, their overwhelming relative occurrence rate greatly offsets this inequity. Global cirrus cloud TOA forcing proves a first-order contributor to global cloud radiative balance overall. We begin the talk by describing seminal early studies focused on monitoring Arctic cirrus cloud physical characteristics. We then shift to the application of these observations to TOA forcing study. The latter describess two consecutive years of continuous lidar cirrus cloud observations at Fairbanks, AK, a sub-Arctic site, and the impact along this unique transition zone in resolving mid-latitude versus purely Arctic dynamic influences. Finally, we describe a unique extrapolation of the fifteen-year CALIOP satellite-based Arctic cloud record for estimating Arctic TOA cirrus cloud forcing over the last forty years. This study applies reanalysis meteorological data, including surface albedos reflective of the decaying summertime ice sheet, illuminating fascinating regional trends in cirrus cloud forcing over this sensitive region. Cirrus clouds are the only cloud genus that can readily induce either a positive or daytime TOA forcing impact, dependent upon a host of input considerations. It’s that unique characteristic, and that we can see the oscillating absolute forcing value in our respective Arctic studies, which strongly highlights the need for focused and sustained long-term cirrus cloud monitoring for proper understanding of our evolving climate.

Session: 3022 Advancing our understanding of the Arctic atmosphere - Part 3 Faire progresser notre compréhension de l'atmosphère arctique - Partie 3 **03/06/2022 13:25**

ID: 11852 Contributed abstract

Poster Order:

The Critical Role of Polar Cold Clouds: Simulation, Analysis and Observations

Jean-Pierre Blanchet [1], *Yann Blanchard* [2], *Adam Bourassa* [3], *Fabien Dubé-Mélanson* [4], *Yi Huang* [5], *Maud Leriche* [6], *Ludovick Pelletier* [7], *Setigui Keita* [8], *Housseyni Sankaré* [9], *Pierre Gauthier* [10]

[1] Université du Québec à Montréal
[2] Université du Québec à Montréal
[3] University of Saskatchewan
[4] Université du Québec à Montréal
[5] McGill University
[6] Université du Québec à Montréal
[7] Université du Québec à Montréal
[8] Université du Québec à Montréal
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Presented by / Présenté par: ***Jean-Pierre Blanchet***
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Processes and feedback mechanisms involving clouds and aerosols represent one of the largest sources of uncertainty in our understanding of Earth’s climate system, especially in the Arctic and during the polar night. Through their modulation of radiation, precipitation, and atmospheric composition, clouds alter the water balance, a prime climate modulator, and contribute strongly in perturbing the atmospheric and surface energy budgets. Progress is being

made on several fronts, from observations, prototype development to simulations, through model parameterisation, data analysis and assimilation. This paper will summarize ongoing research at ESCER Centre and collaboration with HAWC, the High-altitude Aerosols, Water vapour and Clouds consortium, and leading to a Canadian contribution to NASA's Atmosphere Observing System (AOS).

Session: 3022 Advancing our understanding of the Arctic atmosphere - Part 3 Faire progresser notre compréhension de l'atmosphère arctique - Partie 3 **03/06/2022 13:50**

ID: 11719 Contributed abstract

Poster Order:

Cloud microphysical properties at Eureka, Nunavut from 2016 to 2020.

Joseph Hung [1] , *Penny Rowe* [2] , *Emily McCollough* [3] , *Liam Kroll* [4] , *Rachel Chang* [5] , *Kimberly Strong* [6]

[1] University of Toronto Department of Physics
[2] NorthWest Research Associates
[3] Dalhousie University Department of Physics & Atmospheric Science
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[5] Dalhousie University Department of Physics & Atmospheric Science
[6] University of Toronto Department of Physics

Presented by / Présenté par: ***Joseph Hung***
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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, with cloud microphysics a key aspect in this interaction. To investigate the properties of Arctic clouds, an Extended-range Atmospheric Emitted Radiance Interferometer (E-AERI) was installed at the Polar Environment Atmospheric Research Laboratory (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.

In this study, E-AERI observations within cloud-sensitive spectral windows and supporting measurements from the suite of instruments available at PEARL are ingested in an iterative optimal estimation inverse method based on the Levenberg–Marquardt algorithm, the CLoud and Atmospheric Radiation Retrieval Algorithm (CLARRA), to retrieve cloud properties. A climatology of retrieved microphysical properties (cloud height, temperatures, optical depth, thermodynamic phase, and particle effective radii) will be presented over the study period (2016-2020). Additionally, comparisons against a similar study conducted with a precursor instrument to the E-AERI (the Polar-AERI, located at Eureka 2006-2009) will be made. Preliminary trends in cloud morphology will be identified.

Session: 3022 Advancing our understanding of the Arctic atmosphere - Part 3 Faire progresser notre compréhension **03/06/2022 14:05**

de l'atmosphère arctique - Partie 3

ID: 11699 Contributed abstract
Poster Order:

Detailed investigation of possible mechanisms driving recent Arctic PSC and ozone hole events

Liviu Ivanescu [1] , *Norm T. O'Neill* [2]

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Presented by / Présenté par: ***Liviu Ivanescu***
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The investigation of cloud formation mechanisms in the UTLS (Upper-Troposphere/Lower-Stratosphere) is a core activity of the CSA SACIA (Signatures of Aerosol-Cloud Interaction over the Arctic) project (notably the follow-on SACIA-2 project). We analysed the intense Russian Arctic (East Arctic) PSC seasons of 2010/2011 and 2015/2016. Those events were, we believe, related to atmospheric rivers moving along the Gulf Stream path. The 2019/2020 season was, on the other hand, subject to heat and water vapour intrusion into the Canadian Arctic (western Arctic) from the Pacific Ocean via the Bering Strait. The dynamical structure associated with Arctic atmospheric rivers, as captured by CALIPSO and ERA5 analyses, appears to influence the ozone hole, PSC development and tropospheric liquid cloud formation. We will present interpretive illustrations of these dynamics and elaborate on further investigations that we plan to carry out (the used of ERA5 vertical reanalysis superimposed on the CALIPSO paths, Aura MLS vertical profiles, as well as additional ground-based lidar and radiosonde analyses from Barrow and Svalbard).

Session: 4061 Developing Ocean Modelling Capacity in Canada - Part 2 Le développement de la capacité Canadienne de modélisation océanique - Partie 2 **03/06/2022 12:55**

ID: 11481 Contributed abstract
Poster Order:

Nitrous oxide production in the global ocean: Control by nitrification and denitrification pathways

Rebecca Pierce [1] , *Roberta Hamme* [2] , *James R. Christian* [3]

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Presented by / Présenté par: ***Rebecca Pierce***
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Nitrous oxide (N₂O) is a potent greenhouse gas with a high global warming potential and is considered to be the most important ozone-depleting compound in the 21st century. An estimated 10-53% of atmospheric N₂O sources are from the ocean; however, the mechanisms behind marine N₂O production remain poorly understood. The most significant

N₂O production reactions are nitrification and denitrification, but it is uncertain what proportion each contributes to N₂O ocean emissions. Nitrification is most prominent in oxygenated waters, while intense denitrification can occur in the suboxic waters of oxygen minimum zones. With a changing climate these oxygen minimum zones are expected to expand in volume and intensity, implying an increase in the ocean’s N₂O production and emission to the atmosphere. In addition to deoxygenation of seawater, global climate models project altered ocean circulation and biogeochemical properties, impacting biodiversity. As a result, nitrogen cycling pathways may change to produce a transformed ecosystem. This study investigates the controls on nitrification and denitrification through computer modeling to determine the quantity of N₂O produced by each reaction pathway under current ocean conditions, and in conditions that are expected to occur in a changing climate. We focus on oxygen’s role in determining reaction pathways and N₂O yield, using mathematical models to estimate oxic remineralization of organic matter, nitrification production of N₂O, and denitrification production and consumption of N₂O. The model created by this project will be used in global climate models, allowing for better estimation of N₂O emissions from the ocean and the consequent impact on the atmospheric concentration. Improving parameterization of N₂O production mechanisms will advance our understanding of the nitrogen cycle in the present day and the future climate.

Session: 4061 Developing Ocean Modelling Capacity in Canada - Part 2 Le développement de la capacité Canadienne de modélisation océanique - Partie 2 **03/06/2022 13:10**

ID: 11428 Contributed abstract

Poster Order:

Assessment of sea ice with NEMO 4.2 / SI3 coupled model for operational purpose.

Aliette Chenal [1] , *Guillaume Samson* [2] , *Giovanni Ruggiero* [3] , *Gilles Garric* [4] , *Laurent Parent* [5] , *Charles-Emmanuel Testut* [6]

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Presented by / Présenté par: ***Gilles Garric***
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Sea ice is a crucial element in our climate system, and it is very sensitive to climate change. Sea ice volume is a key indicator of the status of the Arctic region and of its ecosystem with respect to climate change, although very challenging to estimate precisely since it is a combination of sea ice area and sea ice thickness.

For more than a decade, Mercator Ocean International develops and produces Global Ocean Reanalysis with a 1/4° resolution system. Based on the NEMO

modelling platform, observations are assimilated by a reduced-order Kalman filter. In-situ CORA database, altimetric data, sea surface temperature, and sea ice concentration are jointly assimilated to constrain the ocean and sea-ice model.

In previous reanalysis products, long-term sea ice volume drift has been observed in the Arctic. A new operational system is under development with new capacities for the assimilation and new version of the NEMO platform. The new NEMO4.2 version coupled to the new sea-ice thermodynamic and dynamic model SI3 is foreseen for this new operational system. Sensitivities experiments have been performed with the global ¼° configuration driven by ERA5 atmospheric conditions and over the last decade (2010-2020). The performance of this new configuration is assessed in both the Arctic and Antarctica with a comprehensive set of satellite and in-situ observations. The evaluation will comprise essential sea-ice variables such as sea ice concentration, thickness, snow depth, and drift. Interannual variability and mean state (seasonal cycle) will be particularly emphasized. Finally, a set of parameters is identified to be used as the reference for future data assimilation deployment.

Session: 4061 Developing Ocean Modelling Capacity in Canada - Part 2 Le développement de la capacité Canadienne de modélisation océanique - Partie 2

03/06/2022 13:25

ID: 11373 Contributed abstract

Poster Order:

Development of a Relocatable Ocean Model System for the West Coast of Canada

Yuehua (Andy) Lin [1], *Michael Dunphy* [2], *Maxim Krassovski* [3], *Hauke Blanken* [4], *Roy Hourston* [5], *Di Wan* [6]

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Presented by / Présenté par: ***Yuehua (Andy) Lin***
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A relocatable ocean model system has the capacity to be easily set up for different geographic regions or scales on demand, with minimal changes in configuration. The rapid deployment can respond to potential impacts of a marine emergency (e.g., oil spill) or prevent accidents during extreme weather events. Relocatable ocean modeling has been significantly facilitated by global and regional operational ocean forecast systems widely developed recently. Research on a fixed domain on-demand near-shore drift prediction system in Canadian waters is included in the Oceans Protection Plan (OPP), to contribute to increased marine safety and provide additional expertise in case of hazardous marine conditions.

In this presentation, we describe a relocatable ocean model system developed

under OPP for the west coast of Canada for demonstration and planning purposes. The implementation of this system has benefited from the port models and tools developed by other OPP modelling efforts and is based on the Nucleus for European Modelling of the Ocean modeling framework. Initial and boundary conditions are provided by the operational Coastal Ice Ocean Prediction System for the West coast with 1/36° horizontal resolution (~2.0 to 2.5 km). At the surface, the operational High-Resolution Deterministic Prediction System provides surface winds, pressure and fluxes with 2.5 km spatial resolution. The ocean model bathymetry is based on high resolution coastal digital elevation models for the west coast of Canada, which integrates ocean bathymetry and land topography from the Canadian Hydrographic Service, Natural Resources Canada, and the National Oceanic and Atmospheric Administration.

Case studies have been carried out and the hindcast ocean model results are compared with tidal station, Acoustic Doppler Current Profiler, and Conductivity-Temperature-Depth oceanographic data. Preliminary results from the ongoing detailed evaluation of the ocean model performance will be shown in this presentation.

Session: 4061 Developing Ocean Modelling Capacity in Canada - Part 2 Le développement de la capacité Canadienne de modélisation océanique - Partie 2 **03/06/2022 13:50**

ID: 11818 Contributed abstract
Poster Order:

Port modelling on the west coast under the Oceans Protection Plan

Michael Dunphy [1] , *Maxim Krassovski* [2] , *Hauke Blanken* [3]

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Presented by / Présenté par: ***Michael Dunphy***
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Under Canada’s Oceans Protection Plan, Fisheries and Oceans Canada has developed high-resolution models for six Canadian ports and these will be operationalized to provide short-term forecasts in support of electronic navigation and emergency response. Each model is based on NEMO 3.6 and forced by ECCC’s operational atmosphere and ocean models, tuned tides and gauged river data. We employ a one-way nesting scheme to downscale from larger scale models and reach resolutions of 100 m, 30 m, and 20 m for the west-coast ports of Kitimat, Fraser River and Vancouver Harbour, respectively. Here we will discuss the construction of these models and present some early evaluation of five-year hindcasts and of forecast performance.

Session: 4061 Developing Ocean Modelling Capacity in Canada - Part 2 Le développement de la capacité Canadienne de modélisation océanique - Partie 2 **03/06/2022 14:05**

ID: 11696 Contributed abstract
Poster Order:

Port Modelling on the east coast under the Oceans Protection Plan

Rachel Horwitz [1], *Stephanne Taylor* [2], *Simon St. Onge-Drouin* [3], *Adam Drozdowski* [4], *Chengzhu Xu* [5], *Jonathan Coyne* [6]

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Presented by / Présenté par: ***Rachel Horwitz***
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The Oceans Protection Plan (OPP) aims to operationalize NEMO-based port scale models to produce short-term forecasts in support of electronic navigation and emergency response (oil spill / trajectory modelling) in high-risk areas. This presentation will cover the three OPP ports in Eastern Canada: the Port of Saint John, the Strait of Canso Port, and the St. Lawrence River.
High resolution models for these areas have been developed with NEMO 3.6. They are forced at the open boundaries by ECCC's Coastal Ice Ocean Prediction Systems, at the surface by ECCC's High Resolution Deterministic Prediction System (HRDPS), and with tuned tides from WebTide. All ports have a first level downscaling at 500 m resolution, which enables 100 or 200 m resolution subdomains. The models have z-levels, partial steps, a variable volume formulation, time sub-stepping for vertical advection, and one-way nesting. River forcing includes gauged flows and runoff climatologies. All ports have completed recent multi-year hindcasts and run ongoing daily forecasts.

Session: 4061 Developing Ocean Modelling Capacity in Canada - Part 2 Le développement de la capacité Canadienne de modélisation océanique - Partie 2

03/06/2022 14:20

ID: 11643 Contributed abstract
Poster Order:

Enabling Ocean Modelling with CIOOS Data

James Munroe [1], *Pramod Thupaki* [2]

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Presented by / Présenté par: ***James Munroe***
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The Canadian Integrated Ocean Observing System (CIOOS) goal is to make connections for a sustainable ocean future as Canada's nucleus for ocean observing. As part of our new strategic plan, we intend to increase the ability to understand current states and predict future states of Canada's ocean spaces by supporting modelling efforts and sharing ocean model results. Our specific goals include cataloguing models and model standards available regionally and nationally to increase overall use of model data and support reusability, developing CIOOS model metadata standards in order to more efficiently ingest model output data, connecting modellers with ocean observational data to

enable the development, assimilation and validation of models, and enabling CIOOS partners to develop data products and applications to address model user requirements.

Session: 10031 Advances in boreal disturbance research - Part 2 Avancées dans la recherche sur les perturbations boréales - Partie 2 **03/06/2022 12:55**

ID: 11645 Contributed abstract

Poster Order:

High rates of methane oxidation in tropical peatland drainage canals moderate methane emissions

Lauren Somers [1], *Alison Hoyt* [2], *Alex Cobb* [3], *Suhailah Binti Isnin* [4], *Muhammad Asri Akmal Bin Haji Suhip* [5], *Rahayu Sukri* [6], *Charles Harvey* [7]

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Presented by / Présenté par: ***Lauren Somers***
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Southeast Asia's peatlands represent a vast carbon stock. Over recent decades, half of the region's peatlands have been converted to managed landcover, including agricultural, forestry and small-holder areas, often using drainage canal networks to control flooding. Groundwater flow transports dissolved methane to canals, where it can escape to the atmosphere, potentially making drainage canals an important methane emission pathway. However, these emissions are poorly characterized, and the extent to which methane is oxidized before being emitted to the atmosphere is unknown. In this study, we present a one-dimensional, isotope-enabled numerical model which simulates transport, degassing, and oxidation of methane and DIC in drainage canals. We fit the model to field data of concentrations and stable carbon isotopic ratios of methane and dissolved inorganic carbon (DIC) in peat porewater and canal water from a deforested tropical peatland in Brunei Darussalam. Our results indicate that a large amount of methane is transported to the drainage canal through shallow porewater flow while the deeper methane-rich porewater contributes very little to canal flow. Of the methane advected into the canal, approximately 70% is oxidized and 26% is degassed to the atmosphere, under low to moderate flow conditions. The methane degassing flux is low at the upstream end of the canal and increases as flow velocity increases downstream. The resulting canal methane flux to the atmosphere is large compared to the peat flux on a per-area basis. However, since the canal covers only a small portion of the catchment area, canal methane fluxes account for only approximately 4.6-7.0% of total methane emissions at our study site. Canals likely make up a larger proportion of total methane emissions in agricultural and drained peatlands.

Session: 10031 Advances in boreal disturbance research - **03/06/2022**

ID: 11580 Contributed abstract
Poster Order:

Horticultural Additives influence soil biogeochemistry and increase CO2 emissions from peat

Tim Moore [1] , *Klaus-Holger Knorr* [2] , *Peter Douglas* [3] , *Isabel Strachan* [4] , *Henning Teickner* [5] , *Nigel Roulet* [6]

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Presented by / Présenté par: ***Bidhya Sharma***
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Peat is used as the chief ingredient of growing media in horticulture. An average of 11.3 ×10^9kg of peat is extracted in Canada every year. Though the extraction comes at a high carbon cost, the high cation exchange capacity, water retention capacity, low bulk density, and appropriate physical properties make peat based growing media desirable for soilless ornamental horticulture and food production. Peat in its natural form is acidic and low in nutrient composition. To make it suitable as a growing media, peat is mixed with liming agents, nutrients, surfactants, perlite among several other possible additives.

We assessed the change in soil biogeochemistry and CO2 fluxes because of additives to horticultural peat. We obtained samples of raw peat and additive mixed growing media (n=52) from four different peat extraction companies in Canada. Our analysis shows that the key soil biogeochemical parameters carbon: nitrogen ratio, pH, dissolved organic carbon, bulk density, carbon content differs significantly (p<0.01) between raw peat and growing media. There is a more than a two-fold increase in emission of CO2 from growing media as compared to that of raw peat. Further experiments using 13C-CO2 measurements showed the longer-term contribution of carbonates (added for liming purpose) borne CO2 to the total flux. In addition, C fluxes correlated with decomposition proxies ranging from pH, humification index (derived from FTIR analysis), C: N ratio to Von post for raw peat, but such correlation ceased to be true for growing media.

IPCC (2007) calculates that all C from harvested peat is lost in the atmosphere in the first year. However, our initial results estimate less than 10% of C loss in the first year from growing media.

ID: 11633 Contributed abstract
Poster Order:

Vulnerability of peatland complexes in the Hudson Plains to permafrost-thaw-driven landcover and hydrological change

Mikhail Mack [1] , *William Quinton* [2] , *James McLaughlin* [3] , *Christopher Hopkinson* [4]

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Presented by / Présenté par: ***Mikhail Mack***
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Owing to the region’s vast scale and remote position, the impacts of permafrost thaw on landcover and hydrologic response in the Hudson Plains, Canada's largest peatland region, are not well known. By contrast, in the Taiga Plains of northwestern Canada, the thaw and subsidence of permafrost peatlands in discontinuous peatland-dominated landscapes is known to reorganize near-surface flowpaths as permafrost-free peatlands expand, connect, merge, and drain. These thaw-driven disturbances increase hydrologic response and subsequently alter biogeochemical and carbon cycles. To assess where the Hudson Plains is vulnerable to similar disturbances, we analyze latitudinal distributions of landcover over a 300 km transect spanning the sporadic (<30% areal) to continuous (> 80% areal) permafrost zones and quantify landcover changes over a 40-year period using multiple remote sensing datasets (lidar DEM, air photographs, and high-resolution satellite imagery). We then interpret these landscapes at a fundamental hydrological unit, the peatland complex. Using this approach, we identify five peatland complex types for which their potential hydrologic response was conceptualized using circuitry analogs. Peatland complexes like those found in the Taiga Plains occur less frequency in the Hudson Plains, but other complexes, though different in structure appear to be similarly vulnerable to permafrost-thaw-driven increases to hydrologic response. We suggest a relatively narrow (~60 km) latitudinal segment (54.5 ° N – 54.9 ° N) within the discontinuous to continuous permafrost zone where peatland complexes are most vulnerable to permafrost-thaw-driven increased hydrologic response.

Session: 10031 Advances in boreal disturbance research - Part 2 Avancées dans la recherche sur les perturbations boréales - Partie 2 **03/06/2022 13:50**

ID: 11606 Contributed abstract
Poster Order:

Ecohydrological implications of the variability of soil hydrophysical properties between two Sphagnum moss microforms and the impact of different sample heights

Vitaly Golubev [1] , *Colin McCarter* [2] , *Pete Whittington* [3]

[1]
[2]
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Presented by / Présenté par: ***Pete Whittington***
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The ecohydrological and biochemical processes responsible for the globally significant stores of carbon in northern peatlands are largely controlled by the soil's hydrophysical properties, in particular the relationship that soil water tension (ψ) has with soil water content (θ) and hydraulic conductivity (K). Despite the importance, little is known about how these relationships vary between species in different physiological Sphagnum microforms, such a hummock and hollow, as well as with depth within a profile. Complicating matters is that laboratory experiments to determine these relationships are almost always completed with 5 cm high samples, despite no real scientific evidence supporting this height. To address these shortcomings, we sampled 8 replicates/samples (moss surface to 15 cm depth) each from a S. magellanicum hollow and a S. fuscum hummock. We determined the K(ψ) and θ(ψ) relationships at various pressure heads (0 to –32 cm) and then sub-sectioned the 15-cm samples into 3x5-cm (top, middle, bottom) samples and repeated the tests. There were important differences in both K(ψ) and θ(ψ) relationships between the top, middle and bottom samples. Additionally, comparison of the average of the 3x5-cm samples versus the 15-cm samples suggested that the 15-cm samples were not a good representation due to not being fully compatible with the methodology, and that 3x5-cm samples were preferred. Using Hydrus-1D to simulate a 30-day drought period with local hydroclimatological data, we assessed whether the statistically significant differences were ecohydrologically significant when accounting for the different topographic niches of the two species. The different moss species responded differently, with S. fuscum becoming more water stressed than S. magellanicum, yet S. fuscum lost less water from soil water storage than S. magellanicum. This highlighted the critically important need to replicate the species' niche in the landscape, and not give two distinct species the same hydrological modelling boundary conditions to compare results.

Session: 10031 Advances in boreal disturbance research - Part 2 Avancées dans la recherche sur les perturbations boréales - Partie 2 **03/06/2022 14:05**

ID: 11622 Contributed abstract
Poster Order:

Prairie Potholes as Transformers on the Landscape: Exploring the Rates of Planktonic Nitrogen Uptake, DNRA, and Denitrification

Amy Hergott [1] , *Helen Baulch* [2] , *Colin Whitfield* [3]

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Presented by / Présenté par: ***Amy Hergott***
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The Prairie Pothole Region of Canada is under substantial anthropogenic

stress associated with climate change, land-use modification, and pollutant release. As food production demands increase in concert with the global population, the need for agricultural fertilizers to supplement plant growth has also increased. This, combined with other anthropogenic activity, has caused an accumulation of nitrogen (N) compounds in managed and natural aquatic ecosystems which pose a significant threat to biodiversity, water quality, and human health. Prairie pothole wetlands may help to offset the risk of downstream nutrient export and pollution through many transformative biogeochemical processes, thereby retaining N on the local landscape. The goal of this research was to quantify the rates of planktonic uptake, denitrification, and dissimilatory nitrate reduction to ammonium (DNRA) across a gradient of parameters observed in pothole wetlands. Planktonic uptake was rapid, reaching a maximum rate of 1.61 x 104 µg N L–1 h–1 ,at ambient concentrations, and displayed a preference for NH4+ . Additionally, uptake was prevalent across light and dark conditions, suggesting bacteria may play a larger role in pelagic N cycling than previously thought. Benthic NO3– reduction was dominated by DNRA, reaching a maximum rate of 0.756 µg N g –1 hr–1 , while comparatively low rates of denitrification were occurring, reaching a maximum of 0.014 µg N g–1 hr–1 . The rapidity at which N cycling via uptake and DNRA occurs highlights the importance of potholes as transformers on the landscape, capable of harnessing and recycling N within the system. As anthropogenic inputs, pothole modifications, and climate change stressors continue to threaten our water resources, it’s imperative we recognize the capacity for prairie potholes to harness N on the landscape and their role in mitigating impacts of nutrient transport.

Session: 10031 Advances in boreal disturbance research - Part 2 Avancées dans la recherche sur les perturbations boréales - Partie 2

03/06/2022 14:20

ID: 11827 Contributed abstract

Poster Order:

Disentangling multiple drivers of dissolved organic matter concentration in a prairie drinking water reservoir

Anthony Baron [1] , *Helen Baulch* [2] , *Colin Whitfield* [3]

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Presented by / Présenté par: ***Anthony Baron***
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Dissolved organic matter (DOM) is an important water quality characteristic of freshwater ecosystems. Elevated DOM and changes in the type of DOM are a major concern for drinking water treatment plants that draw from lakes and reservoirs owing to effects on disinfection byproduct (DBP) formation, risks of bacterial regrowth in water distribution systems, and increasing treatment costs. Buffalo Pound Lake is a crucial drinking water source for two Saskatchewan cities and can experience elevated and variable dissolved organic carbon (DOC) concentrations (median: 6.4 mg/L, range: 3.11–15.0 mg/L), raising concern about DBP levels in treated water. Using 30 years of DOC

concentrations, along with a suite of physicochemical and streamflow data, we assessed drivers of variation in lake DOC. We applied wavelet coherence analyses and generalized additive models (GAMs) to investigate timescale-specific relationships between DOC and streamflow, nutrients, and sulfate. Wavelets revealed coherence between DOC and flows from different water sources and lake phosphorus and sulfate at timescales of 2 months to 10 years. GAMs with these drivers explained significant variation in DOC concentration over the 30-year period. We suggest that climatic change and changes in water and catchment management, including flows and agricultural land-use, may drive source water quality in this already water scarce region. Our results will inform the design of a new $222M upgraded water treatment plant aiming to address the complex source water quality challenges of this shallow lake, which requires consideration of past changes in water quality, and likely future change.

Session: 11030 CSAFM 2: Understanding past, present and future effects of climate on agriculture, forestry and water resources. - Part 1 SCMAF 2: Comprendre les effets passés, présents et futurs du climat sur l'agriculture, la foresterie et les ressources en eau - Partie 1. **03/06/2022 12:55**

ID: 11685 Invited session speaker
Poster Order:

Climate and Prairie Crop Production: Historical and Future Perspectives

Paul Bullock [1]

[1] University of Manitoba

Presented by / Présenté par: ***Paul Bullock***
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Canada’s crop production originates mainly from the prairies but there is significant annual variability. Historically, drought-impacted growing seasons, especially those with preceding dry years, caused the most severe prairie crop production losses. Thus, efforts to estimate inter-annual variation in prairie crop production, such as the Canadian Wheat Board wheat yield model, focused on quantification of drought impacts. However, these models had limitations because they did not quantify effects of other factors, such as early fall frost or growing season excess water, both of which significantly impacted prairie crops in the early 1990’s. Successive drought years in the early 2000’s spawned the Drought Research Initiative. By the time the research program was up and running in 2005, there had been a fundamental shift from drought-dominated prairie climate to more pluvial weather with frequent periods of excess water. In 2011, Manitoba Crop Insurance made a record payment for 2.9 million unseeded acres as a result of excess water at the time of spring seeding but also made significant payments for yield losses due to drought and heat, all within the same growing season. Most recently, prairie crop yields were significantly reduced in 2021 as a result of a series of dry years. This type of variability is extremely difficult to manage. The most effective crop and fertility program for excess water conditions is completely different than that for drought. Historically, large areas of the prairies have experienced an increase in the number and duration of both dry spells and well spells. This increasingly extreme weather is consistent with the trend of increasing variability in prairie

crop yields over the same time period. Future climate projections indicate a trend toward more severe precipitation deficits and more negative values of standardized precipitation evapotranspiration index (SPEI). However, the projections also show a wider range SPEI values under more severe climate change and further into the future. Thus, prairie crop production could experience even greater inter-annual variability as well as more significant drought reductions in the future.

Session: 11030 CSAFM 2: Understanding past, present and future effects of climate on agriculture, forestry and water resources. - Part 1 SCMAF 2: Comprendre les effets passés, présents et futurs du climat sur l'agriculture, la foresterie et les ressources en eau - Partie 1. **03/06/2022 13:25**

ID: 11356 Contributed abstract

Poster Order:

Effects of Delayed Harvest Dates on Gluten Strength of Canada Western Red Spring Wheat

Manasah Mkhabela [1] , *Kathleen Dorrian* [2] , *Paul Bullock* [3] , *Harry Sapirstein* [4]

[1] University of Manitoba
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Presented by / Présenté par: ***Manasah Mkhabela***
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Delayed harvest dates are a common occurrence in Western Canada as a result of inclement weather, especially autumn precipitation. This can have negative impacts on the yield, grade and quality of wheat with deterioration of grading factors. While the effects of delayed harvest on grain quality are known for some grading factors such as pre-harvest sprouting and frost damage, the effects on gluten strength are largely unknown. In this study, four commercial Canada Western Red Spring (CWRS) wheat genotypes (Glenn, Carberry, Brandon and Harvest), with a range of gluten strength were grown at four different locations across Manitoba in 2017. At each location there were four different harvest dates (H): H1 at physiological maturity, H2 at normal harvest period (grain moisture between 13-15%), and H3 and H4 at four and six weeks after physiological maturity, respectively. Harvested grain was graded and analysed to determine physical and milling quality, dough mixing properties and gluten protein composition. Harvest date had a statistically significant impact on Fusarium damaged kernels, test weight, flour ash, mixograph development time, and gluten strength measured by mixograph work input to peak development and work at peak development, and two protein compositional factors related to gluten strength (HMW glutenin/flour protein and HMW glutenin/soluble prolamins). However, the contribution of harvest dates to total variance of these parameters was very small and often lower than residual error. Reduced grades as a result of post-growing season precipitation did not result in reduced gluten strength. Interestingly, results of both mixograph and protein composition analysis showed that gluten strength was slightly increased for wheat samples from the two most delayed harvest dates, H3 and H4.

Session: 11030 CSAFM 2: Understanding past, present and future effects of climate on agriculture, forestry and water resources. - Part 1 SCMAF 2: Comprendre les effets passés, présents et futurs du climat sur l'agriculture, la foresterie et les ressources en eau - Partie 1.

03/06/2022 13:50

ID: 11345 Contributed abstract

Poster Order:

Developing Fusarium head blight risk models for western Canadian cereals using weather data and logistic regression analysis

Taurai Matengu [1] , *Manasah Mkhabela* [2] , *Francis Zvomuya* [3] , *Paul Bullock* [4] , *Timi Ojo* [5] , *Maria Antonia Henriquez* [6] , *Sachithrani Kannangara* [7] , *Dilantha Fernando* [8] , *Rejean Picard* [9] , *Raul Avila* [10] , *Alireza Akhavan* [11] , *Michael Harding* [12]

[1] University of Manitoba
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[5] Manitoba Agriculture
[6] Agriculture and Agri-Food Canada
[7] University of Manitoba
[8] University of Manitoba
[9] Manitoba Agriculture
[10] Government of Saskatchewan
[11] Government of Saskatchewan
[12] Alberta Agriculture, Forestry and Rural Econ Dev

Presented by / Présenté par: ***Taurai Matengu***
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Fusarium Head Blight (FHB) is an economically devastating disease for cereal crops globally. Fusarium-damaged kernels (FDK) reduce crop yield and the fungus can produce mycotoxins, especially deoxynivalenol (DON), which may prohibit grain use for food or livestock feed. One option to reduce FHB damage is fungicide application at flowering. However, weather conditions that promote severe FHB infection do not always occur, and fungicides may be applied unnecessarily. The objective of this project is to develop weather-based models to assess FHB risk in spring wheat, winter wheat, barley, and durum to identify locations where fungicide treatment is most likely to be beneficial. Dependent variables, FHB index (FHBi), FDK and DON, were measured along with Fusarium spore counts and growing season weather at 15 plot sites in western Canada in 2019 and 2020. Kendall correlation and stepwise logistic regression analyses were used to identify potential weather parameters as predictor variables from combinations of relative humidity, air temperature, rainfall, and solar radiation for 4, 7, 10, and 14 days pre-anthesis plus 3 days pre-anthesis to 3 days post-anthesis. Models suitable for disease warning were identified based on their sensitivity, specificity, and accuracy. The models' prediction accuracy ranged from 75 to 81, 77 to 78, and 78 to 79% for FHBi, FDK, and DON, respectively. The models were validated using independent data collected from 199 producer fields during the same two growing seasons. The model validation accuracy ranged from 80 to 100 for FHBi, 54 to 89 for FDK, and 75 to 82% for DON. Drier than normal weather in both years resulted in low

FHB disease pressure. Additional site-years of data will be needed to bolster the models' reliability, especially in years with high disease pressure. An online FHB risk tool is being developed to use real-time weather from western Canada's networks and provide maps of potential FHBi, FDK, and DON epidemics.

Session: 11030 CSAFM 2: Understanding past, present and future effects of climate on agriculture, forestry and water resources. - Part 1 SCMAF 2: Comprendre les effets passés, présents et futurs du climat sur l'agriculture, la foresterie et les ressources en eau - Partie 1.

03/06/2022 14:05

ID: 11661 Contributed abstract

Poster Order:

Feeding Models of Food Production: Scaling Meteorological and Biophysical Data Sets for Agroecosystem Modelling

Catherine Champagne [1] , *Elizabeth Pattey* [2] , *Marilee Pregitzer* [3] , *Sameh Saadi* [4]

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Presented by / Présenté par: ***Catherine Champagne***

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Agroecosystems are complex, integrating the soil-crop-livestock-atmosphere continuum over space/time and incorporate a range of factors that determine both productivity and sustainability. These models show good accuracy in predicting crop yields, greenhouse gas emissions and nutrient runoff at field scales, and are increasingly being use to scale up observations to regional and national scales. This presents a challenge, as the core data sets used to parameterize and run these models are often not available from traditional data sources at the scales needed to make accurate environmental predictions. Instead, meteorological data sets that are gridded (either through interpolation or modelling) are used, which may require a trade off between accuracy and spatial coverage. Additionally, earth observation data sets, such as vegetation indicators or soil moisture are used to optimize other model parameters such as seeding date or soil hydrological properties and these too have challenges in implementing them operationally, such as the precision of the vegetation indicators used given the spectral and spatial coverage of the available satellite data. To examine the tradeoffs, several meteorological and earth observation data sets were examined over sites in eastern Ontario to examine temporal and spatial trends. Multi-resolution (10km and 2.5km) precipitation, temperature, wind speed, solar radiation and relative humidity were validated against station-based measurements and differences in temporal trends were examined over several growing seasons. Similar trends were examined in satellite based leaf area index and vegetation indicators (Normalized Difference Vegetation Index and Modified Transformed Vegetation Index) from Sentinel-2 satellites were examined against field values. Finally, coarse and fine resolution satellite soil moisture from the Soil Moisture Active-Passive mission and the Soil Moisture and Ocean Salinity mission were evaluated against ground measurements.

Results will provide guidance on how these can be applied for forcing and parameterizing agroecosystem models.

Session: 11030 CSAFM 2: Understanding past, present and future effects of climate on agriculture, forestry and water resources. - Part 1 SCMAF 2: Comprendre les effets passés, présents et futurs du climat sur l'agriculture, la foresterie et les ressources en eau - Partie 1.

03/06/2022 14:20

ID: 11425 Contributed abstract

Poster Order:

Exploring the crop yield forecast skill in climate extreme years by alternative treatment of technology induced yield trends in the Canadian Prairies

Yinsuo Zhang [1] , *Aston Chipanshi* [2] , *Budong Qian* [3] , *Catherine Champagne* [4] , *Frédéric Bédard,* [5] , *Gordon Reichert* [6]

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Presented by / Présenté par: ***Yinsuo Zhang***
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The Canadian Crop Yield Forecaster (CCYF) has been used for in-season crop yield forecasts both by Agriculture and Agri-Food Canada and Statistics Canada (STC). In general, the yield estimates by CCYF provide comparable or higher skills than the traditional farm survey based early season estimates in most years. However, CCYF generally over-estimates the yield in years with extremely low crop yields. For example, the final canola yields in the three Prairie Provinces in 2021 reported by STC's November survey were 28-47% below the average yields of previous five years, due to the prolonged severe drought, while the CCYF predicted canola yields in September were only 10-20% below the average. A preliminary analysis showed that the overestimates were mainly contributed by a linear increasing term with year, which explained 10-70% (varied by crop and region) yield variations. In the 2021 case study, the forecast skills for canola yield were improved by 12-23% in the three prairie provinces by removing this trend term in the CCYF model. Over all, we analyzed the yield trends of canola and spring wheat from 1987- 2021 in all the CCYF modelling units, i.e. Census Agriculture Region, in the three Prairie Provinces. Three years with lowest detrended yields were considered as climate extreme years from each CAR . By applying an alternative treatment of the linear trend in the climate extreme years, the forecast skill was improved by 12%, on average, ranging from 2% to 80% across all the CARs. We are further investigating climate thresholds for trigging an alternative treatment in the in-season forecasts, so that this improved algorithm could be applied timely. This

study would have profound impact on the future crop yield forecasting operation as the climate extremes are projected to be more frequent under various future climate scenarios.

Session: 14041 Novel Approach in Seasonal Snow: Field Measurements, Remote Sensing, Modeling, and Data Assimilation & Analytics - Part 2 Nouvelle approche dans la neige saisonnière: mesures sur le terrain, télédétection, modélisation et assimilation et analyse de données -Partie 2 **03/06/2022 12:55**

ID: 11833 Contributed abstract
Poster Order:

Fine scale characterization of snowpack evolution using unpiloted aerial system lidar and SfM photogrammetry

Megan Verfaillie [1] , *Eunsang Cho* [2] , *Jennifer Jacobs* [3] , *Adam Hunsaker* [4] , *Franklin Sullivan* [5] , *Michael Palace* [6] , *Elizabeth Burakowski* [7] , *Cameron Wagner* [8]

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Presented by / Présenté par: ***Megan Verfaillie***
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Unpiloted Aerial Systems (UAS) equipped with lidar and structure-from-motion (SfM) photogrammetry have emerged as viable methods to map snow depths at fine resolutions. In this study, eight UAS lidar/SfM snow depth maps were collected during the 2020/2021 winter season in Durham, NH, USA with the objectives of: (1) validating UAS snow depth retrievals using multiple in-situ measurement techniques (Magnaprobe and field cameras), (2) conducting a quantitative comparison of lidar and SfM snow depths (< 35 cm) throughout the winter, and (3) better understanding a spatial structure of snow depth and its relationship with terrain features. The surveys were conducted over approximately 0.35 km2 including large open and mixed forested areas. Results showed that lidar outperformed SfM compared to in-situ observations, especially at forested sites. In the field, lidar had a lower mean absolute error (MAE) than SfM compared to the Magnaprobe (lidar = 3 cm, SfM = 5 cm) and field cameras (lidar = 3 cm, SfM = 14 cm). The same was true in the forest compared to the Magnaprobe (lidar = 7.2 cm, SfM = 32 cm) and cameras (lidar = 2.7 cm, SfM = 45 cm). The difference between lidar and SfM was much greater in the forest, with SfM overestimating snow depths at most locations. We also found differences between the in-situ measurement techniques used for validation. However, the differences had only a modest impact on snow depth validation. The spatial structures of snow depth captured by lidar were generally consistent throughout the period indicating that static land characteristics such as slope, vegetation, and soil properties, may control the

spatial variability.

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ID: 11553 Contributed abstract
Poster Order:

Estimating Snow Water Equivalent at the watershed scale using drones across in the Arctic shrub-tundra

Branden Walker [1] , *Rosy Tutton* [2] , *Philip Marsh* [3]

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Presented by / Présenté par: ***Branden Walker***
Contact: bwalker@wlu.ca

Spatial variations in snow depth and density translate to heterogenous snow water equivalent (SWE) in shrub tundra environments. Spatial variability in snow depth is primarily due to winter blowing while density variability is due to snow metamorphism process. Recent advances in Remotely Piloted Aircraft systems (RPAS) and Structure-from-motion photogrammetry (SfM) have allowed for the measurement of high-resolution spatial and temporal changes in snow depth across snow covered landscapes. This is a major advance in high-resolution remote sensing that provides significant opportunities to advance hydrological process understanding and testing of predictive snow models. However, due to complexities relating to accurately estimating similar spatial or temporal variability in snowpack density, there has been little advance towards mapping SWE at comparable scales. In this paper we address these shortcomings by combining high-resolution snow depth maps created using RPAS SfM with spatially distributed snowpack bulk density observations to accurately map SWE for a small (1 km2) watershed. These data allowed mapping of late winter snow depth, density and SWE across dominant vegetation and topographic land cover types. Spatially distributed snowpack density observations were collected using representative snow surveying and snow pits. An empirical relationship between snow depth and density was produced applied to the SfM snow depth maps to estimate SWE. Final SWE maps were validated using in situ snow depth and SWE observations obtained within the study area, demonstrating highly accurate snow depth and SWE results. Furthermore, we were able to provide an in-depth analysis of late winter SWE variability across the dominant landcover types, revealing significant differences in water storage across the watershed.

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ID: 11441 Contributed abstract
Poster Order:

Quantifying volumetric scattering bias in ICESat-2 altimetry over snow-covered surfaces

Zachary Fair [1] , *Mark Flanner* [2] , *Carrie Vuyovich* [3] , *Tom Neumann* [4] , *Benjamin Smith* [5] , *Adam Schneider* [6]

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[2] University of Michigan, Ann Arbor
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[5] University of Washington
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Presented by / Présenté par: ***Zachary Fair***
Contact: zachary.fair@nasa.gov

The ICESat-2 mission has collected global measurements of surface elevation for over three years. The sole onboard instrument, the Advanced Topographic Laser Altimeter System (ATLAS), operates at 532 nm, and ice and snow absorb weakly at this wavelength. Previous modeling studies found that aged or melting snow may induce 0.45 m in altimetry bias, though there has yet to be a formal assessment on ICESat-2 acquisitions during the melting season. There is a recent interest in using ICESat-2 data for snow applications, so it is vital to quantify these biases to ensure accurate measurements over snow-covered surfaces.
We perform two case studies that utilize lidar altimetry data from ICESat-2 and the Airborne Topographic Mapper (ATM) over the Greenland Ice Sheet to quantify volumetric scattering bias in snow. The case studies are conducted near the end of the melting season in September 2019. A Monte Carlo photon-tracking model and snow grain sizes derived from ATM waveforms and the Next Generation Airborne Visible/Infrared Imaging Spectrometer (AVIRIS-NG) are used to attribute ICESat-2 biases to snow.
Our results indicate that ICESat-2 and ATM experience centimeter-level bias across the Greenland Ice Sheet, and we generally see increases in bias with increasing grain size. Relative to the ATM 1064 nm beam, we find that mean biases derived from ICESat-2 and ATM over the Greenland Ice Sheet are 6.9 cm and 6.01 cm, respectively. These biases agree best with modeled results when simulated snow density is 250-350 kg m-3. Although the ICESat-2 errors are within mission accuracy requirements, we cannot rule out more significant errors in regions of melting snow, particularly over forested or sloped terrain. We expect to continue this study over mid-latitude field sites in support of the SnowEx mission, with a bias correction algorithm and regional snow depth retrievals as future research goals.

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ID: 11653 Contributed abstract
Poster Order: Poster-14041
Soil freeze-thaw detection using Sentinel-1 SAR data in agricultural fields

Shahabeddin Taghipourjavi [1] , *Christophe Kinnard* [2] , *Roy Alexandre* [3]

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Presented by / Présenté par: ***Shahabeddin Taghipourjavi***
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Seasonal soil freeze-thaw (FT) is a process of the flow of material and energy which occurs in the topsoil and proceeds into the deeper soil layers. In southern Canada, where the farmlands are dominantly located, the process plays an important role in hydrological regime, biogeochemical process, and crop production in farmlands. To detect the FT state, the Saint-Maurice areas in southern Quebec have been selected as the test case for fieldwork purposes. This site has been instrumented and monitored to properly represent the heterogeneous characteristics of soil temperature in an agricultural field. We have used temperature loggers to measure soil temperature in eight patches using 40 points on two vertical levels (e.g., near-surface and 10 cm) including five patches in different agricultural fields and three in the forest areas. C-band Synthetic Aperture Radar (SAR) of Sentinel-1 Ground Range Detected (GRD) scenes have been processed using Google Earth Engine (GEE) to generate the calibrated and incidence angle-corrected product. In this research, logistical regression of the freezing status against the freeze-thaw index has been applied. The FT index has been chosen during a post-harvest, frost, and frost-free period to get reference frozen and thawed values. Fitting a generalized linear model (GLM) as a flexible generalization of linear regression model shows that the probability of freezing in relation to the freeze-thaw index varies within and between farmland patches and forest patches. Based on the results, soil types and crop types significantly affect the probability of soil freezing in relation to sentinel 1 backscattering in agricultural fields.

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ID: 11583 Contributed abstract
Poster Order: Poster-14041
Leveraging adaptive viewing to improve the efficacy of space-borne satellite retrievals of terrestrial snow.
Colin McLaughlin [1] , *Barton Forman* [2] , *Lizhao Wang* [3]

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Presented by / Présenté par: ***Colin McLaughlin***
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Space-borne sensors for snow estimation traditionally employ a “fixed” viewing strategy that applies a static look angle between the sensor and the observed portion of Earth’s surface. However, a fixed viewing strategy often misses the target of interest (e.g., views snow-free valley rather than snow-capped peak). An alternative to fixed viewing is “adaptive” viewing such that the satellite-based sensor can slew in order to preferentially view the target of interest. This project developed an algorithm to model adaptive viewing strategies in order to explore how adaptive viewing by a sensor can maximize the information content of satellite observations. The synthetic retrievals developed in this project are ultimately used in a observing system simulation experiment (OSSE) to quantify how, and to what degree, adaptive sensor viewing has the potential to improve the characterization of terrestrial snow mass.

In this project, the adaptive viewing model is used to generate synthetic retrievals of snow depth and SWE. The adaptive viewing strategy is highly flexible, but remains constrained to user-specified parameters such as satellite trajectory, swath width, maximum rate of slew angle, and maximum extent of slew angle. Results from the adaptive viewing strategy are compared relative to those from the fixed viewing strategy. When using a hypothetical LiDAR sensor with a wide swath width, for example, adaptive viewing model captures 30-50% more of the target of interest relative to the fixed viewing strategy. This investigative approach is repeated over a variety of satellite trajectories, swath widths, and slewing rates.

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ID: 11452 Contributed abstract
Poster Order:

Precipitation phase from atmospheric model improves snowfall estimates across Canada

Vincent Vionnet [1] , *Marc Verville* [2] , *Vincent Fortin* [3] , *Francois Lemay* [4] , *Melinda M. Brugman* [5] , *Julie Thériault* [6]

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[4] National Prediction Development, Environment and Climate Change Canada
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Presented by / Présenté par: ***Vincent Vionnet***
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The precipitation phase at the surface strongly affects the evolution of the snowpack and the associated hydrological response in cold regions. Snowpack models deployed at continental scales usually rely on ground-based precipitation-phase partitioning methods (PPMs) that use near-surface air temperature and humidity. These PPMs still ignore atmospheric conditions in the layers aloft, thus limiting their ability to predict the precipitation phase at the surface.

In this study, gridded phase estimates from a variety of ground-based and atmospheric-based PPMs are evaluated against manual observations of precipitation phase collected across a large region covering Canada and the northern United States (US) from September 2019 to June 2020. The hourly gridded phase estimates are derived from the High Resolution Deterministic Prediction System (HRDPS) running at 2.5-km grid spacing over the region of interest. Two atmospheric-based PPMs are considered from HRDPS: (i) the Bourgouin method relying on the vertical profile of air temperature and (ii) the Latent Heat Release Method (LHRM) relying on the vertical profile of wet-bulb temperature. Ground-based PPMs of various complexity are also considered: (i) single air temperature thresholds, (ii) snowfall fraction depending on air temperature, and (iii) humidity-based PPMs.

Results show that humidity-based PPMs provides the best estimate of precipitation phase at continental scales among the ground-based PPMs. In particular, they outperform PPMs relying only on air-temperature in the mountainous regions of western Canada and US. In these regions, LHRM offers the best performances thanks to its ability to forecast the height of the snow level. In eastern Canada and US, humidity-based PPMs tends to overestimate the occurrence of snowfall. Atmospheric-based PPMs improves these estimates since they can account for the presence of a melting layer above the surface, often encountered during precipitation events in these regions. These results encourage the use of atmospheric-based PPM for snowpack modelling across Canada.

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ID: 11648 Contributed abstract

Poster Order:

DLR Global SnowPack - possible applications of the near real-time product

Sebastian Rößler [1] , *Andreas Dietz* [2]

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Presented by / Présenté par: ***Sebastian Rößler***
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For over 20 years, the MODIS sensors on Terra and Aqua have been providing data on global snow coverage. The daily data provided by the National Snow and Ice Data Center (NSIDC) (currently in version 6.1) is already of very high quality and serves as input data for the DLR Global SnowPack processor. There, remaining data gaps (e.g. due to clouds or polar night) are filled in 4 interpolation steps and cloud-free data is thus provided daily. So far this has only happened retrospectively after the end of a hydrological year (end of the meteorological summer). This data is now made available daily in near real time with a time lag of 3 days in the EOC GeoService Portal. This enables the use of this data in time-critical issues, such as with regard to flood hazards. At the conference we will present the product, the access options and possible applications.

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ID: 11814 Contributed abstract
Poster Order:

An accurate global daily snow cover and albedo product from MODIS and VIIRS

Karl Rittger [1] , *Keith Musselman* [2] , *McKenzie Skiles* [3] , *Ned Bair* [4] , *Mary J. Brodzik* [5] , *Mark Serreze* [6] , *Stephanie Abegg* [7] , *William Kleiber* [8]

[1]

[2] INSTAAR; University of Colorado, Boulder
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Presented by / Présenté par: ***Karl Rittger***
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Water managers need accurate observations of snow cover and albedo to make decisions for a diverse set of applications. Remotely sensed snow cover and albedo products that are currently available do not meet operational requirements for several reasons. We have partnered with snow remote sensing end users who serve diverse needs of national and international water resource decision makers. With their guidance, we create and provide daily gap-filled snow cover and albedo, including impacts of light absorbing particles. The products account for off-nadir views, snow under the forest canopy, and use cloud filtering techniques not employed in existing products. Using algorithms shown to perform consistently across sensors—specifically MODIS and VIIRS—we will process the historical daily record and produce data in near real-time with a sub-daily latency period. This project will complete the transition of the data processing, archiving, and distribution to the National

Snow and Ice Data Center. The transition will ensure the continued production of snow cover and snow albedo products for the lifetime of these sensors. While expanding these products to global coverage, we recognize that snow surface properties vary at a much finer scale than the resolution of MODIS and VIIRS. While the combination of Landsat 8 & 9 and Sentinel 2a&b approach near-daily resolution, they will need to operate for several years together to create a long-term record. To create a daily Landsat resolution dataset for previous periods we fuse the snow and albedo products using a random forest model trained on MODIS, Landsat 8, and a suite of geophysical predictor variables. We develop separate models to address the issue of missing data within the MODIS product caused by its coarse spatial resolution, allowing for more complete spatial fusion coverage, especially near the snow line where snowmelt is prominent.

Session: 3023 Advancing our understanding of the Arctic atmosphere - Part 4 Faire progresser notre compréhension de l'atmosphère arctique - Partie 4 **03/06/2022 14:55**

ID: 11535 Invited session speaker
Poster Order:

Atmospheric impact of carbon fluxes of Arctic ecosystems on local and regional scales

Roisin Commane [1]

[1]

Presented by / Présenté par: ***Roisin Commane***
Contact: r.commane@columbia.edu

Arctic warming could unlock vast stores of carbon from thawing permafrost and high-latitude ecosystems and release the carbon into the atmosphere as either carbon dioxide (CO_2) or methane (CH_4). Carbon fluxes have been measured year round for individual eddy flux towers but how representative of the wider Arctic are these individual tower sites? Are the environmental drivers consistent across regions?
We have developed a framework to combine eddy flux, tower and aircraft observations with an atmospheric transport model to evaluate regional carbon fluxes. We evaluated CO_2 and CH_4 flux models against observations of atmospheric CO_2 mixing ratios from aircraft and a tower that sample air interacting with tundra ecosystems. We find that, for CO_2 models that closer represent the atmospheric flux year round, the magnitude of growing season uptake determines the carbon balance of the Alaska North Slope. We also quantified and proposed mechanisms for the “missing” carbon flux for the early dormant season (during the zero curtain freeze-up). We find no evidence of a regional impact for the previously reported large late dormant season (January - April) CO_2 emissions. For methane, we find that most wetland methane flux models vastly underestimate the flux of methane to the atmosphere from tundra ecosystems, but have the potential to do so.

Session: 3023 Advancing our understanding of the Arctic atmosphere - Part 4 Faire progresser notre compréhension de l'atmosphère arctique - Partie 4 **03/06/2022 15:25**

ID: 11721 Contributed abstract

Poster Order:

Characterization of atmospheric methane release at hotspots in the outer Mackenzie River Delta.

Daniel Wesley [1] , *Scott Dallimore* [2] , *Roger MacLeod* [3] , *Dave Risk* [4]

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[2] Geological Survey of Canada
[3] Geological Survey of Canada
[4] St Francis Xavier University

Presented by / Présenté par: ***Daniel Wesley***
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Atmospheric release of methane from natural sources is poorly quantified generally, but especially in the Arctic where ongoing climate change is occurring at a pace that may be 2 to 4 times the global average. The Mackenzie River Delta in the western Canadian Arctic is an unique setting for natural methane (CH_4) emissions. Thin and destabilizing permafrost, high organic content soils, high proportion of wetlands, and vast natural gas occurrences deep below the surface create a unique ecosystem conducive to methane production and potential atmospheric release. In the present study, stable carbon isotope analyses were used to characterize the source of CH_4 at several aquatic and terrestrial hotspots of CH_4 flux to the atmosphere. In addition, ground transects with continuous measurements were undertaken to characterize spatial variability of atmospheric methane concentrations and association with geologic features including pingos, lakes and river channels and wetlands. Of the eight sites investigated in this study, four had isotopic signatures ($\delta13C$- CH_4) suggesting potential thermogenic sources and four sites were indicative of a biogenic origin. All of the sites had elevated atmospheric methane concentrations that were above global mean values providing some ground truth observations in support of remote sensing assessments identifying hotspots with elevated atmospheric flux. The wide range of isotopic signatures indicates that atmospheric CH_4 flux in the Mackenzie River Delta is from varied sources with significant contributions from buried sources (both thermogenic and biogenic) as well as active surface microbial production (biogenic).

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ID: 11612 Contributed abstract

Poster Order:

Using Ground-Based Fourier Transform Infrared Spectroscopy to Evaluate Model Concentrations of Short-Lived Climate Forcers

Victoria Flood [1] , *Kimberly Strong* [2] , *Kaley Walker* [3] , *Cynthia Whaley* [4]

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[2] University of Toronto
[3] University of Toronto
[4] Environment and Climate Change Canada

Presented by / Présenté par: ***Victoria Flood***

Contact: v.flood@utoronto.ca

This work presents an evaluation of modeled atmospheric concentrations of O3, CO and CH4 from eleven models, as presented in the most recent assessment report by the Arctic Monitoring and Assessment Programme (AMAP) on short-lived climate forcers. AMAP is a scientific working group that was created to advise the Arctic Council on matters of Arctic pollution, climate change and the associated threats to local ecosystems and health. This framework is then used to inform policy and decision making through science-based assessments. The current report focuses on the impacts of Short-Lived Climate Forcers (SLCFs) on the Arctic climate, atmospheric chemistry, and human health. The report presents model-measurement comparisons to assess the performance of atmospheric modelling of SLCFs in the Arctic for the years 2008, 2009, 2014 and 2015. The 3-hourly mixing ratios of select SLCFs and related gases are modelled by CESM, CMAM, DEHM, EMEP-MSC-W, GEM-MACH, GEOS-Chem, MATCH, MATCH-SALSA, MRI-ESM2, UKESM1 and WRF-Chem. This presentation will compare these outputs to corresponding trace gas measurements from ground-based Fourier Transform Infrared (FTIR) spectrometers. The FTIR instruments used are part of the Network for the Detection of Atmospheric Composition Change (NDACC) Infrared Working Group, with emphasis on results from the Canadian High Arctic site at the Polar Environment Atmospheric Research Laboratory, in Eureka, Nunavut (80.05ºN, 86.42ºW). Analyses are performed by converting model outputs into smoothed partial columns of O3, CO and CH4, at the locations of the FTIR instruments. Comparisons include seasonal cycle analysis, percent differences and regression analysis.

Session: 3023 Advancing our understanding of the Arctic atmosphere - Part 4 Faire progresser notre compréhension de l'atmosphère arctique - Partie 4 **03/06/2022 16:05**

ID: 11759 Contributed abstract

Poster Order:

Old air trapped in polar ice cap helps reconstruct recent trace gas histories

Anais Orsi [1]

[1] The University of British Columbia

Presented by / Présenté par: ***Anais Orsi***

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Polar firn at the top of ice caps is a reserve of pre-anthropogenic air. Large quantities (>100L) of air dating back 50 to 100 years can be extracted and analyzed for trace gas composition. In this presentation, we will review recent results of firn air sampling campaigns from Antarctica and Greenland, and demonstrate how firn air can be used to reconstruct trace gas histories. Next, we will present the potential of a future firn air campaign on the Muellers ice cap (Axel Heiberg Island) to recover old air, and seek interested collaborators.

Session: 3023 Advancing our understanding of the Arctic atmosphere - Part 4 Faire progresser notre compréhension de l'atmosphère arctique - Partie 4 **03/06/2022 16:20**

ID: 11524 Contributed abstract

Poster Order:

Validation of Short-Lived Climate Forcer Modelling by Ground-Based Near-Infrared Fourier Transform Spectroscopy

Erin McGee [1], *Kimberly Strong* [2], *Kaley Walker* [3], *Cynthia Whaley* [4], *Rigel Kivi* [5], *Justus Notholt* [6]

[1] University of Toronto
[2] University of Toronto
[3] University of Toronto
[4] Canadian Centre for Climate Modelling and Analysis, Environment and Climate Change Canada
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Presented by / Présenté par: ***Erin McGee***
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The Arctic Monitoring and Assessment Programme (AMAP), a working group of the Arctic Council, studies and documents the effects of climate change and pollution on Arctic climate, with the intent of informing policy recommendations. One subject of interest is the impact of Short-Lived Climate Forcers (SLCFs), atmospheric components with lifetimes shorter than that of carbon dioxide; the 2021 AMAP Assessment Report is focused on the climate and health effects of SLCFs in the Arctic and globally. AMAP uses multiple models to determine levels of SLCFs in the Arctic. These models include CESM, CMAM, DEHM, EMEP-MSC-W, GEM-MACH, GEOS-Chem, MATCH, MATCH-SALSA, MRI-ESM2, UKESM1, and WRF-Chem. This work compares outputs from these models for carbon monoxide and, where possible, methane, to data from ground-based Fourier Transform Infrared (FTIR) Spectrometers focused on the near-infrared spectral region. These spectrometers are part of the Total Carbon Column Observing Network (TCCON) and are located in Eureka (Nunavut, Canada), Ny Ålesund (Spitzbergen, Norway), and Sodankylä (Finland). The model outputs are mixing ratios given at three-hour intervals for the years 2009, 2014 and 2015; these are transformed as necessary to be compared to the TCCON column-averaged dry air mole fraction (Xgas) data product. TCCON has been used for many validation studies in the past and these stations in particular provide an essential high Arctic data set with very low site-to-site bias. We will assess the ability of the AMAP models to simulate high Arctic CO and CH4 in order to better understand their suitability to inform SLCF policies.

Session: 6030 Probabilistic climate risk assessments
Évaluations probabilistes des risques climatiques **03/06/2022 14:55**

ID: 11354 Contributed abstract

Poster Order:

Estimating the likelihood of GHG concentration scenarios from probabilistic IAM simulations

David Huard [1], *Jeremy Fyke* [2], *Iñigo Capellán-Pérez* [3], *H. Damon Matthews* [4], *Antti-Ilari Partanen* [5]

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Presented by / Présenté par: ***David Huard***
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Risk is a key concept in the financial, insurance and engineering worlds, and features prominently in the latest IPCC Assessment Reports. Risk combines the probability of hazards with their economic, social and environmental costs, allowing decision-makers to weigh the benefits of adaptation and mitigation options. It is thus concerning that there is no consensus on how to compute the probability of future climate hazards, and quantify climate risks. Indeed, future climate impacts are either conditional on degrees of warming, or on greenhouse gases concentrations and land-use scenarios that themselves have no assigned probabilities. From a climate services point of view, this is deeply problematic. After decades of climate research, stakeholders expect the climate science community and climate service providers to deliver decision-ready data.

This work proposes an approach to assign probabilities to the CO_2 concentration scenarios defined in RCPs and SSPs. It compares ensembles of probabilistic emissions pathways from various IAMs to compatible emissions diagnosed from the carbon fluxes simulated by Earth System Models driven by concentration scenarios. The results of course depend on the IAM and the storyline reproduced in each simulation, and are plagued by uncertainties stemming from the diagnosis of compatible emissions, but they suggest it's possible to design IAM and climate modeling experiments to deliver fully probabilistic risk assessments.

Session: 6030 Probabilistic climate risk assessments
Évaluations probabilistes des risques climatiques **03/06/2022 15:10**

ID: 11410 Contributed abstract
Poster Order:

Addressing the “Which scenario should I use?” question: a demonstration of probabilistic emission projections for real-world risk-based decision making

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Presented by / Présenté par: ***Jeremy Fyke***
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Today, almost all climate science and physical climate change impact/adaptation efforts use quantitative, probabilistic, methods to describe uncertainty in future climate conditions due to natural climate variability and climate or Earth system model (structural) uncertainty. In contrast, the third and final dimension of climate uncertainty, describing uncertain future emission trajectories, remains characterized by a scenario approach premised on “linguistic narratives of potential socio-economic futures”. Motivated by our

experience as on-the-ground climate service providers supporting consequential, material national adaptation planning efforts, we unambiguously adopt the standpoint that probabilistic emission ‘projections’ (not ‘scenarios’) specifically targeted at adaptation action needs are a highly desirable – if not necessary - precondition for effective climate change adaptation planning. Inspired by this need, here we demonstrate an operational, end-to-end workflow that produces probabilistic emission projections and related risk-relevant physical, regionalized climate change information for climate adaptation planning. This workflow includes:

• an ensemble of probabilistic emissions projections using a novel, geophysically based energy/emissions model
• a corresponding ensemble of CMIP-grade Earth system model simulations directly forced by these emissions projections
• application of these Earth system model outputs to a risk-based climate impacts assessment that reflects real world decision-making needs.

Using this workflow, we demonstrate production of a regional climate hazard dataset that is directly risk-relevant and includes a quantitative evaluation of emission uncertainty. We discuss our physical risk/adaptation-motivated workflow to scenario-based workflows, in the context of global-scale climate policy goals versus local-scale adaptation project needs. In conclusion, we argue that – possibly even for CMIP7 - probabilistic emission projections should be developed alongside policy and mitigation-focussed, and used to produce adaptation-relevant future climate projections from climate/Earth system models.

Session: 6030 Probabilistic climate risk assessments
Évaluations probabilistes des risques climatiques **03/06/2022 15:25**

ID: 11771 Contributed abstract
Poster Order:

Observationally constrained projections of regional warming

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Presented by / Présenté par: ***yongxiao liang***
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The projected climate warming locally or over regions is more relevant for adaptation and mitigation planning than projected changes in global mean temperature. Observational constraint methods based on the emergent relationship between observable constraints in historical simulations and future projected climate across multi-model ensembles are an effective approach to constraining uncertainty of multi-model projections of global warming, but few attempts have been made to apply them at the regional scale where uncertainties are large. Over Northern Hemisphere continental regions, we develop multivariate linear regression models with a metric selection approach based on a set of potential constraints involving tropical and subtropical low-level cloud metrics as well as a series of regional climate indices using the

Sixth Coupled Model Intercomparison Project (CMIP6) multi-model ensemble. We then evaluate the performance of the multivariate linear regression models based on cross-validated tests with metrics selected for in-sample tests using CMIP6 and for out-of-sample tests using CMIP5. The resulting linear regression model using only low-cloud metrics performs more robustly in cross-validated tests than regression models that involve regional climate indices as constraints. Based on the cross-validated evaluation, compared with unconstrained projections the linear regression model using low-level cloud metrics exhibits more accurate best estimate projections, narrower uncertainty ranges, and reliable probability of constrained uncertainty in all Northern Hemisphere continental regions. When compared with unconstrained simulations, application of a regression model using the low-cloud metrics to climate projections based on Shared Socioeconomic Pathway (SSP) 5–8.5 results in substantially narrower uncertainty ranges of projected twenty-first-century warming over Northern Hemisphere continental regions.

Session: 6030 Probabilistic climate risk assessments
Évaluations probabilistes des risques climatiques **03/06/2022 15:50**

ID: 11635 Contributed abstract
Poster Order:

Sensitivity of regional climate projections to differences in model weighting techniques

Martin Leduc [1] , *Anne-Marie Bégin* [2] , *Dominique Paquin* [3]

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Presented by / Présenté par: ***Martin Leduc***
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While the "one model, one vote" paradigm has been used in most climate change assessments to quantify the forced signal and uncertainty from multi-model ensemble of projections, for the first time in an IPCC report the AR6 used observational constraints to reduce uncertainties in future projections of global surface temperature. However, the benefits of applying a similar approach to climate variables projected over small regions are not as clear, given the predominance of internal variability at these scales. In this project, we use an ensemble of climate projections based on several global and regional climate models (from the CMIP5, CORDEX and ClimEx ensemble projects) to evaluate the impact of different weighting schemes on the projected signal over southern Québec. We first compare different model selection strategies such as "one model, one vote", "one centre, one vote", model resolution and other approach based on the type of ensemble used (CORDEX, CMIP5, ClimEx). Overall, despite strong selection hypotheses, the impact on the mean signal is rather modest, being attenuated due to the large ensemble size. In the second part of this work, we use an observational reference to calculate performance metrics in order to constrain the projections. Using the ClimEx initial condition large ensemble, we show that metrics based on local climate change trends and interannual variability are not usable to clearly discriminate model performances at the local scale since internal climate variability generally covers most of the inter-model spread. We finally use performance metrics

based on seasonal climatic means and combine them into a multi-criteria weighting function to show that such a combination may lead to an unreasonable reduction of the the effective ensemble size, which translates into model overconfidence in the projected signal.

Session: 10050 Linking hydrological and biogeochemical processes in disturbed ecosystems: Implications for watershed management Lier les processus hydrologiques et biogéochimiques dans les écosystèmes perturbés : Implications pour la gestion des bassins versants **03/06/2022 14:55**

ID: 11442 Contributed abstract

Poster Order:

Forest Harvesting Impacts on the Chemical Composition of Dissolved Organic Matter in Boreal Streams

Vaughn Mangal [1] , *Haiyong Huang* [2] , *Erik Emilson* [3] , *Carl Mitchell* [4]

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Presented by / Présenté par: ***Vaughn Mangal***
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The disturbance of watersheds from forestry practices can affect water quality, including the amount and composition of dissolved organic matter (DOM), but effects are likely to vary according to the intensity or extensiveness of disturbance, landscape characteristics and hydrology. In this study, DOM was sampled from small boreal forest headwater streams in northern Ontario and Fourier transform ion cyclotron resonance mass spectrometry was used to evaluate changes in the chemical composition of DOM in streams after forest harvesting. We show that forest harvesting accelerates carbon loss from terrestrial soils and that mobilized carbon is particularly susceptible to chemical transformations that promote microbial use in downstream aquatic networks. Specifically, we found that DOM in unharvested regions were mostly comprised of low molecular weight lignin material likely originating from leaf litter. However, after forest harvesting, dissolved organic carbon (DOC) concentrations, overall molecular weight, and DOM aromaticity in streams increased significantly ($p < 0.05$) compared to unharvested sites, with an average increase of 35 % in hydrolysable tannin content. The marked increase in oxygenated DOM after forest harvesting could have significant biogeochemical implications, such as the stimulation of heterotrophic microorganisms in downstream aquatic networks, leading to greater greenhouse gas production.

Session: 10050 Linking hydrological and biogeochemical processes in disturbed ecosystems: Implications for watershed management Lier les processus hydrologiques et biogéochimiques dans les écosystèmes perturbés : Implications pour la gestion des bassins versants **03/06/2022 15:10**

ID: 11519 Contributed abstract

Poster Order:

A history of eating garbage and getting gas

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Presented by / Présenté par: ***Daniel Grégoire***
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Landfills generate outsized environmental footprints due to microbial degradation of organic matter in municipal solid waste, which produces the potent greenhouse gas methane. With solid waste production predicted to increase to 3000 Tg by the year 2050, there is a pressing need to better understand the biogeochemical processes that control microbial methane cycling in landfills to curb global methane emissions. In this study, we had the rare opportunity to characterize the microbial community responsible for methane cycling in landfill waste covering a 30 year timeframe. We coupled long term geochemical analyses with whole-community DNA (i.e., metagenomic) sequencing to identify key features that shaped microbial methane cycling communities over the course of a landfill's lifecycle. We observed that anaerobic methane producing microbes are more abundant, diverse, and metabolically versatile in newer waste, which likely fuels rapid methane production early in the landfill's lifecycle. We also observed that aerobic methane oxidizing microbes were found in landfill leachate where low levels of oxygen were present. Despite requiring oxygen to oxidize methane, aerobic methanotrophs exhibited adaptations in their redox metabolisms that would help them to survive steep redox gradients characteristic of landfills. We also provided some of the first examinations of the potential contributions from anaerobic methane oxidizing pathways, which remain completely overlooked in landfills. Finally, we use the biodiversity within landfills as a launch pad to explore the potential for methane oxidation in lineages that are widespread in aquatic and terrestrial habitats whose capacity to metabolize methane has yet to be tested.

Session: 10050 Linking hydrological and biogeochemical processes in disturbed ecosystems: Implications for watershed management Lier les processus hydrologiques et biogéochimiques dans les écosystèmes perturbés : Implications pour la gestion des bassins versants **03/06/2022 15:25**

ID: 11844 Contributed abstract

Poster Order:

Effects of beaver impoundments on surface water mercury concentrations in boreal watersheds along a gradient of forest harvest disturbance

Wai Ying Lam [1] , *Rob Mackereth* [2] , *Carl Mitchell* [3]

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Presented by / Présenté par: ***Wai Ying Lam***

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Studies in boreal regions concerning the bioaccumulative neurotoxin methylmercury (MeHg) in experimental reservoirs and natural wetlands have shown that these waterbodies contribute to high MeHg levels in downstream waterbodies and aquatic organisms. Though beaver impoundments are ubiquitous natural reservoirs in the Canadian boreal region, impacts of beaver impoundments on stream MeHg are not well quantified, particularly in areas experiencing forest harvest. Forest management in Ontario is largely based on emulating impacts of natural disturbances, and beaver impoundments may be the most impactful natural disturbance affecting MeHg in aquatic systems against which to compare. As such, quantifying MeHg impacts of beaver impoundments in landscapes along a gradient of harvest disturbance could assist in defining acceptable export levels of MeHg post-harvest. To examine landscape factors that may play a role in determining the impact of beaver impoundments on stream mercury, water samples were taken upstream and downstream of 10 in-channel beaver impoundments along a gradient of % watershed harvested near Thunder Bay, Ontario, from July to October, 2021. To quantify the impact of beaver impoundments on stream MeHg, the ratio of downstream to upstream MeHg concentrations (D:U MeHg) was calculated for each site. Mercury concentrations at impoundment outflows were up to twenty times higher than at inflows, though the median ratio of outflow to inflow concentrations was much lower (1.6). Type of tree cover, % harvested area, and % watershed draining directly to the impoundment were significant predictors of D:U MeHg. Higher values of % harvest and % coniferous cover, landscape factors associated with higher MeHg concentrations in boreal streams, led to lower median D:U MeHg. These results suggest that MeHg impacts of beaver impoundments can be very substantial but are highly variable among streams, and that impoundment impacts on stream MeHg are lessened in landscapes already conducive to higher MeHg concentrations.

Session: 10050 Linking hydrological and biogeochemical processes in disturbed ecosystems: Implications for watershed management Lier les processus hydrologiques et biogéochimiques dans les écosystèmes perturbés : Implications pour la gestion des bassins versants **03/06/2022 15:40**

ID: 11698 Contributed abstract
Poster Order: Poster-10050

Effects of forest harvesting on mercury concentration, methylation and demethylation in soils and sediment in Canadian boreal forests

Haiyong (Planck) Huang [1] , *Vaughn Mangal* [2] , *Carl Mitchell* [3]

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Presented by / Présenté par: ***Haiyong (Planck) Huang***
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Mercury (Hg), particularly methylmercury (MeHg), is a potent neurotoxin that biomagnifies through terrestrial and aquatic food webs, threatening wildlife and human health. Forest harvesting activities can increase MeHg exports from affected watersheds; however, the specific mechanisms are less understood at a process level. Little empirical research has been conducted to examine methylation and demethylation processes happening within soils and sediment of forest-harvested watersheds. A field investigation was therefore carried out in 4 harvested and 3 unharvested boreal forests in northwestern Ontario to begin to fill these knowledge gaps. Total Hg (THg) and MeHg concentrations as well as first-order potential rate constants for Hg methylation and MeHg demethylation potentials (Kmeth and Kdemeth) in soils and stream sediment were determined. Specifically, these values were compared between years before (2019) and after (2020) forest harvesting activities, as well as between harvested and unharvested watersheds in the same years. We found some increases in THg and MeHg concentrations in upland soils in harvested forests, but concentrations in most wetland/riparian soils and stream sediment remained relatively consistent and some even declined in the first year after harvesting. We found considerable increases in THg and MeHg concentrations, as well as Kmeth and Kdemeth in stream sediment in only one of the harvested watersheds, where there was a significantly smaller than normal vegetated buffer zone. Additional analysis of 2021 samples is ongoing, but these preliminary results suggest that short-term (< 1 year) mercury-related impacts of harvesting activities are mostly constrained within the harvested upland zones and in areas where machinery damage is very close to streams in this particular region.

Session: 10050 Linking hydrological and biogeochemical processes in disturbed ecosystems: Implications for watershed management Lier les processus hydrologiques et biogéochimiques dans les écosystèmes perturbés : Implications pour la gestion des bassins versants **03/06/2022 15:50**

ID: 11804 Contributed abstract
Poster Order:

From road to stream: A process-based integrated watershed model for stream chloride from road salts using SWMM

Bhaswati Mazumder [1] , *Claire Oswald* [2] , *Christopher Wellen* [3]

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Presented by / Présenté par: ***Bhaswati Mazumder***
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Freshwater salinization due to road salt applications is one of the most ubiquitous water quality concerns in North America today. Models that simulate the fate and transport of chloride from road salts in urbanizing watersheds are very rare. Currently there is a need for process-based, continuous models integrating hydrology and water quality (H/WQ) to investigate the response of mesoscale watersheds to future changes in land use, climate and watershed management. The use of process models in the early stages of urban planning and policy design is often deterred by limitations in data, time, and software expertise. In this study, we used the Storm Water Management Model (SWMM), widely used by urban hydrology design and management practitioners, to create a watershed model for Etobicoke Creek – a heavily

urbanized watershed flowing into Lake Ontario. We then evaluated the performance of such a model to simulate future scenarios for planning and decision support, especially when there is limited data for calibration and validation. The model showed satisfactory performance for streamflow with a 0.5 score on both Nash-Sutcliffe Efficiency (NSE) and coefficient of determination (R2). A differential split sample validation was used to assess the robustness of the model to climate change. In the absence of sufficient continuous (sub-hourly) chloride data for calibration, we validated the model using: (a) supplementary model diagnostics such as mean annual flow, runoff depth, seasonal and annual loads, (b) monthly observations of stream chloride concentrations, and (c) daily chloride concentration estimates from a Weighted Regressions on Time Discharge and Season (WRTDS) model. The modeled stream chloride concentrations scored an Integral Square Error (ISE) of 1.26 when compared to a short sub-hourly dataset, which is considered appropriate for planning and preliminary design, suggesting such models can be used to predict relative H/WQ responses to land use, climate, and management scenarios.

Session: 10050 Linking hydrological and biogeochemical processes in disturbed ecosystems: Implications for watershed management Lier les processus hydrologiques et biogéochimiques dans les écosystèmes perturbés : Implications pour la gestion des bassins versants **03/06/2022 16:05**

ID: 11828 Contributed abstract

Poster Order:

Demystifying mercury geochemistry in contaminated soil–groundwater systems with complementary mercury stable isotope, concentration, and speciation analyses

David McLagan [1] , *Lorenz Schwab* [2] , *Jan Wiederhold* [3] , *Lu Chen* [4] , *Jan Pietrucha* [5] , *Stephan Kraemer* [6] , *Harald Biester* [7]

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Presented by / Présenté par: ***David McLagan***
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Interpretation of mercury (Hg) geochemistry in environmental systems remains a challenge. This is largely associated with the inability to identify specific Hg transformation processes and species using established analytical methods in Hg geochemistry (total Hg and Hg speciation). In this study, we demonstrate the improved Hg geochemical interpretation, particularly related to process tracing, that can be achieved when Hg stable isotope analyses are complemented by a suite of more established methods and applied to both solid- (soil) and liquid-phases (groundwater) across two Hg2+-chloride (HgCl2) contaminated sites with distinct geological and physicochemical properties. This novel approach allowed us to identify processes such as Hg2+ (i.e.,

HgCl2) sorption to the solid-phase, Hg2+ speciation changes associated with changes in groundwater level and redox conditions (particularly in the upper aquifer and capillary fringe), Hg2+ reduction to Hg0, and dark abiotic redox equilibration between Hg0 and Hg(II). Hg stable isotope analyses play a critical role in our ability to distinguish, or trace, these in situ processes. While we caution against the non-critical use of Hg isotope data for source tracing in environmental systems, due to potentially variable source signatures and overprinting by transformation processes, our study demonstrates the benefits of combining multiple analytical approaches, including Hg isotope ratios as a process tracer, to obtain an improved picture of the enigmatic geochemical behavior and fate of Hg at contaminated legacy sites.

Session: 10050 Linking hydrological and biogeochemical processes in disturbed ecosystems: Implications for watershed management Lier les processus hydrologiques et biogéochimiques dans les écosystèmes perturbés : Implications pour la gestion des bassins versants **03/06/2022 16:20**

ID: 11663 Contributed abstract

Poster Order:

Modelling the effects of cover cropping on water quality and crop production in agricultural watersheds of Canadian Prairies

Monireh Faramarzi [1]

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Presented by / Présenté par: ***Sepideh Kheirkhah***

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Ecosystem services are the benefits that people obtain from ecosystems, including food, clean water, protection from natural hazards such as floods, among others. The intertwined human benefit and environmental health necessitate the concurrent advancement of services and ecosystem health. As one of the main anthropogenic interventions, agriculture can adversely affect the ecosystem by nutrient release and accumulation in soil and water bodies. This matter is more highlighted in food exporting regions such as Canadian Prairies with intensive agricultural activities to meet domestic and international market demand. The emergence of eutrophication in many receiving water bodies within exporting regions can threaten long-term water and food security. This signifies the value of simultaneous management of water quality and crop production in the agricultural watersheds of exporting regions. Regenerative Agriculture (RA) can promise safer runoff and more sustainable production among food production alternatives. Therefore, this study investigates the effect of RA practices on water quality and crop production at the Nelson River Basin (NRB), the largest river basin in the Canadian Prairies. A process-based agro-hydrological model is developed using the Soil and Water Assessment Tool (SWAT) to represent ecosystems' biogeochemical processes better. The model is calibrated/validated using streamflow, crop yield, sediment, and Phosphorus (P) load data for a baseline period (1982-2016). The role of the cover-cropping regenerative system is then evaluated on sustaining the crop production and variation of P fate and transport from soil to water bodies. This research would shed light for policymakers upon the applicability of the regenerative cover-cropping practice in the concurrent improvement of water quality and crop

production to achieve regional food and water security in exporting regions.

Session: 11031 CSAFM 2: Understanding past, present and future effects of climate on agriculture, forestry and water resources - Part 2 SCMAF 2: Comprendre les effets passés, présents et futurs du climat sur l'agriculture, la foresterie et les ressources en eau - Partie 2 **03/06/2022 14:55**

ID: 11838 Contributed abstract

Poster Order:

Interpreting Drought in the Canadian Prairies Using Machine Learning and SHAP Values

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Presented by / Présenté par: ***Jacob Mardian***
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The Canadian Prairies are prone to drought conditions, posing a significant risk to the agricultural industry. The region experienced particularly severe droughts in 2015, 2017 and 2021, highlighting the need for timely, accurate drought monitoring. The Canadian Drought Monitor (CDM) is produced by Agriculture and Agri-Food Canada using various types of climate and satellite indicators, and adjusted using local expert interpretation across the country. However, the factors driving various CDM categories (e.g., No Drought, Moderate Drought, Extreme Drought) are generally unknown. As a result, the goal of this research is to build a machine learning model to replicate the CDM in the Canadian Prairies and to identify the most important model predictors to facilitate a biophysical interpretation of the CDM. Data were collected for a wide variety of drought indicators, teleconnection indices, and satellite indicators of vegetation, terrestrial water storage, evaporative stress, and soil moisture across many time scales. These predictors were used to train a machine learning model and were subsequently tested over the 2010-2019 period using time-series cross-validation that replicates real-time monitoring one month at a time. Shapley Additive exPlanation (SHAP) values were then used to quantify variable importance for each individual prediction, enabling a detailed analysis of variable importance both spatially and temporally. The machine learning model showed substantial prediction skill in identifying drought and was able to simulate drought events with accurate spatial structure. SHAP value interpretation was able to identify key thresholds in drought indicator values separating the different drought classes and identify teleconnection-drought relationships. The groundwater storage product from Gravity Recovery and Climate Experiment Drought Assimilation for Drought Monitoring (GRACE-DADM) was the top indicator of high intensity drought in the region, suggesting the dataset should be adopted for large-scale drought monitoring. This research provides a data-driven framework for predicting and interpreting drought.

Session: 11031 CSAFM 2: Understanding past, present and **03/06/2022**

future effects of climate on agriculture, forestry and water resources - Part 2 SCMAF 2: Comprendre les effets passés, présents et futurs du climat sur l'agriculture, la foresterie et les ressources en eau - Partie 2 **15:10**

ID: 11817 Contributed abstract
Poster Order:

Projected changes in the hotspots of agriculturally relevant compound events in Western Canada cropping regions under the RCP8.5 scenario

Richard Agyeman [1] , *Fei Huo* [2] , *Zhenhua Li* [3] , *Yanping Li* [4]

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Presented by / Présenté par: ***Richard Agyeman***
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Global warming and the associated changes in extreme precipitation and temperature events pose significant risks to Canadian agriculture. Compound hazards can cause higher crop failure than isolated events. The co-occurrence of droughts and heatwaves also creates a favorable atmosphere for wildfires. This study uses the return periods of events to assess the potential changes in the hotspots of agriculturally relevant compound events in Western Canada. Two convection-permitting climate simulations were examined for the current (CTL) and future climate under the RCP8.5 scenario based on a pseudo-global-warming (PGW) approach. The multivariate quantile mapping method was used to bias-correct the CTL and PGW simulations to the GEM-CAPA dataset. Specifically, our study analyses agricultural drought, low precipitation, heatwaves, and cool waves related to cool-season crops. The results showed the overall good performance of the CTL simulation in capturing spatial patterns of these compound events in western Canada. Droughts and heatwaves co-occur mostly in southeastern parts of the prairies in the current climate. They are likely to increase in frequency and expand to cover the major croplands of western Canada under the RCP8.5 scenario. This study will provide information that can aid in devising appropriate adaptation in the agricultural sector and disaster control.

Session: 11031 CSAFM 2: Understanding past, present and future effects of climate on agriculture, forestry and water resources - Part 2 SCMAF 2: Comprendre les effets passés, présents et futurs du climat sur l'agriculture, la foresterie et les ressources en eau - Partie 2 **03/06/2022 15:25**

ID: 11624 Contributed abstract
Poster Order:

Integrating climate change research into forest and natural resource management, northern British Columbia

Vanessa Foord [1]

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Presented by / Présenté par: ***Vanessa Foord***

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Many climate change related impacts are affecting the forests and natural resources of northern British Columbia, such as wildfires, drought, landslides, and pest outbreaks. Numerous research projects are underway to understand these impacts; however, integrating that understanding into changes in forest and resource management is incredibly complex and challenging. For example, research to understand the impacts of climate change driven ecological drought mortality to trees has been slow to influence forest management, in part because this impact was thought to still be in the future and decision makers need to focus on present challenges. Recent weather and climate conditions in northern British Columbia, especially the heat dome of summer 2021, have shown that these are indeed present challenges that require resource management change to reduce losses from such extreme events. Another example is forest or natural resource climate change studies to date typically focus on mean changes in climate to future periods, whereas increases in extreme events may be limiting factors in the short term. This presentation will explore some of the lessons learned on integrating climate change research to forest and natural resource management decisions with recommendations for scientists and managers on increasing their success in the process and reducing the impacts of climate change.

Session: 11031 CSAFM 2: Understanding past, present and future effects of climate on agriculture, forestry and water resources - Part 2 SCMAF 2: Comprendre les effets passés, présents et futurs du climat sur l'agriculture, la foresterie et les ressources en eau - Partie 2 **03/06/2022 15:50**

ID: 11449 Contributed abstract
Poster Order:

The Severe Drought of 2021 over Prairies: La Nina provides the forcing mechanism

Ray Garnett [1] , *Madhav Khandekar* [2]

1
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Presented by / Présenté par: ***Ray Garnett***
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The impact of the 2021 drought was the most severe in decades for Canadian prairie spring wheat and canola crops. June-July was the driest since 1967 and came with heat matching that of 1988. June and July are the critical period when spring wheat passes through the stem extension and heading stage and canola flowers.
The extremely dry June-July was foreshadowed in early May by capturing the sustained forcing of cooler than normal sea surface temperature anomalies (SSTA's) in the east equatorial Pacific in the late winter and early spring months prior to summer. The ENSO- El Nino/southern Oscillation in conjunction with the PDO-Pacific Decadal Oscillation constitute the largest single source of inter-annual climatic variability on a global scale. It has been well documented that El Nino (warmer than normal SSTAs) is friend and La Nina (colder than normal SSTAs) is foe to grain and oilseed producers on the Canadian prairies.

We show that dry(wet) summers are hot (cool) summers in which 2021 was a prime example. (Besides ENSO & PDO, other large-scale oscillations like the Arctic Oscillation (AO) also impacts Canadian Prairie summer weather patterns.) We investigate drivers such as AO influence in this research. To offer an explanation for the rare dryness and heat experienced over the Eastern Prairies various teleconnection indices are also explored Finally, our study shows no impact of rising levels of CO_2 on the 2021 summer drought as suggested during the previous severe drought cycle of 2001-2003

Session: 11031 CSAFM 2: Understanding past, present and future effects of climate on agriculture, forestry and water resources - Part 2 SCMAF 2: Comprendre les effets passés, présents et futurs du climat sur l'agriculture, la foresterie et les ressources en eau - Partie 2 **03/06/2022 16:05**

ID: 11656 Contributed abstract

Poster Order:

Land hydroclimatology of the Laurentian Great Lakes region in changing climate

Narayan Shrestha [1] , *Frank Seglenieks* [2] , *André Temgoua* [3] , *Armin Dehghan* [4]

[1] ECCC
[2] ECCC
[3] ECCC
[4] ECCC

Presented by / Présenté par: ***Narayan Shrestha***
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We used high resolution bias-correction climatic forcings from 36 GCM-RCM combinations as input to a widely used hydrological model (WATFLOOD), calibrated and validated for streamflow and evaluated against snow water equivalent and actual evapotranspitation, to assess changes in land-area precipitation, temperature, snowpack and actual evapotranspiration in future periods (mid-century, 2035-2064 and end-century, 2065-2094) with reference to a baseline period (1951-2005) for two emission scenarios (RCP4.5 and RCP 8.5). Increases in annual precipitation (7 to 15%) and annual mean temperature (2.4 to 5.0oC) indicate wetter and warmer future conditions on GL land areas. Seasonal and monthly changes in precipitation and mean temperature are more sporadic (e.g., decreases in summer precipitation). Results also show projected decreases in annual snowpack (29 to 58%) and projected increases in actual evapotranspiration (up to 0.4mm/day). While annual runoff is expected to increase (up to 48% in Superior, 40% in Michigan-Huron, 25% Erie and 28% in Ontario), sporadic seasonal and monthly changes in runoff are also evident (e.g., decrease up to 17% in Erie subdomain in October). Such contrasting patterns of changes in land hydroclimatology of the GL region will pose challenges to sustainable management of the water resources of the region in future.

Session: 11031 CSAFM 2: Understanding past, present and future effects of climate on agriculture, forestry and water resources - Part 2 SCMAF 2: Comprendre les effets passés, **03/06/2022 16:20**

ID: 11651 Contributed abstract

Poster Order:

Future water levels for the Great Lakes under 1.5°C to 3°C warmer climates

Frank Seglenieks [1] , *André Temgoua* [2]

[1] Environment and Climate Change Canda
[2] Environment and Climate Change Canda

Presented by / Présenté par: ***Frank Seglenieks***
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With the many different interests that are connected to the water levels of the Laurentian Great Lakes, the future of these water levels are of great concern to many people, businesses, and institutions. In this study, projected future lake levels were calculated using data from the North American component of the Coordinated Regional Downscaling Experiment. The final lake level results are presented in relation to a 1.5°C, 2.0°C, 2.5°C, and 3.0°C change in global mean temperature.

The results show that the range of possible values grows as the climate changes, with more extreme values for the lake levels becoming possible with greater changes in the global mean temperature. This increase in the range on both the high and low end may be a more important consideration than any general increase in the average water level for those living around the lakes. Since the most severe impacts on the interests around the lake are usually associated with these extreme high or low levels.

A greater understanding that the extremes in water levels observed in the past may be exceeded under a changing climate will help in the planning of future developments and activities within the Great Lakes basin with a forward looking coastal risk assessment and help communities build resilience to future extremes.

Session: 14042 Novel Approach in Seasonal Snow: Field Measurements, Remote Sensing, Modeling, and Data Assimilation & Analytics - Part 3 Nouvelle approche dans la neige saisonnière: mesures sur le terrain, télédétection, modélisation et assimilation et analyse de données -Partie 3 **03/06/2022 14:55**

ID: 11540 Invited session speaker

Poster Order:

Merging models with observations to support open science, NASA SnowEx, and snow satellite missions

Melissa Wrzesien [1] , *Sujay Kumar* [2] , *Carrie Vuyovich* [3] , *Rhae Sung Kim* [4] , *Eunsang Cho* [5]

1
2
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[4]
[5]

Presented by / Présenté par: ***Melissa Wrzesien***
Contact: melissa.l.wrzesien@nasa.gov

Seasonal snow accumulation and melt have a critical role in global water and energy budgets, and the 2017 Earth Science Decadal Survey recommended snow water equivalent (SWE) as an "explorer priority" for future missions. In recent years, NASA SnowEx field campaigns have tested multiple remote sensing techniques as potential mission concepts by collecting ground and airborne observations of snow across a range of land cover and snow types. However, a single sensor will not be able to provide estimates of all snow types in all conditions globally; instead, an integrative approach is required, utilizing multiple observational sources and merging them with models for complete spatiotemporal coverage.
To address the need for an observation-model merging environment for improving estimates of snow properties such as SWE, snow density, snow grain size, and albedo, we discuss plans for the upcoming 2023 SnowEx Alaska campaign. Field and modeling efforts will be brought together, including running near real-time model simulations with the NASA Land Information System (LIS) and designing assimilation experiments once field observations have been collected. We also present ongoing efforts with the NASA Earth Information System (EIS), a project focused on open science and improving the accessibility of data. Discussions will include a pilot study of extreme snowmelt flooding in the Midwest U.S. and how EIS efforts can help build an observation-model environment for snow that addresses the need for open-source science. Such data integration approaches not only benefit field campaigns but merging model and field efforts will also be a crucial step in a future snow mission. This presentation will include a discussion on how the SnowEx model-data fusion work can inform future plans for a snow satellite mission and how such efforts should meet NASA's commitment to open science.

Session: 14042 Novel Approach in Seasonal Snow: Field Measurements, Remote Sensing, Modeling, and Data Assimilation & Analytics - Part 3 Nouvelle approche dans la neige saisonnière: mesures sur le terrain, télédétection, modélisation et assimilation et analyse de données -Partie 3 **03/06/2022 15:25**

ID: 11787 Contributed abstract
Poster Order:

Climate driven changes in snowpack: simulations (1970s to 2020) for the Bay of Quinte, Ontario, Canada

Agnes Richards [1] , *Félix Ouellet* [2] , *Érika Boisvert-Vigneault* [3] , *Xiaoyuan Geng* [4] , *Alexandre Langlois* [5]

[1] Environment and Climate Change Canada
[2] Environment and Climate Change Canada
[3] Sherbrooke University
[4] Agriculture and Agri-Food Canada
[5] Sherbrooke University

Presented by / Présenté par: ***Félix Ouellet***

Contact: Agnes.Richards@ec.gc.ca

SNOWPACK simulations that capture climate driven changes in snow-water equivalent (SWE) and snow cover will be presented from the 1970s to 2020 for the entire Bay of Quinte watershed located in Ontario, Canada. This is an Area of Concern, listed under the Great Lakes Water Quality Agreement due to consistent harmful algal blooms resulting from excessive phosphorus runoff from the watershed. Future management actions should consider the effects of climate change, such as increased frequency and intensity of storm events. These events will amplify erosion and leaching of phosphorus from soils, while ruptured vegetation from freeze-thaw will also contribute to further leaching. Our simulations focus on the changes in snow parameters, specifically SWE which drives snow melt. Other parameters such as snow density will also be discussed. Preliminary simulations show a substantial change in SWE, especially after 2000. The implications of changes in SNOWPACK on runoff and nutrient loadings will be discussed.

Session: 14042 Novel Approach in Seasonal Snow: Field Measurements, Remote Sensing, Modeling, and Data Assimilation & Analytics - Part 3 Nouvelle approche dans la neige saisonnière: mesures sur le terrain, télédétection, modélisation et assimilation et analyse de données -Partie 3 **03/06/2022 15:40**

ID: 11800 Contributed abstract
Poster Order: Poster-14042

Assimilation of GRACE / GRACE-FO Terrestrial Water Storage Retrievals to Improve Snow Mass Estimates across North America

Alireza Moghaddasi [1] , *Barton Forman* [2]

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Presented by / Présenté par: ***Alireza Moghaddasi***
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Accurate estimation of snow mass, and its change in space and time, is necessary for the optimal management of freshwater resources, especially in regions of complex terrain. Assimilation of remotely-sensed observations into a land surface model (LSM) can help better characterize snow mass. Gravimetric observations collected by the Gravity Recovery and Climate Experiment (GRACE / GRACE-FO) are a useful complement to more traditional means of snow remote sensing (i.e., passive microwave radiometry) because, unlike radiometers, gravimetry does not suffer from signal saturation in the presence of deep and/or wet snow. However, gravimetry has its own limitations, primarily in the form of coarse spatial and temporal resolutions.

The Noah-MP land surface model without the benefit of assimilated observations (a.k.a., Open Loop; OL) is first investigated within the NASA Land Information System (LIS) to estimate hydrologic states and fluxes (including snow) across North America. GRACE-based retrievals of terrestrial water storage (TWS) are then assimilated into the Noah-MP model using an ensemble Kalman filter in order to dynamically update model-derived estimates

of snow water equivalent (SWE) based on the TWS retrievals. To evaluate changes in modeled snow with and without assimilation, model results are validated against ground-based measurements of snow mass across North America obtained from the Canadian Snow Water Equivalent dataset (CanSWE), the United States SNOTEL network, and the European GlobSnow product. Preliminary results suggest improvement in terms of both snow amount and timing of snow accumulation and ablation in regions where snow is a significant contributor to the hydrologic cycle. Findings from this study will help water resources managers by providing useful information that ultimately leads to better characterization of snow in regions with limited ground-based stations and in places where snow is variable across time and space.

Session: 14042 Novel Approach in Seasonal Snow: Field Measurements, Remote Sensing, Modeling, and Data Assimilation & Analytics - Part 3 Nouvelle approche dans la neige saisonnière: mesures sur le terrain, télédétection, modélisation et assimilation et analyse de données -Partie 3 **03/06/2022 15:45**

ID: 11584 Contributed abstract
Poster Order: Poster-14042

Evaluation of three different machine learning algorithms for snow mass estimation over the Colorado Rockies using space-based passive microwave brightness temperatures

Bincheng Yu [1] , *Barton Forman* [2]

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Presented by / Présenté par: ***Bincheng Yu***
Contact: jerryyu@umd.edu

Bincheng Yu and Barton A. Forman

This study compares the performance of three different machine learning algorithms used for snow water equivalent (SWE) estimation. Inputs to these algorithms include passive microwave (PMW) brightness temperature (Tb) observations at 10.65 GHz, 18.7 GHz, and 36.5 GHz at both vertical and horizontal polarization as collected by the Advanced Microwave Scanning Radiometer (AMSR-2). The three algorithms include: 1) support vector machine (SVM) regression, 2) long short-term memory (LSTM) networks, and 3) Gaussian process (GP) regression. In-situ SWE measurements from the SNOTEL network collected across western Colorado are used as the training “targets” during the training procedure. The performance of the algorithms is evaluated using a number of different metrics including, but not limited to, root mean square error (RMSE), correlation coefficient, mean square error (MSE), and bias. The evaluation is conducted over a range of different elevations and different land cover classifications in order to assess algorithm performance across a broad range of snowpack conditions. Preliminary results suggest the LSTM algorithm is computationally more efficient during the training process as compared to the other algorithms yet yields a similar level of performance. Some limitations, however, have been found in the study, including poor performance during deep snow conditions, which is likely related to signal

"saturation” within the PMW Tb’s used during the supervised training process. Additionally, algorithm performance is strongly dependent on the amount of training data such that too little training data results in poor performance by the algorithm at successfully reproducing inter-annual variability. The strengths and limitations of these different machine learning algorithms for snow mass estimation will be discussed.

Session: 14042 Novel Approach in Seasonal Snow: Field Measurements, Remote Sensing, Modeling, and Data Assimilation & Analytics - Part 3 Nouvelle approche dans la neige saisonnière: mesures sur le terrain, télédétection, modélisation et assimilation et analyse de données -Partie 3 **03/06/2022 15:50**

ID: 11712 Contributed abstract
Poster Order:

An Observing Simulation System Experiment (OSSE) for Snow Mass Estimation over Western Colorado Using Adaptive Viewing from Space

Lizhao Wang [1] , *Colin McLaughlin* [2] , *BARTON Forman* [3] , *Sujay Kumar* [4] , *Paul GROGAN Grogan* [5] , *Rhae Sung Kim* [6] , *Melissa Wrzesien* [7]

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Presented by / Présenté par: ***Lizhao Wang***
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Snow plays a key role in the freshwater supply of many basins with headwaters in mountainous regions. Optical LiDAR is a promising technology that can help improve our knowledge of snow mass. However, optical LiDAR viewing, in general, is significantly constrained by swath width limitations and cloud attenuation. One potential technique to ameliorate this issue is to dynamically slew the space-based sensor so that it preferentially views the target of interest, and as a result, observes the target of interest (i.e., snow-covered land) more often relating to a traditional, fixed viewing approach.
In this study, we develop an observing simulation system experiment (OSSE) in order to explore the trade-off space between a strategy of fixed sensor viewing versus adaptive sensor viewing. In the experiment, we first generate a “synthetic truth” of snow depth using the NoahMP-4.0.1 land surface model within the NASA Land Information System (LIS). Afterwards, synthetic snow depth retrievals for a given LiDAR configuration are generated using both fixed and adaptive viewing strategies, respectively. Next, a realistic amount of observation error is then injected into the synthetic retrievals so that they serve as a reasonable proxy for real-world LiDAR retrievals. The synthetic retrievals are then assimilated into NoahMP-4.0.1 using an ensemble Kalman filter (EnKF) in order to help quantify the added value that each type of snow retrieval has on the land surface model performance. The results from this

OSSE help reveal the advantages (and disadvantages) of adaptive viewing strategies, and in turn, can help mission planners in determining how to get the most observational "bang for the buck" in the selection of a future snow mission.

Session: 14042 Novel Approach in Seasonal Snow: Field Measurements, Remote Sensing, Modeling, and Data Assimilation & Analytics - Part 3 Nouvelle approche dans la neige saisonnière: mesures sur le terrain, télédétection, modélisation et assimilation et analyse de données -Partie 3 **03/06/2022 16:05**

ID: 11846 Contributed abstract

Poster Order:

Predicting Surface Density using Snow Models and Assimilation for Wildlife Applications

Michael Druand [1] , *Jack Dechow* [2] , *Jessica Lundquist* [3] , *Laura Prugh* [4] , *Ben Sullender* [5] , *Cassie Lumbrazo* [6] , *Katie Breen* [7] , *Calum Cunningham* [8]

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Presented by / Présenté par: ***Michael Druand***
Contact: dechow.5@osu.edu

Surface layer snow density is correlated with the depth that animals sink into snow, which in turn controls their mobility and ultimately impacts predator-prey dynamics. Snow model density parameterizations have a long history, and thus are a promising tool to predict wildlife dynamics. However, surface snow density is challenging to predict in areas that experience melt-refreeze metamorphism in part because it is challenging to accurately predict brief periods of snowmelt. This suggests the use of spaceborne land surface temperature (LST) measurements to correct the model. Here, we explore ability of the NoahMP snow model in conjunction with the NASA Land Informatic System Framework (LIS or LISF) in order to predict surface snow density with and without LST assimilation at a range of spatial resolutions from 1 km to 30 m in Washington State. We evaluate against field surveys of surface snow density made in winter 2021 and 2022. Without assimilating LST, we have successfully predicted whether the density was greater or less than 275 kg m^3 for 80% of snow pits. We have now began assimilating MODIS LST measurements in order to correct the model predictions of meltwater within the snowpack and improve estimates. Furthermore, we have begun to analyze the SWE estimates from the model as well. We use the improved density results of the model and assimilation study to assess the possible utility of snow modeled density to predict snow wildlife dynamics.

ID: 11419 Contributed abstract

Poster Order:

Spatiotemporal assessment of snow density and Snow Water Equivalent (SWE) using the Cone Penetration Test (CPT) and/or Ground Penetrating Radar (GPR)

Adrian McCallum [1]

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Presented by / Présenté par: ***Adrian McCallum***

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In situ tests such as the Cone Penetration Test (CPT) are useful for establishing stratigraphy and physical properties of frozen geomaterials such as snow and ice. Particularly, snow density can be estimated using CPT and these data can then be spatially extrapolated using Ground Penetrating Radar (GPR). Further, GPR can potentially be used in isolation to assess spatiotemporal variability of snow surface and sub-surface snow density, enabling changes in Snow Water Equivalent (SWE) to be estimated. Almost 100 CPTs conducted in Antarctica demonstrated the potential to assess snow density and mass balance variability, directly from CPT data, and GPR testing in the Australian Alps suggested the ability to estimate both surface and sub-surface snow-density, by assessing amplitude variation from air-coupled GPR surveys. Combination of these tests may enable efficient spatiotemporal estimation of snowpack density and SWE variability.

Session: 5030 Space-Based Earth Observation: Climate Information for Society - Part 1 Observation de la Terre depuis l'espace : informations climatiques pour la société - Partie 1 **06/06/2022 08:25**

ID: 11794 Contributed abstract

Poster Order:

HAWC (High altitude Aerosols, Water vapour and Clouds) on the Atmosphere Observing System (AOS)

Thomas Piekutowski [1]

[1]

Presented by / Présenté par: ***Thomas Piekutowski***

Contact: thomas.piekutowski@asc-csa.gc.ca

HAWC (High altitude Aerosols, Water vapour and Clouds) is the proposed Canadian contribution to NASA's Atmosphere Observing System (AOS) mission (2030 launch into polar orbit). The AOS mission is a component of the landmark Earth System Observatory (ESO) to which Canada was invited to contribute. Offering breakthrough technologies to enhance Earth observations, HAWC integrates three (3) innovative Canadian scientific instruments: ALI, SHOW and TICFIRE

1. ALI on a Canadian spacecraft: limb sounding of aerosols
2. SHOW on a Canadian spacecraft: limb sounding of water vapour
3. TICFIRE on a NASA spacecraft: nadir sounding of clouds in the thermal and far infrared

The swath to be observed by the Canadian instruments will allow information obtained by the narrow beam lidar (0.1 km footprint) and radar (1.5 km footprint) to be expanded laterally, providing detailed cloud, aerosol and water vapour measurements with wide coverage and over a high range of altitudes. The Canadian instruments have strong synergies between themselves with other AOS instruments, and can improve observations of many variables listed in the AOS Science and Applications Traceability Matrix. Each instrument addresses a gap in the AOS baseline capability, and in combination, the three instruments provide strong synergies that address NASA requirements for AOS, and extend these measurements to the coldest regions of the world.

Measurements made by HAWC and AOS will lead to improvements in near-term predictions of weather, air quality and surface hydrology, and in long-term climate projections. They will do so by providing data to initialize forecast models and help improve the representations of many physical processes within Numerical Weather Prediction (NWP) models, air quality forecasting models, and Earth System Models (ESMs).

Session: 5030 Space-Based Earth Observation: Climate Information for Society - Part 1 Observation de la Terre depuis l'espace : informations climatiques pour la société - Partie 1 **06/06/2022 08:40**

ID: 11599 Contributed abstract

Poster Order:

HAWC - a Canadian instrument suite for measurements of clouds, aerosol and water vapour: End to end simulators

Landon Rieger [1], *Jeff Langille* [2], *Yann Blanchard* [3], *Adam Bourassa* [4], *Jean-Pierre Blanchet* [5], *Doug Degenstein* [6]

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[2] University of New Brunswick
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[5] Université du Québec à Montréal
[6] University of Saskatchewan

Presented by / Présenté par: ***Landon Rieger***
Contact: landon.rieger@usask.ca

Clouds, aerosol and water vapour in the upper troposphere and lower stratosphere remain a driving force in climate uncertainty. Each of these species has important impacts on the Earth system, however their interactions have been historically difficult to measure. To study these critically important factors, Canada has proposed the High altitude Aerosols, Water vapour and Clouds (HAWC) observation system. HAWC is composed of three instruments. The Thin Ice Clouds and Far Infrared Emissions (TICFIRE) instrument is a nadir-viewing imaging radiometer covering the mid- to far-infrared to target thin ice cloud properties and to provide critical information to study cloud radiative effects and the atmospheric water cycle. High resolution vertical profiles of water vapour will be measured from the limb geometry using Spatial Heterodyne Observation of Water, or SHOW. Lastly, the Aerosol Limb Imager (ALI) will measure 2D multi-spectral views of the limb, providing information on cloud tops and aerosol microphysical properties.

To understand the performance and scientific benefits of the complete HAWC system, end-to-end simulation packages for the three instruments are crucial. The simulators implement realistic input atmospheres, instrument models aligned with Phase 0 concepts, and simulated retrievals to estimate the impact of noise levels, calibration errors and a priori assumptions on the level 2 products. This work presents the software models used for the end-to-end simulators, predicted instrument performance and retrieval algorithms.

Session: 5030 Space-Based Earth Observation: Climate Information for Society - Part 1 Observation de la Terre depuis l'espace : informations climatiques pour la société - Partie 1 **06/06/2022 08:55**

ID: 11671 Contributed abstract

Poster Order:

HAWC - a Canadian instrument suite for measurements of clouds, aerosol and water vapour: Applications of end-to-end simulators to UTLS studies

Yann Blanchard [1], *Jeff Langille* [2], *Landon Rieger* [3], *Adam Bourassa* [4], *Jean-Pierre Blanchet* [5], *Doug Degenstein* [6]

[1] Université de Québec À Montréal
[2] University of New Brunswick
[3] University of Saskatchewan
[4] University of Saskatchewan
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[6] University of Saskatchewan

Presented by / Présenté par: ***Yann Blanchard***
Contact: yann.blanchard@usherbrooke.ca

The processes involving aerosols, clouds, water vapour cycle and their feedback mechanisms remain large sources of uncertainty in our understanding of Earth’s climate system. At cold temperature, in lean aerosol and water vapour environment, the coupling between ice forming nuclei, 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 upper troposphere and lower stratosphere (UTLS) feed back on cloud radiative forcing to promote further convection. Despite growing evidence of strong coupling between aerosol and atmospheric water cycle in the UTLS region, few coincident observations are available. Canada has proposed the High-altitude Aerosols, Water vapour and Clouds (HAWC) observation system. HAWC is composed of three instruments: Aerosol Limb Imager (ALI), Spatial Heterodyne Observation of Water (SHOW) and Thin Ice Clouds and Far Infrared Emissions (TICFIRE).
This work presents the results of the simulation framework for 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. The strong synergy of HAWC on aerosol, water, cloud, precipitation, and radiation interaction in the cold regions of the globe and UTLS is highlighted through selected scenes.

Session: 5030 Space-Based Earth Observation: Climate Information for Society - Part 1 Observation de la Terre depuis l'espace : informations climatiques pour la société - Partie 1 **06/06/2022 09:20**

ID: 11723 Contributed abstract

Poster Order:

A satellite climatology of relative humidity profiles, outgoing thermal radiation, and the super-greenhouse, over Earth's oceans

Colin Goldblatt [1] , *Carsten Abraham* [2] , *Maura Dewey* [3]

[1]
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[3] Stockholm University

Presented by / Présenté par: ***Colin Goldblatt***
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We use satellite observations of Earth’s atmospheric water to develop a climatology of relative humidity profiles over the oceans and to identify regions experiencing super-greenhouse conditions, and to examine the temporal

variation of both the relative humidity and the super-greenhouse. We use a k-means clustering technique applied to data from the Atmospheric Infrared Sounder on Aqua to quantitatively sort observed relative humidity profiles into classes (6 classes for clear-sky observations, 8 classes for all-sky observations), then examine the relationships between these classes, the underlying sea surface temperature, and the outgoing longwave radiation. In particular, we note that in the tropics increasing sea surface temperature is associated with transition to moister relative humidity classes and decreasing outgoing longwave radiation, the super-greenhouse effect. We are thus able to determine criteria for identifying regions in super-greenhouse, for which we also produce a climatology. We further examine how the climatologies of relative humidity and the super-greenhouse change with time, changing seasonally, in response to large-scale atmospheric dynamics (the Madden-Julian Oscillation and El Nino-Southern Oscillation), and some indications of a secular increase in super-greenhouse conditions.

Session: 5030 Space-Based Earth Observation: Climate Information for Society - Part 1 Observation de la Terre depuis l'espace : informations climatiques pour la société - Partie 1 **06/06/2022 09:35**

ID: 11471 Contributed abstract

Poster Order:

The spatiotemporal variability of the outgoing longwave radiation in the far-infrared

Han Haung [1] , *Quentin Coopman* [2] , *Ivy Tan* [3] , *Yi Huang* [4] , *Jean-Pierre Blanchet* [5]

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Presented by / Présenté par: ***Han Haung***
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The outgoing longwave radiation (OLR) at the top of the atmosphere is a critical component of the Earth's radiation energy budget. A substantial portion of the OLR energy lies in the far-infrared (FIR) spectrum, which has not been directly measured for understanding weather and climate variations. Several satellite projects under development, including the Thin Ice Cloud in Far Infrared Experiment (TICFIRE, Blanchet et al. 2011) funded by the Canadian Space Agency, the Polar Radiant Energy in the Far Infrared Experiment (PREFIRE, L’Ecuyer et al., 2021) of U.S. NASA, and the Far-Infrared Outgoing Radiation Understanding and Monitoring (FORUM, Palchetti et al., 2020) of the European Space Agency, are aiming to fill this observation gap. Given that the FIR observation data is not available yet, we use simulations to acquire prior knowledge of the climatological mean distribution of the OLR in FIR as well as its variability, by using a rapid radiative transfer model, RRTMG, to simulate spectrally decomposed OLR in different spectral bands from global instantaneous atmospheric profiles of the fifth generation European Centre for Medium-Range Weather Forecasts atmospheric reanalysis (ERA5). On the other hand, we use the synthetic data based on Global Climate Models (GCMs)

to assess the climate change signals in the FIR and its dependence on key cirrus and mixed-phase cloud microphysical variables. Furthermore, using a diagnostic technique, we dissect the OLR by attributing its distribution and variation to vertically decomposed contributions of the atmosphere and Earth surface in order to understand its spatiotemporal variability. This work provides an initial global view of the FIR measurements to be acquired in near future.

Session: 5030 Space-Based Earth Observation: Climate Information for Society - Part 1 Observation de la Terre depuis l'espace : informations climatiques pour la société - Partie 1 **06/06/2022 09:50**

ID: 11360 Contributed abstract

Poster Order:

Consistency of precipitation products over eastern North America

Tangui PICART [1] , *Alejandro Di Luca* [2] , *René Laprise* [3]

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Presented by / Présenté par: ***Tangui PICART***
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A multitude of precipitation products are available today and thus providing as many precipitation estimates. The consistency across these estimates depends on the quantity or distance metric of interest. They generally show an overall agreement when considering spatial or long-term mean values. However, they show important differences when comparing patterns at specific times or when looking at fine-spatial details (e.g., coastlines and lakes). The objective of this study is to evaluate the consistency of six precipitation products (based on radar, satellite, and in-situ observations) using four distance metrics and test their sensitivity to several methodological choices. The analysis is performed for the 2015 – 2019 period over eastern North America. Three metrics are defined to highlight the impact on consistency of temporal and spatial averages. They are based on the mean precipitation over the domain (spatial and temporal averages), the mean precipitation at each point (temporal average) and the instantaneous precipitation (no average). They show that precipitation products are more consistent on mean precipitation than on how precipitation occurs. In order to compare the use of climatologic variables over instantaneous precipitation, a fourth metric is defined, consisting in decomposing the precipitation at each grid point according to the number of times precipitation occurs (i.e., the frequency) and the precipitation amount (i.e., the intensity). This metric and the instantaneous precipitation-based one share similar geographical patterns of disparities in precipitation variability. When expressed as percentage of the local mean precipitation, largest discrepancies are noted around the Great Lakes and more generally over lakes and large water bodies. The precipitation intensity and frequency are sensitive to methodological choices such as the product resolution or the minimum precipitation threshold choice. The same analysis for different methodological choices shows that products consistency tends to increase as the temporal or spatial resolution of the dataset decreases.

Session: 7040 Extreme Precipitation: Past, Present, Future - Part 1 Précipitations extrêmes: passé, présent et futur - Partie 1

06/06/2022 08:25

ID: 11842 Contributed abstract

Poster Order:

Multi-model evidence for the “intense gets intenser” pattern of extreme precipitation in a warmer climate

Chao Li [1] , *Rui Ma* [2] , *Francis Zwiers* [3]

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Presented by / Présenté par: ***Chao Li***
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The “intense gets intenser” pattern of extreme precipitation with global warming has been found in large ensemble initial-condition simulations from limited global and regional climate models. Using a large ensemble of North American regional climate simulations, we have reported in a previous study that most land areas (>75%) in North America tend to experience more rapid intensification of more extreme precipitation events as climate warms. Estimating long-term responses of very rare precipitation extremes that are expected to occur once in a period of multiple years to multiple decades is unlikely possible from the limited observations, but requires large ensemble initial-condition simulations so as to adequately sample the influence of internal climate variability. Until recently, only a few climate modeling centers have conducted such large ensemble simulations, limiting multi-model evidence for the “intense gets intenser” pattern in different regions of the globe, which is important for adaption policy. This talk pursues this question using a suite of recently available large ensemble initial-condition simulations from multiple global climate models.

Session: 7040 Extreme Precipitation: Past, Present, Future - Part 1 Précipitations extrêmes: passé, présent et futur - Partie 1

06/06/2022 08:40

ID: 11468 Contributed abstract

Poster Order:

Influence of Horizontal Model Resolution on the Spatial Scale of Extreme Precipitation Events

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Presented by / Présenté par: ***Syed Muhammad Anas Ali***
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Previous work has shown that strong ascending motion is a key driver of extreme precipitation events (EPEs). Thus, the horizontal spatial scales of this

"extreme ascent" are likely important for determining the spatial scales of EPEs. Understanding how climate models capture horizontal scales of ascending anomalies is critical to understanding and assessing climate model projections of extreme precipitation.

Analyzing 14 models participating in the Coupled Model Intercomparison Project phase 6 (CMIP6), we show that model resolution is a key influence on the horizontal scales of extreme ascent. We compute the horizontal scale for a given EPE as the e-folding distance of the vertical velocity anomaly on the day of the EPE, which is scaled to produce an inverse wavenumber. We then composite these horizontal scales over all annual maximum EPEs between 1981 and 2000 for each model. We focused on the horizontal scale zonally averaged over the 40-70S latitude band. Our analysis suggests that model horizontal resolution places an upper limit on the horizontal scale of extreme ascent. Models with around 150 longitude points have mean horizontal scales topping out at approximately 400 km, and this upper limit decreases to approximately 300 km for models with 500 longitude points.

Additional analysis shows that the horizontal scales for geopotential anomalies during EPEs have no clear resolution dependence. However, the horizontal scales computed from geopotential were generally larger (700-1100 km) compared to horizontal scales computed from vertical velocity anomalies, and more in line with theoretical expectations based on the Rossby radius of deformation. Altogether, these results suggest that the simulated large-scale dynamics associated with EPEs is realistic, and the resolution dependence of extreme ascent is likely due to representation of other processes like convection.

Session: 7040 Extreme Precipitation: Past, Present, Future - Part 1 Précipitations extrêmes: passé, présent et futur - Partie 1 **06/06/2022 08:55**

ID: 11554 Contributed abstract

Poster Order:

Using a model comparison to support the interpretation of event attribution for extreme precipitation

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Presented by / Présenté par: ***Megan Kirchmeier-Young***
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Extreme event attribution is used to evaluate the role of anthropogenic climate change in the occurrence or characteristics of extreme events. To be most useful, event attribution should be interpreted in the proper context and one part of this is understanding when event attribution results are robust. With a focus on extreme precipitation, we investigate some factors contributing to the robustness of event attribution, by evaluating the roles of model choice, spatial scales, and ensemble sizes. We compare six single-model large ensembles to determine for which regions and variables there is agreement on at least two-fold changes in the likelihood of extreme precipitation events. In some regions,

low signal to noise contributes to a lack of agreement on at least two-fold increases in the likelihood of extreme precipitation events in the current climate, but more model agreement at a global warming level of 3C. In other regions, however, model differences remain, even at a 3C global warming level. We also demonstrate a high sensitivity to the sample size used to estimate the probabilities, particularly when likelihood changes are small. Understanding where and when models do or do not agree on changes in large-scale precipitation extremes can be used to inform the design and interpretation of the local-scale analysis of specific events.

Session: 7040 Extreme Precipitation: Past, Present, Future - Part 1 Précipitations extrêmes: passé, présent et futur - Partie 1 **06/06/2022 09:10**

ID: 11676 Contributed abstract

Poster Order: Poster-7040

Impact of Future Climate on Extreme Precipitation: A Case Study of the 2013 Alberta Flooding Event

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Presented by / Présenté par: ***Xiaohui Zhao***
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The global hydrological cycle is intensifying in the context of greenhouse gas (GHG)-induced warming, which likely enhances extreme precipitations and increases flood hazard risk. Extreme precipitations and associated flooding often cause significant societal disruption; therefore, it is imperative to understand the changes of extreme precipitation events in the future GHG-induced warming climate scenario. Many studies have investigated future changes in extreme precipitation; however, most of the previous studies have focused on the frequency and intensity changes of extreme precipitation events from a statistical or climatological perspective. By contrast, relatively few studies have investigated the physical response of a single extreme precipitation event to future climate.
This research focuses on a particular heavy rainfall event and aims to understand its changes and physical responses to global warming under the Representative Concentration Pathway 8.5 (RCP8.5) emission scenario using a pseudo global warming (PGW) approach. The case studied in this work is the 2013 Alberta heavy rainfall event, which brought severe flooding and socio-economic damage to many locations in southern Alberta on 19-21 June 2013. This work will study the changes and physical response of the 2013 Alberta heavy rainfall event to future climate by running two high-resolution WRF simulations. The first experiment is forced with 6-h European Centre for Medium-Range Weather Forecast Interim (ERA-Interim) reanalysis data; the second experiment is forced with 6-h perturbed ERA-Interim reanalysis data (i.e., ERA-Interim reanalysis + climate change signal derived from 5 CMIP5 GCMs under the RCP8.5 scenario).

Session: 7040 Extreme Precipitation: Past, Present, Future - Part 1 Précipitations extrêmes: passé, présent et futur - **06/06/2022 09:20**

Partie 1

ID: 11669 Contributed abstract

Poster Order:

A new concept of max-stable vector to analyze and predict the probability of precipitation extremes

Mohamed Ali Ben Alaya [1] , *Francis W. Zwiers* [2] , *Xuebin Zhang* [3]

1
2
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Presented by / Présenté par: ***Mohamed Ali Ben Alaya***
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Accurate estimation of the occurrence of extreme precipitation events exceeding the maximum observed values is necessary in many technical mitigation and adaptation procedures. A frequently used approach to solve this type of problem involves the statistical theory of extreme values (EVT). As a solution, classical EVT uses the max-stability assumption, which only holds under certain regularity conditions. Extremes in nature, however, are likely to be non-regular as well as dependent. Here, we introduce a new empirical concept of a local max-stable vector for the analysis and characterization of non-regular dependent extremes. We show how the concept can be used to design an extreme value analysis procedure that is specific to precipitation. We illustrate the approach at several locations in Canada by conceiving a procedure that is guided by observations but also leverages additional information about variation deeper in the upper tail than can be obtained from observations that derives from a large ensemble of CanRCM4 simulations.

Session: 7040 Extreme Precipitation: Past, Present, Future - Part 1 Précipitations extrêmes: passé, présent et futur - Partie 1

06/06/2022 09:35

ID: 11725 Contributed abstract

Poster Order:

Compound flooding analysis over the Canadian coastal zones

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Presented by / Présenté par: ***Farshad Jalili Pirani***
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Severe weather events such as extratropical cyclones can lead to compound flooding across Canadian coastal areas. The interactions between the corresponding fluvial, pluvial, and/or coastal drivers can exacerbate the impacts associated with individual mechanisms. Using the historical tidal gauge records, precipitation and streamflow data, we quantify the compound flooding risks across the three main Canadian coastal zones (Pacific, Great Lakes and the Atlantic coasts). Based on the pair-copulas, we characterize the dependence

structure between flooding drivers followed by the Bayes theorem to infer the corresponding dependence parameters and their associated uncertainties. Further, a trivariate extreme analysis is performed at each location to represent the joint behavior of the three drivers. Finally, the joint return periods (JRP) and failure probabilities (FPs) corresponding to AND, OR and Kendall flood hazard scenarios are compared with the univariate RPs/FPs. The analyses are conducted considering both stationary and non-stationary joint structures. Results highlight the underestimation of flooding risks at almost half of the studied locations across the three regions (especially the Pacific and Atlantic coasts) when the individual flood hazards are analyzed in isolation. For a design lifetime of 50 years, the FPs can be underestimated by almost 70% when the interrelationships between drivers are not considered at the Atlantic region. The results of the time-varying joint behavior of the drivers show increasing flooding risks over time at several locations, particularly the Atlantic area.

Session: 7040 Extreme Precipitation: Past, Present, Future - Part 1 Précipitations extrêmes: passé, présent et futur - Partie 1 **06/06/2022 09:50**

ID: 11451 Contributed abstract

Poster Order:

An assessment of open versus ice-affected high water levels in Canadian rivers

Yonas Dibike [1] , *Laurent de Rham* [2] , *Spyros Beltaos* [3] , *Daniel Peters* [4] , *Barrie Bonsal* [5]

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Presented by / Présenté par: ***Yonas Dibike***
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Spring break-up and associated high water levels are important hydrologic events in many Canadian rivers with different morphological, ecological and socio-economic implications. In some cases, the breakup events result in the dominant annual high water level at a relatively lower discharge compare to the corresponding open water levels. This study examines annual maximum water level occurring during the ice-affected and open-water seasons over the 1985–2015 time period at 151 National Hydrometric Program hydrometric sites identified from the publically available Canadian River Ice Database (CRID). The zero discharge level at each station is computed first so that all water level time series can be referenced to this assumed channel bottom. A regime classification separating ice-affected or open-water dominated high water levels and mixed systems is implemented using a return-period analysis. The result show that 68 (~45%) stations are open water peak water level dominated while the remaining 83 (~55%) stations are ice affected peak water level dominated

and mixed regimes. Stations with predominantly ice affected peak water levels and mixed regimes are mostly located in the cold and continental regions of Northwest Territories, Nunavut, Ontario and part of Saskatchewan, Manitoba, New Brunswick and the island of Newfoundland, while stations with predominantly open water peaks are mostly located in British Columbia, Yukon and Alberta in the west and Quebec in the east. Of those ice-affected peak water levels, most (73%) occur during spring breakup while the rest occur during fall freeze-up (19%) and mid-winter breakup/secondary freeze-up (8%). A follow-up study will examine if the lack of some ice-influenced water level data during highly dynamic breakup events might have affected peak water level regime classification results. The analysis will also be repeated for different temporal windows to examine climate change impact on ice-affected peak water level regime across Canada.

Session: 8010 General Contributions to Solid Earth Geophysics Contributions générales à la géophysique de la Terre solide **06/06/2022 08:25**

ID: 11569 Contributed abstract

Poster Order:

Canada's National Quantum Strategy: A role for Geophysics?

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Presented by / Présenté par: ***Calvin Klatt***
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The Government of Canada has launched the development of a National Quantum Strategy, with an investment of $360M announced in the 2021 Federal Budget.

The strategy will be coordinated by a secretariat at Innovation, Science and Economic Development Canada (ISED). The strategy is expected to be delivered through existing federal programs, university-based research and education, the commercial sector, skills and talent, as well as federal government research, procurement and operations.

The strategy is a seven year effort with three identified pillars:
- Research ($141M)
- Commercialization ($169M), and
- Talent ($45M)

The objectives are as follows:
• Amplify Canada's significant strength in quantum research
• Grow our quantum-ready technologies, companies and talent
• Solidify Canada's global leadership in this area

Quantum technologies can be broken down to three application areas: Quantum Sensing and Metrology Instruments, Quantum Communications, and Quantum Computing. The geoscience community in Natural Resources Canada has identified quantum-enhanced instruments, notably gravimeters and magnetometers, as being of interest. There are other emerging quantum

technologies that are likely of interest.

We will provide examples of geoscience applications of these instruments and seek input from the Geophysics community on actions we might take as a community to support the National Quantum Strategy and reap scientific benefits from the introduction of these instruments.

Session: 8010 General Contributions to Solid Earth Geophysics Contributions générales à la géophysique de la Terre solide **06/06/2022 08:40**

ID: 11647 Contributed abstract

Poster Order:

Seismic structure of the lithosphere in eastern Canada using earthquake and ambient noise seismology

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Presented by / Présenté par: ***Omid Bagherpur Mojaver***
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Broadband seismic stations installed between 2013 and 2015 in eastern Canada enabled us to take the most detailed look at the seismic structure beneath this region to date. Obtaining high resolution tomographic models covering both the crust and mantle lithosphere requires a combination of tomography techniques and seismic datasets, hence two different methods are adopted in this study. We used the ambient noise tomography method to study the crustal structure across the tectonic domains of the southeasternmost Archean Superior craton, the Proterozoic eastern Grenville Province, and the Phanerozoic northern Appalachians. To study the mantle lithosphere structure, we used the two-plane-wave tomography technique and datasets covering a slightly smaller region including the northern Appalachians and the easternmost Grenville Province. The results obtained from these two methods are consistent across the study area and they suggest that seismic signatures, including the inferred lithospheric and crustal thicknesses, and the seismic velocities at different depths, are highly variable across the region. Although systematic differences exist for the velocities across the studied tectonic domains with different heritage, the lithospheric thickness in the northern Appalachians is inferred to vary in 70-120 km range and it does not show a simple correlation with the accretion age of the surface terranes. We interpret that the Moho is located at 30-50 km depth, with the thickest and the thinnest crust being located beneath the Grenville Province and the major sedimentary basins of the northern Appalachians respectively. A step-like Moho along the NE-SW trend of the northern Appalachians is a prominent feature of our crustal model which likely marks the Laurentian-Gondwanan suture at depth. Our high-resolution seismic models along with results from previous studies enable us to discuss a possible tectonic scenario that includes occurrence of a flat subduction during Late Silurian-Early Devonian times.

Session: 8010 General Contributions to Solid Earth Geophysics Contributions générales à la géophysique de la **06/06/2022 08:55**

ID: 11637 Contributed abstract

Poster Order:

Investigating how the accelerometer measurements of the GRACE C satellite are affected by geomagnetic disturbances.

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Presented by / Présenté par: ***Myrto Tzamali***

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The aim of this study is the analysis of how the magnetic disturbances are visible in the residual series of the non-gravitational acceleration measurements from GRACE C satellite. In our analysis, we use an alternative weighted 1B dataset (ACW1B) of non-gravitational accelerations, which comprises the standard deviations of each measurement derived from the 1A data (10 Hz) using a weighted Gaussian filter with a cut-off frequency of 35mHz. We model the Solar Radiation Pressure and the drag components using orthogonal trigonometric functions based on the principle that the dominant force acting on the satellite when crossing the Earth's shadow, is the drag. Weighted residual series are derived in the along-track, cross-track and radial direction of the Science Reference Frame (SRF) and are analyzed based on their latitudinal, longitudinal and local time variations during consecutive months and periods of combined Solstices, and Equinoxes. For the purpose of this study, the residual series are investigated during the ascending and descending tracks of the orbit as well as orbit by orbit. Our results show that the residual series in the along-track direction are the most disturbed during periods of higher geomagnetic activity, while in the radial direction, the Earth Radiation pressure disturbances are visible. In the cross-track direction, the residual series reveal a strong signal due to magnetic inclination and thruster activations. A cross-wavelet analysis is presented between the residual series of the accelerometer measurements and the field-aligned currents (FACs), derived from the magnetic observations of the GRACE C magnetometer. Stronger disturbances are visible in the along-track and radial directions during noon and midnight in the polar regions and they relate to the local time dependency of the FACs.

Session: 8010 General Contributions to Solid Earth Geophysics Contributions générales à la géophysique de la Terre solide **06/06/2022 09:10**

ID: 11861 Contributed abstract

Poster Order: Poster-8010

Shear-velocity and anisotropic model of the Alaskan lithosphere obtained by full-waveform joint inversion of ambient noise and local earthquake data

Tianshi Liu [1] , *Kai Wang* [2] , *Carl Tape* [3] , *Bin He* [4] , *Yingjie Yang* [5] , *Ping Tong* [6] , *Qinya Liu* [7]

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Presented by / Présenté par: ***Tianshi Liu***
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Alaska is one of the most tectonic active regions in North America, and the multiple episodes of tectonic processes shaped the unique and complex structures in the Alaskan lithosphere. These structures can be effectively mapped using seismic imaging, and the mapped shear-velocity and anisotropic structures can provide important constraints on the tectonic evolution of this region.
In this study, we use the high-quality broadband seismic data provided by the USArray deployment in Alaska to image the shear velocity as well as the radial and azimuthal anisotropy of the crust and uppermost mantle. We jointly use the ambient noise data and the local earthquake data for inversion. For ambient noise data, broadband continuous seismic data are collected and processed to extract the three-component empirical Green's functions (EGFs) between station pairs. Frequency-dependent travel-time shifts are measured between the EGFs and the simulated Green's functions. For local earthquake data, to mitigate the effect of uneven source distribution, we measure both the travel-time shifts between synthetics and observations and the difference of the travel-time shifts between station pairs (double difference, Yuan et al. 2016). The measurements are inverted to obtain the model of shear velocity and anisotropy using the adjoint tomography method.
We present our shear-velocity and anisotropic model from the surface down to ~70km depth, revealing the subduction-zone structure in the southern part, several high-radial-anisotropy anomalies related to extensional deformation history, and a fast-axis pattern consistent with the current tectonic movement. Tectonic implication of the model is discussed taking into account shear velocity, radial and azimuthal anisotropy, along with other geophysical observations.

Session: 8010 General Contributions to Solid Earth Geophysics Contributions générales à la géophysique de la Terre solide **06/06/2022 09:10**

ID: 11530 Contributed abstract

Poster Order: Poster-8010

Seismic network development and updated ground motion prediction equations for Georgia, Caucasus

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Presented by / Présenté par: ***Nato Jorjiashvili***
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Georgia is situated within the Caucasus region, which is one among the foremost seismically active regions within the Alpine-Himalayan collision belt. Analysis of the historical and instrumental seismology of this region shows that it's still of moderate seismicity. The seismicity of the country reflects the overall tectonics of the region. Recently, the seismic network of Georgia has been modernized and number of stations has significantly increased. Thus, we had a possibility to run more detailed studies regarding ground motion prediction.
In this work ground motion prediction equations (GMPEs) from Georgia's enhanced digital seismic network were obtained. Strong ground motions caused by earthquake records from local broadband data together with existing three-component accelerograms with magnitudes ranging from 3.5 to 6.9 and hypocentral distances up to 300 km were used for models. In this study, models to predict ground motions for peak ground acceleration (PGA) and 5%-damped pseudo-absolute-acceleration spectra (SA) are described for periods between 0.01 s and 10 s (for both vertical and horizontal components).
Finally, probabilistic seismic hazard assessment was done based on obtained GMPEs in this study and seismic hazard maps were produced for entire Georgia for different return periods and different parameters such as PGA and SA.

Session: 8010 General Contributions to Solid Earth Geophysics Contributions générales à la géophysique de la Terre solide **06/06/2022 09:10**

ID: 11531 Contributed abstract

Poster Order: Poster-8010

Intrinsic and Scattering Attenuation in the lithosphere of the Racha Region, Georgia

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Presented by / Présenté par: ***Ia Shengelia***
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The territory of Georgia is surrounded by the Great and the Lesser Caucasus

and the intermountain depression is located between these mountain ranges. Among the seismic areas of Georgia, the Racha region is notable for its high level of seismicity. The goal of the study is to estimate the quality factors of coda waves (Qc), the direct S waves (Qs) by the single backscattering model and the coda normalization methods, respectively, and then evaluate the relative contribution of intrinsic (Qi) and scattering (Qsc) attenuations in the total attenuation using Wennerberg's method. We have found that Qc, Qs, Qi, and Qsc parameters are frequency dependent in the frequency range of 1.5-24 Hz. Qc values increase both with respect to the lapse time window from 20 to 60 s and the frequency. The frequency-dependent relationships are estimated as $(31\pm3)f^{(1.150\pm0.029)}$, $(44\pm3)f^{(1.055\pm0.032)}$, $(54\pm4)f^{(1.027\pm0.037)}$, $(66\pm4)f^{(0.999\pm0.04)}$ and $(79\pm6)f^{(0.963\pm0.046)}$ for lapse time windows of 20, 30, 40, 50, and 60 s, respectively. Estimated Qs, Qi , and Qsc values also show strong frequency dependence and expressed by using power laws as $Qs=(31\pm2)f^{(1.038\pm0.037)}$, $Qi=(42\pm2.6)f^{(1.049\pm0.048)}$, $Qsc=(125\pm4)f^{(1.002\pm0.043)}$, respectively. The results reflect the average properties of the earth's crust beneath the Racha. The observed Qc and Qi values are almost identical at different center frequencies and are less than Qsc. So, in the Racha region, the effect of intrinsic attenuation is dominated over scattering attenuation. Comparison of our results for similar lapse times to those obtained in other tectonic and seismic active regions show that the Q values and their frequency-dependent relationships are in an interval of values of tectonically active and highly heterogeneous regions.

Session: 8010 General Contributions to Solid Earth Geophysics Contributions générales à la géophysique de la Terre solide — **06/06/2022 09:35**

ID: 11502 Contributed abstract

Poster Order:

Heuristic Measures as a Prospect for Data-Driven Discovery: Application to Observations of Relative Paleointensity During Transitions of the Geomagnetic Field

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Presented by / Présenté par: ***L. Ian Lumb***
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Sparse regression has the potential to estimate the coefficients of a system of governing equations directly from data (e.g., Rudy et al., 2017, Sci. Adv., 3, e1602614). To date, the approach has been most successfully demonstrated through an interdependent loop. In the forward problem, governing equations (subject to boundary and/or initial conditions) generate data - e.g., fluid flow that evolves in time and space. In the inverse problem, this data is sampled, and subsequently generates a library of candidate coefficients for the governing equations. Even in cases involving turbulent flow downstream of a cylindrical object, for example, the approach has proven to be successful in 'discovering' an appropriate form of the Navier-Stokes equations. Moreover, even when noise is liberally added during the forward problem, Deep Learning variants remain robust. Whereas data-driven discovery has been successfully applied to results from laboratory experiments, considerably less established are cases

involving field observations. That observations might present the potential to discover the governing equations for the geodynamo is particularly intriguing as the mechanism for this fundamental characteristic of our planet remains elusive. Recently, Lumb & Aldridge (AGU Fall Meeting 2021, DI35D-0047) initiated uptake of data-driven discovery as a means for deducing the geodynamics responsible for Earth's magnetic field. They concluded that DeePyMoD (Both et al., 2021, J. Comput. Phys., 428, 109985), for example, is readily applicable to fluid flows that might be inferred from measurements of the geomagnetic field. From relative-paleointensity to Beryllium-isotope data, time series capture the temporal evolution of the geomagnetic during reversals and excursions as 'heuristic measures.' Owing to the existence of asymmetries in this data, unique prospects exist to characterize the geodynamo during times of transition. Thus, observational heuristics for the geodynamo motivates the current interest in this new target for data-driven discovery.

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ID: 11836 Contributed abstract

Poster Order:

Application of geophysical techniques to supplement geotechnical analysis of slope stability problems

Mark Lepitzki [1]

[1]

Presented by / Présenté par: ***Mark Lepitzki***
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Our geotechnical understanding of slope stability currently relies heavily on invasive techniques such as drilling and trenching for accurate site characterization. These methods offer many advantages, such as sample collection for lab analysis and high confidence levels, but these measurements are made only at discrete locations. In order to reduce the footprint of these investigations and to create a more comprehensive image of the entire problem, it is proposed to integrate geophysical data collection to supplement current investigation methods. Our current research focuses on the application of 3D DC resistivity, seismic refraction, and analysis of seismic surface waves to help characterize the problem geometry and geotechnical material properties at a site of active slope failure within the Saskatoon region.

Session: 12020 Dynamical processes in the upper ocean related to surface currents and dispersion - Part 1 Processus dynamiques dans la partie supérieure de l'océan liés aux courants de surface et à la dispersion - Partie 1 **06/06/2022 08:25**

ID: 11396 Contributed abstract

Poster Order:

Surface currents in and around an atoll in the South China Sea

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Presented by / Présenté par: ***Rich Pawlowicz***
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Atolls are large ring-shaped reefs. They often contain extensive shallow regions largely protected from surrounding deep ocean waters, but exchange between the two regions can occur through some unusual mechanisms as many parts of the barrier reefs are dry at low tide, even though tidal range is small. In 2018, 9 expendable drifters were deployed in and around Dong-Sha atoll in the South China Sea with deployments lasting as long as several weeks in ordere to better understand these exchange processes. Analysis shows that waters inside the atoll are largely governed by a balance between wind and bottom friction, with speeds of a few cm/s. Outside the atoll, the general circulation is modified by eddies and inertial oscillations with typical current speeds of about 0.5 m/s, as well as high-frequency variations of up to 1.5 m/s that result from the passing of large internal waves. Over the reefs, largely tidally-driven flow can result in excursions of several kilometers in depths of only a few meters.

Session: 12020 Dynamical processes in the upper ocean related to surface currents and dispersion - Part 1 Processus dynamiques dans la partie supérieure de l'océan liés aux courants de surface et à la dispersion - Partie 1 **06/06/2022 08:40**

ID: 11443 Contributed abstract

Poster Order:

Towards an operational drift prediction at sea: verification with drift of containers from the Zim Kingston

Kuo-Hsien Chang [1] , *Graigory Sutherland* [2] , *Felix Therrien* [3] , *Paul Pestieau* [4] , *Eric Legault-Ouellet* [5]

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Presented by / Présenté par: ***Kuo-Hsien Chang***
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On 22 October 2021, 109 shipping containers fell overboard the MV Zim Kingston in rough seas off the B.C. coast. Several containers adrift were reported containing hazardous materials and the general risk to marine traffic required intense monitoring and retrieval efforts. This provided valuable observations to further work already underway in our drift prediction. We present here work to develop and validate an operational tool for emergency responses needing prediction of drifting debris. First, the algorithms used in the

leeway module of the open-source software OpenDrift along with the use of the USCG (United States Coast Guard) 9-parameter leeway table were added to the Modèle Lagrangien de Dispersion Numérique des Particules (MLDP), developed by the Canadian Centre for Meteorological and Environmental Predictions (CCMEP) Environmental Emergency Response Section (EERS). Second, leeway parameters for containers at immersion levels given in the USCG table were scaled to simulate drifting containers at various immersion levels to better respond to real cases – this was needed and applied to the Zim Kingston incident. Third, to facilitate operational search and retrieval, the mean particle trajectory and the probability distribution of location was added to the visual display. The resulting MLDP Leeway Kernel 5-day drift predictions show a good agreement with reported container locations and simulations from OilMap® – the current operational tool for such incidences. The results also suggest that it is necessary to include in MLDP the Stokes drift derived from forecasted significant wave heights to get a better agreement with the observations. This work will further enhance Canada’s future response capacity to oil spills from drifting vessels and other emergencies involving the drift of various types of debris.

Session: 12020 Dynamical processes in the upper ocean related to surface currents and dispersion - Part 1 Processus dynamiques dans la partie supérieure de l'océan liés aux courants de surface et à la dispersion - Partie 1 **06/06/2022 08:55**

ID: 11503 Contributed abstract

Poster Order:

Assessment of drift prediction in ocean models using Finite Scale Lyapunov Exponents

Donovan Allum [1] , *Graig Sutherland* [2] , *Nancy Sootiens* [3] , *Simon St. Onge-Drouin* [4] , *Marek Stastna* [5] , *Christopher Subich* [6]

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Presented by / Présenté par: ***Donovan Allum***
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In 2019 as a part of the tracer-release experience (TReX) conducted by the Marine Environmental Observation, Prediction and Response Network (MEOPAR) over 200 surface drifters were released over a two-day period into the St. Lawrence Estuary in Canada. Using the data from the MEOPAR-TReX program, the goal for this research project is (1) assess the robustness of the Finite-Scale Lyapunov Exponent (FSLE) to measure dispersion in an estuary; and (2) to compare the FSLE computed from physical drifters to the FSLE from their modelled equivalent. The computation of the FSLE is done following (van Sebille et al., JGR, 2015). The FSLE is the growth rate of drifter pair separation as a function of the separation distance. The slope of the FSLE is related to the relative dispersion and relative diffusivity through proportionality arguments. Modelled drifters are computed offline using the open-source software package OpenDrift (Dagestad et al., Gerosci. Model Dev., 2018) applied to two ocean

models with varying degrees of wind forcing. We find that (1) the FSLE produces a robust measure of dispersion which is insensitive to outliers; and (2) the modelled data fails to reproduce the FSLE computed from physical drifters for small separation scales. In addition to these findings, we also show that the FSLE is sensitive to certain exceptional conditions applied to the physical drifters. The ocean models we considered are (1) the Coastal Ice-Ocean Prediction System (CIOPS-E) with grid spacing of 1/36 of a degree and (2) the Gulf of St. Lawrence ocean model with 500 m resolution.

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ID: 11847 Contributed abstract

Poster Order: Poster-12020

Surface drift and dispersion in the Laurentian Channel during the passage of Hurricane Dorian

Graigory Sutherland [1]

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Understanding the drift and dispersion of material and objects at the ocean surface is important for many processes associated with emergency response, such as search and rescue, oil spill response, and the transport of marine pollutants. Drifters are often deployed in the ocean to study these parameters, but these observations are rare in the coastal ocean and during high-wind events making it difficult to parameterize these processes to support emergency response. During August 2019, 10 surface drifters were deployed in the Laurentian Channel and drifted for approximately one month. One week after the initial deployment, Hurricane Dorian passed through the region allowing for the study of dispersion under high-wind conditions. Presented are analysis of the drift and dispersion characteristics of the surface drifters before and after the passage of Hurricane Dorian.

Session: 12020 Dynamical processes in the upper ocean related to surface currents and dispersion - Part 1 Processus dynamiques dans la partie supérieure de l'océan liés aux courants de surface et à la dispersion - Partie 1 **06/06/2022 09:20**

ID: 11716 Contributed abstract

Poster Order:

LES simulation of dye dispersion in the Gulf of St. Lawrence

Anneke ten Doeschate [1] , *Ruth Musgrave* [2] , *Graigory Sutherland* [3] , *Daniel Bourgault* [4]

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Presented by / Présenté par: ***Anneke ten Doeschate***
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The capacity of a new geophysical fluid dynamic solver, 'Oceananigans.jl', to simulate particle dispersion using an LES model is being investigated. This study was motivated by two recent tracer release experiments in the Gulf of Saint Lawrence (GSL). These experiments have resulted in a rich dataset of drifter trajectories,
dye concentrations, current, wave, and CTD observations.
The LES model is setup with a stratification and current fields that represent the hydrological conditions during the field experiments in the GSL. The model is then forced with realistic wind, wave and currents based on in-situ observations made during the 2020 dye-release experiments. Model results indicate that the ambient stratification limits the vertical dispersion of material injected at the surface, corresponding to observed vertical dispersion during the 2020 experiments.
Sensitivity tests are performed to investigate Langmuir circulations and their effect on vertical dispersion. Simulations are performed to test the effect of different wind and wave forcings, as well as different background stratification, on vertical diffusivity and particle dispersion. The model results are compared to observations of material dispersion during the 2021 field experiments, when different forcing conditions were encountered. The outcomes of this study will contribute to the understanding of the complex interaction between waves, currents and turbulence, as well as the parameterization of subgrid processes that affect transport and dispersion of material and pollutants in estuaries.

Session: 12020 Dynamical processes in the upper ocean related to surface currents and dispersion - Part 1 Processus dynamiques dans la partie supérieure de l'océan liés aux courants de surface et à la dispersion - Partie 1 **06/06/2022 09:35**

ID: 11740 Contributed abstract

Poster Order:

Using drifters to understand the dynamics of the Labrador Current System over the shelf

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Presented by / Présenté par: ***Taylor Davies***
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The Labrador Current is the western boundary current of the subpolar gyre. It is a key element of the circulation in the Labrador Sea, and a major outflow from the Arctic to the North Atlantic. This boundary current is a system of currents consisting of an inshore (or coastal) branch, a shelf-break branch, and a deep branch along the lower slope. Given the rapid climate change that the North Atlantic is experiencing, a better understanding of the dynamics along the Labrador coast and shelf is necessary as it may inform and improve future climate models. Historically, sparse in-situ data, particularly over the Labrador shelf and coast, have made it difficult to get a complete picture of the Labrador

Current System. Ocean drifters are a relatively inexpensive and accessible technology that present a Lagrangian perspective of fluid flow in the ocean and can be used to understand boundary current dynamics. The community-based observing of Nunatsiavut coastal ocean circulation (CONOC) project has deployed numerous ocean drifters off northern Labrador since 2018. Here we use these drifters, along with those in the region from the Global Drifter Program, to examine the Labrador Current System along the Labrador coast and shelf. Specifically, we decompose the Lagrangian drifter velocity into a sum of the mean flow, tidal components, and the residual. Further work will decompose the residual into physically meaningful components, including the Ekman flow, the geostrophic flow, inertial oscillations, etc. Results show a clear separation between the coastal and shelf-break branches of the Labrador Current System, highlight the dominance of tidal flows near the northern tip of Labrador, and demonstrate regions of connectivity between the two branches. Ongoing work will examine the wind-driven and geostrophic components of the Labrador Current System off the Labrador coast and shelf.

Session: 12020 Dynamical processes in the upper ocean related to surface currents and dispersion - Part 1 Processus dynamiques dans la partie supérieure de l'océan liés aux courants de surface et à la dispersion - Partie 1 **06/06/2022 09:50**

ID: 11586 Contributed abstract

Poster Order:

The impact of ocean model resolution on the accuracy of drift predictions

Nancy Soontiens [1] , *Jennifer Holden* [2]

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Coastal ocean models are commonly used to predict the trajectories of drifting objects for search and rescue and oil spill response applications. Surface currents in coastal areas can be notoriously difficult to model due to complex interactions between tides, winds and baroclinic effects. It is important to assess the accuracy of drift predictions in these models. This talk presents a framework for evaluating and characterizing drift in ocean models. This framework is used to assess the impact of various choices in drift modelling such as the ocean model resolution. We find that the relationship between drift accuracy and ocean model resolution is not straightforward, particularly in regions where the surface current dynamics are unconstrained due to high variability and eddies.

Session: 13010 Services, Impacts and Adaptation General Session Séance générale - Les services aux usagers, les impacts climatiques et l'adaptation **06/06/2022 08:25**

ID: 11652 Contributed abstract

Poster Order:

Summary of the largest innovation cycle ever at the Meteorological Service of Canada: a journey into Innovation Cycle 3

David Anselmo [1] , *Guillaume Marcotte* [2] , *Thomas Milewski* [3] , *Josée*

Morneau [4] , *Richard Hogue* [5] , *Normand Gagnon* [6]

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Presented by / Présenté par: ***Normand Gagnon***
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The Canadian Centre for Meteorological and Environmental Prediction and the Atmospheric Science and Technology Directorate were successful in completing a very large-scale improvement and innovation project on December 1st 2021. The Innovation Cycle 3 (IC-3) enabled the implementation of numerous modifications to the operational systems, which resulted in improvements to the various numerical guides and to the overall quality of the forecasts and services offered by the Meteorological Service of Canada. In total, over 170 innovations in more than 30 atmospheric, oceanic, hydrological, and land prediction systems were successfully implemented in operations.
In this presentation, we will give an overview of the IC-3 project and highlight the main improvements and changes to our systems, including world and Canadian premieres. We will also discuss the challenges associated with our transition towards an Earth System Model.

Session: 13010 Services, Impacts and Adaptation General Session Séance générale - Les services aux usagers, les impacts climatiques et l'adaptation **06/06/2022 08:55**

ID: 11820 Contributed abstract

Poster Order:

Water level prediction: products and services provided by Environment and Climate Change Canada

Oleksandr Huziy [1] , *Natacha Bernier* [2] , *Frédéric Dupont* [3] , *Benoit Pouliot* [4] , *Devon Telford* [5] , *Patrick Timko* [6] , *Pengcheng Wang* [7]

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Presented by / Présenté par: ***Oleksandr Huziy***
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Water level forecasts are important for the protection of life and property in coastal regions and for safe navigation in shallow waterways. Therefore, Environment and Climate Change Canada (ECCC) maintains and develops water level prediction systems. We present water level prediction products prepared from a global deterministic and regional probabilistic systems that are

ran twice per day at ECCC. The spatial resolution of both systems is 1/12°. The two main variables provided by the systems are storm tide and storm surge. The fields are then processed to add value and facilitate the use by forecasters and decision makers. A few examples of the processed products include time-series at tide gauges, storm tide referenced to the model's highest and lowest astronomical tide, combined maps of storm tide and wave setup. For the ensemble, products are provided including percentiles, interquartile range, probability of exceedance of storm surge at various thresholds (e.g., 0.6 m), and timing of forecast peaks.

Additional products needed to assess potential damage and flooding of coastal regions during storm surge events are under development in the context of the Predicting and Alerting for Coastal Flooding initiative which is part of the 2019 Emergency Management Strategy for Canada.

Session: 13010 Services, Impacts and Adaptation General Session Séance générale - Les services aux usagers, les impacts climatiques et l'adaptation **06/06/2022 09:10**

ID: 11711 Contributed abstract

Poster Order: Poster-13010

Visualizing Canada's Daily Climate Records in 2021: Placing High Impact Weather within a Historical Climatological Context

Judy Kwan [1] , *Rachel Chen* [2] , *Nabila Doctor* [3] , *Ruping Mo* [4]

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Presented by / Présenté par: ***Judy Kwan***
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The Meteorological Service of Canada (MSC) has developed a daily climate records database known as Long Term Climate Extremes (LTCE) for Canada. It was developed to address the fragmentation of climate information due to station changes (opening, closing, relocation, etc.) over time for approximately 750 urban locations in Canada. 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. This poster will illustrate new data visualizations utilized during high impact weather/climate events occurring in 2021 in Western Canada, particularly British Columbia. It will look at significant weather events through the lens of daily climate records (LTCE) together with novel approaches in providing improved situational awareness and climate summaries developed in R. We will showcase several experimental data analytics and visualizations formed during the heatwaves of summer 2021 and the high precipitation events in November 2021. It will highlight what is possible when pairing data science with weather/climate applications and where improvements still need to be made in the future.

Session: 13010 Services, Impacts and Adaptation General Session Séance générale - Les services aux usagers, les impacts climatiques et l'adaptation **06/06/2022 09:20**

ID: 11326 Contributed abstract

Poster Order:

On the development of Canada's homogenized precipitation monthly dataset

Xiaolan Wang [1] , *Yang Feng* [2] , *Vincent Cheng* [3] , *Hong Xu* [4] , *Ming Xiao* [5]

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Presented by / Présenté par: ***Xiaolan Wang***
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The Adjusted and/or Homogenized Canadian Climate Data (AHCCD) were first developed in the early 1990s for trend and climate change studies. The AHCCD includes two generations of the adjusted precipitation data, both of which includes 460+ manual stations of the longest data records back then. As monitoring technology evolves, manual precipitation gauges have been replaced with automated gauges in Canada's monitoring network. As a result, most of the 460+ manual stations were either automated or closed. Data reconciliation to link the automated precipitation observations to the historical manual observations has become imperative. This is the goal of this study. This study documents the development of Canada's homogenized precipitation monthly dataset, version 1 (CanHoPmly v1), for assessing long-term climate trend and variation in support of climate research, climate monitoring, and climate services and applications. The development involves:
(1) Selection and formation of 425 long-term/critical precipitation stations (core stations). The quality and completeness of data were also considered when choosing stations to join, in addition to correlation between the first-difference series of the two data series in question.
(2) In-depth quality control (QC) of each core station data series to exclude outliers (set identified outliers to missing).
(3) Infilling of all temporal data-gaps in each core station data series using spatial thin-plate spline (ANUSPLIN) interpolation of all precipitation data available in Canada for the time step in question.
(4) Homogeneity testing of each core station data series, using four neighbor station data series, as well as the ensemble-mean series of Twentieth Century Reanalysis and the series of ANUSPLIN estimates for the location in question as reference.
(5) Homogenization of each core station data series to diminish the effects of all indentified non-climatic shifts, producing the homogenized monthly precipitation dataset CanHoPmly v1.

Session: 13010 Services, Impacts and Adaptation General Session Séance générale - Les services aux usagers, les impacts climatiques et l'adaptation

06/06/2022 09:35

ID: 11701 Contributed abstract

Poster Order:

A preliminary look at a machine-learning model for the improvement of quality control of MSC's surface observation data

Jim M.C. Young [1] , *Thinesh Sornalingam* [2] , *Adam Filipovich* [3]

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Presented by / Présenté par: ***Jim M.C. Young***
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The Meteorological Service of Canada (MSC) has collected surface meteorological observations for more than 180 years. Today, the MSC collects observed atmospheric surface data across the country from over 500 stations on an hourly and minutely basis. Currently, we also collect data from over 2000 stations provided by our partners. All of the collected data is managed and quality assessed with data quality flag attributions. Not all of the data is corrected. The review and correction for MSC's 500+ stations is still a manual process. This problem is exasperated by the increasing frequency and availability of observations. We are being overwhelmed with data which may or may not be of good quality. Our meteorological observation data lives in the real world so it faces real world problems. Sometimes, our sensors or the telemetry fails. Sometimes birds sit on our wind sensors. Occasionally a hungry bear may eat our sensors. The resultant data requires cleansing. Suspect or erroneous data presents itself as anomalous data. The financial industry has used Artificial Intelligence (AI) systems for the anomalous detection of transactions for some years now. We envision this AI system to help identify our anomalous meteorological data.

We would like to present our initial machine-learning model trained on several years of manual quality-controlled data. Our preliminary investigations into some of the more difficult observation elements (i.e. snow depth and wind) have yielded some positive results. This paper will present some initial results of a random forest algorithm.

Much like panning for gold, the true value of data comes from analyzing what we collect. A well-trained AI system will be well positioned for the current overload of data and to handle the future increasing data volume and rate. High-quality data is fundamental to producing reliable models and insights. Cleaner data will result in a better climate archive, which provides input for better decision making and climate policy for Canadians!

Session: 13010 Services, Impacts and Adaptation General Session Séance générale - Les services aux usagers, les impacts climatiques et l'adaptation **06/06/2022 09:50**

ID: 11433 Contributed abstract

Poster Order:

RADASAT-2 AND SENTINEL-1 FOR ASSESSING GROUND DISPLACEMENTS AT THE HAY RIVER AIRPORT, NWT, CANADA

Nanar Jacobs [1] , *William Quinton* [2]

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Presented by / Présenté par: ***Nanar Jacobs***
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Permafrost degradation due to climate change results in decreasing ground-bearing capacity, which in turn influences the critical infrastructure built on the permafrost. In addition, infrastructure built on the permafrost has less service life due to the fact that they are subject to more intensive wear, and the overall bearing capacity of the infrastructure is weakening with the increase in soil temperature. Therefore, by understanding and assessing the mechanism of the permafrost degradation, and its impact on the ground surface, we can predict and prevent failure of infrastructure built on the permafrost. One of the methods in deriving ground deformation measurements includes the development of advanced remote sensing methods for risk assessment, deformation estimation, and quantification of structural instabilities and ground motions. Currently, remote sensing interferometric data processing techniques are among the technologies that are used to examine the spatial and temporal evolution of surface motion and to detect the motions on small and large scale over areas as large as hundreds of square kilometers using microwave sensors. This work is dedicated for assessing ground displacements at Hay River airport in Northwest Territories. Radarsat-2 and Sentinel-1 datasets are used to investigate Hay River Airports ground-displacement patterns. Particularly, the small baseline subset interferometric synthetic aperture radar (SBAS) technique was applied to obtain surface deformation. SBAS technique is based on an appropriate combination of differential interferograms produced by data pairs characterized by a small orbital separation (baseline) in order to limit the spatial decorrelation phenomena. The Small Baseline (SBAS) approach better identified coherent areas compared to the Persistent Scatterers (PS) method. Velocity and Displacement Maps were also generated for the study region. Time-Series of deformations were derived, and the precision of the measurements were estimated. In this work an attempt was made to integrate measurements made from Sentinel-1 and Radarsat-2 SARs. The results of integration of measurements made from Sentinel-1 and Radarsat-2 SARs are demonstrated.

Session: 5031 Space-Based Earth Observation: Climate Information for Society - Part 2 Observation de la Terre depuis l'espace : informations climatiques pour la société- Partie 2 **06/06/2022 12:55**

ID: 11858 Invited session speaker

Poster Order:

Satellite Earth Observation in Canada – A Strategy in Action Commentary and Q&A

David Harper [1] , *Eric Laliberte* [2] , *Eric Loubier* [3]

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[2] Canadian Space Agency
[3] Natural Resources Canada

Presented by / Présenté par: ***David Harper***

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The Government of Canada is looking to maintain the momentum created by the release of Resourceful, Resilient, Ready: Canada's Strategy for Satellite Earth Observation, and recent investments, by informing stakeholders of additional initiatives under development and seeking feedback on the new strategy. Following the presentation entitled Satellite Earth Observation in Canada – A Strategy in Action, the Director Generals from the Canadian Space Agency (CSA), Environment and Climate Change Canada (ECCC), and Natural Resources Canada (NRCan) will discuss the new EO Strategy and invite input on your priorities for satellite Earth observation in Canada.

Session: 5031 Space-Based Earth Observation: Climate Information for Society - Part 2 Observation de la Terre depuis l'espace : informations climatiques pour la société- Partie 2 **06/06/2022 13:10**

ID: 11860 Invited session speaker

Poster Order:

Satellite Earth Observation in Canada – A Strategy in Action

David Harper [1] , *Eric Laliberte* [2] , *Eric Loubier* [3]

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[3] Natural Resources Canada

Presented by / Présenté par: ***David Harper***
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As a country spanning almost 10 million square kilometres, Canada has always faced a unique challenge in collecting the day-to-day information needed to provide critical services to Canadians. Today, space offers a unique perspective that is increasingly important to understanding our planet and providing these services. Data from Earth observation satellites enable applications and services in a number of critical areas, including: climate change mitigation and adaptation, emergency response, ecosystem protection, public health, and food security. Over the past 18 months, the Canadian Space Agency (CSA), Environment and Climate Change Canada (ECCC), and Natural Resources Canada (NRCan) have facilitated a multi-departmental effort to assess Canada's Earth observation needs. Additionally influenced by engagement with stakeholders from industry and academia across the country, this collaborative effort led to the recent release of Canada's new strategy for satellite Earth observation. Announced in January 2022, Resourceful, Resilient, Ready: Canada's Strategy for Satellite Earth Observation outlines the key priorities and actions necessary to leveraging the capabilities of satellite EO technologies. This new strategy builds upon existing successes, such as recent Budget 2021 investments of $90 million into Earth observation service continuity and ground segment renewal, $8 million in funding for Canadian industry via the CSA's smartEarth program, and a $20 million investment into Canadian private company GHGsat.

Session: 5031 Space-Based Earth Observation: Climate **06/06/2022**

ID: 11387 Contributed abstract

Poster Order:

Development of Composite Data Products at the Canada Centre for Remote Sensing from Visible Infrared Imaging Radiometer Suite Imagery for Climate and Environmental Applications

Alexander Trishchenko [1] , *Calin Ungureanu* [2]

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Presented by / Présenté par: ***Alexander Trishchenko***
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The Visible Infrared Imaging Radiometer Suite (VIIRS) is a multispectral imager for global observations from polar-orbiting satellites operated by the NOAA. In many aspects, the VIIRS is comparable to the Moderate Resolution Imaging Spectroradiometer (MODIS) operated by NASA since 2000. We present the methodology and results obtained at CCRS for the top-of-the atmosphere and surface-level VIIRS clear-sky composite products that are spatially and temporally consistent with the CCRS MODIS time series produced for land climate and environmental applications. The VIIRS I-bands imagery (375 m) are remapped onto a 250-m spatial grid, while M-bands (750 m) are remapped onto a 500-m spatial grid. The 250-m grid is precisely nested within the 500-m grid so that averaging of 2×2 high-resolution pixels replicates one 500-m pixel. The clear-sky composite images are generated for nominal 10-day intervals, three per month, so that 36 composite products are available for one year. The technology for generating special weekly composite products of Normalized Difference Vegetation Index (NDVI) for potential agricultural applications has been also tested. Value-added warm season (April-September) snow/ice probability maps and minimum snow/ice extent are also generated to continue similar products generated at CCRS from the MODIS sensor (Trishchenko, 2021; Trishchenko and Ungureanu, 2021).

This work is supported through the CCRS activity on high-frequency Long-Term Satellite Data Records (LTSDR) as part of the Cumulative Effects (CE) and the NRCan Climate Change Geoscience Programs.

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Session: 5031 Space-Based Earth Observation: Climate Information for Society - Part 2 Observation de la Terre depuis l'espace : informations climatiques pour la société- **06/06/2022 14:05**

Partie 2

ID: 11401 Contributed abstract

Poster Order:

A Neural Network Approach to Arctic Microwave Surface Property Retrievals

Colleen Henschel [1] , *Thomas J. Duck* [2] , *Erika Kember* [3] , *Bhavneet Bhatia* [4]

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Presented by / Présenté par: ***Colleen Henschel***
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Passive microwave satellite measurements, ongoing for the past 30 years, have great potential for Arctic climate monitoring due to the low influence of clouds on microwave radiation. The Advanced Technology Microwave Sounder (ATMS) is one of several microwave sounding instruments available with measurement frequencies ranging from 23.8 GHz to 183.3 GHz. The 183.3 GHz center frequency channels are of particular interest due to high water vapour absorption around this frequency. These channels can be used along with the 165 GHz and 88 GHz channels, where water vapour absorption is relatively low, to measure Arctic water vapour columns. This cannot be done, however, without first having reliable surface property retrievals for these frequencies.

Three retrieval techniques have been implemented to provide surface emitting layer temperatures and emissivities for 88 GHz, 165 GHz, and 183 GHz frequencies. The standard approach uses ATMS brightness temperatures along with a radiative transfer model from the microwave radiative transfer equation and reanalyses to calculate the surface emitting layer temperatures and emissivities. An optimal estimation approach improves upon the standard retrieval by incorporating probability distributions to account for instrument noise. The third approach uses an artificial neural network (ANN) model in place of the physics models.

The ANN approach has the advantage of being able to handle more data while reducing the intermediate steps, such as modelling atmospheric transmittance and surface reflection, and accounting for instrument noise without explicitly requiring probability distributions. A comparison of all three approaches will be presented, along with ground-based surface temperature measurements.

Session: 5031 Space-Based Earth Observation: Climate Information for Society - Part 2 Observation de la Terre depuis l'espace : informations climatiques pour la société- Partie 2 **06/06/2022 14:20**

ID: 11812 Contributed abstract

Poster Order:

Extending aerial surveys with LANDSAT-based canopy cover: A case study in Montreal

Marsha Akkerhuis [1] , *Thomas Walker* [2]

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Presented by / Présenté par: ***Marsha Akkerhuis***
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Urban trees play an essential role in increasing cities' resilience against climate change by reducing stormwater runoff and erosion, contributing to passive cooling, removing pollutants, and sequestering carbon. In some Canadian cities, localized surveys exist that quantify the extent of urban canopy cover through aerial photography; however, these surveys can occur sporadically in time and space. Using GIS, we calibrate a linear model (R2=0.74) between aerial survey data and the LANDSAT-derived Global Forest Cover Change (GFCC) product centered on Montreal in the summer of 2015, reconciling the difference in spatial resolution in the two datasets. The uncertainty on the linear model, which scales close to linearly with the canopy cover, is included in the full-length dataset. Satellite pixels adjacent to water bodies tend to over-estimate urban canopy cover compared to the aerial photography, so the uncertainty in these pixels is inflated to account for this potential bias. This linear model provides a consistent, long-term, spatially extensive record of urban canopy, and is used to extend this detailed analysis to any location and time where satellite tree cover data exists, but aerial surveys do not, which includes more remote or less affluent locations and can be used in analysis of climate policy and public health impacts. A time-evolved map of urban canopy cover over Montreal is produced from 2011 to 2019 and evaluated against recent urban canopy cover initiatives in the city.

Session: 7041 Extreme Precipitation: Past, Present, Future - Part 2 Précipitations extrêmes: passé, présent et futur - Partie 2

06/06/2022 12:55

ID: 11494 Contributed abstract

Poster Order:

High Resolution Climatological Simulations for South and Southeast Asia and the Tibetan Plateau: Mean and Extreme Precipitation Changes

Yiling Huo [1] , *W. Richard Peltier* [2] , *Deepak Chandan* [3]

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2

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Presented by / Présenté par: ***Yiling Huo***
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The extreme concentration of population over South and Southeast Asia (SA and SEA) makes it critical to accurately understand the global warming impact on the South and Southeast Asian monsoon while the complex orography of the regions including the Tibetan Plateau (TP) and the Himalayas makes future projections of monsoon intensity technically challenging. Meanwhile, the TP is widely considered to act as an elevated heat source which contributes to driving the Asian monsoon system and also contains the headwaters of large Asian

rivers. Thus, we constructed a series of climate projections constructed using the Weather Research and Forecasting (WRF) Model to dynamically downscale a global warming simulation constructed using the Community Earth System Model over SA, SEA and TP. All projections are characterized by a consistent increase in average monsoon precipitation and daily extreme precipitation. Further analysis shows that the Clausius–Clapeyron (CC) thermodynamical constraint of 7% increase per °C of warming serves as a good predictor of extreme precipitation changes over the west coast of SA, eastern TP and northern and coastal SEA. However, both the average rainfall intensity changes and the extreme precipitation increases are projected to be larger than expectations based upon the CC thermodynamic reference of 7% °C−1 of surface warming in most parts of SA and southern SEA. This further increase can be primarily explained enhanced moisture flux from the ocean and stronger moisture convergence combined with the fact that the surface warming is projected to be smaller than the warming in the midtroposphere, where a significant portion of rain originates.

Session: 7041 Extreme Precipitation: Past, Present, Future - Part 2 Précipitations extrêmes: passé, présent et futur - Partie 2 **06/06/2022 13:10**

ID: 11631 Contributed abstract

Poster Order:

Climate attribution study of a deep moist convection: the Copenhagen case of July 2011

Dominic Matte [1] , *Jens H. Christensen* [2] , *Henrik Feddersen* [3] , *Henrik Vedel* [4] , *Niels Woetmann Nielsen* [5] , *Rasmus A. Pedersen* [6]

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Presented by / Présenté par: ***Dominic Matte***
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On the evening on July 2, 2011 a severe cloud burst occurred in the Copenhagen area. During the late afternoon deep moist convection developed over nearby Skåne (the southernmost part of Sweden) in an airstream from east-northeast. In the early evening the DMC passed over Øresund to Copenhagen, where it created a severe flash flood. Between 90 and 135 mm of precipitation in less than 2 hours was recorded flooding cellars, streets, and key roads. The deluge caused 6 billion Danish kroner in damage. Although that such extreme events are rare, the impact on society is important and should be understood under a warmer climate. Although regional climate models have recently reached the convection permitting resolution, reproducing such events is still challenging.

Several studies suggest that extreme precipitations should increase under a future warmer climate using transient simulation or a pseudo-warming approach. It is still unclear how such event would behave under warmer or colder conditions. Using a forecast-ensemble method, but keeping a climate

perspective, this study assesses the risk arising from such an event under otherwise almost identical, but warmer or colder conditions. With this set-up, we are computing the so-called upscaled risk of this event in the current climate and under several warmer scenarios. We find that not only the risk of flooding is increasing as the climate warms but also that the risk is also increasing for unprecedented precipitation rate intensity.

Session: 7041 Extreme Precipitation: Past, Present, Future - Part 2 Précipitations extrêmes: passé, présent et futur - Partie 2

06/06/2022 13:25

ID: 11629 Contributed abstract

Poster Order:

PRECIPITATION EXTREMES AND THEIR LINKS WITH REGIONAL AND LOCAL TEMPERATURES: A CASE STUDY OVER THE OTTAWA RIVER BASIN, CANADA

Ana LLerena [1] , *Philippe Gachon* [2] , *René Laprise* [3]

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Presented by / Présenté par: ***Ana LLerena***
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In the context of global warming, the Clausius Clapeyron (CC) relationship has been widely used as an indicator of the evolution of the precipitation regime, including daily and sub-daily extremes. This study aims to verify the existence of links between precipitation extremes and 2-m air temperature for the Ottawa river basin over the period 1981-2010, applying an exponential relationship between the 99th percentile of precipitation and temperature characteristics. Three simulations of the Canadian Regional Climate Model version 5 (CRCM5), at three different resolutions (0.44, 0.22 and 0.1°), and two reanalysis products (ERA5 and ERA5-Land) were used to investigate the CC-scaling hypothesis that precipitation increases at the same rate as the atmospheric moisture-holding capacity (i.e., 6.8%/ °C).
In general, daily precipitation follows a lower rate of change than the CC-scaling, while hourly precipitation increases faster with temperature. In the latter case, rates of change greater than the CC-scaling were even up to 10.2%/°C for the CRCM5 simulation at 0.1°. Beyond the threshold of 20 °C, the atmospheric moisture-holding capacity is not the only determining factor for generating precipitation extremes. In fact, other factors need to be considered such as the moisture availability at the time of the precipitation event, and the presence of dynamical mechanisms that increase for example the upward vertical motion. A hook shape is also observed in summer for CRCM5 simulations, near the 20-25°C temperature threshold.
In conclusion, the applicability of the CC-scaling should not be generalized in the study of precipitation extremes. The time scale, resolution, and season are additional factors to be considered. In fact, the evolution of precipitation extremes and temperatures relationship should be evaluated with very high spatial resolution simulations, knowing that local temperature and regional physiographic features play a major role on the occurrence and intensity of precipitation extremes.

Keywords: Clausius-Clapeyron, precipitation extremes, regional climate simulations, climate risks, climate change.

Session: 7041 Extreme Precipitation: Past, Present, Future - Part 2 Précipitations extrêmes: passé, présent et futur - Partie 2 **06/06/2022 13:50**

ID: 11831 Contributed abstract

Poster Order:

Winter Extreme Precipitation Regimes (EPRs) in eastern North America: Synoptic-Scale Environments and Categorization

Yeechian Low [1] , *John Gyakum* [2] , *Eyad Atallah* [3]

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Presented by / Présenté par: ***Yeechian Low***
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Long-lived and widespread extreme precipitation regimes (EPRs) often lead to flooding and loss of life and property. We define EPRs during the eastern North American winter (December to February) based on extreme normalized precipitation volume persisting for at least five days, using ERA5 precipitation data from 1979 to 2020. EPRs are generally associated with an anomalous 500-hPa trough/ridge pattern over western/eastern North America that slowly moves eastward, favoring intrusions of moist, tropical air in eastern North America. The precipitation is fueled by a large moisture influx into eastern North America from the Gulf of Mexico and Caribbean Sea from the EPR start to mid-time. Backward trajectories of air parcels in heavy precipitation regions can usually be traced back to the Gulf of Mexico, Caribbean Sea, or the western Atlantic.

We also categorize EPRs based on the spatial anomaly correlation (AC) of synoptic-scale weather patterns between individual EPRs and the EPR composite. High AC EPRs have similar 500-hPa features to low AC EPRs over North America, but they are generally stronger, though with the ridge in eastern North America not extending as far north. The synoptic-scale weather patterns among high AC EPRs show less variability than among low AC EPRs. The warmth and moisture anomalies and moisture flux (particularly from the Gulf of Mexico) are substantially greater during high AC EPRs than during low AC EPRs.

Session: 7041 Extreme Precipitation: Past, Present, Future - Part 2 Précipitations extrêmes: passé, présent et futur - Partie 2 **06/06/2022 14:05**

ID: 11411 Contributed abstract

Poster Order:

Overview of the Saint John River Experiment on Cold Season Storms (SAJESS)

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

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Presented by / Présenté par: ***Julie Thériault***
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The amount and phase of precipitation that accumulates in the transboundary Upper Saint John River Basin, located on the border of Maine and the provinces of Quebec and New Brunswick, are critical for forecasting both river-ice and potential flooding. During the cold season, successive storms drive snow accumulation on the ground and when combined with spring rainfall and relatively high temperatures, catastrophic flooding can affect communities downstream. Despite this, no studies of storms and precipitation phase and their impact on snowpack evolution have been conducted in this region. The goal of SAJESS is to identify processes associated with the variability of precipitation amount and phase during cold season storms. To do so, a field experiment was designed during 2020-21 in Edmundston, New Brunswick. A semi-permanent station was installed at Edmundston to monitor precipitation amount and phase throughout the cold season and into spring. A mobile station was used in downtown Edmundston (a few km from the semi-permanent station) during March and April 2021, to monitor precipitation in more detail using manual observations and a Multi-Angle Snowflake Camera (MASC). Atmospheric conditions aloft were monitored using atmospheric soundings released during precipitation events. Finally, precipitation measurements were provided by community members contributing to the Community Collaborative Rain, Hail and Snow (CoCoRaHS) network. A total of 13 precipitation events were documented. In particular, between 25 March and 4 April 2021, five storms were recorded with precipitation phase varying between rain and snow and the rain led to the fast and complete melt of the snowpack. Later in the season (21-22 April 2021), an extreme snowstorm occurred, which produced up to 30 cm of snow on the ground, which was initially free of snow. Overall, SAJESS gathered valuable information to better understand atmospheric conditions leading to extreme flooding events along the Saint John River.

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ID: 11848 Contributed abstract

Poster Order:

Assessing Wastewater Flooding Risk for the City of Charlottetown

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Presented by / Présenté par: ***Farhan Aziz***
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During extreme wet weather events (WWE), the quantity of extraneous flows (EF) to sanitary sewer systems increased in poorly managed urban stormwater systems. The EF often triggered wastewater (WW) flooding and compromised the capacity of existing WW systems. The current study assesses the flow capacity of existing WW collection system in Charlottetown for selected WWE. The study area is a coastal city experiencing the impacts of climate change and population growth. From 2015 to 2021, the city's population is increased from 36,094 to 40,600 inhabitants, respectively. However, the existing WW system has not received a proportionate expansion to accommodate additional capacity during this period. The frequency of sanitary sewer backups and overflows is increased during the past few years due to the compound effects of climate change and population growth. The existing pumping stations and treatment plant, SCADA inflows from Feb 2017-2022 were analyzed to estimate the sanitary flow patterns and daily base infiltration for selected dry and WWE. The substantial variations between dry and wet period inflows were noticed, up to four times the average daily flows during WWE. The PCSWMM model was developed to assess the capacity of the existing WW collection system for current and future scenarios. The hydraulic modeling results of the current scenario of 2021 population and observed EF for Sep 2021 extreme WWE indicate flooding and capacity issues at approximately 28% of the total existing WW network. The model predicted that with the 2040 population and projected RCP 8.5 rain would leave 39% of the total WW network locations under capacity. This will lead to frequent sewer backups and basement flooding, causing adverse property and health damages. Improving the city's coverage of the existing stormwater system is highly recommended to reduce the effects of climate change and EF.

Session: 8030 Geodesy and the United Nations Sustainability Goals La géodésie et les objectifs de durabilité des Nations Unies

06/06/2022 12:55

ID: 11807   Invited session speaker

Poster Order:

Sea-level Change, Geodesy, and the United Nations Sustainable Development Goals

Thomas James [1] , *Catherine Robin* [2] , *Michael Craymer* [3] , *Connor Brierley-Green* [4] , *Maximilian Lauch* [5]

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Presented by / Présenté par: ***Thomas James***
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The United Nations Sustainable Development Goals include Climate Action: Take urgent action to combat climate change and its impacts (Goal 13). An important component of climate change is global sea-level rise, leading to

impacts of increased flooding and erosion where relative sea-level is projected to rise. Space-based geodetic measurements of ice-sheet and ocean heights, and their changes over time, combined with satellite measurements of the ensuing gravitational changes, are vital to monitoring and understanding these key contributors to global sea-level rise. At the local level, the sea-level change that is experienced at a coastline is termed relative sea-level change, which includes the effects of vertical land motion. The Canadian Geodetic Survey develops land motion models for Canada that are key to generating robust relative sea-level projections for Canada, needed to assess the impact of sea-level change and devise robust adaptation strategies. Looking forward, sea-level guidance is being developed for Canada, based on the IPCC Sixth Assessment Report (AR6) and the CGS vertical land motion model, drawing on international best practices, and including engagement with national Indigenous organizations. Improved scientific understanding of the effects of recent (past decades to centuries) glacier and ice cap changes will provide future improvements to the land motion model. This will improve relative sea-level projections and assist planners and engineers to take effective action against the impacts of sea-level change for Canadian society.

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06/06/2022 13:25

ID: 11574 Contributed abstract

Poster Order:

Supporting the UN Sustainable Development goals through UN Geospatial and Geodetic Expert Committee Activities

Calvin Klatt [1] , *Kristine Hirschkorn* [2]

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Presented by / Présenté par: ***Calvin Klatt***
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Canada is actively supporting United Nations efforts related to geospatial information, including support for an international team addressing challenges in Geodesy. The Canadian Federal Government is leading this effort as a formal member of the United Nations but there are opportunities for academia and industry involvement.

The United Nations Economic and Social Council (ECOSOC) established the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) in July 2011. ECOSOC requested contributions from experts in surveying, geography, cartography and mapping, remote sensing, land-sea and geographic information systems and environmental protection.

The UN-GGIM has seven “functional groups”, one of which is the Subcommittee on Geodesy. The UN Americas subcommittee nominates members to the Geodesy subcommittee and these include Dr. Calvin Klatt of Canada (Natural Resources Canada). Also contributing to this work are Dr. Mike Craymer and Bianca D’Aoust from Natural Resources Canada. Calvin Klatt supports the Geodesy Subcommittee “Bureau” which is the senior coordinating body.

On February 2015 the UN General Assembly passed a resolution entitled, A Global Geodetic Reference Frame for Sustainable Development. The resolution outlines the “value of ground-based observations and remote satellite sensing when tracking changes in populations, ice caps, oceans and the atmosphere over time.” (UN Press Release)

Key efforts in 2022 will involve the establishment of a centre of excellence in Germany. In 2021 the Geodesy Subcommittee led several discussions linked to Earth Day about the important role of Geodesy for the global and continental communities.

Session: 8030 Geodesy and the United Nations Sustainability Goals La géodésie et les objectifs de durabilité des Nations Unies

06/06/2022 13:50

ID: 11423 Contributed abstract

Poster Order:

Progress of the North American-Pacific Geopotential Datum of 2022

Jianliang Huang [1] , *Marc Véronneau* [2] , *Yan Ming Wang* [3] , *David Naranjo Avalos* [4]

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Presented by / Présenté par: ***Jianliang Huang***
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The U.S. National Geodetic Survey (NGS), the Canadian Geodetic Survey (CGS) and Mexico’s INEGI are collaborating in the development of a state-of-the-art geoid model under the modernisation of the National Spatial Reference System (NSRS), allowing the replacement of the North American Vertical Datum of 1988 (NAVD 88) with the North American-Pacific Geopotential Datum of 2022 (NAPGD2022). Although Canada already moved to a geoid-based height system in 2013 when introducing the Canadian Geodetic Vertical Datum of 2013, the next step would be for Canada, USA and Mexico to have a unified geoid model, avoiding discontinuity when managing transboundary watershed. NGS and CGS already planned this unification when they agreed to adopt the same equipotential surface to represent the geoid for North America before moving to CGVD2013.
NGS initiated the modernisation of the NSRS in 2007 with the Gravity for the Redefinition of the American Vertical Datum (GRAV-D) project. This challenging project consists in re-observing the gravity field for the entire U.S. (including territories in the Pacific Ocean) by airborne technique in order to improve the geoid solution. In 2017, the abbreviation NAPGD was accepted by the geodetic agencies. Since then, the implementation has been delayed until about 2025 due to a series of factors. In the mean time, NGS, CGS and INEGI developed a first common geoid model in 2020 based on a common data between the three agencies.
The presentation will give the status of the current effort to achieve the common NA vertical datum including latest news on the GRAV-D project, and accuracy of the experimental geoid models XGEOID2020A and B.

Session: 8030 Geodesy and the United Nations Sustainability Goals La géodésie et les objectifs de durabilité des Nations Unies **06/06/2022 14:05**

ID: 11565 Contributed abstract

Poster Order:

How knowledge of terrestrial water storage derived from GRACE/GRACE-FO can lead Canada towards a sustainable future

Stephanie Bringeland [1] , *Georgia Fotopoulos* [2]

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Presented by / Présenté par: ***Stephanie Bringeland***
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In September 2015, the United Nations set forth an agenda outlining 17 different goals, the Sustainable Development Goals (SDGs), designed to address the most significant challenges of the modern world. The SDGs encompass everything from social to environmental and economic to climate change issues, and aim high, with a purposefully urgent deadline of 2030. The final SDG is perhaps the most crucial to their fulfillment - #17 ‘Partnerships for the goals’. The scientific community must be willing to participate in the translation from outlook to action. The purpose of this research is to investigate the relationship between terrestrial water storage (TWS) derived from the Gravity Climate and Recovery (GRACE) and Follow-On (FO) mission and the known environmental and anthropogenic parameters over various regions in Canada. Limited in spatial resolution, but significant in spatial coverage, the opportunities offered through two decades of dedicated satellite gravity monitoring are immense. GRACE and GRACE-FO provide fundamental monitoring observations towards our global system understanding. These geodetic missions are role models for future missions towards addressing the SDGs anywhere on our planet. There are three SDGs that are addressed with this research: #6, Clean Water and Sanitation, #13, Climate Action, and #15, Life on Land. In particular, decade-scale trends of TWS across various hydrological basins within Canada uncover the long-term scope and need for geodetic observations and how our improved knowledge in this area can lead Canada towards a sustainable future.

Session: 12021 Dynamical processes in the upper ocean related to surface currents and dispersion - Part 2 Processus dynamiques dans la partie supérieure de l'océan liés aux courants de surface et à la dispersion - Partie 2 **06/06/2022 12:55**

ID: 11864 Contributed abstract

Poster Order:

Surface Waves Effects on Momentum Fluxes to the Upper-Ocean Currents under a Storm Track

Guoqiang Liu [1] , *William Perrie* [2]

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Presented by / Présenté par: ***Guoqiang Liu***
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Coupled ocean-atmosphere models often assume that the momentum flux into ocean currents is equal to the flux from the atmosphere (wind stress). However, this assumption is usually not valid, except when surface waves are in equilibrium. Generally, when surface waves grow or decay in space or time, they gain or lose momentum, respectively, which reduces or increases the momentum flux into subsurface currents compared to the flux from the wind. In this paper, numerical experiments are performed to investigate the effects of waves on the surface currents in the storm track regions of the midlatitudes of the Northwest (NW) Atlantic for five years, 2005 ~ 2009. The result shows that the surface wave effects on momentum flux, surface currents, and wind-power input (WPI) are related to the wave age, the rate of change of the wind, and the scale of the motion. Typically, the youngest waves and the highest and most rapidly changing winds result in the greatest wave effects on surface currents. In experiments without considering surface waves, the kinetic energy of the surface currents is overestimated by almost 10% and 15% for super-inertial frequencies (greater than 1.2 IF) and inertial frequencies, respectively. Considering the role of the high-frequency motions (HFMs) in dominating upper ocean processes, it is, therefore, necessary to include the effects of surface waves on the momentum flux, especially in storm conditions

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ID: 11495 Contributed abstract

Poster Order:

Altimetric Indices of Whale Habitat in the western Gulf of St. Lawrence

Jing Tao [1] , *Hui Shen* [2] , *Richard Danielson* [3] , *William Perrie* [4]

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Presented by / Présenté par: ***Jing Tao***
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Satellite altimetry-derived sea level anomaly (SLA) indices are employed to monitor whale habitat in the western Gulf of St. Lawrence (GSL), using the strength and extension of the Gaspé Current (GC) as a proxy. Measures of surface slope and volume transport are taken from the SLA profile along a repeating ground track of the JASON-2,3 satellites. These are employed as proxies of GC intensity and are correlated with river discharge of the St. Lawrence River, which is an important driving force of the GC. Their relationship with zooplankton indices in the Shediac Valley are explored and it is indicated that altimetric indices can be used to infer zooplankton variations. Variations in slope are also used to explain distribution patterns of whale sightings in the GSL. Satellite altimetry thereby provides a potential linkage between ocean dynamics, zooplankton, and whale habitat patterns.

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ID: 11742 Contributed abstract

Poster Order:

Estimation of the Stokes drift based on wind field retrieved by single high frequency radar

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Presented by / Présenté par: ***Abïgaëlle Dussol***
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It has been recently established experimentally that High-Frequency (HF) radars measure half of the surface Stokes drift in addition to near-surface Eulerian currents. To make the most use of HF radar measurements, it is necessary to separate these two contributions. In theory, the surface Stokes drift could be estimated directly from wave spectra measured by HF radars. In practice, wave spectra are obtained from the second-order backscatter, which has a shorter range than the first-order backscatter providing current measurements. Here, we estimate the surface Stokes drift using a theoretical Toba wave spectrum based on the wind field (directions and speeds) retrieved by a single HF radar using the first-order backscatter. Wind direction is obtained from the relative strength of the positive and negative Bragg-resonant peaks for single HF radar, using a new algorithm to remove the left-right ambiguity. Radar measurements of the wind directions are compared with in-situ data in the Lower St. Lawrence Estuary (Quebec, Canada). The correlation coefficient between the radar-estimated wind direction and the in-situ wind direction is 0.90. Wind speed is obtained by fitting an empirical relationship between in-situ wind speed and wind-driven HF radar currents using an artificial neural network.

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ID: 11621 Contributed abstract

Poster Order:

Effect of surface gravity waves on the upper ocean circulation and hydrography over the northwestern Atlantic during Hurricane Arthur

Colin Hughes [1] , *Guoqiang Liu* [2] , *William Perrie* [3] , *Jinyu Sheng* [4]

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Presented by / Présenté par: ***Colin Hughes***
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Ocean surface gravity waves significantly affect the air-sea fluxes, vertical mixing and circulation during high wind events. The main objective of this study is to investigate the wave-current interactions during extreme weather events. A fully coupled wave-circulation model based on COAWST for the northwestern Atlantic Ocean is used to examine the role of wave breaking, conservative Stokes drift terms and Langmuir turbulence during hurricanes. The coupled model is first applied in idealized hurricane conditions, with hurricanes moving westward at different translational speeds. Model results in these idealized experiments are used to quantify the contributions of wave-related dynamics to the turbulent kinetic energy (TKE), thermal structure and currents in the upper ocean under high winds. The coupled model is then used to investigate wave-current interactions during Hurricane Arthur in July 2014. Realistic hurricane wind data from HWIND are blended with large-scale atmospheric reanalysis wind from ERA5. Model results demonstrate that wave-current interactions, especially wave breaking and Langmuir turbulence (LT), are important under high wind regions. Wave breaking is also prominent in shallow water regions where swell propagates. Both wave breaking and LT have a reduced impact under lower winds far away.

Session: 12021 Dynamical processes in the upper ocean related to surface currents and dispersion - Part 2 Processus dynamiques dans la partie supérieure de l'océan liés aux courants de surface et à la dispersion - Partie 2 **06/06/2022 14:05**

ID: 11762 Contributed abstract

Poster Order:

Variability of oxygen saturation in the subsurface waters of the Northwest Pacific from Argo-O_2 data

Mohamed Ahmed [1] , *Roberta Hamme* [2]

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Presented by / Présenté par: ***Mohamed Ahmed***
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Trends of declining O_2 (i.e., ocean deoxygenation) in our ocean are expected to increase in conjunction with the increase in ocean warming and acidification, primarily as a result of anthropogenic carbon emissions. One of these significant trends was observed in the North Pacific Intermediate Water (NPIW). NPIW originates as a vertical salinity minimum layer around the isopycnal surface of $\sigma\theta$ = 26.6 kg/m^3 in the subsurface offshore of the east of Japan between the Kuroshio Extension and the Oyashio Front. It is known to play a vital role in transporting low-salinity, and nutrient-rich water from the subarctic into the intermediate depths of the North Pacific subtropical gyre during the local winter-time convections. As ventilation sites are rare, processes within them have the potential to control biological activity and biogeochemical processes over broad areas and time scales. However, recent observations and models suggest that

dissolved gases in these locations do not come to equilibrium with the atmosphere. Although our ship observations during wintertime convection are limited, we are fortunate to have an access to data collected from an array of autonomous profiling floats equipped with oxygen sensors. In this study, we estimate the O_2 content in the newly formed NPIW and quantify the extent of oxygen disequilibria over time and space. Our findings will provide a better understanding of oxygen consumption in the subsurface water and will allow an additional constraint for biogeochemical models and global carbon budgets in the North Pacific.

Session: 12021 Dynamical processes in the upper ocean related to surface currents and dispersion - Part 2 Processus dynamiques dans la partie supérieure de l'océan liés aux courants de surface et à la dispersion - Partie 2 **06/06/2022 13:50**

ID: 11621 Contributed abstract

Poster Order:

Effect of surface gravity waves on the upper ocean circulation and hydrography over the northwestern Atlantic during Hurricane Arthur

Colin Hughes [1], *Guoqiang Liu* [2], *William Perrie* [3], *Jinyu Sheng* [4]

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Presented by / Présenté par: ***Colin Hughes***
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Ocean surface gravity waves significantly affect the air-sea fluxes, vertical mixing and circulation during high wind events. The main objective of this study is to investigate the wave-current interactions during extreme weather events. A fully coupled wave-circulation model based on COAWST for the northwestern Atlantic Ocean is used to examine the role of wave breaking, conservative Stokes drift terms and Langmuir turbulence during hurricanes. The coupled model is first applied in idealized hurricane conditions, with hurricanes moving westward at different translational speeds. Model results in these idealized experiments are used to quantify the contributions of wave-related dynamics to the turbulent kinetic energy (TKE), thermal structure and currents in the upper ocean under high winds. The coupled model is then used to investigate wave-current interactions during Hurricane Arthur in July 2014. Realistic hurricane wind data from HWIND are blended with large-scale atmospheric reanalysis wind from ERA5. Model results demonstrate that wave-current interactions, especially wave breaking and Langmuir turbulence (LT), are important under high wind regions. Wave breaking is also prominent in shallow water regions where swell propagates. Both wave breaking and LT have a reduced impact under lower winds far away.

Session: 13020 Computational Methods, Machine Learning, and Model Development Méthodes de calcul, apprentissage **06/06/2022 12:55**

ID: 11351 Contributed abstract

Poster Order:

Generative Adversarial Networks for Extreme Super-Resolution and Downscaling of Wind Fields at Convection-Permitting Scales

Nic Annau [1] , *Alex Cannon* [2] , *Adam Monahan* [3]

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Presented by / Présenté par: ***Nic Annau***
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High-resolution (HR) regional climate models -- such as convection-permitting models (CPMs) -- can simulate meteorological phenomena better than coarse-resolution (CR) climate models, especially for variables strongly dependent on topography. However, due to their immense computational cost, CPM simulations are typically short (e.g., 1-2 decades) and cover limited spatial domains (e.g., regional to continental). New machine learning (ML) algorithms -- in particular, those developed in computer vision for image super-resolution (SR) -- have begun to be used to downscale CR climate model outputs to the HR scales of observationally-constrained datasets. This work explores generative adversarial network's (GANs) ability to emulate HR simulations using CR model fields as inputs and considers the following topics: (i) Many applications of GANs for downscaling consider input fields that are the HR fields coarsened by a simple function. Practical applications of GANs for downscaling may not have such strong consistency between the CR and HR datasets -- for example, a CPM is free to develop its own climatology and may diverge from its driving model inside the domain. Here, reanalysis fields are directly used to reconstruct the CPM and no coarsening function is used. (ii) Few studies use recent, more stable GAN frameworks. Stability becomes increasingly relevant as researchers both aim to overcome large resolution gaps between CR and HR models, and also customize their GANs with physics-informed model architectures and regularization terms. Here, a Wasserstein GAN with Gradient Penalty (WGAN-GP) was adopted and shown to be stable and generalize well to unseen data despite the high SR scaling factor. (iii) A novel frequency separation scheme was adopted from the computer vision literature to separate spatial scales in wind patterns. Low and high frequency spatial components were delegated to separate terms in the loss function. Several GANs were trained over three geographically separate regions to test this concept.

Session: 13020 Computational Methods, Machine Learning, and Model Development Méthodes de calcul, apprentissage automatique et développement de modèles **06/06/2022 13:10**

ID: 11563 Contributed abstract

Poster Order:

Data efficient statistical post-processing of weather forecasts using neural networks

David Landry [1] , *Geneviève Chafouleas* [2]

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Presented by / Présenté par: ***David Landry***
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Statistical postprocessing is a key step in most operational weather forecasting pipelines. Its overall objective is to automatically reduce the impact of model biases and other systematic errors in forecasts.

The availability of training datasets is a challenging aspect of statistical postprocessing. The most common methods require a varying amount of data to perform well. However, the construction of the training datasets is a complex task from a storage space point of view. Furthermore, the constant evolution of operational models requires the computation of hindcasts for training postprocessing models, which makes it a computationally intensive process as well as a storage intensive one. The issue of data availability also arises in industrial applications, where the opening of new activity sites can warrant statistical postprocessing where little historical data is available.

We study different postprocessing methods with respect to their data efficiency. Our objective is to perform a principled bootstrapping of a statistical postprocessing model with respect to the size of the training dataset available. The MOS approach is compared to an auto-regressive one, which is expected to perform better in data-reduced situations, as well as a more sophisticated machine learning approach, which is expected to perform better in data-rich situations. Neural networks architectures are considered because of their capability to perform transfer learning, which should increase the data efficiency of the postprocessing.

Our approach is evaluated in a deterministic context by post-processing surface temperature forecasts from the Canadian Global Deterministic Prediction System. Our dataset includes forecasts North America over the 2019-2021 three year period.

Session: 13020 Computational Methods, Machine Learning, and Model Development Méthodes de calcul, apprentissage automatique et développement de modèles **06/06/2022 13:25**

ID: 11490 Contributed abstract

Poster Order:

A framework for exploring a complete measurement model

Rick Danielson [1] , *William Perrie* [2] , *Joël Chassé* [3] , *Hui Shen* [4] , *Jing Tao* [5]

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Presented by / Présenté par: ***Rick Danielson***
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Motivation is given for completing a measurement model, or regression model, by accommodating partially overlapping notions of equation error and representation error as signal terms. Implications are that error cross-correlation has the interpretation of nonlinear association, error that is uncorrelated is a lack of association, and all three (linear, nonlinear, and lack of assocation) are needed to describe the signal of interest. An extended sampling model is shown to offer multiple solutions, with two being comparable to ordinary and reverse linear regression, but offering better bounds on systematic bias. A few practical applications are highlighted and a framework for exploring model solutions under controlled settings is given at https://github.com/JuliaAtmosOceanHydro/MeasurementModelDemos

Session: 13020 Computational Methods, Machine Learning, and Model Development Méthodes de calcul, apprentissage automatique et développement de modèles **06/06/2022 13:40**

ID: 11571 Contributed abstract

Poster Order: Poster-13020

Experimental development for AI in weather using Hydra

David Landry [1] , *Geneviève Chafouleas* [2]

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Presented by / Présenté par: ***Geneviève Chafouleas***
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The importation of increasingly sophisticated artificial intelligence techniques for earth science applications is well under way. This enlarges the space of solutions that has to be considered by the weather and earth science communities. Every working hypothesis involves a large amount of hyperparameters and alternative model architectures to choose from, which makes the software development aspect of the research challenging. Fortunately, this problem emerged simultaneously in many fields, and numerous solutions are being considered and designed.

We illustrate the use of the emerging Hydra library for the development of AI models on weather data. Hydra is an experiment configuration library that facilitates software development for research. It features seamless composition and overriding of hierarchical configuration files, which allows the researcher to preserve many similar experiments within the same code base. Hydra interfaces well with schedulers such as Slurm, making it an ideal tool for working in an HPC environment.

This methodology was used to develop the winning contribution to the WMO S2S AI Challenge in 2021.

Session: 13020 Computational Methods, Machine Learning, and Model Development Méthodes de calcul, apprentissage automatique et développement de modèles **06/06/2022 13:50**

ID: 11705 Contributed abstract

Poster Order:

Robustness of the parameterization of sub-grid scale wind variability on sea-surface fluxes

Kota Endo [1] , *Adam Monahan* [2] , *Julie Bessac* [3] , *Hannah Christensen* [4] , *Nils Weitzel* [5]

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[2] University of Victoria
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[5] Ruprecht-Karls-Universität Heidelberg

Presented by / Présenté par: ***Kota Endo***
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Atmospheric processes smaller than model resolution must be parameterized to ensure sub-grid scale processes are appropriately represented in numerical models, however surface wind variability sourced enhancements to sea surface fluxes are difficult to parameterize deterministically. As such, it is appropriate to stochastically parameterize such sea surface flux enhancement due to surface wind variability, and it furthermore becomes paramount to determine if such stochastic parameterization is robust across different model constructions, geographical regions, and time periods. An established statistical model is applied to coarse grained numerical model output in order to quantitatively assess the robustness of the parameterization. To study the sensitivity of the deterministic part of the parameterization, correlations are computed for six different global convection permitting numerical models, four different geographical regions, and three ten-day periods. Results indicate minimal sensitivity for time periods, followed by model differences and regional differences. The stochastic part of the parameterization is fit with a Gaussian process regression, which reveals robust spatial heterogeneity in some geographical regions, indicative of potential improvements that may be made to the studied statistical model. The robustness of the stochastic parameterization studied invites the Canadian Earth System Modelling community to implement stochastic parameterizations in sea surface flux representations for weather and climate models. In particular, the absence of the necessity to make major model-specific or region-specific adjustments to the stochastic parameterization is attractive for numerical model development collaborations.

Session: 13020 Computational Methods, Machine Learning, and Model Development Méthodes de calcul, apprentissage automatique et développement de modèles **06/06/2022 14:05**

ID: 11801 Contributed abstract

Poster Order:

Evaluation of Optical Flow Methods for Radar Precipitation Extrapolation

Norbert Driedger [1] , *Ahmed Mahidjiba* [2] , *Andres Perez Hortal* [3]

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Presented by / Présenté par: ***Norbert Driedger***
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ECCC creates two key North American radar composite products every 10 minutes: 1) a 1-km resolution Dual Polarization Quantitative Precipitation Estimation (DPQPE) version using Doppler dual-pol S-band information for Canadian radars, and 2) a 2.5-km resolution version assimilated into NWP models that uses “BALTRAD” software to heavily filter out non-meteorological echoes. It is desirable to extrapolate both products some number of time steps into the future, 1) to provide a 1-km resolution nowcast suitable for public and external client consumption, and 2) to assimilate the extrapolated echoes into the NWP model to further improve the precipitation forecast quality. Optical flow broadly refers to the spatial displacement between the contents of two images. If the two images are incremental in time, displacements are interpreted as motion vectors. Some optical flow techniques derive from computer vision algorithms. The open source pySTEPS package comes with a collection of optical flow methods built in. A novel method called “Farneback Smoothed” was developed and implemented recently in real-time at the Canadian Meteorological Centre (CMC) Operations to work in conjunction with pySTEPS. Any method used must deliver results well within 10 minutes before the next composite is ready.

North America is a large domain with some precipitation happening practically at all times. There are several well-known challenges when extrapolating precipitation signals. Precipitation forecasting is scale dependent, and small, often convective, scales are at the limits of predictability. Smoothing provides better objective verification scores, yet subjective realism is also desirable in a product for the public. Anchored signals, such as from lake effect snow bands, should remain relatively stationary. Incoming precipitation beyond radar range needs consideration. Growth and decay may or may not be modelled.

Because extrapolation inherently involves a displacement component, it is desirable to measure displacement error during validation. A version of the Displacement Amplitude Score was developed internally to utilise the Farneback optical flow method. This and other scores will be presented, both for seasonal and event based statistics.

Session: 13020 Computational Methods, Machine Learning, and Model Development Méthodes de calcul, apprentissage automatique et développement de modèles **06/06/2022 14:20**

ID: 11632 Contributed abstract

Poster Order:

On preconditioning a discontinuous Galerkin solver for the shallow water equations

Christopher Subich [1]

1

Presented by / Présenté par: ***Christopher Subich***
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Next-generation dynamical cores face the challenge of efficiently using computer resources that will focus on acceleration technologies, where raw compute power outpaces memory and communication bandwidth. Discontinuous Galerkin methods combine strong locality with moderate to high spatial order, and they show promise at meeting the constraints of current and near-future supercomputer systems.

However, the 'discontinuous' part of a discontinuous Galerkin method creates a high number of inter-element boundary condition, and it is a challenge to create efficient and scalable time integrators that permit a high timestep, with Courant numbers well above unity.

This presentation discusses recent work towards creating an efficient, scalable preconditioner for the shallow water equations, discretized with the direct flux reconstruction method, using a geometric multigrid approach.

Session: 4020 Dynamics and chemistry of the upper troposphere and stratosphere (UTS) Dynamique et chimie de la haute troposphère et stratosphère (HTS) **06/06/2022 14:55**

ID: 11436 Contributed abstract

Poster Order:

Ozone-depleting substances: a major contributor late 20th century global warming

Michael Sigmond [1] , *Lorenzo Polvani* [2] , *John Fyfe* [3] , *Jason Cole* [4] , *Chris Smith* [5]

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Presented by / Présenté par: ***Michael Sigmond***
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While previous studies have indicated a substantial role of ozone depleting substances (ODSs) in historical climate change, their relative contribution compared to other historical forcings such as CO2 and aerosols is poorly known. Based on 20 ensemble member historical simulations with a state-of-the-art Earth System Model in which we separately fix ODSs, CO2 and aerosols to 1955 levels, we find that over the 1955-2005 period when ODSs increased, ODSs are responsible for a warming of global mean surface air temperature (GSAT) that is 61% of that associated with CO2. Complementary atmosphere-only simulations from which the corresponding effective radiative forcings (ERFs) are calculated reveal that the ODS impacts on GSAT are larger than expected based on their ERF. The ensemble mean efficacy of ODSs, which measures the relative efficiency compared to CO2 of changing the global mean surface temperature, is 1.2, which is statistically larger than unity ($p=0.014$). The spatial pattern of ODS temperature impacts is similar to that of CO2 and aerosols, peaking in the Arctic. The temporal evolution of the ODS impacts is similar to that of CO2, quickly accelerating after the 1980s, while the cooling impacts of aerosols rapidly increased between the 1950s and 1980s and

remained fairly constant afterwards. These findings suggest that ODSs are a more important climate forcer of past global climate change than previously appreciated, and further emphasize the importance of the Montreal Protocol for mitigating future climate change.

Session: 4020 Dynamics and chemistry of the upper troposphere and stratosphere (UTS) Dynamique et chimie de la haute troposphère et stratosphère (HTS) **06/06/2022 15:10**

ID: 11450 Contributed abstract

Poster Order:

How Does Coupled Tropospheric Chemistry Influence Ozone in the Upper Troposphere and Stratosphere?

Noah Stanton [1] , *Neil F. Tandon* [2]

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Presented by / Présenté par: ***Noah Stanton***
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The depiction of tropospheric chemistry in climate models has greatly improved in recent years. The Community Earth System Model version 2 Whole Atmosphere Community Climate Model (CESM2-WACCM) has implemented fully-coupled tropospheric chemistry with 228 chemical species, an updated aerosol scheme, as well as a fully-coupled ocean. In addition to their effects on climatological parameters like cloud radiative effect (CRE), surface temperature and sea level pressure, these model improvements also have a large impact on the chemical composition of the troposphere and stratosphere. To further examine these impacts, two 100-year preindustrial control simulations were run: 1) the “simplified” CESM2 configuration in which coupled chemistry is confined to the middle atmosphere, and 2) the CESM2-WACCM configuration with fully-coupled chemistry in both the troposphere and the middle atmosphere. Differences of climatological mean parameters between the model configurations were analyzed. Regional differences in surface temperature and the CRE range between -5 K and 5K and -10 W/m^2 to 15 W/m^2, respectively. There are also significant differences in the number concentration of ozone. Compared to the CESM2 configuration, CESM2-WACCM produces 1.5*10^17 to 3.0*10^17 molecules/m^3 more ozone in the upper troposphere, an increase of approximately 10-20%. CESM2-WACCM also produces 1.5*10^17 molecules/m^3 (3%) more ozone in the southern polar stratosphere compared to CESM2. These ozone changes appear to drive dynamical changes that extend down into the troposphere including an equatorward shift of Southern Hemisphere midlatitude jet. These changes in turn influence cloud distribution, precipitation patterns, and sea ice area.

Session: 4020 Dynamics and chemistry of the upper troposphere and stratosphere (UTS) Dynamique et chimie de la haute troposphère et stratosphère (HTS) **06/06/2022 15:25**

ID: 11347 Contributed abstract

Poster Order:

Tropopause-level NOx in the Asian Summer Monsoon

Kimberlee Dube [1], *William Randel* [2], *Adam Bourassa* [3], *Doug Degenstein* [4]

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Presented by / Présenté par: ***Kimberlee Dube***
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Deep convection within the Asian summer monsoon (ASM) transports surface level air into the Upper Troposphere – Lower Stratosphere (UTLS), affecting the chemistry within this region. This work aims to understand the distribution of NO2, NO, and NOx in ASM anticyclone at the UTLS level. Observations of NO2 from the Optical Spectrograph and InfraRed Imager System (OSIRIS), the Atmospheric Chemistry Experiment - Fourier Transform Spectrometer (ACE-FTS), and the Stratospheric Aerosol and Gas Experiment (SAGE) III on the International Space Station (ISS) are considered, along with NO observations from ACE-FTS. The PRATMO photochemical box model is used to understand the NOx photochemistry, and to derive the NOx concentration using OSIRIS NO2 and O3 observations. The satellite data are compared to NOx from the Whole Atmosphere Community Climate Model (WACCM). We find a low NO2 anomaly from 100 to 60 hPa over the Asian continent in the summer months. The NO and NOx anomalies are elevated throughout the same region and time period. There is very good agreement between WACCM and the instrument data.

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ID: 11797 Contributed abstract

Poster Order:

Variability and long-term changes of the tropical cold point temperature

Mona Zolghadrshojaee [1], *Susann Tegtmeier* [2], *Robin Pilch Kedzierski* [3], *Sean Davis* [4]

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Presented by / Présenté par: ***Mona Zolghadrshojaee***
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The cold point tropopause is defined as the level at which the vertical temperature profile reaches its minimum. Final dehydration for air masses en route from the troposphere to the stratosphere typically occurs at these lowest temperatures, so the cold point tropopause effectively controls the overall water vapor content of the lower stratosphere.
Here we present seasonally and horizontally resolved trends of the cold point temperature derived from the Global Positioning System-Radio Occultation

(GPS-RO) data and the most recent atmospheric reanalysis data sets ERA5, JRA-55, and MERRA-2. A multivariate regression analysis has been applied to isolate the long-term changes from interannual variability driven by tropospheric and stratospheric forcings such as the Quasi Biennial Oscillation (QBO), the El Niño-Southern Oscillation (ENSO), the solar cycle and the stratospheric aerosol loading. The analysis will highlight consistencies and differences between observational and reanalysis results. Longitudinal asymmetries and seasonal variations of the cold point temperature trends will be linked to signals of tropospheric variability such as the Walker Circulation and the Pacific Decadal Oscillation.

Session: 4020 Dynamics and chemistry of the upper troposphere and stratosphere (UTS) Dynamique et chimie de la haute troposphère et stratosphère (HTS) **06/06/2022 15:50**

ID: 11367 Contributed abstract

Poster Order:

Convectively injected moisture plumes in the extratropical lower stratosphere: their characteristics, fate, and detectability by satellite instruments

Xun Wang [1] , *Yi Huang* [2] , *Zhipeng Qu* [3]

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Presented by / Présenté par: ***Xun Wang***

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Stratospheric water vapor is an important greenhouse gas, which affects the earth’s radiative budget. It also plays an important role in the life cycle of ozone. In the extratropical lowermost stratosphere, water vapor is mainly contributed by the Brewer-Dobson circulation, isentropic mixing from the tropics to higher latitudes, and deep convective transport. Deep convection can penetrate the tropopause, injecting ice and water vapor into the lowermost stratosphere. It effectively moistens the lowermost stratosphere and results in strong water vapor enhancements, since it bypasses the thermal control of cold point temperatures in the tropical tropopause layer. In situ measurements have shown evidence of anomalously elevated water vapor in the North American monsoon region during summer, which can be traced back to convective moistening. However, it is hard to collectively quantify the characteristics of such moistening plumes from the limited in situ measurements or from existing satellite observations, which smears out the water vapor anomaly. 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. We demonstrate the typical gravity wave breaking process caused by convective overshooting, which generates the moistening plume. We statistically quantify the vertical and horizontal size of the moisture plume and the water vapor mixing ratio. We investigate the detectability of the convective water vapor anomalies by satellite instruments with a range of hypothetical resolutions. To investigate the fate of the moisture plume after entering the stratosphere, we use a Lagrangian trajectory model to track the moisture plume for at least two days.

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06/06/2022 16:05

ID: 11724 Contributed abstract

Poster Order:

Development of a Long-Term Relative Humidity Climatology Directly from Simultaneous Vibrational-Rotational Raman Lidar Measurements

Vasura Jayaweera [1] , *Robert Sica* [2] , *Alexander Haefele* [3] , *Giovanni Martucci* [4]

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Presented by / Présenté par: ***Vasura Jayaweera***

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Water vapor is the dominant greenhouse gas in our atmosphere and plays a crucial role in our planet's future climate. Raman lidars have become one of the prime tools for measuring the atmospheric water vapor content and temperature of the troposphere. We will present relative humidity retrievals from the Raman Lidar for Meteorological Observations (RALMO), located at the Swiss Meteorological Services (MeteoSwiss) facility in Payerne, Switzerland. RALMO is a fully automated lidar that has been operating since 2007 and simultaneously measures both temperature and water vapour mixing ratio.

Gamage et al. (2020) have presented a new method in which RALMO temperature and relative humidity are assimilated with ERA5 reanalysis data directly from the lidar measurements. Unlike traditional methods this method uses raw measurements rather than separate processing of temperature and water vapour, or combining measurements from different instruments. Gamage et al. also showed it significantly improved the ERA5 reanalysis temperature and relative humidity. It also gives the full uncertainty budget which includes both random and systematic uncertainties of the retrieval and allows the retrieval of other atmospheric and instrument parameters.

We are in the process of calculating a relative humidity climatology with high temporal and vertical spatial resolution. Our final goal is to reprocess 12 years of RALMO data to calculate a full relative humidity climatology in the troposphere and lower stratosphere (UTLS) region to look at trends in relative humidity as a function of altitude. This study will give valuable insights on the long-term trends in relative humidity and will expand the trends study of Hicks-Jalai et al. (2020) using RALMO water vapour mixing ratio to relative humidity. To be able to extract trends requires the lidar be properly calibrated. We will present our calibration procedure and initial results using this calibration.

ID: 11853 Contributed abstract

Poster Order:

On the Contribution of Thin Ice Clouds to Radiative Forcing and Dynamics of the UTLS

Jean-Pierre Blanchet [1] , *Housseyni Sankaré* [2] , *Setigui Keita* [3] , *Yann Blanchard* [4] , *René Laprise* [5] , *Adam Bourassa* [6] , *Doug Degenstein* [7] , *Yi Huang* [8]

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Presented by / Présenté par: ***Jean-Pierre Blanchet***
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In the Upper Troposphere and Lower Stratosphere (UTLS), trace gases, aerosol and clouds play a determinant role in the generation of Available Potential Energy (APE) driving the general circulation and storm activity on the synoptic scale. At cold UTLS temperatures, the atmosphere transparency become highly sensitive to the concentration of water vapour, especially in the Far Infra-Red (FIR) range. Furthermore, in response to the ice refractive index, the thermal emission of clouds has a strong IR wavelength dependency. The emissivity is also closely linked to ice crystals size and shape especially in the low Cloud Optical Depth (COD) range. To further enhance the cloud sensitivity, the nucleation of ice crystal is highly dependent on the aerosol composition and on the available fraction of Ice Forming Nuclei (IFN). The production of sulfuric acid aerosols, from volcanic, fires, anthropogenic emissions and chemical conversion, enhances the occurrence of larger crystals, precipitating and dehydrating the UTLS. This complex interaction between water vapour, aerosol and cloud is now investigated with models, diagnostics and observations. To address this issue, a consortium of 11 Canadian universities is developing a satellite mission called HAWC that will target UTLS with the aim to advance knowledge and atmospheric models. Joining NASA’s Atmosphere Observing System (AOS), 3 Canadian instruments: Aerosol Limb Imager (ALI), Spatial Heterodyne Observation of Water (SHOW) and Thin Ice Clouds and Far IR Emission (TICFIRE), will team up to address this important question for the atmospheric dynamics and storm activities at an unprecedented resolution and sensitivity.

Session: 5032 Space-Based Earth Observation: Climate Information for Society - Part 3 Observation de la Terre depuis l'espace : informations climatiques pour la société - Partie 3 **06/06/2022 14:55**

ID: 11871 Contributed abstract

Poster Order:

Canadian Operational Atmospheric Science Space Missions and Recent Results

Marcus Dejmek [1] , *Cassandra Bolduc* [2]

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Presented by / Présenté par: ***Cassandra Bolduc***
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Current Canadian satellite missions that measure the Earth's atmosphere include SCISAT, OSIRIS on Odin, and MOPITT on Terra. These missions continue to measure the Earth's stratospheric ozone layer, a multitude of ozone depleting substances, all major greenhouse gases, and various air quality gases. This presentation will describe these Canadian satellites and instruments, present recent scientific discoveries that use these Canadian space-based datasets, along with numerical models that are advanced, resulting research collaborations, and comparison activities conducted with other satellite datasets. Results of a Canadian study on methane science and technology from space will also be presented. This body of work helps advance Canada's monitoring efforts of the UN Montreal Protocol and the Kigali Amendment, along with space-based measurements important for the Paris Climate Agreement.

Session: 5032 Space-Based Earth Observation: Climate Information for Society - Part 3 Observation de la Terre depuis l'espace : informations climatiques pour la société - Partie 3 **06/06/2022 15:10**

ID: 11650 Contributed abstract

Poster Order:

Comparison of carbon monoxide variability over North America using IASI and MOPITT satellite sensors

Heba Marey [1] , *James R. Drummond* [2] , *Dylan Jones* [3]

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Presented by / Présenté par: ***Heba Marey***
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Long-term observations of carbon monoxide (CO) are available from the Measurement Of Pollution In The Troposphere (MOPITT) instrument and the Infrared Atmospheric Sounding Interferometer (IASI). Comparison of the CO

retrievals can help us to understand the differences in the information on variations in atmospheric CO that the two instruments provide. In this study, we compared the CO products derived from the MOPITT V9 TIR with the corresponding IASI data, both for total columns (TC) and vertical profiles. The analysis was performed over the North American domain for the year 2020 which encompassed several fire events in both the USA and Canada. In the winter months, the daily time series of CO data showed that MOPITT TC data are slightly higher than the corresponding IASI data. This increase is because MOPITT exhibited higher values than IASI in the lower troposphere. During the fire activity season (July-September) IASI CO TC data showed higher values which are reflected in their vertical profiles between the surface and 600 hPa. A detailed analysis of the collocated vertical profiles of both MOPITT and IASI shows large discrepancies, especially in the lower troposphere. In these case, vertical profiles of CALIPSO aerosol backscatter at 532 nm and MODIS fire products at the same locations and times suggest the presence of elevated smoke emissions above the boundary layer, in the free troposphere, due to convective lofting. It appears that in some cases these plumes have been transported from the USA to Canada.

MOPITT was built in Canada by COMDEV of Cambridge, ON, data processing is performed at the National Center for Atmospheric Research in Boulder, CO, the Terra instrument is funded and operated by NASA and the MOPITT instrument and operations are funded by the Canadian Space Agency.

Session: 5032 Space-Based Earth Observation: Climate Information for Society - Part 3 Observation de la Terre depuis l'espace : informations climatiques pour la société - Partie 3 **06/06/2022 15:25**

ID: 11592 Contributed abstract

Poster Order:

OSIRIS on Odin: Twenty One Years and Counting

Doug Degenstein [1] , *Adam Bourassa* [2] , *Daniel Zawada* [3] , *Taran Warnock* [4]

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Presented by / Présenté par: ***Doug Degenstein***
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The Canadian Optical Spectrograph and InfraRed Imaging System (OSIRIS) turned 21 years old on February 21, 2022. I said this last year but it is important to reiterate, 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 over 20 years of high quality measurements of vertically resolved 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: 5032 Space-Based Earth Observation: Climate Information for Society - Part 3 Observation de la Terre depuis l'espace : informations climatiques pour la société - Partie 3 **06/06/2022 15:50**

ID: 11595 Contributed abstract

Poster Order:

Validation and Science Results from the Canadian Atmospheric Chemistry Experiment

Kaley Walker [1] , *Ali Jalali* [2] , *Paul S. Jeffery* [3] , *Niall J. Ryan* [4] , *Laura N. Saunders* [5] , *Patrick E. Sheese* [6] , *Jiansheng Zou* [7]

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Presented by / Présenté par: ***Kaley Walker***
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The Canadian-led Atmospheric Chemistry Experiment (ACE) mission on board the SCISAT satellite has been making routine measurements of the Earth's atmosphere since February 2004. The long lifetime of ACE provides a valuable time series of composition measurements that contribute to our understanding of ozone recovery, climate change and pollutant emissions.

The SCISAT/ACE mission uses infrared and UV-visible spectroscopy to make its solar occultation measurements. The ACE Fourier Transform Spectrometer (ACE-FTS) is an infrared FTS operating between 750 and 4400 cm-1 and the ACE-MAESTRO (Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation) is a dual UV-visible-NIR spectrophotometer which was designed to extend the ACE wavelength coverage to the 280-1030 nm spectral region. From these measurements, altitude profiles of atmospheric trace gas species, temperature and pressure are retrieved.

The ACE data set can be combined with other data sets to provide the climate data records required for long term monitoring of ozone and related species and for initialization and testing of chemistry-climate models. In order to do this, it is essential to quantify the biases between the different instruments and investigate their changes over the operational time period. Validation and comparison studies are a necessary component of this data assessment process. Highlights of validation and science results from the ACE mission will be presented in this paper along with mission and instrument status.

Session: 5032 Space-Based Earth Observation: Climate **06/06/2022**

ID: 11422 Contributed abstract

Poster Order:

Results from the 2016 Canadian Space Agency Data Analysis Grants Program

Cassandra Bolduc [1] , *Marcus Dejmek* [2] , *Thomas Piekutowski* [3]

1

2

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Presented by / Présenté par: ***Cassandra Bolduc***

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The Canadian Space Agency provides funding for a number of projects that carry out scientific investigations using space-based atmospheric observations from Canadian satellites and instruments. For instance, over the past two decades, Canada has developed the Atmospheric Chemistry Experiment (ACE/SCISAT) satellite, the Measurement of Pollution in the Troposphere (MOPITT) instrument onboard the NASA Terra satellite and the Optical Spectrograph and InfraRed Imaging System (OSIRIS) onboard the Swedish Odin satellite. The Data Analysis Grants program helps advance the understanding of physical and chemical processes of the atmosphere as well as Earth-surface processes that affect atmospheric composition, and stimulate the development of models that capture this understanding. This presentation will describe the data analysis grants that were awarded in 2016 and the scientific advancements they produced. It will also highlight collaborations between academic and government researchers, the Earth system models they advance, and other performance indicators.

Session: 5032 Space-Based Earth Observation: Climate Information for Society - Part 3 Observation de la Terre depuis l'espace : informations climatiques pour la société - Partie 3 **06/06/2022 16:20**

ID: 11570 Contributed abstract

Poster Order:

A Portrait of Canadian Science & Applications Activities in Preparation for Data from the SWOT Mission

Jean Bergeron [1]

[1] Canadian Space Agency

Presented by / Présenté par: ***Jean Bergeron***

Contact: jean.bergeron@asc-csa.gc.ca

The Surface Water and Ocean Topography (SWOT) mission will provide spaceborne measurements of surface water elevation over inland water bodies and oceans. The Canadian Space Agency (CSA) has delivered its hardware

contribution to the mission and continues to support SWOT science activities through grants to Canadian universities and through shared investments with Environment and Climate Change Canada, and with Fisheries and Oceans Canada. As the satellite launch date, scheduled in November 2022, is approaching, Canadian scientists are planning calibration / validation activities over the Canadian territory in early 2023 and anticipating the use of SWOT data in applications that will benefit Canadians such as monitoring and forecasting inland water bodies, rivers, estuaries and coastal ocean zones. The presentation provides a mission status update and a portrait of Canadian-led SWOT science activities supported by CSA.

Session: 12030 Advancing our understanding of fjord systems Faire progresser notre compréhension des systèmes de fjords **06/06/2022 14:55**

ID: 11515 Contributed abstract

Poster Order:

Three-dimensional nature of flow near a sill in the Saguenay Fjord

Jérôme Lemelin [1] , *Daniel Bourgault* [2]

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Presented by / Présenté par: ***Jérôme Lemelin***
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Silled fjords are glacially carved inlets for which the bathymetry is characterized by one or several sills that play a key role in the dynamics and structure of water masses circulating there. Although it has widely been assumed that the typical tidally-driven stratified flow over fjord sills could be approximated as being laterally-homogeneously two-dimensional (that is, in the longitudinal–vertical plane), there are some indications that suggest otherwise, namely that the lateral component of the flow can and may actually be more important than previously hypothesized. The Saguenay Fjord, in Québec, is a 110 km long three-silled fjord connecting a freshwater input from the Saguenay River at its head to the tidally upwelled dense estuarine waters of the St. Lawrence Estuary at its mouth, making it strongly stratified and tidally energetic. Since several lateral surface flow structures have been observed near the 20 km upstream and 60 m deep intermediate sill of the Saguenay Fjord, the site has been chosen to carry out field studies to characterize the three-dimensionality of the flow around it. A year-worth of moored current and seawater properties data were collected on the upstream side of the sill while shore-based and aerial photogrammetry of drifting ice floes collected over complete tidal cycles allowed to infer surface currents fields using velocimetry techniques. Surface currents observations show that there is flow separation over the sill during ebb tide, taking the form of a recirculating anticyclonic vortex. As the tide slackens, a cyclonic vortex is formed upstream and the overall surface flow field around the sill becomes a lateral dipole vortex. During flood tide, supercritical gravity currents flowing downslope on the leeside of the sill also include a non-negligible lateral component below sill depth, suggesting that three-dimensionality might not only be of significance on the surface.

Session: 12030 Advancing our understanding of fjord **06/06/2022**

ID: 11737 Contributed abstract

Poster Order:

WINTER OUTFLOW (GAP) WINDS CAUSE COOLING AND REOXYGENATION IN BUTE INLET, BRITISH COLUMBIA

Jennifer Jackson [1], *Laura Bianucci* [2], *Wiley Evans* [3], *Bill Floyd* [4], *Charles Hannah* [5], *Alex Hare* [6], *Keith Holmes* [7], *Jody Klymak* [8], *Di Wan* [9]

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Presented by / Présenté par: ***Jennifer Jackson***
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Winter outflow or gap winds occur when a cold, dry continental air moves through mountain passes towards the coast. In British Columbia, these winds normally occur at least once every winter and flow down mountain valleys towards some fjords. Research in the 1960s and 1970s documented near-surface cooling and the subsequent formation of a cold water mass in Bute and Knight Inlet that was associated with outflow events. Despite the importance and persistence of these events, their impact on coastal British Columbia has not been studied since the 1970s. The Hakai Institute have been collecting monthly CTD data in Bute Inlet since 2017. Here we jointly use high resolution continental atmospheric data (wind speed and direction and air temperature) and oceanographic data (temperature, salinity, pressure and oxygen) to examine the impact of a February 2019 outflow event on Bute Inlet. Results show cooling and reoxygenation to 100 m, which persisted as a unique water mass for almost one year. A 2-D model is used to show that outflow events add enough kinetic energy into the system (in the form of wind stress and heat fluxes) to cause mixing to 100 m. Potential changes to outflow events due to climate change and the impact of outflow events on the coastal ecosystem will be discussed.

Session: 12030 Advancing our understanding of fjord systems Faire progresser notre compréhension des systèmes de fjords **06/06/2022 15:25**

ID: 11859 Contributed abstract

Poster Order:

A persistent mid-water column hypoxic zone with low pH and CaCO3 saturation state in Toba Inlet

Alex Hare [1], *Justin Belluz* [2], *Isabelle Desmarais* [3], *Wiley Evans* [4], *Ian Giesbrecht* [5], *Jennifer Jackson* [6], *Eva Jordison* [7], *Colleen Kellogg* [8], *Carolyn Prentice* [9] , *Rosie Savage* [10] , *Suzanne Tank* [11]

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Presented by / Présenté par: ***Alex Hare***
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Oxygen concentrations in many coastal areas have declined over the last several decades, increasing the prevalence of low oxygen zones and hypoxia ($[O_2] < 63$ μmol kg^{-1}). This trend is driven by warming temperatures that decrease oxygen solubility but increase biological metabolism and ocean stratification, and by anthropogenic nutrient loading. Coastal waters, however, also contain environments naturally predisposed to low-oxygen concentrations, particularly in fjords where sills restrict sub-surface water exchange and associated re-oxygenation, and geography constrains freshwater runoff and nutrient loadings. Low-oxygen waters are also commonly associated with low pH and conditions corrosive to $CaCO_3$ through mechanistic links between processes related to both deoxygenation and the inorganic carbon system. Such settings are therefore sensitive to further oxygen decline and additional carbon inputs, making them susceptible to both hypoxia and ocean acidification. Here, we identify and characterize a persistent mid-water column hypoxic zone with regionally low pH in Toba Inlet in the northern Salish Sea, and evaluate the processes controlling this feature. The hypoxic zone is present year-round and is most intense near the fjord head, but extends seaward across the entire fjord (~ 40 km) at its greatest extent, often encompassing > 200 m of the water column. However, in contrast with typical fjord systems, Toba Inlet does not contain a sill, but joins a network of deep channels that connect to the Strait of Georgia at roughly twice the oxygen minimum depth, commonly observed around 100 m deep. Together, these characteristics imply processes additional to sub-surface water exchange control and maintain the extent and intensity of hypoxia and low seawater pH conditions in Toba Inlet. We investigate a suite of processes including sub-surface water exchange, riverine input, particulate fluxes, and biological metabolism, to develop a simple model to explain the oxygen and inorganic carbon characteristics in Toba Inlet.

Session: 12030 Advancing our understanding of fjord systems Faire progresser notre compréhension des systèmes de fjords **06/06/2022 15:40**

ID: 11366 Contributed abstract

Poster Order: Poster-12030

Sill Processes in the Saguenay Fjord

Jérôme Guay [1] , *Daniel Bourgault* [2] , *Cédric Chavanne* [3]

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Presented by / Présenté par: ***Jérôme Guay***
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The Saguenay Fjord is a 110 km long and 250 m deep (max depth) multi-silled glacial valley that connects the Saguenay River at its head with the St. Lawrence Estuary at its mouth. The bathymetry is characterized with 3 sills: a shallow 20-m deep sill at the mouth, an intermediate 60-m deep 20 km landward sill and a deep 120 m sill 35 km landward. These sills separate 3 basins, the outer, the intermediate and the inner basins. The circulation in the fjord is forced by the Saguenay River at its head that brings freshwater, large tides (up to 6 m range) at its mouth that brings salt water and by wind. The large-scale circulation has been characterized by three seasonally dependent regimes during which the deep, intermediate and subsurface waters of the inner basin are being renewed, respectively, during early winter, summer and late winter. There are indirect indications that those regimes are determined by turbulent processes occurring locally at each of these three sills. Here, we carried out a field experiment to more directly investigate the detailed dynamics of tidally-driven sill processes and water mass modifications occurring across these three sills. Our measurements provide to date the most accurate and complete description of the stratified tidal flow structures around these sills. We also found that an internal hydraulic jump seems to form every ebb tide on the seaward side of the intermediate sill but not during flood tide on the landward side. Research is ongoing to better understand this asymmetry but our hypothesis is that it is the presence of a salty pool landward of the sill that prevents the formation of a hydraulic jump, a process that may be similar to that documented in Knight Inlet (British Columbia, Canada).

Session: 12030 Advancing our understanding of fjord systems Faire progresser notre compréhension des systèmes de fjords

06/06/2022 15:40

ID: 11627 Contributed abstract

Poster Order: Poster-12030

Towards a mechanistic understanding of physical transport in Quatsino Sound, B.C.: An FVCOM modeling study

Krysten Rutherford [1] , *Laura Bianucci* [2] , *Andy Lin* [3]

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Presented by / Présenté par: ***Krysten Rutherford***
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The coastal ocean experiences the effect of climate change on much shorter timescales than the open ocean, while simultaneously being the home of many economic, traditional and recreational services. Many models do not, however, have high enough resolution to accurately capture the small-scale and local processes in these regions and are therefore often not suitable tools for

addressing questions related to these coastal areas. It is thus important to develop models specific to these important coastal areas so that we can better understand present-day trends and potential future states. Here, we focus specifically on the coastal community of Quatsino, located on the Northwest corner of Vancouver Island, British Columbia. Quatsino Sound, composed of many inlets, bays and islands, is home to a large aquaculture industry, currently experiencing some of the largest water temperature fluctuations and harmful bloom events in the Vancouver Island region. We are, however, currently lacking information about the mechanisms and processes driving this system. The present study thus develops a high-resolution Finite-Volume Community Ocean Model (FVCOM) for the Quatsino region in collaboration with community and industry partners to better understand this important coastal system. The overall aim of this work is to constrain what mechanisms are underlying the present-day seasonal cycling, and how the region will be affected under future climate scenarios with potentially more frequent warming, harmful bloom, and low oxygen events. Here, we present initial results, with the goal of defining for the first time the physical transport mechanisms in this fjord system, and quantifying the effects of off-shore water intrusions versus river runoff. The results of this work will inform the development of mitigation and management strategies for climate change effects in the region.

Session: 12030 Advancing our understanding of fjord systems Faire progresser notre compréhension des systèmes de fjords

06/06/2022 15:50

ID: 11458 Contributed abstract

Poster Order:

Understanding oxygen dynamics in two nearby Canadian fjords with different oxygen characteristics (oxic vs. hypoxic subsurface waters)

Laura Bianucci [1], *Michael Foreman* [2], *Wendy Callendar* [3], *Jennifer Jackson* [4], *Wiley Evans* [5], *Alex Hare* [6]

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Presented by / Présenté par: ***Laura Bianucci***
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In the west coast of Canada, 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. In 2019, summer observations in two nearby fjords, Bute Inlet and Toba Inlet, showed quite different oxygen characteristics. While Bute was fully oxygenated and had high oxygen concentrations in the upper waters, Toba experienced an oxygen minimum layer, with near-hypoxic waters. In this work, we aim to explore the mechanisms that led to these differences by the means of a coupled physical-biogeochemical ocean model. Our physical model is a high resolution (up to ~60 m) application of the Finite Volume Community

Ocean Model (FVCOM) that extends from the northern tip of Texada Island to Johnstone Strait. The biogeochemical module, called FVCOM-ICM, allows for the representation of plankton, 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, how they differ between the two neighbouring inlets, and whether these processes could change along with climate. In this presentation, we will discuss our latest results and future plans.

Session: 12030 Advancing our understanding of fjord systems Faire progresser notre compréhension des systèmes de fjords

06/06/2022 16:05

ID: 11465 Contributed abstract

Poster Order:

Tidal Influence on the Fraser River Plume in the Strait of Georgia.

Shumin Li [1] , *Rich Pawlowicz* [2]

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Presented by / Présenté par: ***Shumin Li***
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The Fraser River plume in the Strait of Georgia, BC, is significantly influenced by the tide. Here we use 17 years of daily MODIS observations of suspended particulate matter to understand the tidal variability of the plume. Care must be taken to deal with the biases that arise from highly aliased sampling scheme. Our results show a negative correlation between the Fraser River plume area and the tidal elevation with a phase lag at about one hour. The plume area routinely increases/decreases by about 20% during the ebb/flood tides, and a lower river flowrate typically leads to a more dramatic tidal variation in the plume area. A simple analytical model based on the volume conservation and salinity balance equations is built to analyze the dynamical features of the plume, and the observed tidal patterns of the plume area variation is reproduced using tidally modulated plume salinity (observed from instrumented ferries) and river flowrate (from numerical model outputs). These new findings will improve our understandings in the sediment transport within the plume and its potential impact on the coastal ecosystems of the fjord-like Strait of Georgia.

Session: 12030 Advancing our understanding of fjord systems Faire progresser notre compréhension des systèmes de fjords

06/06/2022 16:20

ID: 11634 Contributed abstract

Poster Order:

Dynamics of Renewal Events in Seasonally Anoxic Saanich Inlet

Roberta Hamme [1] , *Grayson Soetaert* [2] , *C. Erinn Raftery* [3]

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Presented by / Présenté par: ***Roberta Hamme***
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A number of fjord systems are characterized by anoxic conditions in their deep water, making them natural laboratories for the study of biogeochemical reactions and ecosystems in Oxygen Deficient Zones. Understanding the impact of these zones on the Earth System has become ever more pressing as deoxygenation causes them to expand. In some of these fjords, oxygenated water is irregularly injected into the deep waters, setting off a fascinating cascade of biogeochemical reactions and ecosystem shifts. Here, we present an analysis of these “renewal” events in Saanich Inlet, a fjord in SW British Columbia, one of the most accessible and well-studied anoxic basins in the world. In late summer and early fall, dense water crosses the sill into this fjord and partially flushes the stagnant deep water. Using high frequency measurements from a profiling mooring installed by Ocean Networks Canada, we show that a range of densities intrudes into the deep water over the course of each event. Rather than creating a homogeneous new water mass in the deep inlet, renewal events instead result in a complex layering of water masses containing different proportions of new oxygenated and old anoxic water. We further show that each renewal within one season conditions the inlet to promote further renewals, by increasing the average density of the waters within the inlet so that new waters encounter less reduction in their density as they mix with the older waters. Finally, we examine predictability for future renewals in this system based on interannual variations in the low tidal current speeds that allow high density waters to move over the sill with minimal dilution. The dynamic renewal process in this fjord has important implications for interpretation and planning of biogeochemical studies.

Session: 13040 Collaborative Weather, Water, Ice and Climate Data Inventory Development in Canada Développement collaboratif d'inventaires de données météorologiques, hydrologiques, glaciaires et climatiques au Canada	**06/06/2022 14:55**

ID: 11753 Invited session speaker

Poster Order:

Collaborative Permafrost Data Inventory Development in Canada

Nicholas Brown [1] , *Stephan Gruber* [2]

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Presented by / Présenté par: ***Nicholas Brown***
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The analysis of past permafrost change and the prediction of likely future changes require knowledge and data about the atmosphere, the ground surface, and the subsurface. As many permafrost datasets were collected without considering interoperability, a lack of permafrost data frequently impedes studies extending beyond individual sites. Improved standardization and data availability can enable a new class of research and services.

NSERC PermafrostNet is a Strategic Partnership Network developing prototype

data systems to promote data sharing and interoperability within the wider permafrost community. Activities also include online workshops for identifying challenges in the collection, standardization and publication of permafrost data, and a community of practice on permafrost data management has started to take shape between participating organizations and researchers.

Data interoperability in permafrost needs to extend beyond the core fields of geoscience and geotechnical engineering and, therefore, can also benefit from experience in other fields based on an adopt-and-adapt approach. Standards and software developed by the oceanographic and meteorological communities are good candidates, for example, controlled vocabularies such as the CF standard names, and standards for distributing data such as OPenDAP. However, these tools do not yet fully support the broad range of permafrost data, which include time series of measured subsurface temperature, qualitative and quantitative soil profiles, site characterization, and spatial data on geomorphic change.

The adoption of and participation in the development of these tools and data standards offers an opportunity for the permafrost science community to improve cohesion and the ability to produce better predictions of permafrost evolution. It also has the potential to create stronger connections to other scientific communities through shared standards for interoperability. Examples will be used to illustrate recent progress.

Session: 13040 Collaborative Weather, Water, Ice and Climate Data Inventory Development in Canada
Développement collaboratif d'inventaires de données météorologiques, hydrologiques, glaciaires et climatiques au Canada

06/06/2022 15:25

ID: 11328 Contributed abstract

Poster Order:

Establishing what weather, water, ice, and climate (WWIC) information users need for safe vessel operation in the Canadian Arctic

Jean Holloway [1] , *Jackie Dawson* [2] , *Jelmer Jeuring* [3] , *Machiel Lamers* [4] , *Brent Else* [5]

[1] University of Ottawa
[2] University of Ottawa
[3] Norwegian Meteorological Institute
[4] Wageningen University
[5] University of Calgary

Presented by / Présenté par: ***Jean Holloway***
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Vessel operators in the Canadian Arctic rely on accurate weather, water, ice, and climate (WWIC) information to make safe navigational decisions, particularly where ice is present. Despite the necessity of accurate WWIC information, it is currently unknown what services are being accessed by users on vessels in the Canadian Arctic, and whether user needs are being fully met by available WWIC products. User engagement throughout the value-chain is crucial for developing meaningful WWIC products, but the user perspective often remains overlooked, creating a gap between what scientists understand

as useful information and what users need for their decision-making. To address this gap, a mixed-methods survey using Qualtrics online software was established to target individuals who have experience using WWIC information while travelling onboard marine vessels of various sizes and types (e.g., cargo ships, yachts, and cruise ships) in the Canadian Arctic. A total of 56 responses were gathered from operators with a range of experience (from less than 1 year to more than 30 years). Results show that just over half of survey participants (55%) felt that their needs were met “frequently” by current WWIC services, but 72% said that their voyages would benefit from additional information and products. Participants identified sea ice concentration and sea ice age/thickness as the two most important information needs to support safe navigation. Most respondents (58%) said they need information about sea ice concentration on a one-day or real-time scale, which is currently unavailable. The southern route of the Northwest Passage through Lancaster Sound was identified as an area where information about sea ice concentration was regularly inaccurate and where improvement is needed. This work is ongoing, and further analysis of text responses will be completed using constant comparison and thematic coding. Survey results will be shared with service providers in order to help stimulate the co-production of meaningful WWIC products to aid safer navigation through the Canadian Arctic.

Session: 13040 Collaborative Weather, Water, Ice and Climate Data Inventory Development in Canada
Développement collaboratif d'inventaires de données météorologiques, hydrologiques, glaciaires et climatiques au Canada

06/06/2022 15:50

ID: 11389 Contributed abstract

Poster Order:

Summer Minimum Snow and Ice Cover over the Northern Latitudes: Long-term Variations since 2000 and Consistency among Various Definitions

Alexander Trishchenko [1] , *Calin Ungureanu* [2]

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Presented by / Présenté par: ***Alexander Trishchenko***
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Snow and ice over land are important hydrological resources and sensitive indicators of climate change. Snow cover extent is identified by the Global Climate Observing System (GCOS) and WMO as an Essential Climate Variable (ECV). The related land cover type is included in all global land cover schemes. We analyzed several approaches for mapping this land cover variable and found no consistent definition and accepted name for this land-cover category despite the apparent simplicity of the concept. The definitions vary from snow/ice that covers land surface “throughout the year” to “at least ten months of the year.” The percentage of pixel area covered by snow/ice also varies between different schemes and can be as low as 60%. The list of suggested names contains “snow and ice,” ”permanent snow and ice,” “perennial snow/perennial ice,” and “snow and glaciers.” The mapping approaches also vary from using a static input data layer to a multi-temporal analysis of satellite composites. To address this problem we suggested the name “minimum snow/ice (MSI) extent,” which suits most mapping scenarios ranging from

multiple scenes to multi-year compositing intervals.
The MSI extent in this study was derived from the clear-sky composites generated at the Canada Centre for Remote Sensing (CCRS) from the Moderate Resolution Imaging Spectroradiometer (MODIS) imagery at 250m spatial resolution since 2000. For mapping the MSI extent on an annual basis, we suggest the use of a snow/ice probability map derived for the warm season, i.e., April–September in the Northern Hemisphere (Trishchenko and Ungureanu, 2021). Examples of MSI extent time series for the 2000-2021 period over various regions over Canada and the Northern Hemisphere will be presented, compared to other sources and correlated with temperature anomalies. Continuation of MODIS MSI time series using imagery from the Visible Infrared Imaging Radiometer Suite (VIIRS) will be also discussed.
This work is supported through the CCRS activity on high-frequency Long-Term Satellite Data Records (LTSDR) as part of the Cumulative Effects (CE) and the NRCan Climate Change Geoscience Programs. Snow/Ice maps derived at CCRS are freely available from the open data archive (Trishchenko, 2021) supported by the NRCan.
References:
Trishchenko, A.P., 2021: Probability maps of the annual minimum snow and ice (MSI) presence over April,1 to September, 20 period since 2000 derived from MODIS 250m imagery over Canada and neighboring regions.” Available at https://open.canada.ca/data/en/dataset/808b84a1-6356-4103-a8e9-db46d5c20fcf
Trishchenko, A.P., and C. Ungureanu, 2021: Minimum Snow/Ice Extent Over the Northern Circumpolar Landmass in 2000-2019: How Much Snow Survives the Summer Melt? Bulletin of American Meteorological Society (BAMS). Vol. 102, No. 4, pp. E748–E764. https://doi.org/10.1175/BAMS-D-20-0177.1.

Session: 13040 Collaborative Weather, Water, Ice and Climate Data Inventory Development in Canada Développement collaboratif d'inventaires de données météorologiques, hydrologiques, glaciaires et climatiques au Canada **06/06/2022 16:05**

ID: 11777 Contributed abstract

Poster Order:

Improving Crisis Management by Inventorying Social Media Responses to Canadian Extreme Weather

Renee Siebert [1] , *Andrei Romascanu* [2] , *Rosie Zhao* [3] , *Drew Bush* [4]

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Presented by / Présenté par: ***Renee Sieber***
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During extreme weather events, crisis managers rely on situational awareness to increase public safety and security. Artificial intelligence can be deployed to classify information disseminated during these events along salient categories (e.g., injured people, damage to infrastructure). Our project, funded by Environment and Climate Change Canada, used Natural Language Processing (NLP) to automatically classify social media content like Twitter posts.

Supervised models rely on training examples labeled with predetermined categories, which removes costly content analysis and produces rapid actionable results. However, models assume these categories are universal across crises. Existing training datasets, such as CrisisNLP, include events like earthquakes and floods in Pakistan, which can fail to capture important aspects of Northern climates (e.g., snowstorms and the infrastructure to mitigate them). Unsupervised classification does not have the overhead of training datasets but its ad hoc nature generates far more noise and requires more interpretation to achieve actionable results.

Durable challenges in classificatory systems led to our present research, where we are building a labeled data repository, which then allows for supervised classification customized to extreme weather events in Northern climates. We begin with unsupervised classification of thousands of posts we harvest. Focus groups–volunteers are welcome!–provide formal and colloquial terms that describe extreme weather in regions in Canada. Unsupervised classification plus the terms guide creation of categories (buckets) for crowdworkers to manually annotate those thousands of posts. The resulting trained data will lead to analysis and refinement processes in our AI pipeline (from data harvesting and labeling to model design and evaluation). We conclude by addressing the value gained from multiple methods to analyze social media content, performance of our NLP models, data training processes (automated and crowdsourced human annotation) and adaptability of these methods to new types of events or data.

Session: 13040 Collaborative Weather, Water, Ice and Climate Data Inventory Development in Canada Développement collaboratif d'inventaires de données météorologiques, hydrologiques, glaciaires et climatiques au Canada **06/06/2022 16:20**

ID: 11359 Contributed abstract

Poster Order:

An inventory of historical climate data and climate projections for the Canadian North

Emilia Paula Diaconescu [1] , *Paul Kushner* [2]

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Presented by / Présenté par: ***Emilia Paula Diaconescu***
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There is increasing demand at the national and regional scales for climate services to support stakeholders in building their resilience to climate change and increase their capacity to address climate change risks. An important first step in the complex task of developing climate services consists of identifying which data exist and how they can be reliably transformed into products that respond to user needs.
Over the past year, the Canadian Centre for Climate Services (CCCS) has brought together researchers from a wide range of universities and organizations and formed a ‘Northern Climate Data Working Group’ whose main objective was to analyse climate data for climate risk and climate-change adaptation decision-making and planning in the Canadian North. The Working

Group's principal tasks were to identify which climate data exist, the quality and limitations of them, and prospects for their use in development of products for Northern stakeholders and communities.
This presentation summarizes the activities of the working group and gives an overview of the report that was produced, including a large data inventory. Datasets for meteorological, snow, hydrology, sea ice, and permafrost related data were inventoried for the historical period and for future projections. The main information for the selected variables were tabulated in the report with links to websites and descriptive documents, many of them presented as appendices. The appendices describe the metadata, contain links to download data, and information on methods used to develop datasets. The report also summarizes the present understanding of datasets, recommends some best practices for their use, and provides additional recommendations on knowledge gaps and priorities for future work.

Session: 13080 Electronic delivery of geophysical science services Prestation électronique de services de sciences géophysiques **06/06/2022 14:55**

ID: 11372 Contributed abstract

Poster Order:

Visualization of wind energy icing maps and wind time series using MSC's GeoMet API for geospatial web services

Simon-Philippe Breton [1] , *Franco Petrucci* [2]

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Presented by / Présenté par: ***Simon-Philippe Breton***
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As part of a collaboration project with Natural Resources Canada, the Meteorological Service of Canada (MSC) is working on improving forecasts of wind ramps and icing for wind energy. 2.5 km resolution gridded forecasts over the Gaspé peninsula and the Maritimes, as well as 250m resolution forecasts over a smaller area, are run 4 times a day, with outputs every 3 minutes to better predict the onset and end of wind ramps. A Kalman filter has been tested on the model outputs to improve the forecasts. High-resolution icing gridded forecasts that are produced through this project are also now made available through the MSC's GeoMet API for geospatial web services. This presentation will illustrate highlights from this project.

Session: 13080 Electronic delivery of geophysical science services Prestation électronique de services de sciences géophysiques **06/06/2022 15:10**

ID: 11421 Contributed abstract

Poster Order:

PAVICS-GIS : Integrating online climate data services with Geographic Information Systems

Travis Logan [1] , *Camilo Perez Arrau* [2]

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Presented by / Présenté par: ***Travis Logan***
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Geographic Information Systems (GIS) are widely used software for geospatial data analysis and management, with applications in areas ranging from urban planning, to agriculture, to hydrology, among others. GIS professionals therefore represent a diverse user group, and could act as a conduit to key climate change datasets facilitating adaptation efforts for a vast number of sectors. This presentation describes an initial proof of concept for integrating online climate datasets, and analysis tools, directly into a GIS environment. More specifically, initial tools developed for accessing and analyzing climate datasets via Ouranos' Power Analytics and Visualization for Climate Science (PAVICS https://pavics.ouranos.ca/) within ESRI's ArcGIS Pro platform are presented. Direct integration of climate service data, and associated analysis tools, represent advantages in that climate data is made available directly in a familiar workspace, as well as offers the possibility where sensitive spatial data layers can be directly overlaid in visualizations or used in subsequent data analysis.

Session: 13080 Electronic delivery of geophysical science services Prestation électronique de services de sciences géophysiques

06/06/2022 15:25

ID: 11684 Contributed abstract

Poster Order:

ClimateData.ca: a modern interface for climate information delivery

Carrington Pomeroy [1] , *Elaine Barrow* [2] , *Trevor Murdock* [3]

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Presented by / Présenté par: ***Carrington Pomeroy***
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Climate change poses many risks to the health and well-being of Canadians and their communities. In order for cities, organizations and businesses to increase their resilience to the effects of climate change and plan adaptation strategies, they need to understand how the climate is changing. Specifically, they need to be able to understand and consider changes specific to their unique location and targeted time horizons.
Climate services exist to fill this gap between climate science and planning by translating climate information to users. This includes enabling access to usable, interpretable, credible, and freely available climate information to inform on-the-ground planning.
This session will focus on the Canadian Climate Data Portal, ClimateData.ca, a user-friendly online climate data source, which has brought together the expertise of national and regional climate service providers. The Canadian Centre for Climate Services, the Pacific Climate Impacts Consortium, Ouranos and the Prairie Climate Centre are working together to jointly deliver climate

information, with the Centre de recherche informatique de Montréal and Habitat7 developing and operating the portal.
This partnership has enabled the delivery of robust, action-oriented climate information via a modern interface. Features include interactive maps, time series charts, data organized by watershed, health region and census division, relevant guidance and a first of its kind “Analysis Tool” that allows users to customize certain climate indices to reflect their location of choice.
These features will be presented alongside a description of the different components of the website, lessons learned from the process, and proposed future enhancements.

Session: 4050 Collaborative Earth System Modelling in Canada - Part 1 Modélisation collaborative du système terrestre au Canada - Partie 1

07/06/2022 08:25

ID: 11788 Contributed abstract

Poster Order:

Developing the Collaborative Platform for CanESM (CP4C)

Paul Kushner [1] , *Neil Swart* [2] , *Jason Cole* [3] , *Haruki Hirasawa* [4] , *Yanping Li* [5] , *Paul Myers* [6] , *Ivy Tan* [7] , *Jack Wong* [8] , *Kirsten Zickfeld* [9]

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Presented by / Présenté par: ***Paul Kushner***
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Disruptive anthropogenic climate change will come to define many aspects of life in the 21st century and will entail potentially severe consequences for Canadian society, ecosystems and infrastructure. Canada's need to meet net-zero GHG commitments, while adapting to projected climate change as those commitments are undertaken, poses an urgent and ongoing need for advanced climate-science knowledge that serves to inform decision making and planning. In this vein, we are pursuing a university-government partnership focused on the use of Canadian Earth System Model (CanESM) of Environment and Climate Change Canada (ECCC).
We report on our efforts to develop and implement the Collaborative Platform for CanESM (CP4C), a research platform for CanESM that will enable the Canadian research community, within and outside of ECCC, to use CanESM in partnership with ECCC for development, analysis, and application. Building on previously presented efforts to port CanESM to Compute Canada HPC platforms, we report on recent technical progress to port the configuration system for CanESM from the ECCC HPC environment, to optimize the parallel sequencing of CanESM, to port the CanESM diagnostics pipeline, and to develop new capacity to continually verify reproducibility of CanESM as such ports are undertaken. We will also report on a spring workshop led by the CMOS Special Interest Group on atmosphere-related research in Canadian universities (CMOS ARRCU SIG). The workshop serves to engage in scientific planning and provide technical overviews on CanESM for our collaborative community. Favourable progress has been made towards lowering barriers to collaboration with ECCC in R&D activities focused on CanESM. It is hoped that CP4C will set the stage for research and development in partnership with ECCC and numerous directions for scientific exploration.

Session: 4050 Collaborative Earth System Modelling in **07/06/2022**

ID: 11434 Contributed abstract

Poster Order:

Analysis in support of CanESM development

Michael Sigmond [1] , *James Anstey* [2] , *Vivek Arora* [3] , *Jason Cole* [4] , *Nathan Gillett* [5] , *Slava Kharin* [6] , *Bill Merryfield* [7] , *John Scinocca* [8] , *Andrew Shao* [9] , *Neil Swart* [10] , *Jack Virgin* [11] , *Libo Wang* [12]

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Presented by / Présenté par: ***Michael Sigmond***
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The analysis for development (A4D) activity at ECCC's Climate Research Division seeks to establish a comprehensive process through which output from the Canadian Earth System Model (CanESM) is analysed in a systematic and ongoing manner, with the goal of improving future model versions. The activity is organized around working groups that tackle systematic model biases documented on a gitlab issue tracker. In this presentation we discuss some lessons learned about CanESM5, the CMIP6 version of CanESM. This includes the identification of processes that have increased the climate sensitivity compared to CanESM2, biases in the amplitude and seasonal cycle of ENSO variability, spurious stratospheric summer warmings, and biases in atmospheric circulation. While the A4D activity is led by ECCC's Climate Research Division, we encourage other scientists interested in CanESM models to engage in existing A4D working groups or to propose new ones.

Session: 4050 Collaborative Earth System Modelling in Canada - Part 1 Modélisation collaborative du système terrestre au Canada - Partie 1 **07/06/2022 08:55**

ID: 11362 Contributed abstract

Poster Order:

Verification of CanESM porting on Compute Canada Supercomputers using Ensemble Consistency Testing

Haruki Hirasawa [1] , *Neil Swart* [2] , *Paul Kushner* [3]

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Presented by / Présenté par: ***Haruki Hirasawa***
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Recent efforts by Environment and Climate Change Canada (ECCC) has enabled the use of the Canadian Earth System Model version 5 (CanESM5) outside of ECCC computing environments. This provides an opportunity for the wider Canadian climate modeling community to conduct CanESM5 simulations on other machines, such as Compute Canada's Cedar and Niagara supercomputers. However, substantial changes to the model's climate can occur when moving between machines, necessitating a method for verifying model consistency between compiler environments. To do this, we use Ensemble Consistency Testing (ECT) which was developed by Baker et al., 2015 for the National Center for Atmospheric Science (NCAR) Community Earth System Model. The ECT allows for rapid, cheap verification of the model in cases where we do not expect changes in the climate, but cannot expect bit-for-bit reproduction (such as machine or compiler changes).

For our ECT, we first generate a 250-member ensemble of one-year CanESM5 simulations on the WestGrid Cedar machine. Then, we verify our port of the model to the Scinet Niagara machine by testing a 3-member ensemble against this reference. We find that the Niagara port is consistent with the Cedar port using the ECT. A larger Niagara ensemble is used to confirm the verification and analyse the statistical properties of the ECT. We conduct further tests to determine the sensitivity of the ECT for CanESM5 by changing parameters in the model, such as the solar constant, and testing the output. These simulations indicate that the model must diverge substantially from the reference before the ECT can detect it, though we are able to improve sensitivity by using a False Detection Rate and increasing the test ensemble size.

Session: 4050 Collaborative Earth System Modelling in Canada - Part 1 Modélisation collaborative du système terrestre au Canada - Partie 1 **07/06/2022 09:10**

ID: 11508 Contributed abstract

Poster Order: Poster-4050

Quantifying the Asymmetry in Land Carbon Cycle Feedbacks under Positive and Negative CO2 Emissions

Rachel Chimuka [1] , *Kirsten Zickfeld* [2]

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Presented by / Présenté par: ***Rachel Chimuka***
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Land and ocean carbon sinks play a major role in regulating atmospheric CO_2 concentration and climate. However, their future efficiency depends on feedbacks in response to changes in atmospheric CO_2 concentration and climate. As atmospheric CO_2 concentration increases, carbon sinks will sequester more carbon, resulting in a negative concentration-carbon feedback. Changes in climate, in response to increasing CO_2 concentration, will decrease the efficiency of carbon sinks, resulting in a positive climate-carbon feedback.

Nearly 90% of emissions scenarios consistent with the 2°C climate target utilize negative emissions to offset positive emissions, with the assumption that carbon cycle feedbacks are symmetric i.e., a given change in atmospheric CO2 concentration or climate under positive emissions would result in changes in land and ocean carbon storage of the same magnitude but opposite sign under negative emissions. Recent research suggests that these feedbacks are, in fact, asymmetric. This study uses an Earth system model to investigate the asymmetry in land carbon cycle feedbacks under positive and negative CO2 emissions. To this end, two symmetric concentration-driven simulations are initialized from a state at equilibrium with twice the preindustrial CO2 concentration and run in biogeochemically coupled, radiatively coupled and fully coupled modes. Our results suggest that land carbon cycle feedbacks are asymmetric. The asymmetry in the concentration-carbon feedback is related to the saturation of the CO2 fertilization effect, whereas the asymmetry in the climate-carbon feedback is partly related to asymmetric vegetation carbon responses to temperature. Compared to their respective magnitudes under positive emissions, the concentration-carbon feedback parameter is larger under negative emissions whereas, the climate-carbon feedback is smaller. As a result, the combined behaviour of both carbon cycle feedbacks under negative emissions results in larger land carbon release to the atmosphere and reduced effectiveness of CDR than if the feedbacks were assumed to be symmetric.

Session: 4050 Collaborative Earth System Modelling in Canada - Part 1 Modélisation collaborative du système terrestre au Canada - Partie 1 **07/06/2022 09:20**

ID: 11689 Contributed abstract

Poster Order:

Coupling a wildfire model to an Earth System Climate Model of intermediate complexity

Étienne Guertin [1]

1

Presented by / Présenté par: ***Étienne Guertin***

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Fire is an integral part of the Earth system, interacting in complex ways with humans, vegetation and climate. Global fire activity is an important driver of the carbon cycle, and understanding its role in the context of climate change is crucial. So far global fire models that bear good agreement with observed global fire activity have been so far running offline with prescribed fine-scale climate and/or vegetation data rather than being fully coupled to both climate and vegetation models.

This research aims to parameterize global wildfire activity in the UVic ESCM in order to obtain a means of studying the long term fire-vegetation-climate interactions. A mechanistic fire model is used, which simulates a burned area per grid cell based primarily on relative humidity, soil moisture and biomass density. The poor accuracy and precision of simulated relative humidity in the UVic ESCM is corrected by parameterizing it according to the simulated precipitations. The fire parametrization, originally designed and calibrated for a spatially and temporally much finer scale, is adapted to the UVic ESCM by prescribing natural variability to the simulated climatology.

The simulations show that adding natural variability to the simulated climatology improves the global spatial correlation of burnt fraction with observations, and that despite the lower resolution inputs, the fire activity patterns are similar to other models. Owing to the poorly simulated relative humidity of the atmosphere module of the UVic ESCM, the fire-free rainforest tropical regions, however, display high burned fractions. Using prescribed relative humidity is necessary to correct this regional pattern.

This research shows the importance of variability of the climatology for global wildfire activity and the limitations of ESCMs that simplify atmospheric circulation. The author suggests using pattern scaling of climate variables to provide such ESCMs with the ability to simulate global fire activity.

Session: 4050 Collaborative Earth System Modelling in Canada - Part 1 Modélisation collaborative du système terrestre au Canada - Partie 1 **07/06/2022 09:35**

ID: 11695 Contributed abstract

Poster Order:

Land Surface Modeling of Wheat Growth in the Canadian Prairies – Current Representation and Potential Future Climate Change

Zhe Zhang [1] , *Fei Chen* [2] , *Yanping Li* [3] , *Phillip Harder* [4] , *Warren Helgason* [5] , *Prasanth Valayamkunnath* [6] , *Zhenhua Li* [7]

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Presented by / Présenté par: ***Zhe Zhang***
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Representing agricultural processes in the land surface component in Earth System Models (ESMs) has been one of the major challenges to the development of integrative ESMs. It is difficult to study these complex processes in croplands, including plant photosynthesis, transpiration, and biomass accumulation. Addressing these complex processes require collaborative efforts from observation, modeling, and remote sensing communities. In this study, we attempted to represent the dynamic wheat growth in the Canadian Prairies and the U.S. Northern Great Plains, using the NoahMP-Crop model. Three sub-tasks are addressed: (1) first, single-point simulations were conducted from the field observation in Kenaston, Saskatchewan, to develop crop growth parameters; (2) then, these parameters are propagated to regional scale, given spatially-varied planting/harvest date and accumulation of GDD. The regional simulation results were evaluated against MODIS LAI product and agricultural survey data from Stats Canada and USDA. (3) a Pseudo Global Warming (PGW) scenario was applied to the model to assess the climate change impacts on wheat growth in this region. Two aspects were studied in particular, as the impacts of extreme heat events on

wheat growth and the possibility of adjusting planting date to mitigate extreme heat or drought in late growing seasons under potential future climate. Although great uncertainties remain from modeling crop growth in ESMs, the collaborative approach among field observation, remote sensing, and modeling communities opens a new perspective in this research field.

Session: 4050 Collaborative Earth System Modelling in Canada - Part 1 Modélisation collaborative du système terrestre au Canada - Partie 1 **07/06/2022 09:50**

ID: 11529 Contributed abstract

Poster Order:

Optimizing spring maize yield and water productivity in an arid irrigation area by using deficit irrigation strategies at different plant growth stages

Ya Huang [1] , *Yanping Li* [2] , *Zhe Zhang* [3] , *Zhenhua Li* [4] , *Danqiong Dai* [5]

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Presented by / Présenté par: ***Ya Huang***
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Developing sustainable and efficient irrigation strategies is a priority for farmers and policymakers facing water scarcity. A promising strategy to improve water use efficiency (WUE) is managed deficit irrigation, which attempts to optimize yield and WUE by synchronizing crop water use with the reproductive stages of crops. Our modeling study aims to determine the optimal deficit irrigation strategy for spring maize with different plant growth stages. We used the Noah-MP model coupled with dynamic crop growth and irrigation scheme to study the relationship between WUE and maize yield under different climatic conditions in Hetao Irrigation District. We conducted six groups of simulation experiments with different irrigation intensities (decrease the intensity of flood irrigation by 20% interval) for eight growth stages of spring maize. The corresponding WUE and irrigation water use efficiency (IWUE) show that the severe SM deficit during the growing season significantly decreases the maize yield in the HID under rain-fed conditions, with almost no harvest in dry years. With traditional flood irrigation, the irrigation amount per unit area exceeds 1000 mm, leading to low WUE and IWUE, while more than 18~25% of irrigation water is wasted as runoff. With the increase of irrigation intensity, both WUE and IWUE show a significant diminishing marginal effect, usually occurring when SM is greater than 0.24~0.27 m3/m3. The worst WUE is obtained at flood irrigation (FI), while the optimal WUE is obtained near 0.6FI. In the vegetative stage, as most irrigation water becomes SM and transpiration, changes in irrigation intensity have little effect on yield. With effective irrigation in the reproductive stage, only a small amount of irrigation is needed to promote yield formation. Considering the maize yield, WUE, ecosystems, and the available water resources in the HID together, adequate irrigation should be prioritized during the initial reproductive and maturity stages.

Session: 5040 The 2030 mitigation challenge: Science-based **07/06/2022**

ID: 11520 Contributed abstract

Poster Order:

Field deployment of multiple top-down approaches to investigate methane emissions from two municipal solid waste landfills in Ontario, Canada

Sebastien Ars [1] , *Lawson Gillespie* [2] , *Amy Van Kolken Banister* [3] , *Roger B. Green* [4] , *Michael J. Whiticar* [5] , *Philip Reece* [6] , *Richard Kovacich* [7] , *Juliano Hayashi* [8] , *Debra Wunch* [9] , *Riley Duren* [10] , *Dan Cusworth* [11] , *Felix Vogel* [12]

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Presented by / Présenté par: ***Sebastien Ars***
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After COP26, Canada joined the Global Methane Pledge, which aims to reduce global methane (CH4) emissions by 30% below 2020 levels by 2030. The waste sector is a major source of CH4 and municipal solid waste landfills (MSWLF) are responsible for about 23% of Canada's CH4 emissions. To help achieve significant reductions by 2030 in this sector new regulation could require MSWLF operators to measure and monitor their CH4 emissions.
During fall 2021, we deployed multiple atmospheric measurement approaches at two MSWLF, one facility closed since 2017 and one still in its active phase, both located in Ontario. The objectives of this study were to 1) compare the ability of different techniques to identify the locations of the main sources of CH4 within each site, and 2) quantify the overall facility CH4 emissions and compare the different estimates to the annually reported emissions.
The techniques applied at these two landfills, included surface emission monitoring using hand-held detectors (SEM), plume measurements with high precision laser spectrometers mounted on a bike, a car, a small unmanned aerial vehicle (sUAV), and spectral plume imaging from an aircraft platform. Furthermore, two solar-viewing Fourier Transform Spectrometers observed the total column enhancement of methane upwind and downwind of the active site, and a scanning Laser Dispersion Spectroscopy system provided continuous horizontal column measurements by targeting a series of retroreflectors on the

We found that SEM, walking, driving and sUAV surveys reliably identified emission hot spots on the closed landfill site and identified some of the major sources of the active landfill.
We derive emission rates for both landfills from plume studies using the ground-based platforms, while from the sUAV data we were only able to estimate emissions from the closed landfill, and the aircraft-based system was limited to detecting the larger plume of the active landfill site.

Session: 5040 The 2030 mitigation challenge: Science-based tracking of Canada's methane emissions to support policy - Part 1 Le défi de l'atténuation à l'horizon 2030 : un suivi scientifique des émissions de méthane du Canada à l'appui des politiques - Partie 1	**07/06/2022 08:40**

ID: 11435 Contributed abstract

Poster Order:

Satellite-Based Tracking of Global Methane Emissions to Support Policy and Mitigation

Eric Choi [1]

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Presented by / Présenté par: ***Eric Choi***
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At the 26th U.N. Climate Conference (COP26), Canada joined more than a hundred countries in launching the Global Methane Pledge, an initiative to reduce global methane emissions by 30% from 2020 levels no later than 2030. The Pledge calls for a move "towards using best available inventory methodologies to quantify methane emissions, with a particular focus on high emission sources." In Canada, the Canadian Net-Zero Emissions Accountability Act enshrines into legislation the country's commitment to achieving net-zero emissions by 2050.

Satellite-based monitoring of anthropogenic methane emissions will be crucial in supporting effective policies and mitigation by providing the objective and timely data needed for the verification of commitments. Scientific studies have consistently reported that anthropogenic methane emissions are characterized by skewed distributions in which a small percentage of sources account for the majority of emissions ("super-emitters"). This understanding of the characteristics of leak distributions drives the need for innovative monitoring strategies, for example, one that combines satellites, aircraft-based instruments, and ground-based sensors in a system-of-systems approach.

GHGSat operates satellites for the quantification of facility-level methane emissions, providing data and analytics for stakeholders in the energy, resource, power generation, agricultural, waste management, and sustainability sectors to make informed environmental decisions. The company has three satellites in orbit with the next three scheduled for launch in this summer towards the goal of a ten satellite constellation. No other government or commercial satellite mission is currently capable of quantifying methane emissions from point sources as small as individual oil and gas wells.

This presentation will include a short history of satellite-based methane

monitoring, a summary of GHGSat's satellites and their capabilities, a description of how GHGSat's high-resolution satellites work synergistically with regional-scale data from space agency missions, and conclude with examples of how GHGSat observations can support science, policy, and mitigation.

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ID: 11687 Contributed abstract

Poster Order:

A lightweight open-cell sensor for methane based on mid-infrared tunable diode laser absorption spectroscopy

Jalal Norooz Oliaee [1] , *Nicaulas Sabourin* [2] , *James Gupta* [3] , *Prem Lobo* [4] , *Kevin Thomson* [5] , *Greg Smallwood* [6]

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Presented by / Présenté par: ***Jalal Norooz Oliaee***
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Measurement of minute atmospheric enhancements of methane often requires single-digit parts-per-billion concentration measurement resolution. To achieve this resolution level through absorption-based spectroscopic methods, it is advantageous to probe methane via its strong mid-infrared bands, particularly the fundamental C-H stretching mode (v3 band) centred around 3.3 µm. The next strong absorption band of methane, centred around 7.7 µm (v4 band), is due to a fundamental bending mode. Molecular transitions in the v3 band are generally 2-5 times stronger than those in the v4 band. An overtone band of the v3 mode (2v3, centred around 1.66 µm), about 2 orders of magnitude weaker than its fundamental, has been used extensively in methane measurement instruments, based on the availability of commercial near-infrared lasers developed for the telecommunication industry. Access to the strong mid-infrared bands of methane has been limited mostly to laboratory studies until the recent development of compact, near-room temperature, single mode light sources such as distributed feedback (DFB) diode lasers, quantum cascade lasers (QCLs) and inter-band cascade lasers (ICLs) which are becoming more widely available for use in field instruments. Here we report the development of a lightweight ppb-resolution sensor for methane employing a GaSb-based DFB diode laser exciting the v3:R(3) transitions of methane at 3.2704 µm. The laser is operated in wavelength modulation mode and is coupled to a lightweight, custom-built, Herriot-type multi-pass cell that provides an absorption pathlength of 6.8 m. The combination of an open multi-pass cell, wavelength modulation, and the use of the strongest transition of methane has resulted in a fast response (1-10 Hz) and high-resolution (~ 4 ppb at 1 Hz) instrument for methane. The instrument is battery powered, consumes less than 15 W, and weighs less than 2 kg, excluding batteries. The availability of such high-

sensitivity, field-deployable methane sensors is expected to greatly expand methane monitoring activities and generate measurement data at multiple scales.

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07/06/2022 09:10

ID: 11522 Contributed abstract

Poster Order: Poster-5040

Estimating Methane Emissions Using an Instrument-Specific Gaussian Plume Inversion Model

Lawson Gillespie [1], *Sébastien Ars* [2], *James Williams* [3], *Louise Klotz* [4], *Mary Kang* [5], *Felix Vogel* [6], *Debra Wunch* [7]

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Presented by / Présenté par: ***Lawson Gillespie***
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Mitigating anthropogenic methane emissions plays an important role in municipal and federal emissions reductions strategies. Emission reduction efforts rely on geospatial inventories to identify emission sources and strengths, which can have large uncertainties or other errors in spatial attribution at the local scale. We use repeated mobile in situ measurements to verify emission strengths of individual emitters, and also to identify sources unaccounted for in these inventories. Our study domain, the Greater Toronto Area (GTA), is the largest urban region in Canada, and is responsible for 2.2% of the total national anthropogenic methane emissions.

Since 2017, the GTA Urban Emissions Project has measured in situ CH4 concentrations using a Los Gatos Research (LGR) Ultraportable Greenhouse Gas Analyzer (UGGA) mounted in a bicycle trailer. To accurately quantify methane emissions with this setup, we develop and evaluate an instrument model for the LGR UGGA. This is done to improve upon semi-emperical statistical equations in the literature, which are based on peak observed enhancements. In narrow downwind plumes, this variable is sensitive to different instrument characteristics. Our model minimizes differences with coincidental observations from Environment and Climate Change Canada's vehicle-based Picarro Cavity Ring-Down laboratory. We use this instrument model with mobile in situ measurements of methane to estimate emissions using the Gaussian Plume model in the Polyphemus air quality modelling system. We performed a series of controlled release experiments in a parking lot and live traffic environments to develop this instrument model. We present these results and evaluate the improvement to the emissions we infer from the

Polyphemus model. Additionally, we further analyze the model error sensitivity to several input parameters to the model.

We apply our optimized model to quantify emissions from previous observations within the GTA, including plumes from urban engineered fresh water sources, and sources from the waste sector.

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07/06/2022 09:10

ID: 11539 Contributed abstract

Poster Order: Poster-5040

Detecting and quantifying methane emissions with the high-resolution GHGSat satellite constellation

Jean-Philippe MacLean [1] , *Dylan Jervis* [2] , *Jason McKeever* [3] , *Antoine Ramier* [4] , *Mathias Strupler* [5] , *Ewan Tarrant* [6] , *David Young* [7]

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Presented by / Présenté par: ***Jean-Philippe MacLean***
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Methane emissions from industrial facilities account for a significant fraction of the current yearly total and are dominated by a relatively small number of "super-emitting" point sources. As such, the ability to quantify emissions from these point sources using satellite measurements of the atmospheric methane column is of considerable interest to provide actionable feedback to industrial operators. The high spatial resolution GHGSat satellite constellation measures methane plumes over targeted 150 km2 domains with a pixel resolution of 25×25 m2 and measurement precision below 2% of background. The satellites detect and quantify methane emissions from a variety of anthropogenic sources: from oil & gas to hydroelectric reservoirs, coal mines, and landfills.
Since the launch of GHGSat's demonstration satellite in 2016, two more satellites have been launched, GHGSat-C1 ("Iris") in September 2020 and GHGSat-C2 ("Hugo") in January 2021. In 2021 alone, the three satellites detected industrial methane emissions equivalent to 143 MTCO2e. With nine additional satellites planned for launch by the end of 2023, the GHGSat constellation will enable the detection and quantification of methane emissions from any site across the globe with near daily revisit times.
We present a variety of examples of the detection and quantification of methane leaks using Iris and Hugo. As part of our calibration and validation program, we have conducted a series of controlled releases where emissions as low as 103 kg/hr have been detected and quantified, including some blind releases organized by third parties. We also present improvements in the retrieval algorithm, error analysis, source rate quantification, and the future of the

GHGSat constellation.

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ID: 11548 Contributed abstract

Poster Order:

A preliminary evaluation of GHGSat for methane emissions monitoring over Canada

Chris McLinden [1] , *James Smith* [2] , *Debora Griffin* [3] , *Ray Nassar* [4] , *Chris Sioris* [5]

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Presented by / Présenté par: ***Chris McLinden***
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GHGSat, a small Canadian company, has developed and launched three commercial, high spatial resolution methane-sensing nano-satellites, with plans to launch several more in the coming years. GHGSat targets a location, acquires 1.6 μm spectra across a 12 km x 12 km scene at a 25-50 m spatial resolution using a Fabry-Perot spectrometer, and from this derives excess-methane for each pixel in the scene. If a plume is detected, GHGSat then estimates the methane emission rate and uncertainty. The goal of this European Space Agency/Canadian Space Agency-sponsored project is to independently evaluate the quality of GHGSat observations, with a focus on understanding methane emissions detection limits and accuracy, and ultimately their utility for methane emissions monitoring in Canada. This presentation will show initial findings from several lines of research, including: quantifying the precision of the excess-methane and understanding how and why it varies from scene to scene and performing emissions calculations using different approaches and contrasting these with the GHGSat methodology. A final activity is generating synthetic GHGSat observations using the MLDP (Modèle Lagrangien de dispersion de particules) dispersion model combined with GHGSat instrument characteristics in order to further understand GHGSat performance and to explore detection limits. These findings will be discussed in the context of methane emissions monitoring for Canada and its ambitious 2030 goals.

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ID: 11384 Contributed abstract

Poster Order:

Using carbon-14 and carbon-13 measurements for source attribution of atmospheric methane in the Athabasca oil sands region

Regina Gonzalez Moguel [1] , *Felix Vogel* [2] , *Sebastien Ars* [3] , *Hinrich Schaefer* [4] , *Jocelyn Turnbull* [5] , *Peter Douglas* [6]

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Presented by / Présenté par: ***Regina Gonzalez Moguel***
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The rapidly expanding and energy-intensive production from the Canadian oil sands, one of the largest oil reserves globally, accounts for almost 12 % of Canada's greenhouse gas emissions according to inventories. Developing approaches for evaluating reported methane (CH4) emission is crucial for developing effective mitigation policies, but only one study has characterized CH4 sources in the Athabasca oil sands region (AOSR). We tested the use of 14C and 13C carbon isotope measurements in ambient CH4 from the AOSR to estimate source contributions from key regional CH4 sources: (1) tailings ponds, (2) surface mines and processing facili- ties, and (3) wetlands. The isotopic signatures of ambient CH4 indicate that the CH4 enrichments measured at the site were mainly influenced by fossil CH4 emissions from surface mining and processing facilities (56 ± 18 %), followed by fossil CH4 emissions from tailings ponds (34 ± 18 %) and to a lesser extent modern CH4 emissions from wetlands (10 ± <1 %). Our results confirm the importance of tailings ponds in regional CH4 emissions and show that this method can successfully distinguish wetland CH4 emissions. In the future, the isotopic characterization of CH4 sources and measurements from different seasons and wind directions are needed to provide a better source attribution in the AOSR.

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ID: 11728 Contributed abstract

Poster Order:

Soil surface flux measurements of fugitive gas migration across soils and seasons

Mark Argento [1] , *Sarah Kennedy* [2] , *Fiona Henderson* [3] , *Rachel Lewis* [4] , *Deirdre Mallyon* [5] , *David Risk* [6] , *Nicholas Nickerson* [7]

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Presented by / Présenté par: ***Mark Argento***
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More oil and gas wells are drilled each year to satisfy growing energy demand across the globe, but as these wells age, the risk of well integrity failure increases. Integrity failure can result in fugitive methane (CH4) releases into soils and emissions to the atmosphere. This process is known as soil gas migration (GM). Measurement of GM is difficult because soils are spatiotemporally variable. Changes in the soil environment can influence gas transport and our ability to accurately measure soil emissions, so it's important that we choose measurement methodology carefully. Two common techniques include (1) measurement of subsurface (in-soil) CH4 concentration, and (2) measurement of soil surface CH4 flux using flux chambers. We conducted a numerical modelling study examining how soil textures, environmental conditions and CH4 leak rates into the soil profile would influence measurement CH4 using either technique. We observed that flux measurements were far less dependent on soil texture or conditions and were better at determining severity of the CH4 leak into the soil. Based on model evidence that flux measurements are less affected by the local soil environment, we then conducted field measurements using two types of automatic flux chambers with integral analyzers and data logging capabilities to evaluate GM incidence and severity at well sites in Alberta and Saskatchewan. We observed that CH4 flux rates were spatiotemporally variable, but found evidence that rates are controlled by meteorological conditions like wind speed and barometric pressure. Our model results and field evidence support the use of flux chambers for detection and quantification of GM. In the future we propose more field measurements, plus long-term measurements coupled with meteorological monitoring, to allow for a better understanding of these sources and improved methane inventories - both of which are important for policy makers and industry.

Session: 7010 Extremes General Session Séance générale - Les extrêmes **07/06/2022 08:25**

ID: 11364 Contributed abstract

Poster Order:

Understanding Wind Extremes in Canada

Alessio Spassiani [1] , *Alex Cannon* [2]

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Presented by / Présenté par: ***Alessio Spassiani***
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Extreme winds results in billions of dollars in damages to global infrastructure each year. Structures need to be designed to ensure they will withstand the strongest wind likely to occur at a location over many years. In Canada the National Building Code of Canada (NBCC) uses 10 and 50-year return periods to understand the risk due to extreme winds. Calculating this risk requires an understanding of the physical processes responsible for the occurrence of extreme winds as well as a reliable and robust observational data. When considering long return periods it becomes important to also understand how

climate change might impact the risk extreme wind events pose to infrastructure in 50 to 100 years. While some attention has been given to understanding historical and future projections of wind means, little research has been conducted with respect to extreme winds in Canada.
Through the use of Self-organizing Maps (SOMs) this work looks to improve the understanding of the large scale physical processes responsible for two main types of extreme winds, convective and synoptic. SOMs are used to sort synoptic type weather maps over North America, using hourly ERA-5 data, into different weather regimes. Hourly gust data, extracted from Automatic Weather Stations from 1998 to 2020, were used to develop an observational data set of extreme convective and synoptic wind events. Extreme winds are defined here as gust greater than 90kmh-1. Gusts were identified as convective if lightning, from the Canadian Lightning Detection Network, was observed around the time a gust was recorded. The SOMs and observational data were coupled to determine relationships between the weather regimes and the occurrence of extreme wind events. Focus was put on 4 major cities across Canada (Vancouver, Calgary, Toronto, and Montreal) where the observational data is considered to be complete in both time and space. The developed SOMs can then be utilized with global climate models to examine potential changes in the occurrence rate of the different weather regimes. This can help provide some insight into how the risk associated with both extreme convective and synoptic wind gusts might change over the next 50-100 years.

Session: 7010 Extremes General Session Séance générale - Les extrêmes **07/06/2022 08:40**

ID: 11473 Contributed abstract

Poster Order:

Spatiotemporal Patterns of Successive Dry and Wet Spells over Canada

Melika Rahimimovaghar [1] , *Reza Rezvani* [2] , *Mohammad Fereshtehpour* [3] , *Mohammad Reza Najafi* [4]

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Presented by / Présenté par: ***Melika Rahimimovaghar***
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Successive hydro-hazards such as wet-dry spells can lead to severe impacts and challenge current water management strategies. Understanding the spatial and temporal characteristics of these events is important to improve these strategies and develop effective disaster risk measures. In this study, we assess the consecutive dry-wet and wet-dry hazards over Canada’s watersheds for the period of 1963-2012 based on the run theory. The characteristics of these lagged compound events including their frequency, magnitude, and transition time are analyzed for 269 gauged data records obtained from the Reference Hydrometric Basin Network (RHBN) and World Survey of Canada (WSC). Further, historical changes in the individual and successive events are investigated using the Mann Kendall test. The spatial and temporal characteristics of successive dry-wet and wet-dry events vary across Canada and show different behavior compared to the corresponding individual components. The results indicate that the transition times of the successive

events are highest in the east and west of Canada, specifically in coastal areas, and are lowest in the central zones. Besides, wet and dry hydro-hazards show abrupt transitions in several coastal regions including the Great Lakes. Coastal locations tend to experience the greatest shift in the frequency of the abrupt successive events. The findings of this research can help enhance water resource management in the future by identifying hot spots of wet-dry and dry-wet occurrences.

Session: 7010 Extremes General Session Séance générale - Les extrêmes **07/06/2022 08:55**

ID: 11617 Contributed abstract

Poster Order:

Seasonality of continental extratropical-cyclone wind speeds over northeastern North America

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Presented by / Présenté par: ***Ting-Chen Chen***
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This study investigates the seasonality of wind speeds associated with extratropical cyclones (ETCs) over northeastern North America using the ERA5 reanalysis dataset during 2000–2020. While past studies on ETC-related high-wind events primarily focus on the winter season, we show that ETCs with extreme near-surface winds are most frequent in fall over this region. Continental ETCs in the region exhibit stronger averaged intensity in fall and spring than winter and summer. On top of that, the low-level stability in ETCs is found significantly the weakest in fall, favoring downward momentum transport from the free atmosphere. Another marginal factor attributed to the predominance of extreme near-surface winds in fall is that ETCs occur more frequently over inland Great Lakes and the Hudson Bay during the low-ice-content (fall) season. Therefore, these fall storms experience a lower surface roughness than those over land surfaces. Based on these results, we derive a simple linear regression that effectively estimates the ETC near-surface wind speeds and their seasonality with three given variables: 850-hPa wind speed of the storm, the low-level stability (measured by the bulk Richardson number), and the surface roughness length. This multi-variable regression outperforms the single-variable regression considering only the 850-hPa wind speed with the root-mean-square error decreased by 46%, serving as a valuable tool for cyclone wind risk detection and assessment.

Session: 7010 Extremes General Session Séance générale - Les extrêmes **07/06/2022 09:20**

ID: 11704 Contributed abstract

Poster Order:

Canadian Extreme Wind Events in Models and Reanalysis

Michael Morris [1], *Paul Kushner* [2], *Oya Mercan* [3], *GWK Moore* [4]

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Presented by / Présenté par: ***Michael Morris***
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Extreme surface wind speeds in urban regions can cause significant damage to the built environment. Understanding how extreme winds, which are used in infrastructure design, may change under climate change is a potentially important consideration for climate change adaptation. Climate model projections of future extreme winds are highly uncertain, in part because models do not adequately capture turbulent boundary-layer processes at small scales. Nevertheless, large-scale dynamics in the free troposphere, well resolved by models, could provide reliable constraints on local extreme winds. To validate model representation of extreme near-surface winds, we bridge information from weather stations, reanalysis, and the National Center for Atmospheric Research's Community Earth System Model (NCAR CESM) to study the scale and structure of extreme wind events in Canada. To focus on events with the greatest potential for damage to infrastructure, we use observations at multiple stations to robustly characterize the strongest wind events in several of Canada's most populated urban regions. Despite underestimating the magnitude of extreme wind speeds, we find that ERA5 reanalysis correctly "captures" about 50% of observed extreme wind speeds as extremes, with those that are not "captured" systematically of smaller spatial scale. To investigate the large-scale dynamics, we compare composites of ERA5 fields over North America during observed extremes to those during simulated extreme winds in the CESM1 Large Ensemble and a variant of this model, NCAR VR-CESM, with refined resolution over Southern Ontario. We composite separately for events with different wind direction. For several of the dominant wind direction events, VR-CESM better captures surface ageostrophic circulation patterns and upper-tropospheric jet streaks. In each case, agreement between the free-running model and reanalysis varies regionally, but where agreement is strong, we gain confidence that models can capture the dynamics important for driving these extremes.

Session: 7010 Extremes General Session Séance générale - Les extrêmes **07/06/2022 09:35**

ID: 11675 Contributed abstract

Poster Order:

Evaluation of BCCAQv2 for downscaling precipitation extremes using large ensemble regional climate simulations and a high-resolution convection-permitting model

Mohamed Ali Ben Alaya [1], *Francis W.* [2], *Xuebin Zhang* [3]

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2
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Presented by / Présenté par: ***Mohamed Ali Ben Alaya***
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Information from statistically downscaled climate data is widely used in climate impacts research and adaptation planning. In Canada, statistical downscaling using the Bias Correction Constructed Analogues with Quantile mapping reordering version 2 (BCCAQv2) method is the primary source of downscaled future climate information. Even though this information is widely used, our basic understanding of its reliability remains somewhat limited. In particular, the reliability of the downscaling process relies on the stability of the BCCAQv2 transfer function in a future warmer climate. Observational records, however, cannot be used to check this property. The aim of this presentation is to determine whether the BCCAQv2 transfer function is able to reliably downscale precipitation extremes from a conventional Canadian Regional Climate model CanRCM4 to a convection-permitting (CP) 4 KM resolution over the southern part of British Columbia, Canada.
We first calibrate the BCCAQv2 transfer function using historical CanRCM4 precipitation simulations and a Weather Research Forecasting (WRF) model retrospective simulation (CTL, 2000-2014) as a target that is forced by ERA-Interim. Then we apply the transfer function to downscale CanRCM4 future precipitation simulations. A pseudo-global warming (PGW) WRF simulation of future climate forced with climate change (2071–2100 to 1976–2005) determind from the CMIP5 ensemble that is added on ERA-Interim is used to evaluate the results and verify whether the BCCAQv2 transfer function is not affected by climate change. Furthermore, a large ensemble of CanRCM4 simulations is used to build information about the impact of internal variability on downscaling calibration and performance. Main results suggests that we should think a little more deeply about the impact of using a transfer function that is strongly affected by warming signals and how to reduce its related biases.

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ID: 11566 Contributed abstract

Poster Order:

Northern Tornadoes Project 2021 Summary and the New Northern Hail Project

David Sills [1] , *Julian Brimelow* [2]

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Presented by / Présenté par: ***David Sills***
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The Northern Tornadoes Project (NTP), founded in 2017 by Western University and ImpactWX and supported by a number of academic and industry partners, is focused on the detection, assessment and documentation of all tornadoes across Canada. The 2021 campaign was NTP's third covering the entire country and included 400 investigations, 340 high-resolution satellite surveys, 52 ground surveys, 48 drone surveys and 18 aircraft surveys. Of the 290 'events' documented by the Project, 100 were tornadoes. Ontario recorded the most tornado events of any province or territory, and a record number of strong

tornadoes (16 EF2s). At the same time, tornado activity on the Prairies was unusually quiet. In fact, no tornadoes were recorded in Alberta, Saskatchewan or Manitoba from mid-June to mid-August, which is historically the peak period for Prairie tornado occurrence. These and other details will be discussed in the presentation.

In early 2022, Western University and ImpactWX announced the creation of a new project focused on damaging hail – the Northern Hail Project (NHP) – the will build on the success of the Northern Tornadoes Project. In collaboration with the Institute for Catastrophic Loss Reduction (ICLR), NHP researchers will primarily target southern Alberta's notorious hail corridor over a five-year period (2022-2026). ICLR, a Western-affiliated centre for multidisciplinary disaster prevention research and communication, has already started important work to capture and collect data during the province's large hail events. Western Engineering is acquiring new monitoring equipment for surveillance of damaging hailstorms and will also assemble field research teams that will investigate significant urban hail damage and collect hailstones on the ground in the wake of severe thunderstorms. These field teams will include researchers and student interns, and are expected to begin operations in June. Further details on plans for the NHP will be discussed at the meeting.

Session: 12040 Physical Oceanography Océanographie physique **07/06/2022 08:25**

ID: 11341 Contributed abstract

Poster Order:

The Nonlinear Evolution of Internal Tides: The Superharmonic Cascade

Bruce Sutherland [1] , *Maninderpal Dhaliwal* [2]

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Presented by / Présenté par: ***Bruce Sutherland***
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Propagating in non-uniform stratification, the internal tide excites superharmonics with double the horizontal wavenumber of the internal tide and nearly double the frequency. Particularly in the tropics, where the Coriolis parameter is small, the superharmonics are nearly resonant with the internal tide, growing to large amplitude and themselves exciting superharmonics. This work will present theory, in the form of coupled ordinary differential equations, which predict that the superharmonic cascade leads to the formation of a solitary wave-train. The results are in excellent agreement with fully nonlinear numerical simulations. For long waves in strong near-surface stratification, the results agree well with the prediction of shallow water theory including rotation through the Ostrovsky equation. The predictions of the Miyata-Choi-Camassa model including rotation are qualitatively similar, but less quantitatively accurate. Our theory thus provides new insight into the dynamics leading to the nonlinear steepening of the internal tide, and it provides an efficient algorithm for predicting the evolution of the waves going beyond the restrictions of shallow water theory.

Session: 12040 Physical Oceanography Océanographie **07/06/2022**

ID: 11357 Contributed abstract

Poster Order:

Gulf Stream: Skewed Jet Dynamics

Jonathan Tessier [1] , *Francis J. Poulin* [2]

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Presented by / Présenté par: ***Jonathan Tessier***
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The Gulf Stream plays an important role in the meridional overturning circulation (MOC) in the North Atlantic, as the only mechanism by which the warm salty water can move from low to high latitudes. It also provides closure to the North Atlantic subtropical gyre circulation as a western boundary current and makes Western European countries much warmer by transporting warm water across the ocean.

Observational data of the Gulf Stream (along the Oleander line, between New Jersey and Bermuda) has found that its stream-wise velocity skews to the right with increasing depth. This has motivated our development of an idealized model of a laterally skewed Gulf Stream jet that is surface trapped overlying a flat bottom. The nonlinear evolution of this unstable asymmetric jet is investigated using the Oceananigans.jl library for multiple values of a skewness parameter. The results show that the maximum growth rate has a nonlinear dependency on the skewness parameter, though weak and strong skew tend to be stabilizing and destabilizing, respectively. Linear stability analysis is done the barotropic limit of the jet as validation.

Session: 12040 Physical Oceanography Océanographie physique **07/06/2022 08:55**

ID: 11439 Contributed abstract

Poster Order:

Energy Cascades in a Two-Layer Shallow Water Ocean Model

Francis Poulin [1] , *Nicholas Kevlahan* [2]

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Presented by / Présenté par: ***Francis Poulin***
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The dynamically adaptive WAVETRISK-OCEAN global model is used to solve one- and two-layer shallow water ocean models of wind-driven western boundary current turbulence (WBC) in various configurations. Both the one-layer simulations and the barotropic mode of the two-layer simulations have an energy spectrum with a power law of -3, while the baroclinic mode has a power law of $-5/3$ to -2. (The baroclinic mode has much lower energy than the barotropic mode.) We have therefore shown that adding a single baroclinic

mode qualitatively changes WBC turbulence, introducing an energy spectrum component typically observed in three-dimensional ocean flows. This suggests that the first baroclinic mode may be primarily responsible for the sub-mesoscale turbulence energy spectrum of the oceans. Adding more vertical layers could strengthen the baroclinic mode differently at different wavenumbers compared to the barotropic mode, producing a dual cascade spectrum $(-5/3,-3)$ or $(-3,-5/3)$ similar to that predicted by quasi-geostrophic and surface quasi-geostrophic models respectively.

Session: 12040 Physical Oceanography Océanographie physique **07/06/2022 09:10**

ID: 11715 Contributed abstract

Poster Order: Poster-12040

Observations of upwellings and downwellings on the edge of the Gaspé Current

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Presented by / Présenté par: ***Théau Leclercq***
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The Gaspé Current is the most remarkable current in the Gulf of St. Lawrence, presenting a complex dynamics and sometime developing meanders. A salinity front separates the surface fresher waters of the estuary from the saltier surface waters of the Gulf of St. Lawrence. For 40 years, upwellings and downwellings observed on the edge of this front have been the subject of several investigations. In 1982, Tang developed an analytical model featuring a permanent circulation consisting of an upwelling offshore of the front and a downwelling below the front. Observations made with CTD (Conductivity Temperature Depth) profilers and ADCP (Acoustic Doppler Current Profiler) data collected between September 1991 and June 1993, as well as wind and SST (Sea Surface Temperature) data made it possible to determine via the ω equation that these vertical currents are mostly due to frontogenesis and frontolysis (strengthening and weakening of the front) during the cruise of September 1991. The highest concentration of upwellings observed in June 1993 could be associated with the fact that the flow from the estuary is maximum during this period promoting the establishment of vertical shear at the front and consequently associated baroclinic instabilities developing into meanders. Westerly and easterly winds can lead to the formation of near-surface upwellings and downwellings via nonlinear Ekman transport but cannot explain the vertical motions at the depth of the cold intermediate layer. These observations show that upwellings along the Gaspé Current are sporadic and dependent on favorable conditions leading to the establishment of Gaspé Current instabilities and to frontogenesis or frontolysis.

Session: 12040 Physical Oceanography Océanographie physique **07/06/2022 09:20**

ID: 11670 Contributed abstract

Poster Order:

Dynamic response characterization of the RBRArgo3 CTD from numerical modeling and laboratory experiments

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Presented by / Présenté par: ***Clark Richards***
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Profiling oceanographic conductivity-temperature-depth (CTD) sensors are known to suffer from errors related to dynamic response when sampling through vertical temperature gradients. Errors in measured salinity are of particular concern, as salinity is a derived property determined from the combination of temperature, electrical conductivity, and pressure. Common causes of dynamic salinity errors include spatial/temporal mismatch of temperature and conductivity measurements, and the more elusive "thermal inertia error" that results from the transfer of heat between the conductivity cell and the seawater being sampled. The latter has been extensively studied for commonly-used pumped CTD systems, however is less well understood for unpumped inductive sensors such as the RBRArgo3 CTD. Given the rising prevalence of such sensors as part of the global Argo program, there is a need to understand the associated thermal inertia errors in order to facilitate correction either onboard the float or in post-processing. Here we describe a series of laboratory flume experiments and a numerical model of heat conduction to explain previously observed behavior which indicated a dual time constant response, and to extend previously proposed corrections to include flow-speed dependence.

Session: 12040 Physical Oceanography Océanographie physique **07/06/2022 09:35**

ID: 11510 Contributed abstract

Poster Order:

Numerical study of tidal amplification in the Sable Gully of the Scotian Shelf

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Presented by / Présenté par: ***Shengmu Yang***
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The Sable Gully is a large and deep submarine canyon at the shelf break of the eastern Scotian Shelf and an area rich in marine life. Previous observations in

the Gully demonstrated that tidal currents have large amplification towards the bottom, especially for the tidal constituent K1 (Greenan et al., 2011). Using a simple analytical model, Swart et al. (2011) suggested that the along-shelf barotropic tidal flow generates along-Gully velocities which are subsequently amplified by resonance. The phenomenon of tidal amplification in the Gully has not been well studied using a primitive-equation ocean circulation model. In this study, a nested-grid modeling system for the eastern Canadian shelf (NGMS-ECS) based on the Regional Ocean Modeling system (ROMS) is used to examine the main dynamic processes affecting tidal amplification in the Gully. The NGMS-ECS is driven by atmospheric forcing at the sea surface based on hourly atmospheric reanalysis produced by the European Centre for Medium-Range Weather Forecasts (ECMWF) and tidal forcing specified at the model open boundaries based on the global tidal solution of TPXO9. The hydrography and non-tidal currents at the open boundaries of NGMS-ECS are specified based on the daily-mean GLORYS reanalysis data from the European Copernicus Marine Environment Monitoring Service (CMEMS). The performance of the NGMS-ECS is validated using observations and other model results. Model results in the Gully feature a large spatial variation of tidal currents both in the horizontal and vertical directions. At the center of the Gully, K1 tidal currents near the bottom (at depth of 1400 m) are about twice that at the 100 m depth. Analysis of model results suggests internal tides generated by tide-topography interactions are the main reason for the tidal amplification in the Gully.

Session: 12040 Physical Oceanography Océanographie physique **07/06/2022 09:50**

ID: 11823 Contributed abstract

Poster Order:

An Intermittent Gravity Current in Deep Water of the Strait of Georgia

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Presented by / Présenté par: ***Mina Masoud***
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The most dramatic aspect of the Strait of Georgia's circulation is its deep-water renewal which have the characteristics of gravity currents. These renewals initiate during neap tides and replace the Strait's bottom water several times over the summer with heavier waters associated with increased density, turbidity and current velocity. These renewal events propagate northward as a intermittent gravity current extending along the right side of the Strait slopes due to the Coriolis force.
We analysis and interpret several datasets measured at deep part of the Strait of Georgia to describe the structure of the gravity currents driving deep renewal in the Strait of Georgia, averaged over the renewal periods. The results show strong evidence of deep water renewal events based on episodic fluctuations in the oceanographic characteristics.
We also develop an analytical model with a depth-dependent eddy viscosity

which provides a good description of the vertical structure of the "mean" gravity current, highlighting the important dynamical processes.

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07/06/2022 08:25

ID: 11457 Contributed abstract

Poster Order:

Urban Water Infrastructure Design in the Climate Change Context: Recent Advances and Shortcomings in Modeling of Extreme Rainfall Processes

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Presented by / Présenté par: ***Van-Thanh-Van Nguyen***
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There exists an urgent need to assess the possible impacts of climate change on the design storm for improving the design of urban water infrastructures in the context of a changing climate. This design storm is commonly estimated from the intensity-duration-frequency (IDF) relations at the location of interest. Consequently, the derivation of IDF relations in the climate change context for a given location has been recognized as one of the most challenging tasks in current engineering practice. The main challenge is how to establish the linkages between the climate projections given by Global/Regional Climate Models at global/regional scales and the observed extreme rainfalls at a given local site or at many sites concurrently over an urban catchment area. If these linkages could be established, then the projected climate change conditions given by climate models could be used to predict the resulting changes of local extreme rainfalls and related runoff characteristics. Hence, innovative downscaling approaches are needed in the modeling of extreme rainfall processes over a wide range of temporal and spatial scales and given the high uncertainty in climate projections by different climate models. Therefore, the overall objective of the present paper is to provide an overview of some recent progress and shortcomings in the modeling of extreme rainfall processes in a changing climate from both theoretical and practical viewpoints. In particular, the main focus of this paper is on the development of some guidance to water professionals on how to consider the climate change information in the design of urban water infrastructures.

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soutenir l'adaptation et l'atténuation du changement climatique - Partie 1

ID: 11642 Contributed abstract

Poster Order:

High-Resolution Modelling of Climatic Hazards Relevant for the Canadian Northern Transportation Sector

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Presented by / Présenté par: ***Laxmi Sushama***
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Infrastructure and transportation systems on which northern communities rely are exposed to a variety of climatic hazards over a broad range of scales. Efforts to adapt these systems to the rapidly warming Arctic climate require high-quality climate projections. Here, a state-of-the-art regional climate model is used to perform simulations at 4-km resolution over the eastern and central Canadian Arctic. These include, for the first time over this region, high-resolution climate projections extending to the year 2040. Validation shows that the model adequately simulates base climate variables, as well as variables hazardous to northern engineering and transportation systems, such as degrading permafrost, extreme rainfall, and extreme wind gust. Added value is found over coarser resolution simulations. A novel approach integrating climate model output and machine learning is used for deriving fog – an important, but complex hazard. Hotspots of change to climatic hazards over the next two decades (2021-2040) are identified. These include increases to short-duration rainfall intensity extremes exceeding 50%, suggesting Super–Clausius–Clapeyron scaling. Increases to extreme wind gust pressure are projected to reach 25% over some regions, while widespread increases in active layer thickness and ground temperature are expected. Overall fog frequency is projected to increase by around 10% over most of the study region by 2040, due to increasing frequency of high humidity conditions. Given that these changes are projected to be already underway, urgent action is required to successfully adapt northern transportation and engineering systems located in regions where the magnitude of hazards is projected to increase.

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ID: 11556 Contributed abstract

Poster Order:

Evaluating Climate Change Adaptation Policies for Urban Transportation in India

Ashish Verma [1] , *Harsha Vajjarapu* [2]

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Presented by / Présenté par: ***Ashish Verma***
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Globally, the response to climate change has been through mitigation to reduce the greenhouse gas emissions. But the inevitable climate change effects due to constant feeding of emissions into atmosphere leads to severe and extreme precipitation causing flooding. The combined impact of flooding, rapid urbanization and vehicular growth has become a looming threat to the transportation system which is affecting the developing economies disproportionately. There is an urgent need for the transport infrastructure to adapt to these climate change effects to reduce human as well as economic losses and adaptation is seen as the necessary tool to address this. In this presentation, a methodological approach to formulate the adaptation strategies from urban transport to urban flooding in developing economies is presented. Further three adaptation policy bundles are formulated specifically to enhance the resilience of transportation system against urban flooding thereby strengthening the adaptive capacity of the system. The methodology is demonstrated using a case study of Bangalore Metropolitan Region (BMR).

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ID: 11765 Contributed abstract

Poster Order: Poster-13030

Evaluation of River Flows and Stages Variability Considering Impacts of Climate Change

Pooja Singh [1] , *Asaad Y. Shamseldin* [2] , *Bruce W. Melville* [3] , *Liam Wootherspoon* [4]

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Presented by / Présenté par: ***Asaad Y. Shamseldin***
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Climate change study is raising concern about the planet's future management of water resources. Understanding and projecting hydrological variables with

stochastic nature of frequency and magnitude are becoming inevitably important for the effective flood management strategies. To further strengthen these flood management strategies, it is extremely important to do an in-depth study of climate change impact on engineering structures. Thus, the major challenge for the river managers is to develop a strategy to minimize the future pain of engineering structures by accounting uncertainties associated with the river discharge.
The modelling framework shall consider precipitation as the main factor affecting flood flow generation and allows evaluation of different climate change scenarios generated by Global Climate Models (GCMs). Further, the study shall use MIKE FLOOD to determine the stage-discharge relationship for different return periods. The resulting flows and stages will be useful to assess performance of the engineering structures. The adopted strategy shall be flexible enough to regulate discharge over the river branches by building the temporary and emergency detention areas.

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ID: 11640 Contributed abstract

Poster Order: Poster-13030

Centre for Climate Science and Engineering (CSE)

Daniela A. Bodden [1], *Jamie Fine* [2], *Marianne Hatzopoulou* [3], *Paul Kushner* [4], *Oya Mercan* [5], *Graeme Norval* [6], *Daniel Posen* [7], *Karen Smith* [8], *Marianne Touchie* [9]

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Presented by / Présenté par: ***Daniela A. Bodden***
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The Centre for Climate Science and Engineering (CSE) is a multi-disciplinary research and education centre established in 2019 hosted at the University of Toronto (https://uoftcse.ca/). Given the strong connection between climate change and infrastructure, our team focuses on the intersection of climate science, engineering, and policy through research, education, and outreach activities. The proposed poster will introduce the Centre and provide an overview of its activities.

The CSE has led research projects on energy systems, air quality, GHG emissions, building science, and transportation to mitigate and adapt to climate

change impacts. At the heart of the centre is the application of applied climate change science (e.g., including downscaled weather files and new runs with a variable resolution version of the CESM global climate model) to engineering problems such as building wind loading and local energy demand. Strategic and transdisciplinary collaborations between the CSE team, faculty members across UofT, non-profit organisations, and government have been achieved.

As part of the goal to accelerate the awareness and adoption of climate change resilience choices in urban design, the Centre has created multi-level educational programs. This initiative has included developing and implementing a high-school educational program that focuses on Building Resilience; eight online e-learning modules; and two graduate courses that respectively emphasise adaptation and mitigation of different urban engineering systems. These initiatives aim to train current and future professionals on the fundamentals of climate science and promote opportunities to connect climate data and models to engineering design and analysis.

Finally, the CSE hosts monthly lecture series featured by industry professionals and other academic institutions to communicate actionable knowledge for engineering decisions and policy development under climate change. Overall, the CSE efforts can stimulate strategic alliances across the private, public, and academic sectors to collaborate in initiatives that support professionals to face climate change challenges.

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ID: 11613 Contributed abstract

Poster Order:

Flash flood-traffic interaction studies for the City of Ottawa

Keihan Kouroshnejad [1] , *Laxmi Sushama* [2]

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Presented by / Présenté par: ***Keihan Kouroshnejad***
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The urban transportation system, both infrastructure and traffic, has been identified as particularly vulnerable to extreme weather. Flash flooding from intense precipitation is the predominant cause of weather-related traffic disruption in summer. This problem is particularly important for the road network in urban areas due to the high proportion of impermeable surfaces. The relationship between flash floods, traffic flow, and congestion is acknowledged but not well understood. In this study, high-risk areas of the Ottawa road network in current and future climates are identified by combining high-resolution GEM (Global Environmental Multiscale) simulations of flash floods with inundation modeling using PCSWMM and exposure analysis based on transport network modeling.

The GEM-PCSWMM framework is first validated by comparing PCSWMM simulated flows at selected outfalls with those observed, for up to 5 high-intensity short-duration precipitation events during the 2014–2021 period that are simulated using GEM at 4 km to 100 m resolutions. The results show the added value of high-resolution simulation, with spatial structure realistically captured at 100 m resolution. Inundation depths and velocities identified using the GEM-PCSWMM framework for current and future climates for flash floods of different durations and return periods for the study area comprising the eight inner Ottawa wards are then converted into journey travel time via the transport network model. High-risk/critical sections of the network thus identified by combining the hazard (depth of water on the road) and the exposure (average daily traffic flow along the road) are further considered to develop adaptation strategies by assessing the current drainage for these sections and other greener options.

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07/06/2022 09:35

ID: 11514 Contributed abstract

Poster Order:

The Effects of Climate and Climate Change on Electric Vehicle Charging Demand

Daniel B. Henrique [1] , *Xuesong Zhang* [2] , *An Wang* [3] , *Elise Lagace* [4] , *Kyup Lee* [5] , *Paul Kushner* [6] , *I. Daniel Posen* [7]

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Presented by / Présenté par: ***I. Daniel Posen***
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Mass adoption of battery electric vehicles (BEVs), while important for reducing road transport greenhouse gas and pollutant emissions, may pose a challenge for the electric grid, especially if charging occurs during peak demand hours. The effect of environmental temperature has only been considered to a limited extent in studies of BEV effects on the electric grid. This study quantifies the effect of temperature on BEV charging demand in the Greater Toronto and Hamilton Area (GTHA) using a model of individual vehicle trips in the region. BEV charging demand is superimposed onto regional electricity demand to find BEV-related increase in peak electricity demand, including the relative contribution of seasonal variability and projected change of temperature. This is performed using 2019 temperature observations and 2040 temperature projections under climate change (RCP 8.5), as modeled by a variable resolution global climate model (NCAR VR-CESM) that features high resolution

over the Great Lakes region.

Given that BEV energy use is minimized at around 20 degrees Celsius and that GTHA is a cold-climate region, the impact of temperature on BEV charging demand are larger in winter than in summer. Based on the 2019 analysis, increases in daily BEV charging demand due to temperature reach up to 52% on an average January day, and up to 82% on January's coldest extreme day (relative to mild weather conditions). At 30% market penetration of BEVs, BEV's increase total peak demand on January's coldest day by 600-3600 MW (3-5%), of which 300-700 MW is driven by temperature, depending on the charging scenario. Projected climate change in 2040 introduces changes on the order of a few percent, increasing summer and decreasing winter charging demand. These results highlight the importance of adjusting for regional climate variation and temperature extremes when analyzing the impact of BEVs on the grid.

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07/06/2022 09:50

ID: 11513 Contributed abstract

Poster Order:

Cold temperature limits to biodiesel use under present and future climates in North America

Xuesong Zhang [1] , *Paul J. Kushner* [2] , *Bradley A. Saville* [3] , *I. Daniel Posen* [4]

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Presented by / Présenté par: ***I. Daniel Posen***
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While there is growing recognition of the need to adapt existing engineering systems to future climatic conditions, fewer studies have investigated the opportunities or barriers that climate change may pose for mitigation strategies. In this work, we present a case study to investigate how climate change may alter winter conditions, thereby paving the way for increased use of certain renewable fuels.
In particular, cold weather operability is sometimes a limiting factor in the use of biodiesel blends for transportation. Regional temperature variability can therefore influence biodiesel adoption, with potential economic and environmental implications. This study assesses biodiesel cold weather operability limits in North America for both historic and future climates. We use a combination of weather-station networks, ERA5 reanalysis, a benchmark global climate model (CESM-LENS) and a variable resolution global climate model (NCAR VR-CESM) that features high resolution over the Great Lakes region. Temperature projections for the period 2031-2050 using RCP8.5 show up to 4 weeks increase in duration of use for certain seasonal fuel blends. Fuel cloud

point specifications among supply orbits in Ontario increase up to +6 oC during non-winter seasons, with most increases observed in Fall and Spring. We further analyze whether these fuel supply orbits could be better optimized to follow regional temperature profiles and thereby reduce cloud point “giveaway” of diesel fuels arising due to the existence of a cold region within an otherwise warmer orbit. Optimized temperature clusters in Ontario show potential to reduce temperature variability by 18% compared to existing supply orbits. Finally, we consider the potential for geographically localized municipal fleets in Southern Ontario and Quebec to adopt warmer cloud point fuel blends than their surrounding supply orbits. Overall, the case study demonstrates strong potential for historical and projected climate data to inform fuel specifications and associated policies.

Session: 4030 Assessing the Canadian and global terrestrial carbon cycle - Part 1 Évaluation du cycle du carbone terrestre canadien et mondial - Partie 1 **07/06/2022 12:55**

ID: 11604 Contributed abstract

Poster Order:

The sensitivity of future carbon dynamics to model biases, vegetation dynamics, and wildfires

Christian Seiler [1]

[1]

Presented by / Présenté par: *Christian Seiler*
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In the last two decades, about half of all anthropogenic CO_2 emissions have accumulated in the atmosphere, while the remaining part has been absorbed by the ocean (23%) and the terrestrial biosphere (31%). Although the amount of annual CO_2 absorbed by land and ocean has increased over the last six decades, the fraction of emissions absorbed by land and ocean is projected to decline as anthropogenic CO_2 emissions continue to rise. The strength of this decline varies considerably among earth system models. This study explores the sensitivity of the future terrestrial carbon sink to biases, vegetation dynamics, and wildfires for the land surface component (CLASSIC) of the Canadian earth system model (CanESM). To assess the impacts of model biases on projections, CLASSIC is forced with two meteorological data sets from CanESM, where one data set presents raw CanESM output, while the other data set has been bias-corrected. The simulations are conducted using different model configurations where competition among plant functional types and fires are either turned on or off. Comparing the results from these simulations show how model biases, vegetation dynamics, and wildfires affect terrestrial carbon sink projections. Particular attention is paid to carbon dynamics in the Amazon basin, where CanESM has a strong dry bias.

Session: 4030 Assessing the Canadian and global terrestrial carbon cycle - Part 1 Évaluation du cycle du carbone terrestre canadien et mondial - Partie 1 **07/06/2022 13:10**

ID: 11658 Contributed abstract

Poster Order:

Optimizing the Soil Carbon Module of CLASSIC using Soil Carbon Bulk Pools and Fluxes Datasets

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Presented by / Présenté par: ***Charles Gauthier***
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Soil carbon dynamics parameterization presents a challenge for the modelling community as parameters are rarely measurable in the field. Badly constrained parameter distributions result in greater model uncertainty in simulated soil carbon dynamics. Using soil carbon bulk pools and fluxes datasets, we plan on optimizing the parameters of CLASSIC's soil carbon module using a bayesian optimization framework. We will perform a Sobol sensitivity analysis beforehand to identify and remove nonsensitive parameters. Doing so will also ensure a lower computational cost by reducing the size of the parameter search space. The bayesian optimization framework uses a Tree of Parzen Estimator algorithm to perform the parameter space search and computes a Taylor score to evaluate the model-data comparison. The bulk carbon dataset included in the framework is the World Soil Information Service Database (WOSIS) and the carbon fluxes dataset included in the framework is the Soil Respiration Database (SRDB-V5). Using multiple types of data in our framework should reduce the equifinality of the results. We expect the framework to produce constrained parameter distributions that could lead to better represented soil carbon dynamics and more reasonable future simulations.

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ID: 11763 Contributed abstract

Poster Order:

Global sensitivity analysis applied to the CLASSIC model for a single site.

Raj Deepak Suruli Nagarajan [1]

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Presented by / Présenté par: ***Raj Deepak Suruli Nagarajan***
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Land surface models (LSMs) are a component of global climate models that simulate land-atmosphere fluxes. LSMs such as the Canadian Land Surface Scheme Including biogeochemical Cycles (CLASSIC) model are dynamic systems that have evolved to represent the environmental processes in a better manner. This representation requires an increasing complexity in parameter interactions and processes. The CLASSIC model has been evaluated for various sites around the world. This study focuses on identifying the influential parameters that govern the carbon and heat fluxes from a single evergreen broad leaf forest site in French Guyana. The study will also help in examining model limitations and parameter interactions. The global sensitivity analysis has been split into two parts to ease computational need. The first part is to screen out the most influential parameters from all input parameters, by using the

Morris elementary effects (EE) method. The second part is to identify the parameters that result in a high variability of the output variable(s), by a variance based sensitivity analysis, the Sobol' method. Preliminary results from this study suggest that only 10% of all the model input parameters are important when evaluating the carbon and heat fluxes. These parameters are related to processes like photosynthesis, phenology, and/or allocation of biomass to various parts of the vegetation. Identifying the most influential parameters will help us optimize our model output values to the observed values.

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ID: 11402 Contributed abstract

Poster Order: Poster-4031

Winter carbon fluxes measurements in Arctic tundra and Boreal forest using the snowpack gas diffusion method

Alex Mavrovic [1] , *Carolina Voigt* [2] , *Oliver Sonnentag* [3] , *Juha Lemmetyinen* [4] , *Alexandre Roy* [5]

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Presented by / Présenté par: ***Alex Mavrovic***
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In arctic and boreal regions, carbon exchanges between the soil and atmosphere outside of the growing season is highly uncertain. These exchanges are mainly carried out by emission and absorption of carbon dioxide (CO_2) and methane (CH_4). The insulating properties of snow allow the ground to maintain soil temperatures high enough to allow soil microbial activity despite the freezing air temperatures. The winter contribution to the annual carbon balance of the arctic tundra and boreal forest cannot be neglected in order to determine whether these regions are net carbon sources or sinks, and toward which one will they shift in a warming climate. The harsh environmental conditions combined with the challenge to access the snow-covered ground surface without altering the snowpack present several technical difficulties for the measurement of winter carbon fluxes. Here we present CO_2 and CH_4 winter flux estimates using the snowpack gas diffusion method. This technique consists of extracting air samples within the snowpack without altering it in order to measure the carbon concentration gradient to estimate carbon diffusion through the snowpack and, thus, the carbon fluxes. We will present the spatial variability of winter CO_2/CH_4 exchanges according to the characteristics of snow cover, soil and vegetation for two sites in arctic tundra (Trail Valley Creek and Cambridge Bay) and two sites in boreal forest (Forêt Montmorency and Havipak Creek). Our results show an emission of CO_2 to the atmosphere in both the boreal forest and the arctic tundra with a high spatial variability at the scale of one hundred meters. Soil temperature seems to be the main driver of winter CO_2 fluxes with the majority of fluxes becoming negligible below -10oC. Our results also show negligible methane fluxes in winter at the Arctic sites

studied, but a clear uptake of methane by the soil at the Montmorency Forest site.

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07/06/2022 13:40

ID: 11690 Contributed abstract

Poster Order: Poster-4031

Plant functional type mapping from ESA CCI land cover data for use in CLASSIC

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Presented by / Présenté par: ***Libo Wang***
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Accurate representation of global land cover (LC) is important due to its influence on the exchange of energy, water, and carbon between the land surface and the atmosphere. Previous studies suggested that biases in surface albedo in the presence of snow (particularly across the boreal forest) simulated by climate models in the Coupled Model Intercomparison Projects were linked to vegetation characteristics in the models. Plant functional types (PFTs) are groups of plant species that share similar structural, phenological, and physiological traits, and have been used in land surface models to represent vegetation distribution. There are large differences among PFTs currently used in models, which may result from the differences in the LC datasets and/or the methods used to map LC data to the PFTs represented in various models. Previous methods for PFT mapping are mainly based on LC class descriptions, expert knowledge, and the spatial distribution of global biomes.

The Climate Change Initiative (CCI) LC data generated by the European Space Agency are available annually from 1992 to 2018 at 300m resolution. This dataset was produced based on broad user consultation, specifically to address the needs of the climate modelling community. In this study, the sub-pixel fractional error matrices and a continuous vegetation field tree cover fraction product are used to assist the partitioning of the CCI LC data into nine PFTs in the Canadian Land Surface Scheme Including Biogeochemical Cycles (CLASSIC). The sub-pixel fractional error matrices are created by assigning sub-dominant LC classes from all fine-resolution pixels in the reference data to the corresponding single coarse-resolution pixel. This allows a quantitative assessment of the fractional composition of each class in the coarse-resolution map. A 30m resolution LC map over Canada is used to compute the sub-pixel fractional error matrices of the 300m CCI data. Based on the sub-pixel fractional error analyses and the tree cover fraction data, a cross-walking table is created for converting the CCI LC classes into nine PFTs in CLASSIC. CLASSIC offline

simulation using the CCI-derived PFTs show improved winter albedo simulation over that using PFTs based on GLC2000 LC data currently operational in CLASSIC.

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ID: 11655 Contributed abstract

Poster Order: Poster-4031

Implementation of plant hydraulics in the Canadian Land Surface Scheme Including Biogeochemical Cycles (CLASSIC)

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Presented by / Présenté par: ***Muhammad Umair***
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Simulated stomatal behavior in land surface models (LSMs) plays a critical role in accurately estimating water and carbon fluxes and for evaluating the impacts of land surface-atmosphere interactions on climate change. Climate change impacts include an increasing incidence of drought conditions, which tests the LSM formulations of the impact of moisture stress and need to be investigated thoroughly. Empirical approaches to model stomatal conductance in LSMs, such as the β-stress factor approach, typically perform poorly in conditions of low soil moisture and vapor pressure deficit, especially during drought. The β-stress factor approach for incorporating the soil moisture effect on stomatal conductance is used in Canadian Land Surface Scheme Including Biogeochemical Cycles (CLASSIC). The β-stress factor in CLASSIC does not use plant hydraulic traits in its formulation and misses the plant hydraulic linkage within the soil-plant-atmosphere continuum. Our study will implement plant hydraulics in CLASSIC using stomatal optimization based on xylem hydraulics (SOX; Eller et al., 2020). The SOX model will be implemented using three parameters (obtained from empirical observations) which is a more parsimonious approach in comparison with four-to-five parameters (tuned with the model) used in the current β-stress factor approach. Plant hydraulic traits data collected from the literature and in the field will be used to parameterize and evaluate the performance of SOX as part of CLASSIC to shed light on the modelled impacts of drought conditions on land surface-atmosphere interactions across biomes. Our changes to CLASSIC will improve simulations of water and carbon fluxes during drought conditions, future projections of climate change, and will provide policymakers more accurate estimates of water and carbon fluxes across biomes, which are currently often underestimated during drought conditions.

Keywords: plant hydraulics, land surface models, stomatal optimization, xylem hydraulics, drought, climate change.

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07/06/2022 13:50

ID: 11418 Contributed abstract

Poster Order:

Calibrating land models to reproduce the historical terrestrial carbon sink in the absence of nitrogen cycling compromises future projections

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Presented by / Présenté par: ***Sian Kou-Giesbrecht***
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The terrestrial carbon sink has increased over recent decades due to rising CO2 and associated rising temperature. However, its persistence over the 21st century is uncertain due to the combined influences of multiple global change drivers. In particular, nitrogen, an essential limiting nutrient to vegetation, is expected to constrain the future terrestrial carbon sink. However, intensive agriculture and fossil fuel use cause elevated nitrogen deposition, which has been suggested to relieve nitrogen limitation. Additionally, elevated temperature drives soil organic matter decomposition which releases plant-available nitrogen and is suggested to further relieve nitrogen limitation. Quantifying the extent to which nitrogen limitation will constrain the future terrestrial carbon sink under this cast of interacting and intensifying global change drivers remains a challenge.
Here, we simulate the Canadian Land Surface Scheme including Biogeochemical Cycles (CLASSIC) over the 20th and 21st centuries and examine how representing coupled carbon and nitrogen cycling influences the response of terrestrial carbon sequestration to primary global change drivers (CO2, nitrogen deposition, climate, and land use change). We consider the historical period and three future scenarios from the Shared Socioeconomic Pathways (SSP126, SSP370, and SSP585). We show that, while the carbon-only land model reproduces the present-day terrestrial carbon sink, it cannot reliably project the future terrestrial carbon sink because the strength of the CO2 fertilisation effect compensates for the stimulation of terrestrial carbon sequestration by both elevated nitrogen deposition and elevated nitrogen mineralisation (which are not represented in the carbon-only land model) over the historical period. In the future, this causes the carbon-only land model to project a terrestrial carbon sink that is up to 3.2 Pg C yr-1 (280%) greater than that projected by the land model with coupled carbon and nitrogen cycling at the end of the 21st century.

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07/06/2022 14:05

ID: 11409 Contributed abstract

Poster Order:

Increased productivity in arid/semi-arid regions due to modified ET partitioning in CLASSIC

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Presented by / Présenté par: ***Gesa Meyer***
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Recently, we reported on our efforts to improve the representation of carbon and energy fluxes in Arctic tundra including shrub plant functional types, in addition to trees, crops, and grasses, in the Canadian Land Surface Scheme Including biogeochemical Cycles (CLASSIC). Our attempts to extend the work and simulate shrubs in low-latitude shrublands were limited by low plant productivity in sparsely vegetated areas during the peak growing season due to excessive water stress. The low productivity was caused by an overestimation of evaporation (E) during periods of high soil moisture yielding low soil moisture later in the year, limiting photosynthesis, vegetation growth and evapotranspiration (ET). Comparing against global benchmarks, CLASSIC represents ET quite well, however, its partitioning into E and transpiration (T), which affects carbon fluxes as well, can be improved.

Biases in E and T resulting in underestimated T/ET have been observed in several land surface and Earth system models. To address biases in ground E, we included a dry surface layer parameterization in CLASSIC to increase surface resistance to water vapour and heat fluxes. We now also allow T to occur from the dry fraction of the plant canopy while water evaporates from the wet fraction. These modifications reduced ground E and ET during wet periods at sparsely vegetated sites and in arid/semi-arid regions in general, improving the seasonality of ET and increasing gross primary productivity (GPP). Tropical forests experiencing seasonal dry periods, on the other hand, showed a reduction in GPP with the modified CLASSIC, as T increased significantly and ET somewhat, leading to an increased reduction in soil moisture during dry periods. Globally, GPP was slightly (~1.5%) lower in the modified than the baseline CLASSIC. The proportion of T relative to ET, however, was improved compared to observations with an increase from ~25% to ~41%.

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ID: 11470 Contributed abstract

Poster Order:

Carbon cycle feedbacks in an idealized and a scenario simulation of carbon dioxide removal in CMIP6 Earth system models

Ali Asaadi [1] , *Jörg Schwinger* [2] , *Hanna Lee* [3] , *Jerry Tjiputra* [4] , *Vivek Arora* [5] , *Roland Séférian* [6] , *Spencer Liddicoat* [7] , *Tomohiro Hajima* [8] , *Yeray Santana-Falcòn* [9] , *Chris Jones* [10]

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Presented by / Présenté par: ***Ali Asaadi***
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Limiting global warming to 1.5°C by the end of the century currently seems to be an ambitious target that might require massive carbon dioxide removal on large scales. The effect of such removals on biogeochemical cycles and climate is not well understood. Changes in atmospheric CO2 concentration ([CO2]) and climate alter the CO2 exchange between the atmosphere and the underlying carbon reservoirs of land and ocean. Carbon-concentration and carbon-climate feedback metrics are useful tools for quantifying such changes in the carbon uptake by land and ocean, currently acting as a sink of carbon. An ensemble of Coupled Model Intercomparison Project 6 (CMIP6) Earth system models that conducted an idealized experiment (1pctCO2, with increasing and later decreasing [CO2] at a rate of 1% per year) has been used and compared against a scenario simulation involving negative emissions (SSP5-3.4-OS). For the positive emission phases, the model-mean global average carbon-climate feedback looks roughly similar between the SSP5-3.4-OS and the 1pctCO2 simulations, with a gradual monotonic decreasing behavior in absolute values which translates to a reduction in carbon uptake. Terrestrial areas simulate an increase in carbon uptake during the ramp-up, while the ramp-down phase shows a hysteresis behavior. This feature is more prominent in the idealistic 1pctCO2 experiment with a higher [CO2] growth rate and without land use change effects than in the more realistic SSP5-3.4-OS scenario. In addition, changes in carbon fluxes are compared over the high latitude permafrost and non-permafrost regions in the Northern Hemisphere. Furthermore, feedback metrics are also calculated using an alternative approach of instantaneous flux-based feedback metrics to further compare differences between models. The difference between the two approaches can be seen more obviously in the geographical distribution of the two feedbacks, especially during the negative emission phases of the 1pctCO2 experiment.

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ID: 11816 Contributed abstract

Poster Order:

Improving the detection accuracy for fugitive methane emissions from petroleum storage tanks

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Presented by / Présenté par: ***Alex Pletnyov***
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With the Environment and Climate Change Canada (ECCC) proposed target to reduce the methane emission by 39% by 2025. Recent studies indicate that fugitive emissions from petroleum storage tanks make a significant percentage of vented emissions from upstream oil and gas facilities, and are often unreported. One of the root causes for storage tanks to emit methane is the temperature differential between the new and old product batches when products are mixed in a storage tank. Typically, fluid at surface is warmer than that at the bottom of the tank as such vapor is released into free space above the liquid level. With the proposed research we have created a computational model to better predict, quantify and estimate the distribution of methane emissions from the fluid surface in a vertical storage tank. The fugitive emissions are primarily measured by installing external sensors around the storage tanks and using the obtained data to create mathematical models to estimate and quantify methane emissions from the tank of interest. However, presence of various external factors such as emissions from other tanks, wind, etc. affect the measurements, making it extremely difficult to obtain an accurate reading and narrowing the source location down to a single tank. Further, existing programs provide a generalized approach to modeling the fluid dynamics inside reservoirs and do not take thermal convection into account, thereby largely underestimating the methane accumulation and emissions in storage tanks. The proposed research uses Computational Fluid Dynamics modelling to quantify the emissions and estimate the distribution inside a storage tank while simulating flows of gases and liquids, heat and mass transfer, multiphase physics, chemical reaction and fluid structure interactions. This increased accuracy in quantification of methane emissions, will allow the industry to take corrective action and reduce these fugitive emissions.

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07/06/2022 13:10

ID: 11667 Contributed abstract

Poster Order:

A statistical framework for uncertainty estimation when quantifying methane emissions from Canada’s oil and gas sector

Paule Lapeyre [1] , *Kyle J. Daun* [2] , *Christiane Lemieux* [3] , *Audrey Beliveau* [4] , *Jack Johnson* [5] , *Kirk Osadetz* [6] , *Augustine Wiggle* [7] , *Daniel*

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Presented by / Présenté par: ***Paule Lapeyre***
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The Federal and Provincial governments are currently enacting regulations with the objective of realizing a 45% drop in methane emissions from Canada’s oil and gas industry compared to 2012 levels. To achieve this goal, a wide range of systems are being developed to quantify emissions at the component, site, and facility levels. In general, methane concentration measurements made at a series of locations (e.g., fixed point sensors), over a line-of-sight (e.g., open path laser absorption spectroscopy), or through a 2D image (e.g., quantitative optical gas imaging, QOGI). Concentration measurements are then integrated into a transport model to obtain an overall emission rate.
While much effort has focused on developing new measurement systems, assessing the uncertainty of emission rates obtained from these systems has lagged behind. Uncertainty estimates are almost exclusively based on separate controlled-release studies in which the discrepancy between the inferred and true release rates are interpreted as samples drawn from an overall error probability density function (pdf) of the measurement error. A candidate pdf is fit to these samples and then resampled using a Monte Carlo procedure to generate confidence intervals that may be applied to other measurements. This approach treats the measurement system as a “black box”, and does not explicitly consider how the uncertainties of various model parameters may be related. Moreover, the number of possible controlled release measurements is insufficient to capture all possible environmental parameters that may affect the estimate. Other studies have attempted to quantify uncertainty by comparing estimates from multiple systems without a ground-truth.
This presentation outlines a rigorous statistical framework for uncertainty quantification that explicates the various uncertainty sources common to multiple measurement systems, and how these uncertainties may be estimated from controlled release experiments and previous studies reported in the literature.

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ID: 11416 Contributed abstract

Poster Order:

METHANE VENTING RELATED TO PETROLEUM WELL INTEGRITY ISSUES IN ALBERTA: CHARACTERISTICS, MAGNITUDES AND IMPACTS

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Presented by / Présenté par: ***KIRK OSADETZ***
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Methane emissions, migration or contamination from petroleum well integrity issues including surface casing vent flow (SCVF), gas migration (GM) and aquifer contamination impact: safety, climate, groundwater resources, crop and plant health, human health and business performance. Well integrity issues affect about 10,000 of ¾ of a million Alberta wells. Average problem wells emit ~13 m3/day, persistently. This makes climate impacts a key concern, accounting for about 20% of Alberta's upstream methane emissions. SCV use coupled with improvements in well design, construction and regulatory compliance help reduce and suppress gas migration and aquifer contamination such that groundwater impacts are also uncommon. Safety impacts are likewise uncommon. Plant impacts associated with well-studied pipeline leaks mimic GM issues. Impacts are rarely due to methane asphyxia. More common are effects associated with CO2 induced stress or asphyxia caused by vadose microbial natural gas oxidation. The effects of anthropogenic and natural methane seepage on vegetation and crops are indistinguishable. Where microbial methane oxidation produces CO2, vegetation can be impacted by groundwater chemistry changes and inorganic chemical reactions among CO2, groundwater, minerals and vegetation. Several attempts to determine correlations between GM methane flux and plant health impacts show variable plant health effects, including improvements in some species at low gas migration rate. Detrimental impacts and even plant mortality occur at higher leakage rates. No quantitative migration recommendations exist because impacts are complicated by factors including, soil composition and characteristics, meteorological conditions, microbial flora, and plant species. There are several "sinks" where methane is oxidized, in the atmosphere, oceans and in the vadose zone of soils. The effectiveness and efficiency of the microbial soil sink plays an important role in the rates of microbial methane oxidation, which can be affected adversely by agricultural and land use practices, even after agriculture ceases.

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ID: 11755 Contributed abstract

Poster Order: Poster-5041

Spatial variation and magnitude of methane emissions from inactive oil and gas infrastructure in Western Canada

Gilles Perrine [1] , *Martin Lavoie* [2] , *Judith Vogt* [3] , *Evelise Bourlon* [4] , *Katlyn MacKay* [5] , *David Risk* [6]

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Presented by / Présenté par: ***Gilles Perrine***
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The federal and provincial governments are striving to reduce oil and gas methane emissions by 45% below the 2012 level by 2025. Studies suggest that the official Environment and Climate Change Canada inventory is underestimated by a factor of 1.5-2. While many sources in the inventory are well understood, key uncertainties exist, including the contribution from inactive wells, which is modeled on old data. In most oil and gas developments in Canada, inactive infrastructure constitutes 30-40% of the total infrastructure, and therefore cumulatively many tens of thousands of sites across Canada. The purpose of this study is to measure volumetric estimate rates of inactive wells (abandoned, and capable but currently suspended), and establish incidence and severity by geographic region, fluid, and infrastructure type. Here, we re-analyze extensive truck-based mobile survey datasets in which we measured concentration enhancements downwind of infrastructure, and estimated emission rates using a Gaussian Dispersion Model. The measurements were acquired in multi-year and multi-region field campaigns that are now published, but in many cases the contribution of inactive sites were either not included in published reports, or were not drawn clearly into view. To test the possibility that inactive well measurements are simply mis-attributions from nearby active infrastructure, we also applied a varying isolation parameter to add a focus on inactive infrastructure and to generate likelihoods of causation. Results show that inactive infrastructure, in particular suspended wells and facilities, often emit less often and less severely than active infrastructure, but at rates that are non-negligible, and which must be taken into account in a more rigorous way within the federal inventory. Isolation tests show that inactive infrastructure has clear capability to emit, but that new targeted measurements of inactive infrastructure would ideally take place in more historic regions with low densities of actively-producing infrastructure. In addition, the components or sources of methane at inactive sites are poorly understood, and there is an important role for detailed future studies that trace emissions back to source.

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ID: 11609 Contributed abstract

Poster Order: Poster-5041

Methane inventories, but not regulatory submissions, show major variations in methane intensity for Canadian oil and gas producers

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Presented by / Présenté par: ***Martin Lavoie***
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Methane is the second most important anthropogenic greenhouse gas, and methane emissions from the oil and gas industry are underestimated in Canada which also suggests systemic under-reporting of emissions in this key area of carbon intensity. Here we investigate the emission intensity gaps for many of Canada's largest oil and gas producers, between 1) basic regulatory submissions, 2) assumed contributions to the federal inventory estimates, and 3) assumed contributions based on a newly measured inventory. We de-aggregated existing inventory estimates, and emissions measured at thousands of sites across Alberta, Canada's largest producing region. We found >1000-fold variation in methane intensities within the 70-producer cohort. We also found surprisingly broad agreement in assumed methane emission intensity between different inventory realizations, suggesting they capture the same signals. Regulatory submissions captured only a small amount of the total methane inventory. We also observed a low bias in regulatory reporting that was expected. In conclusion, we believe that significant alterations to regulatory- and self-reporting, and systems management frameworks will be needed for oil and gas companies that wish to differentiate or preserve market access based on carbon intensity. Oversight is becoming easier and more cost-effective with alternative measurement tools and as transparency continues to increase, producers may be called in to explain discrepancies from third-party oversight values or federal inventories as part of their MMV outcomes.

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ID: 11766 Contributed abstract

Poster Order:

Characterization of methane and hydrogen sulfide emissions from oil and gas wells in Ontario

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Presented by / Présenté par: ***Khalil El Hachem***
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Oil and gas (O&G) exploration in Ontario started in 1858 and led to the drilling of an estimated 50,000 wells. Like other O&G infrastructure, O&G wells emit methane, a potent greenhouse gas, and one of the main drivers of climate change. In addition to methane, anecdotal evidence suggests that O&G wells in Ontario emit hydrogen sulfide, a highly toxic gas that causes damage to human, animal, and ecosystem health and safety. Here, we present 85, previously unavailable, measurements of methane and hydrogen sulfide emissions from 63

O&G wells and a wetland area overlying a potential undocumented well in Ontario. We study the link between methane and hydrogen sulfide emissions and the influence of well attributes on methane emission rates. We find that high hydrogen sulfide emitting wells are high methane emitters, and find that methane emission rates vary by well status, county, and well density. Compared to inventory estimates, we find that methane emissions from abandoned unplugged and producing oil and gas wells in Ontario are underestimated by factors of 920 and 2.1, respectively. Our results indicate the importance of additional measurements from O&G wells to better characterize methane and hydrogen sulfide emissions. Our measurements and analysis can be used to quantify environmental safety risks posed by hydrogen sulfide exposure from O&G wells, identify high methane emitters to concentrate mitigation efforts, and accurately estimate methane emissions from O&G wells in greenhouse gas inventories.

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ID: 11477 Contributed abstract

Poster Order:

Do underground leaks from abandoned hydrocarbon wells and through shallow aquifers significantly contribute to methane emissions?

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Presented by / Présenté par: ***Geneviève Bordeleau***
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In Canada, there are approximately 370 000 abandoned oil and gas (O&G) wells, in addition to wells that are "suspended" for an undetermined period. These wells continue to pose a risk of gas emissions to the atmosphere. In addition to emissions from wellheads, unconventional hydrocarbon production has raised concerns regarding potential contamination of shallow aquifers through upward migration of natural gas and other contaminants. As a result, strong research efforts have been devoted to this issue over the last decade. While groundwater contamination was the focus of these efforts, it must also be considered that if gases migrate upwards and reach shallow aquifers, they will eventually reach the atmosphere, thus constituting an anthropogenic diffuse source of emissions. However, discerning the source of methane in shallow aquifers (i.e. hydrocarbon-related versus methane naturally produced in situ) is challenging.
In the last decade, the Geological Survey of Canada undertook three major research projects in Quebec, New Brunswick and Alberta, to determine whether hydrocarbon activities have caused groundwater contamination through upward fluid migration. These multidisciplinary projects included a strong hydrogeochemistry component, with the development of a thorough groundwater quality assessment and monitoring strategy. The geochemical approach allowed determining that methane in shallow aquifers from the three regions was naturally produced within the aquifer or in relatively shallow

underlying units. Hence, these findings suggest that O&G-related subsurface gas migration (followed by emissions to the atmosphere) may currently be negligible compared to emissions of methane naturally present in shallow aquifers. However, this may change in the future, as abandoned wells continue to age and the integrity of their materials may become compromised. Considering this, groundwater monitoring strategies developed in the last years would remain useful for identifying new leaks. Hence, we recommend that monitoring wells be available in all areas where these O&G wells are present.

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07/06/2022 14:20

ID: 11505 Contributed abstract

Poster Order:

Differentiating and mitigating methane emissions from natural gas distribution, historic landfills, and manholes in Montréal, Canada

Philip James Williams [1] , *Mary Kang* [2] , *Felix Vogel* [3] , *Sebastien Ars* [4] , *Amara Regehr* [5]

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[2] McGill University
[3] Environment and Climate Change Canada
[4] Environment and Climate Change Canada
[5] McGill University

Presented by / Présenté par: ***Philip James Williams***
Contact: philip.williams@mail.mcgill.ca

Rapidly reducing urban methane (CH4) emissions is a critical component of strategies aimed at limiting climate change. Individual source measurements provide the data necessary to categorize and characterize methane sources which is a key towards developing actionable mitigation strategies. Here we perform 616 individual source measurements in Montréal, Canada, to measure CH4 emissions from historic landfills, manholes, and natural gas (NG) distribution systems. We quantify CH4 emissions from these three source types, breakdown these emissions by subcategory, and analyze samples for geochemical indicators (i.e., C2:C1 ratios, carbon dioxide, and δ13C-CH4) to evaluate their ability to differentiate between different source subcategories. We find that historic landfills produced 901 tons CH4 per year and manholes emitted 786 tons of CH4 per year, placing them as the third and fourth largest CH4 sources in Montréal. Methane emissions from both historic landfills and manholes are not accounted for in greenhouse gas inventories but would cumulatively account for 11% of Montreal's CH4 emissions in 2018. We find that NG distribution systems emitted 439 tons of CH4 per year and are governed by third party breaks to NG distribution lines and leaks from residential meter sets. We show that even a combination of all three geochemical indicators can only differentiate 44% of the emission source subcategories we consider showing the benefit of the confidence in source attribution provided by individual source measurements. Overall, our results highlight the need for individual source measurements to develop actionable CH4 mitigation strategies to meet municipal, regional, and national climate action plans.

Session: 7060 Severe and Extreme Convective Storms - Part 1 Les orages convectifs sévères et extrêmes - Partie 1

07/06/2022 12:55

ID: 11517 Invited session speaker

Poster Order:

Global Perspectives on Hail and Severe Storms

John Allen [1]

1

Presented by / Présenté par: ***John Allen***
Contact: allen4jt@cmich.edu

Severe thunderstorms and the phenomena they produce are a global hazard, with hail producing a significant fraction of the associated losses. Despite this global impact, it is only in recent years that the techniques and tools to assess occurrence, impacts and observation of severe thunderstorms have reached the point where ample opportunity exists to better quantify these events worldwide. There is also a need to identify where physical observations and climatology can be enhanced to better serve scientific applications, insurers and end users.

A complete understanding of severe thunderstorm climatology would require globally uniform high-quality observations. However, inconsistent and regional approaches to data collection instead provide the majority of insights we have in to the occurrence of phenomena such as hail and tornadoes. This incomplete picture has catalyzed the development of proxies, from remotely sensed sources derived from radar and satellite products, to ingredients-based approaches that use formative environments to describe occurrence. These proxies provide us with a more complete insight as to where severe thunderstorms have occurred and may occur into the future. This provides a framework to identify opportunities to collect new and more insightful observations to better understand these hazardous events.

In this presentation, the understanding of severe storm climatology, and particularly hail, will be discussed from a global perspective, highlighting new developments, opportunities and challenges to shed light on these complex hazards.

Session: 7060 Severe and Extreme Convective Storms - Part 1 Les orages convectifs sévères et extrêmes - Partie 1

07/06/2022 13:25

ID: 11480 Contributed abstract

Poster Order:

The Correlation of Radar-Derived Hail Data and Reported Insured Losses in Canada: An Investigation

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

1

2

Presented by / Présenté par: ***Caroline Floyd***
Contact: vortmax@gmail.com

Damage from severe convective storms (SCS) is a leading source of insured losses in North America. It is responsible for hundreds of millions of dollars in insured losses in Canada every year. In fact, in most years of the past two decades, severe storm-related damage made up the largest share of loss, by peril type, for the country. In 2020, SCS losses for Canada's insurance industry topped CAN $1.5 billion. In 2021, the number again approached CAN $1 billion.

In turn, of the natural perils tracked by the insurance industry, hail damage tends to drive most of the insured losses related to SCS. This is especially true in Canada's so-called 'Hailstorm Alley,' a region of southern and central Alberta where summer hailstorms are frequent and prolific.

A better understanding of the threats posed by extreme weather events – particularly as the severity and location of these events shifts with climate change – is key to reducing impacts on Canadians. Insured loss data combined with climate data and mitigation techniques can provide decision-makers with the necessary information to act.

In 2020 and 2021, two SCS events – known as "catastrophes" in the insurance industry – were responsible for approximately CAN $1.2 billion and CAN $570 million in losses, respectively. Both events included severe hailstorms that impacted the City of Calgary to devastating effect.

This presentation will examine the correlation of radar data available from Environment and Climate Change Canada with FSA-level insured loss data collected by Catastrophe Indices and Quantification Inc. (CatIQ), Canada's insured loss and exposure indices provider, for these hailstorm events.

Session: 7060 Severe and Extreme Convective Storms - Part 1 Les orages convectifs sévères et extrêmes - Partie 1 **07/06/2022 13:40**

ID: 11598 Contributed abstract

Poster Order: Poster-7060

A Study of the Favorable Locations and Patterns of Squall Lines in BC

Quanzhen (Gary) Geng [1] , *Ruping Mo* [2] , *Jim Goosen* [3]

[1] Environment and Climate Change Canada
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Presented by / Présenté par: ***Quanzhen (Gary) Geng***
Contact: gary.geng@ec.gc.ca

The favorable locations and large-scale circulation patterns of squall lines in BC are investigated using the severe thunderstorm data from 2000 to 2018. It is found that squall lines tend to occur in two preferred regions in BC: Okanagan Valley to Boundary-West Kootenay area and the Cariboo-Prince George to Bulkley Valley-southeast. All squall lines occur when a cold front passes through the region and an upper trough provides strong wind shear. There are two patterns favorable for squall lines to develop. The first is a positively tilted upper trough with a NE-SW oriented cold front moving southward. The second is a negatively tilted upper trough with a NW-SE or N-S oriented cold front moving northeast or eastward. A combined lead-time and accuracy score is created to measure squall line forecast performances. It is shown that forecasts have little skills in BC except when a long lasting squall line produces a sequence of events affecting multiple downstream regions.

Session: 7060 Severe and Extreme Convective Storms - Part 1 Les orages convectifs sévères et extrêmes - Partie 1 **07/06/2022 13:50**

ID: 11597 Contributed abstract

Poster Order:

SEASONAL AND SPATIAL ORGANIZATION OF CHANGES IN HAIL FREQUENCY AND THERMODYNAMIC MECHANISMS WITHIN WRF-HAILCAST SIMULATIONS

Daniel Betancourt [1] , *John Hanesiak* [2] , *George Liu* [3] , *Julian Brimelow* [4] , *Zhenhua Li* [5] , *Yanping Li* [6]

[1] University of Manitoba
[2] University of Manitoba
[3] University of Manitoba
[4] ECCC
[5] University of Saskatchewan
[6] University of Saskatchewan

Presented by / Présenté par: ***Daniel Betancourt***
Contact: john.hanesiak@umanitoba.ca

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)]. As such, it allows for an evaluation of thermodynamic drivers on the changes in occurrence of severe weather parameters including hail. Competing processes – greater moisture and instability on one hand, and higher temperatures aloft (leading to increased thermodynamic capping) result in considerable heterogeneity in terms of hail increases versus decreases across the region. Additionally, these different scenarios appear to be organized spatially and seasonally - with increases in hail frequency outpacing decreases during the shoulder seasons, and the opposite during the late summer. Thermodynamic driving mechanisms are examined.

Session: 7060 Severe and Extreme Convective Storms - Part 1 Les orages convectifs sévères et extrêmes - Partie **07/06/2022 14:05**

ID: 11851 Contributed abstract

Poster Order:

Assessing gaps in hail reports in Canada using a lightning proxy

Dominique Brunet [1] , *Nitish Joshi* [2] , *Julian Brimelow* [3]

[1] Environment and Climate Change Canada
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[3] Environment and Climate Change Canada

Presented by / Présenté par: ***Dominique Brunet***
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A database of hail reports has the potential to not only serve severe weather warning verification needs, but also to provide ground truth data for High Impact Weather (HIW) detection algorithms from remote sensing and for the post-processing of Numerical Weather Prediction (NWP) model data for HIW forecasts. An archive of hail reports in Canada for 2005-2021 has been generated at Environment and Climate Change Canada (ECCC) using the National Severe Weather Event Database (NSWED) and the Prairies Chronology Files. These databases are populated by operational meteorologists drawing on hail reports communicated via phone calls or reports seen in social media. The NSWED database in particular is known to suffer from several data gaps because each region and province of the country do not necessarily update the databases regularly, if at all. We first present a merged database integrating NSWED and the Prairies Chronology Files into a single master database with standardized quality controlled fields for timing, location and diameter of hail. We then assess gaps in hail reports by training a simple statistical model on the Canadian Lightning Detection Network (CLDN). The lightning flashes density is used as a proxy for the probability of (severe) hail occurrence, allowing to derive a spatio-temporal hail climatology. The results indicate that hail is significantly underreported in Canada. The gap assessment exercise has also identified several issues with the current way we collect and archive hail reports: inconsistent collection methods of hail reports, non-standard data formats and hail size categories, errors or contradictory information in the same report, and duplication of reports within and between databases. Finally, we discuss on the need for a better approach/system for collecting and archiving hail reports.

Session: 7060 Severe and Extreme Convective Storms - Part 1 Les orages convectifs sévères et extrêmes - Partie 1

07/06/2022 14:20

ID: 11611 Contributed abstract

Poster Order:

Large hail in weakly sheared environments in Alberta

Daniel Brown [1]

[1] Environment and Climate Change Canada

Presented by / Présenté par: ***Daniel Brown***
Contact: daniel.brown@ec.gc.ca

Large hail often causes extensive property damage during the summer in Alberta. For example, the 2020 hailstorm in Calgary caused well over $1 billion in insured damages. Thunderstorms require moisture, instability, and a trigger. Supercell thunderstorms additionally require sufficient deep-layer vertical wind shear. Hail larger than 4.5 centimeters (golf ball sized) is thought to be exclusively caused by supercell thunderstorms. However, a number of cases have been found in Alberta with weak wind shear, yet supercell thunderstorms still formed and produced large hail. Six cases of hail greater than 4.5 centimeters (from the National Severe Weather Event Database) and 0-6 kilometer shear less than 25 knots (from the North American Regional Reanalysis) were found between 2019 and 2021. In most of these cases, the surface winds were nearly opposite the mid-level flow, and the surface winds were slightly stronger than the NARR reanalysis suggested. Usually the surface wind is used to calculate the vertical wind shear, but the surface to 50 millibar (about 500 meter) mixed-layer is used for temperature and humidity when calculating severe storm indices. Instead of the surface wind, the mean wind in the lowest 500 meters was calculated from the surface wind using a log wind profile, and was used in the shear calculations. The mean wind was about 70% stronger than the surface wind. When the shear was calculated in this way, in most cases it was, in fact, sufficient for supercell thunderstorms.

Session: 12050 Arctic Ocean Climate and Climate Change
Climat de l'océan Arctique et changement climatique **07/06/2022 12:55**

ID: 11438 Contributed abstract

Poster Order:

Impact of runoff forcing on ocean model simulations in the Pan-Arctic region

Tahya Weiss-Gibbons [1] , *Paul Myers* [2] , *Tricia Stadnyk* [3] , *Andrew Tefs* [4]

[1] University of Alberta
[2] University of Alberta
[3] University of Calgary
[4] University of Calgary

Presented by / Présenté par: ***Tahya Weiss-Gibbons***
Contact: weissgib@ualberta.ca

The Arctic is warming faster than the rest of the planet, impacting the Arctic Ocean and its sources of freshwater. Changes in freshwater distributions and stratification affect Arctic Ocean circulation, and may impact deep water formation in the Atlantic after its export to that basin. Thus, understanding the impact of freshwater sources is an important question to examine in ocean general circulation models. We use version 3.6 of the NEMO model, with the Arctic and Northern Hemisphere Atlantic (ANHA) configuration, run at 1/4 degree resolution, to examine the role of river runoff into the Pan-Arctic domain. River runoff is a major source of freshwater to the high-latitude ocean, and has been increasing recently. Yet, traditionally, ocean models have used a runoff dataset based on climatology that has limitations in the Arctic, as well as lacks the recent changes in river runoff. Here we collaborate with the Hydrological Analysis Lab at the University of Calgary who have produced runoff scenarios for the Arctic Ocean using the Swedish Hydrological Predictions for the

Environment (HYPE) hydrological model that now extend to the present day. Differences between the two runoff datasets are significant, and comparing the model results from the different experiments will help to show the sensitivity of the model to freshwater input changes. Results show large differences in the freshwater content, particularly in the Canadian Arctic Archipelago, which can have impacts on modelling within the region, as well as transport of freshwater out of Arctic gateways to lower latitudes.

Session: 12050 Arctic Ocean Climate and Climate Change
Climat de l'océan Arctique et changement climatique **07/06/2022 13:10**

ID: 11619 Contributed abstract

Poster Order:

Response of the upper Arctic Ocean to marine heatwaves for regionally differing ice-ocean regimes

Benjamin Richaud [1] , *Eric Oliver* [2] , *Katja Fennel* [3] , *Xianmin Hu* [4]

[1] Dalhousie University
[2] Dalhousie University
[3] Dalhousie University
[4] Dalhousie University

Presented by / Présenté par: ***Benjamin Richaud***
Contact: bn512787@dal.ca

Arctic regions are warming at two to three times the global average rate. Superimposed on this trend, extreme events such as heatwaves are expected to become more frequent and intense. Simultaneously the sea ice phenology with which these events interact is also changing significantly in some regions. The Siberian atmospheric heatwave of 2020 saw temperature anomalies of +5°C from January to June of that year, with a record-high temperature of 38°C north of the Arctic circle reached at the end of June. The effects of such a heatwave on the Arctic Ocean depends in part on the specific sea ice regime present at that time, due to the high coupling between the atmosphere, the ocean and the cryosphere in those regions. In this study, we use a three-dimensional ice-ocean regional numerical model and apply a two-layer heat budget to investigate the ice-ocean response to the 2020 Siberian Heatwave and then further generalize across other extreme events in different Arctic regions. We consider different ice-ocean regimes, such as perennial versus seasonal ice-covered regimes and characterize the preconditioning of the system to an extreme warming event, the feedback between the climate components, and the recovery of the sea ice and ocean after anomalous warming events

Session: 12050 Arctic Ocean Climate and Climate Change
Climat de l'océan Arctique et changement climatique **07/06/2022 13:25**

ID: 11659 Contributed abstract

Poster Order:

Accelerated sea ice loss along Nares Strait during the summers 2017-2019 leads to an unprecedented ocean surface warming.

Yarisbel Garcia Quintana [1] , *Kent Moore* [2] , *Paul Myers* [3]

[1]
[2] University of Toronto Mississauga
[3] University of Alberta

Presented by / Présenté par: ***Yarisbel Garcia Quintana***
Contact: yarisbel@ualberta.ca

Nares Strait 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. The remoteness of Nares Strait and the harsh atmospheric and oceanic conditions that predominate nearly all year round, makes it difficult for observational (atmospheric, ice and ocean) data collection. While the satellite imagery might offer a very high spatial resolution, their usage is considerably limited as they fail in providing information on sub-surface ocean dynamics properties. Here, we use an eddy-permitting configuration of the Nucleus for European Modelling of the Ocean to explore ocean and sea-ice variability along Nares Strait, 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. Model data shows that the sea ice concentration along Nares Strait reached a minimum every summer from 2016-2019, with the sea ice thickness following the same trend. This led to an almost 50% increase in the atmosphere-to-ocean heat fluxes, during the summers from 2017-2019. Consequently, model output shows an unprecedented ocean surface warming, with a temperature increase of 1 °C and 2°C degrees Celsius north and south of Kennedy Channel, respectively, during the same time period compared to previous summers. With continued sea ice thinning and more frequent low summer sea ice events, ocean warming due to decrease albedo along Nares Strait should be expected. Furthermore, this could potentially impact the formation and stability of the winter-time ice arch that form at both ends of Nares Strait.

Session: 12050 Arctic Ocean Climate and Climate Change
Climat de l'océan Arctique et changement climatique **07/06/2022 13:40**

ID: 11543 Contributed abstract

Poster Order: Poster-12050

Decadal simulations of ocean temperature and salinity in the eastern Beaufort Sea

Zhenxia Long [1] , *Will Perrie* [2] , *Minghong Zhang* [3]

[1] Bedford Institute of Oceanography
[2] Bedford Institute of Oceanography
[3] Bedford Institute of Oceanography

Presented by / Présenté par: ***Zhenxia Long***
Contact: longz@dfo-mpo.gc.ca

Ocean temperature and salinity are the key ocean tracers for the ecosystems in the Arctic Ocean. To understand the decadal variations of ocean temperature and salinity in the eastern Beaufort Sea, NEMO 3.6 is implemented in the Arctic Ocean, forced by PHC temperature and salinity, GLORYS currents and JRA-55

atmospheric surface fields (1958-2019). Compared to observations, NEMO can reproduce mean sea ice, ocean temperature and salinity in the Arctic Ocean. Thus, we suggest that there is an increase in the freshwater content in Canada Basin in recent decades, mostly due to enhanced Ekman convergence and accelerated ice melting, and the eastern Beaufort Sea has become saltier near Victoria Island. The increase in the ocean salinity is related to changes in the freshwater pathways due to the decadal variations of atmospheric circulation in the Arctic. Moreover, the sea surface temperature tends to increase in the eastern Beaufort Sea, dominated by the impacts of accelerated ice melting.

Session: 12050 Arctic Ocean Climate and Climate Change
Climat de l'océan Arctique et changement climatique **07/06/2022 13:50**

ID: 11469 Contributed abstract

Poster Order:

Multiyear evolution of surface roughness and radar backscatter of the Nansen Sound sea ice plug, 2016-2019

Mara Neudert [1] , *Stefan Hendricks* [2] , *Arttu Jutila* [3] , *Veit Helm* [4] , *Christian Haas* [5]

[1] Sea ice physics, Alfred Wegener Institute, Bremerhaven, Germany
[2] Sea ice physics, Alfred Wegener Institute, Bremerhaven, Germany
[3] Sea ice physics, Alfred Wegener Institute, Bremerhaven, Germany
[4] Glaciology, Alfred Wegener Institute, Bremerhaven, Germany
[5] Sea ice physics, Alfred Wegener Institute, Bremerhaven, Germany & University of Bremen, Institute of Environmental Physics, Bremen, Germany

Presented by / Présenté par: ***Mara Neudert***
Contact: mneudert@awi.de

The evolution of the surface topography of multiyear sea ice and melt season processes are closely interrelated and sensitive to changing Arctic climate. The Nansen Sound sea ice plug is a recurring multiyear landfast ice region near Ellesmere Island, Canada. It has occurred less frequently in recent years, but it recurred between October 2016 and August 2019. The immobile ice presents a unique opportunity to study the impacts of strong annual summer melt and winter accretion on the evolution of the roughness and radar backscatter of the same ice. Airborne laser scanning and electromagnetic ice thickness surveys in springs of 2017, 2018, and 2019 showed large ice thickness and roughness differences between two distinct regions of younger FYI and older MYI. The average thicknesses were 2.3±0.1 m and 4.0±1.4 m, respectively. Between April 2017 and 2019, the mean ice thickness of the younger ice increased from 1.9 m to 2.4 m, and the surface roughness remained similar despite strong melt ponding experienced in the two intermediate summers. However, over the same period bottom roughness decreased by 30%. Sentinel-1 images show an increase of mean HH-polarized backscatter of the younger ice from -21 dB in 2017 to -13 dB in 2019. The backscatter incidence angle dependence decreased over the first melt season from -0.26 dB/° to -0.15 dB/°. Results are consistent with enhanced volume scattering of aging sea ice. Using ERA5 climate reanalysis data we conclude that the ice plug remained intact in 2017 and 2018 due to three times less melting-degree days than in 2016 and 2019. Low ice concentration at the northern edge and high summer air temperatures contributed to its collapse in 2019. In the context of recent efforts to predict summer melt pond fractions from winter SAR backscatter, our results

demonstrate the usefulness of studying fast ice for fundamental sea ice processes.

Session: 12050 Arctic Ocean Climate and Climate Change
Climat de l'océan Arctique et changement climatique **07/06/2022 12:55**

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Poster Order:

Impact of runoff forcing on ocean model simulations in the Pan-Arctic region

Tahya Weiss-Gibbons [1] , *Paul Myers* [2] , *Tricia Stadnyk* [3] , *Andrew Tefs* [4]

[1] University of Alberta
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[3] University of Calgary
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Presented by / Présenté par: ***Tahya Weiss-Gibbons***
Contact: weissgib@ualberta.ca

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Poster Order:

Response of the upper Arctic Ocean to marine heatwaves for regionally differing ice-ocean regimes

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[1] Dalhousie University
[2] Dalhousie University

[3] Dalhousie University
[4] Dalhousie University

Presented by / Présenté par: ***Benjamin Richaud***
Contact: bn512787@dal.ca

Arctic regions are warming at two to three times the global average rate. Superimposed on this trend, extreme events such as heatwaves are expected to become more frequent and intense. Simultaneously the sea ice phenology with which these events interact is also changing significantly in some regions. The Siberian atmospheric heatwave of 2020 saw temperature anomalies of +5°C from January to June of that year, with a record-high temperature of 38°C north of the Arctic circle reached at the end of June. The effects of such a heatwave on the Arctic Ocean depends in part on the specific sea ice regime present at that time, due to the high coupling between the atmosphere, the ocean and the cryosphere in those regions. In this study, we use a three-dimensional ice-ocean regional numerical model and apply a two-layer heat budget to investigate the ice-ocean response to the 2020 Siberian Heatwave and then further generalize across other extreme events in different Arctic regions. We consider different ice-ocean regimes, such as perennial versus seasonal ice-covered regimes and characterize the preconditioning of the system to an extreme warming event, the feedback between the climate components, and the recovery of the sea ice and ocean after anomalous warming events

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[1]

[2] University of Toronto Mississauga
[3] University of Alberta

Presented by / Présenté par: ***Yarisbel Garcia Quintana***
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Nares Strait 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. The remoteness of Nares Strait and the harsh atmospheric and oceanic conditions that predominate nearly all year round, makes it difficult for observational (atmospheric, ice and ocean) data collection. While the satellite imagery might offer a very high spatial resolution, their usage is considerably limited as they fail in providing information on sub-surface ocean dynamics properties. Here, we use an eddy-permitting configuration of the Nucleus for European Modelling of the Ocean to explore ocean and sea-ice variability along Nares Strait, 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. Model data shows that the sea ice concentration along Nares Strait reached a minimum every summer from 2016-2019, with the sea ice thickness following the same trend. This led to an almost 50% increase in the atmosphere-to-ocean heat fluxes, during the summers from 2017-2019. Consequently, model output shows an unprecedented ocean surface warming, with a temperature increase of 1 °C and 2°C degrees Celsius north and south of Kennedy Channel, respectively, during the same time period compared to previous summers. With continued sea ice thinning and more frequent low summer sea ice events, ocean warming due to decrease albedo along Nares Strait should be expected. Furthermore, this could potentially impact the formation and stability of the winter-time ice arch that form at both ends of Nares Strait.

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Decadal simulations of ocean temperature and salinity in the eastern Beaufort Sea

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Presented by / Présenté par: ***Zhenxia Long***
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Ocean temperature and salinity are the key ocean tracers for the ecosystems in the Arctic Ocean. To understand the decadal variations of ocean temperature and salinity in the eastern Beaufort Sea, NEMO 3.6 is implemented in the Arctic Ocean, forced by PHC temperature and salinity, GLORYS currents and JRA-55 atmospheric surface fields (1958-2019). Compared to observations, NEMO can reproduce mean sea ice, ocean temperature and salinity in the Arctic Ocean. Thus, we suggest that there is an increase in the freshwater content in Canada Basin in recent decades, mostly due to enhanced Ekman convergence and accelerated ice melting, and the eastern Beaufort Sea has become saltier near Victoria Island. The increase in the ocean salinity is related to changes in the freshwater pathways due to the decadal variations of atmospheric circulation in the Arctic. Moreover, the sea surface temperature tends to increase in the eastern Beaufort Sea, dominated by the impacts of accelerated ice melting.

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Poster Order:

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[2] Sea ice physics, Alfred Wegener Institute, Bremerhaven, Germany
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[4] Glaciology, Alfred Wegener Institute, Bremerhaven, Germany
[5] Sea ice physics, Alfred Wegener Institute, Bremerhaven, Germany & University of Bremen, Institute of Environmental Physics, Bremen, Germany

Presented by / Présenté par: ***Mara Neudert***
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The evolution of the surface topography of multiyear sea ice and melt season processes are closely interrelated and sensitive to changing Arctic climate. The Nansen Sound sea ice plug is a recurring multiyear landfast ice region near Ellesmere Island, Canada. It has occurred less frequently in recent years, but it recurred between October 2016 and August 2019. The immobile ice presents a unique opportunity to study the impacts of strong annual summer melt and winter accretion on the evolution of the roughness and radar backscatter of the same ice. Airborne laser scanning and electromagnetic ice thickness surveys in springs of 2017, 2018, and 2019 showed large ice thickness and roughness differences between two distinct regions of younger FYI and older MYI. The average thicknesses were 2.3±0.1 m and 4.0±1.4 m, respectively. Between April 2017 and 2019, the mean ice thickness of the younger ice increased from 1.9 m to 2.4 m, and the surface roughness remained similar despite strong melt ponding experienced in the two intermediate summers. However, over the same period bottom roughness decreased by 30%. Sentinel-1 images show an increase of mean HH-polarized backscatter of the younger ice from -21 dB in 2017 to -13 dB in 2019. The backscatter incidence angle dependence decreased over the first melt season from -0.26 dB/° to -0.15 dB/°. Results are consistent with enhanced volume scattering of aging sea ice. Using ERA5 climate reanalysis data we conclude that the ice plug remained intact in 2017 and 2018 due to three times less melting-degree days than in 2016 and 2019. Low ice concentration at the northern edge and high summer air temperatures contributed to its collapse in 2019. In the context of recent efforts to predict summer melt pond fractions from winter SAR backscatter, our results demonstrate the usefulness of studying fast ice for fundamental sea ice processes.

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ID: 11496 Contributed abstract

Poster Order:

Meteorologically-driven complementarity between daily renewable energy resources at one location and demand at another

Frederic Fabry [1] , *Joseph Samuel* [2]

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Presented by / Présenté par: ***Frédéric Fabry***
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In a future world where most energy must come from intermittent renewable energy sources such as wind or solar energy, it would be more efficient if we could determine the locations where an energy source will naturally be more suited to fulfill the need of a specific region. For example, on days where more energy than usual is needed in Toronto, are there areas that naturally provide more renewable energy and where it would make more sense to install energy infrastructure? In parallel, meteorological weather systems such as midlatitude cyclones are organized in a way that naturally shapes where areas of energy need (say, regions with more cold air) are with respect to windy or sunny areas, and these are generally not collocated. This suggests that the best place to get your renewable energy may not be near your location.

Using a combination of reanalysis and climate model data, we analyzed for several locations in North America the complementarity between different sources of energy as well as the complementarity between daily demand and daily renewable resources in the recent past and in the expected future. In general, demand and solar energy tend to be slightly positively correlated at nearby locations, while correlated wind energy often needs to come from greater distances. Expected climate until the end of this century is only expected to cause minor changes to these patterns.

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ID: 11688 Contributed abstract

Poster Order:

An innovative methodology to understand the real cost of climate change on public sector infrastructure

Yann Chavaillaz [1] , *Charles-Antoine Gosselin* [2]

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Presented by / Présenté par: ***Charles-Antoine Gosselin***
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Quantifying climate change impacts on infrastructure deterioration, O&M, repair, retrofit and replacement costs is vital to long-term financial sustainability of governments. However, climate change cost has yet to be properly factored into asset management models used by province. The methodology of how to calculate costs is acritical building blocks in Canada’s adaptation to a changing climate.
The Financial Accountability Office (FAO) of Ontario has developed current deterioration rates based on historic data and associated costs only. The project

is then a quantification of the cost of anthropogenic climate change to public infrastructure at the provincial or territorial scale. The methodology designed could be adapted to other jurisdictions using several climate hazards of interest. It combines the established fields of asset management and climate science with the emerging field of climate resilience economics.
We developed relationships between the evolution of climate conditions to deterioration costs within the FAO's existing model, through tailoring engagement of subject-matter experts based on respective knowledge and fields of expertise. This process involved frequent conversations to improve accuracy and justification for estimates of climate-cost elasticities for each asset-hazard interaction.
Cost projections were established for buildings, roads, transit, bridges, culverts, water infrastructure. For instance, roads will most likely have a 43% reduction in their useful service life, increase in their O&M costs; and their retrofit and renewal costs would increase by 52% and 107%, respectively. These increases in cost reflect the need to spend more money on the maintenance, such as asphalt roads needing more crack sealing to prevent water infiltration or on the addition of cement additives to concrete during renewal.
At a high level, the project results show that the impacts of climate change on Ontario's public assets are significant, and at this order of magnitude, are relevant for Ontario's long-term infrastructure and capital planning.

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07/06/2022 13:25

ID: 11335 Contributed abstract

Poster Order:

Regional-scale investigation of pile bearing capacity for Canadian permafrost regions in a warmer climate

Amro Faki [1] , *Laxmi Sushama* [2]

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Presented by / Présenté par: ***Amro Faki***
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Climate change is being experienced particularly intensely in the Arctic and therefore adaptation of engineering systems for this region cannot be further delayed. However, one of the major barriers to studies focused on adapting northern engineering systems is the lack of information at the spatial and temporal scales required for engineering applications. This study presents the development of ultra-high resolution (4 km) climate change information using the Global Environmental Multiscale (GEM) model for Canada's northern regions, and subsequent application to investigate pile bearing capacity for different pile material and configurations, for current and future climates. Comparison of the ultra-high-resolution GEM simulation, driven by reanalysis, with available observations confirms the model's ability in representing near-surface permafrost and related climate variables. The estimated adfreeze

contribution to the total bearing capacity, for current climate, for a standard cement pile, is found to be of the order of 15% for regions with shallow bedrock and 70% for regions with deeper bedrock. Application of the GEM climate change simulation, for RCP8.5 scenario, point to projected decreases to adfreeze contribution in the 5-30% range by 2040, with the largest differences noted for regions with deeper bedrock. For steel piles of same configuration, although the adfreeze contributions are only about 70% of that for cement piles, the projected percentage changes are of similar magnitude. Further downscaling of results to 250 m for important transport corridors, using simulations performed with the land surface model of GEM, provides many useful insights. The results of this study, including the ultra-high resolution climate change information, will form the basis for additional detailed investigations on climate-infrastructure interactions and climate resiliency studies.

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07/06/2022 13:50

ID: 11810 Contributed abstract

Poster Order:

Building-climate interaction modeling for permafrost regions to inform climate-responsive designs in a changing climate

Muna Younis [1] , *Bernardo Teufel* [2] , *Meseret Kahsaya* [3] , *Girma Bitsuamlak* [4] , *Laxmi Sushama* [5]

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Presented by / Présenté par: ***Muna Younis***
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Buildings in Canada’s northern regions are subject to extreme environmental stressors: above-grade high-intensity precipitation events – including thunderstorms, snow, rain, and sub-grade permafrost degradation due to climate change and local activities. These, coupled with the remoteness of the region, warrants unique climate-responsive building design through passive methods and efficient energy use strategy. Under these multi-stressor design conditions, the solution for one stressor often contradicts the solution for another stressor. Adaptation of building designs to a changing climate thus continues to be a pressing and challenging issue for northern communities, particularly given the significant changes to building-relevant climate variables projected for the 21st century, including those associated with extreme weather and climate events. This study, utilizing a multiscale (regional to building scale) climate-infrastructure modeling framework, investigates the optimal height of buildings above ground in the case of raised buildings from near-surface permafrost degradation and efficient energy use perspectives for both current

and future climates. While raising the building above ground creates an open space underneath that prevents wind-drifted snow accumulation and reduces the thermal stress on near-surface permafrost, it is not desirable from a building energy efficiency perspective. Ultra-high-resolution Global Environmental multiscale current and future climate simulations developed for a domain covering Nunavut and adjoining regions provide boundary and initial conditions to the computational fluid dynamics simulations of elevated buildings (0, 0.25, 0.5, 1, 1.5 m), of various configurations (0°, 45°, and 90°), for the Iqaluit region. Preliminary experiments suggest that 1m height above the ground is essential to preserve the permafrost frozen state. The useful insights obtained from this study are expected to inform the design of sustainable and climate-responsive buildings by contributing to northern building design guidelines and recommendations and promoting the development of design factors for estimating permafrost soil bearing capacity considering projected climate and building climate heat transferred to the ground.

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ID: 11486 Contributed abstract

Poster Order:

Cold energy storage as a solution for year-round renewable artificial ground freezing: Case study of the Giant Mine Remediation Project

Ahmad Zueter [1] , *Agus Sasmito* [2]

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Presented by / Présenté par: ***Ahmad Zueter***
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In cold regions, passive thermosyphons are often employed in permafrost protect and artificial ground freezing (AGF) applications. While passive thermosyphons utilize available cold wind during cold seasons, energy-intensive refrigeration plants are sometimes needed to run thermosyphons in warmer seasons. In this study, we propose a novel cold energy storage (CES) concept that operates thermosyphons year-round using renewable energy resources. Our proposed system is based on additional assistant thermosyphons (AT) and heat extraction pipes (HEP). In cold seasons, the ATs store wind cold energy, which is then transferred in warmer seasons using HEPs to the site of interest. The system is mathematically demonstrated using well-validated numerical models derived in our previous work. The results reveal our proposed system enhances the heat extraction capacity of primary thermosyphons by more than 15%. Overall, this study study presents the foundation of a innovative concept that can help run thermosyphons using renewable resources in cold regions.

Session: 13031 Emerging methods, strategies and frameworks in climate/engineering system interaction **07/06/2022 14:20**

ID: 11577 Contributed abstract

Poster Order:

Climate-resilience of dams and levees: Perspectives from the literature

Md Robiul Islam [1] , *Mohammad Fereshtehpour* [2] , *Mohammad Reza Najafi* [3] , *M. Naveed Khaliq* [4]

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Presented by / Présenté par: ***Md Robiul Islam***
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There is a large number of dams and levees across Canada that were constructed to serve multiple societal needs in addition to protecting communities and critical infrastructure from flooding. The stability of these structures is at risk due to future climate change, which is expected to alter local and regional scale intense precipitation patterns, snowpack/snowmelt processes, sea levels and associated risks across space and time. Based on rising flood-related economic losses over time, there is mounting evidence that such changes are already occurring across Canada. Given the complex nature of the climate system, nonstationary behavior of several climatic variables and drastic uncertainty in future climate variability, the existing design flood estimation techniques can either over- or under-estimate the desired design flood magnitudes. Therefore, it is crucial to evaluate and improve the climate-resilience of these structures that can be catastrophic in case of failures. To initiate research along these lines, the National Research Council Canada, with financial support from the federal government, is leading a multi-year project on the climate-resilience of dams. To start with, a comprehensive review of national and international perspectives on the estimation of design floods and potential climate change mitigation and adaptation solutions has been undertaken. This presentation will focus on flood estimation techniques commonly used to design dams and levees in different parts of the world, including Canada. A systematic framework for integrating climate change information with design flood estimation techniques and potential avenues of research will also be discussed. The ultimate outcomes of this research will support the development of national guidelines for assessing the climate-resilience of dams and levees in Canada

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ID: 11769 Contributed abstract

Poster Order:

Impact of seismic lines on peatland plant productivity and carbon exchange

Percy Korsah [1] , *Maria Strack* [2]

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Presented by / Présenté par: ***Percy Korsah***
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Peatlands are threatened by both natural and anthropogenic disturbances resulting in potential release of large amounts of carbon (C) to the atmosphere. Linear disturbances such as seismic lines for oil and gas exploration constitute the largest area of anthropogenic disturbances. The impact of seismic lines on peatland functions, such as carbon cycling and hydrology, is not very well understood although physical changes in topography and lack of tree re-establishment are well-documented.
This study was conducted in the Peace River oil sands region of Alberta and focused on evaluating changes in CH_4 and CO_2 fluxes and potential alteration to long-term carbon storage in peatlands impacted by seismic lines. The closed chamber technique was deployed to measure fluxes of CH_4 and the net ecosystem exchange of CO_2 (NEE), from 48-paired plots in a poor fen and wooded bogs. Data was collected over two growing seasons together with environmental variables such as water table, peat temperature and vegetation cover.
Sections of the peatland impacted by seismic lines are significantly warmer and wetter providing ideal conditions for increased CH_4 emissions, as was observed on most lines. Significant changes were also observed in changes to vegetation community composition and productivity in response to disturbance and among study sites with greater productivity of the ground layer observed on seismic lines. However, this increase in productivity did not compensate for the loss of productivity from the overstory on the seismic lines. These results help to fill our gap in understanding of the impact of seismic line disturbance on peatland carbon cycling informing estimation of land-use effects on greenhouse gas emissions and restoration planning.

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07/06/2022 15:10

ID: 11552 Contributed abstract

Poster Order:

Modeling soil respiration and its influencing factors for an ongoing peat extraction site

Hongxing He [1] , *Laura Clark* [2] , *Oi Yin Lai* [3] , *Rachel Kendall* [4] , *Ian Strachan* [5] , *Nigel Roulet* [6]

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Presented by / Présenté par: ***Hongxing He***
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By removing vegetation, installing drainage ditches and harvesting peat, peat extraction changes the hydrological and thermal regimes of the peatlands, which makes the peatlands a strong source of CO2 emissions. We adopted the CoupModel (www.coupmodel.com) to simulate the soil CO2 emissions and its associated abiotic drivers for an ongoing extraction site, located in Rivière-du-Loup, Quebec. COUP was first evaluated against three-year (2018-2021) manual chamber measurements of CO2 flux, multi-layered soil moisture and temperature profile, and water table depth data. The validated model was then used to assess the sensitivity of climate on the simulated CO2 emissions. Over 2018-2021, the average CO2 emissions measured mainly over summer was 0.73 ± 0.46 g CO2-C m-2 d-1, with 0.76 ± 0.31 g C m-2 d-1 for 2018, 0.81 ± 1.1 for 2019 (0.57 ± 0.42 g C m-2 d-1 removing the two extreme data), and 0.76 ± 0.31 g C m-2 d-1 for 2020. COUP reproduced the measured summer flux data well with an R2 of 0.5 and a mean bias of 0.2 g C m-2 d-1 and simulated the hydrology and thermal conditions well. Using the simulated data and integrated over a full year, the emission average over 2018 -2021 was reduced to 0.42 g C m-2 d-1, or 153 g C m-2 yr-1. We further performed a long-term (1994-2021) simulation using available climate data from the nearby station. The simulated 27-year annual CO2 emission was 137 ± 24 g C m-2 yr-1, ranging from 80 to 190 g C m-2 yr-1. Overall, the annual variation of the soil respiration was small both in our simulations and the measured data. Our simulated annual CO2 emission rate, 137-153 g C m-2 yr-1 for the studied field is c.a. half of the Tier 1 default emission factor 280 (110 - 420) g CO2-C m-2 yr-1 provided in the IPCC 2013 wetland supplement, also much lower than current emission factors, 310 g CO2-C m-2 yr-1 (by an IPCC Tier 2 methodology) for drained areas used for peat extractions in Canadian national greenhouse gas reporting. This study provides an excellent and unique opportunity to examine heterotrophic respiration on its own. Therefore testing a component of the model that cannot normally be examined. We also discuss the coupled hydrological-C dynamics and examine mitigation of management strategies.

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ID: 11378 Contributed abstract

Poster Order:

A boreal forest model benchmarking dataset for North America: a case study with the Canadian Land Surface Scheme including Biogeochemical Cycles (CLASSIC)

Bo Qu [1] , *Alexandre Roy* [2] , *Joe R. Melton* [3] , *T. Andrew Black* [4] , *Brian Amiro* [5] , *Eugenie Euskirchen* [6] , *Masahito Ueyama* [7] , *Hideki Kobayashi* [8] , *Christopher Schulze* [9] , *Gabriel Hould Gosselin* [10] , *Oliver Sonnentag* [11]

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Presented by / Présenté par: ***Bo Qu***
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Climate change and permafrost thaw are rapidly changing boreal forest composition, structure, and functioning. These changes present a challenge for efforts to accurately simulate exchanges of carbon dioxide (CO2) and energy between the land surface and atmosphere in the Arctic-Boreal Region (ABR). Eddy covariance (EC) measurements of the CO2 and energy fluxes made at different boreal forest stands provide valuable data for evaluation of terrestrial ecosystem models. Here, we create a boreal forest model benchmarking dataset for North America by compiling and homogenizing EC and supporting measurements (meteorology, soil, and vegetation) from eight boreal forest stands. The eight forest stands have different stand characteristics and soil and permafrost conditions and are representative of mature boreal forests across North America. We produce complete gap-filled meteorological data and a complete set of ancillary measurements essential for stand-level model simulations and provide screened daily fluxes to exclude low-quality data and improve model evaluation efficiency. We used the benchmarking dataset to investigate the model performance of the Canadian Land Surface Scheme including Biogeochemical Cycles (CLASSIC). CLASSIC output was analysed with several statistical skill metrics and compared to the observations in the environmental responses for CO2 and energy fluxes. Our case study using CLASSIC demonstrates the utility and capability of our dataset to benchmark models.

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ID: 11764 Contributed abstract

Poster Order: Poster-4031

Long-term carbon and water cycle variability in Canadian watersheds using coupled MESH-CLASSIC model

Daniel Mutton [1] , *M. Altaf Arain* [2] , *Bruce Davidson* [3] , *Daniel Princz* [4]

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Presented by / Présenté par: ***Daniel Mutton***
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Recent advances in the Mod´elisation Environmentale Communautaire Surface and Hydrology system (MESH) allowing for vector-based routing, and the coupling of MESH to the Canadian Land Surface Scheme Including Biogeochemical Cycles (CLASSIC) model has given researchers a new tool to model water and carbon cycles at the catchment scale. This research shows the application of the coupled MESH-CLASSIC model to three watersheds across Canada representing three different biomes with the purpose of demonstrating the functionality and flexibility of the model and the value it will provide researchers globally. The three watersheds assessed are the Groundhog River watershed in Northern Ontario (part of the Hudson Bay Lowlands), the Big Creek watershed in southern Ontario (a managed agricultural watershed), and the White Gull Creek watershed in Saskatchewan.

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ID: 11757 Contributed abstract

Poster Order: Poster-4031

Better than butter tarts: Benchmarking a Canadian terrestrial ecosystem model with Canadian eddy covariance sites

Joe Melton [1] , *Sung-Ching (Nick) Lee* [2] , *Bo Qu* [3] , *Gesa Meyer* [4] , *Jade Skye* [5] , *Elyn Humphreys* [6] , *Oliver Sonnentag* [7] , *Alexandre Roy* [8]

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Presented by / Présenté par: ***Joe Melton***
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Terrestrial ecosystem models require careful evaluation to ensure model performance matches observations well. This is especially important as models, like the Canadian Land Surface Scheme including Biogeochemical Cycles (CLASSIC), are used for applications ranging from serving as the terrestrial component of Earth system models, investigating climate change adaptation options in national level assessments, to performing detailed process analysis at the site-level. To evaluate CLASSIC performance over the national domain we have greatly expanded the CBC (CLASSIC Benchmarking Collection) to include more Canadian eddy covariance (EC) sites. These EC sites collectively offer decades of EC observations across diverse landscapes including boreal and temperate forest, tundra, grasslands, and peatland ecosystems allowing evaluation of simulated carbon, energy, and water fluxes. In this poster, we detail the newly integrated sites along with some preliminary results of CLASSIC version 1.5 compared to version 1.0 at the various sites.

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ID: 11424 Contributed abstract

Poster Order:

Evaluating the performance of the Canadian Land Surface Scheme Including Biogeochemical Cycles (CLASSIC) tailored to the pan-Canadian domain

Salvatore Curasi [1] , *Elyn Humphreys* [2] , *Joe Melton* [3] , *Christian Seiler* [4] , *Libo Wang* [5]

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Presented by / Présenté par: ***Salvatore Curasi***
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Canada's extensive boreal forests, peatlands, and tundra ecosystems are critical components of the global carbon (C) cycle. These ecosystems are responding to unprecedented climate change with implications for the region's C balance and global climate. Despite the region's importance, there has been no comprehensive, high-resolution, process-based assessment of Canada's terrestrial C cycle to date. Pre-existing regional assessments have relied upon forest inventories, atmospheric inversion, remote sensing, or data-driven approaches, which have a limited ability to disentangle the effects of different processes on the C cycle and make projections. Therefore, we adapted the Canadian Land Surface Scheme Including Biogeochemical Cycles (CLASSIC), to the Canada domain. We use remotely sensed data to specify vegetation cover and add 5 plant functional types (PFTs) including shrubs, sedges and two region-specific tree PFTs to represent major genera. We compared the results of our model runs to remotely sensed and data-driven products using the Automated Model Benchmarking R package. Our benchmarks showed that using Canada-specific land cover products and plant functional types improved the models' skill in representing the regional C cycle relative to the standard model setup. Our evaluations also allowed us to identify several processes, most notably disturbance, where a region-specific representation could improve model performance. This is the first work to tailor a process-based model towards a comprehensive, high-resolution assessment of Canada's terrestrial C cycle. Our results have implications for better understanding the processes driving changes in the Canadian terrestrial C cycle. They have implications for future regional modeling efforts in Canada and other regions.

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07/06/2022 16:05

ID: 11855 Contributed abstract

Poster Order:

Combined inventory and model based assessments of the carbon balance of Canada's managed forests

Werner Kurz [1]

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Presented by / Présenté par: ***Werner Kurz***
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Canada's National Forest Carbon Monitoring, Accounting and Reporting System (NFCMARS) is used to estimate and report on emissions and removals in Canada's managed forest and forest product sector for the period 1990 to the present. It is also used to make projections and to quantify the outcomes of mitigation actions aimed at supporting national greenhouse gas emission reduction targets. Inventory-based models have the advantage that they can operate at high spatial resolutions: the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) which is the core model of NFCMARS represents 226 Mha of managed forest with nearly 3 million records (or on average about 75 ha per record). The next generation Generic Carbon Budget Model (GCBM) is running at 1 ha and 0.1 ha spatial resolutions but has not yet been applied to all of Canada. The high spatial resolution allows for representation of forest age-class distributions and the many age-dependent processes, including post-disturbance recovery. Moreover, analyses at 1 ha or finer resolution allows informing models of forest carbon dynamics with remote-sensing derived time series of forest cover and forest cover changes. The limitation of these models is that they are operating in annual time steps and thus do not permit the representation of diurnal or season dynamics. Inventory-based models rely on forest yield curves derived from temporary and permanent sample plots to estimate current (and projected future) growth and mortality rates. While this provides empirical constrains on the model estimates, it also risks that important changes in growth and mortality rates (other than those from disturbances which are monitored directly) may remain undetected for some time. Remote sensing offers opportunities to further inform estimates of recent carbon dynamics and to improve the models.

Session: 5042 The 2030 mitigation challenge: Science-based tracking of Canada's methane emissions to support policy - Part 3 Le défi de l'atténuation à l'horizon 2030 : un suivi scientifique des émissions de méthane du Canada à l'appui des politiques - Partie 3	**07/06/2022 14:55**

ID: 11504 Contributed abstract

Poster Order:

Aerial mass balance measurements of methane emissions in 11 oil and gas production regions and 15 facilities in Alberta, Canada

Hugh Li [1], *Scott Seymour* [2], *James Wang* [3], *Katlyn MacKay* [4], *MacKenzie Smith* [5], *Donglai Xie* [6]

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Presented by / Présenté par: ***Hugh Li***

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The Canadian government aims to achieve a 40-45% reduction of oil and gas (O&G) methane emissions by 2025, and 75% by 2030 though recent studies consistently suggested the government inventory underestimates the actual emissions by a factor of 1.5 to 2. Field emission measurements are critical for assessing methane regulation effectiveness and whether the government is on track to meet the methane reduction goals. Environmental Defend Fund conducted aerial mass balance measurements of 11 representative O&G production regions and 15 O&G facilities in Alberta from September 29 – November 6, 2021. Facility-level measurements show that measured emissions generally agree within a factor of 2 with the 2019 reported emissions. The largest discrepancy was observed at a natural gas liquids extraction plant, where the measurement was more than 40 times higher than the inventory emission value. There was a factor of 3 variation across repeated measurements taken at the same facilities, suggesting that a single snapshot of target facilities might not represent the actual long-term emissions from the source. The regional emissions per unit area were from 0.22 to 6.24 kg/h/km2. This wide range of variability implies comprehensive regional measurements at diverse O&G production fields are needed to provide a representative picture of methane emissions from the O&G infrastructure in Alberta. By comparing the regional measurements with a bottom-up inventory built up following National Inventory Report methods, we show that methane emissions from the O&G industry remain underreported by a factor of 1.5 to 2 — a finding that is consistent with studies dating back to 2016. Methane emissions dropped by about 50% in Lloydminster while increased by 44% in Red Deer in comparison with a similar EDF aerial study in 2016. The data suggests that the implementation of methane regulation rules over the last five years has not completely resolved this underreporting issue.

Session: 5042 The 2030 mitigation challenge: Science-based tracking of Canada’s methane emissions to support policy - Part 3 Le défi de l'atténuation à l'horizon 2030 : un suivi scientifique des émissions de méthane du Canada à l'appui des politiques - Partie 3 **07/06/2022 15:10**

ID: 11743 Contributed abstract

Poster Order:

Stationary sensing of temporal emissions from natural gas infrastructures using a Back-trajectory Lagrangian Stochastic model

Afshan Khaleghi [1] , *Evelise Bourlon* [2] , *Nick Nickerson* [3] , *Colleen Gosse* [4] , *Mathias Goeckede* [5] , *David Risk* [6]

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Presented by / Présenté par: ***Afshan Khaleghi***
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Many oil and gas methane sources are temporally variable, and continuous monitoring is necessary to define emissions over time. The combination of continuous monitoring data with models allows for the interpretation of source strength and location with varying wind speed and direction. Lagrangian stochastic footprint models have the potential to be used with continuous sensor data and involves projecting particle movements backward in time and have potential to be used with continuous sensor data for the measurement period to predict the prospective location of emission particles back towards the source, in assumed horizontal homogenous flat terrain. This study applies a Back-trajectory Lagrangian footprint method (TERRAFEX) for temporal measurements downwind of natural gas distribution infrastructure. We developed a gradient indicator tool to interpret the output maps and to locate emitting sources. Our study first comprised synthetic testing to understand the limitations of TERRAFEX and to improve the gradient indicator, in which we examined the uncertainty associated with distance and height offset between source(s) and sensor. Results showed that with a maximum, one-meter height difference between source(s) and sensor and a minimum distance of 50-meters in plane-surface, it was possible to locate at least one source, but that sources with very small relative distance were difficult to discern individually. The model application was extended to a continuous stationary measurement campaign at a natural gas distribution site to measure the temporal nature of emissions from activities onsite, and where the Lagrangian results were compared against those from a Gaussian-based model. Regular temporal variability was observed for sources depending on the wind direction, emission strength and time of the day. As the use of continuous sensors increases for oil and gas monitoring, the Lagrangian method has the potential for use along with more routine Gaussian approaches.
Keywords: fugitive emission, footprint, Lagrangian Stochastic, gas infrastructure, gradient

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07/06/2022 15:25

ID: 11702 Contributed abstract

Poster Order:

Quantification of anthropogenic methane emissions in four different regions of western Canada

Judith Vogt [1] , *Gilles Perrine* [2] , *Justin Laforest* [3] , *Mark Argento* [4] , *Sarah Kennedy* [5] , *Evelise Bourlon* [6] , *Martin Lavoie* [7] , *David Risk* [8]

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Presented by / Présenté par: ***Judith Vogt***
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Oil and gas production is the main contributor of anthropogenic methane emissions in Canada, followed by the agricultural sector and landfills. Although national emission reduction targets are in place, including regulation recently introduced for oil and gas operators, methane emissions from these sectors are seldom quantified. To fill this gap, we conducted transect-based and stationary measurements with a mobile laboratory equipped with a greenhouse gas analyzer over two-week campaigns in south-western Saskatchewan in September 2020 and north-western Alberta in November 2021. An inverse Gaussian plume model was used to quantify emissions mainly for oil and gas infrastructure on a site level, but we also detected emissions from livestock and a recycling and waste management plant. Super-emitters from the upstream oil and gas industry released up to 4155 m^3/day of methane, but more commonly oil and gas sites emitted in the range of 4 m^3/day to 54 m^3/day. We estimated emission rates up to 33 m^3/day for grazing cattle or bison herds (when herds were simplified to point sources in the Gaussian model). Emissions from a recycling and waste management plant were higher than livestock emissions, and comparable in magnitude with emissions from oil and gas sites. Overall, agricultural and waste sector methane emissions were significant and further investigation is needed to validate inventories, and to help understand these sources as Canada works to meet its ambitious methane targets.

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ID: 11596 Contributed abstract

Poster Order:

Methane emissions from upstream oil and gas production in Canada are underestimated

David Risk [1] , *Katlyn MacKay* [2] , *Martin Lavoie* [3] , *Evelise Bourlon* [4] , *Emmaline Atherton* [5] , *Elizabeth O'Connell* [6] , *Jennifer Baillie* [7] , *Chelsea Fougère* [8] , *Afshan Khaleghi* [9] , *Lindelwa Coyle* [10] , *Judith Vogt* [11]

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Presented by / Présenté par: ***David Risk***
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Methane emissions were measured at ~7000 sites across major oil and gas producing regions in Canada to examine regional emission trends, and to derive an inventory estimate for Canada's upstream oil and gas sector. Emissions varied by fluid type and geographic region, with the heavy oil region of Lloydminster ranking highest on both absolute and intensity-based scales. Emission intensities varied widely for natural gas production, where older, low-producing developments showed high emission intensities, and where emissions intensity in newer developments was amongst the lowest in North America. Emissions from offshore production were in-line with reported estimates. Overall, we estimate that the Canadian upstream oil and gas methane inventory is underestimated by a factor of 1.5, which is consistent with previous studies.

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ID: 11691 Contributed abstract

Poster Order:

Canada's Methane Emissions from Oil & Gas: Sources of Claimed Emissions Reductions

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Presented by / Présenté par: ***Scott Seymour***
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In Alberta – Canada's largest oil and gas producing province – federal methane emissions estimates suggests that emissions are down ~35% in 2020 from a 2012 baseline. With Canada's pledge to reduce methane emissions from the oil and gas sector by 40-45% by 2025, and to further reduce by 75% by 2030, federal and provincial modelling suggests that Canada is on track to meet its reduction targets. However, it is not yet clear what industry segments are responsible for the reported reductions and what drivers have been most effective – methane regulations are likely driving change but modelling artefacts may also account for reported reductions.

To attribute the reported emissions reductions to specific sources, we recreate the federal inventory model between 2011 and 2021. By incorporating new data sources and modelling the impacts of new regulations, it is possible to track the changes in emissions by source type over the past decade. The methane inventory leverages operator-reported data (venting, flaring, natural gas fuel use volumes) and uses these data to model historiocally unreported emissions, such as storage losses and pneumatic emissions. The present analysis demonstrates that at least a third of the reported emissions reductions (over 125 kt of methane) are caused by a contraction in the number of active wells and facilities – an artefact of the modelling approach – that may not accurately reflect

emissions trends in the field.

To better understand whether the modelled emissions reductions are expected to accurately reflect emissions in the field, we test the sensitivity of these models to their underlying assumptions. The analysis shows that the modelled emissions can vary widely with different scaling assumptions and, ultimately, it shows that there is significant uncertainty in the methane inventory trend.

Session: 7061 Severe and Extreme Convective Storms - Part 2 Les orages convectifs sévères et extrêmes - Partie 2 **07/06/2022 14:55**

ID: 11455 Contributed abstract

Poster Order:

S-Band Dual-Polarization Radar Evaluation of the Barrie, Ontario Tornado of July 15 2021.

Arnold Ashton [1] , *Daniel Liota* [2]

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Presented by / Présenté par: ***Arnold Ashton***
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Environment and Climate Change Canada (ECCC) is well underway in the renewal of its national radar network from C-band to S-band polarimetric radars. On June 28 2021 the newly installed King City S-band radar went live. On July 15th 2021, a prominent EF2-rated tornado tore through southern Barrie, one of ten tornadoes that struck Southern Ontario that day. There were 11 injuries but no fatalities, with insurable losses reaching $100M. The timely radar installation just prior to a major tornado outbreak provided an excellent initial evaluation of the new S-band dual-polarization products as well as the improved temporal scan strategy (six-minutely). In this talk, several dual-polarization radar scans of the supercell thunderstorm that spawned the Barrie tornado will be examined. This assessment suggests promising results for assisting with improved tornado alerting lead-times in the future.

Session: 7061 Severe and Extreme Convective Storms - Part 2 Les orages convectifs sévères et extrêmes - Partie 2 **07/06/2022 15:10**

ID: 11403 Contributed abstract

Poster Order:

Are Significant Tornadoes Occurring Later in the Year in Southern Ontario?

David Sills [1] , *Connor Durfy* [2] , *Camila de Souza* [3]

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Presented by / Présenté par: ***David Sills***
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Though tornadoes in southern Ontario have been recorded March to December, the peak months are May to August. Over the last decade or more, some in Ontario's severe weather community have noted anecdotally that significant tornadoes seem to be occurring later in the season here. One example: in 2018 an EF3 tornado developed as part of a 7-tornado outbreak in southern Ontario and neighboring Quebec in late September - the first September F/EF3+ Canadian tornado in 120 years and the first tornado outbreak of such magnitude that late in the year in Canada.

In order to test this hypothesis, we analyzed a long-term data set (1875–2019) of southern Ontario tornadoes. Using only F/EF2+ tornadoes and 10-year rolling periods having modes at 5-year intervals, we found a statistically significant (99% confidence interval) moderate positive trend. While the median and mode for the 1895–1950 events are 5.5 and 5.0, respectively, events in the 1955–2010 period have both a median and a mode of 8.0 – representing an increase of approximately 3 months (i.e., May to August).

Interestingly, we identified no statistically significant trend (positive or negative) using the same methods over the same period with tornado data from the neighbouring US states Michigan and New York.

Though we do not investigate causes with this work, this is the first study to identify a robust long-term trend in the frequency of significant tornadoes for any region of Canada. Also of note is that an increase in significant tornadoes later in the year has implications for public safety, as will be discussed in the presentation.

Session: 7061 Severe and Extreme Convective Storms - Part 2 Les orages convectifs sévères et extrêmes - Partie 2 **07/06/2022 15:25**

ID: 11399 Contributed abstract

Poster Order:

Updating Canada's National Tornado Climatology

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Presented by / Présenté par: ***Francis Lavigne-Theriault***
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The Northern Tornadoes Project (NTP), founded in 2017 by Western University and ImpactWX, 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. The project was initially limited in scope – attempting to find at least a few undocumented tornadoes in the northern forests of Ontario and Quebec. However, the project expanded across all of Canada in 2019 based on successful pilot campaigns in 2017 and 2018.

NTP not only investigates present tornadoes, but also seeks to extend the historical record. One NTP goal has been to create an updated 30-year tornado climatology for Canada that covers the years 1991-2020. Satellite imagery is one of the ways NTP collects data on historical tornadoes across Canada. A total of 277 historical tornadoes were discovered across Canada's Boreal Forest between 1980-2020. There was also a need to fill the 10-year gap (between 2009 and 2020) since the last climatology, with the bulk of the data here originating from ECCC records. Once the data were assembled, thorough quality control measures were applied to ensure accuracy and consistency.

Comparing the new 1991-2020 climatology to the previous 1980-2009 climatology (amended with additional discovered events) shows that tornado counts have generally decreased slightly across Canada. The 1980-2009 amended database contains 1965 tornadoes with an annual mean of 65.5 while the new 1991-2020 database contains 1866 tornadoes with an annual mean of 62.2.

Data for each province were analysed and compared, showing that Quebec and Ontario tornadoes have increased throughout the 1991-2020 period, while Prairie tornadoes have decreased. In fact, Saskatchewan no longer holds the title of 'Canada's tornado capital'. Ontario is now the province with the most tornadoes annually.

Other key findings, major amendments and climatological trends for Canadian tornadoes will be discussed during the presentation.

Session: 7061 Severe and Extreme Convective Storms - Part 2 Les orages convectifs sévères et extrêmes - Partie 2 **07/06/2022 15:50**

ID: 11550 Contributed abstract

Poster Order:

Canada's First and Only F5/EF5 Tornado: Observational and Modelling Analysis

Wang Chun-Chih [1] , *John Hanesiak* [2] , *Justin Hobson* [3]

1

2

3

Presented by / Présenté par: ***Wang Chun-Chih***

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Canada's first and only F5/EF5 tornado touched down and impacted Elie, Manitoba in the early evening of 22 June 2007; 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. Early-afternoon (1800Z) surface observations and a targeted Winnipeg sounding revealed a local environment that was primed for supercells, with surface dewpoints of 21-24C, high MUCAPE (>2000 J/kg) and strong low-level shear (~15 m/s 0-1 km; 0-3 km SRH 350 m^2/s^2) within the warm sector of a slow-moving surface low in the southern Parklands Region. However, high (-160

J/kg) convective inhibition (CIN) was also present, making a tornado forecast difficult given uncertain triggering strength. WRF sufficiently reproduced the synoptic and mesoscale features, including a supercell-like storm in the region of interest, and supplemented available observations. Analyses of the WRF simulation and proxy observational datasets suggest that the shear likely weakened slightly during the afternoon while a narrow moisture axis developed near Elie. 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) and persisted for ~40 min. WRF produced a supercell with persistent updraft helicity track very near Elie; its internal dynamics fed back positively on the near-storm shear, likely contributing to its maturation and increasing the likelihood of tornadogenesis. 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.

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ID: 11866 Contributed abstract

Poster Order:

Exploring the Meteorological Conditions Associated with Classic Type Supercell Thunderstorms - in the Canadian Prairies

Mostofa Kamal [1] , *Yanping Li* [2] , *Xiaohui Zhao* [3]

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Presented by / Présenté par: ***Mostofa Kamal***
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Classic supercell thunderstorms account for a significant percentage of tornadoes over the Canadian Prairies. The main goal of this study is to identify the meteorological conditions which favor the development and maintenance of classic supercells over the Canadian prairies specifically over southern Saskatchewan and southwestern Manitoba and quantify physical characteristics. This study analyzed the radiosonde observation of 16 classic type supercells that occurred over the Canadian prairies. We find that CAPE, downdraft CAPE (DCAPE), temperature lapse rate, Bulk Richardson Number (BRN), and effective inflow layer shear are significantly higher for the classic type of supercell than low-precipitation supercell. We observed that surface-based CAPE, most-unstable CAPE, and DCAPE values are drastically higher for the classic supercell than the low-precipitation supercell. Further, the elevated mixed layer (EML) originated from the elevated terrain of the Rocky Mountain plays a dominant role in triggering classic type supercell compared to low- and high- precipitation supercell. The EML ensure explosive convective development and kept the thunderstorm development isolated which in turn helped in the development and maintenance of the tornadic supercell. This study's findings will help operational weather forecasters in issuing more accurate high-impact weather events including tornados, hail, and damaging straight-line wind.

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07/06/2022 14:55

ID: 11832 Contributed abstract

Poster Order:

The Multi-Partner Research Initiative: A Scientific Research Network to Support Decision Making in Oil Spill Response

Kenneth Lee [1]

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Presented by / Présenté par: ***Kenneth Lee***
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Under the Government of Canada’s Oceans Protection Plan (OPP) to establish a world-leading marine safety system to protect marine ecosystems, while enabling inclusive economic growth, the Multi-Partner Research Initiative (MPRI) aims to advance oil spill research by fostering a national/international research network with scientific experts in the field. The core studies under this program are focused on the provision of scientific knowledge to support the development, validation and regulatory approval of Alternative Response Measures (ARMs) that include: spill treating agents, in situ burning, oil translocation and decanting/oily waste disposal. Additional research includes studies on key “cross-cutting” issues, such as natural attenuation and bioremediation of oil, assessment of toxic impacts associated with oil spills and the application of oil spill countermeasures, oil detection and mapping by autonomous underwater vehicles (AUVs) and the development of numerical predictive models for oil transport, fate and behaviour. The deliverables from this research program involving more than 250 researchers under 50 projects will provide essential information to support Net Environmental Benefit Analysis (NEBA) for decision making to select the optimal oil spill response option(s) to protect the marine environment and its living resources.

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07/06/2022 15:10

ID: 11375 Contributed abstract

Poster Order:

Developments in ECCC Oil Spill and drift modelling

Paul Pestieau [1] , *Kuo-Hsien Chang* [2] , *Guillaume Marcotte* [3]

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

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The Government of Canada five year Ocean Protection Plan funded new regional high-resolution ocean numerical models, on both the East and West coasts. The development and delivery of this increased forecasting capability has been achieved through a collaboration between Environment and Climate Change Canada (ECCC) and Fisheries and Oceans Canada (DFO) in large part for the enhancement of electronic navigation and emergency response. At the Canadian Centre for Meteorological and Environmental Predictions (CCMEP), the Environmental Emergency Response Section (EERS) adapted its atmospheric Modèle Lagrangien de Dispersion des Particules (MLDP) for aquatic applications with the addition of algorithms for the fate and behaviour of oil. This was a critical part of the development of the Canadian Oil Spill Modeling Suite (COSMoS) which includes a graphical interface for the query of environmental data and product delivery for operational use. The presentation will include lessons learned when EERS responders used COSMoS during a two year long Parallel Phase to emulate real-time operational responses to actual requests for oil spill modelling from ECCC's National Environmental Emergency Centre (NEEC). Application of the new ocean models for emergency response using COSMoS will be shown, as well as the ongoing work to further develop COSMoS so it may be integrated into the operational workflow to enhance Canada's response to oil spills and other emergencies involving the drift of debris (vessels, containers, whale carcasses) and the dispersion of pollution including radionuclides.

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ID: 11576 Contributed abstract

Poster Order:

Long-term multi-species consequences of an oil spill in the Salish Sea using an Atlantis model

Raisha Lovindeer [1] , *Sara Mynott* [2] , *Javier Porobic* [3] , *Beth Fulton* [4] , *Susan Allen* [5] , *Doug Latornell* [6] , *Heidi Pethybridge* [7] , *Jess Melbourne-Thomas* [8] , *Natalie Ban* [9]

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Presented by / Présenté par: ***Raisha Lovindeer***
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The Salish Sea is a major transportation route for oil between Canada and the

USA, but is also a thriving ecosystem, from productive kelp beds to endangered resident killer whales. The long-term effects of oil contamination throughout this ecosystem are not well understood. While many assessments of oil spill scenarios focus on preparing for, responding to, and recovering from spills in the short-term, few of these scenarios simulate long-term impacts of spilled oil. An end-to-end Atlantis ecosystem model has been developed for the Salish Sea (Salish Sea Atlantis Model, SSAM) that simulates the effect of oil contaminants through the food web. The model incorporates all components of the ecosystem—physical and chemical parameters such as salinity, temperature and currents forced with time series data from the SalishSeaCast NEMO Model; biological interactions between flora and fauna; human-related activities, such as fishing; as well as representations of major polycyclic aromatic hydrocarbons (PAH; Naphthalene, Phenanthrene, Pyrene, and Benzo(a)pyrene) in different types of oils. We used SSAM to examine the consequences of specific oil spill scenarios developed in conjunction with the Department of Fisheries & Oceans Canada (DFO-Pacific) and Transport Canada. Here, we highlight the simulated long-term consequences of two such spill scenarios on the food web, as well as on select organisms, such as salmon, that are of major cultural and economic importance within the Salish Sea. With this, we demonstrate how ecosystem models can be employed to understand the long-term impacts of oil spills, and better plan for incidents on the water.

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ID: 11512 Contributed abstract

Poster Order: Poster-12070

Development and testing of an offshore oil spill trajectory modeling tool

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Presented by / Présenté par: ***Zhaoyang Yang***

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We present a two-dimensional lagrangian particle tracking model (OSMT) to predict the transport and weathering of oil spills at the sea surface. A novel calibration approach for spill trajectory prediction has been proposed to calibrate the OSMT using synthetic aperture radar (SAR) image time-series. Through the evaluation of model performance with different parameter combinations using the KL divergence, the model was calibrated by minimizing the discrepancy between simulated trajectory and detected oil slicks. To test OSMT, a comprehensive comparison between OSMT and the well-known GNOME model was conducted to examine model validity in a hypothetical case. Furthermore, the applicability of the newly developed calibration method was examined through the 2018 Sanchi oil tanker accident. Preliminary results suggested that OSMT can provide reliable simulations. It was found that KL divergence-based approach is effective to support the oil transport model and has better modeling results than the calibration method using the traditional separation distance

method.

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ID: 11489 Contributed abstract

Poster Order:

Ocean feature extraction from Radarsat-2 synthetic aperture radar, with a view to monitoring right whale habitat in the Gulf of St. Lawrence

Rick Danielson [1] , *Hui Shen* [2] , *Jing Tao* [3] , *Will Perrie* [4]

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Presented by / Présenté par: ***Rick Danielson***
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Coherent filaments at the ocean surface often appear to be transient watermass boundaries, where currents converge, surfactants accumulate, and frontal structure at depth can possibly delineate enhanced biological activity in the upper water column. Spaceborne synthetic aperture radar (SAR) permits filaments to be observed at O[100-m] resolution, but extensive coherent structure is more apparent in weaker winds. A wind speed adjustment is considered for filaments (i.e., contiguous SAR contrasts) of at least 10 km in length. Measures of dependence (distance correlation and Pearson correlation) are examined to identify a broad peak in the relationship between filament contrast and weak or moderate values of surface wind speed, where a variable wind speed exponent is employed to maximize these measures.

Three locations of recent North Atlantic right whale (Eubalaena glacialis) sightings in the Gulf of St. Lawrence are sampled between 2008 and 2020 by 324 Radarsat-2 SAR scenes and 10-m wind speed from the ERA5 reanalysis. The inverse relationship between SAR contrast magnitude and wind speed is quantified, and a reduced correlation is obtained for all three domains when SAR contrast is weighted by wind speed to the power of 0.8. A simple adjustment can thus be considered in a search for potential hotspots of biological activity in the water column, both within and across multiple SAR scenes.

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ID: 11784 Contributed abstract

Poster Order:

Beyond Scenarios: A statistical representation of oil spills in the Salish

Sea

Rachael Mueller [1] , *Susan Allen* [2] , *Ashutosh Bhudia* [3] , *Stephanie Chang* [4] , *Vy Do* [5] , *Krista Forysinski* [6] , *Casey Hilliard* [7] , *Doug Latornell* [8] , *Shihan Li* [9] , *Haibo Niu* [10] , *Cam Power* [11] , *Ryah Rondolo* [12]

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Presented by / Présenté par: ***Susan Allen***
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Oil spill response planning specialists need good information on the spatial distribution of the most likely oil spill scenarios in order to mitigate harm and help bequeath to future generations a Salish Sea that is absent of oil spill impacts. Traditionally oil spill impacts have been evaluated based on a few spill scenarios selected based on expert opinion of most likely accidents. Here, we look at the distribution of all possible medium to large spills using a 10000 spill sample and assuming spills depend simply on the time vessels are at sea. Oil spill location, month, and volume are randomly generated from a year's worth of AIS ship track data that was organized into vessel time exposure maps for seven different vessel classifications. For oil cargo vessels, we use AIS ship tracks to create voyages that identify the ship's origin and destination and, where applicable, attribute oil type based on Washington State Department of Ecology oil transfer data. We randomly select a spill day, hour, and year between January 1, 2015 and December 31, 2018 to capture a wide range of spill conditions. Our 7-day spill scenarios use currents, winds, and waves that are predicted by the SalishSeaCast NEMO ocean model, Environment and Climate Change's HRDPS winds, and a WW3 wave model, respectively. We generated 10,000 random oil spills with our Monte Carlo simulation and predicted oil dispersion, emulsification, dilution, biodegradation, beaching, and advection for these spills using a modified version of the MOHID oil spill model. In this talk, we will detail the design of the Monte Carlo simulation and present maps of the likelihood of oil presence and volume on the water and beaches.

Session: 12070 Integrating ocean-atmosphere data and models to support environmental response operations in the marine environment Intégrer des données et des modèles océan-atmosphère pour soutenir les opérations d'intervention environnementale dans le milieu marin **07/06/2022 16:20**

ID: 11770 Contributed abstract

Poster Order:

Space-time variations of ocean circulation and hydrography in coastal and deep oceans off Canada's east coast: Analysis and verification of high-

resolution model simulations

Youyu Lu [1] , *Yongxing Ma* [2] , *Michael Casey* [3]

[1] Bedford Institute of Oceanography
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Presented by / Présenté par: ***Youyu Lu***
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Simulation and forecasting results of high resolution numerical ocean models, produced using realistic forcing at surface and lateral boundaries (i.e., open ocean and rivers), are highly valuable for marine environmental research and response operations. The model results enable the quantification of multi-scale ocean variabilities that are less easily derived from sparse ocean observations. This presentation summarizes several recent results on space-time variations of ocean circulation and hydrography in coastal and deep oceans off Canada's east coast, based on analyses of a global ocean reanalysis product (GLORYS12) and the shelf and coastal models developed in Canada. The analyses quantify the significant contributions of meso-scale eddies over and beyond the shelf break, the intrusion of watermass from deep ocean onto the shelf, and the presence of fronts and river plumes in coastal waters. Certain aspects of the model solutions are evaluated with available observational data.

Session: 13032 Emerging methods, strategies and frameworks in climate/engineering system interaction studies to support climate change adaptation and mitigation - Part 3 Méthodes, stratégies et cadres émergents dans les études d'interaction climat/système d'ingénierie pour soutenir l'adaptation et l'atténuation du changement climatique - Partie 3

07/06/2022 14:55

ID: 11545 Contributed abstract

Poster Order:

Physically Based Deep Learning Framework to Model Intense Precipitation Events at Engineering Scales

Bernardo Teufel [1] , *Fernanda Carmo* [2] , *Laxmi Sushama* [3] , *Lijun Sun* [4] , *Naveed Khaliq* [5] , *Stephane Belair* [6] , *Asaad Shamseldin* [7] , *D. Nagesh Kumar* [8] , *Jai Vaze* [9]

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Presented by / Présenté par: ***Bernardo Teufel***
Contact: teufelbernardo@gmail.com

The high computational cost of super-resolution (< 250 m) climate simulations is a major barrier for generating climate change information at such high spatial and temporal resolutions required by many sectors for planning local and asset-specific climate change adaptation strategies. This study couples machine learning and physical modelling paradigms to develop a computationally efficient simulator-emulator framework for generating super-resolution climate information. To this end, a regional climate model (RCM) is applied over the city of Montreal, for the summers of 2015 to 2020, at 2.5 km (i.e., low resolution – LR) and 250 m (i.e., high resolution – HR), which is used to train and validate the proposed super-resolution deep learning (DL) model. In the field of video super-resolution, convolutional neural networks combined with motion compensation have been used to merge information from multiple LR frames to generate high-quality HR images. In this study, a recurrent DL approach based on passing the generated HR estimate through time helps the DL model to recreate fine details and produce temporally consistent fields, resembling the data assimilation process commonly used in numerical weather prediction. Time-invariant HR surface fields and storm motion (approximated by RCM-simulated wind) are also considered in the DL model, which helps further improve output realism. Results suggest that the DL model is able to generate HR precipitation estimates with significantly lower errors than other methods used, especially for intense short-duration precipitation events, which often occur during the warm season and are required to evaluate climate resiliency of urban storm drainage systems. The generic and flexible nature of the developed framework makes it even more promising as it can be applied to other climate variables, periods and regions.

Session: 13032 Emerging methods, strategies and frameworks in climate/engineering system interaction studies to support climate change adaptation and mitigation - Part 3 Méthodes, stratégies et cadres émergents dans les études d'interaction climat/système d'ingénierie pour soutenir l'adaptation et l'atténuation du changement climatique - Partie 3	**07/06/2022 15:10**

ID: 11437 Contributed abstract

Poster Order:

Machine learning framework to aid climate model assessment and improvements

Francisco Andree Ramirez Casas [1] , *Laxmi Sushama* [2] , *Bernardo Teufel* [3]

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Presented by / Présenté par: ***Francisco Andree Ramirez Casas***
Contact: francisco.ramirezcasas@mail.mcgill.ca

Improving climate model performance/simulations often requires several sensitivity experiments, to identify appropriate values of parameters and also to ensure that physical mechanisms are adequately represented. These experiments come at great computational cost given the ever-increasing complexity and resolutions of models. This study explores the possibility of using machine learning approaches to simplify this process, by identifying key mechanisms that are responsible for biases in the model outputs. To this end, near-surface soil moisture (SM) and its predictors in ERA5, along with outputs from the Global Environmental Multiscale (GEM) model are selected for developing and testing the framework. Climate variables related to gain and loss of water at the soil surface are used as predictors in random forest (RF) models: water availability (defined here as precipitation minus evaporation), relative humidity, 2-meter temperature, snowmelt and snow water equivalent. In addition, to account for the way water travels in the soil, topography and soil texture are also used as predictors. A RF model that accurately predicts SM is first developed. Here, two sets of models are developed using April-September ERA5 data for the 1989–2020 period. The first model is trained on a cell-by-cell approach, allowing it to learn the specific range of SM values at every location, which also provides the ability to generate a map of regionally controlling predictors. The second model is developed using data for the entire domain. Both models have the ability to replicate regional patterns of SM, with the first model being more accurate. Following this, predictors are taken from GEM outputs, with the assumption that where an important predictor/mechanism is misrepresented in the climate model, the error will propagate through the random forest model and biases can be identified by comparing these outputs against the baseline error, thus simplifying the model improvement process by informing the small set of numerical simulations that should be undertaken with GEM.

Session: 13032 Emerging methods, strategies and frameworks in climate/engineering system interaction studies to support climate change adaptation and mitigation - Part 3 Méthodes, stratégies et cadres émergents dans les études d'interaction climat/système d'ingénierie pour soutenir l'adaptation et l'atténuation du changement climatique - Partie 3

07/06/2022 15:25

ID: 11578 Contributed abstract

Poster Order:

Exploring machine learning frameworks to fill the spatial and temporal gaps in satellite-based soil moisture and freeze-thaw data over Canada

Arun Kuttiyanikudiyil Sasidharan [1] , *Laxmi Sushama* [2] , *Lijun Sun* [3] , *Bernardo Teufel* [4] , *Fernanda Carmo* [5] , *Francisco Ramirez Casas* [6]

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Presented by / Présenté par: ***Arun Kuttiyanikudiyil Sasidharan***
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Satellite-based observations are often used for various purposes, including validation of climate model outputs. The soil moisture data and freeze/thaw soil state data from Canadian radiometers aboard the Soil Moisture Active Passive (SMAP) and the Soil Moisture Ocean Salinity (SMOS) missions are examples of this. However, over Canada, the data coverage both in space and time is limited. This study aims to develop supervised machine learning/deep learning-based frameworks to learn and generalize the complex dependencies of soil moisture and freeze-thaw on climate attributes, which can then be applied to a reasonable period outside of the observation period available in the original SMAP and SMOS satellite products and verified with the ASCAT and AMSR soil moisture data as they are available for periods prior to 2010. To this end, Random Forest (RF) and Convolutional Neural Network (CNN) based models are trained on climate attributes and geophysical fields from the ERA5 reanalysis and the available SMAP/SMOS soil moisture data. The results show that both RF and CNN based models are able to capture the main spatial and temporal variations in soil moisture and freeze-thaw state as seen by SMAP/SMOS, and also compare favorably to ASCAT and AMSR when applied to periods prior to 2010. Strategies to combine these models for application outside of the SMAP/SMOS observation period and preliminary results will also be presented.

Session: 13032 Emerging methods, strategies and frameworks in climate/engineering system interaction studies to support climate change adaptation and mitigation - Part 3 Méthodes, stratégies et cadres émergents dans les études d'interaction climat/système d'ingénierie pour soutenir l'adaptation et l'atténuation du changement climatique - Partie 3	**07/06/2022 15:50**

ID: 11388 Contributed abstract

Poster Order:

Super-resolution climate and tailings pond modelling for the Mont-Wright mine

Khalil Hashem [1] , *Laxmi Sushama* [2] , *Agus Sasmito* [3] , *Bernardo Teufel* [4]

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Presented by / Présenté par: ***Khalil Hashem***
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Responsible management of mining facilities, including tailings storage facilities (TSFs), is important to avoid risks that can impact safety, health and environment, amongst others. TSFs generally comprise of the confining embankments or tailings dams and associated structures that are designed to contain tailings, which is the residue following valuable material extraction through metal ore processing. The Mont Wright mining complex, which consists of several open-pit mines, uses the Hesse-Park tailings site for co-depositing fine and coarse flooded tailings as the current management method for tailings. The facility will allow the storage of 493 Mt of tailings, by 2026. To ensure proper management of these facilities it is important to understand projected changes to mine-relevant climatic variables at super-resolution, where the open pits and tailings ponds are resolved. This study, using super-resolution simulations, performed at 100 m resolution with the Global Environmental

Multiscale (GEM) model for selected years in current climate, demonstrates the need for such modelling to capture realistically the spatial and temporal variation of variables over the mine areas, particularly the open-pit and tailings ponds. For example, the study demonstrates realistic representation of wind and therefore wind-induced waves and currents in the tailings ponds, which is generally responsible for tailings resuspension and tailings erosion. Similar added value is also noted with extreme temperature, precipitation and snowmelt events over the mine. This framework will be applied in further studies to quantify climate-mine interactions for future climate scenarios, particularly for the open-pit and tailings impoundment, to inform pro-active adaptation plans and design guidelines.

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ID: 11572 Contributed abstract

Poster Order:

Nature-Based Solutions for Urban Flood Mitigation: Perspectives on Emerging Techniques

Yeowon Kim [1] , *M. Naveed Khaliq* [2]

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[2] National Research Council

Presented by / Présenté par: ***Yeowon Kim***
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Natural catchments are continuously altered for residential, industrial, and commercial purposes. Specially, urbanization activities directly affect the natural environment and often results in increased runoff, decreased infiltration and groundwater recharge, increased water temperatures in urban waterways, and altered habitat behaviours, all leading to several challenges for urban water management in the face of climate change. Urban nature is a potential source of solutions to the compound challenge, presented by urbanization and climate change. Nature-based solutions (NBS), sometimes referred to as green infrastructure, ecosystem-based adaptations, or urban ecological infrastructure, are increasingly being implemented in cities to promote public health and safety, enhance livability, promote equity, and restore natural hydrologic and ecological processes. Traditionally, stormwater drainage systems are commonly used to contend with surface runoff from impervious areas. More recently, alternative techniques such as green roofs, bio-retention systems, permeable pavements, vegetative swales, and constructed wetlands and ponds are gaining attraction as NBS to mitigate risks of urban flooding. Nature-based measures implemented throughout urban catchments can support natural hydrologic and environmental functions, associated with retention, detention, evaporation, and recycling of the stormwater for flood mitigation. This presentation will focus on NBS for urban flood mitigation and discuss various perspectives on current implementation techniques, gathered from global case studies, including Canada. A systematic framework for integrating climate change information with

urban flood estimation techniques and evaluating effectiveness of various NBS for the Canadian landscape will be discussed. The outcomes of this research will contribute to the development of national guidelines on the use of NBS to future flooding in Canadian urban regions.

Session: 13032 Emerging methods, strategies and frameworks in climate/engineering system interaction studies to support climate change adaptation and mitigation - Part 3 Méthodes, stratégies et cadres émergents dans les études d'interaction climat/système d'ingénierie pour soutenir l'adaptation et l'atténuation du changement climatique - Partie 3

07/06/2022 16:20

ID: 11559 Contributed abstract

Poster Order:

City-level modelling of the thermal and hydrologic regimes of road network to inform long-term management strategies

Hang YIn [1] , *Laxmi Sushama* [2] , *Bernardo Teufel* [3] , *Sylvie Leroyer* [4] , *Stephane Belair* [5] , *Jean-Pascal Bilodeau* [6]

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Presented by / Présenté par: ***Hang YIn***
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Despite experimental and numerical modelling efforts in the investigation of road conditions in the context of a changing climate, systematic city-scale studies, which are crucial in developing long-term road management strategies, are lacking for most cities. Some attempts have been made to infer changes in pavement/road conditions with outputs from global climate models. However, the resolutions of these models are often coarse and furthermore they lack a detailed description of the urban surface. This study aims to understand how climate change would affect pavement/road conditions and management strategies for Montreal, using ultra high-resolution GEM (Global Environmental Multiscale) simulations at 250 m resolution, with urban regions represented using the Town Energy Balance Model, which explicitly models road temperatures. An ERA5-driven simulation for current climate, verified against available station observations suggests reasonable performance of the model, including road temperature characteristics. Analysis of provincial and municipal roadways suggests that the temperature of the pavement/road surface exhibits a much larger diurnal variation compared to that of the 2-meter air temperature. In summer, the pavement surface can be up to 10 degrees warmer than the 2-m air temperature around noon, while in winter, it is slightly colder than the air mainly due to the snow and/or ice cover on the ground. Investigation of the road hydrology, particularly road runoff, shows important variations in space. Current

(2001–2020) and future (2041–2060; RCP8.5) GEM simulations are analyzed and pavement-specific indices are developed to identify hot spots in space and time with respect to pavement/road characteristics as well as the implications from long-term management perspectives, which can guide further hot-spot specific detailed analysis to inform maintenance planning of road infrastructure.

Session: 4051 Collaborative Earth System Modelling in Canada - Part 2 Modélisation collaborative du système terrestre au Canada - Partie 2 **08/06/2022 08:25**

ID: 11850 Contributed abstract

Poster Order:

High-Resolution Regional Climate Modeling and Projection over Western Canada using a Weather Research Forecasting Model with a Pseudo-Global Warming Approach

Yanping Li [1] , *Zhenhua Li* [2]

[1] University of Saskatchewan
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Presented by / Présenté par: ***Yanping Li***
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Climate change poses great risks to western Canada's ecosystem and socioeconomical development. To assess these hydroclimatic risks under high-end emission scenario RCP8.5, this study used the Weather Research Forecasting (WRF) model at a convection-permitting 4 km resolution to dynamically downscale the mean projection of a 19-member CMIP5 ensemble by the end of the 21st century. The WRF simulations include a retrospective simulation (CTL, 2000–2015) for verification forced by ERA-Interim and a pseudo-global warming (PGW) for climate change projection forced with climate change forcing (2071–2100 to 1976–2005) from CMIP5 ensemble added on ERA-Interim. The retrospective WRF-CTL's surface air temperature simulation was evaluated against ANUSPLIN, showing good agreements with cold biases east of the Rockies, especially in spring. WRF-CTL captures the main pattern of observed precipitation distribution from CaPA and ANUSPLIN but shows a wet bias near the BC coast in winter and over the immediate region on the lee of the Rockies. The WRF-PGW shows significant warming relative to CTL, especially over the polar region in the northeast during the cold season. Precipitation changes in PGW over CTL vary with the seasons: in spring and late autumn precipitation increases in most areas, whereas in summer in the SRB and southern Prairies, the precipitation change is negligible or decreased slightly. With almost no increase in precipitation and much more ET in the future, the water availability during the growing season will be challenging for the Prairies. WRF-PGW shows an increase in high-intensity precipitation events and shifts the distribution of precipitation events toward more extremely intensive events in all seasons. Due to this shift in precipitation intensity to the higher end in the PGW simulation, the seemingly moderate increase in the total amount of precipitation in summer east of the Rockies may underestimate the increase in flooding risk and water shortage for agriculture. These simulations provide abundant opportunities both for investigating local-scale atmospheric dynamics and for studying climate impacts on hydrology, agriculture, and ecosystems.

Session: 4051 Collaborative Earth System Modelling in Canada - Part 2 Modélisation collaborative du système terrestre au Canada - Partie 2 **08/06/2022 08:40**

ID: 11358 Contributed abstract

Poster Order:

Sensitivity of sea-ice and AMOC to snow conductivity in NEMO4

Duo Yang [1] , *Oleg Saenko* [2]

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Presented by / Présenté par: ***Duo Yang***
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CanESM5 features excessive sea-ice cover over the Labrador Sea and GIN seas. Studies show strong sensitivity of sea-ice to snow thermal conductivity. A constant value of 0.31 W m-1 K-1 is commonly used in large-scale sea-ice models with a single-layer representation of snow. However, it has been noted (e. g., Lecomte et al., JAMES, 2013) that this value is too large (except for very dense snow), which may lead to an overestimation of the Arctic sea-ice thickness. Therefore, variations of snow conductivity (within its uncertainty ranges) can be used for tuning of sea-ice and some other major quantities in coupled models.

In this study, sensitivity experiments of snow conductivity are presented based on NEMO4 coupled to SI3. Our preliminary results indicate that reducing snow conductivity and density leads to a widely reduced sea-ice area in the Labrador Sea and GIN seas, increased mixed layer depth in those regions, stronger and deeper Atlantic meridional overturning circulation (AMOC) and increased northward heat transport in the ocean. Some mechanisms behind these changes are also discussed.

Session: 4051 Collaborative Earth System Modelling in Canada - Part 2 Modélisation collaborative du système terrestre au Canada - Partie 2 **08/06/2022 08:55**

ID: 11488 Contributed abstract

Poster Order:

Simulating COVID-19: How well do CMIP6 models capture the response of aerosol optical depth to a sudden reduction in emissions?

Ruth Digby [1] , *Nathan Gillett* [2] , *Adam Monahan* [3] , *Knut von Salzen* [4] , *Sarah Hanna* [5]

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Presented by / Présenté par: ***Ruth Digby***
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In order to predict the short-term climate impacts of aerosol mitigation pathways, climate models must accurately represent both the change in atmospheric aerosol concentrations caused by a reduction in emissions, and

the impact that this change in aerosol concentrations has on climatic variables such as temperature and precipitation. Here we focus on the first of these two processes, and present the results of a model validation study in which the simulated response to a COVID-19-like reduction in aerosol emissions is compared to remotely-sensed and ground-based measurements from four high-emission regions around the globe.

Before differences between the observed and simulated responses to an emissions reduction can be attributed to details of model implementation, the contribution of other factors that can influence AOD must be accounted for. We present a detailed assessment of these contributions, which include the choice of baseline emissions inventory, the models' simulated responses to that baseline, the size of emissions perturbation applied, uncertainty in the observations, and meteorological variability. We then discuss insights on model validation afforded by the unprecedented emissions reductions of the COVID-19 pandemic.

Session: 4051 Collaborative Earth System Modelling in Canada - Part 2 Modélisation collaborative du système terrestre au Canada - Partie 2

08/06/2022 09:20

ID: 11756 Contributed abstract

Poster Order:

Storm-track weakening in response to Arctic sea ice loss arises with ocean coupling

Alexandre Audette [1] , *Paul Kushner* [2]

[1]

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Presented by / Présenté par: ***Alexandre Audette***
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The storm tracks play a major role in shaping the midlatitude climate through important contributions to the atmospheric heat transport between tropical and polar regions and its associated effects on energy balances. In response to changes in the climate from anthropogenic forcing, the location and intensity of the storm tracks is projected to change, with the North Atlantic storm track projected to shift poleward, affecting the weather and climate of western Europe. The poleward shift of the North Atlantic storm track arises from competing effects on the region’s meridional temperature gradient. Arctic Amplification weakens the climatological gradients, hence weakening the storm track, while on the other hand, low latitude warming has the opposite effect by strengthening the climatological gradient. To determine the mechanisms driving these competing changes, we use the atmosphere-land general circulation model (AGCM) and extended ocean-atmosphere coupled simulations (CGCM) from the Polar Amplification Model Intercomparison Project (PAMIP). These serve to separate the effects of sea ice loss and low latitude warming. We also complement the standard PAMIP CGCM experiments with CO2 doubling experiments in which the sea ice state is fixed, using a full ocean model and a slab-ocean model coupled to WACCM4. In the coupled simulations, the sea ice is constrained using a novel hybrid nudging method that combines ghost-flux forcing and direct sea ice area nudging. We find that coupled simulations with either a full ocean model or a slab ocean model capture the weakening of the

storm track, but atmosphere-only simulations fail to capture this response, potentially due to the weaker and more meridionally confined Arctic warming in the uncoupled simulations. We carry additional atmosphere-only simulations with meridionally varying prescribed sea surface temperature warming that is attributable to sea ice loss, to investigate the role of the meridional extent of the warming on the storm tracks.

Session: 4051 Collaborative Earth System Modelling in Canada - Part 2 Modélisation collaborative du système terrestre au Canada - Partie 2 **08/06/2022 09:35**

ID: 11865 Contributed abstract

Poster Order:

A Novel Bias-Correction Method for High-Resolution Regional Climate Model

Zhenhua Li [1] , *Yanping Li* [2] , *Ya Huang* [3] , *Danqiong Dai* [4]

[1] Global Institute for Water Security, University of Saskatchewan
[2] Global Institute for Water Security, University of Saskatchewan
[3] Hohai University
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Presented by / Présenté par: ***Zhenhua Li***
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Bias-correction of regional climate model output is often needed due to systematic bias commonly present in regional climate simulations. Here we present a novel method to deal with the bias-correction of convection-permitting simulation to preserve its temporal-spatial characteristics and match observation in terms of climatology and extreme statistics.

Session: 4051 Collaborative Earth System Modelling in Canada - Part 2 Modélisation collaborative du système terrestre au Canada - Partie 2 **08/06/2022 09:50**

ID: 11856 Contributed abstract

Poster Order:

Biogeophysical responses to forest cover change under different climate baselines

Alexander Koch [1] , *Kirsten Zickfeld* [2]

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Presented by / Présenté par: ***Alexander Koch***
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Deforestation and reforestation present challenges and opportunities for climate change mitigation through biogeochemical responses, such as carbon release and drawdown, and biogeophysical responses, such as changes in surface temperature and water cycle. The biogeophysical responses to these forms of land cover change have been assessed under present-day climate but so far no

evaluation of the state dependency of these responses under different future climate change scenarios has been undertaken. This may lead to unintended consequences by tree planting efforts as, for example, higher CO2 levels may amplify the biogeophysical response to reforestation through further “greening” of vegetation, thereby increasing albedo differences between forested and non-forested land, leading to stronger surface warming in some regions compared to a world with less climate change. Likewise, deforestation impacts on the hydrological cycle may also be more pronounced under a more severe climate change scenario compared to a moderate climate change scenario.
Here we evaluate the response of surface temperature, surface energy fluxes, and precipitation to forest cover change under two different climate states (SSP1-26 and SSP3-70) in three state-of-the art CMIP6 ESMs and the UVicESM of intermediate complexity. Using existing output from the Land Use Intercomparison Project (SSP1-26 climate with SSP3-70 land use and vice versa) complemented by further simulations with the UVicESM we present an uncertainty-driven approach to extract tree cover change from CMIP6 vegetation carbon and evaluate each ESM’s biogeophysical sensitivity to tree cover change.

Session: 6020 Climate Variability and Predictability - Part 1
Variabilité et prévisibilité du climat - Partie 1 **08/06/2022 08:25**

ID: 11353 Invited session speaker

Poster Order:

Linking Arctic variability and change with extreme winter weather in the US including the Texas Freeze of February 2021

Judah Cohen [1] , *Laurie Agel* [2] , *Mathew Barlow* [3] , *Chaim Garfinkel* [4] , *Ian White* [5]

[1]

[2] University of Massachusetts, Lowell
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Presented by / Présenté par: ***Judah Cohen***
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The Arctic is warming at a rate twice the global average and severe winter weather is reported to be increasing across many heavily populated mid-latitude regions, but there isn’t yet agreement on whether there is a physical link between the two phenomena. Here I will present observational analysis to show that a lesser-known stratospheric polar vortex (SPV) disruption that involves wave reflection and stretching of the SPV is linked with extreme cold across parts of Asia and North America, including the recent February 2021 Texas cold wave, and has been increasing over the satellite era (post 1980). I will also present numerical modeling experiments forced with trends in autumn snow cover and Arctic sea ice to establish a physical link between Arctic change and SPV stretching and surface impacts. This phenomenon is also active in January and February 2022 and I will present on the weather of winter 2022.

Session: 6020 Climate Variability and Predictability - Part 1 **08/06/2022**
Variabilité et prévisibilité du climat - Partie 1 **08:55**

ID: 11323 Contributed abstract

Poster Order:

Interannual variability of the warm Arctic-cold North American pattern

Bin Yu [1] , *Hai Lin* [2]

[1] Climate Research Division, ECCC
[2] Meteorological Research Division, ECCC

Presented by / Présenté par: ***Bin Yu***
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This study examines the evolution of the interannual warm Arctic-cold continents (WACC) pattern over the North American sector, which refers to the warm Arctic-cold North American pattern and is termed as WACNA, and explores its driving mechanism. WACNA features a pair of opposite surface air temperature anomalies centered over the Chukchi-Bering Seas and Northern American Great Plains. A negative phase of the warm Arctic-cold Eurasia (WACE) pattern tends to lead a positive phase of the WACNA pattern by about 25 days. Negative Asian-Bering-North American (ABNA) and Pacific-North American (PNA) like atmospheric circulation patterns also appear upstream and precede a positive WACNA by about 25 days, gradually develop, reach their peaks when both circulation patterns lead the WACNA by 5 days, and weaken afterwards. The negative ABNA-like pattern can be driven by the Siberian snow decline that is related to a negative WACE pattern and its featured Eurasian warming, whereas the negative PNA-like pattern is influenced by negative SST anomalies over the tropical central-eastern Pacific that resemble the tropical ENSO variability. The surface signatures of both patterns highlight a horseshoe shaped high-pressure anomaly straddling over Gulf of Alaska, Alaska and northwestern Canada. The anomalous warm advection from the North Pacific and cold advection from Arctic that follow the circulation anomalies, as well as sea ice declines over the Chukchi-Bering Seas and growth over Hudson Bay, lead to the formation of the positive WACNA pattern. Processes with circulation anomalies of opposite signs will likewise lead to the negative WACNA pattern.

Session: 6020 Climate Variability and Predictability - Part 1
Variabilité et prévisibilité du climat - Partie 1 **08/06/2022 09:20**

ID: 11380 Contributed abstract

Poster Order:

Stratosphere-Troposphere Coupling Leading to Extended Seasonal Predictability of Summer North Atlantic Oscillation and Boreal Climate

Lei Wang [1] , *Mingfang Ting* [2]

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Presented by / Présenté par: ***Lei Wang***
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The boreal summer climate is of significant societal importance and is trending towards increased risks of extreme climate events such as heatwaves. The

summer North Atlantic Oscillation, as the primary mode of atmospheric variability in the northern hemisphere, has been long considered lacking predictability on seasonal time scales. Here we show that the summer North Atlantic Oscillation is predictable with a two-month lead for the recent decades. The primary predictor is the March North Atlantic jet strength, which is correlated with the summer North Atlantic Oscillation index at a correlation coefficient of 0.66 over 1979-2018. Spring stratosphere-troposphere coupling plays a critical role in this extended predictability from spring to summer, in contrast to the common knowledge that this dynamical coupling is relatively inactive outside the winter season. These results may bring sound prospects for summer seasonal prediction of boreal climate that benefits the energy and public health sectors.

Session: 6020 Climate Variability and Predictability - Part 1
Variabilité et prévisibilité du climat - Partie 1 **08/06/2022 09:35**

ID: 11346 Contributed abstract

Poster Order:

Role of Diurnal Cycle in the Maritime Continent Barrier Effect on MJO Propagation in an AGCM

Ajaya Mohan Ravindran [1] , *Boualem Khouider* [2] , *Praveen V* [3] , *Andrew Majda* [4]

[1]
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[4]

Presented by / Présenté par: ***Ajaya Mohan Ravindran***
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The barrier effect of the Maritime Continent (MC) in stalling or modifying the propagation characteristics of MJO is widely accepted. The strong diurnal cycle of convection over the MC is believed to play a dominant role in this regard. This hypothesis 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 the diurnal convective variability on the MJO propagation. The effect of deterministic and stochastic diurnal forcings on MJO characteristics are compared. It is found that the precipitation and zonal wind variance, on the intraseasonal timescales, over the Western Pacific region decreases with the increase in diurnal forcing, indicating the blocking of MC precipitation. An increase in precipitation variance over the MC associated with the weakening of precipitation variance over the West Pacific is evident in all experiments. The striking difference between deterministic and stochastic diurnal forcing 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 the MC seems to be more detrimental in blocking the MJO propagation. This hints at the notion that the models with an inadequate representation of organized convection tend to suffer from the MC-barrier effect.

Session: 12060 Coastal Oceanography and Inland waters - Part 1 Océanographie côtière et eaux intérieures - Partie 1 **08/06/2022 08:25**

ID: 11869 Contributed abstract

Poster Order:

Response of the Gulf of St. Lawrence circulation to atmospheric forcing in the operational Canadian coastal ice-ocean prediction system

Gregory Smith [1] , *Francois Roy* [2] , *Jean-Philippe Paquin* [3] , *Sarah MacDermid* [4] , *Audrey-Anne Gauthier* [5]

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Presented by / Présenté par: ***Gregory Smith***
Contact: Gregory.Smith2@canada.ca

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 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 Canadian weather forecast system configurations (33 km to 2.5 km resolution). We examine how the atmospheric forcing modulates the evolution of water masses in multi-year simulations (2016-2021). The sensitivity to the atmospheric forcing variability (seasonal to inter-annual) and resolution is quantified, correlating local circulation features (transports through cross-sections) with the intensity and frequency of larger scale weather events (wind energy and orientation) in and around the GSL. We also characterize the water mass transformation generated by these weather events for different regions of the GSL, focusing on its three-layer water column (surface layer, CIL, bottom Atlantic waters).

Session: 12060 Coastal Oceanography and Inland waters - Part 1 Océanographie côtière et eaux intérieures - Partie 1 **08/06/2022 08:55**

ID: 11453 Contributed abstract

Poster Order:

Circulation and Inflow within Emerald and LeHave Basins and surrounding areas on the Scotian Shelf

Michael Casey [1] , *Youyu Lu* [2]

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[2] Bedford Institute of Oceanography, Department of Fisheries and Oceans

Presented by / Présenté par: ***Michael Casey***
Contact: mpcasey70@gmail.com

Emerald and LeHave Basins are two deeper-water (200 to 260 m depth) basins located on Atlantic Canada's Scotian Shelf, off the coast from Halifax, Nova Scotia. Inflow into the deeper portions of the basins appears to be dominated by off-shelf intrusions of Scotian Slope Water through the shallower channel between Emerald and LeHave Banks, a channel that connects
the Basins to the edge of the continental shelf. In contrast, shallower layers (depth < 100m) are dominated by along-shelf flow from the northeast, particularly the coastal Nova Scotia Current, and by interactions with local weather systems. Substantial vertical current shear can result from these competing influences. Here, we use a combination of observations from various platforms (e.g. autonomous gliders, ADCPs) and high-resolution models to explore the interplay between these various forces, and identify the importance of inflow events in renewing and changing the deep-water areas of the Basins. With the models as guidance, we identify key locations in which further observations would be extremely useful for quantifying the (potentially sudden) changes that take place in this important area of the Scotian Shelf.

Session: 12060 Coastal Oceanography and Inland waters - Part 1 Océanographie côtière et eaux intérieures - Partie 1 **08/06/2022 09:10**

ID: 11431 Contributed abstract

Poster Order: Poster-12060

Trends in Coastal Upwelling on the Scotian Shelf over the Past Two Decades

Christopher Reid [1] , *Shiliang Shan* [2]

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Presented by / Présenté par: ***Shiliang Shan***
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The frequency, intensity, and duration of coastal upwelling regulate the productivity of marine ecosystems by bringing nutrient-rich deep waters to the sunlit surface. How coastal upwelling regimes might shift in a warming climate is therefore a question of vital importance. In this study, coastal upwelling events off Nova Scotia over the past two decades are quantified by using observations made from various platforms, including marine buoys, remote-sensing satellites, and autonomous underwater gliders. A series novel upwelling metrics are derived to objectively describe coastal upwelling trends in terms of frequency, intensity, and duration on the Scotian Shelf. The predictability of observed upwelling trends is also explored by assessing the performance of coastal operational model products.

Session: 12060 Coastal Oceanography and Inland waters - Part 1 Océanographie côtière et eaux intérieures - Partie 1 **08/06/2022 09:20**

ID: 11500 Contributed abstract

Poster Order:

Hydrodynamics and sediment transport in the submarine canyons of Pointe-des-Monts

Khouloud Baccara [1]

[1]

Presented by / Présenté par: ***Khouloud Baccara***

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Submarine canyons play a significant role in the transport of sediment from shelf seas to the deep ocean. This project studies the hydrodynamic processes and sediment resuspension in the submarine canyons of Pointe-des-Monts located near the northern shore of the Lower St. Lawrence Estuary. The sediment remobilization documented in this canyon system could be generated by turbidity currents and internal tidal bores. Turbidity currents have already been documented at Pointe-des-Monts during storms, but the exact triggering mechanism is not yet well understood. Internal tidal bores have been shown to induce significant sediment transport and turbulence near canyon heads in other coastal systems, and preliminary analysis of the data suggests their presence at Pointe-des-Monts. Data analysis methods are applied on two 12-month datasets, the first was acquired in 2016-2017 and the second in 2020-2021. They are composed of current measurements recorded with ADCPs (Acoustic Doppler Current Profiler) moored in the canyons at strategic locations thought to be affected by both turbidity currents and internal tidal bores. Preliminary analyses indicate a regular occurrence of internal bores (478 identified throughout the year 2016-2017), which occurred at any phase of the semi-diurnal tidal cycle with the highest occurrence in the hour after the local high tide. Therefore, these internal bores are more likely to arise from the elevation phase of incoming semi-diurnal internal tide. They are suspected to resuspend and transport the sediments upslope but this remains to be confirmed. In addition, four turbidity currents have been identified in 2016-2017, which occurred during strong winds, high surface waves and cold air temperature. Thus, storms are the main trigger of turbidity currents, although other conditions, not yet identified, must be also present to trigger them, since not all major storms have generated turbidity currents.

Session: 12060 Coastal Oceanography and Inland waters - Part 1 Océanographie côtière et eaux intérieures - Partie 1 **08/06/2022 09:35**

ID: 11429 Contributed abstract

Poster Order:

Numerical Study of Topographic Effects on Wind-driven Coastal Upwelling on the Scotian Shelf

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Presented by / Présenté par: ***Shiliang Shan***
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Wind-driven coastal upwelling can cause a sudden drop of sea surface temperature (SST) up to more than 8°C on the inner Scotian Shelf (ScS) in summer months. Three major coastal upwelling events on the ScS in the summer of 2012 are analyzed using in-situ SST observations and satellite remote sensing SST data. A spatial correlation analysis of satellite SST data shows an asymmetric distribution in the along-shore direction with smaller correlation coefficients in the downstream area than in the upstream area over the inner ScS during upwelling events. A regression analysis indicates that the wind impulse plays a major role in generating the SST cooling during the initial response stage of upwelling events. A multi-nested ocean circulation model is used to examine the effect of irregular coastline and rugged bathymetry on the spatial and temporal variability of wind-driven upwelling over the inner ScS. The model has four submodels downscaling from the eastern Canadian Shelf to the central ScS. The model external forcing includes tides, winds, river discharges, and net heat flux at the sea surface. A comparison of results produced by submodel L3 with the satellite SST data reveals the satisfactory performance of the model in reproducing the development of coastal upwelling on the ScS. Model results demonstrate that the irregular coastline and rugged bathymetry play important roles in influencing the temporal and spatial evolution of the upwelling plume over the inner ScS. The irregular coastline (e.g., cape) is responsible for the relatively warm SSTs in two downstream inlets (i.e., St. Margarets Bay and Mahone Bay) and adjacent coastal waters. The rugged bathymetry (e.g., submerged bank) influences the spatial extend of filaments through advection process.

Session: 12060 Coastal Oceanography and Inland waters - Part 1 Océanographie côtière et eaux intérieures - Partie 1 **08/06/2022 09:50**

ID: 11525 Contributed abstract

Poster Order:

Improving extreme sea level estimates along the Pacific coast of Canada

Jing Lu [1] , *Guoqi Han* [2]

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Presented by / Présenté par: ***Jing Lu***
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A high-resolution, baroclinic ocean circulation model for the Pacific coast of Canada, accounting for tides, storm surges, intra-seasonal, seasonal and climatic-scale sea-level changes, has been used to simulate coastal sea levels from 1993-2020. The model forcing includes the European Centre for Median-range Weather Forecasting Reanalysis Version 5 atmospheric field, ocean tides and river runoffs. The model results are evaluated against sea level and current observations at long-term tide-gauge stations and an ocean monitoring site, demonstrating overall good model skills at various time scales. The model coastal sea levels are used to estimate extreme sea levels, in approximate

agreement with those estimated from tide-gauge data. The present study indicates the importance of accounting for intra-seasonal, seasonal, as well as climate-driven events in estimating extreme sea levels along the Pacific coast of Canada.

Session: 13060 Delivering applied climate change science amidst large data and contingent futures Fournir une science appliquée du changement climatique au milieu de données volumineuses et de futurs contingents **08/06/2022 08:25**

ID: 11802 Contributed abstract

Poster Order:

A narrative approach to building computational capacity for climate change impact assessment in professional graduate students

Conor Anderson [1] , *Karen Smith* [2]

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Presented by / Présenté par: ***Conor Anderson***
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With the growing recognition of the cascading consequences of climate change, there is an increasing demand for professional graduate education in climate change impact assessment (CCIA). The goal of professional graduate programs is to enable students to rapidly transition from undergraduate learners to work-ready professionals. This presents a unique challenge for instructors to balance conceptual content with continually-evolving and often technical real-world application. One approach that instructors have taken is to make use of new climate data platforms, aimed at non-technical end-users, which are now available online. Many of these platforms provide pre-processed data and off-the-shelf climate indices or variables, allowing students (and professionals) to conduct CCIA, but without first building sufficient understanding of how such data resources are generated. Although this approach allows for a focus on teaching the application of projected climate changes, it diverts attention from the scientific and technical aspects of CCIA leading to a lack of methodological transparency, and a reliance on external, sometimes proprietary, data platforms. Consequently, students are often left ill-equipped to independently acquire unprocessed Earth/global climate model (ESM/GCM) data, understand how to read that data into statistical analysis software, and to perform analysis of novel climate indices. To facilitate improved transparency and technical skill-building in CCIA, we have developed a new series of step-by-step, coherently narrated, open-source python labs (https://claut.gitlab.io/man_ccia/) aimed at building students' computational capacity and confidence, while providing foundational knowledge in CCIA and the opportunity to interact with state-of-the-art methods and data. Our in-progress research focuses on assessing the effectiveness and limitations of our approach, with an emphasis on quantifying the extent to which the labs have improved students' (1) knowledge of the course material, (2) knowledge of the software, and (3) confidence in applying the CCIA methods.

Session: 13060 Delivering applied climate change science amidst large data and contingent futures Fournir une science appliquée du changement climatique au milieu de données **08/06/2022 08:55**

volumineuses et de futurs contingents

ID: 11523 Contributed abstract

Poster Order:

Climate model projections for Canada: A comparison of CMIP5 and CMIP6

Stephen Sobie [1] , *Francis Zwiers* [2] , *Charles Curry* [3]

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[3] University of Victoria

Presented by / Présenté par: ***Stephen Sobie***
Contact: ssobie@uvic.ca

Recent studies have identified stronger warming in the latest generation of climate model simulations globally, and the same is true for projected changes in Canada. This analysis examines differences for Canada and six sub-regions between simulations from the latest Sixth Coupled Model Inter-comparison Project (CMIP6) and its predecessor CMIP5. Ensembles from both experiments are assessed using a set of derived indices calculated from daily precipitation and temperature, with projections compared at fixed future time intervals and fixed levels of global temperature change. For changes calculated at fixed time intervals most temperature indices display higher projected changes in CMIP6 than CMIP5 for most sub-regions, while greater precipitation changes in CMIP6 occur mainly in extreme precipitation indices. Comparing the mean and variance of future projections for Canada in CMIP5 and CMIP6 simulations from the same modelling centre suggests CMIP6 models are significantly warmer in Canada than CMIP5 models at the same level of forcing, with some evidence that internal temperature variability in CMIP6 is reduced compared to CMIP5. When future projections are calculated at fixed levels of global average temperature increase, the differences for future projected changes between CMIP6 and CMIP5 are substantially reduced for most indices. Such an approach enables the construction of larger ensemble sizes by including all simulations following different emissions pathways that reach the specified levels of global warming, and reduces the spread in the range of projected changes. These results indicate that substantially similar information is available from both CMIP5 and CMIP6 concerning impacts at specified levels of warming for Canada and its sub-regions.

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ID: 11772 Contributed abstract

Poster Order:

Selecting a representative climate model subset considering both model spread and central tendency

Charles Curry [1] , *Dhouha Ouali* [2] , *Stephen Sobie* [3]

[1] Pacific Climate Impacts Consortium
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[3] Pacific Climate Impacts Consortium

Presented by / Présenté par: ***Charles Curry***
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The Pacific Climate Impacts Consortium (PCIC) recently produced a dataset of statistically downscaled daily temperature and precipitation from CMIP6 global climate models (GCMs) for Canada (CanDCS-U6). With 26 different GCMs following three different Shared Socioeconomic Pathways (SSPs), a total of 78 possible realizations of climate at each model grid location are therefore represented. While the results for all GCMs are available via PCIC's Data Portal, we recognize that users frequently prefer more manageable, but still representative datasets of future climate change.

Here we describe a strategy to select a subset of GCMs that is reasonably representative of the entire ensemble of CMIP6 model projections for the late 21st century over Canada. The aim is to select a more manageable subset (~10 GCMs) that captures the medians and ranges of projected changes from 27 climate extremes (Climdex) indices simulated by the full ensemble. For the previous CMIP5 downscaling exercise, PCIC made use of the objective Katsavounidis–Kuo–Zhang (KKZ) algorithm (Katsavounidis et al., 1994), an objective procedure that focuses on capturing the spread of projected change in each index to provide a representative GCM subset. However, the KKZ algorithm does not require the ensemble median or mean of the subset to resemble that of the entire ensemble, which has implications for other important climate model diagnostics.

We augmented the KKZ procedure to constrain the subset median of each index from deviating too far from the full enemble median. As in KKZ, representative models are added sequentially; however, once the difference between the subset and ensemble medians increases, the previous subset is considered final. In this presentation, we compare the results of this selection procedure (median-constrained KKZ) with those of KKZ, using several ensemble metrics including the captured spread over all climate indices, the spread in climate sensitivity, and cluster analysis.

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ID: 11484 Contributed abstract

Poster Order:

Communicating Change in Peak Flow Design Values using Temperature Scaling

Markus Schnorbus [1] , *Qiaohong Sun* [2]

[1] Pacific Climate Impacts Consortium
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Presented by / Présenté par: ***Markus Schnorbus***
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The British Columbia Ministry of Transportation and Infrastructure (BCMoTI) has released directives and guidance that stipulates that transportation engineering design work evaluate risk and include adaptation measures to address the impacts of future climate change. One of the primary risks to transportation infrastructure is the possibility of increased flooding hazard. To address this gap BCMoTI supported the Pacific Climate Impacts Consortium (PCIC) in a pilot project to quantify design flood values (2-, 5-, 10-, 20-, 50-, 100- and 200-year events) for historical and future periods in the Fraser River basin and make them accessible as a gridded product. One component of the project was to explore the potential use of temperature scaling to describe and communicate extreme streamflow changes in a simple scenario-agnostic fashion. We analyzed the relationship between extreme streamflow change factors (the ratio of future value to historic value) and four levels of simulated global mean temperature (GMT) change: 1.5°C. 2°C, 3°C, and 4°C. Preliminary analysis shows that design value changes are complex. Relative change in design values are not monotonic functions of GMT change, and the relationship between stream flow change factors and GMT varies regionally and by design values. This makes generalization of changes in streamflow design values challenging. Yet the analysis offers some clues that may yet afford further simplification. Namely, the non-monotonic nature of the relationship (and its spatial variability) may be associated with the rate at which the hydrologic regime throughout most of the Fraser basin transitions from snowmelt-dominated (nival), to hybrid or rainfall-dominated (pluvial). Although this simple analysis does not directly consider multiple global climate or other emissions scenarios, it will help to articulate the research that could be done to generalize from these results to other forcing scenarios.

Session: 13060 Delivering applied climate change science amidst large data and contingent futures Fournir une science appliquée du changement climatique au milieu de données volumineuses et de futurs contingents **08/06/2022 09:50**

ID: 11379 Contributed abstract

Poster Order:

Warming water temperature in the coastal rivers of British Columbia due to climate change

Md. Shahabul Alam [1] , *Markus Schnorbus* [2]

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Presented by / Présenté par: ***Md. Shahabul Alam***
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Climate change is expected to alter stream water temperature in the coastal region of British Columbia (BC), Canada. As warming temperatures pose one of the greatest risks to the survival of salmon populations, understanding how future water temperature may evolve in time and space will be essential for salmon vulnerability assessment and management. In this study, we will characterize the large-scale changes in the water temperature between the historical (1950-2005) and future (2006-2100) periods for the BC coastal domain. The models employed in this study are a large-scale hydrological model called Variable Infiltration Capacity (VIC) and a one-dimensional semi-

Lagrangian water temperature model called River Basin Model (RBM). Streamflow projections were obtained from VIC model simulations based on an ensemble of six global climate models and two representative concentration pathways. For this study, RBM was calibrated using Dynamically Dimensioned Search algorithm. Since observed water temperature data rely on spot measurements as opposed to a continuous time series, the objective function uses the Root Mean Square Error (RMSE) calculated between the percentile values of spot measurements and the modelled time series. The RMSE values in both calibration and validation were quite promising and we are confident the calibrated RBM model can be employed for the long-term simulation of water temperature in the past as well as in the future. Over the unique complex geographical domain of BC coastal watersheds, the simulated water temperature is expected to show spatial variability in the warming of water temperature in the future relative to the historical values. The spatial and temporal characterization of changing water temperature afforded by this large-scale analysis will facilitate the identifications of those watersheds most vulnerable to changing climatic conditions.

Session: 13100 Science Serving Societies to Become Climate Resilient - Part 1 La science aidant les sociétés à devenir plus résilientes aux changements climatiques - Partie 1 **08/06/2022 08:25**

ID: 11605 Invited session speaker

Poster Order:

Integration of disaster risk and climate adaption as key driver to enhance disaster resilience in Canada.

Scott Vaughan [1] , *Jérôme Marty* [2]

[1] International Institute for Sustainable Development (IISD)
[2] Council of Canadian Academies

Presented by / Présenté par: ***Scott Vaughan***
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As the human and economic costs of climate disasters continue to mount, Canada faces a choice. It can continue to respond to disasters as they unfold — with the attendant economic, social, and health harms — or it can proactively prepare for them, mitigating the worst of the damages or avoiding them altogether. One way to improve disaster resilience in a changing climate is to better integrate disaster risk reduction and climate change adaptation practices. This topic was at the core of the recent report from the Council of Canadian Academies (CCA), Building a Resilient Canada, which was sponsored by Public Safety Canada.
According to the Expert Panel, decision makers need prompt access to better data on extreme weather events to understand and reduce risks. Funding, investment, and insurance programs and policies can also be adapted to build resilience. For example, actions could include dissuading homeowners from building or rebuilding on floodplains, lowering insurance premiums for households with backwater flood valves, and improving building codes and engineering practices to climate-proof buildings and infrastructure. Recognizing the value of Indigenous and Local Knowledge and actively engaging with Indigenous knowledge holders is also critical in the effective reduction of risk. Building a Resilient Canada identifies choices that households, communities,

businesses, and governments can make to reduce the impacts of extreme weather on Canada's people, communities, and economy in a changing climate. The report details the resources, funding programs, investment options, insurance offerings, and governance structures that can support effective decision-making and a more resilient Canada.

Session: 13100 Science Serving Societies to Become Climate Resilient - Part 1 La science aidant les sociétés à devenir plus résilientes aux changements climatiques - Partie 1 **08/06/2022 08:55**

ID: 11557 Contributed abstract

Poster Order:

Building Infrastructure Resilience to Address the Climate Emergency

John Stone [1]

[1] Carleton University

Presented by / Présenté par: ***John Stone***
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This talk is based on Key Messages and Recommendations from a policy conference organized in the Fall of 2021 by the Group of 78 - an organization of progressive individuals - with the intention of highlighting the need for greater attention by all levels of government to adaptation to climate change. The talk will focus on adaptation in the built environment.
Climate change policy in Canada has been dominated by mitigation and any discussion of adaptation has been reduced to a Cinderella role. This is despite the fact that there have already been impacts. Adaptation thus becomes a policy imperative.
There is a huge corpus of science and technology that has been developed over time to address specific adaptation challenges. Much of this literature however is not necessarily in the published literature as we know it. Any new public infrastructure project should be subject to examination with a climate change adaptation lens in order to identify multiple benefits.

Session: 13100 Science Serving Societies to Become Climate Resilient - Part 1 La science aidant les sociétés à devenir plus résilientes aux changements climatiques - Partie 1 **08/06/2022 09:20**

ID: 11541 Contributed abstract

Poster Order:

Indigenous-led nature-based solutions for climate crisis: Insights from Canada

Brennan Vogel [1] , *Lily Yumagulova* [2] , *Gordon McBean* [3]

[1] King's University College / Huron University College / Chippewas of the Thames First Nation
[2] Preparing Our Home / HazNet
[3] UWO Geography / ICLR

Presented by / Présenté par: ***Brennan Vogel***

Contact: bvogel@uwo.ca

This inter-disciplinary presentation provides an international and national overview of climate change and biodiversity frameworks and centres on illustrative national case studies and emerging evidence of Indigenous leadership and collaborations in Canada on matters of climate change adaptation and disaster risk reduction efforts. Nested within the context of the weather- climate-governance-societal-health issues previously discussed in ‘Building Climate Resilient Communities’ (McBean et al., 2021) and the current findings illustrated in the ‘Council of Canadian Academies report on Disaster Resilience in a Changing Climate’ (Vaughan et al., 2022), this presentation will discuss findings related to effective approaches for enabling and motivating actions across all levels of governance with an emphasis on cases of Indigenous communities building resiliency and reducing the impacts of climate-related extremes through inter-disciplinary collaborations and cross-cultural learning approaches. After introducing the international context and unpacking the national policy landscape, we provide preliminary evidence documenting emerging national, regional and local examples of Indigenous led collaborative conservation projects and nature-based climate change solutions to reduce disaster risk and build adaptive capacity to climate change impacts in Indigenous territories and communities. Based on case studies and emerging findings, we suggest that Indigenous Peoples and communities are very well positioned to play important roles in the protection, conservation management and restoration of lands and waters in Canada and globally to mitigate greenhouse gases (GHGs) and support regional ecosystem-based adaptation to climate change. Indigenous led efforts and partnerships are critical to the global mitigation, sequestration and storage of GHGs precipitating the climate crises, while also building resiliency to reduce impacts at regional scales. Emerging Canadian evidence suggests that there are a diversity of co-benefits that Indigenous-led nature-based solutions to climate change and biodiversity protection bring, motivated and enabled by creating ethical space for reconciliation and conservation collaborations on shared issues of climate concern. 298 words

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ID: 11615 Contributed abstract

Poster Order:

Maximizing place-based potential: translating interdisciplinary knowledge into climate change action in Gros Morne National Park enclave communities

Camille Ouellet Dallaire [1] , *Christina Smeaton* [2] , *Colleen Kennedy Young* [3]

[1] Memorial University of Newfoundland
[2] Memorial University of Newfoundland
[3] Gros Morne Co-Operating Association

Presented by / Présenté par: ***Camille Ouellet Dallaire***
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Newfoundland and Labrador (NL) is facing increased impacts of climate change (CC) that have fragilized the resilience of remote communities. Western NL is home to Gros Morne National Park (GMNP) and multiple enclave communities which are especially vulnerable to the effects of CC including sea level rise and flooding, and changes in precipitation patterns due to warming. For example, extensive flooding and landslides in Trout River during the winters of 2016, 2018, and 2022 were caused by unseasonably warm temperatures, rapid snowmelt, and heavy rain which caused extensive damage.

Researchers from Grenfell Campus (Memorial University) and the Gros Morne Cooperating Association have partnered to increase CC adaption/mitigation in these communities and their livelihood (i.e. tourism) by creating the Gros Morne Climate Action Network (GM-CAN). Working towards this goal requires building an intersectional team focused on increasing CC resilience across multiple fronts. As such, Grenfell researchers provides interdisciplinary expertise, including geochemistry, hydrology, environmental policy, landscape planning and community sustainability, and the partner communities provide place-based knowledge and understanding to anchor potential nature-based solutions to their needs and reality.

Through a series of community visits/consultations and workshops held in enclave communities, we will: 1) identify, co-develop, and communicate a common interdisciplinary understanding of the effects of CC in the region; 2) identify the challenges of CC adaptation/mitigation; 3) discuss place-based CC action; and, 4) identify potential nature-based solutions and associated research questions. Using a community-based participatory research approach grounded in interdisciplinary CC science, the GM-CAN will be poised to support GMNP enclave communities to increase their ability to mitigate and respond to climate change. The long-term objective of this initiative is to use this pilot project to increase the number of communities within the network to better support larger-scale actionable nature-based solutions in other Western NL communities beyond those located near GMNP.

Session: 13100 Science Serving Societies to Become Climate Resilient - Part 1 La science aidant les sociétés à devenir plus résilientes aux changements climatiques - Partie 1 **08/06/2022 09:50**

ID: 11738 Contributed abstract

Poster Order:

Understanding and Responding to Changing Sea Ice and Weather Conditions in Northern Communities

Armel Castellan [1], *Laura Eerkes-Medrano* [2], *Sara Hoffman* [3], *Adrienne Tivy* [4], *David Atkinson* [5]

[1] ECCC
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Presented by / Présenté par: ***Armel Castellan***
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We will present an overview of work in the Western Arctic to identify and respond to Indigenous people's needs for weather and ice information. The work is in direct response to community requests for better sea ice information, training on how to use information that is currently available on the internet, and the development of a working relationship with federal weather and ice forecasting services to co-develop new products. We will provide a few examples from the Meteorological Service of Canada’s (MSC) response to specific requests and in particular highlight the establishment and use of a Facebook group page: Hilaakput, which links directly MSC staff with Indigenous people. Community participants in Hilaakput are elected by their community as a representative and are responsible for requesting information from the MSC to assist their communities while hunting. The MSC responds directly to these requests and also provides ongoing forecasts focusing on weather events that are problematic for the community. The community representatives are responsible for distributing this information back to the communities and reporting any feedback to the MSC via the Hilaakput page. The participant communities in this project are Sachs Harbour, Ulukhaktok and Tuktoyaktuk.

Session: 4052 Collaborative Earth System Modelling in Canada - Part 3 Modélisation collaborative du système terrestre au Canada - Partie 3 **08/06/2022 12:55**

ID: 11630 Contributed abstract

Poster Order:

Linking cumulative carbon emissions with observable climate impacts

Claude-Michel Nzotungicimpaye [1] , *Damon Matthews* [2]

[1] Concordia University
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Presented by / Présenté par: ***Claude-Michel Nzotungicimpaye***
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Anthropogenic carbon emissions are causing climate change, and climate impacts are already affecting every region on Earth. Here, (i) we identify which climate impacts respond linearly to cumulative carbon emissions by analyzing climate simulations by the UVic ESCM v2.10; and (ii) we explore how to define a generalized framework for linking carbon emissions and the identified climate impacts. Our results suggest that cumulative carbon emissions scale linearly with several climate impacts including changes in global mean surface air temperature, sea surface temperature, sea ice extent, and sea level height. These results are highly relevant for climate policy as they provide a way for assessing climate impacts associated with every amount of cumulative carbon emissions. Finally, we propose a generalized framework for linking cumulative carbon emissions to observable climate impacts by building on the transient climate response to cumulative emissions (TCRE) framework.

Session: 4052 Collaborative Earth System Modelling in Canada - Part 3 Modélisation collaborative du système terrestre au Canada - Partie 3 **08/06/2022 13:10**

ID: 11760 Contributed abstract

Poster Order:

The implications of Earth system feedbacks from using reforestation to stabilize the climate in net-zero pathways

Alexander MacIsaac [1] , *Kirsten Zickfeld* [2]

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Presented by / Présenté par: ***Alexander MacIsaac***
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Reforestation is a nature-based climate solution (NbCS) that can serve to sequester and store large quantities of atmospheric carbon dioxide. It requires no new technological advancements for deployment, is relatively cost-effective, and it would lead to important co-benefits for ecosystems and ecosystem services. For these reasons reforestation is a key measure in deep-mitigation and net-zero pathways. However, reforestation at scale alters land-surface biophysical properties (albedo, evapotranspiration and latent heat release, and sensible heat flux) that can induce either a warming or cooling effect on surface temperature. The magnitude and sign of this temperature response depend on the background climate state and latitude over which reforestation is implemented. Therefore, depending on the scale and region of reforestation, these biophysical effects could lead to additional warming in emission pathways that use reforestation to compensate for residual CO2 emissions.

Our research investigates the effectiveness of reforestation at stabilizing global mean temperature when used to compensate for residual CO2 emissions. Using a climate model of intermediate complexity (the UVic-ESCM v2.10) we conduct a set of idealized simulations where fossil fuel emissions decline towards zero by 2050 but remain at 1 and 5, Gt CO2/yr between 2050 to 2100 to represent emissions that are difficult to eliminate. Meanwhile reforestation is implemented globally and in different latitudinal zones (tropics, mid-latitudes, and high-latitudes) at an areal coverage appropriate to sequester the ongoing emissions so that cumulative CO2 emissions between 2050 and 2100 are net-zero. From these simulations we quantify the effectiveness of reforestation at stabilizing global mean temperature under consideration of biogeochemical and biophysical effects and feedbacks.

While we expect our results to show that the carbon sequestration from reforestation could be effective at stabilizing global mean temperature, the biophysical effects could also induce important variations in global mean temperature. As such, our research is intended to provide an Earth system analysis of reforestation that can inform forestation carbon markets and net-zero policy frameworks.

Session: 4052 Collaborative Earth System Modelling in Canada - Part 3 Modélisation collaborative du système terrestre au Canada - Partie 3

08/06/2022 13:25

ID: 11883 Contributed abstract

Poster Order:

Discussion Period

Presented by / Présenté par: ***Discussion***
Contact:

Collaborative Earth System Modelling in Canada - Discussion Period

Session: 6021 Climate Variability and Predictability - Part 2
Variabilité et prévisibilité du climat - Partie 2 **08/06/2022 12:55**

ID: 11340 Invited session speaker

Poster Order:

Enhanced jet stream waviness induced by suppressed tropical Pacific convection during boreal summer

Xiaoting Sun [1] , *Qinghua Ding* [2] , *Simon (Shih-Yu) Wang* [3] , *Dani Topal* [4] , *Qingquan Li* [5] , *Chris Castro* [6] , *Haiyan Teng* [7] , *Rui Luo* [8] , *Yihui Ding* [9]

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[3] USU
[4] UCSB
[5] CMA, China
[6] U. of Arizona
[7] PNNL
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Presented by / Présenté par: ***qinghua ding***
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Consensus on the cause of recent midlatitude circulation changes toward a wavier manner in the Northern Hemisphere has not been reached, albeit a number of studies collectively suggest that this phenomenon is driven by global warming and associated Arctic amplification. Here, through a fingerprint analysis of various global simulations and a tropical heating-imposed experiment, we suggest that the suppression of tropical convection along the Inter Tropical Convergence Zone induced by sea surface temperature (SST) cooling trends over the tropical Eastern Pacific contributed to the increased summertime midlatitude waviness in the past 40 years through the generation of a Rossby-wave-train propagating within the jet waveguide and the reduced north-south temperature gradient. This perspective indicates less of an influence from the Arctic amplification on the observed mid-latitude wave amplification than what was previously estimated. This study also emphasizes the need to better predict the tropical Pacific SST variability in order to project the summer jet waviness and consequent weather extremes.

Session: 6021 Climate Variability and Predictability - Part 2
Variabilité et prévisibilité du climat - Partie 2 **08/06/2022 13:25**

ID: 11338 Contributed abstract

Poster Order:

Origin of the warm Arctic – cold North American pattern on the intraseasonal time scale

Hai Lin [1] , *Bin Yu* [2] , *Nicholas Hall* [3]

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Presented by / Présenté par: ***Hai Lin***
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The warm Arctic – cold continent pattern (WACC) of near surface air temperature variability has often been associated with the connection between Arctic sea ice reduction and cold weather over the middle latitude continents. Whether the existence of this pattern is due to variability of sea ice or is caused by atmospheric internal dynamics is subject to debate. Based on a long integration of a primitive equation atmospheric model (SGCM), this study examines the origin of the warm Arctic – cold North American pattern (WACNA), which is characterized by a pair of opposite surface air temperature anomalies over the high-latitude Chukchi-Bering Sea region and the North American continent, in boreal winter on the intraseasonal time scale. The model atmosphere is maintained by a time-independent forcing, so that atmospheric internal dynamics is the only source of variability. It is found that the SGCM model simulates well the behavior of the observed WACNA pattern. The WACNA pattern develops by interacting with the time-mean flow and synoptic-scale transient eddies. Two pathways of Rossby wave propagation are associated with WACNA. The northern pathway originates from eastern Siberia moving eastward across the Bering Strait to Canada, and the southern pathway is rooted in the subtropical waveguide propagating across the eastern North Pacific. Our simulation of this pattern implies that tropospheric dynamics alone can generate the WACNA, and the predictability associated with this pattern is likely limited by its internal dynamics nature.

Session: 6021 Climate Variability and Predictability - Part 2
Variabilité et prévisibilité du climat - Partie 2 **08/06/2022 13:50**

ID: 11507 Contributed abstract

Poster Order:

Large-scale atmospheric and marine features connected to interannual and interdecadal fog variability in Atlantic Canada

Patrick Duplessis [1] , *Minghong Zhang* [2] , *William Perrie* [3] , *Rachel Chang* [4]

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Presented by / Présenté par: ***Patrick Duplessis***
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Atlantic Canada is one of the foggiest regions of the world, with frequent disruptions in the land and air transportation, marine traffic and off-shore operations. The main formation mechanism of marine and coastal fog in the region is the cooling of warm and moist air advected over a colder sea surface brought by the Labrador current. On longer time-scales, changes in fog frequency can affect the global radiative budget. Clouds, including fog, are the greatest source of uncertainty in the current climate projections because of their complex feedback mechanisms. Meteorological records indicate that the occurrence of foggy conditions has been decreasing over the past six decades at most airports in Atlantic Canada, with large internal variability, including interannual and interdecadal variations. Using various datasets, including airport observations, reanalysis data and climate model outputs, we investigated the variability on the trend, at interannual and interdecadal scales, and linked to potential drivers for these changes in fog frequency. Our analyses revealed that the strength and position of the North Atlantic Subtropical High as well as the sea-surface temperature of the cold and warm waters near Atlantic Canada were highly correlated with fog occurrence. In addition, we applied the method to current climate model outputs and projected the fog trends and variability in the different future climate scenarios. The index derived from this study will be compared to other circulation patterns and the implications of these results will be discussed.

Session: 6021 Climate Variability and Predictability - Part 2
Variabilité et prévisibilité du climat - Partie 2 **08/06/2022 14:05**

ID: 11491 Contributed abstract

Poster Order:

The North Pacific Blob acts to increase the predictability of the Atlantic Warm Pool

Yusen Liu [1], *Cheng Sun* [2], *Fred Kucharski* [3], *Jianping Li* [4], *Chunzai Wang* [5], *Ruiqiang Ding* [6]

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Presented by / Présenté par: ***Yusen Liu***
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The Atlantic warm pool (AWP) has profound impacts on extreme weather events and climate variability. Factors influencing the AWP and its predictability are still not fully understood. Other than local ocean-atmosphere feedbacks and ENSO, we find an extratropical precursor from the Northeast Pacific (known as the Blob), which leads the AWP by one year with a robust correlation (r = 0.68). A suite of Northeast Pacific pacemaker experiments successfully reproduces the leading influence of the Blob on the AWP. The preceding summer Blob-related sea surface temperature (SST) warming signal can be transmitted towards the lower latitudes through the seasonal footprint mechanism, leading to the central Pacific warming in the winter and following spring. Such a strong tropical Pacific SST heating excites an anomalous atmospheric wave train that

resembles the Pacific/North American (PNA) teleconnection pattern. At the downstream portion of the PNA, the low sea surface pressure (SLP) anomalies can be found over the AWP region during the following spring. The anomalous low initiates the AWP SST warming, and the AWP warmer SST can persist into summer and is further amplified due to ocean-atmosphere feedbacks. Our results show that the North Pacific Blob may act as a useful predictor of the AWP one year in advance through trans-basin interactions. A Blob-based prediction model shows considerable hindcast skill for the observed AWP SST anomaly.

Session: 13070 Developing Actionable Canadian Climate Information - Part 1 Développer des informations climatiques canadiennes exploitables - Partie 1 **08/06/2022 12:55**

ID: 11588 Invited session speaker

Poster Order:

Climate services promise better decisions but mainly focus on better data

Kieran Findlater [1] , *Sophie Webber* [2] , *Milind Kandlikar* [3] , *Simon Donner* [4]

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Presented by / Présenté par: ***Kieran Findlater***
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Climate services are intended to improve climate-sensitive decisions by making climate information ‘useful, useable and used’. We analyzed 27 expert interviews to evaluate whether this user-driven model of climate science has been successfully implemented in the public sector. We show that, although climate services promise better decision-making, they mainly focus on delivering better data. The norms and institutions of climate science produce three key tensions in operationalizing climate services: a focus on products rather than processes, services based on broad assumptions about demand rather than being demand-driven, and the narrow economic valuation of products rather than evaluation of improvements in decision-making. These tensions help explain why climate services often generate nominal changes in climate science where transformations are promised. Transformational change requires that climate services account for diverse social structures, behaviours and contexts. Integrating social science is no panacea for demand-driven climate services, but it is certainly a prerequisite.

Session: 13070 Developing Actionable Canadian Climate Information - Part 1 Développer des informations climatiques canadiennes exploitables - Partie 1 **08/06/2022 13:25**

ID: 11587 Contributed abstract

Poster Order:

Developing tailored climate information for various audiences with varied needs

Anne Frigon [1] , *Dominique Paquin* [2] , *Louis-Philippe Caron* [3] , *Isabelle Charron* [4] , *Hélène Côté* [5] , *Martin Leduc* [6] , *Travis Logan* [7]

[1] Ouranos
[2] Ouranos
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Presented by / Présenté par: ***Dominique Paquin***
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At Ouranos, the increased interest, number of demands and diversity of needs, along with the fast evolution of science, has forced us to develop an integrated approach in order to provide tailored, useful and credible climate information responding to various needs. The strategy developed in the Climate Science and Services programming aims at responding to the needs of a larger number of users through the development of public tools, data and climate services platforms. To do so, we keep abreast of advancements in science, knowledge gaps and user needs, to guide the development of fundamental and applied R&D projects done in collaboration with universities. This allows us to advance the necessary scientific knowledge and helps consolidate our public tools, data and climate services platforms, always through good science and following international standards. Keeping up to date on the evolution of user needs is an ongoing task, as their knowledge evolves and as legislation requires to take climate change into account more specifically. So we interact with many users to better understand their needs, often in a two-way fashion, be it by receiving specific demands on our 'Portraits climatiques' web site, by collaborating with practitioners and decision makers from different organizations, or through closer relationship with certain users and researchers. We will present the strategy developed, along with a few examples on how this approach has contributed to develop tailored public climate information and tools.

Session: 13070 Developing Actionable Canadian Climate Information - Part 1 Développer des informations climatiques canadiennes exploitables - Partie 1 **08/06/2022 13:40**

ID: 11875 Contributed abstract

Poster Order: Poster-13070

Building Resilient Communities with Confidence: The Risk and Return on Investment Tool

Christine Zimmer [1] , *Karen Finney* [2] , *Kirsten MacMillan* [3]

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Presented by / Présenté par: ***Christine Zimmer***
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Municipalities and watershed management agencies in Canada have foremost responsibility for ensuring the resiliency of their communities. As weather-related risk increases with climate change, Canadian cities and towns are facing

the social, environmental, and economic impacts of extreme events. Understanding and assessing these risks to plan for the future remains a high priority and requires mobilizing climate related information. While advancements in the availability and quality of data related to historical and future climate trends have improved our understanding, gaps remain in our knowledge of how these climate change impacts will be felt in our communities. Municipal staff, engineers and other decision makers need more guidance to understand where uncertainty exists in future climate and shift perspectives away from what we don't know towards what is needed to take action. Guidance and tools are required to better incorporate climate change into decision making while also balancing existing challenges with level of service, risk and cost.

The Risk and Return on Investment Tool (RROIT) is a multi-flood hazard guidance tool that is helping municipalities, property owners, and financial investors. The RROIT utilizes data that many communities already have, such as stormwater modelling outputs, to identify flood and erosion risk in current and future climate scenarios, calculate economic impacts, and produce priority mapping for high-risk areas. The RROIT also compares economic impacts with green and grey infrastructure management options to identify cost-optimized strategies for community resilience. Some communities across Canada are already looking at how storm return periods will change in future scenarios and the RROIT can use customized probability adjustments or built-in functionality to generate future return periods using a regionalized approach to a Clausius-Clapeyron adjustment and CMIP5 temperature data. This approach generates life cycle costs under three scenarios (baseline, 2050s and 2080s) to estimate increasing future damages and make the case for prioritization. This presentation will share key lessons learned in applying the tool across Canada in 6 case studies. This will include reflections regarding the role of and potential new opportunities for integrating specific climate information products.

Session: 13070 Developing Actionable Canadian Climate Information - Part 1 Développer des informations climatiques canadiennes exploitables - Partie 1 **08/06/2022 13:50**

ID: 11750 Contributed abstract

Poster Order:

The role of climate services in connecting practitioners and scientists: an example using IDF curves

Maginda Magendrathajan [1] , *Elaine Barrow* [2] , *Teah Lizee* [3]

1

2

3

Presented by / Présenté par: ***Maginda Magendrathajan***
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To build resiliency to climate hazards, long-term decisions that are vulnerable to weather and climate impacts must incorporate climate change information. Climate services act as a bridge that facilitates this process, from plain language explanations about climate science through to technical science efforts to address outstanding data gaps. In this presentation, the Canadian Centre for Climate Services (CCCS) will describe the steps taken to provide and communicate information to decision-makers and practitioners on adjusting

Intensity-Duration-Frequency (IDF) curves to consider climate change. IDF curves are a widely used tool for flood forecasting and urban drainage design that describe short-duration rainfall intensity across a range of rainfall event timescales, with their risk-relevant frequency of occurrence. However, it is no longer appropriate to use IDF curves based on historical information alone for long-term planning. Armed with this knowledge and seeing signs of growing interest in this type of information, the CCCS identified the need for guidance on how practitioners should adjust existing IDF curves to incorporate climate change. Here we will share how the CCCS identified user needs and partnered with experts to evaluate, endorse and communicate a practical approach to adjusting IDF curves (as described in CSA PLUS 4013:2019 Technical Guide: Development, interpretation and use of rainfall intensity-duration-frequency (IDF) information: Guideline for Canadian water resources practitioners). The resulting plain language messaging and guidance materials were made publically available on ClimateData.ca. We will highlight how the process of linking practitioners and scientists helped to co-develop a robust and useable product to facilitate decision-making.

Session: 13070 Developing Actionable Canadian Climate Information - Part 1 Développer des informations climatiques canadiennes exploitables - Partie 1

08/06/2022 14:05

ID: 11697 Contributed abstract

Poster Order:

Application of Climate Information to assess the impacts of climate change on Ontario's municipal and provincial infrastructure budgets

Kenneth Kin Cheung Chow [1] , *Jeremy Fyke* [2] , *Teah Lizee* [3] , *Edward Crummey* [4] , *Sabrina Afroz* [5] , *Nicolas Rhodes* [6] , *Jay Park* [7]

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[2] Environment and Climate Change Canada
[3] Environment and Climate Change Canada
[4] Financial Accountability Office of Ontario
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[6] Financial Accountability Office of Ontario
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Presented by / Présenté par: ***Kenneth Kin Cheung Chow***
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The CCCS is a multi-disciplinary team that aims to support Canadians in their adaptation decision-making by providing access to relevant climate information. One major concern is how climate change will impact Canadian infrastructure and the costs that will be associated with these impacts.

The FAO is an independent office of the Legislative Assembly of Ontario that provides analysis on the state of the province’s finances and trends in the provincial economy. In December 2021, the FAO assessed the impacts of extreme rainfall, extreme heat, and changes in freeze-thaw cycles on the long-term costs of maintaining public buildings and facilities in a state of good repair. The report noted that in a high emissions scenario, cumulative costs to maintain existing public buildings would increase by $116 billion by 2100.

CCCS provided the FAO with relevant climate data, resources, and climate-

related guidance to help complete their assessment. This talk will explore the details of FAO's project, the work that CCCS undertook for the FAO, tools that were used to customize the data, how this data was applied, and key takeaways from this collaboration.

Session: 13070 Developing Actionable Canadian Climate Information - Part 1 Développer des informations climatiques canadiennes exploitables - Partie 1 **08/06/2022 14:20**

ID: 11783 Contributed abstract

Poster Order:

Applying a Multi-Factor Vulnerability Approach to the Development of the City of Calgary's Community Climate Risk Index

Christina Schwantes [1] , *Yann Chavaillaz* [2]

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Presented by / Présenté par: ***Christina Schwantes***
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Local climate resilience indices have been credited as a leading practice by international experts in community climate resilience to understand geospatial climate risk to help inform adaptation measures, benchmark risk and measure progress, and communicate climate risk.
The rise of climate risk indices has emerged in parallel with a shift from impacts-driven to vulnerability-driven approaches for measuring the effects of climate change. While impact-driven approaches look at changes in climate hazards and potential hazard impacts, vulnerability-driven approaches evaluate the socioeconomic, demographic, environmental and physical drivers of vulnerability to understand how systems will be affected and respond to climate hazards. In the IPCC Fifth Assessment Report (AR5), vulnerability was identified as the main constituent of risk, distinguishing hazard probability and exposure as two other functions to measure risk.
The Community Climate Risk Index represented one of the first projects in Canada to employ the AR5 conceptualization of risk for a geospatial, community-scale risk index. Using geospatial analysis, WSP measured relative levels of exposure, using a scale with defined thresholds, to each of six specific climate hazards geospatially within Calgary. Forty indicators, using City-specific and publicly available datasets, were developed to estimate the adaptive capacity and sensitivity (i.e. vulnerability) of people, the natural environment, and the built environment to each of the key climate change hazards in each of the over 250 sub-communities. Digital tools were developed to easily filter results from extremely large datasets and produce data visualizations in the form of dashboards and heat maps.
While WSP has employed a range of different climate risk standards and protocols in a variety of sectors and applications, this vulnerability-focused method was regarded as a more suitable measurement of community needs in terms of providing more distinct differentiation of risk between sub-communities, and allow for targeted adaptation interventions more effectively.

Session: 13101 Science Serving Societies to Become **08/06/2022**

Climate Resilient - Part 2 La science aidant les sociétés à devenir plus résilientes aux changements climatiques - Partie 2 **12:55**

ID: 11708 Invited session speaker

Poster Order:

Resilience in Recovery: Achieving transformative improvement in climate resilience following major loss events

Paul Kovacs [1]

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

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Loss and damage from climate related events doubled every 5 to 10 years for the past 40 years, and alarming and unsustainable trend. Canadians experience more than $5 billion a year in preventable direct damage to buildings and public infrastructure due to flooding, wildfire, severe wind, and other climate related hazards. Canadians have not adapted to the present risk of loss from climate extremes. Climate change will further increase the expected damage unless we significantly increase investment in climate resilience.

Most property owners choose not to adopt resilience knowledge in existing structures. Decision science research finds deeply rooted behavioural biases that limit society's capacity to appropriately prepare for climate hazards. Some progress in climate resilience is evident in new construction, but with a lag. A promising opportunity to significantly increase climate resilience is found immediately following a large loss. This presentation will focus on four exciting case studies of resilience in recovery – High River, Alberta; Calgary, Alberta; Barrie, Ontario; and Lytton, British Columbia. Resilience in these communities has increased significantly through actions taken in recovery. Indeed, ICLR research finds that the majority of community climate adaptation success in Canada takes place in recovery. Pre-disaster recovery planning is an essential tool to advance climate resilience in Canada. It is possible to achieve transformative improvement in climate resilience following a major loss.

Session: 13101 Science Serving Societies to Become Climate Resilient - Part 2 La science aidant les sociétés à devenir plus résilientes aux changements climatiques - Partie 2 **08/06/2022 13:25**

ID: 11799 Contributed abstract

Poster Order:

Flood emergency response and preparedness in New Brunswick – an empirical study on the spring floods in 2019

Sebastian Weissenberger [1] , *Omer Chouinard* [2] , *Mélanie Madore* [3]

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[2] Université de Moncton
[3] Université de Moncton

Presented by / Présenté par: ***Sebastian Weissenberger***

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The spring flood of 2018 in southwest New Brunswick is considered one of the most serious in its recent history. Through a series of semi-directed interviews (11 respondents in 6 interviews) with selected actors from governments and NGOs, we analysed the efficacy of the response to the spring floods in 2019 in the Wolastoq/St. John estuary. The analysis was declined according to a triple time frame: crisis response, recovery, and resilience planning. We found that the immediate crisis response was perceived as efficient and well-organized by most actors, including the coordination of actions via the incident command system. Recovery was more difficult because of lengthy delays in the treatment of private, provincial or federal insurance claims. Long-term resilience planning is underway in municipalities through the elaboration of adaptation plans, mainstreaming adaptation in investment and infrastructure decisions, the integration of climate change data in long-term planning and collaborations with universities. Several respondents highlighted the exceptional nature of the 2019 spring flood, with a peak flood of over 8 meters lasting for 9 days, resulting from a coincidence of several factors: significant snow cover in the river basin, early and rapid spring warming, heavy rainfall and high tides in the Bay of Fundy.

Session: 13101 Science Serving Societies to Become Climate Resilient - Part 2 La science aidant les sociétés à devenir plus résilientes aux changements climatiques - Partie 2 — **08/06/2022 13:50**

ID: 11395 Contributed abstract

Poster Order:

Building Resilient Communities KSG Report - Synthesis

Gordon McBean [1]

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Presented by / Présenté par: ***Gordon McBean***
Contact: gmcbean@uwo.ca

A SSHRC-funded Knowledge Synthesis Grant funded this project and it was prepared by a team of 22 scientists from across disciplines. This presentation will provide a general synthesis of the findings in the Report. The full report "Building Climate Resilient Communities: Living Within the Earth’s Carrying Capacity" (MS #1386) is now showcased on Scholarship@Western. https://ir.lib.uwo.ca/geographypub/369

Session: 13101 Science Serving Societies to Become Climate Resilient - Part 2 La science aidant les sociétés à devenir plus résilientes aux changements climatiques - Partie 2 — **08/06/2022 14:05**

ID: 11754 Contributed abstract

Poster Order:

Designing a vulnerability indicator for climate change impacts in coastal communities in Senegal and Benin

Émilie Gauthier [1] , *Sebastian Weissenberger* [2]

[1] Université du Québec à Montréal (UQÀM)
[2] TÉLUQ

Presented by / Présenté par: ***Émilie Gauthier***
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Climate change induce significant impacts in many countries, particularly in sub-Saharan Africa which is considered by many to be the most vulnerable region to the harmful effects of climate disturbances (Sono, Wei and Jin, 2021). Vulnerability to climate change can be described as the combination of three indices: exposure, sensitivity, and adaptability (Füssel and Klein, 2006; IPCC, 2007). As part of the project "Adaptation to climate change and variability in coastal zones in Senegal and Benin: an exchange of African and Canadian experiences", funded by IDRC, questionnaires have been administered to five fishing villages in the Saloum Delta in Senegal and two communities on the west coast of Benin. The sub-indices of sensitivity and adaptability to the impacts of climate change are calculated by transforming the questionnaire's responses into indicators using normalization and a Principal Component Analysis (PCA). Furthermore, the sub-indice of exposure to climate and weather hazards is obtained using ERA5 climate reanalysis data, which is driven by the European Center for Medium-Range Weather Forecast (ECMWF). In total, twelve environmental and socio-economic variables are analyzed as part of this project, and then aggregated in the form of a unique vulnerability indicator for each village.
The proposed method makes it possible to quantify the vulnerability of communities by integrating both the socio-economic reality of the affected populations, but also the amplitude of the consequences of climate change at a local level, where instrumental data is not readily available. This technique improves the understanding of adaptation factors, hence providing a tool for reducing vulnerability and improving the resilience of populations to present and future climate change.

Session: 13101 Science Serving Societies to Become Climate Resilient - Part 2 La science aidant les sociétés à devenir plus résilientes aux changements climatiques - Partie 2 **08/06/2022 14:20**

ID: 11819 Contributed abstract

Poster Order:

The Water-Energy-Food (WEF) Nexus: a Potential Framework for using Earth Science and Observations to Benefit Society

Richard Lawford [1]

1

Presented by / Présenté par: ***Richard Lawford***
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The WEF Nexus concept (also known as the FEWS Nexus) has attracted increasing attention over the past decade because of its potential to provide new insights and coordination for the planning and management of the water, energy, and food sectors and their interactions with society, the economy, and

the environment. Integrated evidence-based planning could improve productivity, increase capabilities to assess the effects of global trends, and facilitate the development of coherent policies for addressing environmental issues including climate change.

Canada is endowed with relatively large reserves of freshwater, access to non-renewable and renewable energy sources, and a land base that supports levels of agriculture production that allow the country to be a food exporter. Canadians could benefit from the development and application of the WEF Nexus framework at the national, provincial, and regional (river basin) scales.

However, operationalizing the WEF Nexus concept presents challenges. For example, the scope of the Nexus would need to be defined and the scales of application clarified. Planning Nexus actions and policies will require observations and forecasts of future conditions over a range of time scales. There is a clear role for Earth observations and relevant science to support specific applications. Also, the models and tools that can support the Nexus applications need to be identified and evaluated.

This presentation will review the promise and status of WEF Nexus framework developments and some of the challenges facing its implementation. In addition, the role of Earth science and observations within this framework will be explored. It will also provide a few examples of practical applications of the concept at the regional scale. Finally, it will conclude with recommendations for several areas where aspects of the WEF Nexus could be launched.

Session: 8050 Tectonics and Dynamics of the Earth's Interior - Part 1 Tectonique et dynamique de l'intérieur de la Terre - Partie 1 **08/06/2022 13:50**

ID: 11352 Contributed abstract

Poster Order:

Reconstructing the southern North Atlantic Ocean back through time using deformable plate tectonic models

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Presented by / Présenté par: ***Michael King***
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The offshore rifted margins of the southern North Atlantic Ocean have been demonstrated to have a complex present day crustal structure comprised of sedimentary basins, inherited structures, variable basement affinities, and continental blocks. Consequently, this has led to challenges when studying the crustal evolution of the southern North Atlantic. In particular, the kinematic history of continental blocks (e.g. Flemish Cap) and micro-plates (e.g. Iberia) and their subsequent impact on strain-partitioning during poly-phase rifting experienced along the Newfoundland, Irish, and West Iberian margins.

Recently, deformable plate tectonic models, built using the GPlates software, have proven to be an advantageous method for investigating the interplay between plate kinematics and deformation experienced throughout the North Atlantic. Furthermore, their ability to calculate temporal variations in strain rate and crustal thickness provides a quantitative method of comparison with present day crustal thickness estimates calculated by gravity inversion and interpretations made from offshore seismic and well data. However, previous

deformable plate models of the North Atlantic have included assumptions that are geologically problematic. Examples of assumptions include, but are not limited to, the rigid nature of continental blocks and model boundaries, and the specification of uniform crustal thicknesses within pre-rift templates.
In this study, we present a new deformable plate modelling approach using GPlates and its python programming module, pyGPlates, which aims to address these limitations by reconstructing present day crustal thicknesses back through time. Using previously published and newly presented models, our results demonstrate the pre-rift crustal thickness template of the southern North Atlantic and the crustal thickness evolution of continental blocks and sedimentary basins within. In addition, this study highlights the potential impact of Appalachian and Caledonian terrane boundaries on the crustal segmentation observed within pre-rift templates and subsequent rift events.

Session: 8050 Tectonics and Dynamics of the Earth's Interior - Part 1 Tectonique et dynamique de l'intérieur de la Terre - Partie 1 **08/06/2022 14:05**

ID: 11561 Contributed abstract

Poster Order:

Seismic evidence for crustal thickening controlling aseismic deformation at the Beaufort Sea continental margin

Clément Estève [1] , *Yajing Liu* [2] , *Ivan Koulakov* [3] , *Andrew Schaeffer* [4] , *Pascal Audet* [5]

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Presented by / Présenté par: ***Clément Estève***
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The Canadian Beaufort Sea continental margin of northwestern Canada has recorded several episodes of deformation from Late Cretaceous to Late Miocene time. An arcuate fold-and-thrust belt was formed in the area due to the Late Paleocene-middle Eocene north-south compression. The lack of seismic deformation indicates that this north-south compression is accommodated by aseismic deformation due to either high crustal temperatures and/or slow deformation, and/or infrequent large earthquakes (M > 6). Here we investigate whether or not the Beaufort Sea margin is a newly forming convergent margin, potentially representing a rare case of incipient subduction. We develop high-resolution seismic velocity models (VP, VS, VP/VS) of the region using recordings of regional earthquakes. The velocity models reveal an anomalously low-velocity region within the crust beneath the Beaufort Sea continental margin of northern Yukon, which we interpret to reflect a hot and highly deformed crust. This is consistent with our event relocations showing that the brittle ductile transition is shallow across the study area. Furthermore, we show that localized crustal thickening, due to the stacking of sedimentary and volcanic rocks, occurs below the Arctic coast of northern Yukon. These evidence suggest that the Beaufort Sea margin of northern Yukon is a juvenile slow convergent margin, however, the limited resolution of our velocity models prevents us from confidently interpreting features offshore within the Beaufort Sea. Therefore, it is

highly critical to deploy ocean-bottom seismometers on the continental shelf and offshore within the Beaufort Sea in order to obtain a robust and reliable information about the detailed crustal structure of the area.

Session: 8050 Tectonics and Dynamics of the Earth's Interior - Part 1 Tectonique et dynamique de l'intérieur de la Terre - Partie 1 **08/06/2022 14:20**

ID: 11662 Contributed abstract

Poster Order:

Surface expressions of lithospheric delamination

Tai-Chieh Yu [1] , *Claire A. Currie* [2]

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Presented by / Présenté par: ***Tai-Chieh Yu***
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Orogens form through lithosphere shortening, leading to crustal thickening and surface uplift. However, in some orogens, the mantle lithosphere is thinner than expected, and anomalous episodes of localized surface subsidence/uplift, crustal deformation, and magmatism are observed. These can not be explained by regional tectonic processes, and instead are proposed to be associated with local gravitational removal of the deep lithosphere. In this study, 2D thermal-mechanical models are used to study the surface expressions of lithospheric removal by delamination. Models are constructed to address delamination within a pre-thickened orogen. Earlier work has shown that eclogitization of thickened lower crust can induce gravitational instabilities. Our models systematically examine how variations in the density and rheology of the eclogitized lower crust affect the dynamics and surface expressions of delamination. Delamination is inhibited in models with high eclogite viscosity (>1021 Pa s) and negative density contrast relative to the mantle (<-68 kg/m3). Models with lower viscosity and higher density rapidly initiate delamination, where the lithosphere founders as either a coherent slab, an internally deformed slab or localized drips. The models show that delamination is accompanied by surface uplift, including pulses of rapid uplift if the foundering slab breaks during delamination. In addition, delamination is marked by surface extension and mantle melting due to asthenospheric upwelling, with areas of surface contraction at the margins of the thinned lithosphere. The surface expressions also depend on the properties of the crust above the delaminating slab. Plateau-like uplift, rough topography, and steep hills at the edges of the uplifted region are observed in models with cold/strong crust, weak crust, and weak sediments, respectively. Our models provide insight into the interpretation of surface topography, crustal deformation, and magmatism areas associated with lithospheric delamination, such as the southern Sierra Nevada, Alboran Sea, and Tibetan Plateau.

Session: 6022 Climate Variability and Predictability - Part 3 Variabilité et prévisibilité du climat - Partie 3 **08/06/2022 14:55**

ID: 11674 Contributed abstract

Poster Order:

The Canadian Seasonal to Interannual Prediction System Version 2.1 (CanSIPSv2.1)

Ryan Muncaster [1], *Hai Lin* [2], *William Merryfield* [3], *Gulilat Diro* [4], *Radenko Pavlovic* [5]

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Presented by / Présenté par: ***Ryan Muncaster***
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As part of the third innovation cycle of Environment and Climate Change Canada (ECCC), the Canadian seasonal to inter-annual prediction system (CanSIPS) has been upgraded to Version 2.1. This talk gives an overview of this update, including modifications to the models, reforecast initialization, and skill evaluation comparing to the previous CanSIPSv2. The main change is that one of the CanSIPS models, GEM-NEMO, is upgraded to GEM5-NEMO, which improves the forecast skill of the Madden-Julian Oscillation (MJO) and ENSO. In general, CanSIPSv2.1 outperforms the previous CanSIPSv2.

Session: 6022 Climate Variability and Predictability - Part 3
Variabilité et prévisibilité du climat - Partie 3 **08/06/2022 15:25**

ID: 11668 Contributed abstract

Poster Order:

Impact of improved land initialization of ECCC's seasonal prediction system on the skill of summer 2021 forecast

Gulilat T. Diro [1], *Hai Lin* [2], *Ryan Muncaster* [3], *William Merryfield* [4], *Radenko Pavlovic* [5]

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Presented by / Présenté par: ***Gulilat T. Diro***
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Environment and Climate Change Canada (ECCC) is using Canadian seasonal to inter-annual prediction system (CanSIPS) to produce and provide seasonal prediction of key climate variables for various stake holders. CanSIPS is composed of GEM-NEMO and CanCM4i models with each model contributing 10 ensemble members. Recently, the version of GEM-NEMO is upgraded to GEM5-NEMO as part of the 3rd innovation cycle. The new system has also improved the configurations of its offline surface prediction system (SPS), which is used to produce land initial conditions for GEM5-NEMO. The aim of this study is to assess the role of land initialization on the performance of the new and the old versions of CanSIPS in operational setup. For this presentation, summer of 2021 is selected as a case study as this season is characterized by episodes of

extreme high temperature events over North America. In CanSIPSv2, GEM-NEMO predicted below-normal conditions of summer temperature for most of northern Canada at one-month lead time (i.e. for Forecast issued on May 1st, 2021). Analysis indicated that the cold prediction over higher latitudes are attributed to large values of snow initial conditions, which are produced by the offline SPS run driven with CMC analysis, in contrast to the forcing by ERA-Interim used in the hindcasts. Further comparison of surface variables in the two systems clearly shows that the land initial conditions are better represented in the new system. This is illustrated by the improved simulation of snow water equivalent when SPS is driven with CMC analysis, which led to better land initial conditions. Comparison of surface temperature forecasts in the two systems at various lead times also shows that the new version of CanSIPS improved various aspects of the forecast.

Session: 6022 Climate Variability and Predictability - Part 3
Variabilité et prévisibilité du climat - Partie 3 **08/06/2022 15:50**

ID: 11381 Contributed abstract

Poster Order:

Influences of atmospheric blocking on North American winter cold spells and summer heatwaves in a changing climate: CanESM2 and CanESM5 large ensembles

Dae Jeong [1] , *Bin Yu* [2] , *Alex Cannon* [3]

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Presented by / Présenté par: ***Dae Jeong***
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Winter cold spells and summer heatwaves have severe adverse impacts on human society and ecosystems; thus, there is need to better understand their meteorological drivers and future changes under climate change. This study investigates changes in linkages between atmospheric blocking and winter (December-February) cold spells as well as summer (June-August) heatwaves over the Pacific-North America region in two large-ensembles of Canadian Earth System Models (CanESM2 and CanESM5 under high-emission scenarios). CanESM5 generally shows better performance than CanESM2 in its reproduction of blocking frequency, which is consistent with its overall improvements in simulating large-scale climate patterns. The two ensembles show decreases in winter blocking frequency over the North Pacific from 1981-2010 baseline to 2071-2100 period, with larger decreases in CanESM5 (-3.1 %/decade) than CanESM2 (-1.7 %/decade). Projected changes in summer blocking frequency in the two climate models are relatively small compared to internal variability, with the changes ranging from +2.4 %/decade to -1.7 %/decade from the baseline to 2071-2100. The two ensembles display similar blocking-cold spell linkages between the baseline and future periods; however, the linkage is weaker and exhibits larger uncertainty in the future. Moreover, temperature advection and net heat flux anomalies during winter blocking are generally weaker for the future period, resulting in weaker impacts on North American cold spells with larger uncertainty associated with increases in internal-variability. Future projections to the linkage between blocking and summer heatwaves differ between the models in central Canada, largely due to

the significant under-representation of summer blocking frequency by CanESM2. However, the two ensembles generally project similar behavior between the baseline and future period for spatial distributions of blocking-heatwave linkages, indicating blocking will continue to play an important role in the development of summer heatwaves in the future.

Session: 6022 Climate Variability and Predictability - Part 3
Variabilité et prévisibilité du climat - Partie 3 **08/06/2022 16:05**

ID: 11782 Contributed abstract

Poster Order:

Seasonal Predictability of Regional and Pan-Antarctic Sea Ice Extent with the Canadian Seasonal to Interannual Prediction System V2

Robert Payne [1] , *Adam Monahan* [2] , *Michael Sigmond* [3] , *Joseph Martin* [4]

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Presented by / Présenté par: ***Robert Payne***
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We present an assessment of sea ice forecast skill for the Canadian Seasonal to Interannual Prediction System version 2 (CanSIPSv2) and its two constituent global coupled ocean-atmosphere models, CanCM4 and GEM-NEMO. Instead of focusing our analysis on the Arctic as is conventional, we instead consider the model’s skill relative to Antarctic sea ice extent. We find that, on average, CanSIPSv2 displays greater skill in the Antarctic in comparison to previous studies of CanSIPSv2 forecast skill in the Arctic. The constituent models of CanSIPSv2 are found to differ in skill dramatically, with GEM-NEMO showing substantially higher skill than CanCM4 in predicting sea ice extent over the entire Antarctic. Additionally, the skill of CanSIPSv2 is found to vary substantially across the different regions of the Antarctic, with lower skill in the Amundsen, Bellingshausen, and West Pacific sectors compared to that of the Ross and Weddell seas. It’s found that any long-term trend in the Antarctic is not a substantial source of skill. Finally, we show that forecasts initialized in the months of April to August show a rapid drop in skill compared to those initialized outside of this time interval. Since this drop in skill is less pronounced in GEM-NEMO compared to CanCM4, this winter predictability barrier may be attributed to biases in the models as opposed to physical processes in the Antarctic.

Session: 8051 Tectonics and Dynamics of the Earth’s Interior - Part 2 Tectonique et dynamique de l'intérieur de la Terre - Partie 2 **08/06/2022 14:55**

ID: 11511 Contributed abstract

Poster Order:

Fundamental differences between lithosphere drips in 2D and 3D

David Quiroga [1] , *Claire Currie* [2]

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Presented by / Présenté par: ***David Quiroga***
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Gravitational removal of the deep lithosphere is an important process in continental evolution. Lithosphere dripping is a removal mechanism in which a perturbation in the deep mantle lithosphere sinks because of its lower temperature and therefore higher density compared to the underlying mantle. Lithosphere drips produce a set of characteristic time-dependent surface expressions such as symmetric local alterations in surface heat flow, topography and crustal deformation patterns (contraction/extension zones). Some examples include the Arizaro Basin (South America), the Congo Basin (Africa) and the Nalwomga Corona (Venus). Even though lithosphere drips are considered to have 3D geometries and surface expressions, most previous studies use 2D model domains, owing to the high computational cost of 3D models. In this study, we use numerical models to investigate the fundamental differences in the dynamics and surface expressions of lithosphere drips in 2D and 3D, triggered by an imposed perturbation in the mantle lithosphere. Models show that the growth of a 3D perturbation is faster, reaching a depth of 660 km approximately 0.1 Ma earlier than a 2D drip. In 3D drips, the downward stresses within the crust are localized above the centre of the drip, and the magnitude decreases radially in all directions. This results in less subsidence above a 3D drip (reduced by 66%). Also, the 3D drips are considerably thicker as material is drawn from the radial directions. In addition to the topographic signature, drips may also be recognized by changes in surface gravity and deformation. Future work will investigate if the change in drip thickness in a 3D geometry produces a significant difference in the associated gravity anomaly, and future models including a visco-plastic crust will explore if 3D lithosphere drips can produce concentric brittle deformation in the shallow crust such as in the Nalwomga Corona.

Session: 8051 Tectonics and Dynamics of the Earth's Interior - Part 2 Tectonique et dynamique de l'intérieur de la Terre - Partie 2 **08/06/2022 15:10**

ID: 11854 Contributed abstract

Poster Order:

Generating exact solutions for 2D thermochemical mantle convection models

Sean Trim [1] , *Sam Butler* [2] , *Ray Spiteri* [3]

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Presented by / Présenté par: ***Sean Trim***
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Numerical solutions of thermochemical mantle convection are notoriously difficult due to the absence of physical diffusion in the compositional transport equation and sharp gradients in the composition field. These challenges often lead to numerical errors such as overdiffusion and spurious oscillations. To quantify the impact of such errors it is helpful to refer to exact solutions that

exist for similar problems.

In this study, we present a mathematical derivation for a suite of exact solutions for 2D thermochemical mantle convection models in Cartesian geometry. In our method, a stream function representative of mantle convection is presumed. Subsequently, the time-dependent solution for composition is found using the method of characteristics, which allows a solution without adding artificial terms to the advection equation for composition. Applying the Navier--Stokes equation then allows the time-dependent solution for temperature to be found. Substitution of the temperature into the advection-diffusion equation for energy balance allows us to select an internal heating rate corresponding to the presumed stream function, the solution for composition, and the solution for temperature.

In our solutions, the aspect ratio, convective velocities, Rayleigh numbers, and buoyancy ratio can be varied, leading to solutions covering a wide range of scenarios. Our solutions may be used for testing numerical models of mantle convection by using the internal heating rate found in our derivation as input for mantle convection codes. Numerical solutions for velocity, temperature, and composition may then be compared to the exact solutions.

Session: 8051 Tectonics and Dynamics of the Earth's Interior - Part 2 Tectonique et dynamique de l'intérieur de la Terre - Partie 2 **08/06/2022 15:25**

ID: 11682 Contributed abstract

Poster Order:

"It's not the heat, it's the humidity": The impact of planetary climate on tectonic regime stability in numerical mantle convection models

Rob McGrory [1] , *Julian Lowman* [2] , *Paul Tackley* [3]

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Presented by / Présenté par: ***Rob McGrory***
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On a planetary scale, lithospheric rheology is controlled most by the dependence of the pyrolytic mantle's viscosity on temperature and stress. We present a systematic analysis of the impact of planetary surface temperature and lithospheric yield stress (a parameter dependent on water content) to determine how the surface conditions on an Earth- (and Venus-) like planet, can influence surface mobility of the solid planet. The method used involves ensuring the rheological temperature dependence and governing flow parameters that depend directly on surface temperature (Rayleigh number and non-dimensional internal heating) are adjusted to the dimensional temperature scale of the model. In addition to varying surface temperature and yield stress, we investigate variations in activation energy for the temperature dependent viscosity, and the impacts of fixing the specified Rayleigh number versus varying the Rayleigh number with surface temperature. Initial conditions consisting of surface tectonic states of mobile-lid, episodic-lid and stagnant-lid are obtained for yield stress variation of 55 MPa, 80 MPa, 95 MPa and 135 MPa, for internal heating rates of 7x10^{-12} W/kg and 10^{-11} W/kg, at an

Earth-like surface temperature of 270 K. Our findings show that the linear decrease in the temperature gradient across the systems examined, due to increased surface temperature, is less impactful on the effective Rayleigh number than the corresponding exponentially determined decrease in viscosity. Accordingly, we find that for a constant temperature core, increasing planetary surface temperature over the range applicable to the contrast between the Earth and Venus, does not promote an immobile lid on a planet with a Venusian surface temperature. More likely, Venus has remained locked in the stagnant-lid mode due to higher surface yield stress, due to lithospheric dehydration.

Session: 8051 Tectonics and Dynamics of the Earth's Interior - Part 2 Tectonique et dynamique de l'intérieur de la Terre - Partie 2 **08/06/2022 15:50**

ID: 11334 Contributed abstract

Poster Order:

Stranding of continental crustal fragments during continental break-up: mantle suture reactivation in the Nain province of Eastern Canada

Phil Heron [1] , *Alex Peace* [2] , *Ken McCaffrey* [3] , *Russ Pysklywec* [4]

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Presented by / Présenté par: ***Phil Heron***
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The Earth's continental crust has evolved via a series of supercontinent cycles that have resulted in patchworks of Archaean cores surrounded by terranes, fragments and slivers of Proterozoic (and younger) crustal additions. However, the dispersal and/or stranding of continental fragments during break-up is not well understood. Inherited structures from previous tectonic activity can offer an explanation for the generation of continental terranes through controlling first-order deformation during rifting.

In this submission, we explore the influence of lithospheric deformation related to ancient orogenesis, focusing on the influence of the Torngat Orogen in the origin of the Nain Province continental fragment in Eastern Canada. Using the open-source community code ASPECT, we present 3-D continental extension numerical models in the presence of an inherited lithospheric structure. The results show that a narrow continental terrane could be localized by deep lithospheric scarring.

Our analysis estimates that continental terranes formed by this method would only have a width of 100 – 150 km, limited by subduction conditions during continental suturing. The findings here have broad implications and demonstrate an original theory on the fundamental geological problem of terrane generation and continental breakup.

Session: 8051 Tectonics and Dynamics of the Earth's Interior - Part 2 Tectonique et dynamique de l'intérieur de la Terre - Partie 2 **08/06/2022 16:05**

ID: 11618 Contributed abstract

Poster Order:

Slab-Pull vs. Plate Flexure: Syn-Drift Extension of Oceanic Plateaus

Erkan Gün [1] , *Russell N. Pysklywec* [2] , *Gültekin Topuz* [3] , *Oğuz H. Göğüş* [4]

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Presented by / Présenté par: ***Erkan Gün***
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Oceanic lithosphere is usually pictured as a homogenous plate, yet, it often includes anomalously thick and tens to several hundred kilometres wide crustal regions such as seamounts and oceanic plateaus. These bathymetric rises are naturally not stationary and move together with their host oceanic lithosphere towards subduction plate boundaries. Most research focuses on the origin of these bathymetric rises and their effect on subduction zones at the time or after the arrival to plate boundaries, i.e., flat subduction, accretion, post-collisional deformations, etc. However, the geological evidence from the Tethyan orogenic belts and numerical models show that pre-collisional deformations can take place in continental and also oceanic terranes before they reach convergent plate boundaries, and this has been neglected. Here we provide evidence from the Pacific Ocean that contemporary oceanic plateaus are effectively damaged and even torn apart while they drift to their final destinations. The seismic reflection profiles show active or recently active normal faults in the Pacific oceanic plateaus, and numerical models demonstrate the source for this extensional deformation, namely, the slab-pull. According to our experiments, the tensile stress—created by the sinking oceanic slab—can be transmitted hundreds (even thousands) of kilometres from the subduction zone to the oceanic plateaus and deform them while they are still far away from the plate boundary. This is different than the previously suggested plate flexure mechanism for the extensional faults observed in the oceanic plateaus because flexural bending could affect only a limited distance from the subduction zones. Yet, models and geophysical/geological evidence suggest otherwise, and oceanic plateaus can be damaged remotely and long before they arrive to plate boundaries.

Session: 8051 Tectonics and Dynamics of the Earth's Interior - Part 2 Tectonique et dynamique de l'intérieur de la Terre - Partie 2 **08/06/2022 16:20**

ID: 11729 Contributed abstract

Poster Order:

The influence of deep lithosphere dynamics on crustal deformation in the Central Andes: Insights from 2D numerical models

Zhihong Pan [1] , *Claire Currie* [2]

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Presented by / Présenté par: ***Zhihong Pan***
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The central Andes is an active Cordillera orogen that formed during the subduction of the Nazca plate beneath the South American continent. Today, the central Andes is a high plateau that has an average elevation of 4000 km above sea level. This region is characterized by crustal thicknesses 50 to 75 km, which resulted from trench-normal crustal shortening more than 300 km over the last 30 Ma. Crustal shortening and thickening should be accompanied by thickening of the underlying mantle lithosphere. However, both geophysical and geological observations in the central Andes indicate that mantle lithosphere is spatially heterogeneous, and in several areas, the mantle lithosphere is anomalously thin or absent. In particular, there is a widespread consensus that the mantle lithosphere has been completely removed below the southern Altiplano and the northern Puna plateaux. However, the dynamics of lithosphere removal during Andean shortening and possible feedbacks between crustal deformation and lithosphere foundering remain unknown. In this study, 2D thermal-mechanical models are used to study the role of lithosphere removal on Andean deformation, using a model domain that extends to a depth of 1200 km. The models examine subduction of an 80 km thick oceanic plate below a continental plate that has an initial lithosphere thickness of 100 km, including a 42 km thick crust. Convergence is imposed through side boundary conditions, and the subduction geometry evolves dynamically. Models show that a combination of high trenchward continental motion and interactions between the subducting plate result in shortening of the continent. The details of shortening are affected by both the lithosphere rheology and the possible presence of dense eclogite produced through metamorphic or igneous processes. Through systematic parameter tests, our models highlight how deep lithosphere dynamics are reflected in crustal thickness and elevation changes over time.

Session: 12062 Coastal Oceanography and Inland waters - Part 3 Océanographie côtière et eaux intérieures - Part 3 **08/06/2022 14:55**

ID: 11829 Contributed abstract

Poster Order:

Seasonal and interannual variations in the shelf circulation off the west coast of Canada

Guoqi Han [1] , *Jing Lu* [2] , *Nicolas Lambert* [3]

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Presented by / Présenté par: ***Guoqi Han***
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A 1/36o ocean circulation model has been used to study seasonal and interannual circulation and transport variability off the west coast of Canada. The model is forced by the European Centre for Median-range Weather Forecasting Reanalysis Version 5 atmospheric field, major ocean tides and river runoffs. The simulation was carried out for the period from 1993 to 2021. The model results are evaluated for sea level, ocean temperature and salinity and currents, showing good qualitative and approximate quantitative agreement with

observations. The model results show that the Vancouver Island Coastal Current is poleward year round strongest in December and weakest in May. The upper-layer shelf-edge current is poleward in winter and equatorward in summer, while the poleward California Undercurrent at mid-depth intensifies from late spring to following winter. There are substantial interannual variations in these currents, related to longshore winds, the El Niño Southern Oscillation, and the Pacific Decadal Oscillations.

Session: 12062 Coastal Oceanography and Inland waters - Part 3 Océanographie côtière et eaux intérieures - Part 3 **08/06/2022 15:25**

ID: 11735 Contributed abstract

Poster Order:

Characterizing extremes in temperature, ocean acidification, and deoxygenation along the Canadian North Pacific continental margin

Amber Holdsworth [1] , *James Christian* [2] , *Andrew Shao* [3]

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Presented by / Présenté par: ***Amber Holdsworth***
Contact: Amber.Holdsworth@dfo-mpo.gc.ca

As ocean acidification and deoxygenation encroach on the continental shelf of the Canadian Pacific and marine heat waves increase in frequency and severity, it is increasingly important to advance our understanding of ocean extremes. The compound effects of marine stressors can impact marine life in ways that exceed the effects of any stressor in isolation. A high resolution model of the Northeastern Pacific Ocean has been developed to characterize extremes in ocean acidification and deoxygenation for the diverse regions of the Canadian Pacific continental shelf including Queen Charlotte Sound, the west coast of Vancouver Island and the oceans surrounding Haida Gwaii. We present our model hindcast of the ocean biogeochemical state from 1997-2019 and examine where and when marine extremes have occurred for events involving single and multiple stressors. Using high frequency (3 h) outputs for the continental shelf we characterize the frequency distribution of extremes in the recent past and explore linkages with the physical mechanisms that influence or drive them.

Session: 12062 Coastal Oceanography and Inland waters - Part 3 Océanographie côtière et eaux intérieures - Part 3 **08/06/2022 15:50**

ID: 11739 Contributed abstract

Poster Order:

Future Climate Simulations for the Salish Sea Using a High Resolution Ocean Model with Biogeochemistry

Natasha Ridenour [1] , *Timothy Chui* [2] , *Eva Gnegy* [3] , *Armaan Randhawa* [4] , *Susan Allen* [5] , *Roland Stull* [6] , *Rachel White* [7] , *Michael Dunphy* [8] , *Amber Holdsworth* [9]

[1] Department of Fisheries and Oceans
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Presented by / Présenté par: ***Natasha Ridenour***
Contact: Natasha.Ridenour@dfo-mpo.gc.ca

The Salish Sea, a marginal sea located between Vancouver Island, mainland British Columbia and Washington state, supports an active and diverse ecosystem in addition to the economic and recreational activities of nearly 9 million locals who live along its shores. Given the Salish Sea's importance, future climate projections can provide useful information for how to manage the resources and services it provides in the years to come. However, global climate models are too coarse to capture the small-scale features of coastal regions. To fill this gap in knowledge, high-resolution climate projections for the Salish Sea are under development at a grid spacing of 500m. Using the SalishSeaCast ocean model configuration, based on Nucleus for European Modelling of the Ocean (NEMO), an historical period (1986-2005) will be used to evaluate changes in the Salish Sea for the years 2046-2065 using the Canadian Earth System Model (CanESM2) under two future climate scenarios; Representative Concentration Pathway (RCP) 4.5 (moderate mitigation) and RCP 8.5 (no mitigation). We will present results from our recently developed multi-stage atmospheric downscaling system, based on the Weather Research Forecasting (WRF) model, which is used to downscale the atmospheric forcing to an appropriate resolution. In addition to the physical model, SalishSeaCast will be run with biogeochemistry including the addition of a benthic sediment component that allows for interaction of chemical fluxes between the ocean bottom sediments and seawater above it. Sensitivity tests will be conducted with future projections of Fraser River discharge to better understand how the future changes in river runoff will impact the ocean state. The ultimate goal of this project is to identify vulnerable regions with regards to changes in the three main ecological stressors: temperature, oxygen, and ocean acidification, for conservation and protection in future climates. We will detail the project plans and present preliminary results.

Session: 12062 Coastal Oceanography and Inland waters - Part 3 Océanographie côtière et eaux intérieures - Part 3 **08/06/2022 16:05**

ID: 11746 Contributed abstract

Poster Order:

The Southern expansion of the La Grande river plume

Christopher Peck [1] , *Sergei Kirillov* [2] , *Zou Zou Kuzyk* [3] , *Jens Ehn* [4]

[1]

[2] University of Manitoba
[3] University of Manitoba
[4] University of Manitoba

Presented by / Présenté par: ***Christopher Peck***
Contact: peckc@myumanitoba.ca

The La Grande river plume is well known to extend to the north as it enters James Bay and then travel into the rest of Hudson Bay; this is because the Coriolis force and the natural background circulation of James Bay is to the north. Peck et al. 2022 (in prep) found that the under ice plume of the La Grande did not extent as far north as would be expected, given the large increase in discharge since the 1980’s, and in fact the plume had begun to expand to the south. To address this and how the coastal waters interacted with the La Grande river plume, a series of moorings were deployed at a depth of 3-4m in coastal inlets in close proximity to eelgrass beds for a full year. During the ice covered period all the moorings showed a simultaneous decrease in salinity for approximately 20 days. The salinity decreased by 15 points close to mouth and by 10 points at the mooring site furthest to the south. Before this low salinity period, the discharge of the La Grande was at its highest for the year and there was a persistent westerly wind. Confirmed with ice images, the westerly wind pushed mobile pack ice up against the landfast ice. Through transfer of motion into the water column, the plume was in tern pushed up against the shore and reduced the salinity at the mooring sites. When the westerly wind relaxed, the salinity at all the moorings increased again to previous levels before the low period.

Session: 12062 Coastal Oceanography and Inland waters - Part 3 Océanographie côtière et eaux intérieures - Part 3 **08/06/2022 16:20**

ID: 11793 Contributed abstract

Poster Order:

Influence of seasonal freshwater dynamics on nutrient distributions in the region of freshwater influence of the La Grande River, northeastern James Bay.

Alessia Guzzi [1] , *Jens Ehn* [2] , *Christine Michel* [3] , *Robie Macdonald* [4] , *Zou Zou Kuzyk* [5]

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[2] University of Manitoba
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Presented by / Présenté par: ***Alessia Guzzi***
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River water additions to coastal areas alter the typical marine nutrient distributions in terms of concentrations and ratios, creating unique and dynamic coastal systems. This is especially true in subarctic regions where there is a seasonality associated with riverine discharge and sea ice cycles. Nutrient and accompanying freshwater tracer data from subarctic coastal areas, particularly in winter, are scarce. In northeastern coastal James Bay, the shortage of data has hampered the understanding of ecosystem changes observed by local communities and land users over the last several decades, speculated to be due to both climate change and hydroelectric development of the La Grande River watershed. In this paper we examine the seasonal relationships between oxygen isotope tracer data and salinity from both winter and summer field campaigns in 2016-2017, to identify freshwater sources (sea-ice vs. river

discharge) of the northeast James Bay coast. Additionally, we use nutrient (nitrate, phosphate, and silicate) concentrations and ratios to assess the influence each water type has on nutrient distribution in this region. Here, the dominant source of freshwater was La Grande River. During both seasons, La Grande inflow had higher concentrations of nitrate than surrounding coastal waters. The diluted Hudson Bay source waters (salinity of 20 - 25) had N:P ratios (~5) well below the classic Redfield ratios for phytoplankton (16), implying possible N limitation along the coast. In contrast, low salinity waters (< 10) had higher N:P ratios because of low riverine phosphate concentrations. As a result, nitrate stocks in the surface layer of this coastal region nearly double from summer to winter, whereas phosphate stocks increase from winter to summer. The shift in discharge and thus fluvial nitrate inputs from spring to winter with river regulation has produced a mismatch between high surface nitrate stocks (under-ice), and the growing season (ice-free).

Session: 13071 Developing Actionable Canadian Climate Information - Part 2 Développer des informations climatiques canadiennes exploitables - Partie 2 **08/06/2022 14:55**

ID: 11363 Contributed abstract

Poster Order:

Heat Stress Indices - Estimating historical and projected values of Humidex-based indices

Kenneth Kin Cheung Chow [1] , *Housseyni Sankare* [2] , *Emilia Diaconescu* [3] , *Trevor Murdock* [4] , *Alex Cannon* [5]

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Presented by / Présenté par: ***Kenneth Kin Cheung Chow***
Contact: kenneth.chow2@ec.gc.ca

The Canadian Centre for Climate Services (CCCS) is a dedicated multi-disciplinary team, within Environment and Climate Change Canada with expertise across a broad range of climate-related disciplines. Its goal is to help Canadians understand and adapt to climate change by providing guidance and resources in support of climate-smart decisions. This presentation is intended to provide information about CCCS work in partnership with the Climate Research Division on developing climate change projections for Humidex, a heat-stress index that quantifies how the heat is experienced by the human body.

Heat-stress indices are used in meteorological forecasts to release warnings when certain threshold values are exceeded. With the warming projected by climate models for the next decades, an increase is expected in the number of days when those thresholds will be exceeded. However, projections of heat-stress indices are challenging to produce because those meteorological indices are computed from hourly values, whereas most available climate projections are available at daily temporal resolution.

This talk will present results for the evaluation of historical estimations of three

Humidex-based indices and explore methods for production of climate projections over Canada. Two high-resolution datasets were evaluated for potential use as a target in bias correction of climate models: ERA5-Land from ECMWF and Regional Deterministic Reforecast System (RDRS) from the Canadian Centre for Meteorological and Environmental Prediction (CCMEP). Several bias correction methods were also explored.

Session: 13071 Developing Actionable Canadian Climate Information - Part 2 Développer des informations climatiques canadiennes exploitables - Partie 2 **08/06/2022 15:10**

ID: 11404 Contributed abstract

Poster Order:

Application of Future Weather Files in Building Performance Simulation

Pouriya Jafarpur [1] , *Trevor Murdock* [2] , *Jeremy Fyke* [3] , *Stephen Sobie* [4]

[1] Environment and Climate Change Canada
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[3] Environment and Climate Change Canada
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Presented by / Présenté par: ***Pouriya Jafarpur***
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Building components and systems are affected by changes in climate. In terms of energy use, buildings are regarded as particularly vulnerable to the impacts of climate change in part because energy needs for heating and cooling purposes are strongly linked to local climate conditions. Building simulation tools are commonly used at various stages of the design process to ensure building codes compliance, for sizing of heating, ventilation, and air conditioning systems, or to determine the effect of various designs on the overall building performance. These tools use a series of climate parameters stored in a “weather file” for input to the simulation. Current building simulation practices use hourly weather files that have been constructed based on historical station records. However, given that the impacts of a changing climate are already affecting buildings and their occupants, using historical weather is no longer sufficient. Therefore, there is a pressing need to shift towards using historical and future weather files to assess long-term building performance.
It is recognized that the application of future weather file is essential for supporting climate resilient building design. As a result, the Pacific Climate Impacts Consortium and the National Research Council of Canada have been working on generating a set of future weather files for various locations across Canada. The focus of this presentation will be to highlight the importance of using future weather files such as these in simulating building energy performance. Additionally, this presentation will illustrate how climate data information made available through the “Buildings Module” on ClimateData.ca could help building professionals consider future weather impacts on building designs and operations. The goals are to provide future climate data and to support communication of the strengths and limitations of each product through the simulation of different reference-building model around the country.

Session: 13071 Developing Actionable Canadian Climate Information - Part 2 Développer des informations **08/06/2022 15:25**

ID: 11686 Contributed abstract

Poster Order:

Using Ensemble Weather Forecast and Climate Data to Study Over-Heating and Over-Shadowing in Canadian Urban Fabric

Parisa Kloss [1] , *Mojtaba Samimi* [2]

[1] Executive Director, Resilient Urban Planning and Development (RUPD) GbR
[2] SOLARCHVISION technologies

Presented by / Présenté par: ***Mojtaba Samimi***
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Quality of life and performance of both indoor and outdoor urban environments could be improved by detailed considerations of the variable effects of the sun in relation to most likely and extreme weather scenarios.
Canadian open data namely real-time and long-term historical data e.g. SWOB & CWEEDS as well as high resolution and ensemble numerical weather prediction models e.g. HRDPS & NAEFS/GEPS should be important inputs to the design and day to day operations of buildings and communities.
One of the barriers to taking resilient action towards climate issues such as urban heat island effect is the lack of tools to effectively detect the existing and future hotspots in 3 dimensions and time and visualize the architectural impacts for the decision makers, planners, architects and other stakeholders.
In this article using 2020 raw data and in-house post-processing we present the SOLARCHVISION studies over Montreal downtown model that includes buildings, trees and open spaces.
Views to such high resolution models can help fulfil the previous methodologies, investigate the issue from various perspectives and empower the decision makers to take resilient actions while saving budget, time and the planet.

Session: 13071 Developing Actionable Canadian Climate Information - Part 2 Développer des informations climatiques canadiennes exploitables - Partie 2 **08/06/2022 15:50**

ID: 11414 Contributed abstract

Poster Order:

Delivering user-relevant projections of future fire weather for Canada

Laura Van Vliet [1] , *Jeremy Fyke* [2] , *Pouriya Jafarpur* [3] , *Carrington Pomeroy* [4] , *Derek Van der Kamp* [5]

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[5] Natural Resources Canada

Presented by / Présenté par: ***Laura Van Vliet***
Contact: laura.vanvliet@ec.gc.ca

Recent increases in both Canadian and international wildfire activity have had

major impacts on communities and the economy, and have been attributed to climate change (Kirchmeier-Young et al., 2017). To support national resilience to wildfire, the Canadian Centre for Climate Services (CCCS, at ECCC) is developing projections of fire weather using the Canadian Forest Fire Weather Index (FWI) system and future projections from CanLEADv1, a multi-variate downscaled climate model product based on the CanRCM4 regional climate model. The FWI system uses meteorological variables to estimate relative potential for wildfire activity, and is actively used by wildfire practitioners across Canada.
After production and validation of initial FWI projections (the subject of a 2021 CMOS presentation), CCCS performed a series of interviews with provincial and territorial fire weather experts. These interviews provided important understanding of the key metrics and indices of fire weather for on-the-ground decision-making. Interviewees indicated that that FWI projections would be valuable, and are most applicable to strategic fire management decisions, e.g., related to long-term budgets, human and equipment material asset management, as well as broad wildfire policy actions.
This presentation will walk through the still in-progress stages of development of national FWI projections, focusing on user-needs engagement, post-processing of projected FWI system indices (e.g., downscaling and bias adjustment, calculating key metrics), and potential mechanisms for delivery to practitioners across Canada. We will also address key challenges in creating a useful set of fire weather projections, including the regional nature of interpreting FWI, data limitations, and communication of uncertainty.

Session: 13071 Developing Actionable Canadian Climate Information - Part 2 Développer des informations climatiques canadiennes exploitables - Partie 2

08/06/2022 16:05

ID: 11573 Contributed abstract

Poster Order:

Worth the Risk? How Large Outdoor Event Attendees Obtain, Perceive, and Respond to Severe Thunderstorm Information in a Southwestern Ontario County

Kyle Woods [1]

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Presented by / Présenté par: ***Kyle Woods***
Contact: kwoods@uwaterloo.ca

Southwestern Ontario, specifically, Windsor-Essex county is a hotspot for high-attendance, outdoor public events and dangerous severe thunderstorms each summer. Severe thunderstorms here present life-threatening hazards ranging from large hail to, rarely, tornadoes. To best protect the public from these hazards, Environment Canada provides three severe thunderstorm information levels, forecasts, and official watch and warning alerts, each exhibiting incremental increases in probability and urgency of a severe thunderstorm impact. It is well understood that these levels of severe thunderstorm information contain appropriate information to enact proper protective behaviours by the public before and during severe thunderstorms. Less understood, though, is how the public perceives these levels of severe thunderstorm information and subsequently interprets them while deciding upon planned or continued attendance of large outdoor events. This study

investigated how individuals obtain, perceive, and then respond to severe thunderstorm forecasts, watches, and warnings when planning to, or in attendance at a large outdoor public event (i.e. an outdoor concert). Planned or continued attendance likelihoods were analyzed for correlations with respondent's innate weather knowledge, weather communication media usage, demographics, and trust in Environment Canada and event managers. A voluntary online survey was completed by Windsor-Essex residents (n = 152) from February to April, 2021, consisting of closed-ended and open-ended questions. It was found that respondents typically neither monitored present weather conditions, left, nor cancelled planned attendance of an event, until the weather was most threatening and imminent (i.e. a severe thunderstorm warning issuance). Furthermore, age and education affected the forms of weather communication used, and the ability to receive timely severe weather updates in a real-world scenario. Results suggest that these events may be at heightened risk to life-threatening severe weather hazards and further studies should assess the social vulnerability of attendants, and further, lower it through education and better risk communication.

Session: 13071 Developing Actionable Canadian Climate Information - Part 2 Développer des informations climatiques canadiennes exploitables - Partie 2

08/06/2022 16:20

ID: 11876 Contributed abstract

Poster Order:

Tool support and User Engagement: Lessons Learned from the Climate Change Vulnerability Assessment Tool for Drinking Water Source Quality

Deborah Balika [1] , *Glenn Milner* [2]

[1]

[2] Climate Risk Institute

Presented by / Présenté par: ***Deborah Balika***

Contact: dbalika@conservationontario.ca

The climate is changing. Severe rain, ice and wind storms, prolonged heat waves and milder winters are much more common. Forests, waters and wildlife across Ontario are and will continue to be significantly impacted by these changes.

Climate change impacts may also affect our drinking water sources. The Government of Ontario has recognized the need to better incorporate climate change considerations into drinking water source protection planning and management, to identify and reduce the potential impacts of climate change on sources of drinking water. The assessment of the potential impacts from climate change on source water quantity is included in water quantity risk assessments, under the Drinking Water Source Protection program. The Government of Ontario has also recognized the need to do the same for drinking water source quality. To undertake an assessment at the local scale, a climate change vulnerability assessment tool has been developed through a comprehensive, multi-stakeholder process, which included Conservation Ontario, that spanned from early 2018 through spring 2020, for surface water and groundwater source quality, along with an accompanying guidance document.

The assessment tool is one of the first of its kind in the Province of Ontario, and its main purpose it to provide science-based guidance to municipalities, source protection authorities, and source protection committees on how to conduct a

climate change vulnerability assessment for drinking water source quality. The tool relies on the user curating and analyzing 'local' climate data and trends from a number of credible climate data portals and climate information sources. There is interest in finding ways to link the tool more directly to best-in-class climate information products as tailored as possibly for its application.
Over the past 3 years, several in person and online training sessions have been provided to support the use of the tool. There are many lessons learned about engagement, tool maintenance, ongoing user support, climate data access and use, and potential next steps including the consideration of implementing the tool as a web application.

Session: 13102 Science Serving Societies to Become Climate Resilient - Part 3 La science aidant les sociétés à devenir plus résilientes aux changements climatiques - Partie 3 **08/06/2022 14:55**

ID: 11527 Contributed abstract

Poster Order:

Canada's Net Zero challenge: Concerned citizens making impact

Charles Lin [1] , *James Lin* [2] , *Stephen Phoon* [3]

[1] Retired scientist
[2] University of Alberta alumni
[3] Seneca College

Presented by / Présenté par: ***Charles Lin***
Contact: charles.augustin.lin@gmail.com

On June 29, 2021, the Canadian Senate passed the Canadian Net-Zero Emissions Accountability Act, which enshrines in law Canada's commitment to reach net zero greenhouse gas emissions by 2050. The first target for 2030 aligns with Canada's commitment under the Paris Agreement, which is 40-45% below 2005 emission levels. Subsequent targets will be set every five years, at least 10 years in advance of the target date. Polls show about half of Canadians (49%) feel the 2030 targets are about right, with 29% saying they are too ambitious, and 21% saying they are not ambitious enough; there are regional and partisan differences. The challenge now is to develop the policies and actions for Canada to meet these targets. The pathways to reach net zero, with varying technological, economic, and political uncertainties and risks, have not been fully defined. Governments, corporations and citizens have a role in this effort. We are a group of concerned citizens who have created a website (https://impactnetzero.ca/) to educate and empower Canadians on the net zero journey. We work with grassroot organizations in this initiative. In this talk, we update progress since our paper presented at the 2021 CMOS Congress – the achievements to date and the next phase of work, where we further engage concerned Canadians to take actions as consumers and citizens to help our country reach the net zero goals.

Session: 13102 Science Serving Societies to Become Climate Resilient - Part 3 La science aidant les sociétés à devenir plus résilientes aux changements climatiques - Partie 3 **08/06/2022 15:10**

ID: 11392 Contributed abstract

Poster Order:

Building Climate Resilient Communities – International Dimensions

Gordon McBean [1]

[1] Western University

Presented by / Présenté par: ***Gordon McBean***
Contact: gmcbean@uwo.ca

Around the world, actions are being taken by various countries to build more climate resilient communities. This presentation will review the international activities and their relationships with Canadian actions. The Adaptation without Borders project is an example.

Poster Gallery

NOTES: For the first time in CMOS history the posters presented and discussed at the 2022 CMOS-CGU-ESC Joint Congress have been saved and archived in a readable way. Links have also been added to each poster abstract.

This index is part of the Congress Program and Abstracts but the actual posters are in another folder. More plentiful storage space has made this possible and no file reduction of the poster images has been made so all data and diagrams remain as readable as they were during the Congress. You may zoom to see any poster details.

Please use back keys to return to this index or to the main Program and Abstracts table of contents. This list may be searched using the standard *find* app in any browser.

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Alireza Moghaddasi	P2 11800	Assimilation of GRACE / GRACE-FO Terrestrial Water Storage Retrievals to Improve Snow Mass Estimates across North America
Joe Melton	P3 11757	Better than butter tarts
Christine Zimmer	P4 11875	Building Resilient Communities with Confidence_The Risk and Return on Investment Tool
Daniela A. Bodden	P5 11640	Centre for Climate Science and Engineering (CSE)
Mathilde Jutras	P6 11781	Classification of Lagrangian trajectories in the Labrador Current with a Machine Learning algorithm
Laura Alvarez Salinas	P7 11776	Conductive Heat Flow Through Temperate Region Lake Ice
Kayla Wicks	P8 11626	Controls of Differing Non-Growing Season Cover Crops On Winter Soil Temperatures
Zhenxia Long	P9 11543	Decadal simulations of ocean temperature and salinity in the eastern Beaufort Sea
Jean-Philippe MacLean	P10 11539	Detecting and quantifying methane emissions with the high-resolution GHGSat satellite constellation
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Okan Aygün	P12 11562	Diagnosing the Future Hydrology of a Central Asian Glacierized Basin using a Hydrological-Glaciological Land Surface Model
Haiyong (Planck) Huang	P13 11698	Effects of forest harvesting on mercury concentration, methylation and demethylation in soils and sediment in Canadian boreal forests
Lawson Gillespie	P14 11522	Estimating Methane Emissions Using an Instrument-Specific Gaussian Plume Inversion Model
Morgan Braaten	P15 11432	Estimating soil moisture storage using a Geological Weighing Lysimeter
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CMOS Awards Ceremony

Tuesday, June 7

7:00pm - 8:30pm EDT

Awards

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Fisheries and Oceans Canada	**Pêches et Océans Canada**
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CNC-SCOR Award	**Prix du CNC du SCOR**
Early Career Scientist Award	Prix du océanographe en début de carrière
CMOS Awards	**Prix SCMO**
Scholarships	Bourses d'étude
Awards	Prix de la SCMO
Special Recognition	**Reconnaissance spéciale**
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The purpose of SCOR is to further international scientific activity in all branches of oceanic research. The Scientific Committee on Oceanic Research (SCOR) is a non-governmental organization, created in 1957 by the International Council of Science (ICSU). SCOR promotes international cooperation in planning and conducting interdisciplinary oceanographic research programs and solving methodological and conceptual problems that hinder research. SCOR promotes scientific excellence and integrity and has direct access to the international ocean science community. The primary purpose of CNC-SCOR is to provide communication between the Canadian Ocean Science community and the international activities that come under SCOR’s umbrella. Under the auspices of CMOS, CNC-SCOR brings together the Canadian Ocean Science community across disciplinary boundaries and the boundaries of universities, government and private sector organizations.

Stantec Consulting Ltd.
Platinum Sponsor

Communities are fundamental. Whether around the corner or across the globe, they provide a foundation, a sense of place and of belonging. That’s why at Stantec, we always design with community in mind.

We care about the communities we serve—because they're our communities too. This allows us to assess what's needed and connect our expertise, to appreciate nuances and envision what's never been considered, to bring together diverse perspectives so we can collaborate toward a shared success.

We're designers, engineers, scientists, and project managers, innovating together at the intersection of community, creativity, and client relationships. Balancing these priorities results in projects that advance the quality of life in communities across the globe. Stantec trades on the TSX and the NYSE under the symbol STN.

Stantec Climate Solutions:

No matter your level of climate action maturity, our experts offer a broad range of innovative solutions to help you achieve net zero goals and protect assets from climate change impacts. We are much more than a traditional AE firm. Our design professionals partner with our climate and environmental scientists, digital solutions developers, project economists, funding specialists, and members of our industry-leading Innovation Office to deliver integrated climate change solutions that are informed by systems thinking. Our Climate Solutions team has been identifying vulnerabilities and risks associated with climate change for over 20 years. We've helped communities identify risks associated with extreme weather, developed mitigation strategies to reduce the generation of greenhouse gas and identified adaptation strategies to enhance resilience. Stantec is currently active in drafting climate risk reduction regulations, assisting various levels of government and agencies develop and implement adaptation programs and routinely supporting municipal updates to local planning and zoning regulations to enhance resilience to a changing climate.

A changing climate will result in more extreme weather events such as heat waves, floods and storms, as well as more gradual shifts impacting our lifestyles and health. How we design and build today will determine how well we can maintain and improve our quality of life moving forward. Our philosophy is to keep our clients well informed and well prepared for a future of climate uncertainty. Our tailored approach to climate change risk assessment sets us apart and is based on the premise that climate risk and vulnerability are project specific. Stantec has developed a framework that is consistent with the ISO 31000:2018 (Risk Management) and under the umbrella of the ISO 14090:2019 Adaptation to Climate Change standard which includes several complementary standards to provide guidance on the use of screening assessments and impacts which allows for both qualitative and quantitative analysis.

Stantec has a core team of climatologists, engineers, and environmental scientists that collaborate with our subject matter experts to help our clients and our professionals understand and adapt to a changing climate. Whether it's hospitals, roadways, buildings, water supply systems or largescale infrastructure projects, through rigorous data analysis and process, our team can help you consider the impacts of climate change and craft a plan on how to best adapt to the challenges it may bring.

Pacific Climate Impacts Consortium
Platinum Sponsor

Global Institute for Water Security (GIWS)
Gold Sponsor

The Global Institute for Water Security (GIWS) at the University of Saskatchewan (USask) is the top water resources research institute in Canada and one of the most advanced hydrology research centres in the world. GIWS is dedicated to helping protect our precious freshwater resources needed for the world's growing demand for sustainable food production, mitigating the risk of water-related disasters such as floods, droughts, and fires, predicting and forecasting extremes of global change through the use of advanced remote sensing and modelling techniques, and co-creating traditional knowledge with western science to empower Indigenous communities in protecting water health.

Hoskin Scientific
Gold Sponsor

The Environmental Department of Hoskin Scientific provides expert consultative support to find the right product to fit your application needs. Whether you require sampling and monitoring instruments for air, water and soil for the environmental, agricultural, mining and forestry markets, we are where you need us to be across Canada.

MetOcean Telematics
Gold Sponsor

MetOcean Telematics provides complete end-to-end telematics services, with a focus on niche MetOcean solutions and custom Defence & Security products. As a prominent Iridium® Satellite Value-Added Reseller (VAR) focused on data services, MetOcean Telematics is a leader in the satellite communications industry. Our business ranges across many different industry sectors, with our partners spanning the globe as experts in these fields. We have a long history of assisting our customers with integrating Iridium hardware into a wide range of devices and applications. From Unmanned Surface Vehicles to Autonomous Underwater Vehicles or Buoys and Profilers, our team understands the challenges you face when integrating and deploying your device. We work with you to ensure your data is transmitted, received, and processed in the fastest and most reliable manner possible.

Additionally, we develop and manufacture state-of-the-art data acquisition and telemetry systems. MetOcean Telematics has been a world leader in integrated systems used for real-time environmental monitoring, with specialization in the production of air-deployed and ship-deployed drifting buoys, search and rescue buoys, oil spill tracking buoys, ice platforms and acoustic systems, and defense and security systems. MetOcean Telematics marine-focused products have been developed to support niche markets in a wide variety of scientific and commercial fields. These markets include Oil and Gas, Search and Rescue (SAR), Oceanographic, Meteorological, Military, Polar, ARGO Program, Aquaculture, and Port Authorities.

The Weather Network
Gold Sponsor

WSP Golder
Silver Sponsor

One of the world's leading professional services firms, WSP provides strategic advice and technical expertise to businesses and governments in all areas of earth sciences and environmental consultancy, including ESG matters, throughout the entire project life cycle. With the addition of Golder Associates Inc. in 2021, we have built a practice of more than 14,000 professionals collaborating to protect and conserve natural landscapes, create firm foundations for communities to stand on, and champion sustainable development to combat climate change, for a more Future Ready world. With headquarters in Montreal, Canada, WSP numbers 55,000 staff across the globe.

Engineers Canada
Silver Sponsor

Engineers Canada upholds the honour, integrity, and interests of the engineering profession by supporting consistent high standards in the regulation of engineering, encouraging the growth of the profession in Canada, and inspiring public confidence. For over 80 years, we have worked on behalf of the provincial and territorial associations that regulate engineering practice and license the country's 300,000 members of the engineering profession.

Our work is focused on 10 core purposes, as established by Engineers Canada's members, the engineering regulators:

1. Accrediting undergraduate engineering programs.
2. Facilitating and fostering working relationships between and among the regulators.

3. Providing services and tools that enable the assessment of engineering qualifications, foster excellence in engineering practice and regulation, and facilitate mobility of practitioners within Canada.
4. Offering national programs.
5. Advocating to the federal government.
6. Actively monitoring, researching, and advising on changes and advances that impact the Canadian regulatory environment and the engineering profession.
7. Managing risks and opportunities associated with mobility of work and practitioners internationally.
8. Fostering recognition of the value and contribution of the profession to society and sparking interest in the next generation of professionals.
9. Promoting diversity and inclusivity in the profession that reflects Canadian society.
10. Protecting any word(s), mark, design, slogan, or logo, or any literary, or other work, as the case may be, pertaining to the engineering profession or to its objects.

Engineers Canada's work in support of climate action

Since 2005, Engineers Canada has partnered with the provincial and territorial engineering regulators and other organizations to engage engineers with scientists, policy planners, industry leaders, and government decision-makers to advance the adaptation of public infrastructure to climate change.

Advocacy

As the national voice of the engineering profession, Engineers Canada advocates to the federal government on climate change issues that affect the engineering profession. Engineers Canada encourages the federal government to continue to require climate vulnerability processes and risk assessments to be a condition of funding approvals for infrastructure projects. In meetings and consultations with the federal government, Engineers Canada also recommends the continued funding of climate research; promoting awareness of climate change impacts, adaptation measures, and GHG reductions; promoting information-sharing on best adaptive practices and climate data; maintaining and improving a national network of climate and watershed data collection systems; continuing efforts to improve the accuracy and resolution of climate change projection models; continuing to support the Natural Resources Canada Climate Adaptation Platform; and continuing to support the Canadian Centre for Climate Services.

RBR

RBR
Silver Sponsor

Since 1973, RBR has been designing and manufacturing oceanographic instruments in Ottawa, Canada. From the ocean abyss to the polar ice cap, our sensors track water parameters: temperature, depth, salinity, dissolved gases, pH, and many others.

* * *

Exhibitors

ASL Environmental Sciences

ASL Environmental Sciences Inc.
Victoria BC
Exhibitor

ASL Environmental Sciences Inc. is a 100% Canadian owned company, incorporated in 1977 under the laws of the province of British Columbia. Today ASL is the largest Canadian oceanographic consulting company specialising in physical oceanography, with over 39 years experience working for Clients in Canada and all over the world. Our website provides more detail on the company's projects at www.aslenv.com. ASL's strength lies in its highly qualified staff of over 40 scientists, engineers, programmers and technicians, specialising in the fields of physical oceanography, remote sensing, physical limnology and modelling of dynamic oceanography, sea-ice, underwater acoustic, sediment transport and permafrost data. ASL began with studies of oceanography in the Canadian Arctic and has expanded its geographic expertise to include all oceans in Canada as well as in the United States, European waters, the western Pacific Ocean, the South Atlantic and Indian Oceans and in the Southern Ocean. This includes all aspects of marine and freshwater field data collection in all environments, with specialist expertise in the Arctic, coastal sediments and deep/ultradeep waters. ASL provides project Client support from conception, through planning, implementation and analysis. ASL's Metocean Consulting Services Division maintains an extensive lease pool of Metocean equipment. A complete MatLab based suite of software is available for data editing, analysis and plotting. We provide information on currents, waves and other oceanographic properties for a range of Clients, including the Oil and Gas, mining, construction, engineering, aquaculture and renewable energy industries. Studies for ports and harbours include LNG, coal and bulk mineral terminals worldwide. Expert testimony was provided at the National Energy Board hearings for Enbridge's Northern Gateway project as well having a great deal of engagement with CEAA and provincial and territorial environmental review and screening agencies (British Columbia, Nova Scotia, Newfoundland and Labrador, Nunavut and the Inuvialiut Settlement Area of the NWT). Recent projects include sites in the Mediterranean for Noble Energy; Chukchi Sea for Shell, ConocoPhillips and Statoil; Beaufort Sea for BP, ExxonMobil and Chevron; Baffin Bay for ConocoPhillips, BaffinLand Mines and Shell; Fram Strait for Statoil and Chevron; Barents Sea for Statoil; BC coastal for TransCanada Pipelines, Stantec, ERM/Rescan and Worley Parsons. ASL has a niche modelling team who provide wave, currents, sediment transport and dispersion modelling solutions. The focus is on generating hindcast metocean design criteria required for EA, Pre-FEED and FEED design for development of large marine terminals, related marine pipeline projects and port developments. ASL has developed an in house 3D hydrodynamic numerical model, COCIRM. This is a coupled hydrodynamic-wave-sediment transport and geomorphic model which can be used to model effluent or sediment transport and deposition. This model has been validated and used extensively along with DELFT3D, SWAN and other mainstream models as required by Clients. All metocean studies conducted by ASL adhere to international standards, in particular the ISO 19901-1 standard (Petroleum and natural gas industries: Metocean design and operating considerations). ASL has a well-developed HSE system based on ExxonMobil's template. Processes at ASL follow standard practices to meet QA/QC requirements.

CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

Campbell Scientific Canada
Edmonton AB
Exhibitor

We are a leading designer and manufacturer of data loggers, data acquisition systems, and measurement and control products used worldwide in a variety of applications related to weather, water, energy, gas flux and turbulence, infrastructure, and soil. We specialize in rugged, low-power systems for long-term, stand-alone monitoring and control.

At Campbell Scientific, we are proud to be internationally recognized in the measurement and control industry for producing accurate and dependable instruments.

Canadian Geophysical Union (CGU)
Exhibitor

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

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

Eastern Snow Conference
Exhibitor

The Eastern Snow Conference (ESC) is a joint Canadian/U.S. organization founded in the 1940s originally with members from eastern North America. Today, Our members come from the United Kingdom, Japan and Germany, as well as North America. Our current membership includes scientists, engineers, snow surveyors, technicians, professors, students and professionals involved in operations and maintenance. The western counterpart to this organization is the Western Snow Conference (WSC), also a joint Canadian/US organization. Every fifth year or so, the ESC and WSC hold joint meetings.

At its annual meeting, the Eastern Snow Conference brings the research and operations communities to discuss recent work on scientific, engineering and operational issues related to snow and ice. The location of the conference alternates yearly between the United States and Canada, and attendees present their work by giving talks or presenting posters. Authors can choose to have their papers reviewed if they desire feedback on ways to improve the manuscript prior to publication in our yearly ***Proceedings of the Eastern Snow Conference*** Papers may also be submitted for a special annual ESC edition of the journal ***Physical Geography***. These manuscripts are subject to a standard academic journal peer review process.

Geonor
Exhibitor

Geonor has been supplying the T-200B Series Weighing Precipitation Gauge since it was first developed in 1985 in Norway.

With proven long term stability and accuracy it has shown it's accuracy is unsurpassed for monitoring precipitation rates and precipitation total amounts.

The accuracy, longevity, and cost effectiveness of the vibrating-wire transducer has been proven over the years with some meteorological organizations reporting more the 1 million operating hours without a single failure.

Canadian Meteorological and Oceanographic Society (CMOS)
Ottawa ON
Exhibitor

The Society exists for the advancement of meteorology and oceanography in Canada.

The Canadian Meteorological and Oceanographic Society (CMOS) is the national society of individuals and organisations dedicated to advancing atmospheric and oceanic sciences and related environmental disciplines in Canada. The Society's aim is to promote meteorology and oceanography in Canada, and it is a major non-governmental organisation serving the interests of meteorologists, climatologists, oceanographers, limnologists, hydrologists and cryospheric scientists in Canada. CMOS was officially created in 1967 as the Canadian Meteorological Society and adopted its present name in 1977, following an invitation by the Canadian Meteorological Society to the oceanographic community in Canada to join the Society. However, CMOS has a rich history dating back to 1939 when it was known as the Canadian Branch of the Royal Meteorological Society.The Society comprises over 700 members and subscribers, including students, corporations, institutions, and others who are involved in the educational functions, communications, the private sector and government. Membership is open to all who share an interest in atmospheric and oceanic sciences, their related sciences and applications. The Society addresses a broad range of national and international meteorological and oceanographic concerns including weather and weather extremes, global warming, ozone depletion and surface air quality and their effects on all aspects of life in Canada including forestry, agriculture and fisheries. Special interest groups in the Society build communities of members with common interests.

CMOS Toronto Chapter
Toronto ON
Exhibitor

The Society exists for the advancement of meteorology and oceanography in Canada.

Science Program Committee

2022 CMOS-CGU-ESC Joint Congress

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2022 CMOS-CGU-ESC Joint Congress

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