

CMOS 60th Congress

1 - 4 June 2026, virtual (CMOS National)

*** * ***

Table of Contents

[Congress Poster](#)

[Congress at a Glance](#)

[Schedule / Agenda](#)

[Sessions by Discipline](#)

[All Abstracts and Plenaries](#)

[Poster Session with Links](#)

[Program Committees and Volunteers](#)

CMOS 60TH Congress 2026

Navigating uncertainty

JUNE 1 - 4, 2026 // VIRTUAL



60e congrès 2026 de la SCMO

Naviguer l'incertitude

1 - 4 JUIN, 2026 // VIRTUEL

CMOS

Canadian Meteorological and
Oceanographic Society



SCMO

Société canadienne de météorologie
et d'océanographie

2026 Congress at a Glance / Aperçu du Congrès de 2026

| Time (EDT) Temps (HAE) | Monday June 01 Lundi 01 juin | Tuesday June 02 Mardi 02 juin | Wednesday June 03 Mercredi 03 juin | Thursday June 04 Jeudi 04 juin | Time (EDT) Temps (HAE) | |
|---|---|--|--|--|--|---------------|
| PLENARY SESSIONS WEB PAGE / PAGE WEB DES SESSIONS PLÉNIÈRES | | | | | | |
| 11:00 - 12:00 | <p style="text-align: center;">Plenary / Plénière --- 1 Dr. David Spiegelhalter (University of Cambridge)</p> <p><i>The Art of Uncertainty: Planning for a Future that is Hard to Imagine</i> <i>L'Art de L'incertitude: planifier un avenir difficile à imaginer</i></p> | <p style="text-align: center;">Plenary / Plénière --- 2 Dr. Claudie Beaulieu (University of California Santa Cruz)</p> <p><i>Is the Rate of Warming Accelerating? A Statistical Assessment from Global to Regional Scales</i> <i>Le rythme du réchauffement s'accélère-t-il? Une analyse statistique à l'échelle mondiale et régionale</i></p> | <p style="text-align: center;">Plenary / Plénière --- 3 Dr. Christopher Subich (Meteorological Research Division of Environment and Climate Change Canada (ECCC))</p> <p><i>Navigating Uncertainty in the AI Era of Weather Forecasting</i> <i>Faire face à l'incertitude à l'ère de l'IA dans le domaine des prévisions météorologiques</i></p> | <p style="text-align: center;">Plenary / Plénière --- 4 Dr. Katharine Hayhoe (Chief Scientist for The Nature Conservancy and a Distinguished Professor at Texas Tech University)</p> <p><i>What We Don't Know, and Why It Matters</i> <i>Ce que nous ignorons, et pourquoi c'est important</i></p> | 11:00 - 12:00 | |
| 12:00 - 12:30 | <p style="text-align: center;">Opening Remarks / Allocution d'ouverture</p> | <p>Break / Pause (30 minutes)</p> | | | <p style="text-align: center;">Closing Remarks / Allocution de fermeture</p> | 12:00 - 12:30 |
| 12:30 - 13:30 | <p style="text-align: center;">Parallel Sessions / Sessions parallèles (5)</p> <p style="text-align: center;">(2030-1, 4010, 5010-1, 5030-1, 5100)</p> | <p style="text-align: center;">Parallel Sessions / Sessions parallèles (6)</p> <p style="text-align: center;">(2030-4, 2050-2, 3010-3, 4080-1, 4070-1, 5060)</p> | <p style="text-align: center;">Parallel Sessions / Sessions parallèles (6)</p> <p style="text-align: center;">(2020-1, 2030-6, 2050-4, 3020-1, 4040-1, 5050-2)</p> | <p style="text-align: center;">Parallel Sessions / Sessions parallèles (6)</p> <p style="text-align: center;">(2020-3, 3030-1, 4040-3, 4060-2, 5050-4, 5070)</p> | 12:30 - 13:30 | |
| 13:30 - 13:50 | <p>Break / Pause (20 minutes)</p> | | | | 13:30 - 13:50 | |
| 13:50 - 14:50 | <p style="text-align: center;">Parallel Sessions / Sessions parallèles (5)</p> <p style="text-align: center;">(2030-2, 3010-1, 4020, 5010-2, 5030-2)</p> | <p style="text-align: center;">Parallel Sessions / Sessions parallèles (6)</p> <p style="text-align: center;">(2030-5(+4F), 2050-3, 3040 (+1F), 4080-2(5F), 4070-2, 5050-1)</p> | <p style="text-align: center;">Parallel Sessions / Sessions parallèles (6)</p> <p style="text-align: center;">(2010, 2020-2, 3020-2, 4040-2, 4060-1, 5050-3)</p> | <p style="text-align: center;">Parallel Sessions / Sessions parallèles (5)</p> <p style="text-align: center;">(2040, 3030-2, 4060-3, 5040, 5080)</p> | 13:50 - 14:50 | |
| 14:50 - 15:10 | <p>Break / Pause (20 minutes)</p> | | | <p>CONGRESS CONCLUDED / CONGRÈS TERMINÉ</p> | | 14:50 - 15:10 |
| 15:10 - 16:10 | <p style="text-align: center;">Parallel Sessions / Sessions parallèles (5)</p> <p style="text-align: center;">(2030-3, 2050-1, 3010-2, 4030, 5090)</p> | <p style="text-align: center;">Poster Session Session d'affiches</p> | <p style="text-align: center;">Awards Ceremony / Cérémonie de remise des prix</p> | <p style="text-align: center;">See you at the 2027 Congress / Rendez-vous au congrès de 2027</p> | | 15:10 - 16:10 |

Congress Time Zone is UTC-4 hours or Eastern Day Time (EDT) /Le fuseau horaire du Congrès est UTC-4 heures, soit l'Heure Avancée de l'Est (HAE)

| TIME | ROOM | SESSION | CHAIR |
|--------------------------|----------------------------|--|--|
| June 01, 2026 | | | |
| Monday - Day 1 | | | |
| 11:00 - 12:00 EDT | Myst | 1010 Plenary - The Art of Uncertainty: Planning for a Future that is Hard to Imagine | Adam Monahan |
| 12:00 - 12:20 EDT | Myst | OPENING SESSION | Patrick McCarthy Serge Desjardins Stephen Dery |
| 12:20 - 12:30 EDT | | COFFEE BREAK | |
| 12:30 - 13:30 EDT | Mechanical | 5100 Multidisciplinary- Community, Service and Education | André Giguère |
| 12:30 - 13:30 EDT | Myst | 2031 Weather, Climate, and Environmental Extremes in Changing Climate - Part 1 | Elizaveta Malinina |
| 12:30 - 13:30 EDT | Riven | 4010 Climate variability and predictability | Bin Yu Hai Lin |
| 12:30 - 13:30 EDT | Selenetic | 5031 Atmosphere, Ocean, and Climate Dynamics - Part 1 | Michael Waite |
| 12:30 - 13:30 EDT | Stoneship | 5011 Ocean–Sea Ice–Atmosphere Interactions and Dynamics in the Changing Arctic and Sub-Arctic Seas - Part 1 | Yarisbel Garcia Quintana |
| 13:30 - 13:50 EDT | | COFFEE BREAK | |
| 13:50 - 14:50 EDT | Mechanical | 4020 Regional scaling of climate projections: robustness, credibility, and criteria for selecting available data | Dominique Paquin |
| 13:50 - 14:50 EDT | Myst | 2032 Weather, Climate, and Environmental Extremes in Changing Climate - Part 2 | Nathan Gillett |
| 13:50 - 14:50 EDT | Riven | 3011 Coastal Oceanography and Inland Waters - Part 1 | Susan Allen |
| 13:50 - 14:50 EDT | Selenetic | 5032 Atmosphere, Ocean, and Climate Dynamics - Part 2 | Marek Stastna |
| 13:50 - 14:50 EDT | Stoneship | 5012 Ocean–Sea Ice–Atmosphere Interactions and Dynamics in the Changing Arctic and Sub-Arctic Seas - Part 2 | Kent Moore |

14:50 - 15:10
EDT

COFFEE BREAK

15:10 -
16:10 EDT

[Mechanical](#)

4030 Applications of regional climate modeling

Alejandro Di Luca
Dominique Paquin

15:10 -
16:10 EDT

[Myst](#)

2033 Weather, Climate, and Environmental Extremes in
Changing Climate - Part 3

Megan Kirchmeier-
Young

15:10 -
16:10 EDT

[Riven](#)

3012 Coastal Oceanography and Inland Waters - Part 2

Shiliang Shan

15:10 -
16:10 EDT

[Selenetic](#)

2051 Atmosphere - Theoretical to applied science - Part 1

Colin Lee

15:10 -
16:10 EDT

[Stoneship](#)

5090 Multidisciplinary - Theoretical to applied science

Serge
Desjardins

June 02,
2026

Tuesday - Day 2

11:00 -
12:00 EDT

[Myst](#)

1020 Plenary - Is the Rate of Warming Accelerating? A
Statistical Assessment from Global to Regional Scales

Julie Theriault

12:00 - 12:30
EDT

COFFEE BREAK

12:30 -
13:30 EDT

[Channelwood](#)

4071 Canada's Changing Climate Report 2026: findings
from the new national climate science assessment - Part 1

Chris Derksen
Elizabeth Bush

12:30 -
13:30 EDT

[Mechanical](#)

4081 Climate - Theoretical to applied science - Part 1

Reinel Sospedra-
Alfonso

12:30 -
13:30 EDT

[Myst](#)

2034 Weather, Climate, and Environmental Extremes in
Changing Climate - Part 4

Elizaveta
Malinina

12:30 -
13:30 EDT

[Riven](#)

3013 Coastal Oceanography and Inland Waters - Part 3

Guoqi Han

12:30 -
13:30 EDT

[Selenetic](#)

2052 Atmosphere - Theoretical to applied science - Part 2

Peter Taylor

12:30 -
13:30 EDT

[Stoneship](#)

5060 Hydrological Change in Canada: Impacts on Water
Quantity, Quality and Aquatic Ecology

Daniel Peters

13:30 - 13:50
EDT

COFFEE BREAK

| | | | |
|------------------------------|-----------------------------|--|---------------------------------|
| 13:50 - 14:50 EDT | Channelwood | 4072 Canada's Changing Climate Report 2026: findings from the new national climate science assessment - Part 2 | Chris Derksen Elizabeth Bush |
| 13:50 - 14:50 EDT | Mechanical | 4082 Climate - Theoretical to applied science - Part 2 | Reinel Sospedra-Alfonso |
| 13:50 - 14:50 EDT | Myst | 2035 Weather, Climate, and Environmental Extremes in Changing Climate - Part 5 | Neil Tandon |
| 13:50 - 14:50 EDT | Riven | 3040 Ocean - Theoretical to applied science | Jared Penney |
| 13:50 - 14:50 EDT | Selenetic | 2053 Atmosphere - Theoretical to applied science - Part 3 | Milena Dimitrijevic |
| 13:50 - 14:50 EDT | Stoneship | 5051 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 1 | Adam Bourassa Kaley Walker |

**14:50 - 15:10
EDT**

COFFEE BREAK

**15:10 -
16:10 EDT**

[Myst](#)

6010 POSTER SESSION

Serge Desjardins

**June 03,
2026**

Wednesday - Day 3

**11:00 -
12:00 EDT**

[Myst](#)

1030 Plenary - Navigating Uncertainty in the AI Era of Weather Forecasting

Nancy Soontiens

**12:00 - 12:30
EDT**

COFFEE BREAK

**12:30 -
13:30 EDT**

[Channelwood](#)

3021 Towards development of Canada's Digital Twin of the Ocean: Research, Development and Work Examples - Part 1

Floris Goerlandt

**12:30 -
13:30 EDT**

[Mechanical](#)

4041 Collaborative Earth System Modelling in Canada - Part 1

Neil Swart

**12:30 -
13:30 EDT**

[Myst](#)

2036 Weather, Climate, and Environmental Extremes in Changing Climate - Part 6

Neil Tandon

**12:30 -
13:30 EDT**

[Riven](#)

2021 Advances and applications of artificial intelligence in meteorology - Part 1

Simon-Philippe
Breton
Vikram Khade

| | | | |
|------------------------------|-----------------------------|--|--|
| 12:30 - 13:30 EDT | Selenetic | 2054 Atmosphere - Theoretical to applied science - Part 4 | Milena Dimitrijevic |
| 12:30 - 13:30 EDT | Stoneship | 5052 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 2 | Jason Cole |
| 13:30 - 13:50 EDT | COFFEE BREAK | | |
| 13:50 - 14:50 EDT | Channelwood | 3022 Towards development of Canada's Digital Twin of the Ocean: Research, Development and Work Examples - Part 2 | Nancy Soontiens |
| 13:50 - 14:50 EDT | Mechanical | 4042 Collaborative Earth System Modelling in Canada - Part 2 | Michael Morris |
| 13:50 - 14:50 EDT | Myst | 4061 Climate services and the confidence-confusion chasm - Part 1 | Megan Hartwell |
| 13:50 - 14:50 EDT | Riven | 2022 Advances and applications of artificial intelligence in meteorology -Part 2 | Simon-Philippe Breton Vikram Khade |
| 13:50 - 14:50 EDT | Selenetic | 2010 Dynamics and Impacts of Atmospheric Rivers: Challenges and Solutions for Prediction and Risk Management | Stephen DeryTamar Richards-Thomas |
| 13:50 - 14:50 EDT | Stoneship | 5053 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 3 | Adam BourassaKaley Walker |
| 14:50 - 15:10 EDT | COFFEE BREAK | | |
| 15:10 - 16:10 EDT | Myst | Awards Ceremony | Gordon Griffith Patrick McCarthy |
| June 04, 2026 | Thursday - Day 4 | | |
| 11:00 - 12:00 EDT | Myst | 1040 Plenary - What We Don't Know, and Why It Matters | Adam Monahan |
| 12:00 - 12:20 EDT | Myst | Closing Remarks | Serge Desjardins Gordon Griffith Dominique Brunet |

**12:20 - 12:30
EDT**

HEALTH BREAK

**12:30 -
13:30 EDT** [Channelwood](#) 5070 Managing Hydrometeorological Risks in an Uncertain World Philippe Gachon

**12:30 -
13:30 EDT** [Mechanical](#) 4043 Collaborative Earth System Modelling in Canada - Part 3 Paul Kushner

**12:30 -
13:30 EDT** [Myst](#) 4062 Climate services and the confidence-confusion chasm - Part 2 Megan Hartwell

**12:30 -
13:30 EDT** [Riven](#) 2023 Advances and applications of artificial intelligence in meteorology - Part 3 Simon-Philippe Breton
Vikram Khade

**12:30 -
13:30 EDT** [Selenetic](#) 3031 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 1 Susan Allen

**12:30 -
13:30 EDT** [Stoneship](#) 5054 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 4 Jeffery Langille

**13:30 - 13:50
EDT**

COFFEE BREAK

**13:50 -
14:50 EDT** [Mechanical](#) 2040 Improving Weather Services Across the Weather Enterprise Erik de Groot

**13:50 -
14:50 EDT** [Myst](#) 4063 Climate services and the confidence-confusion chasm - Part 3 Trevor Murdock

**13:50 -
14:50 EDT** [Riven](#) 5080 Bolstering Resilience in Uncertain Times Caroline Floyd
Laura Twidle

**13:50 -
14:50 EDT** [Selenetic](#) 3032 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 2 Frederic Dupont

**13:50 -
14:50 EDT** [Stoneship](#) 5040 Satellite Earth Observations for understanding atmospheric composition and fluxes Debora Griffin

ATMOSPHERE

2010 Dynamics and Impacts of Atmospheric Rivers: Challenges and Solutions for Prediction and Risk Management

Convenors: Tamar Richards-Thomas (University of Regina), Stephen Déry (University of Northern British Columbia)

Atmospheric rivers are becoming more frequent, intense and impactful, in a warmer world, serving as major contributors to extreme weather and hydrological events. This trend highlights the need for a comprehensive and enhanced scientific understanding of these phenomena. However, the complex atmospheric-oceanic interactions that shape atmospheric river evolution, formation, and landfall can introduce considerable uncertainty in predicting their outcomes.

This session examines the dynamics, potential predictability, and emerging solutions designed to understand atmospheric river hazards. Discussions will include the dynamical mechanisms, such as large-scale circulation patterns, moisture transport processes, and orographic influences, that drive the evolution and strength of atmospheric rivers and compound the effects of natural hazards.

The prediction and risk management of atmospheric rivers present unique challenges due to their complex dynamics interconnected with hydrological responses, meteorological processes, and climate change. This session will also address the strengths and limitations of current forecasting efforts and tools, explore sources of uncertainty, and challenges in translating atmospheric predictions into actionable decision-making strategies for water management resources, flood preparedness, and hazard mitigation.

2020 Advances and applications of artificial intelligence in meteorology

Convenors: Simon-Philippe Breton, Canadian Meteorological Center, ECCC, Vikram Khade, Canadian Meteorological Center, ECCC

We invite the meteorological community to contribute to an exciting session on the integration of Artificial Intelligence (AI) into meteorology. This session aims to explore how AI, in particular machine learning (AI/ML) and high performance computing, is revolutionising modern meteorology.

Potential topics:

- Data-driven modelling in meteorology: Examples of fully data-driven models offering new insights into the understanding of meteorological phenomena.
- Hybridization of models: Fusion of data-driven approaches and traditional physical models for more accurate and robust weather forecasting.
- AI/ML for nowcasting: Innovation in very short-term forecasting, using AI to improve the speed and accuracy of forecasts.
- Improvements in S2S forecasting: Use of innovative statistical methods and AI/ML to refine sub-seasonal to seasonal predictions.
- Operationalisation of AI/ML: Discussion on how to make AI/ML technologies more accessible and useful for daily weather forecasting and decision support.

•Ethical and responsible AI: Importance of developing and using AI ethically and responsibly in meteorological research.

•Improving AI Literacy: Encouraging AI adoption by improving AI understanding and skills within the meteorological community.

•AI/ML in data assimilation : Use of AI/ML to augment/replace components of data assimilation systems (4DVar, EnVar, Ensemble based DA etc.)

•AI/ML applications in climate and environmental sciences : Use of AI/ML in climate projections, estimation of green house gases and climate change, climate change mitigation strategies, environmental impact/adaptation, policy formulations.

•AI applications in renewable energies : Use of AI/ML to improve forecasts for renewable energies.

In order to align this session with the “Navigating Uncertainty” theme of the conference, we encourage presentations that demonstrate how artificial intelligence can be used to characterize, quantify, or manage uncertainty in the context of measurements, forecasts, and projections in meteorology and climatology. Contributions that illustrate the application of AI to monitoring, reducing, or communicating uncertainty, as well as interdisciplinary approaches—including those integrating social sciences—are welcome.

2030 Weather, Climate, and Environmental Extremes in Changing Climate

Convenors: Elizaveta Malinina, Environment and Climate Change Canada, Neil Tandon, York University, Nathan Gillett, Environment and Climate Change Canada

Extreme events in weather and climate pose significant risks to lives, ecosystems, and economies, often resulting in devastating losses and long-term impacts. Nevertheless, current knowledge of extremes and how they are evolving in a changing climate is associated with a high degree of uncertainty, often arising from short historical records, incomplete process understanding, or model biases. This session invites contributions addressing all aspects of weather and climate extremes, including but not limited to studies covering uncertainties in physical mechanisms, observations, predictions or projections of extremes, and their communication. We welcome submissions examining extremes of varying durations (from hours to months) and types, including heatwaves, wildfires, extreme precipitation, wind-related events, hydrological extremes (e.g., floods and droughts), and oceanographic extremes (e.g., storm surges, coastal flooding, and marine heatwaves). Submissions may focus on historical changes, event attribution, future projections, or any other extremes-related topic.

2040 Improving Weather Services Across the Weather Enterprise

Convenors: Blake Barber and Erik de Groot, Meteorological Service of Canada (MSC)

As Canada faces increasingly complex meteorological and climate-related risks, improving weather services has become a central priority across the Canadian weather enterprise. In alignment with the Congress theme “Navigating Uncertainty,” this session, led by the Meteorological Service of Canada (MSC), will highlight ongoing efforts to improve weather services in Canada.

The session will feature MSC's current service-modernization activities—spanning improvements in alerting, forecasting, communication, and user-centered design

Objectives

- Present MSC's service improvement efforts within the context of a changing weather enterprise and fiscal realities
- Encourage sharing of innovative tools, services, and communication strategies that enhance the delivery of weather information.

2050 Atmosphere - Theoretical to applied science

Convenors:

Milena Dimitrijevic, Environment and Climate Change Canada
Syed Husain, Environment and Climate Change Canada

Related to scientific studies and/or information sharing about the atmosphere, including weather, meteorology, clouds and precipitation, air quality, atmospheric dynamic and extreme events, using various approaches.

This session covers many topics, including, but not limited to, theoretical research, model development, observation techniques, real-time monitoring, databases, diagnostic methods, data analysis and artificial intelligence.

OCEAN

3010 Coastal Oceanography and Inland Waters

Convenors: Jinyu Sheng, Dalhousie University, Susan Allen, University of British Columbia, Guoqi Han, DFO, 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.

The proposed session will link strongly to “3. Oceans and Ice in a Changing Climate”. 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 in marine conditions over coastal and inland waters, including the Canadian Arctic waters, due to the climate change.

3020 Towards development of Canada's Digital Twin of the Ocean: Research, Development and Work Examples

Convenors: Nancy Soontiens, Fisheries and Oceans Canada, Guoqi Han, Fisheries and Oceans Canada, Youyu Lu, Fisheries and Oceans Canada, Hui Shen, Fisheries and Oceans Canada, Di Wan, Fisheries and Oceans Canada, Floris Goerlandt, Dalhousie University

Digital Twins of the Ocean (DTO) has emerged as a framework to provide a virtual representation of the real ocean for effective monitoring, predicting, and managing complex marine systems, in applications such as fishery and ecosystem protection and management, safe navigation, search and rescue, and climate change adaptation. Internationally, there are fast progresses in all aspects of DTO development, including the various activities under the United Nations Decade of Ocean Science for Sustainable Development. In Canada, there is a tremendous amount of activity relevant to DTO development, including ocean observations, modelling, prediction, analyses, data management, etc. These activities spread among government departments, academia, and the private sector. To be successful in building DTO for oceans around Canada, there are imminent needs to enhance the knowledge and technology exchanges, coordination and collaboration among management and researchers in various organizations and also with the international community. To this end, this session aims to bring together national and international researchers and managers to 1) share the client needs and plans of relevant projects and activities; 2) review existing resources and challenges (data, models, technology and knowledge); 3) present achievements in research and development, and showcase examples; and 4) discuss collaboration opportunities.

3030 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada

Convenors: Paul Myers (University of Alberta), Youyu Lu (DFO - BIO), Susan Allen (University of British Columbia), Greg Smith (ECCC), David Greenberg (DFO - BIO retired), Frederic Dupont (ECCC), Juliana Marson (University of Manitoba), Inge Deschepper (University of Alberta), Tahya Weiss-Gibbons (University of Alberta)

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.

3040 Ocean - Theoretical to applied science

Convenor: Jared Penneym, Fisheries and Oceans Canada

Related to scientific studies and/or information sharing about the ocean, including studies in physical, chemical, and biological oceanography, ocean waves and storm surge using various approaches.

This session covers many topics, including, but not limited to, theoretical research, model development, observation techniques, real-time monitoring, databases, diagnostic methods, data analysis and artificial intelligence.

CLIMATE

4010 Climate variability and predictability

Convenors: Hai Lin, Environment and Climate Change Canada, Bin Yu, 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 Niño/Southern Oscillation (ENSO), atmospheric circulation patterns, tropical-extratropical-polar interactions 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.

4020 Regional scaling of climate projections: robustness, credibility, and criteria for selecting available

Convenors: Dominique Paquin (Ouranos), Martin Leduc (Ouranos)

Regional climate projections are essential for assessing the impacts of climate change in various sectors, including hydrology, agriculture, health, and infrastructure. Methods for downscaling global climate projections can be divided into dynamic and statistical downscaling. Dynamic downscaling includes regional climate models, while statistical downscaling encompasses a range of approaches, from simple climatological bias correction to advanced methods involving artificial intelligence.

This multiplicity of sources of regional climate simulations and the complexity of the methodologies used to produce them can sometimes leave users bewildered, unable to grasp the advantages and limitations of the different products available for their intended application. This raises many questions: How can regional downscaling be properly evaluated and the best data source selected for a given type of application? Can a confidence or robustness index be associated with projected trends? As a user, how do you decide which product to employ? Are the datasets equivalent? What should you do if they diverge? As a data producer, how can you guide users in making these choices?

This session aims to bring together studies and applications using regional climate data, whether based on regional climate model (RCM) projections, global climate model (GCM) projections, or regional projections scaled using conventional statistical methods or artificial intelligence-based emulators. We invite people to present studies that assess the quality and credibility of regional projections and highlight the advantages and limitations of the data, as well as selection criteria based on applications.

4030 Applications of regional climate modeling

Convenors: Dominique Paquin (Ouranos), Alejandro Di Luca (UQAM)

Over the past few years, the development of regional climate models (RCMs) has focused on various aspects such as increasing spatial resolution, integrating more sophisticated physical parameterizations, and using improved geophysical fields. Whether by reaching resolutions that allow the partial simulation of convection (convection-permitting RCMs), by incorporating advanced schemes (surface, microphysics, etc.), or by using new databases as input variables or for evaluation purposes, the models currently in use have undergone profound transformations.

This session welcomes contributions on recent developments in RCMs or on the analysis of regional climate simulations. Submissions focusing on methodological advances, innovative applications of regional models, and their evaluation are particularly encouraged

4040 Collaborative Earth System Modelling in Canada

Convenors: Michael Morris, University of Toronto, Paul J. Kushner, University of Toronto, Neil Swart, Environment and Climate Change Canada

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 pose barriers to their development, application, and analysis without 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 submissions 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. Areas of interest include atmospheric/ocean model process and parameterization development (including sea-ice modelling), short-lived climate forcers and geoengineering/climate intervention, carbon cycle modelling (including climate change mitigation approaches such as atmospheric carbon dioxide removal), land-surface model development and application, and sea-ice/land-ice modelling. We invite submissions covering 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 continue the discussion concerning challenges and opportunities for collaboration between

universities, government laboratories, and the private sector; and the scientific results emerging from such collaborations.

4060 Climate services and the confidence-confusion chasm

Convenors: Megan Hartwell, Canadian Centre for Climate Services, ECCC, Trevor Murdock, Canadian Centre for Climate Services, ECCC

Climate services operate at the interface between climate science and real-world decision making. Climate service providers endeavour to communicate relevant climate information to decision makers, while also communicating the limitations of the information, the uncertainty in the data and its applications. The inherent and unavoidable uncertainty in climate projections makes it tempting to either oversimplify the information or to include everything causing info overload. Climate services plays the vital role of bridging the chasm between confidence and confusion.

Demand is at an all-time high for reliable and usable climate data, information and guidance in ways that are relevant and usable to potential users. This is driven by an increase in the explicit consideration of future climate in many activities such as climate risk disclosures; assessments of climate impacts, vulnerabilities, and risks; adaptation plans; and consideration of future climate in disaster risk reduction.

The goal of this session is to encourage those in the climate field to share their experiences in creating and communicating robust, tailored climate information, data products, and guidance, for delivery to practitioners, researchers, and local communities. We also welcome users of climate information and climate data to share their experiences and findings, highlight how climate service providers have met or not met their needs, and identify ways in which climate services offerings could be expanded to improve their ability to build resilience to a changing climate.

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 and climate scientists
- Translation of technical climate information into a usable format
- Examples of successful application of climate information, particularly for climate change adaptation

4070 Canada's Changing Climate Report 2026: findings from the new national climate science assessment.

Convenors: Chris Derksen, Climate Research Division, ECCC, Elizabeth Bush, Climate Research Division, ECCC

The first edition of Canada's Changing Climate Report, released in 2019, was the first comprehensive national science assessment of past and future changes in climate in Canada. This session will provide a forum for presenting findings from the second edition of Canada's Changing Climate Report, planned for release in

May 2026. In a world of rapid climate change and with a rapid expansion in the amount of published scientific research on climate change in Canada, up-to-date syntheses and assessments of this scientific knowledge are important for both informing action on climate change and for generating a collective understanding of the problem. Canada's Changing Climate Report 2026 is the outcome of a major, collaborative, multi-year assessment process designed to provide timely, robust evidence about both past and future changes in climate in Canada. This edition draws primarily on new science produced by the Canadian research community and is informed by new observations, improved datasets, a better understanding of the climate system, and new modelling of future changes in climate across Canada since the first edition released in 2019. The content of CCCR2026 also reflects an intention to include more topics that are important to Canadians and people living in Canada, to make the report more accessible to a variety of audiences, and to better bridge the gap between scientific assessments and adaptation planning. This session will include presentations directly based on assessment material and we invite other relevant submissions.

4080 Climate - Theoretical to applied science

Convenors: TBA

Related to scientific studies and/or information sharing about the climate, including studies on slowly varying aspects of the Earth's systems, as well as past and future conditions, using various approaches.

This session covers many topics, including, but not limited to, theoretical research, model development, databases, diagnostic methods, climate projections, data analysis and artificial intelligence.

MULTIDISCIPLINARY

5010 Ocean-Sea Ice-Atmosphere Interactions and Dynamics in the Changing Arctic and Sub-Arctic Seas

Convenors: Yarisbel Garcia Quintana (University of Toronto Mississauga), Kent Moore (University of Toronto Mississauga), Paul G. Myers (University of Alberta), Stephen Howell (ECCC)

Global warming is amplified by a factor of four in the Arctic, driving a rapid and unprecedented transformation of the Arctic and Sub-Arctic Seas. Declining sea-ice extent and thickness, increased freshwater input, and enhanced Atlantic Water inflow are reshaping the physical and biogeochemical state of these regions. Sea ice, as both a driver and an indicator of change, integrates complex thermodynamic and dynamic processes that couple the ocean, atmosphere, and cryosphere. Its evolution modulates feedbacks across the system, influencing ocean circulation, stratification, vertical mixing, and the exchange of heat, moisture, and momentum between the ocean and the atmosphere.

These interconnected processes have cascading impacts on marine ecosystems, biogeochemical cycling, and climate feedbacks, as well as on northern communities whose livelihoods and cultural practices are closely tied to sea-ice and ocean conditions. Understanding how the coupled ocean-sea-ice-atmosphere system is responding to and amplifying global change remains a critical scientific and societal challenge.

This session welcomes contributions that explore physical and biogeochemical oceanographic processes in the Arctic and Sub-Arctic Seas using observational, remote-sensing, modelling, and community-based approaches. Topics include (but are not limited to) Atlantic Water pathways, freshwater and heat budgets, land-ice-ocean interactions, sea-ice and polynya dynamics, coastal and open-ocean circulation, and atmosphere-ocean coupling. Cross-disciplinary studies linking ocean processes with the cryosphere, atmosphere, ecosystems, or Indigenous and local knowledge are especially encouraged.

By fostering discussion across disciplines, this session aims to advance our understanding of the processes shaping the rapidly changing Arctic system and to strengthen collaborations that inform sustainable futures in northern regions.

5030 Atmosphere, Ocean, and Climate Dynamics

Convenors: Michael Waite (University of Waterloo), Adam Monahan (University of Victoria), Ron McTaggart-Cowan (ECCC), Marek Stastna (University of Waterloo)

This session combines submissions that document studies of the dynamics of the atmosphere, oceans and/or climate system. The scope of the session is deliberately broad in order to include research that spans the full 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 theoretical, diagnostic and modelling studies that employ the latest analytic and prediction techniques, including those based on machine learning. However, any topic that is relevant to atmosphere, ocean, or climate dynamics will fit well into this session.

5040 Satellite Earth Observations for understanding atmospheric composition and fluxes

Convenors: Debora Griffin (Environment and Climate Change Canada), Chris McLinden (Environment and Climate Change Canada), Mark Gordon (York University)

Satellite Earth Observations (SEO) have significantly advanced the monitoring, assessment, and prediction of changes in the ozone layer, atmospheric composition, air quality, and emission fluxes. With new geostationary sensors now complementing established low-Earth orbit (LEO) missions, unprecedented spatial and temporal coverage is now available for studying atmospheric processes.

This session invites contributions that use SEO data from existing GEO and LEO satellite missions, as well as future constellation concepts to further our understanding of atmospheric composition and fluxes. We welcome research on algorithm development, flux estimates including natural and anthropogenic emissions, assimilation of SEO in prediction systems, trends, and validation across all spectral regions and viewing geometries focusing on greenhouse gases, pollutants, and aerosols. We also encourage studies that apply machine learning or hybrid physical-ML approaches to enhance satellite retrievals, quantify emissions, or characterize surface concentrations.

5050 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future

Convenors: Kaley Walker, University of Toronto, Adam Bourassa, University of Saskatchewan

Satellite Earth observation (SEO) provides a unique global perspective on our planet's atmosphere and surface, including the oceans, land, vegetation, ice, and snow. Current and planned satellite missions from Canada and international agencies have provided and will provide a wealth of new information about the Earth system and that can be used to investigate a wide range of environmental and scientific questions.

This session encourages contributions from across the full SEO value chain, upstream, midstream and downstream, to illustrate the activities currently underway in Canada, involving industry, academia and government. This includes new measurement technologies and techniques, both passive and active; mission development; 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.

5060 Hydrological Change in Canada: Impacts on Water Quantity, Quality and Aquatic Ecology

Convenors: Daniel L. Peters, Environment and Climate Change Canada, Yonas B. Dibiye, Environment and Climate Change Canada

Water bodies across Canada - including wetlands, lakes, and rivers - are undergoing significant and complex change/shifts in hydrology, geochemistry, and aquatic ecology due to accelerating climate change, land-use alterations, and increasing anthropogenic pressures. These changes are affecting the timing and quantity of water availability, water quality, and the overall health and functioning of aquatic ecosystems.

Canadian hydrological systems are strongly shaped by temperature-dependent processes. The formation, growth, and ablation of seasonal snow and ice cover regulate the timing, duration, and magnitude of streamflow and water levels. For instance, ice-jam induced high water levels often represent the extreme end of flood magnitude and dynamics; thus, underscoring the need to explicitly analyze both ice-affected and open-water conditions when assessing hydrological change. Moreover, the timing and rate of the spring snow/ice melt exert a major influence on subsequent flows, levels and the overall hydrological response of a system. The hydrology is also closely linked to water quality and aquatic ecology, which respond to these temperature-driven changes in interconnected ways.

The goal of this session is to bring together scientists engaged in the assessment and modelling of climate- and natural resource development-driven changes in flow and water level regimes across Canada. By fostering interdisciplinary dialogue, we aim to advance the data, models and research needed to guide effective mitigation and adaptation strategies, ensure sustainable water resources, and support environmental flow frameworks that restore and protect riverine and floodplain ecosystems.

Topics of interest include: Cold-regions hydrology in rivers, lakes, and wetlands; Extreme hydrological events, including ice-jam and open-water floods, as well as droughts; Relationships between hydrology, water quality and aquatic ecosystems; Water management strategies for environmental flows, ecosystem restoration, and anthropogenic uses (eg, hydropower generation, resource extraction).

5070 Managing Hydrometeorological Risks in an Uncertain World

Convenors: Philippe Gachon & Bernard Motulsky, University of Québec in Montréal, Claude Masse & Johanne St-Coœur, Meteorological Service of Canada, ECCC, Jacques Lavigne, Améthyste communications

Our planet's climate system is approaching a critical and potentially irreversible tipping point due to the continuous rise in greenhouse gas concentrations. Yet, this evolution unfolds within pervasive uncertainty: uncertainty about the magnitude and speed of changes, their cascading impacts on natural and human systems, and society's adaptive capacity. Recent decades and years have seen accelerated warming, particularly in Arctic and subarctic regions such as Canada, accompanied by increasingly occurrence and intense hydrometeorological extremes and hazards. These hazards interact with demographic growth and economic development, amplifying vulnerabilities and exposures in unpredictable ways.

To tackle these complex issues and turning uncertainty into opportunity to work under crossed disciplines and breaking silos, various research networks have been developed, as the RIISQ (InterSectoral Flood Network of Québec), both in Canada and abroad. Then, this session is an excellent opportunity to bring together various experiences and expertise, and invites contributions addressing key issues in climate risk management, namely:

- Characterization and predictability of hydrometeorological hazards under uncertainty
- Strategies to reduce vulnerability and enhance resilience
- Governance and risk management frameworks adaptable to evolving scenarios and disruptive climate futures
- Risk communication and stakeholder engagement in uncertain contexts

5080 Bolstering Resilience in Uncertain Times

Convenors: Caroline Floyd, CatIQ, Laura Twidle, CatIQ

Canadian catastrophes are on the rise. Each year, the insured cost of severe weather events in Canada tops 2 billion dollars - sometimes much more - as homeowners and businesses face damage from hail, flood, wind, and fire. The overall economic toll, encompassing items such as lost business revenue, un- or underinsured property, and damage to infrastructure - is significantly larger, and significantly harder to quantify.

Attempting to bend down the risk curve for Canadians is a difficult proposition, with underlying difficulties in data availability and collection, inconsistent support from governments, and the challenge of motivating a broad social change against the backdrop of uncertain future conditions. Asking people and

communities to protect themselves from a flood that is certain to occur tomorrow may be relatively straightforward; asking them to prepare for a 1-in-100 storm may engender a very different response. Changing trends in extreme weather both exacerbate that issue and make it even more pressing to address.

This session will welcome speakers working in the risk and resilience space, with an emphasis on applied and social science. Topics we hope to explore include mapping natural perils in Canada; what do we know (and not know) about climate change's impacts on exposure of the built environment to hail, wildfire, and flood? How are the economic impacts of 'natural disasters' changing with time? What avenues are available to both mitigate risks, and protect the natural environment? What links are there between vulnerable populations and increased risks? And how can we advocate for governments, communities, and individuals to steps to take to mitigate their own risk(s) when there is inherent uncertainty in forecasts and climate outlooks?

5090 Multidisciplinary - Theoretical to applied science

Convenors: TBA

Related to multidisciplinary environmental studies and/or information sharing , which includes, but not limited to Arctic studies, wildfire fires, hydrology, and cryology using various approaches.

This session covers all studies related to environmental topics that are not addressed in the atmosphere, ocean, and climate sessions. For example, all models other than atmospheric, ocean, and climate models.

5100 Multidisciplinary- Community, Service and Education

Convenor: André Giguère

Related to multidisciplinary environmental studies and/or information sharing , which includes, but not limited to Arctic studies, wildfire fires, hydrology, and cryology using various approaches.

This session covers many topics, including but not limited to education, community science and data collection, data dissemination, and other activities as well as all environmental topics that are not addressed in the atmosphere, ocean, and climate sessions.

Information and Legend for Sessions, Plenaries and Abstracts

Sessions and Abstracts are listed in the order presented.

Convenors and Session Numbers precede session abstracts

Plenaries are in blue / bold at the beginning of each day.

Please search pdf using keywords, author name or session date / time.

Day 1 – 1 June 2026

Session: 1010 Plenary - The Art of Uncertainty: Planning for a Future that is Hard to Imagine Plénière - L'Art de L'incertitude: planifier un avenir difficile à imaginer **01/06/2026**
11:00

ID: 12863 Invited plenary speaker

The Art of Uncertainty: Planning for a Future that is Hard to Imagine
L'Art de L'incertitude: planifier un avenir difficile à imaginer

*David Spiegelhalter*¹

¹ University of Cambridge

Presented by / Présenté par: *David Spiegelhalter*

Contact: D.Spiegelhalter@statslab.cam.ac.uk

YouTube Recording: <https://youtu.be/qQQqmVkOkIA>

In today's world of profound uncertainty—aptly described as the "conscious awareness of ignorance"—traditional decision-making frameworks often fall short. Where appropriate, we can assess and evaluate probabilities for well-defined events, rather than relying on 'vague verbiage' to communicate uncertainty. But when facing "deep" uncertainty, where we cannot even imagine all the possible futures, conventional methods requiring exhaustive lists of possibilities with assigned probabilities become impractical.

This talk explores some essential qualities for navigating our uncertain age. First, humility requires maintaining openness to unanticipated events. Second, imagination allows us to envision potential futures, particularly adverse scenarios. Finally, resilience enables recovery from unexpected shocks. Both individuals and organizations need physical and mental reserves rather than systems optimized solely for current conditions.

By cultivating imagination, humility, and resilience, we can better face an unpredictable future—not by eliminating uncertainty, but by developing the capacity to adapt and recover when the unexpected inevitably occurs.

Dans le monde d'aujourd'hui où règne l'incertitude, que l'on pourrait qualifier à juste titre de « conscience de l'ignorance », les cadres décisionnels traditionnels ne sont souvent pas à la hauteur. Le cas échéant, nous pouvons évaluer les probabilités pour des événements bien définis, plutôt de se fier au « verbiage vague » pour communiquer l'incertitude. Mais face à une incertitude « profonde », où nous ne pouvons même pas imaginer tous les avenir possibles, les méthodes conventionnelles qui nécessitent des listes exhaustives de possibilités assorties de probabilités deviennent irréalisables.

Cette allocution se penchera sur certaines qualités essentielles pour nous guider dans cette époque incertaine. Premièrement, l'humilité nécessite de rester ouvert aux imprévus. Deuxièmement, l'imagination nous permet d'envisager des avenir possibles, notamment les scénarios défavorables. Enfin, la résilience permet de se remettre de chocs imprévus. Tant les particuliers que les organisations ont besoin de réserves physiques et mentales plutôt que des systèmes optimisés exclusivement pour les conditions actuelles.

En cultivant l'imagination, l'humilité et la résilience, nous pouvons mieux faire face à un avenir imprévisible — non pas en éliminant l'incertitude, mais en développant notre capacité à nous adapter et à rebondir lorsque l'imprévu survient inévitablement.



Time: Monday June 1, 2026 11:00 – 11:55 EDT

Title: *The Art of Uncertainty: Planning for a Future that is Hard to Imagine*

Speaker: Dr. David Spiegelhalter (University of Cambridge)

Bio: Professor Sir David Spiegelhalter FRS OBE is Emeritus Professor of Statistics at the University of Cambridge. He is a regular media commentator on statistical issues, and was very busy over the Covid crisis. His bestselling book, *The Art of Statistics*, was published in 2019, and *The Art of Uncertainty* in 2024. His career highlights include appearing on *Desert Island Discs* in 2022, and in 2011 coming 7th in an episode of BBC1's *Winter Wipeout*. He was elected Fellow of the Royal Society in 2005, awarded an OBE in 2006, and knighted in 2014 for services to medical statistics. He was President of the Royal Statistical Society for 2017-2018, and has been a Non-Executive Director of the UK Statistics Authority since 2020.

Convenors:

Elizaveta Malinina, Environment and Climate Change Canada

Neil Tandon, York University

Nathan Gillett, Environment and Climate Change Canada

Extreme events in weather and climate pose significant risks to lives, ecosystems, and economies, often resulting in devastating losses and long-term impacts. Nevertheless, current knowledge of extremes and how they are evolving in a changing climate is associated with a high degree of uncertainty, often arising from short historical records, incomplete process understanding, or model biases. This session invites contributions addressing all aspects of weather and climate extremes, including but not limited to studies covering uncertainties in physical mechanisms, observations, predictions or projections of extremes, and their communication. We welcome submissions examining extremes of varying durations (from hours to months) and types, including heatwaves, wildfires, extreme precipitation, wind-related events, hydrological extremes (e.g., floods and droughts), and oceanographic extremes (e.g., storm surges, coastal flooding, and marine heatwaves). Submissions may focus on historical changes, event attribution, future projections, or any other extremes-related topic.

**Session: 2031 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 1 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 1**

**01/06/2026
12:30**

ID: 12701 Contributed abstract

High-latitude heat waves: trends and attribution

*Megan Kirchmeier-Young*¹, *Guilong Li*², *Hui Wan*³, *Xuebin Zhang*⁴

¹ Environment and Climate Change Canada

² Environment and Climate Change Canada

³ Environment and Climate Change Canada

⁴ Pacific Climate Impacts Consortium

Presented by / Présenté par: *Megan Kirchmeier-Young*

Contact: megan.kirchmeier-young@ec.gc.ca

Extreme heat is increasing in frequency and intensity in a warming climate. The Arctic is warming faster than other global land areas. Heat waves in the high latitudes can have widespread impacts, with lingering implications for the cryosphere, in addition to effects on humans, ecosystems, and industries in the region. In this presentation, we cover two studies on heat waves in the high latitudes, defined here as north of 40 degrees N. The first

study quantifies trends in observed heat waves across Canadian regions. This work expands on existing information from the analysis of daily extremes, to consider multi-day events that exceed a climatological 90th percentile of daily maximum temperature. We show that these climatological heat waves increased in frequency, duration, and cumulative intensity between 1961 and 2020 across Canada and in most subregions. The second study considers a broader spatial domain to investigate attribution of the observed trends to external forcings. We show that the observed increasing trends in heat wave metrics over the whole Northern high latitudes and all three continental subregions can be attributed to anthropogenic forcing and, in most cases, greenhouse-gas forcing specifically. For some cases, the impacts of anthropogenic aerosols and volcanic eruptions are also detected. Overall, heat waves have increased across the Northern high latitudes, including in Canada, because of human influence on the climate.

**Session: 2031 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 1 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 1**

**01/06/2026
12:42**

ID: 12779 Contributed abstract

Historical Trends of Blizzard Events over the Canadian Prairies

*Wenwei Zhu*¹, *Alex Crawford*²

¹ University of Manitoba

² University of Manitoba

Presented by / Présenté par: *Wenwei Zhu*

Contact: zhuw1@myumanitoba.ca

The Prairies are one of the most active regions for blizzards in Canada. However, we currently do not know whether long-term climate change has included any trends in blizzards on the Canadian Prairies. To address this question, we use ERA5-land data and weather station data to explore Prairie blizzard trends from 1950 to 2024.

Blizzard hours were first identified from observations at 18 weather stations across the Canadian Prairies based on visibility falling below 400 m when snowfall or blowing snow were reported. Corresponding ERA5-Land variables, including near-surface wind speed, snowfall, snow depth, and temperature, were collocated with these observed events. For each combination of meteorological conditions in ERA5-Land (wind speed, snowfall rate, 2-m air temperature, and snow age), we calculated a “credibility score” as the fraction of occurrences in the full ERA5-Land record that co-occurred with observed blizzard hours at corresponding

weather stations. A quadratic relationship was then fitted between the ERA5-Land combinations and their associated credibility scores. This empirical function was subsequently applied across the entire Prairie domain to generate a spatially continuous blizzard credibility dataset. Defining any instance with a credibility score higher than 0.3203 as a “blizzard hour” yields the same average number of blizzard hours in ERA5-Land grid cells as for the 18 corresponding weather stations and a year-to-year Spearman correlation of 0.7.

Using this calibrated ERA5-Land dataset, a Mann-Kendall test revealed a significant decrease in the annual sum of blizzard hours across all Canadian Prairie grid cells, at a rate of -276 hours per decade. The historical trend was significant in Manitoba (-100 hours per decade), but not in Alberta and Saskatchewan. Next steps include diagnosing the drivers of these trends and whether it presages future declines with continued global warming.

**Session: 2031 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 1 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 1**

**01/06/2026
12:54**

ID: 12609 Contributed abstract

**Observed trends in health and agriculture relevant temperature
indices across Canada: 1949-2024**

*Hui Wan*¹ , *Alessio Spassiani*² , *Lucie Vincent*³ , *Dae Jeong*⁴ ,
*Megan Kirchmeier-Young*⁵ , *Alex Cannon*⁶

¹ Environment and Climate Change Canada

² Environment and Climate Change Canada

³ Environment and Climate Change Canada

⁴ Environment and Climate Change Canada

⁵ Environment and Climate Change Canada

⁶ Environment and Climate Change Canada

Presented by / Présenté par: *Hui Wan*

Contact: hui.wan@ec.gc.ca

Trends in health and agricultural indices based on the fourth generation of Canada’s homogenized daily temperature dataset are examined for 1949-2024. Health indices are characterized by warm and cold spells, heatwaves and cold waves, indices associated to thermal comfort, and to heating and cooling requirements. Agriculture temperature-based indices include those related to damaging cold and heat, and to growing season. The results show that the frequency and duration of warm spells have increased across Canada, mainly in the northern and western regions, while a small decrease

is observed in the frequency and duration of cold spells across the country. Heatwaves are more frequent in Canada, especially in the north, British Columbia and Atlantic provinces whereas the frequency of cold waves has decreased across the country, mostly in the north and west. The number of summer days and hot days above 30°C have increased in the southern regions, although that some decreasing trends are found in the number of hot days in the Prairies. The number of tropical nights (when night temperature remains above 20°C) has increased in southern Ontario and Quebec. Heating degree-days have decreased across the country whereas cooling degree-days have increased at most stations in the south. All agriculture cold-related indices, including ice days and frost days, have decreased. The annual highest daily maximum and lowest daily minimum temperatures have increased during the past 76 years, although that some decreasing trends are found in the highest daily maximum temperature in the Prairies. Overall, the growing season is now longer with an earlier start and later end to the season, and the number of growing degree-days has increased across the country.

**Session: 2031 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 1 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 1**

**01/06/2026
13:06**

ID: 12630 Contributed abstract

**Observed trends in precipitation extreme indices as inferred from a
homogenized daily precipitation dataset for Canada**

*Xiaolan L. Wang*¹, *Yang Feng*²

¹ Climate Research Division, Environment and Climate Change Canada

² Climate Research Division, Environment and Climate Change Canada

Presented by / Présenté par: *Xiaolan L. Wang*

Contact: Xiaolan.Wang@ec.gc.ca

This study first developed a homogenized daily precipitation dataset for 425 long-term stations across Canada. Then, it used the homogenized data to assess trends in annual maximum one-day and five-day precipitation, annual maximum one-day snowfall and rainfall, and annual number of heavy precipitation days, of heavy snowfall days, and of heavy rainfall days. The results show that trends in precipitation extreme indices are dominantly positive across Canada, while trends in extreme snowfall amounts are dominantly negative in southern Canada but dominantly positive in northern Canada. Over the period of 1949-2023, the rate of increase in regional mean indices is estimated to be 3.5% and 1.4% per decade for Canada's North and South, respectively, for annual maximum one-day precipitation,

and 2.8% and 1.0% per decade for annual maximum five-day precipitation. The regional mean annual number of heavy precipitation days is estimated to have increased by 6.0% per decade in Canada's North and 0.8% per decade in Canada's South (increased at 72% and 58% of the stations, respectively). The regional mean annual maximum 1-day snowfall is estimated to have decreased by 0.9% per decade in Canada's South but increased by 2.1% per decade in Canada's North. For regional mean heavy snowfall days, the rate of decrease is estimated to be 4.1% per decade in Canada's South, matched with an increase of 0.5% per decade in Canada's North. Similar trend characteristics are seen at southern stations over their longer data record periods (since 1900 or later but before 1949).

**Session: 2031 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 1 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 1**

**01/06/2026
13:18**

ID: 12658 Contributed abstract

Monthly CAPE generation rates predict tropical precipitation trends and extremes

*Monica Figueroa*¹, *Robert Fajber*², *Yi Huang*³

¹ McGill University

² McGill University

³ McGill University

Presented by / Présenté par: *Monica Figueroa*

Contact: monica.figueroa@mail.mcgill.ca

Predicting the spatial distribution, intensity, and variability of extreme tropical precipitation is important in the context of present and future climate change. However, climate models have consistently failed to simulate tropical precipitation correctly, even as their resolution has progressively improved (Tian and Dong, 2020). Convective Available Potential Energy (CAPE) is a measure of the amount of buoyant energy usable by convection, frequently employed to analyze the distribution of tropical convection. Inspired by convective quasi-equilibrium theory (Arakawa, 1974), we demonstrate that the rate of CAPE generation predicts the spatial distribution and intensity of observed tropical precipitation significantly better than CAPE itself. Specifically, we show that there is strong correlation between CAPE generation and tropical precipitation climatology, trends, and extremes in the past four decades of the Japanese Reanalysis for Three Quarters of a Century (JRA-3Q) and the Global Precipitation Climatology Project (GPCP). CAPE generation is therefore a better proxy than CAPE proxy to study tropical convective environments. Further, we

decompose the physical sources of buoyancy generation and find that local evaporation is the main energy source in the tropical rainbands, and surprisingly, heat and moisture convergence play a minor role in providing buoyancy for convection. This can be attributed to vertical diffusive moistening being more efficient than advection and radiation in providing energy available for convection. Based on these conclusions, it may be useful to study air-sea fluxes and local evaporation as a key to improving climate simulations of tropical extreme precipitation.

Session 4010

Convenors:

Hai Lin, Environment and Climate Change Canada

Bin Yu, 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 Niño/Southern Oscillation (ENSO), atmospheric circulation patterns, tropical-extratropical-polar interactions 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.

Session: 4010 Climate variability and predictability
Variabilité et prévisibilité du climat

01/06/2026
12:30

ID: 12673 Contributed abstract

Calibrating Multi-Year Temperature and Precipitation Forecasts

*Julia Velletta*¹, *William Merryfield*², *Viatcheslav Kharin*³, *Reinel Sospedra-Alfonso*⁴

¹ Environment and Climate Change Canada

² Environment and Climate Change Canada

³ Environment and Climate Change Canada

⁴ Environment and Climate Change Canada

Presented by / Présenté par: *Julia Velletta*
Contact: vellettajulia@gmail.com

Probabilistic calibration is standard practice in weather and seasonal forecasting to improve reliability. However, in the context of decadal forecasting, calibration is less commonly applied due to challenges related to the limited number of independent multi-year hindcasts and the non-stationarity of the climate on decadal timescales.

Environment and Climate Change Canada (ECCC) produces annually initialized decadal forecasts using a 40-member ensemble of the Canadian Earth System Model version 5 (CanESM5). A 60-year hindcast dataset enables the evaluation of past forecast performance and the statistical correction of systematic model biases.

In this study, we adapt the calibration methodology developed for seasonal forecasts by Kharin et al. (2017) to multi-year CanESM5 forecasts for temperature and precipitation. This method adjusts mean and spread of the forecast distribution using coefficients that were optimized based on the Continuous Ranked Probability Score (CRPS). Using a sequential out-of-sample skill assessment, we find that spatial smoothing of the rescaling coefficients reduces sampling noise and enables effective calibration, leading to improved reliability and probabilistic skill compared with the raw ensemble. This work suggests that calibration can add value to probabilistic decadal forecasts, supporting their use in climate services and decision-making on multi-year timescales.

Kharin, V. V., Merryfield, W. J., Boer, G. J., and Lee, W.-S., 2017: A Postprocessing Method for Seasonal Forecasts Using Temporally and Spatially Smoothed Statistics. *Mon. Wea. Rev.*, 145, 3545–3561, <https://doi.org/10.1175/MWR-D-16-0337.1>.

Session: 4010 Climate variability and predictability
Variabilité et prévisibilité du climat

01/06/2026
12:42

ID: 12662 **Contributed abstract**

Mechanisms Controlling Northern Hemisphere Summer Extreme Heatwave Trends

*Dingrui Cao*¹, *Hai Lin*², *Yi Huang*³

¹ Department of Atmospheric and Oceanic Sciences, McGill University

² Recherche en Prévision Numérique Atmosphérique, Environment and Climate Change Canada

³ Department of Atmospheric and Oceanic Sciences, McGill University

Presented by / Présenté par: *Dingrui Cao*

Previous studies have shown that summer surface warming over mid- to high-latitude land in the Northern Hemisphere (NH) is highly heterogeneous, with prominent hotspots in Europe–Western Asia, Mongolia–Northern China, and western North America. Here we show that, within these hotspots, the observed intensification of extreme heat largely tracks the rise in seasonal-mean temperature, with little evidence for a systematic strengthening of the most extreme temperatures relative to the mean. This motivates a process-based investigation of the seasonal-mean warming trend, which largely governs the magnitude of heatwave amplification in these regions. We find that seasonal-mean warming in these hotspots reflects the combined influence of (1) large-scale circulation anomalies, notably the circumglobal Rossby wave train in the upper troposphere, (2) land–atmosphere coupling that regulates evaporative cooling, and (3) radiative feedbacks linked to downwelling longwave radiation, with their relative contributions differing across the three regions. Together, these results indicate that extreme-temperature intensification in NH hotspots is fundamentally tied to seasonal-mean warming, and that clarifying the distinct processes shaping this warming is essential for improving future projections of heatwave risk.

Session: 4010 Climate variability and predictability
Variabilité et prévisibilité du climat

01/06/2026
12:54

ID: 12704 Contributed abstract

A Probabilistic Ensemble U-Net for Precipitation Downscaling

*Youssef Diouane*¹, *Julie Carreau*²

¹ Polytechnique Montréal

² Polytechnique Montréal

Presented by / Présenté par: *Freddy Francois Ateba*

Contact: freddy.francois.ateba@gmail.com

Statistical downscaling bridges the resolution gap between global climate models (50-100 km) and the fine scales (1-10 km) needed for regional impact assessment. Beyond point accuracy, the core challenge is generating ensembles that represent uncertainty across the full precipitation distribution, including extremes. Current approaches typically address only part of this: deterministic models provide no uncertainty quantification, single probabilistic models capture only aleatoric variability, and standard deep ensembles introduce model diversity without explicit mechanisms for aleatoric uncertainty. This study proposes a deep ensemble of Probabilistic

U-Nets designed to capture two complementary sources of uncertainty simultaneously. Aleatoric uncertainty, reflecting the irreducible variability of the climate system, is encoded through the probabilistic latent space within each member. Epistemic uncertainty, reflecting model uncertainty, emerges from diversity across independently trained members, each initialized differently and trained on bootstrap-resampled data subsets with varying regularization settings. Training is guided by a composite loss that brings together four terms: the adjusted fair Continuous Ranked Probability Score (afCRPS) for probabilistic skill, noting that its fairness correction also penalizes ensemble collapse; a weighted mean-squared error combined with multi-scale structural similarity (WMSE-MSSSIM) to preserve spatial structure and extreme-value statistics; the KL divergence to regularize the latent space; and a calibration term penalizing miscalibration between ensemble spread and forecast error, an objective the KL term alone cannot enforce. The relative weights are treated as tunable hyperparameters to be explored. The approach will be evaluated on ClimEx daily precipitation at 16x spatial upscaling, using metrics covering deterministic accuracy, probabilistic skill, extreme-value fidelity, and ensemble calibration. The study will examine how this uncertainty decomposition affects reliability and whether the ensemble produces well-calibrated estimates across the full distribution.

Session: 4010 Climate variability and predictability
Variabilité et prévisibilité du climat

01/06/2026
13:06

ID: 12631 Contributed abstract

Atmospheric circulation and moisture budget drivers of dominant modes of winter extreme precipitation variability over North America

*Dae Il Jeong*¹, *Bin Yu*², *Alex Cannon*³

¹ Climate Research Division, Environment and Climate Change Canada

² Climate Research Division, Environment and Climate Change Canada

³ Climate Research Division, Environment and Climate Change Canada

Presented by / Présenté par: *Dae Il Jeong*

Contact: jeong.daeil@ec.gc.ca

Multiday winter precipitation events can trigger significant natural hazards, including flooding and landslides. This study examines the dominant modes of variability in monthly maximum consecutive five-day precipitation extremes (Rx5day) over North America (NA), along with the associated large-scale dynamical, thermodynamical, and moisture-budget drivers during the extended winter season (November–March) for the period 1961–2023. Using common Empirical Orthogonal Function analysis on ERA5 and JRA-55 reanalyses, we identify three dominant modes accounting for 30.7%

of the total variance, characterized by distinct anomaly centers across western and eastern NA. The three modes are primarily driven by large-scale atmospheric circulation anomalies, extending from the North Pacific across NA to the North Atlantic, and atmospheric moisture anomalies, particularly wind-driven moisture transport concentrated in the lower troposphere (surface to ~500 hPa). Anomalous westerly and southerly flows enhance moisture transport from the Pacific into western NA and from the Gulf of Mexico into the southeastern region, respectively. In these areas, enhanced ascent and deep tropospheric moisture columns promote extreme precipitation. Moisture-budget analyses indicate that moisture flux convergence is the dominant source of moisture for Rx5day extremes, whereas local evaporation plays a comparatively minor role. In particular, the convergence of climatological mean moisture by transient winds emerges as the primary contributor to extreme precipitation variability, frequently exceeding the contribution from total moisture flux convergence. Moisture-budget components evaluated at 850 hPa closely resemble their vertically integrated counterparts, underscoring the critical role of the lower troposphere in large-scale moisture transport and convergence processes associated with winter precipitation extremes.

Session: 4010 Climate variability and predictability
Variabilité et prévisibilité du climat

01/06/2026
13:18

ID: 12611 Contributed abstract

Combined impacts of ENSO and Arctic sea ice on North American climate

*Bin Yu*¹, *Hai Lin*², *Shangfeng Chen*³, *Zhibiao Wang*⁴

¹ Climate Research Division, ECCC

² Meteorological Research Division, ECCC

³ Institute of Atmospheric Physics, Chinese Academy of Sciences

⁴ Institute of Atmospheric Physics, Chinese Academy of Sciences

Presented by / Présenté par: *Bin Yu*

Contact: bin.yu@ec.gc.ca

This study explores the combined effects of the El Niño–Southern Oscillation (ENSO) and Arctic sea ice on North American climate. Based on observational data from October 1960 to January 2025 and idealized AGCM experiments with CAM5 of CESM, we show that sea ice anomalies in the western Arctic, particularly when in phase with ENSO during boreal winter, can substantially amplify or dampen ENSO-related surface air temperature (SAT) responses. In-phase combinations (e.g., El Niño with high sea ice) produce SAT anomalies over southern Canada and the northern United

States that are up to 2–3 times stronger than those from ENSO alone. Conversely, out-of-phase pairings (e.g., El Niño with low sea ice) yield weaker and less spatially coherent temperature responses. The enhanced response arises from constructive interference in the tropospheric circulation, which amplifies Pacific–North American (PNA)-like patterns and strengthens heat and moisture transport into North America. These circulation anomalies interact with water vapor and cloud feedbacks, reinforcing SAT anomalies through changes in downwelling longwave radiation. AGCM results confirm both the amplifying influence of Arctic sea ice and the physical mechanisms involved. Our findings highlight Arctic sea ice as a key modulator of ENSO teleconnections. As the Arctic continues to warm and lose sea ice, its role in shaping tropical–extratropical linkages and thus the strength and predictability of ENSO impacts, is likely to intensify. Incorporating Arctic variability will be critical for improving seasonal forecasts and understanding climate variability in a warming world.

Session: 4010 Climate variability and predictability
Variabilité et prévisibilité du climat

01/06/2026
13:30

ID: 12633 Contributed abstract

Summer amplification of rainfall forecast skill in midlatitude western North America

*Hai Lin*¹, *Ryan Muncaster*², *Jacques Derome*³

1

2 ECCC

3 McGill University

Presented by / Présenté par: *Hai Lin*

Contact: hai.lin@ec.gc.ca

Predicting summer precipitation is of great value, as rainfall anomalies are often associated with floods and droughts, but extremely challenging. Here, we show that useful seasonal forecasts for summer precipitation are possible more than half a year in advance in midlatitude western North America. Contrary to the expectation that prediction skill drops with lead time, the rainfall forecast skill in this region amplifies and peaks in the summer season. The interannual variability of summer precipitation in this region is found to be linked to a tropospheric circum-global wave train and correlated with tropical El Niño-like SST anomalies in the preceding spring. Land surface conditions in southwestern North America in winter and spring have a long-lasting impact on the atmosphere, contributing to the summertime rainfall forecast skill. This finding provides scientific support for extending the range of seasonal rainfall predictions and opens possibilities for reliable long-range climate services. It calls for increased scientific

Session 5011 Part 1

Convenors:

Yarisbel Garcia Quintana (University of Toronto Mississauga)

Kent Moore (University of Toronto Mississauga)

Paul G. Myers (University of Alberta)

Stephen Howell (ECCC)

Global warming is amplified by a factor of four in the Arctic, driving a rapid and unprecedented transformation of the Arctic and Sub-Arctic Seas. Declining sea-ice extent and thickness, increased freshwater input, and enhanced Atlantic Water inflow are reshaping the physical and biogeochemical state of these regions. Sea ice, as both a driver and an indicator of change, integrates complex thermodynamic and dynamic processes that couple the ocean, atmosphere, and cryosphere. Its evolution modulates feedbacks across the system, influencing ocean circulation, stratification, vertical mixing, and the exchange of heat, moisture, and momentum between the ocean and the atmosphere.

These interconnected processes have cascading impacts on marine ecosystems, biogeochemical cycling, and climate feedbacks, as well as on northern communities whose livelihoods and cultural practices are closely tied to sea-ice and ocean conditions. Understanding how the coupled ocean–sea-ice–atmosphere system is responding to and amplifying global change remains a critical scientific and societal challenge.

This session welcomes contributions that explore physical and biogeochemical oceanographic processes in the Arctic and Sub-Arctic Seas using observational, remote-sensing, modelling, and community-based approaches. Topics include (but are not limited to) Atlantic Water pathways, freshwater and heat budgets, land-ice–ocean interactions, sea-ice and polynya dynamics, coastal and open-ocean circulation, and atmosphere–ocean coupling. Cross-disciplinary studies linking ocean processes with the cryosphere, atmosphere, ecosystems, or Indigenous and local knowledge are especially encouraged.

By fostering discussion across disciplines, this session aims to advance our understanding of the processes shaping the rapidly changing Arctic system and to strengthen collaborations that inform sustainable futures in northern regions.

**Session: 5011 Ocean–Sea Ice–Atmosphere Interactions
and Dynamics in the Changing Arctic and Sub-Arctic Seas
- Part 1 Interactions et dynamique entre l'océan, la glace
de mer et l'atmosphère dans les mers arctiques et
subarctiques en mutation - Partie 1**

**01/06/2026
12:30**

ID: 12645 Contributed abstract

A new high resolution pan-Arctic extreme wind climatology

*Kent Moore*¹, *Ian Renfrew*²

¹ University of Toronto

² University of East Anglia

Presented by / Présenté par: *Kent Moore*

Contact: gwk.moore@utoronto.ca

The Arctic is known for its extreme winds, often associated with topographic features. These include tip or corner jets that form in southern Greenland and in the Bering Strait region; katabatic winds that develop along Greenland's fjords; downslope windstorms that develop along Novaya Zemlya; and gap winds that develop along Nares Strait and the Alaskan Panhandle. These winds play an important role in the region's oceanography and in forcing sea-ice motion. In addition, the Arctic's rapid warming relative to the rest of the Earth may alter the character of these winds and their impacts on the ocean and sea ice. Despite their importance, there have been few systematic studies of the entire Arctic region that characterize where these winds form. Moreover, many of these wind systems are highly localized in space, making them challenging to study with current-generation global reanalyses. Here, we use the recently released Copernicus pan-Arctic regional reanalysis, with a horizontal resolution of 2.5 km and available from 1986 onwards, to develop an extreme wind climatology for the entire Arctic. In addition to providing new information on the structure of existing tip and corner jets, katabatic winds, downslope windstorms, and gap winds, the analysis also identifies new instances of extreme winds.

Session: 5011 Ocean–Sea Ice–Atmosphere Interactions and Dynamics in the Changing Arctic and Sub-Arctic Seas - Part 1 Interactions et dynamique entre l'océan, la glace de mer et l'atmosphère dans les mers arctiques et subarctiques en mutation - Partie 1

**01/06/2026
12:42**

ID: 12675 Contributed abstract

Investigating Non-linear Interactions That Confound Diagnosis of the Shortwave Arctic Cloud Feedback

*Calvin Coulbury*¹, *Robert Fajber*², *Aaron Donohoe*³

¹

² McGill University

Presented by / Présenté par: *Calvin Coulbury*

Contact: calvin.coulbury@mail.mcgill.ca

The Arctic is warming faster than the rest of the globe, a phenomenon termed Arctic Amplification. However, model projections of the Arctic climate have a near 100% disagreement in simulated warming rates. This disagreement is due in large part to uncertainty surrounding changes in Arctic cloud properties with warming - termed the cloud feedback - which may result in amplification or damping of Arctic warming. Definitions of the cloud feedback and methods to quantify it are varied and seldom agree on sign and magnitude, particularly in the Arctic region. This is in part due to the surface-albedo cloud-masking effect, which describes how the surface-albedo interacts with the clouds to change their radiative impact. In regions with large surface-albedo changes in a warming climate, such as the Arctic, this can have a confounding impact on diagnoses of the Arctic cloud feedback.

We present a unified definition of the Arctic cloud feedback that accounts for the cloud-masking of non-cloud properties such as surface-albedo and clear sky reflectivity. We apply a single layer isotropic radiative transfer model to climate model radiative fields. Using this isotropic model we perform a Taylor series expansion of the change in the shortwave cloud radiative effect (SWCRE) with cloud reflectivity, cloud fraction, surface-albedo, and clear sky reflectivity. This method is applied to 10 CMIP6 models, and the radiative closure it provides between a warming and control scenario is evaluated. This decomposition allows for a highly accurate diagnosis of changes in SWCRE, with radiative closure achieved in a majority of the models used in this study. Additionally, radiative closure is achieved in over 80 % of individual model grid cells in the majority of models used in this study. Model representations of the change in SWCRE and its decomposition are compared, and sources of intermodel spread are discussed.

Session: 5011 Ocean–Sea Ice–Atmosphere Interactions and Dynamics in the Changing Arctic and Sub-Arctic Seas - Part 1 Interactions et dynamique entre l'océan, la glace de mer et l'atmosphère dans les mers arctiques et subarctiques en mutation - Partie 1

**01/06/2026
12:54**

ID: 12802 Contributed abstract

Coupled Canadian Arctic Prediction System (CAPS) at Environment Canada

*Jean-Philippe Paquin*¹, *Sarah MacDermid*², *Frédéric Dupont*³,

Gregory C. Smith ⁴ , Danahé Paquin-Ricard ⁵ , Barbara Casati ⁶ ,
Mathieu Plante ⁷ , François Roy ⁸ , Nathalie Gauthier ⁹ , Fraser
Davidson ¹⁰ , François Lemay ¹¹

¹ MRD / ECCC

² MSC / ECCC

³ MSC-MRD / ECCC

⁴ MRD / ECCC

⁵ MRD / ECCC

⁶ MRD / ECCC

⁷ MRD / ECCC

⁸ MRD / ECCC

⁹ MSC / ECCC

¹⁰ MRD / ECCC

¹¹ MSC / ECCC

Presented by / Présenté par: *Jean-Philippe Paquin*

Contact: jean-philippe.paquin@ec.gc.ca

With the changing conditions in the Arctic, the need for improved forecasting of the meteorological and environmental conditions are increasing. Variability in surface conditions, especially over the ocean and sea ice, increases the uncertainties in heat, moisture and momentum fluxes between the atmosphere, ice and ocean, especially close to the marginal ice zone. These uncertainties increase the potential risks for operating in these harsh areas, both for aircraft and vessels.

Following the success of the Canadian Arctic Prediction System (CAPS) implemented at Environment and Climate Change Canada (ECCC) during the Year of Polar Prediction (YOPP), a second version was reinstated as of June 2025 to address the growing need for accurate meteorological and environmental predictions in the pan-Arctic region. The GEM NWP model in CAPS covers the entire Arctic Ocean, from Bering Strait to south of Iceland (~60oN) at 3km resolution. The NEMO-CICE ice-ocean component follows the Regional Ice-Ocean Prediction System (RIOPS) covering Canada's three oceans on a 1/12o ORCA grid. This presentation evaluates CAPS short-term 48h forecasts with a specific focus on the impact of coupling to the ice-ocean over and near the marginal ice zones.

ID: 12816 Contributed abstract

Assessing Sources of Arctic Sea Ice Loss Using Lagrangian Analysis

*Kaitlin McNeil*¹, *Kent Moore*², *Stephen Howell*³, *Mike Brady*⁴,
*Amy Mann*⁵

¹ University of Toronto

² University of Toronto

³ ECCC

⁴ ECCC

⁵ Oxford University

Presented by / Présenté par: *Kaitlin McNeil*

Contact: gwk.moore@utoronto.ca

The export of sea ice from the Arctic plays a critical role in the decline of multiyear sea ice. Exported Arctic sea ice also contributes to changes in the freshwater budget of the Arctic Ocean as well as the subpolar North Atlantic. Much of the sea ice is exported through Fram Strait or paths through the Canadian Arctic Archipelago (CAA). Changes in sea ice transport through major pathways such as Fram Strait have previously been assessed using sea ice motion products that rely on passive microwave satellite observations. In this work, the feasibility of active microwave products to construct the back trajectories of ice floes across the CAA is assessed. The analysis looks at using a combination of active microwave (RadarSat Constellation Mission and Sentinel 1) and passive microwave products (NSIDC) to construct Lagrangian back trajectories of sea ice being transported out of the Arctic Ocean. Utilizing active microwave allows for regions where ice motion was not previously resolved to be included in this analysis. This enables the origin of ice in the CAA, where higher-resolution is required to assess sea ice motion, to be better understood and may aid predictions of years with reduced ice cover in channels within the CAA.

**Session: 5011 Ocean–Sea Ice–Atmosphere Interactions
and Dynamics in the Changing Arctic and Sub-Arctic Seas
- Part 1 Interactions et dynamique entre l'océan, la glace
de mer et l'atmosphère dans les mers arctiques et
subarctiques en mutation - Partie 1**

**01/06/2026
13:18**

ID: 12672 Contributed abstract

Estimating the contribution of snow on Arctic sea ice to wintertime

freshwater flux through Fram Strait and Davis Strait

*Alex Cabaj*¹ , *Stephen Howell*² , *Marion Bocquet*³ , *Nicole Loeb*⁴
 , *Kaitlin McNeil*⁵ , *Alek Petty*⁶ , *Robert Ricker*⁷

¹ Environment and Climate Change Canada

² Environment and Climate Change Canada

³ NORCE Norwegian Research Centre

⁴ University of Ottawa

⁵ University of Toronto

⁶ University of Maryland

⁷ NORCE Norwegian Research Centre

Presented by / Présenté par: *Alex Cabaj*

Contact: alex.cabaj@ec.gc.ca

Arctic freshwater fluxes play a key role in the Earth's climate system through their influence on both regional and global ocean circulation, and sea ice is a crucial component of the Arctic freshwater budget. However, when calculating freshwater fluxes through flux gates in the Arctic, the contribution from snow on Arctic sea ice is seldom considered. This work presents a first assessment of snow-on-sea-ice freshwater flux across Fram Strait and Davis Strait flux gates during winter (October-April) 2016-2021. We estimate the freshwater content of snow on Arctic sea ice using snow loading from snow-on-sea-ice models (NESOSIM and SnowModel-LG) and passive microwave observations (AMSR2), and estimates of snow salinity derived from in situ observations. We combine this with sea ice area flux derived from the RADARSAT Constellation Mission and Sentinel-1 to derive estimates of snow freshwater flux through both Fram Strait and Davis Strait and assess the proportion of snow freshwater flux relative to the combined total snow-and-ice freshwater flux. Although the seasonality of snow freshwater flux is influenced by the seasonality of ice area flux, some differences remain due to variability in snow loading. Inter-gate differences are also apparent, with Fram Strait having a higher proportion of snow freshwater flux than Davis Strait. We find that the average winter-season snow freshwater volume flux from 2016-2021 is $85 \pm 37 \text{ km}^3$ in Fram Strait and $24 \pm 6 \text{ km}^3$ in Davis Strait, corresponding to 9% and 4% of the total (snow-plus-ice) average winter-season freshwater volume flux in each strait, respectively.

Session 5031 Part 1

Convenors:

Michael Waite (University of Waterloo)

Adam Monahan (University of Victoria)

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 the full 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 theoretical, diagnostic and modelling studies that employ the latest analytic and prediction techniques, including those based on machine learning. However, any topic that is relevant to atmosphere, ocean, or climate dynamics will fit well into this session.

**Session: 5031 Atmosphere, Ocean, and Climate Dynamics
- Part 1 Dynamique de l'atmosphère, des océans et du
climat - Partie 1**

**01/06/2026
12:30**

ID: 12693 Contributed abstract

A New Simple Model of the Biological Carbon Pump

*Francis Poulin*¹, *Aurore Billant*², *Katja Fennel*³

¹ University of Waterloo

² Ecole Polytechnique

³ Dalhousie University

Presented by / Présenté par: *Francis Poulin*

Contact: fpoulin@uwaterloo.ca

The biological carbon pump (BCP) transfers carbon from the surface ocean to depth through production, transformation, and remineralization of organic matter. Phytoplankton convert dissolved CO₂ into organic carbon, which then moves through the food web and is ultimately transformed into sinking particulate organic matter. As this material descends, bacterial decomposition releases CO₂; a fraction is transported to the deep ocean and stored on centennial timescales. Although the BCP strongly influences atmospheric CO₂, ocean acidity, and marine ecosystem structure, the processes controlling remineralization depth remain poorly constrained.

In this talk, I present a simplified biogeochemical model of the BCP that tracks nutrients, organic matter, and apparent oxygen utilization. The model is coupled to an Oceananigans/OceanBioME physical framework and applied using parameter values characteristic of the North Atlantic. Simulations in one and two dimensions allow us to estimate carbon export,

remineralization profiles, and carbon deposition at depth under a range of scenarios. This modelling approach provides a computationally efficient tool for exploring BCP dynamics and their sensitivity to physical and biogeochemical forcing. Ultimately, this framework offers a pathway toward more accurate estimates of carbon sequestration in the ocean interior.

**Session: 5031 Atmosphere, Ocean, and Climate
Dynamics - Part 1 Dynamique de l'atmosphère, des
océans et du climat - Partie 1**

**01/06/2026
12:42**

ID: 12854 Contributed abstract

**Characterizing Metocean and Ice Extremes and Observational
Limitations for Offshore Wind Development in Atlantic Canada**

*Matthew Asplin*¹, *David Fissel*², *Sahar Tavangar*³, *Dallán Friel*⁴, *Indrasenan Thusyanthan*⁵

¹ ASL Environmental Sciences Inc., Victoria, B.C.

² ASL Environmental Sciences Inc., Victoria, B.C.

³ Nicholas O'Dwyer Company, Dublin, Ireland

⁴ INESC TEC.OCEAN, INESC TEC – Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência, Porto, Portugal.

⁵ Venterra Group Ltd, London, United Kingdom

Presented by / Présenté par: *Matthew Asplin*

Contact: masplin@aslenv.com

Offshore wind development in Atlantic Canada requires robust characterization of atmospheric, oceanographic, and cryospheric conditions to support engineering design and long-term operational reliability. This study evaluates the adequacy of existing metocean datasets across Atlantic Canada in relation to international offshore wind standards (IEC 61400-3; ISO 19901-1), with particular focus on observational coverage, temporal length, and representation of extreme conditions.

Key environmental variables assessed include wind fields, waves, ocean currents, water levels, temperature, sea ice concentration and thickness, freezing spray, iceberg occurrence, and bathymetry. Regional data sources, including in situ observations, hindcast models, reanalysis products, and forward-looking Global Climate Models (CMIP5, CMIP6) are reviewed to identify spatial and temporal data gaps relevant to offshore wind lease area prioritization. Results indicate that while wind and wave climatologies are generally well characterized in select regions, significant gaps persist in near-surface current observations, statistical characterizations of extreme

sea ice and iceberg conditions, and long-term concurrent measurements required for joint probability assessments. In addition, non-stationarity associated with climate change introduces uncertainty in extreme value estimation for design-level return periods.

A regional gap analysis framework is presented to guide future collaborative observation programs and relevant model-based analyses involving industry, government, academia, and Indigenous organizations. The findings highlight the need for integrated, multi-parameter metocean monitoring strategies to reduce uncertainty in offshore wind development across Atlantic Canada.

**Session: 5031 Atmosphere, Ocean, and Climate
Dynamics - Part 1 Dynamique de l'atmosphère, des
océans et du climat - Partie 1**

**01/06/2026
12:54**

ID: 12778 Contributed abstract

The Impacts of Ocean-Atmosphere Coupling over Ocean Mesoscale Fronts

*Jakob Braga*¹, *Francis Poulin*², *Michael Waite*³

¹ University of Waterloo

² University of Waterloo

³ University of Waterloo

Presented by / Présenté par: *Jakob Braga*

Contact: jnbraga@uwaterloo.ca

Understanding the interaction between the atmosphere and ocean is crucial to modelling or predicting the dynamics of both the atmosphere and ocean. Observational studies and numerical simulations of atmospheric responses to ocean mesoscale fronts have found strong correlation between the sea surface temperature (SST) and near surface wind speeds, which is interpreted as the SST driving the atmosphere at these scales. Furthermore, studies have shown that SST fronts are capable of modifying surface turbulent heat and momentum fluxes which can affect winds, clouds and rainfall, as well as have larger scale effects on storm tracks. These larger scale effects have been observed to feed back onto the ocean and further evolve the SST fronts, thus making the need to understand the fully coupled atmosphere-ocean system more significant.

To investigate the influence coupling has on the evolution of the atmosphere and ocean, idealized large eddy simulations are used to model an atmosphere and ocean initialized with an SST warm patch in the

presence of weak winds over the course of 24 hours. For simplicity the SST is initialized to only vary in the zonal direction and winds are initialized to be uniform in space blowing across the warm patch. Uncoupled systems are first considered followed by a comparison of the simulations coupled together. Large scale structures of the potential temperature and velocities are investigated alongside the turbulent kinetic energy. To assist in the understanding of dominant factors a momentum budget and turbulent kinetic energy budget will also be analyzed term by term. The coupling is found to have a small impact on the atmosphere over the short time scale, mainly affecting the turbulent kinetic energy, while there is a larger impact in the ocean with coupling causing large scale flow changes as well as greatly altering the turbulent kinetic energy distribution.

**Session: 5031 Atmosphere, Ocean, and Climate
Dynamics - Part 1 Dynamique de l'atmosphère, des
océans et du climat - Partie 1**

**01/06/2026
13:06**

ID: 12808 Contributed abstract

**Numerical simulations of barotropic and baroclinic instabilities in the
Beaufort Gyre**

*Rosalie Cormier*¹, *Francis Poulin*², *Andrea Scott*³

1

2 University of Waterloo

3 University of Waterloo

Presented by / Présenté par: *Rosalie Cormier*
Contact: rosaliecormier17@gmail.com

The Beaufort Gyre is a major region of oceanic circulation in the Canada Basin. Atmospheric winds and a dynamic sea-ice cover exert stresses on the gyre's surface, driving a horizontally and vertically sheared background flow. The sheared flow is balanced by a strong, baroclinic background stratification, which signifies available potential energy. In this configuration, the gyre is susceptible to barotropic and baroclinic instabilities. Barotropic (respectively baroclinic) instability converts background-state kinetic energy (respectively potential energy) into kinetic energy of a perturbation field, thus amplifying initially small disturbances.

I use simulations (created using Oceananigans) of an idealized model to investigate barotropic and baroclinic instabilities in the parameter space relevant to the Beaufort Gyre. The simulations reveal that perturbations grow very slowly via barotropic instability in this regime, in line with our predictions based on classical stability theory. I contend that, due to their

slow growth rates and large spatial scales, pure barotropic instabilities are insignificant in energizing the Beaufort Gyre's (predominantly mesoscale) eddy field. Simulations of baroclinic instabilities in the same parameter regime indicate that these instabilities are more relevant to mesoscale eddy development. I discuss the results in the context of the climatological importance of baroclinic eddies: Baroclinic eddies are able to weaken the Beaufort Gyre's stratification, thus permitting more vertical overturning. Hence, they provide a pathway for the redistribution of salt and heat throughout the gyre's depth, and in particular may allow warm water to impinge upon the surface ice cover.

**Session: 5031 Atmosphere, Ocean, and Climate
Dynamics - Part 1 Dynamique de l'atmosphère, des
océans et du climat - Partie 1**

**01/06/2026
13:18**

ID: 12635 Contributed abstract

Turbulent Flow Analysis of Rayleigh Taylor Instability With Strong Cabbeling

*Marek Stastna*¹, *Michael Waite*²

¹ University of Waterloo

² University of Waterloo

Presented by / Présenté par: *Marek Stastna*

Contact: mmstastn@uwaterloo.ca

We present direct numerical simulations of Rayleigh Taylor instability in cold, fresh water. The non monotonic nature of the equation of state implies that two fluid parcels with different temperatures may have the same density. When these two mix, they yield a fluid parcel with a larger density than the initial two. This phenomenon, called strong cabbeling, can serve to bootstrap the initial instability and drive long lived turbulence. We conduct numerical simulations over long enough time scales so that the instability thoroughly mixes the water column. However, the mixing is never complete. Indeed, we show that the long time state of the simulation exhibits a weak stable stratification and maintains a low level of active overturning. Invoking the horizontal isotropy of the underlying instability we utilize horizontal averaging as a proxy for Reynolds averaging. Moreover, we demonstrate that the often invoked eddy viscosity hypothesis cannot be applied to the vertical component of velocity. Nevertheless, the averaged quantities allow for the assessment of the importance of strong cabbeling during the complete evolution of the instability.

Convenor: André Giguère

Related to multidisciplinary environmental studies and/or information sharing , which includes, but not limited to Arctic studies, wildfire fires, hydrology, and cryology using various approaches.

This session covers many topics, including but not limited to education, community science and data collection, data dissemination, and other activities as well as all environmental topics that are not addressed in the atmosphere, ocean, and climate sessions.

Session: 5100 Multidisciplinary- Community, Service and Education Multidisciplinaire- Communauté, Services et Éducation

**01/06/2026
12:30**

ID: 12651 Contributed abstract

Session: 5100 Multidisciplinary- Community, Service and Education Multidisciplinaire- Communauté, Services et Éducation

**01/06/2026
12:30**

ID: 12651 Contributed abstract

From Monitoring to Access: Strengthening British Columbia's Climate Data through the Provincial Climate Data Set (PCDS)

*Tong Li*¹ , *Ted Weick*² , *Francis Zwiers*³ , *John Sampson*⁴ ,
*James Hiebert*⁵ , *Rod Glover*⁶

¹ Pacific Climate Impacts Consortium, University of Victoria

² Environmental Monitoring Branch, Ministry of Environment and Parks

³ Pacific Climate Impacts Consortium, University of Victoria

⁴ Pacific Climate Impacts Consortium, University of Victoria

⁵ Pacific Climate Impacts Consortium, University of Victoria

⁶ Pacific Climate Impacts Consortium, University of Victoria

Presented by / Présenté par: *Tong Li*

Contact: tongli1997@uvic.ca

British Columbia's climate varies dramatically over short distances, from coastal temperate rainforests to inland fjords and glaciated alpine terrain. Capturing this variability requires continuous, high-resolution climate monitoring supported by robust data infrastructure.

As a core partner within British Columbia's Climate Related Monitoring Program (CRMP), the Pacific Climate Impacts Consortium (PCIC) has developed the Provincial Climate Data Set (PCDS) and an associated online data portal that gives convenient open access to PCDS data holdings. The PCDS is a comprehensive, continually updated archive of historical, station-based weather and climate data for British Columbia. It aggregates historical information with observations from operational networks maintained by provincial agencies, industry partners, and

Environment and Climate Change Canada to support research, infrastructure planning, and public safety decisions. The dataset and portal are used by provincial government departments, regional districts, researchers, infrastructure planners, and environmental consultants to inform climate risk assessments and adaptation strategies. The PCDS aims to provide high-quality, standardized, and accessible climate data to support adaptation to a changing climate across BC.

In this talk, I will provide an inside look at PCIC's role in collecting, managing, and distributing station-based climate data. While long-term data archiving has been an ongoing PCIC commitment, we have recently completed a major refinement and upgrade of the database system. I will highlight key technical advancements, including extensive metadata updates, the implementation of PCDS change tracking, and work that is underway to improve data quality control and provide standardization of data from different networks. Finally, I will briefly demonstrate how users can search, visualize, and download PCDS data products to support regional climate analysis.

Session: 5100 Multidisciplinary- Community, Service and Education Multidisciplinaire- Communauté, Services et Éducation

**01/06/2026
12:42**

ID: 12774 Contributed abstract

Bridging Monitoring Gaps: Volunteer Snow Observations in Northwestern New Brunswick

*Hadleigh Thompson*¹, *Julie Thériault*², *Stephen Déry*³, *Amélie Sauvageau*⁴, *Ronald Stewart*⁵

¹ Université du Québec à Montréal

² Université du Québec à Montréal

³ University of Northern British Columbia

⁴ Université du Québec à Montréal

⁵ University of Manitoba

Presented by / Présenté par: *Hadleigh Thompson*
Contact: thompson.hadleigh@uqam.ca

The variable nature of snow accumulation and melt over time and space complicates hydrological forecasting, yet conventional monitoring networks lack the density required to capture localized snowpack dynamics. In this study, we evaluated daily and weekly snow depth and snow water equivalent (SWE) observations collected at 22 sites by volunteer citizen scientists (individuals and school groups) during the Saint John River Experiment on Cold Season Storms (SAJESS) around Edmundston, northwestern New Brunswick, from December 2020 to May 2021. Volunteers contributed over 1,100 snow depth measurements and 450 SWE measurements, with particular emphasis on daily sampling during the spring melt period. Snow depth observations agreed well with those from a

nearby federal weather station (R^2 up to 0.99; mean bias ≈ -1.14 cm), providing finer spatial detail and highlighting subtle differences across the 22 sites that were not resolved by the ~ 4 km gridded model product. SWE comparisons showed reasonable correspondence with modeled values, though with greater site-to-site variability. We demonstrate that volunteer-collected snowpack data can reveal local anomalies and meaningfully augment existing monitoring networks. We also discuss the benefits and challenges for groups considering the integration of daily citizen science measurements. Overall, strengthening local engagement can substantially improve the coverage and reliability of snowpack assessments in data-limited regions.

Session: 5100 Multidisciplinary- Community, Service and Education Multidisciplinaire- Communauté, Services et Éducation

**01/06/2026
12:54**

ID: 12804 Contributed abstract

Uncertainty as a Resource: Utilizing Urban Scale Shared Socioeconomic Pathways in Community Futuring

*Navyata Neeraj*¹, *John Robinson*², *Robert Soden*³

1

² Munk School of Global Affairs and School of the Environment, University of Toronto

³ Faculty of Computer Science and School of the Environment, University of Toronto

Presented by / Présenté par: *Navyata Neeraj*

Contact: n.neeraj2201@gmail.com

This research explores the appropriation of data-driven scenarios developed by the United Nation's Intergovernmental Panel on Climate Change (IPCC) for community-based climate action in Toronto. The IPCC's global Shared Socioeconomic Pathways (SSPs), developed by climate experts operating within the context of global climate science and policy-making, conceptualize uncertainty through model structure, boundary conditions, and scenario assumptions. But these forms of uncertainty rarely translate into the experiential frames through which cities and communities understand climate risk. As a result, the utility of global SSPs for national and subnational planning has been increasingly questioned.

As part of a longer-running partnership aimed at developing neighbourhood-level sustainability pathways, we collaborated with neighbourhood organizations to adapt the SSPs for use in Toronto. We translated global SSPs into place-based indicators and combined them with interactive scenario artefacts to create Toronto-scale SSPs for 2050 to support discussion around sustainable futures. We introduced uncertainty to the public not as a technical obstacle, but as a generative resource – something that helps surface values, lived experiences, and divergent interpretations of how futures could unfold. By presenting a range of plausible socioeconomic

trajectories, the localized SSPs enabled participants to see uncertainty as a space of possibility rather than a source of confusion. In facilitated workshops, participants interpreted these Toronto-level scenarios through personal histories, identities, and lived experiences, producing situated understandings and concrete actions for their neighbourhood that were resilient across alternative futures and extended far beyond the original SSP narratives.

We argue that utilizing localized SSPs, complemented with participatory interpretive backcasting methods - offers a practical way to bridge scientific uncertainty and public understanding. This approach does not reduce uncertainty; rather, it operationalizes it as a resource for decision making, enabling communities and the City to navigate climate futures with greater relevance and contextual grounding.

Session: 5100 Multidisciplinary- Community, Service and Education Multidisciplinaire- Communauté, Services et Éducation

**01/06/2026
13:06**

ID: 12669 Contributed abstract

Canadian component of the North American Decade Collaboration Centre

*C. Harold Ritchie*¹, *Gregory Smith*², *Fraser Davidson*³, *Enrique Alvarez*⁴

¹ ECCC

² ECCC

³ ECCC

⁴ Mercator Ocean International

Presented by / Présenté par: *C. Harold Ritchie*

Contact: Hal.Ritchie@ec.gc.ca

The Ocean Prediction Decade Collaboration Centre (DCC) is a cross-cutting structure of the United Nations Decade of Ocean Science for Sustainable Development (UNDOS) with the goal of promoting collaboration towards “a predicted ocean”, one of the transformative outcomes of UNDOS. The DCC is promoting collaborations to build the ocean forecasting we need by building the assets to enable it through a loop of activities implemented by our community. These activities include the Architecture Guide for development of forecasting services, and the Operational Readiness Level (ORL) Guide for production operations and upgrades. The DCC is a community organized in regional teams connecting the world around ocean forecasting with an Atlas of ocean forecasting systems and a forum for discussion amongst groups. There are 8 Regional Teams where members interact on a more local scale particularly including North America (our NA-DCC covering the Atlantic and Pacific coasts of the USA and Canada, also Bermuda, Hawaii, Midway and Aleutians) and Arctic and Antarctic. Each Regional Team has a Steering Team to provide ideas

for steering and contribute to the Regional Team activities. The DCC is also producing special publications on operational prediction.

Within the Canadian Operational Network of Coupled Environmental Prediction Systems (CONCEPTS), fully integrated environmental prediction systems composed of atmosphere, ice, ocean, and wave modeling and analysis systems have been developed and are being implemented operationally to produce a range of value-added marine environmental prediction products to support a variety of users. The Canadian component of the NA-DCC provides an international forum to leverage, diversify, enhance, motivate and demonstrate Canadian participation in the UNDOS activities. This presentation will highlight some of these systems and applications and will be made on behalf of our colleagues in CONCEPTS, many of whom will be giving further details in companion presentations.

Session 2032 Part 2

Convenors:

Elizaveta Malinina, Environment and Climate Change Canada

Neil Tandon, York University

Nathan Gillett, Environment and Climate Change Canada

Extreme events in weather and climate pose significant risks to lives, ecosystems, and economies, often resulting in devastating losses and long-term impacts. Nevertheless, current knowledge of extremes and how they are evolving in a changing climate is associated with a high degree of uncertainty, often arising from short historical records, incomplete process understanding, or model biases. This session invites contributions addressing all aspects of weather and climate extremes, including but not limited to studies covering uncertainties in physical mechanisms, observations, predictions or projections of extremes, and their communication. We welcome submissions examining extremes of varying durations (from hours to months) and types, including heatwaves, wildfires, extreme precipitation, wind-related events, hydrological extremes (e.g., floods and droughts), and oceanographic extremes (e.g., storm surges, coastal flooding, and marine heatwaves). Submissions may focus on historical changes, event attribution, future projections, or any other extremes-related topic.

**Session: 2032 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 2 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 2**

**01/06/2026
13:50**

ID: 12648 Contributed abstract

**Summers over land and ocean are becoming longer, transitioning
faster, and accumulating more heat**

*Ted Scott*¹ , *Rachel White*² , *Simon Donner*³

- 1 University of British Columbia, Geography
- 2 University of British Columbia, EOAS
- 3 University of British Columbia, Geography

Presented by / Présenté par: *Ted Scott*

Contact: tedjs@student.ubc.ca

Midlatitude summers are now longer and hotter, and seasonal transitions are more abrupt, relative to the 1961-1990 period. These changes to the timing and length of summer weather conditions matter due to connections with extreme weather events, plant and animal phenology, economic productivity, human and ecosystem health, drought and wildfire, and energy demand. From 1990-2023, mean summer length has increased by 5-7 days/decade across inland areas, and similarly for coastal margins and oceans in the midlatitudes, with length generally expanding symmetrically. This rate is faster than the ~4 days/decade reported in prior works for midlatitude land through 2012. The speed of summer seasonal transitions is also increasing, with temperatures changing more rapidly at onset and withdrawal of summer, altering important cues to organisms. Accumulated heat, or cumulative summer heat stress, is growing at 44 °C·day/decade since 1990 for Northern Hemisphere land, more than three times as fast as the 14 °C·day/decade increase from 1961 to 1990. This increase in accumulated summer heat may challenge the ability of humans in the midlatitudes to physiologically adapt and will likely increase the energy expended for daytime and nighttime cooling. We provide theoretical explanations for the increase in seasonal transition speed and non-linear growth of accumulated heat in response to warming. Additionally, we highlight changes for ten urban areas around the globe, with summer lengthening in some, such as Sydney and Minneapolis, by more than one day per year. We then investigate whether similar trends in summer length, seasonal transition speed, and accumulated heat are captured in climate model output.

Session: 2032 Weather, Climate, and Environmental

Extremes in Changing Climate - Part 2 Conditions

météorologiques, climatiques et environnementales extrêmes

dans un climat en mutation - Partie 2

01/06/2

026

14:02

ID: 12737 Contributed abstract

**Investigation of Community Earth System Model Dynamical
Temperature Trends using Circulation Analogs Under Multiple
Climates**

*Jamie Robson*¹, *Rachel White*², *Taylor Swift-Lapointe*³

- 1 University of British Columbia
- 2 University of British Columbia
- 3 University of British Columbia

Presented by / Présenté par: *Jamie Robson*

Contact: jrobso01@student.ubc.ca

Understanding how climate change is and will be affecting extreme weather in different regions of the world is of the utmost importance. Global climate models can allow for the comparison between different climates, but the underlying processes must be understood in order to fully interpret the results. There remain large uncertainties in the extent to which climate change is impacting the circulation of the atmosphere, despite potentially significant consequences. Here we use a temperature reshuffling method known as taking the “analogs” to condition the temperature record to specific atmospheric circulation patterns. This method has been used in the past to determine whether circulation patterns that lead to weather extremes are becoming more frequent due to climate change, and to quantify the impacts on extreme weather. Using results from model runs of the Community Earth System Model (CESM2) we investigate trends in the frequency of circulation anomalies associated with extreme heat under three different climates, namely pre-industrial, historical (1950-2022), and a future high emissions scenario. We compare the dynamical temperature trends between current observations and pre-industrial simulations to quantify the relative roles of natural variability and forced climate change in the observed trends. We then investigate individual parameters of the analog method in order to understand how the dynamical temperature trend changes as a result of individual parameters. This work provides an important investigation into the role of forced climate change in the trends observed in circulation patterns leading to extreme heat events.

**Session: 2032 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 2 Conditions
météorologiques, climatiques et environnementales extrêmes
dans un climat en mutation - Partie 2**

**01/06/2
026
14:14**

ID: 12745 Contributed abstract

**From Circulation Anomalies to Local Flood Risk: CM1-Based Modeling
of Convective Extremes related to atmospheric blocking**

*Marie-Christin Eckert*¹, *Annette Rudolph*², *Lisa Schielicke*³

¹ Technische Universität Berlin

² Technische Universität Berlin

Presented by / Présenté par: *Marie-Christin Eckert*

Contact: m.eckert@tu-berlin.de

A rising trend in extreme precipitation events (EPEs) is observed in many regions worldwide, with warm-season heavy rainfall increasingly associated with mesoscale convective systems (MCSs). While atmospheric blockings are known to modulate large-scale flow and promote persistent weather regimes, their role in shaping the vertical thermodynamic and kinematic environments that govern MCS organization and rainfall efficiency remains insufficiently quantified. Because climate change is altering both the frequency and structure of blocking events, understanding the dynamical pathways linking blocking regimes to convective extremes is essential. This approach directly links large-scale circulation anomalies to convective storm behavior in a controlled modeling environment.

The simulations quantify how variations in blocking structure modulate vertical wind shear, moisture stratification, instability, and mesoscale moisture convergence, thereby influencing MCS initiation, organization, propagation and rainfall intensity. Extreme precipitation metrics, including maximum hourly rainfall, event duration, spatial footprint, and track, will be used as input for a deep learning–based groundwater monitoring network across multiple stations in Germany. This network serves as a testbed to illustrate how circulation-conditioned convective extremes translate into hydrological impact metrics. By explicitly linking large-scale circulation regimes to localized hydrological responses, this framework enhances process understanding across scales.

Session: 2032 Weather, Climate, and Environmental

Extremes in Changing Climate - Part 2 Conditions

**météorologiques, climatiques et environnementales extrêmes
dans un climat en mutation - Partie 2**

01/06/2

026

14:26

ID: 12806 Contributed abstract

Evaluation of WRF and RegCM5 Performance in Simulating a High-Impact Extreme Precipitation Event Over Eastern Canada

*Rohtash Rohtash*¹, *Hamed D. Ibrahim*², *Paul Kushner*³

¹ Department of Civil and Mineral Engineering, University of Toronto, Canada

² Department of Civil and Mineral Engineering, University of Toronto, Canada

³ Department of Physics, University of Toronto

The performance of two state-of-the-art regional climate models, the Weather Research and Forecasting (WRF) model and the Regional Climate Model (RegCM5), was assessed using simulations of the high-impact extreme rainfall event of October 10, 2016, over Nova Scotia, Canada. WRF employed a convection-permitting nested km-scale configuration, and RegCM5 mirrored the same setup, with identical grid spacing and land surface parameters. The initial and boundary conditions for both models are the same. Precipitation intensity, duration, mechanism, and model computational demand also assessed and compared. Statistical skill score analyses is used to validate model output against ERA5 reanalysis and against gauge station observations. Preliminary results show that WRF performs better, capturing the spatio-temporal pattern of the event (correlation, $r=0.93$ and probability of detection, $POD=0.82$) relative to ERA5 observation, compared to RegCM5 ($r=0.41$, $POD=0.25$). WRF captures key convective-scale features such as low-level jets and moisture convergence. RegCM5 shows substantial underestimation of extreme precipitation intensity. The results suggest that WRF's has strength in forecasting extreme precipitation in Eastern Canada, while RegCM5 offers advantages in computational efficiency. These results provide a benchmark that is useful for model selection. Three planned experiments with differing RegCM5 configuration are expected to further distinguish the relative strengths of WRF and RegCM5.

Session: 2032 Weather, Climate, and Environmental

Extremes in Changing Climate - Part 2 Conditions

**météorologiques, climatiques et environnementales extrêmes
dans un climat en mutation - Partie 2**

**01/06/2026
14:38**

ID: 12840 Contributed abstract

**Future Hydrological Extremes with Bias-Corrected CanESM5-1 and
CanRCM5-1 Simulations**

*Marlen Kolbe*¹ , *Rachel White*² , *Michael Sigmond*³ , *John Scinocca*⁴ , *Slava Kharin*⁵ , *Yanjun Jiao*⁶

1

2 UBC

3 ECCC

4 ECCC

5 ECCC

6 ECCC

Presented by / Présenté par: *Marlen Kolbe*

Contact: marlen.kolbe@ubc.ca

Accurate representation of the local frequency and intensity of precipitation extremes and atmospheric rivers (ARs) remains a challenge in climate modeling over North America. Systematic biases in large-scale atmospheric circulation, temperature, and moisture fields in both global and regional models affect the frequency, intensity, and spatial structure of ARs and associated extreme precipitation. These limitations reduce confidence in projections of future hydrological extremes under continued warming.

Here we investigate how different bias-correction strategies influence the simulation of historical and future climatology and extremes using the Canadian global and regional climate modeling framework, including the Canadian Earth System Model (CanESM5.1) and the Canadian Regional Climate Model (CanRCM5.1) at 0.22° resolution. We assess diagnostic bias correction of the driving atmosphere, spectral nudging, and Climatological Adaptive Bias Correction (CABCOR), an empirical runtime bias-correction scheme applied during model integration in both the global and regional configurations.

With particular focus on AR-related events, we use ensemble simulations for the historical period and the SSP3-7.0 scenario of the global and regional model to show how these methods influence the mean state, daily variability and precipitation extremes.

Session 3011 Part 1

Convenors:

Jinyu Sheng, Dalhousie University

Susan Allen, University of British Columbia

Guoqi Han, DFO

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.

The proposed session will link strongly to “3. Oceans and Ice in a Changing Climate”. 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

in marine conditions over coastal and inland waters, including the Canadian Arctic waters, due to the climate change.

**Session: 3011 Coastal Oceanography and Inland Waters -
Part 1 Océanographie côtière et eaux intérieures - Partie
1**

**01/06/2026
13:50**

ID: 12642 Contributed abstract

**Mobile Sea Ice Contributed to the Trapping of the R/V Norseman II
during June 2024**

*Kent Moore*¹ , *Michael Steele*² , *Jinlun Zhang*³ , *Axel Schweiger*⁴
*, Thomas Ballinger*⁵ , *Irina Trukhanova*⁶ , *Michael Michael Lawson*
7 , *William Beatty*⁸ , *Scott Hameister*⁹

- ¹ University of Toronto
- ² University of Washington
- ³ University of Washington
- ⁴ University of Washington
- ⁵ University of Alaska
- ⁶ U.S. Fish and Wildlife Service
- ⁷ National Weather Service
- ⁸ USGS
- ⁹ Support Vessels of Alaska

Presented by / Présenté par: *Kent Moore*
Contact: gwk.moore@utoronto.ca

Amplified Arctic warming is leading to reduced sea ice cover and a younger, thinner and more mobile ice pack. These changes offer the possibility of increased maritime activity across the Arctic Ocean. However, the increased mobility of a thinner ice pack can also produce more frequent maritime hazards. Here, we examine the case of the Norseman II research ship that was trapped in sea ice in the southern Chukchi Sea for 14 days in June 2024. This is the first study of its sort in this region. We show that anomalously thick and extensive sea ice was present northward of the region prior to the event and that strong northerly winds in early June advected this ice southwards, trapping the ship. Later in June, southerly winds advected ice northwards away from the ship, helping to free it. We further show that the event was forecastable.

ID: 12656 Contributed abstract

Development of a coupled physical-biogeochemical model of Quatsino Sound, a mid-latitude fjord in British Columbia

*Kyoko Ohashi*¹, *Laura Bianucci*²

¹ Fisheries and Oceans Canada

² Fisheries and Oceans Canada

Presented by / Présenté par: *Kyoko Ohashi*

Contact: kyokoohashi@gmail.com

Fjords act as transition zones between terrestrial ecosystems and the open ocean, and are thought to play an important role in the global climate system due to their high rates of carbon burial. Numerical modelling of fjords is a relatively underdeveloped field, likely due to the challenge presented by the range in scales of interest from the fjords themselves to the adjacent continental shelf and open ocean. Models with unstructured grids can be useful in such cases, given their variable horizontal resolution. In this study, we present a coupled physical-biogeochemical (BGC) numerical ocean model in which the Finite Volume Community Ocean Model (FVCOM) and the Integrated Compartment Water Quality Model (FVCOM-ICM) are used respectively for the hydrodynamic and BGC simulations, using an unstructured grid with horizontal resolution varying from ~10 m to ~800 m. The study area is Quatsino Sound, a mid-latitude fjord located on the Pacific coast of northern Vancouver Island, British Columbia. The fjord consists of a main channel connected to three major inlets and has about 500 sources of freshwater discharge. Collaboration among Fisheries and Oceans Canada, the Quatsino First Nation, and an industry partner has provided a rich set of in situ observations that has greatly aided the modelling effort and highlighted the presence of severe hypoxic conditions. Previous work showed that the output of the hydrodynamic model is realistic with respect to observations, and here we show that this is still the case when the model simulation is extended to a full year and updated from FVCOM version 4.1 to version 5.0. We also present a preliminary assessment of the BGC model's performance as well as a discussion of the possible roles played by factors such as the freshwater discharge and the differing degrees of physical connection between the fjord's main channel and inlets.

ID: 12663 Contributed abstract

Effects of Remotely Generated Coastal Trapped Waves in Extreme Coastal flooding in the Bohai Sea in October 2024

*Yan Yang*¹, *Jinyu Sheng*²

¹ Dalhousie University

² Dalhousie University

Presented by / Présenté par: *Yan Yang*

Contact: rn385140@dal.ca

Record-breaking coastal flooding occurred in the Bohai Sea on 21 October 2024 in the calm weather condition, which was not forecasted accurately in time. In this study, hydrodynamics in the Bohai Sea and adjacent waters during this flooding event are examined using a nested-grid ocean circulation model based on the Regional Ocean Modeling System. Analysis of model results demonstrates that this widespread flooding was caused by three major drivers including (a) remotely generated coastal trapped waves (CTWs), (b) large spring tides, and (c) elevated background sea level associated with large-scale circulation over the northwestern Pacific. The CTWs were generated by atmospheric forcing over the Yellow Sea, Korea Strait, and Sea of Japan. The Complex Empirical Orthogonal Function (CEOF) analysis is used to examine the main characteristics of these CTWs, which propagated from the Korean shelf to Bohai Sea and then to the Chinese shelf. Our findings highlight the importance of trans-basin dynamics in coastal flood forecasting.

Session: 3011 Coastal Oceanography and Inland Waters -

Part 1 Océanographie côtière et eaux intérieures - Partie

1

01/06/2026

14:26

ID: 12742 Contributed abstract

Seasonal and interannual variations in the California Undercurrent off Western Canada

*Guoqi Han*¹

¹ Fisheries and Oceans Canada

Presented by / Présenté par: *Guoqi Han*

Contact: Guoqi.Han@dfo-mpo.gc.ca

A 1/36-degree ocean model in the northeast Pacific is used to study seasonal and interannual variability in the California Undercurrent. The ocean model is forced by hourly winds and heat flux, major ocean tides and climatological monthly river runoffs. The model monthly temperature, salinity and currents are evaluated against in situ observations. On the seasonal scale, the California Undercurrent strengthens from spring to fall and diminishes in winter. On the interannual scale, the transport anomalies of the California Undercurrent are positively correlated with the Oceanic Niño Index. The interannual variability of the California Undercurrent off Western Canada is likely associated with the sea level variability off South California propagating poleward, providing the poleward longshore pressure gradient along the upper continental slope. El Niño enhances the California Undercurrent mainly due to the equatorial coastal sea level variation propagating poleward.

**Session: 3011 Coastal Oceanography and Inland Waters -
Part 1 Océanographie côtière et eaux intérieures - Partie
1**

**01/06/2026
14:38**

ID: 12833 Contributed abstract

**Implementation of the Global Ensemble Storm Surge Prediction
System for operational forecasting.**

*Oleksandr Huziy*¹, *Pengcheng Wang*², *Natacha Bernier*³, *Benoit
Pouliot*⁴, *Patrick Timko*⁵, *Frédéric Dupont*⁶

¹ ECCC

² ECCC

³ Météo-France

⁴ ECCC

⁵ ECCC

⁶ ECCC

Presented by / Présenté par: *Oleksandr Huziy*

Contact: oleksandr.huziy@ec.gc.ca

The Global Ensemble Storm Surge Prediction System has been running with experimental status at Environment and Climate Change Canada since June 2025. It produces 21 realizations of 16-day forecasts of ocean water level twice daily (00Z and 12Z runs). The system is based on the Global Deterministic Storm Surge Prediction system, operational since 2023, and is bound to replace the current Regional Ensemble Storm Surge Prediction

System, covering eastern portions of the Canadian coastline. The system includes baroclinic and ice effects. A novel perturbation of the tides is also applied.

We present the evaluation of the new global system's performance against the current operational regional system and discuss details of the implementation, de-tiding, and remaining challenges.

Session 4020

Convenors:

Dominique Paquin (Ouranos)

Martin Leduc (Ouranos)

Regional climate projections are essential for assessing the impacts of climate change in various sectors, including hydrology, agriculture, health, and infrastructure. Methods for downscaling global climate projections can be divided into dynamic and statistical downscaling. Dynamic downscaling includes regional climate models, while statistical downscaling encompasses a range of approaches, from simple climatological bias correction to advanced methods involving artificial intelligence.

This multiplicity of sources of regional climate simulations and the complexity of the methodologies used to produce them can sometimes leave users bewildered, unable to grasp the advantages and limitations of the different products available for their intended application. This raises many questions: How can regional downscaling be properly evaluated and the best data source selected for a given type of application? Can a confidence or robustness index be associated with projected trends? As a user, how do you decide which product to employ? Are the datasets equivalent? What should you do if they diverge? As a data producer, how can you guide users in making these choices?

This session aims to bring together studies and applications using regional climate data, whether based on regional climate model (RCM) projections, global climate model (GCM) projections, or regional projections scaled using conventional statistical methods or artificial intelligence-based emulators. We invite people to present studies that assess the quality and credibility of regional projections and highlight the advantages and limitations of the data, as well as selection criteria based on applications.

Les projections climatiques régionales sont indispensables pour évaluer les impacts des changements climatiques dans divers secteurs, notamment l'hydrologie, l'agriculture, la santé et les infrastructures. Les méthodes pour la mise à l'échelle des projections climatiques globales se distinguent par une mise à l'échelle dynamique ou statistique. La mise à l'échelle dynamique inclut les modèles régionaux de climat, tandis que la mise à l'échelle statistique comprend un éventail d'approches, de la correction simple des biais climatologiques aux méthodes avancées impliquant l'intelligence artificielle.

Cette multiplicité des sources de simulations climatiques régionale et la complexité des méthodologies employées pour les produire laissent parfois parfois l'utilisateur qui ne saisit pas les avantages et les limitations des différents produits disponibles en fonction de l'application visée. De nombreuses questions peuvent ainsi être posées : Comment évaluer correctement la mise à l'échelle régionale et choisir le meilleur source de données en fonction du type d'application ? Peut-on associer un indice de confiance ou de robustesse aux tendances projetées ? En tant qu'utilisateur, comment décider quel produit utiliser ? Les jeux de données sont-ils équivalents? Que faire s'ils divergent? En tant que producteur de données, comment guider un utilisateur face à ces choix?

Cette session propose de rassembler des études et applications utilisant des données climatiques régionales, que celles-ci soient basées sur des projections de modèles climatiques régionaux (MRC), des projections de modèles climatiques globaux (MCG) ou régionaux mises à l'échelle à l'aide de méthodes statistiques classiques ou d'émulateurs basés sur l'intelligence artificielle. Nous invitons les gens à présenter des études permettant d'évaluer la qualité et la crédibilité des projections régionales et à mettre en lumière les avantages et les limitations des données, ainsi que des critères de sélection en fonction des applications.

Session: 4020 Regional scaling of climate projections: robustness, credibility, and criteria for selecting available data
Mise à l'échelle régionale des projections climatiques : robustesse, crédibilité et critères de sélection des données disponibles

**01/06/2026
13:50**

ID: 12690 Contributed abstract

A perfect-model framework for evaluating statistically downscaled bias-adjusted climate simulations affected by multiple levels of error

*Éric Dupuis*¹, *Martin Leduc*², *Blaise Gauvin St-Denis*³

¹ Ouranos

² Ouranos

³ Ouranos

Presented by / Présenté par: *Éric Dupuis*

Contact: eric.dupuis.1@umontreal.ca

To reliably drive impact models in a variety of sectors, climate model outputs often need to be post-processed using statistical downscaling and bias adjustment methods to improve their agreement with the observed climatology. This post-processing introduces a supplementary uncertainty to

climate change projections which needs to be quantified. We present a framework to evaluate the performance of several contemporary post-processing methods in reducing biases in both present and future climates for an ensemble of temperature-based climate indicators. A Perfect-model approach is employed: A regional climate model simulation is spatially filtered to remove small-scale features and is subsequently post-processed toward three reference simulations acting as pseudo-observations. The biases of the simulation relative to these pseudo-observations mimic three levels of errors in climate simulations: 1) errors associated with the lack of small-scale spatial features, 2) internal climate variability and 3) model systematic bias. All diagnosed methods fail to recover the small spatial scales of temperature patterns at the daily time scale. At the climatological scale, methods perform differently depending on the complexity of both the method and the indicator. Finally, some climate indicators are more affected than others by non-stationary biases emerging from climate change. Notably, regional feedbacks from snow cover melting in future climate can significantly affect future model biases and therefore modulate the climate change signal of post-processed simulations.

Session: 4020 Regional scaling of climate projections: robustness, credibility, and criteria for selecting available data
Mise à l'échelle régionale des projections climatiques : robustesse, crédibilité et critères de sélection des données disponibles

**01/06/2026
14:02**

ID: 12650 Contributed abstract

How close are IPCC regions to their 1.5° and 2°C equivalent warming limits?

*Tong Li*¹, *Francis Zwiers*², *Xuebin Zhang*³, *Qiaohong Sun*⁴

¹ Pacific Climate Impacts Consortium, University of Victoria

² Pacific Climate Impacts Consortium, University of Victoria

³ Pacific Climate Impacts Consortium, University of Victoria

⁴ School of Atmospheric Sciences, Nanjing University of Information Science and Technology

Presented by / Présenté par: *Tong Li*

Contact: tongli1997@uvic.ca

Global temperatures during the 2015-2024 decade averaged more than 1.2°C above pre-industrial levels, indicating that only limited global warming budgets remain before reaching the Paris Agreement 1.5°C and 2°C warming thresholds. Questions remain, however, about the magnitude of comparable remaining warming “budgets” in individual years, and whether

these regional thresholds will be breached at the same time as the Paris Accord global thresholds. One impediment to clarifying these questions is that many regions, including Canada, have insufficient preindustrial period observational data to well quantify their preindustrial climatological reference temperatures.

Here, we quantify regional warming between 1850–1900 and 2016–2025 in all IPCC regions and attribute it to specific external forcing agents using a Bayesian framework that constrains multi-model simulations with observations, enabling robust warming estimates even in data-sparse regions. We find that most land areas have warmed by more than 1°C above pre-industrial levels during the past decade, with high-latitude regions exceeding 2.5°C. Despite these marked differences across regions, all regions have consistently already attained approximately 91% of the regional warming expected under 1.5°C global warming limit, and about 70% under 2°C limit. Thus, roughly 9% and 30% respectively remain in the fractional warming budgets relative to the regional warming amounts expected under the Paris Accord global limits. Attribution confidence is highest in low-latitude tropical regions, including much of Africa, where internal variability is low, while high-latitude regions show greater uncertainty. Greenhouse gases contributed 4–24% more warming than the observed, partially offset by aerosol cooling. These results underscore the urgency of regional adaptation strategies and highlight the limited time remaining to avoid overshooting Paris Agreement warming limits.

Session: 4020 Regional scaling of climate projections: robustness, credibility, and criteria for selecting available data
Mise à l'échelle régionale des projections climatiques : robustesse, crédibilité et critères de sélection des données disponibles

**01/06/2026
14:14**

ID: 12724 Contributed abstract

Integrating freezing rain projections for Québec in a climate services portal: challenges and opportunities

*Dominique Paquin*¹, *Émilie Bresson*², *Pierre Pellerin*³,
*Christopher McCray*⁴

¹ Ouranos

² Ouranos

³ Ouranos

⁴ Ouranos

Presented by / Présenté par: *Dominique Paquin*

Contact: paquin.dominique@ouranos.ca

This study presents the approach used to provide decision makers and stakeholders with information on the future evolution of freezing rain events, based on two sets of regional climate model (CRCM5) simulations driven by CMIP5 and CMIP6 global climate models. Three main steps are described: (1) comparing selected indicators with observations, (2) assessing the climate change signal for these indicators, and (3) addressing various technical issues, including questions related to ensemble size, before, during, and after publication on the website.

The climatological evaluation shows a general overestimation of long freezing rain events compared to station observations, consistent with the known wet bias in CRCM5 and the lack of atmospheric feedback from latent heat release in the diagnostic method used. CRCM5-CMIP6 simulations (0.11°) produce more freezing rain hours and events than CRCM5-CMIP5 (0.22°), confirming the influence of model resolution. Despite these differences in historical period, the projected climate change signal is similar in both ensembles.

The integration of freezing rain into the Ouranos Climate Portraits website raised several open questions, including the scarcity of observations, the use of multiple diagnostic methods, and inconsistencies among data sources compared to other published variables. However, discussions with users highlighted that the need for guidance on the direction of change for rare but potentially hazardous variables such as freezing rain outweighs modellers' concerns about providing imperfect information. This insight is relevant for other marginal variables, especially those that cannot be properly diagnosed from global climate models, are strongly influenced by topography, or require high resolution to represent complex physical processes.

Session: 4020 Regional scaling of climate projections: robustness, credibility, and criteria for selecting available data
Mise à l'échelle régionale des projections climatiques 01/06/2026
: robustesse, crédibilité et critères de sélection des données disponibles 14:26

ID: 12696 Contributed abstract

ESPO-R : A bias-adjusted ensemble of regional climate projections based on a dynamically downscaled CMIP6 subset

*Martin Leduc*¹, *Juliette Lavoie*², *Éric Dupuis*³, *Guillaume Evin*⁴,
*Gabriel Rondeau-Genesse*⁵, *Dominique Paquin*⁶, *Dominic Matte*⁷,
*Sarah Gammon*⁸, *Travis Logan*⁹, *Louis-Philippe Caron*¹⁰

- 1 Ouranos
- 2 Ouranos
- 3 Ouranos
- 4 INRAE
- 5 Ouranos
- 6 Ouranos
- 7 Ouranos
- 8 Ouranos
- 9 Ouranos
- 10 Ouranos

Presented by / Présenté par: *Martin Leduc*

Contact: leduc.martin@ouranos.ca

Using climate model simulations for driving hydrological and other impacts models often requires the application of statistical adjustment methods aiming to minimise biases that are inherent to every climate model output. The Coupled Model Intercomparison Project Phase 6 (CMIP6) is today's most popular database of climate simulations used for producing such adjusted datasets, mostly due to its large ensemble size which allows to cover the main components of uncertainty associated with climate projections. Due to both their inherent biases and coarse spatial resolutions, raw CMIP simulations are often inadequate for local impacts and adaptation assessments. Bias adjustment methods applied to these model output allow to mostly resolve climatological biases and result in a downscaled dataset when a high-resolution reference dataset such as a reanalysis is used as the target for the statistical adjustment. Such implicit statistical downscaling thus impose small-scale climatological features from the historical climate onto coarse-resolution simulations, thus limiting their use for local climate projections in areas with complex surface-atmosphere interactions. To circumvent this issue, here we present the first sample of a new dataset of bias-adjusted climate projections based on a dynamically downscaled subset of CMIP6 models from the Canadian Regional Climate Model version 5 (CRCM5). Referred to as ESPO-R (for "Ensemble de simulations post-traitées d'Ouranos - Régional"), this new ensemble aims to complement another similar Ouranos product based on statistically-downscaled bias-adjusted CMIP6 global climate model simulations (ESPO-G). In this presentation, we show the results of the methodological steps and decisions that were required to obtain ESPO-R, followed by an extensive evaluation of the dataset using several metrics and climate indicators. We finally discuss its application and complementarity with ESPO-G, its global sibling in the context of research and climate services.

ID: 12743 Contributed abstract

**Multivariate downscaling of CanRCM5 with approaches to reduce
computational costs**

*Stephen Sobie*¹, *Charles Curry*²

¹ Pacific Climate Impacts Consortium

² Pacific Climate Impacts Consortium

Presented by / Présenté par: *Stephen Sobie*

Contact: ssobie@uvic.ca

Statistical downscaling aims to correct for biases that may be present in global and regional climate models, and provide information about climate change for users at locally-relevant scales. While many statistical downscaling methods are univariate, multivariate methods enable better representation of events defined by the interaction of multiple variables, such as snowfall or compound extreme events. However, multivariate methods generally incur higher computational costs, making them more challenging to apply to large ensembles or with high-resolution target datasets. Here, we investigate how changing the order of operations when applying a multivariate downscaling method can potentially reduce the overall computational requirements.

Simulations from the latest version of the Canadian Regional Climate model (CanRCM5, horizontal resolution ~25km) are downscaled using historical data from the Canadian Surface Reanalysis (CaSR, Version 3.2, resolution ~10km) as the calibration target dataset. We apply N-dimensional Multivariate Bias Correction (MBCn) to downscale 9 climate variables over Canada using two approaches. The first approach applies MBCn directly from CanRCM5 to the target. In the second approach, the CaSR target dataset is aggregated to the RCM resolution and then MBCn is applied to adjust the RCM inputs to match the multivariate structure of CaSR. Next, the bias corrected RCM output is downscaled to CaSR using a faster univariate method, substantially reducing the overall computational time required to produce the downscaled results. The results from the two approaches are then quantified via the calculation of multivariate indices, inter-variable correlation, and a multivariate distance metric to quantify the differences in performance between them.

Convenors:

Yarisbel Garcia Quintana (University of Toronto Mississauga)

Kent Moore (University of Toronto Mississauga)

Paul G. Myers (University of Alberta)

Stephen Howell (ECCC)

Global warming is amplified by a factor of four in the Arctic, driving a rapid and unprecedented transformation of the Arctic and Sub-Arctic Seas. Declining sea-ice extent and thickness, increased freshwater input, and enhanced Atlantic Water inflow are reshaping the physical and biogeochemical state of these regions. Sea ice, as both a driver and an indicator of change, integrates complex thermodynamic and dynamic processes that couple the ocean, atmosphere, and cryosphere. Its evolution modulates feedbacks across the system, influencing ocean circulation, stratification, vertical mixing, and the exchange of heat, moisture, and momentum between the ocean and the atmosphere.

These interconnected processes have cascading impacts on marine ecosystems, biogeochemical cycling, and climate feedbacks, as well as on northern communities whose livelihoods and cultural practices are closely tied to sea-ice and ocean conditions. Understanding how the coupled ocean–sea-ice–atmosphere system is responding to and amplifying global change remains a critical scientific and societal challenge.

This session welcomes contributions that explore physical and biogeochemical oceanographic processes in the Arctic and Sub-Arctic Seas using observational, remote-sensing, modelling, and community-based approaches. Topics include (but are not limited to) Atlantic Water pathways, freshwater and heat budgets, land-ice–ocean interactions, sea-ice and polynya dynamics, coastal and open-ocean circulation, and atmosphere–ocean coupling. Cross-disciplinary studies linking ocean processes with the cryosphere, atmosphere, ecosystems, or Indigenous and local knowledge are especially encouraged.

By fostering discussion across disciplines, this session aims to advance our understanding of the processes shaping the rapidly changing Arctic system and to strengthen collaborations that inform sustainable futures in northern regions.

Session: 5012 Ocean–Sea Ice–Atmosphere Interactions and Dynamics in the Changing Arctic and Sub-Arctic Seas - Part 2 Interactions et dynamique entre l'océan, la glace de mer et l'atmosphère dans les mers arctiques et subarctiques en mutation - Partie 2

**01/06/2026
13:50**

ID: 12694 Contributed abstract

A Process-Based Evaluation and Filtering of CMIP6 Models for Northern Canada

*Asli Bese*¹, *Martin Leduc*², *Travis Logan*³

- 1 Ouranos Inc.
- 2 Ouranos Inc.
- 3 Ouranos Inc.

Presented by / Présenté par: *Asli Bese*

Contact: bese.asli@ouranos.ca

We develop a process-based assessment and filtering of 32 CMIP6 models for the Inuit regions of Canada that targets sea ice processes in adjacent Arctic and sub-Arctic basins. We first quantify the coupling of near-surface temperature anomalies in each Inuit region with sea ice concentration anomalies in nearby basins. We find that basin–land coupling is strongest for nearby basins and yields distinct basin importance profiles across regions. We then assess models’ skill in reproducing the basin-mean sea ice seasonal cycle relative to the ERA5 reanalysis, and use the basin–land coupling strengths to weight basin performance by regional relevance and filter the ensemble for each region. Models with large, systematic sea ice errors in the basins most relevant to each region are excluded, yielding filtered ensembles for each Inuit region and a 17-member pan-regional subset. Our assessment shows that sea ice seasonal cycle skill is strongly basin dependent, with the largest intermodel spread and highest median errors in the Labrador Sea and the smallest spread and lowest median errors in the Hudson Bay System. Performance filtering has a modest effect on ensemble medians but consistently raises the lower tail of projected land temperature change across regions and seasons, whereas filtering by the IPCC AR6 likely range of transient climate response (TCR) primarily reduces the upper tail. Approximately 29\% of models retained in the regional performance-filtered subsets fall outside the AR6 likely TCR range, indicating that process-based regional constraints and global sensitivity screening can shift projections in different directions. Overall, the framework is transferable to other regions and target variables, and provides constrained subsets that can serve as a practical starting point for regional applications where decision-relevant lower and upper bounds of change matter.

Session: 5012 Ocean–Sea Ice–Atmosphere Interactions and Dynamics in the Changing Arctic and Sub-Arctic Seas - Part 2 Interactions et dynamique entre l'océan, la glace de mer et l'atmosphère dans les mers arctiques et subarctiques en mutation - Partie 2

**01/06/2026
14:02**

ID: 12852 Contributed abstract

Occurrence and Drivers of Polynyas in Nares Strait from High-Resolution Modelling

Yarisbel Garcia Quintana ¹ , Clark Pennelly ² , G.W. Kent Moore ³ ,
Paul Myers ⁴

¹ University of Toronto Mississauga

² University of Alberta

³ University of Toronto Mississauga

⁴ University of Alberta

Presented by / Présenté par: *Yarisbel Garcia Quintana*

Contact: yarisbel.garciaquintana@utoronto.ca

Nares Strait is a narrow and dynamically complex Arctic gateway connecting the Arctic Ocean with northern Baffin Bay, where strong tides, winds, and ice–ocean interactions regulate the exchange of freshwater, heat, and sea ice. Within this region, recurrent polynyas and flaw leads—most prominently associated with the North Water system—maintain areas of open water during winter and strongly influence regional air–sea heat fluxes, sea-ice production, ocean ventilation, and marine ecosystem productivity. Despite their importance, the small-scale processes governing polynya formation and variability along Nares Strait remain poorly understood, particularly the coupled effects of tides, winds, and ice dynamics. High-resolution modelling offers a critical opportunity to resolve these mechanisms in this rapidly changing Arctic gateway.

Here, we use a high-resolution ocean–sea ice model to examine the occurrence and variability of polynyas along Nares Strait, north of Smith Sound. Our analysis is based on ARC60, a pan-Arctic configuration with 1/60° horizontal resolution, 50 vertical levels, tidal forcing, and coupling to the LIM2 sea-ice model, in a configuration that resolves mesoscale and tidal processes. The simulation includes glacial and river runoff, and atmospheric forcing from ERA5. We quantify the spatial distribution and seasonal cycle of polynya occurrence and assess the relative roles of tides, winds, and ice dynamics in their formation and persistence. This work advances understanding of fine-scale air–sea–ice interactions and their implications for heat and freshwater exchange across the Arctic–Baffin Bay gateway.

**Session: 5012 Ocean–Sea Ice–Atmosphere Interactions
and Dynamics in the Changing Arctic and Sub-Arctic Seas
- Part 2 Interactions et dynamique entre l'océan, la glace de
mer et l'atmosphère dans les mers arctiques et
subarctiques en mutation - Partie 2**

**01/06/2026
14:14**

ID: 12713 Contributed abstract

Evaluating Labrador Sea convection in the Arctic regionally refined

E3SM Model

*Romina Piunno*¹, *Kent Moore*², *Milena Veneziani*³, *Georgina Gibson*⁴

¹ University of Toronto

² University of Toronto

³ Los Alamos National Laboratory

⁴ Los Alamos National Laboratory

Presented by / Présenté par: *Romina Piunno*

Contact: romina.piunno@mail.utoronto.ca

The Labrador Sea is a key region for the formation of North Atlantic deep water. The maximum mixed layer depth observed at the end of the winter season is strongly modulated by ocean-atmosphere heat fluxes. While this relationship is commonly known, numerically modelling the turbulent and highly non-linear processes remains a challenge, particularly in fully coupled Earth system models. Here we evaluate the skill of the Energy Exascale Earth System Model (E3SM) in its Arctic refined configuration (E3SM-Arctic) in representing convection in the Labrador Sea. The model is configured with a regionally refined horizontal resolution of 10 km for the ocean/ice model components and $\frac{1}{4}^\circ$ for the atmosphere/land components in the Arctic-Subarctic regions. Work by Veneziani et al. have shown E3SM to be skillful in representing convection in the Greenland Sea, though this work suggests that the Labrador Sea is overly sensitive to atmospheric heat fluxes. Here we quantify model biases in the Labrador Sea convection, and discuss areas for model improvement to better represent Labrador Sea Water formation.

Session: 5012 Ocean–Sea Ice–Atmosphere Interactions and Dynamics in the Changing Arctic and Sub-Arctic Seas - Part 2 Interactions et dynamique entre l'océan, la glace de mer et l'atmosphère dans les mers arctiques et subarctiques en mutation - Partie 2

01/06/2026
14:26

ID: 12687 Contributed abstract

Intermodel Comparison of Surface-Forced Water Mass Transformation in CMIP6 Simulations

*Jiechao Zhu*¹, *Robert Fajber*²

¹ McGill University

² McGill University

Presented by / Présenté par: *Jiechao Zhu*

Contact: jiechaozhu04@gmail.com

The Atlantic Meridional Overturning Circulation (AMOC) is fundamental to climate regulation, yet its representation in climate models remains a primary source of uncertainty. Using CMIP6 pre-industrial simulations, we investigate surface-forced water mass transformation (SFWMT) to quantify the buoyancy forcing of the AMOC across the subpolar North Atlantic. Our results reveal substantial intermodel spread in SFWMT across the Labrador Sea (LS), the Eastern Subpolar Gyre (ESPG) and the Nordic Seas (NS). While the ESPG exhibits the largest magnitude of SFWMT, the LS shows the highest intermodel variability, which is comparable to its multi-model mean. These SFWMT biases are driven by coupled errors in surface buoyancy fluxes and underlying density fields, which are strongly correlated across models. Mechanistically, we show that SFWMT in the LS is modulated by the marginal ice zone (MIZ). Reduced MIZ extent causes surface heat fluxes to concentrate along the ice edge and within a narrow density bin, leading to sharply peaked SFWMT. Conversely, wider MIZs distribute fluxes and transformations more broadly. Finally, while surface-forced MOC generally tracks the actual AMOC, discrepancies within specific model families suggest that internal mixing partially offsets surface-driven components. These findings highlight that large intermodel differences in SFWMT, mediated by MIZ-atmosphere-ocean interactions, continue to complicate robust projections of future AMOC strength.

Session 5032 Part 2

Convenors:

Michael Waite (University of Waterloo)

Adam Monahan (University of Victoria)

Ron McTaggart-Cowan (ECCC)

Marek Stastna (University of Waterloo)

This session combines submissions that document studies of the dynamics of the atmosphere, oceans and/or climate system. The scope of the session is deliberately broad in order to include research that spans the full 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 theoretical, diagnostic and modelling studies that employ the latest analytic and prediction techniques, including those based on machine learning. However, any topic that is relevant to atmosphere, ocean, or climate dynamics will fit well into this session.

ID: 12788 Contributed abstract

Overshooting Top Dynamics above Supercell Thunderstorms

*Parveer Banwait*¹, *Morgan O'Neill*²

¹ University of Toronto

² University of Toronto

Presented by / Présenté par: *Parveer Banwait*

Contact: parveer.banwait@mail.utoronto.ca

A lot of climate science research focuses on how climate change affects severe weather. However, the converse is also important, and severe weather in aggregate could impact warming trends. Large supercell thunderstorms in particular have the ability to inject large amounts of water vapour high up into the stratosphere. This stratospheric water vapour can have many impacts, including hampering the recovery of ozone, or causing increased surface warming, although this effect is disputed. In 2021, numerical experiments showed that the mechanism is a new kind of hydraulic jump in locations with strong winds in the stratosphere, which also creates an above anvil cirrus plume (AACP). However, those experiments used unrealistic updraft forcing alongside an extremely unstable sounding; artificially forcing the formation of the hydraulic jump. To remedy this, we designed new experiments using the Bryan Cloud Model 1 (CM1) in which thunderstorms are allowed to evolve more naturally. This includes adding model noise and using a low amplitude thermal bubble to initiate convection; allowing for a more realistic evolution of the UTLS dynamics. Here we demonstrate the impact of upper-level winds on wave breaking above the overshooting top, before a hydraulic jump occurs to form the visible AACP. The precursor turbulence is a necessary condition for allowing the storm-top flow to become supercritical. This improved understanding of storm top dynamics will allow for better representation of water vapour global climate models. Understanding these storm top dynamics better will also allow us to improve forecasting lead times of the most dangerous storms, potentially saving lives and property.

Session: 5032 Atmosphere, Ocean, and Climate Dynamics - Part 2 Dynamique de l'atmosphère, des océans et du climat - Partie 2

**01/06/2026
14:02**

ID: 12636 Contributed abstract

Process-based summary verification diagnostics leveraging Arctic

supersite multi-variate observations

Barbara Casati ¹ , Johanna Tjernström ²

¹ Meteorological Research Division, ECCC

² University of Oslo

Presented by / Présenté par: *Barbara Casati*

Contact: barbara.casati@ec.gc.ca

Verification of operational prediction systems generally considers traditional meteorological and environmental variables (temperature, humidity, wind, precipitation, snow cover, sea-ice, etc.) and compares the predicted versus observed values for each state variable separately. However, these variables are often interrelated through physical processes. Therefore, assessing whether prediction systems can reproduce these relationships provides insight into the accuracy of the representation of these physical processes.

Process-based evaluation will become increasingly important as operational NWP systems move towards Earth System Modelling, in which different components (atmosphere, surface, ocean, sea-ice, ...) are coupled through interfacial fluxes. Diagnostics that assess these interactions can guide improvements both within individual components and across the range of coupling processes. Finally, the advent of data-driven models also highlights the need of diagnostics that assess physical coherence (in-built in traditional physical models) between AI-predicted variables.

In this study, we propose some process-based summary diagnostics for routine verification in operational environments. These summary statistics, based on the 2-d Earth Mover Distance, aim to provide an overall assessment of the strength of the process representation (while the in-depth process understanding needs to be addressed by a separate analysis). The diagnostics are illustrated by evaluating the Canadian deterministic prediction systems, against the YOPPsiteMIIP Arctic supersite multivariate observations.

Session: 5032 Atmosphere, Ocean, and Climate Dynamics - Part 2 Dynamique de l'atmosphère, des océans et du climat - Partie 2

**01/06/2026
14:14**

ID: 12678 Contributed abstract

Avalanche dynamics in a 2D tumbling drum with frictionless, cohesive oil droplets

Simaya Rosenbloom ¹ , *Johnathan Hoggarth* ² , *Hamza Khattak* ³ ,

¹ McMaster University

² Yale University

³ University of Cambridge

⁴ McMaster University

Presented by / Présenté par: *Simaya Rosenbloom*

Contact: rosens13@mcmaster.ca

With a changing climate, the prediction of natural disasters such as avalanches and landslides is integral to the safety of communities, and the preservation of the environment. The macroscopic behaviours of these collapses are highly dependent on the microscopic forces between the particles; in the same way that one can make a snowman from sticky packing snow, but not with powdery snow you'd hope to ski on. We create a minimal model of avalanche dynamics by tumbling frictionless and cohesive particles in a rotating drum to study micro-avalanches.

**Session: 5032 Atmosphere, Ocean, and Climate
Dynamics - Part 2 Dynamique de l'atmosphère, des
océans et du climat - Partie 2**

**01/06/2026
14:26**

ID: 12637 Contributed abstract

Anisotropy of Stratified Turbulence near Boundaries

Michael Waite ¹ , *Nikhil Murali* ²

¹ University of Waterloo

² University of Waterloo

Presented by / Présenté par: *Michael Waite*

Contact: mwaite@uwaterloo.ca

Surface cooling can create strong stable density stratification in the atmospheric boundary layer. Stratification leads to anisotropy in boundary layer turbulence by inhibiting vertical motion across a wide range of length scale. In this talk, we investigate anisotropy in direct numerical simulation of turbulence in an open channel with surface cooling, as an idealized model for stratified boundary layer turbulence. Two techniques are used to quantify anisotropy. At large scales, the invariants of the anisotropy tensor are employed to characterize anisotropy of the Reynolds stresses. At small scales, the contributions of different velocity gradients to the kinetic energy

dissipation are compared to their isotropic values. A range of stratifications, from neutral to strongly stratified, are considered. Implications for sub-grid turbulence models are discussed.

Session 2033 Part 3

Convenors:

Elizaveta Malinina, Environment and Climate Change Canada

Neil Tandon, York University

Nathan Gillett, Environment and Climate Change Canada

Extreme events in weather and climate pose significant risks to lives, ecosystems, and economies, often resulting in devastating losses and long-term impacts. Nevertheless, current knowledge of extremes and how they are evolving in a changing climate is associated with a high degree of uncertainty, often arising from short historical records, incomplete process understanding, or model biases. This session invites contributions addressing all aspects of weather and climate extremes, including but not limited to studies covering uncertainties in physical mechanisms, observations, predictions or projections of extremes, and their communication. We welcome submissions examining extremes of varying durations (from hours to months) and types, including heatwaves, wildfires, extreme precipitation, wind-related events, hydrological extremes (e.g., floods and droughts), and oceanographic extremes (e.g., storm surges, coastal flooding, and marine heatwaves). Submissions may focus on historical changes, event attribution, future projections, or any other extremes-related topic.

**Session: 2033 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 3 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 3**

**01/06/2026
15:10**

ID: 12812 Contributed abstract

**From individual extreme event attribution studies to Canada's rapid
extreme event attribution system**

*Elizaveta Malinina*¹ , *Nathan Gillett*² , *Megan Kirchmeier-Young*³ ,
*Yongxiao Liang*⁴ , *Konstantinos Menelaou*⁵ , *Robin Stevens*⁶ ,
*Madalina Surcel*⁷ , *Karen Garcia Perdomo*⁸

¹ Environment and Climate Change Canada (ECCC)

² Environment and Climate Change Canada (ECCC)

³ Environment and Climate Change Canada (ECCC)

⁴ Environment and Climate Change Canada (ECCC)

⁵ Environment and Climate Change Canada (ECCC)

- 6 Environment and Climate Change Canada (ECCC)
- 7 Environment and Climate Change Canada (ECCC)
- 8 Environment and Climate Change Canada (ECCC)

Presented by / Présenté par: *Elizaveta Malinina*

Contact: elizaveta.malinina-rieger@ec.gc.ca

In the last decade, Canada has experienced a growing number of impactful extreme events, amongst others the notorious 2021 Pacific Northwest heatwave, the 2021 British Columbia floods, the 2022 post-tropical storm Fiona, and the 2023 wildfire season. To better understand the role of human-induced climate change on these extreme events, we have conducted individual event attribution studies, as well as developed an automated system for the attribution of some types of events in near real time. For these purposes, we have used CMIP6 historical and future projections simulations, as well as HighResMIP data for multiple daily variables. In this presentation, we show how these attribution studies were conducted, how the models were selected, and briefly summarize the results. We also show how some of the individual analyses were operationalized to create the automated rapid extreme event attribution system.

**Session: 2033 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 3 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 3**

**01/06/2026
15:22**

ID: 12750 Contributed abstract

**On the Development of a Rapid Event Attribution System for Extreme
Precipitation over Canada**

*MADALINA SURCEL*¹ , *Megan Kirchmeier-Young*² , *Nathan Gillett*³
 , *Elizaveta Malinina*⁴ , *Konstantinos Menelaou*⁵ , *Yongxiao Liang*⁶ ,
*Robin Stevens*⁷ , *Karen Garcia Perdomo*⁸ , *Aaron Tamminga*⁹

1 ECCC

2 ECCC

3 ECCC

4 ECCC

5 ECCC

6 ECCC

7 ECCC

⁸ ECCC

⁹ ECCC

Presented by / Présenté par: *MADALINA SURCEL*

Contact: madalina.surcel@ec.gc.ca

To provide timely, scientifically grounded insights into the role of climate change in the occurrence of extreme precipitation events, Environment and Climate Change Canada is developing an extension of its rapid event attribution system to now consider extreme regional precipitation. This system monitors daily extreme precipitation events over Canada in real time using Canadian Surface Reanalysis (CaSR) and Regional Deterministic Precipitation Analysis (RDPA) data. If an extreme event is detected, the change in the likelihood of that event between factual and counter-factual climates is calculated using data from CMIP6 models, which were pre-processed over 89 regions of interest covering the entire country. In this way, attribution results are available almost immediately after an event. This presentation will focus on the evaluation of CMIP6 models in terms of representing extreme precipitation at regional scales over Canada. Furthermore, a way of best leveraging the evaluation results for event attribution will be discussed. This presentation will include a summary of the attribution results from more than 50 events analyzed by the system since it started running in May 2025. Future developments, such as using alternative climate model data, the experience of running the system in real-time since May 2025, and the challenges of communicating the results will also be addressed.

**Session: 2033 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 3 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 3**

**01/06/2026
15:34**

ID: 12831 Contributed abstract

**Development of a rapid event attribution system for Canada based on
CanAM6 and GEM5.3**

*Nathan Gillett*¹ , *Megan Kirchmeier-Young*² , *Eric Lai*³ , *Yongxiao Liang*⁴ , *Hai Lin*⁵ , *Elizaveta Malinina*⁶ , *Konstantinos Menelaou*⁷ , *Ryan Muncaster*⁸ , *Robin Stevens*⁹ , *Madalina Surcel*¹⁰

¹ Environment and Climate Change Canada

² Environment and Climate Change Canada

³ Environment and Climate Change Canada

⁴ Environment and Climate Change Canada

- 5 Environment and Climate Change Canada
- 6 Environment and Climate Change Canada
- 7 Environment and Climate Change Canada
- 8 Environment and Climate Change Canada
- 9 Environment and Climate Change Canada
- 10 Environment and Climate Change Canada

Presented by / Présenté par: *Nathan Gillett*

Contact: nathan.gillett@ec.gc.ca

Quantification of the influence of human-induced climate change on the probability of observed extreme events can help inform climate change adaptation and public understanding of the effects of climate change. Simulating many of the extreme events which impact Canada, such as atmospheric rivers and post-tropical cyclones, requires higher resolution than is typical of CMIP-class climate models. Environment and Climate Change Canada is therefore developing a rapid event attribution system using ensembles of simulations from the Canadian Atmosphere Model (CanAM6) and the Global Environmental Multiscale Model (GEM5.3) at 100km and later 25km resolutions. Probabilities of observed extreme events are compared between 500-member factual ensembles run with observed anthropogenic forcings, sea surface temperatures and sea ice, and counterfactual ensembles from which anthropogenic influence on forcings, sea surface temperatures and sea ice has been removed. This presentation will describe event attribution analysis of recent extreme events in Canada using these ensembles and their application in an automated rapid event attribution system for Canada.

**Session: 2033 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 3 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 3**

**01/06/2026
15:46**

ID: 12703 Contributed abstract

**Conditional attribution of cold extremes in Canada: The role of
atmospheric circulation in a changing climate**

*Yongxiao Liang*¹, *Megan Kirchmeier-Young*², *Bin Yu*³

¹ Climate Research Division, Environment and Climate Change Canada, Canada

² Climate Research Division, Environment and Climate Change Canada, Canada

Presented by / Présenté par: *Yongxiao Liang*

Contact: yongxiao.liang@ec.gc.ca

This study examines the influence of large-scale atmospheric circulation patterns, specifically the Pacific-North American (PNA), Asian-Bering-North American (ABNA), and North Atlantic Oscillation (NAO) climate indices, on the likelihood of cold extremes across Canada, utilizing ERA5 data and CMIP6 model simulations. The analysis reveals that PNA is closely linked to cold anomalies in western Canada, ABNA influences the west and central regions, and NAO impacts eastern Canada. A decrease in the likelihood of cold extremes is attributed to human-induced climate change, using both unconditional event attribution and event attribution conditioned on the observed circulation patterns. Under similar atmospheric circulation patterns as observed, human-induced climate change reduced the likelihood of recent cold extremes by 3–10 times across Canadian regions in the current climate compared to the pre-industrial climate. Under both the current and pre-industrial climates, negative PNA/ABNA phases and positive NAO phases can increase the likelihood of regular cold extremes, with synergies between indices significantly amplifying risks. Conversely, the opposite phases can reinforce the climate signal, further reducing the probability of cold extremes. These findings highlight the critical role of natural variability in cold extreme dynamics, offering valuable insights for improved climate prediction, attribution, and regional adaptation strategies in Canada.

**Session: 2033 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 3 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 3**

**01/06/2026
15:58**

ID: 12670 Contributed abstract

**Attribution and future projection of summer streamflow drought in
western Canadian watersheds**

*Rajesh Shrestha*¹, *Alex Cannon*²

¹ Environment and Climate Change Canada

² Environment and Climate Change Canada

Presented by / Présenté par: *Rajesh Shrestha*

Contact: rajesh.shrestha@ec.gc.ca

Successive summer streamflow droughts occurred in southern British Columbia in 2023 and 2024, impacting water and energy supplies in the region. In this study, we characterize the two drought events under the storyline framework by driving the Community Water Model (CWatM)—set up over the Fraser and upper Columbia River basins—with meteorological forcings from factual, counterfactual, and future climates. Specifically, by driving CWatM with a plausible combination of conditional forcings from the factual climate, we show that the 2023 drought was primarily caused by anomalously high May–June temperatures, whereas the 2024 drought resulted mainly from exceptionally low snowpack. The results also show that the two drought events would have been even more severe under the co-occurrences of extreme drivers. Counterfactual climate simulations indicate that long-term climate change has reduced summer flows, and intensified the severity of both drought events. Future projections, using 11 statistically downscaled CMIP6 GCMs, show increasing frequency and severity of summer streamflow drought, with the 3.0 °C global warming level a threshold when the frequency of drought years exceeds that of non-drought years. Furthermore, the compounding effect of meteorological and snow droughts on streamflow drought is projected to become more prevalent at higher GWLs, leading to extreme streamflow drought conditions. Overall, our study advances understanding of the drivers of summer streamflow drought and future pathways towards more intensified drought occurrence in the region.

Session 2051 Part 1

Convenors:

Milena Dimitrijevic, Environment and Climate Change Canada

Syed Husain, Environment and Climate Change Canada

Related to scientific studies and/or information sharing about the atmosphere, including weather, meteorology, clouds and precipitation, air quality, atmospheric dynamic and extreme events, using various approaches.

This session covers many topics, including, but not limited to, theoretical research, model development, observation techniques, real-time monitoring, databases, diagnostic methods, data analysis and artificial intelligence.

Session: 2051 Atmosphere - Theoretical to applied science - Part 1
Atmosphère - De la théorie à la science appliquée - Partie 1

**01/06/2026
15:10**

ID: 12640 **Contributed abstract**

Moving Block Bootstrap for Uncertainty Estimation in GEM-MACH Scenario Analysis

*Amina El Kasmi*¹, *Colin Lee*², *Michael Sitwell*³, *Daniel Figueras*

¹ ECCC

² ECCC

³ ECCC

⁴ ECCC

⁵ ECCC

⁶ ECCC

⁷ ECCC

Presented by / Présenté par: *Amina EL Kasmi*

Contact: amina.elkasmi@ec.gc.ca

Quantifying and interpreting uncertainty in air quality modeling is essential for regulatory applications as well as health and environmental impact studies, particularly because model performance varies across spatial and temporal contexts. A persistent challenge in scenario evaluation is that uncertainty in the difference between two model simulations is typically assessed using large model ensembles or through a priori error estimates and assumptions, both of which are costly to produce and often unavailable or unreliable. This study addresses this gap by proposing a data-driven framework to extract uncertainty information directly from paired GEM-MACH simulations, without the benefit of an ensemble and without relying on external error characterizations.

This work contributes to the CMOS 2025 theme “Navigating Uncertainty” by investigating how to quantify the statistical significance of differences between two modeling scenarios generated with the GEM-MACH (Global Environmental Multiscale–Modelling Air quality and CHemistry) system: a baseline simulation using unmodified emission inventories, and a configuration incorporating an emission-reduction policy scenario targeting key pollutants (PM_{2.5}, NO₂, and O₃). Because air quality time series exhibit strong temporal autocorrelation, the moving block bootstrap technique is employed to preserve serial dependence while estimating confidence intervals for scenario-to-scenario differences in key performance metrics.

Results show that both the magnitude and structure of uncertainty in the scenario differences vary substantially across pollution episodes and transitional meteorological regimes. The proposed bootstrap-based methodology therefore provides a practical and computationally efficient alternative to ensemble approaches, enabling robust quantification of uncertainty in time-dependent environmental systems when only a limited number of deterministic model runs are available. This framework offers a new pathway toward more resilient air-quality forecasting and evidence-based policy assessment.

Keywords: Uncertainty quantification, moving block bootstrap, GEM-MACH air quality modeling evaluation, temporal dependence.

Session: 2051 Atmosphere - Theoretical to applied science - Part 1 Atmosphère - De la théorie à la science appliquée - Partie 1

**01/06/2026
15:22**

ID: 12688 Contributed abstract

Distinct sub-period trends in tropospheric ozone column over the East Asian outflow region during 1990–2019: insights from a newly constructed dataset

*Zhou Zang*¹, *Jane Liu*², *David Tarasick*³, *Jing Chen*⁴, *Yingjie Li*⁵, *Lingyun Meng*⁶

¹ Department of Geography and Planning, University of Toronto, Toronto, Canada

² Department of Geography and Planning, University of Toronto, Toronto, Canada

³ Environment and Climate Change Canada, Toronto, Canada

⁴ Department of Geography and Planning, University of Toronto, Toronto, Canada

⁵ School of Geography, Geomatics and Planning, Jiangsu Normal University, Xuzhou, China

⁶ International Institute for Earth System Science, Nanjing University, Nanjing, China

Presented by / Présenté par: *Zhou Zang*

Contact: joey.zang@mail.utoronto.ca

Tropospheric ozone, an important greenhouse gas and pollutant, has been reported to increase over East Asia in recent decades. However, whether the increase is monotonic or variable remains unclear. Here we construct a spatially-resolved global tropospheric ozone column (TrOC) dataset based on the TOST dataset for 1990–2019. The dataset agrees well with individual ozonesonde measurements ($R = 0.74$, relative difference $< 1.8\%$), and a new gap-filling method improves data coverage over simple integration of TOST by more than 20%. Applying this dataset to the East Asian outflow region reveals three distinct transitions in TrOC trends: a slow increase (1990–2002), a rapid increase (2002–2008), and a stagnation (2008–2019). While ozone persistently increases in the lower troposphere, a post-2008 reversal or stagnation in the middle and upper troposphere drives the

observed TrOC shift. Ensemble modelling, trajectory analysis, and tagged stratospheric ozone simulations robustly these transitions to both enhanced net chemical production and a shift in stratospheric intrusion. This study provides previously undocumented insights into sub-period trends in regional tropospheric ozone, underscoring the joint modulation of chemical and dynamic processes. Beyond this study, TOST TrOC would enable broader applications given its observational constraints and spatial continuity.

Session: 2051 Atmosphere - Theoretical to applied science - Part 1 Atmosphère - De la théorie à la science appliquée - Partie 1

**01/06/2026
15:34**

ID: 12732 Contributed abstract

Performance of regional surface ozone prediction by GEM-MACH: Sensitivities to dry deposition and canopy effects on chemistry and diffusion

*Kenjiro Toyota*¹, *Paul Makar*², *Verica Savic-Jovcic*³, *Alain Robichaud*⁴, *Alexandru Lupu*⁵, *Jack Chen*⁶, *Olivia Clifton*⁷, *Stefano Galimalini*⁸

¹ Environment and Climate Change Canada, Air Quality Modelling and Integration Section, Toronto, ON

² Environment and Climate Change Canada, Air Quality Modelling and Integration Section, Toronto, ON

³ Environment and Climate Change Canada, Air Quality Modelling and Integration Section, Toronto, ON

⁴ Environment and Climate Change Canada, Air Quality Modelling and Integration Section, Dorval, QC

⁵ Environment and Climate Change Canada, Air Quality Modelling and Integration Section, Toronto, ON

⁶ Environment and Climate Change Canada, Air Quality Modelling and Integration Section, Ottawa, ON

⁷ NASA Goddard Institute for Space Studies, New York, NY, USA and Center for Climate Systems Research, Columbia University, New York, NY, USA

⁸ European Commission, Joint Research Centre, Ispra, Italy

Presented by / Présenté par: *Kenjiro Toyota*

Contact: kenjiro.toyota@ec.gc.ca

The high concentrations of ozone at the ground level pose adverse impacts on human health, forest growth and agricultural crop yields and are prone to occur under meteorological conditions favorable to the photochemical processing of ozone precursors and their accumulation in the atmospheric boundary layer. Dry deposition of ozone to vegetation is one of the main processes controlling the ozone concentrations over land, while the fidelity of dry deposition parameterizations is poorly quantified in the benchmark of air-quality model performance. Shading and reduced turbulence within dense vegetation canopies add to this challenge by creating a new realm of questions to address the realism of a connection between reactive gas emissions and photochemical ozone production/loss within the canopies and the surrounding environment. We will present our recent exercise aimed at improvement in the prediction of ground-level ozone concentrations across North America in Canada's operational air-quality forecast model GEM-MACH by updating its algorithms for dry deposition and canopy processes. Parameterizations for the forest canopy effect of shading and reduced turbulence were developed by Makar et al. (2017), reducing summertime ozone biases that were significantly positive at the time in GEM-MACH. However, this scientific innovation was not selected for our latest operational forecast implementation in order not to aggravate negative ozone biases plaguing that version of GEM-MACH. From the evaluation of a point model version of our dry deposition algorithm, we find that it systematically overestimates observationally derived values for the ozone dry deposition velocities over a variety of plant-covered surfaces in summer. This finding has led us to make several updates to our dry deposition algorithm, including its dependence on seasonal plant phenology. The combination of the updated deposition velocity algorithm and the canopy effect parameterizations is found to optimize the GEM-MACH model performance for ground-level ozone concentrations from spring to fall.

Session: 2051 Atmosphere - Theoretical to applied science - Part 1 Atmosphère - De la théorie à la science appliquée - Partie 1

**01/06/2026
15:46**

ID: 12755 Contributed abstract

Spatiotemporal Variation and 40-Year Trends of Arctic Tropospheric Ozone

*Yi Zhang*¹, *Jane Liu*², *Zhou Zang*³

¹ Department of Geography and Planning, University of Toronto, Toronto, Canada

² Department of Geography and Planning, University of Toronto, Toronto, Canada

³ Department of Geography and Planning, University of Toronto, Toronto,

Presented by / Présenté par: Yi Zhang

Contact: yiy.zhang@mail.utoronto.ca

The Arctic is a pivotal region responding significantly to climate change. Tropospheric ozone is the third most significant greenhouse gas, directly modulating surface energy budgets. However, our understanding of Arctic tropospheric ozone remains controversial, complicated by advection from lower latitudes, stratospheric contribution, and local production. Meanwhile, spatially explicit datasets of tropospheric ozone in the Arctic are scant due to limited surface and sounding measurements, as well as aircraft and satellite data; current atmospheric chemistry models still exhibit uncertainties in simulating tropospheric ozone trends in this region. Here, we investigate 40-year trends (1980-2020) in Arctic tropospheric ozone and its spatiotemporal variation, basing on the Trajectory-mapped Ozonesonde dataset for the Stratosphere and Troposphere (TOST) dataset, which is observationally constraint and spatially continuous. We validate TOST at six ozonesondes stations in the Arctic. Throughout the troposphere, the Normalized Root Mean Square Error (NRMSE) is within 10%, lowest in the middle troposphere (3-5 km, ~5%). TOST reveals that the tropospheric ozone column (TrOC) generally decreases with latitude and significantly influenced by topography, thus showing high TrOC over northern Atlantic ocean and low TrOC over Greenland. Seasonally, in the lower troposphere (0-3 km), ozone exhibits a peak in April and a minimum in September, while in the middle-to-upper troposphere (3-8 km), the seasonal maximum shifts to May, with the lowest records in December. In the long-term trend, we found 1993 as a turning point. Prior to 1993, TrOC declines rapidly at a rate of approximately -0.11 DU/year, reaching a minimum of ~31 DU in 1993. Subsequently, a gradual recovery (~0.05 DU/year) is apparent. This study offers new understanding of the tropospheric ozone variations in the Arctic from perspectives of spatial variation, seasonal variation, and long-term trend.

Session: 2051 Atmosphere - Theoretical to applied science - Part 1
Atmosphère - De la théorie à la science appliquée - Partie 1

**01/06/2026
15:58**

ID: 12841 Contributed abstract

How Vertical O₃ and SO₂ Vary Under Rainfall Condition Within and Above a Boreal-temperate Forest

*Yi Zhang*¹, *Jane Liu*², *Holly Croft*³, *Ralf Staebler*⁴, *Michael S. Wang*⁵, *Xiangzhong Luo*⁶, *Liming He*⁷, *Alemu Gonsamo*⁸, *Jing M. Chen*⁹

- 1 Department of Geography and Planning, University of Toronto, Toronto, Canada
- 2 Department of Geography and Planning, University of Toronto, Toronto, Canada
- 3 School of Biosciences, The University of Sheffield, Sheffield, UK
- 4 Air Quality Research Division, Environment and Climate Change Canada, Toronto, Canada
- 5 Department of Geography and Planning, University of Toronto, Toronto, Canada
- 6 Department of Geography, National University of Singapore, Singapore
- 7 Canada Centre for Mapping and Earth Observation, Natural Resources Canada, Ottawa, Canada
- 8 School of Earth, Environment and Society, McMaster University, Hamilton, Canada
- 9 Department of Geography and Planning, University of Toronto, Toronto, Canada

Presented by / Présenté par: *Yi Zhang*

Contact: yiy.zhang@mail.utoronto.ca

Ozone (O₃) and sulfur dioxide (SO₂) in the atmospheric boundary layer are critical air pollutants that negatively affect forest health. Rainfall can significantly alter the vertical variations of these trace gases in forests. It is essential to quantify rainfall impacts on such vertical variations and understand the underlying mechanisms driving such changes. This study explores how rainfall modulates the vertical distribution of O₃ and SO₂ within and above a boreal-temperate forest, drawing upon multi-year measurements (2009-2013) from a 42-meter tower. Based on 194 persistent rainfall events, we compare vertical O₃ and SO₂ concentrations between rain and non-rain conditions at the matched height, hour, and month to isolate rainfall impacts from background variability. Diverging from observations in tropical forests where rainfall could increase surface O₃, our results indicate a consistent decline in O₃ by 2-6 ppb (10-20%) across all heights, except at lower layers during nighttime rainfall. SO₂ exhibited even more pronounced declines, with concentrations decreasing by 0.3-0.5 ppb (40-50%) throughout the vertical profile. We further assess multiple processes, including washout, photochemistry, deposition, vertical transport, and NO_x-dependent chemistry. The substantial SO₂ loss is mainly attributed to its high solubility, whereas daytime O₃ reductions are largely due to declined photochemistry. Surface wetness enhances non-stomatal deposition of both gases, whereas daytime O₃ deposition remains stable due to the compensatory decrease in stomatal deposition. Downward transport could contribute to O₃ enhancement, especially apparent at night. Meanwhile, reduced NO levels during nighttime rainfall can suppress nocturnal O₃ titration, thereby contributing to nighttime O₃ accumulation.

These findings clarify rainfall impacts on air pollutants and highlight key processes shaping O₃ and SO₂ profiles in boreal-temperate forests.

Session 3012 Part 2

Convenors:

Jinyu Sheng, Dalhousie University

Susan Allen, University of British Columbia

Guoqi Han, DFO

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.

The proposed session will link strongly to “3. Oceans and Ice in a Changing Climate”. 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 in marine conditions over coastal and inland waters, including the Canadian Arctic waters, due to the climate change.

**Session: 3012 Coastal Oceanography and Inland Waters -
Part 2 Océanographie côtière et eaux intérieures - Partie
2**

**01/06/2026
15:10**

ID: 12762 Contributed abstract

**Assessing the Risk of Spilled Contaminants from Saint John Harbour
Reaching the Musquash Estuary MPA through Particle Tracking
Experiments**

*Rachel Horwitz*¹, *Lanli Guo*², *Katherine Lee*³, *Stephanne Taylor*⁴, *Nancy Soontiens*⁵

¹ Bedford Institute of Oceanography, Fisheries and Oceans Canada

² Bedford Institute of Oceanography, Fisheries and Oceans Canada

³ Dalhousie University

⁴ Bedford Institute of Oceanography, Fisheries and Oceans Canada

⁵ Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada

Presented by / Présenté par: *Rachel Horwitz*

Contact: rachel.horwitz@dfo-mpo.gc.ca

The Musquash Estuary is the largest ecologically-intact estuary in the Bay of Fundy and since 2006 it has been designated as a marine protected area (MPA) in order to maintain the ecosystem's biodiversity and habitat. The estuary is located 20 km southwest of the port of Saint John, New Brunswick (NB), so an understanding of the hydrodynamic connectivity between the MPA and this major industrial waterway is needed for effective ecosystem management. This study evaluates the risk of contaminant transport from Saint John Harbour to the Musquash MPA using particle tracking simulations driven by currents from a recently developed circulation model. Risk was quantified by the probability of impact and by the transit time from spill sites. Wind plays a significant role in the transport of surface-trapped particles, along with the tide phase and seasonal circulation patterns. 3D advection increases the chance of any MPA contamination, while lowering the average contamination volume.

**Session: 3012 Coastal Oceanography and Inland Waters -
Part 2 Océanographie côtière et eaux intérieures - Partie
2**

**01/06/2026
15:22**

ID: 12649 Contributed abstract

**Abnormal Subsurface Temperature Changes on the Slope Water off
the Scotian Shelf**

*Jinyu Sheng*¹, *Winnie Guan*²

¹ Dalhousie University

² Dalhousie University

Presented by / Présenté par: *Jinyu Sheng*

Contact: Jinyu.Sheng@dal.ca

Marine ecosystems on the Scotian Shelf and Gulf of Maine are affected significantly by hydrodynamics and variability over the Slope Water off the Scotian Shelf. The abnormal changes in subsurface temperatures on the Slope Water are examined based on the daily global ocean analysis known as GLORYS12 for the 30-year period of 1995-2024. The 30-year averaged monthly mean temperatures and salinity over the Slope Water show very large cross-slope gradients in the top 200 m, varying from relatively cold and low-saline shelf waters from the shelf-break to relatively warm and high-saline waters over the offshore deep ocean waters. Consistent with in-situ observations, the monthly mean temperatures in the upper ocean of this

region have large seasonal variability, with relatively cold (~4 oC) and nearly uniform waters in the top 50 m in winter and spring, and relatively warm (~20 oC) and highly stratified surface waters in the thin surface layers of less than 20 m in summer. The subsurface (100 m) temperatures have warming trends of about 0.08-0.09 oC/year over the Slope Water region, ~0.010 oC/year over the southern Flemish Pass. Examination of daily anomalies of subsurface temperatures shows relatively large interannual variability over the Tail of the Grand Banks, Slope Water region, and the slope off the Gulf of Maine. The abnormal subsurface cooling over the Slope Water is caused by the stronger-than-normal equatorward advection of the cold and low-saline upper Labrador water mass carried by the offshore branch of the Labrador Current. The latter is prompted by retreats of warm and high-saline waters from the continental slope off the southern Grand Banks.

Session: 3012 Coastal Oceanography and Inland Waters

- Part 2 Océanographie côtière et eaux intérieures - Partie

2

01/06/2026

15:34

ID: 12671 Contributed abstract

**Coupled Circulation-Ice Modelling System for the Region of
Cumberland Sound and David Strait**

*Qiantong Pei*¹, *Jinyu Sheng*²

¹ Dalhousie University

² Dalhousie University

Presented by / Présenté par: *Qiantong Pei*

Contact: qn317878@dal.ca

A nested-grid and coupled circulation-ice modelling system has been developed recently, with a fine resolution (~1.4 km) child model domain covering the region of Cumberland Sound and David Strait, nested within the coarse-resolution (1/12 degree in longitude) parent model domain for the northwest Atlantic. The latter is the coupled circulation-ice modelling system known as DalROMS-NWA12 developed and validated by Ohashi et al. (2024). Results produced by the child model are used to examine the influence of sea ice on ocean dynamics over the child model domain in winter 2020. Model results show that the southward propagation of remotely generated sea ice plays an important role for the sea-ice budget over the study region. In addition, packed ice was found to limit the momentum and heat fluxes across the atmosphere–ocean interface. The sea-ice formation and melting strongly modify the hydrography and currents. These impacts are significant not only during formation and melt periods but also persist into ice-free seasons, with implications for shelf stratification and local

**Session: 3012 Coastal Oceanography and Inland Waters -
Part 2 Océanographie côtière et eaux intérieures - Partie
2**

**01/06/2026
15:46**

ID: 12748 Contributed abstract

**Temporal and Spatial Variability of Lobe–Cleft Instability at the Fraser
River Plume Front**

*Shumin Li*¹, *Rich Pawlowicz*²

¹ The University of British Columbia

² The University of British Columbia

Presented by / Présenté par: *Shumin Li*

Contact: shumini@eoas.ubc.ca

The lobe–cleft (LC) instability is a small-scale frontal feature that plays a key role in the mixing at river plume fronts. However, its small spatial scale and rapid evolution challenge observation, requiring high resolution in both space and time. Recent advances in aerial drone technology have drawn growing interest in studying frontal instabilities. Here, leveraging UAV technology, we present a case study of LC instability at the Fraser River plume front in the Strait of Georgia, BC, Canada. Using oblique aerial drone footage geo-rectified with flight attitude data and corrected by horizon, coastline, and ship positions, we map the plume front with spatial and temporal resolutions of tens of centimetres and seconds, respectively, over multiple days and in multiple conditions. The frontal structure is identified and digitized using colour contrast between turbid river water and clear seawater. In this study, we discovered the formation and rapid development of LC instability within hours before the daily low water. This instability occurs at a scale of 20 to 50 m, and its properties are highly linked to larger-scale frontal structures (500m - 1km). A convergence node is identified, dividing oppositely rotating frontal instability vortices, resulting in an along-front convergence at a speed of 15-25 cm/s. This along-front convergence is then found to be associated with a divergence in the background current field. This work demonstrates the advantages and applicability of oblique-angle drone imagery for investigating small-scale frontal dynamics. We also captured multiple previously unreported instability features, which could greatly advance our understanding of the mixing processes at river plume fronts.

ID: 12770 Contributed abstract

Projecting future climate changes and shifting extremes using a high resolution downscaling of the Salish Sea

*Natasha Ridenour*¹, *Eva Gnegy*², *Susan Allen*³, *Michael Dunphy*⁴, *Amber Holdsworth*⁵

¹ Environment and Climate Change Canada

² Environment and Climate Change Canada

³ University of British Columbia

⁴ Fisheries and Ocean Canada

⁵ Fisheries and Oceans Canada

Presented by / Présenté par: *Natasha Ridenour*

Contact: Natasha.Ridenour@ec.gc.ca

The Salish Sea, a marginal sea located and shared between 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. Using the SalishSeaCast ocean model configuration, based on Nucleus for European Modelling of the Ocean (NEMO), a historical period (1986-2005) is used to evaluate changes in the Salish Sea for the years 2046-2065 using downscaled forcing from 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). In addition to the physical model, SalishSeaCast is run with biogeochemistry, with our focus being on three ecosystem stressors: temperature, oxygen, and ocean acidity. Generally, projected changes in the RCP 8.5 simulation are larger than the projected changes in the RCP 4.5 simulation. While temperature is projected to increase in the Salish Sea, oxygen and aragonite saturation state (a measure of acidity) are projected to decrease. The volume of water reaching extreme thresholds for both aragonite saturation and oxygen increase in the future scenarios compared to the historical simulation. We also identify regions in the Salish Sea that are likely to experience extreme conditions in the future using two different baselines. We find that the majority of the domain experiences an extreme level of bottom aragonite saturation state (for most of the future 20 year period) when using a historical threshold. Regions projected to experience fairly consistent low oxygen extremes are mostly confined to fjords along the BC coast, as well as the deep Strait of Georgia.

Session 4030

Convenors:

Dominique Paquin (Ouranos)

Alejandro Di Luca (UQAM)

Over the past few years, the development of regional climate models (RCMs) has focused on various aspects such as increasing spatial resolution, integrating more sophisticated physical parameterizations, and using improved geophysical fields. Whether by reaching resolutions that allow the partial simulation of convection (convection-permitting RCMs), by incorporating advanced schemes (surface, microphysics, etc.), or by using new databases as input variables or for evaluation purposes, the models currently in use have undergone profound transformations.

This session welcomes contributions on recent developments in RCMs or on the analysis of regional climate simulations. Submissions focusing on methodological advances, innovative applications of regional models, and their evaluation are particularly encouraged

Session: 4030 Applications of regional climate modeling

Applications de la modélisation climatique régionale

01/06/2026

15:10

ID: 12608 Contributed abstract

Cold-Season Subtropical Air Mass Intrusions into the Saint-Lawrence River Valley in a Warming World: Dynamic-Thermodynamic Impacts on Extreme Precipitation and Regional Climate

*Florence Dion-Ladouceur*¹, *John R. Gyakum*², *Yeechian Low*³,
*Dominique Paquin*⁴, *Christopher McCray*⁵

¹ McGill University

² McGill University

³ McGill University

⁴ Ouranos

⁵ Ouranos

Presented by / Présenté par: *Florence Dion-Ladouceur*

Contact: dion.ladouceur.florence@gmail.com

The Saint Lawrence River Valley (SLRV), home to the urban Canadian centers of Ottawa, Montreal, and Quebec City, is one of the most ice-storm-prone regions in North America. Historical cases such as the 1998 Great Ice Storm and the April 2023 event reveal a common feature: the presence of

warm, moist subtropical air overrunning shallow cold air entrenched in the valley. This study investigates the role of subtropical air mass intrusions in driving extreme cold-season precipitation in the SLRV and their evolution in future climate. To identify subtropical air masses, we use equivalent potential temperature θ_e (theta-e) and calculate its maximum value in the lower-tropospheric layer (900–700 hPa), which is commonly the base of the precipitation layer. Considering that theta-e is a conservative quantity for both dry- and moist-adiabatic processes, we can track such air parcels to examine their dynamic and thermodynamic impacts on cold-season sensible weather in the SLRV. Using the Canadian Regional Climate Model 5 (CRCM5) driven by ERA5 reanalysis, we identify these intrusions when the 99th percentile value of θ_e at the city location is exceeded and then link them to extreme precipitation events. Synoptic-scale circulation fields associated with subtropical intrusions are categorized using self-organizing maps (SOMs), which highlight distinct dynamic-thermodynamic patterns favorable for heavy winter precipitation. To assess climate change impacts, we analyze the CRCM5 driven by CMIP6 global models under historical and future climate scenarios. Comparisons between reanalysis-driven and GCM-driven CRCM5 runs allow us to evaluate the robustness of synoptic patterns and their projected frequency changes. By directly linking a thermodynamic metric (θ_e) to regional extreme precipitation, this work provides a novel framework to diagnose the dynamic and thermodynamic pathways of cold-season subtropical intrusions. These findings highlight the importance of subtropical–polar interactions in shaping high-impact weather in southeastern Canada and offer a pathway for improving risk assessment under future climate change.

Session: 4030 Applications of regional climate modeling
Applications de la modélisation climatique régionale

01/06/2026
15:22

ID: 12695 Contributed abstract

Disentangling errors in the simulated diurnal cycle of precipitation across multiple configurations of a climate model over northeastern North America

*Tangui Picart*¹, *Alejandro Di Luca*², *Danahé Paquin Ricard*³

¹ UQAM, ESCER

² UQAM, ESCER

³ ECCC

Presented by / Présenté par: *Tangui Picart*

Contact: tangui.picart@laposte.net

Over northeastern North America in summer, the diurnal cycle of precipitation (DCP) peaks in the afternoon as a result of coupled land–

atmosphere and convective processes. Because it integrates surface forcing, boundary-layer dynamics, and convective development, the DCP provides a powerful process-oriented framework to evaluate regional climate models, including convection-permitting configurations.

Here, we developed a process-based framework to diagnose errors in simulated DCP by disentangling the contribution from different sources, including pre-existing near-surface conditions (2-m temperature and humidity) and the representation of convective precipitation (triggering and intensity). The evaluation is performed over northeastern North America using hourly data from 372 stations during an 11-year period from 2012-2022. Three model configurations are tested: a 12-km horizontal grid spacing with parameterised deep convection, and two 2.5-km grid spacing simulations, with parameterised and explicit deep convection.

The results reveal strong contrasts in the convective contribution to the DCP across model configurations. Both 2.5-km simulations substantially overestimate the DCP amplitude, while the 12-km simulation underestimates it. In the southern part of the domain, the bias in the 2.5-km simulations is mainly linked to an excessive frequency of convective triggering in the afternoon rather than to precipitation intensity. This bias is particularly pronounced when deep convection remains parameterized. In contrast, the 12-km model exhibits a strong negative bias in precipitation intensity, partially compensated by longer-lasting precipitation events.

Further analysis shows that, in convection-permitting simulations, convective precipitation is often triggered under warmer and drier conditions than observed. Parameterized deep convection favors triggering under more realistic conditions but does not prevent unrealistic triggering in dry environments, amplifying DCP biases. Overall, this work highlights that errors in convective triggering dominate DCP biases and demonstrates the need for process-based diagnostics to evaluate and improve regional climate simulations.

Session: 4030 Applications of regional climate modeling
Applications de la modélisation climatique régionale

01/06/2026
15:34

ID: 12858 Contributed abstract

Multiyear Sector-Specific Air Quality Attribution Using a Nested CMAQ Super-Domain Over Quebec and Ontario (2002–2019)

*Shayamila Mahagammulla Gamage*¹, *Marianne Hatzopoulou*²

¹ University of Toronto

² University of Toronto

Presented by / Présenté par: *Shayamila Mahagammulla Gamage*
Contact: shayamila.gamage@utoronto.ca

In recent decades, reductions in industrial and mobile emissions have significantly improved air quality in Canada. To quantify 2002–2019 source contributions to PM_{2.5}, SO₂, and NO₂ across Quebec and Ontario, we apply the Community Multiscale Air Quality (CMAQ) model within a nested framework featuring a 4 km × 4 km inner domain over major urban and industrial corridors including Toronto, Hamilton, Ottawa, Rouyn-Noranda, Saguenay, Montreal, and Quebec City embedded in a 12 km × 12 km EPA 12US1 outer domain. Canadian emissions are based on Environment and Climate Change Canada inventories, with U.S. inputs from the EPA 2019 platform.

To isolate contributions from key source categories, a series of emission removal scenarios was applied, covering all industrial sources, smelters, metal refineries and foundries, petroleum refineries, pulp and paper facilities, on-road, and off-road. Simulations are planned for nine target years, but preliminary results are available for 2002 and 2019 using four representative months per year to estimate annual mean concentrations. Base-case [SM1.1] results indicate significant domain-wide improvements over this period: PM_{2.5} decreased by approximately 7%, SO₂ by 39%, and NO₂ by 43%. Industrial emission removal scenarios reveal consistent declines across most sectors, with NO₂ reductions of roughly 50% reflecting substantial decreases in combustion related emissions. PM_{2.5} exhibited moderate declines, though smelters showed slight increases in localized areas. SO₂ reductions were most pronounced in the pulp and paper sector, highlighting the effectiveness of emission control measures, while petroleum refinery contributions remained consistently low. On-road and off-road source contributions also declined, reflecting cleaner technologies and stricter regulations.

These preliminary results show that regulations and cleaner technologies have reduced industrial and mobile air pollution. High-resolution nested modeling clarifies spatial patterns, sector contributions, and transboundary transport. Extending simulations to intermediate years will enable a comprehensive multiyear assessment to inform future air quality policy.

Session: 4030 Applications of regional climate modeling

Applications de la modélisation climatique régionale

01/06/2026

15:46

ID: 12835 Contributed abstract

The contribution of the surface temperature inversion to Antarctic warming

*Ben Tyler*¹, *Anais Orsi*², *Cécile Davrinche*³, *Cécile Agosta*⁴

¹ The University of British Columbia

² The University of British Columbia

³ Université catholique de Louvain

⁴ Laboratoire des sciences du climat et de l'environnement

Presented by / Présenté par: *Ben Tyler*

Contact: btyler01@student.ubc.ca

Antarctica is expected to warm faster than the global average throughout the 21st century in a phenomenon called Antarctic amplification. The polar atmosphere is unique in having a strong surface temperature inversion layer, and its changing properties can dramatically affect surface warming. In this work, we aim to reveal mechanisms behind Antarctic amplification by quantifying the contribution of this surface temperature inversion to Antarctic warming. Global climate models used in future climate projections often miss the vertical resolution and physical processes needed to correctly simulate the intense near-surface inversion. Here, we downscale four global climate models with the regional atmospheric model MAR to decompose the Antarctic July near-surface potential temperature into the background potential temperature and the surface temperature inversion under SSP5-8.5. From the late 20th to the late 21st century, we attribute the majority of warming over Antarctica and the surrounding ocean to large-scale background warming. However, the spatial variability in this warming is driven by surface processes through their weakening of the surface temperature inversion. Over the ocean, this inversion weakening is strongly associated with sea ice loss. On the continent, greater inversion weakening is correlated with stronger atmospheric stability, which indicates that the lapse-rate feedback contributes to the spatial variability in warming. Our analysis shows the key role of surface processes in driving Antarctic warming and the importance of properly simulating the fine details of the Antarctic boundary layer when quantifying these processes.

Session: 4030 Applications of regional climate modeling

Applications de la modélisation climatique régionale

01/06/2026

15:58

ID: 12686 Contributed abstract

The future climate of the coastal Pacific Northwest: projected changes in mean climate, extremes, and compound extremes from a convection-permitting model

*Amber M. Holdsworth*¹, *Eva Gnegy*², *Timothy Chui*³, *Michael Dunphy*⁴, *Natasha Ridenour*⁵, *Rachel H. White*⁶

¹ Fisheries and Oceans Canada

² Environment and Climate Change Canada

³ University of British Columbia

⁴ Fisheries and Oceans Canada

⁵ Environment and Climate Change Canada

⁶ University of British Columbia

Presented by / Présenté par: *Amber Holdsworth*

Contact: northpacificbgc@gmail.com

A convection-permitting (3 km) dynamical model is used to project mid-21st century climate changes over the coastal Pacific Northwest, including southwestern British Columbia, Vancouver Island, and Washington State, under both moderate mitigation, RCP 4.5, and no mitigation, RCP 8.5, scenarios. By explicitly resolving convective processes and complex topography, the high-resolution simulations have substantially reduced historical surface air temperature, precipitation, and wind speed biases compared to the parent CanESM2 and intermediary models. By mid-century, in addition to significant warming of between 1 and 4°C, projections include a slightly lower amplitude seasonal cycle, wetter winters with an increased frequency and intensity of precipitation events, and faster winter winds over the ocean. Significant increases in dry-warm and wet-warm compound extremes are projected over the ocean for all seasons, with increases in wet-warm compound extremes projected over most land regions. In general, future temperature, precipitation and wind extremes will move in concert with average conditions. However, there are localized regions and seasons where extremes may outpace the mean changes. Scenario differences shown here highlight the importance of emission reductions: the more we mitigate, the less we need to adapt.

Session 5090

Convenor: Serge Desjardins

Related to multidisciplinary environmental studies and/or information sharing, which includes, but not limited to Arctic studies, wildfire fires, hydrology, and cryology using various approaches.

This session covers all studies related to environmental topics that are not addressed in the atmosphere, ocean, and climate sessions. For example, all models other than atmospheric, ocean, and climate models.

Session: 5090 Multidisciplinary - Theoretical to applied science Multidisciplinaire - De la théorie à la science appliquée

**01/06/2026
15:10**

ID: 12706 Contributed abstract

Surface Air Temperature Field Verification Assessment for the Meteorological Service of Canada

*Annie Chow*¹, *Jeffery Hoover*², *Kai Wong*³, *Hagop Mouradian*⁴,
*Joshua Ching*⁵, *Jessie Lee*⁶

- 1 Environment & Climate Change Canada
- 2 Environment & Climate Change Canada
- 3 Environment & Climate Change Canada
- 4 Environment & Climate Change Canada
- 5 Environment & Climate Change Canada
- 6 Environment & Climate Change Canada

Presented by / Présenté par: *Annie Chow*

Contact: annie.chow@ec.gc.ca

The Meteorological Service of Canada (MSC) operates a nationwide surface network of approximately 600 automatic weather stations (AWS) that measure air temperature and other essential meteorological parameters. These measurements are influenced by multiple sources of uncertainty that affect their overall quality. The World Meteorological Organization (WMO) Measurement Quality Classification Scheme identifies the main components including the operational sensor, reference thermometers and calibration systems, instruments and coupling, maintenance and field verification, environmental effects, and the sensor siting classification system. This research studies the contribution of the field verification by investigating the influence of the methodology and comparison mediums on the coupling behaviour and agreement between travelling standard and operational thermometers. The investigation consists of two components. Part 1 evaluates the performance of thermometers immersed in distilled water in three containers: a clear polycarbonate container, a stainless-steel insulated thermos, and a dewar flask made of borosilicate glass with silver-doubled walls. Part 2 investigates the performance of the thermometers under varying comparison media: air in a Stevenson screen, an aluminum dry block and a thermos filled with distilled water. The findings indicate that the comparison medium significantly affects measurement uncertainty contributions to uniformity and stability. The lowest combined uncertainty was observed for the thermos-based distilled water approach, with higher uncertainty for the dry block, and greatest uncertainty for air inside the Stevenson screen under the present field verification methodology. Increasing the number of measurements during field verification further reduced the overall uncertainty of the comparison mediums under the test conditions. This study demonstrates the importance of the comparison medium on the coupling between reference and operational thermometers during field verification, where the associated uncertainty can exceed the contributions from the reference and operational thermometers. These findings have implications for both acceptance tolerances and the overall effectiveness of field verification procedures.

ID: 12727 Contributed abstract

From Scenarios to Probabilities using Earth System Modelling: Demonstration and Progress Towards Multi-Model Products for Risk-Aligned Climate Services

*Jeremy Fyke*¹, *Neil Swart*², *David Huard*³

¹ Environment and Climate Change Canada

² Environment and Climate Change Canada

³ Ouranos

Presented by / Présenté par: *Jeremy Fyke*

Contact: jeremy.fyke@ec.gc.ca

Motivated by opportunities for improved climate science and services for adaptation planning, we have extended the concept of climate projections based on probabilistic estimates of future emissions—rather than scenarios—into a tractable prototype methodology for application to full-complexity, CMIP-grade Earth system modelling. We trialed this approach using an ensemble of CanESM simulations to produce projections with, for the first time in a full-complexity Earth system model (ESM) setting, directly embedded 'probability exceedance' estimates reflecting emission uncertainty. Using this dataset, we demonstrate through two climate impact case studies how this new type of climate data product is particularly well-suited for serving the regional climate services that support risk-based adaptation planning. We will summarize this completed work, as well as challenges encountered in the process, in this presentation. Additionally we will look forward, to describe a potential pathway for expanding this single-model prototype to a multi-model (model intercomparison project; MIP) setting. This would provide the first direct and complete quantitative closure of the full canonical climate uncertainty budget. This advance would open opportunities for scientific exploration of the joint distribution of model, variability, and emissions uncertainty for arbitrary measures of climate change produced by ESMs. At the same time, we hypothesize it would also provide substantial operational benefits for global risk-based adaptation planning.

Fluxes in the Water – Energy-Food Nexus: A country-scale example of these fluxes and their variability

*Richard Lawford*¹

¹ University of North Dakota

Presented by / Présenté par: *Richard Lawford*

Contact: rlawford@gmail.com

The extensive interactions among the water, energy, and food sectors have given rise to a framework and strategies for more coordinated planning and management of food, energy and water resources. This framework, often referred to as the Water-Energy-Food (WEF) Nexus, has been applied in different contexts. The interactions within this Nexus are driven by physical, chemical and biological fluxes and processes which, in turn, are influenced by climatological, geomorphological, environmental and genetic factors. Nexus interactions also are affected by government regulations, trade policies, and technological innovations. Optimizing WEF Nexus fluxes in ways that maximize the food and energy outputs, conserve water, and minimize environmental impacts need to be based on reliable data and understanding of these fluxes.

This paper considers the annual fluxes among water, food and energy over a large well-documented area known as the CONUS (Contiguous United States). Annual fluxes, including inputs such as precipitation and outputs such as food exports and energy use, are drawn from published country reports and global satellite data sets, Current Interactions are reviewed (quantitatively) and possible new demands are discussed (qualitatively). Suggestions about possible effects of long-term goals and policy decisions are introduced. The presentation concludes with suggestions for better data collection procedures to facilitate more robust WEF Nexus tracking and understanding.

Day 2 – 2 June 2026

Is the Rate of Warming Accelerating? A Statistical Assessment from Global to Regional Scales

Le rythme du réchauffement s'accélère-t-il? Une analyse statistique à l'échelle mondiale et régionale

Claudie Beaulieu ¹

¹ University of California Santa Cruz

Presented by / Présenté par: *Claudie Beaulieu*

Contact: clbeauli@ucsc.edu

YouTube Recording: <https://youtu.be/U3yumfqYbs4>

With record-breaking temperatures observed in 2023 and 2024, there is ongoing debate about whether the rate of global warming has accelerated since the 1970s. The observed warming rate reflects the superposition of anthropogenic forcings and natural variability, and an acceleration can only be detected if the change in trend is large enough relative to background climate variability. In this talk, I address this question from a statistical perspective using changepoint models specifically designed to objectively identify changes in the parameters of a statistical model. Analyzing global mean surface temperature time series over 1850–2024, we find limited evidence for a recent warming acceleration at the global level — in most datasets, no significant change in the rate of warming is detectable beyond the 1970s. However, regional surface temperature observations tell a more nuanced story, with emergence of warming accelerations and shifts from cooling or near-zero trend toward warming in several regions. We conclude by discussing potential physical causes behind these regional changes in the rate of warming.

Au vu des températures record observées en 2023 et en 2024, le débat fait toujours rage pour savoir si le rythme du réchauffement climatique s'est accéléré depuis les années 1970. Le taux de réchauffement observé reflète la superposition de forçages anthropiques et de variabilité annuelle, et une accélération ne peut être détectée que si le changement de tendance est suffisamment important par rapport à la variabilité climatique de fond. Dans cette allocution, j'aborde cette question sous l'angle statistique en utilisant des modèles de points de changement conçus expressément pour identifier objectivement les changements apportés aux paramètres d'un modèle statistique. En analysant des séries chronologiques de la température en surface moyenne mondiale au cours de la période 1850-2024, nous ne disposons que de peu d'éléments indiquant une accélération récente du réchauffement à l'échelle mondiale — dans la plupart des ensembles de données, aucun changement significatif du rythme du réchauffement n'est perceptible au-delà des années 1970. En revanche, les observations régionales de la température en surface donnent une image plus nuancée avec l'émergence des accélérations du

réchauffement et le passage d'une tendance au refroidissement ou proche de zéro à une tendance au réchauffement dans plusieurs régions. Nous concluons en évoquant les causes potentielles à l'origine de ces variations régionales du rythme du réchauffement.



Time: Tuesday June 2, 2026 11:00 – 11:55 EDT

Title: *Is the Rate of Warming Accelerating? A Statistical Assessment from Global to Regional Scales*

Speaker: Dr. Claudie Beaulieu (University of California Santa Cruz)

Bio: Dr. Claudie Beaulieu is an Associate Professor in the Ocean Sciences Department at the University of California Santa Cruz where she leads the Ocean and Climate Data Science Lab. She earned a Ph.D. in Water Sciences from the INRS Eau Terre Environnement research centre in Quebec and conducted postdoctoral research in the Atmospheric and Oceanic Sciences Program at Princeton University. Before joining the UCSC faculty, she was a lecturer in the School of Ocean and Earth Science at the University of Southampton. She is a recipient of the prestigious CAREER Award from the National Science Foundation to support her integrated research and education program, leveraging data science techniques to gain insights on climate change.

Session 2034 Part 4

Convenors:

Elizaveta Malinina, Environment and Climate Change Canada

Neil Tandon, York University

Nathan Gillett, Environment and Climate Change Canada

Session: 2034 Weather, Climate, and Environmental Extremes in Changing Climate - Part 4 Conditions météorologiques, climatiques et environnementales extrêmes dans un climat en mutation - Partie 4

**02/06/2026
12:30**

ID: 12682 Contributed abstract

Global warming leads to increased fire risk in Canada

*Daniel Garduno*¹, *Andrew Weaver*², *Cynthia Whaley*³, *Carsten Abraham*⁴, *Colin Goldblatt*⁵, *Stanley Netherton*⁶

¹ University of Victoria

² University of Victoria

³ CCCMA

⁴ CCCMA

⁵ University of Victoria

⁶ University of Victoria

Presented by / Présenté par: *Daniel Garduno*

Contact: danielgardunoruiz@uvic.ca

We compute the Canadian Fire Weather Index (CFWI) in 5000-year integrations of the Canadian Earth System Model (CanESM5) under a range of prescribed atmospheric CO₂ concentrations, from pre-industrial levels to four times pre-industrial values. Our results show that increasing atmospheric CO₂ is associated with higher Fire Weather Index (FWI) values and extended fire seasons across Canada. Annual maximum FWI values also rise with CO₂ concentration, indicating an elevated likelihood of extreme wildfire under future warming. The projected increase in FWI is primarily temperature-driven: warmer conditions under higher CO₂ promote more persistent and effective drying, resulting in more combustible forest fuels. At the same time, elevated CO₂ leads to increases in precipitation and relative humidity, along with reductions in wind speed, creating regionally variable CFWI responses. We perform a provincial-scale analysis of fire indices to assess how climate warming may differentially affect regions within Canada. These modeling results provide valuable insight for assessing future wildfire risk across the country.

**Session: 2034 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 4 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 4**

**02/06/2026
12:42**

ID: 12643 Contributed abstract

How much carbon was emitted by the record-setting 2023 Canadian wildfires?

*Debora Griffin*¹, *Sal Curasi*², *Jack Chen*³, *Daniel Thompson*⁴,
*Carolyn Smyth*⁵, *Vivek Aurora*⁶, *Joe Melton*⁷, *Chris McLinden*⁸,
*Paul Makar*⁹

1

2 ECCC

3 ECCC

4 NRCan

5 NRCan

6 ECCC

7 ECCC

8 ECCC

Presented by / Présenté par: *Debora Griffin*

Contact: debora.griffin@ec.gc.ca

Canada has seen an unprecedented surge in wildfire activity over the past few years (2023-2025). In 2023, extreme wildfire activity across the country resulted in the release of almost 10 times more carbon than an average year. While all fire emission inventories suggest much higher total carbon emissions in 2023 compared to an average fire year, the estimates for 2023 fire emissions exhibit large uncertainty with a range varying from 200-800 Tg C.

Our study explores various wildfire emission inventories, to identify the cause of the wide range in total emission estimates. We examine differences in emission factors and coefficients, area burned, fuel consumption, and CO₂:CO ratio among different inventories. We identify the primary cause of the large uncertainty reported for 2023 fire carbon emissions as the variability in fuel consumption rate (dry matter consumed per area burned), which is especially pronounced in boreal forest regions. Better reference data for this and more consistency across various approaches is expected to reduce the spread in emissions estimates for future fire seasons.

**Session: 2034 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 4 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 4**

**02/06/2026
12:54**

ID: 12747 Contributed abstract

**Multiscale Weather Responses to a Week-Long Canadian Wildfire
Emission Scenario Across Canada**

*Md Razib Vhuiyan*¹

1

Presented by / Présenté par: *Md Razib Vhuiyan*

Contact: vhuiyan.md_razib@courrier.uqam.ca

Large wildfire outbreaks can perturb the coupled aerosol–radiation–boundary-layer system and thereby influence weather predictability from local conditions to synoptic circulation. We investigate these forecast-relevant impacts for a coordinated Canadian fire scenario using a one-week-long WRF-Chem simulation over Canada during early June 2025 at 25-km horizontal resolution, based on a 21-member ensemble. Fire emissions are derived from an independent integrated fire–weather

forecasting model (WRFSC) and injected into WRF-Chem as 100 fire sources distributed across Canada, enabling a controlled assessment of fire-driven modifications to the evolving atmospheric state. The simulated response emerges robustly after the third day, with statistically significant perturbations in surface temperature, surface wind, and planetary boundary layer height (PBLH), indicating systematic changes to surface weather and boundary-layer structure as smoke forcing accumulates and is advected downstream. In addition to regional impacts, diagnostics reveal significant changes in large-scale circulation, suggesting that widespread, concurrent burning can modulate broader flow patterns beyond immediate source regions. These results demonstrate that sustained, spatially extensive Canadian fires can noticeably alter the multiscale forecast state within several days, underscoring the need to represent fire emissions and associated feedbacks in coupled prediction frameworks when evaluating fire–weather interactions.

**Session: 2034 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 4 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 4**

**02/06/2026
13:06**

ID: 12734 Contributed abstract

**Extraordinary North American heatwaves in 1941 and 2021:
Understanding impacts and lessons for future extremes**

*Sam Anderson*¹, *Shawn Chartrand*²

¹ Simon Fraser University

² Simon Fraser University

Presented by / Présenté par: *Sam Anderson*

Contact: anderson.sam.lucas@gmail.com

The 2021 Western North American heatwave was one of the most extreme events ever recorded and had severe impacts on human mortality and morbidity, agriculture, critical infrastructure, cryospheric and hydrologic systems, and wildfire. Because this event was so rare and because impacts of climate extremes are determined in part by both complex physical and social systems, it is difficult to know how such impacts may differ for future extreme heatwaves. Although such extreme heatwaves are rare, recent work has identified an event of comparable magnitude and geographic extent in 1941, adding climatological context for the 2021 heatwave (Malinina and Gillett, 2024). However, the impacts of the 1941 heatwave are not well understood. Here, we review historic documentary sources including 357 newspaper issues from 25 North American publications from before, during, and after the 1941 heatwave, and we pair qualitative textual analysis with a quantitative analysis of climate reanalysis, streamflow, tidal,

and crop yield data. Our analyses reveal widespread impacts from the 1941 heatwave, including water shortages, agricultural losses, damage to critical infrastructure, wildfires, flooding, and human mortality and morbidity.

Further, we detail adaptation mechanisms via changes to social customs, behaviours, mobility, and infrastructure. Importantly, we identify several causes for why many heatwave impacts differed between 1941 and 2021, including contrasting continental-scale heatwave evolution (which propagated to Eastern North America in 1941 but not 2021), differing social norms and behaviours, and the heatwaves' relation to co-occurring crises (World War II in 1941 and the COVID-19 pandemic in 2021). Overall, our study details a new storyline of what can happen during extreme heatwaves in North America, and expands our understanding of potential impacts of future heatwaves.

**Session: 2034 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 4 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 4**

**02/06/2026
13:18**

ID: 12846 Contributed abstract

Evaluating the relationship between LWA and heatwaves in CanESM5-LE: a comparison to ERA5

*Matthew Pereira Wilson*¹, *Adam Monahan*², *Nathan Gillett*³

¹ University of Victoria

² University of Victoria

³ CCCma

Presented by / Présenté par: *Matthew Pereira Wilson*

Contact: mhpereir@gmail.com

Recent extreme heat events, such as the 2021 heatwave in the Pacific Northwest (PNW), have raised questions about whether climate change is altering not only the frequency of temperature extremes but also the dynamical mechanisms that produce them. Our lack of understanding of the various mechanisms and interactions which allow extreme temperature events to build up have hindered our ability to understand how climate change is affecting the frequency of extreme events. Earth System Models have emerged as the primary tools used to project future changes in extreme events; however, it remains unexplored whether they reproduce extremes through physically realistic processes or through compensating biases.

We evaluate how the CanESM5 Large Ensemble (LE) represents the dynamical drivers of temperature extremes in the PNW by examining the relationship between anticyclonic circulation and surface temperature

variability. Anticyclonic wave activity is quantified using the Local Wave Amplitude (LWA) index, which provides a dynamical measure of upper-level waviness. We compare the LWA–temperature relationship in CanESM5-LE with that in the ERA5 reanalysis.

We find that CanESM5-LE exhibits surface temperature variability comparable to ERA5 in the PNW. However, this variability is achieved with systematically weaker anticyclonic LWA anomalies. This result suggests that CanESM5-LE compensates for weaker circulation anomalies through alternative mechanisms, allowing it to reproduce realistic temperature variability despite insufficient dynamical waviness. We investigate the possibility of soil-moisture anomalies as a potential compensation mechanism that CanESM-LE uses to achieve the same temperature variability. These findings highlight the importance of evaluating not only the statistical characteristics of extremes in climate models, but also the physical processes through which they arise.

Session 2052 Part 2

Convenors:

Milena Dimitrijevic, Environment and Climate Change Canada
Syed Husain, Environment and Climate Change Canada

Related to scientific studies and/or information sharing about the atmosphere, including weather, meteorology, clouds and precipitation, air quality, atmospheric dynamic and extreme events, using various approaches.

This session covers many topics, including, but not limited to, theoretical research, model development, observation techniques, real-time monitoring, databases, diagnostic methods, data analysis and artificial intelligence.

Session: 2052 Atmosphere - Theoretical to applied science - Part 2 Atmosphère - De la théorie à la science appliquée - Partie 2

**02/06/2026
12:30**

ID: 12733 Contributed abstract

Explicit Hail Forecasting Using the Operational HRDPS Model: Evaluating the Current State and Investigating Potential Improvements Using CM1 Simulations

*Clinton Macadam*¹, *John Hanesiak*², *Jason Milbrandt*³, *Julian Brimelow*⁴, *Lisa Schielicke*⁵

¹ University of Manitoba

² University of Manitoba

³ Environment and Climate Change Canada

⁴ Western University

⁵ Western University

Presented by / Présenté par: *Clinton Macadam*

Contact: clintonmacadam@outlook.com

This study investigates the ability of ECCO's operational 2.5 km HRDPS to predict hail using direct model output for nine Alberta hail cases. The HRDPS uses the Predicted Particle Properties (P3) bulk microphysics scheme, which represents ice-phase hydrometeors using a user-specified number of freely evolving "generic" ice-phase categories. For each case, HRDPS output variables related to hail microphysics were used to derive estimates of maximum hail size and were examined for physical realism. The operational HRDPS exhibits a systematic inability to simulate large rimed ice, likely primarily due to a strict size limiter imposed to control gravitational size sorting in the older, two-moment version of P3 used in the HRDPS. As a result, all rimed ice melts before reaching the surface for the cases examined, rendering the current HRDPS unable to model hail at the surface. For four of the nine hailstorm cases, quasi-idealized simulations were conducted using CM1 to inform how to improve the HRDPS's hail modelling capabilities. CM1 runs conducted using the two-moment configuration of the latest version of P3, which does not impose the size limiter, produce consistently larger hail than CM1 runs using the older version used in the HRDPS. Horizontal grid spacing sensitivity tests conducted in CM1 using the two-moment configuration of the latest P3 indicate that a 1km operational model would improve hail modelling performance, though respectable performance is still achieved at 2.5 km. Finally, CM1 runs conducted using other configurations of the latest version of P3 that include innovations such as three-moment ice, predicted liquid fraction, and multiple free ice-phase categories improve the overall realism of modeled ice-phase hydrometeors, including hail. These results indicate that implementing a newer version of the P3 microphysics scheme into the HRDPS model will likely improve its ability to realistically model hailstorms.

Session: 2052 Atmosphere - Theoretical to applied science - Part 2
Atmosphère - De la théorie à la science appliquée - Partie 2

**02/06/2026
12:42**

ID: 12764 Contributed abstract

Applying a cloud lamination detection algorithm to airborne lidar measurements

*Emily M. McCullough*¹ , *Robin Wing*² , *James R. Drummond*³ ,
*Mengistu Wolde*⁴ , *Keyvan Ranjbar*⁵

¹ Department of Physics and Atmospheric Science, Dalhousie University, Halifax, NS, Canada

² Leibniz Institute for Atmospheric Physics, Schloßstrasse 6, 18225
Kühlungsborn, Germany

³ Department of Physics and Atmospheric Science, Dalhousie University,
Halifax, NS, Canada

⁴ National Research Council Canada, Ottawa, ON, Canada

⁵ National Research Council Canada, Ottawa, ON, Canada

Presented by / Présenté par: *Emily McCullough*

Contact: emily@purplecrowlidar.ca

A computer algorithm has been developed to automatically identify laminated (finely layered) clouds in time-altitude arrays of lidar data. The laminated features were first identified in sky scenes from four years of measurements (2016-2019) from Candac Rayleigh-Mie-Raman Lidar (CRL) at Eureka, Nunavut. Such laminations are strongly correlated with ground-level snowfall. The computer algorithm has been validated by comparing visual classifications of lidar scenes and correlating with weather reports from Environment and Climate Change Canada (ECCC).

Here, we present the first application of the computer algorithm to data from the National Research Council of Canada (NRC) Airborne Elastic Cloud Lidar (AECL). Laminated clouds are clearly visible in AECL's cloud measurements, and the computer algorithm successfully identified laminated regions. The AECL's excellent range resolution and the aircraft's complementary instrumentation, combined with the lamination detection computer algorithm, enable detailed case studies of the internal structures of laminated clouds and precipitation processes.

**Session: 2052 Atmosphere - Theoretical to applied
science - Part 2 Atmosphère - De la théorie à la science
appliquée - Partie 2**

**02/06/2026
12:54**

ID: 12792 Contributed abstract

Characteristics of Tornado Outbreaks in Canadian Quasi-Linear Convective Systems

*Morgan Schneider*¹, *David Sills*², *Lisa Schielicke*³

¹ Canadian Severe Storms Laboratory

² Canadian Severe Storms Laboratory

³ Western University

Presented by / Présenté par: *Morgan Schneider*

Contact: morgan.schneider@uwo.ca

Predicting the tornadic potential of a thunderstorm presents a significant challenge for forecasters. These challenges are amplified in eastern Canada, where a large proportion of tornadoes are associated with quasi-linear convective systems (QLCSs). QLCS tornadoes develop and dissipate quickly, making them difficult to anticipate, and the differences between tornadic and nontornadic QLCSs and their evolutionary pathways are less understood than supercell thunderstorms. Because of this, the potential human and societal impacts of a QLCS tornado outbreak are substantial. This work presents comparisons between the radar evolution of observed tornado outbreaks and null event cases in Ontario and Quebec. These comparisons will be used to identify radar characteristics and signatures that have the potential to distinguish a QLCS tornado outbreak from a non-outbreak before tornado activity begins. The environments of these cases will also be compared to identify any differences in environmental evolution leading up to an outbreak versus a non-outbreak in eastern Canada.

Session: 2052 Atmosphere - Theoretical to applied science - Part 2 Atmosphère - De la théorie à la science appliquée - Partie 2

**02/06/2026
13:06**

ID: 12838 Contributed abstract

Historical increase in autumn and winter cyclone-associated precipitation over the Arctic Ocean driven primarily by enhanced local evaporation

*Alex Crawford*¹, *Kripa Vyas*², *Mark Serreze*³

1

² University of Ottawa

³ University of Colorado Boulder

Presented by / Présenté par: *Alex Crawford*

Contact: alex.crawford@umanitoba.ca

What is the relative importance of variability in local evaporation versus moisture convergence from lower latitudes to changes in autumn/winter Arctic Ocean precipitation? Past research has offered sometimes contradictory answers. Here we offer some resolution to this question by addressing two research gaps. First, recognizing that most studies ascribing greater local evaporation (and sea ice loss) to increasing Arctic precipitation have been conducted with climate models, we turn to the ERA5 atmospheric reanalysis to examine a 46-year record (1979-2024) of Arctic precipitation and related moisture, circulation, and radiation variables. Second, we focus attention on precipitation specifically associated with extratropical cyclones, offering insights beyond what can be gained only looking at Arctic-wide seasonal averages. We find that cyclone-associated precipitation (CAP) over the Arctic Ocean primarily changes in the cold

season (October-March), increasing by 5.3% per decade. Spatial patterns of positive CAP trends along the margins of the Arctic Ocean align closely with patterns of sea ice loss and enhanced local evaporation, and typically exhibit negative trends in moisture convergence. Conversely, the area around the North Pole, with no significant sea ice loss, has experienced more modest precipitation increases driven by enhanced moisture convergence. For the Arctic Ocean overall, 78% of the increase in cold-season CAP is explained by the increase in local evaporation. A complementary Lagrangian moisture budget analysis of migratory cyclones yields more uncertainty but also shows enhanced local evaporation as the greatest driver of enhanced cold season precipitation.

Session: 2052 Atmosphere - Theoretical to applied science - Part 2 Atmosphère - De la théorie à la science appliquée - Partie 2

**02/06/2026
13:18**

ID: 12850 Contributed abstract

Diagnosing Forecast Underestimation of the 4 July 2020 Southern Saskatchewan Tornadoic Supercell Through Multi-Model Environmental Verification.

*Mostofa Kamal*¹, *Yanping Li*², *Zhenhua Li*³

1

² University of Saskatchewan

³ University of Saskatchewan

Presented by / Présenté par: *Mostofa Kamal*

Contact: mostofa.kamal@usask.ca

On July 4, 2020, a long-lived supercell thunderstorm produced at least three confirmed tornadoes and large hail between 4:30 and 6:30 pm (CST) in southern Saskatchewan, although Environment and Climate Change Canada's (ECCC) operational thunderstorm outlook indicated only a marginal severe-weather risk. Forecast products substantially underestimated the event's convective and tornadoic potential. This forecasting shortfall motivates a detailed multi-model performance assessment to evaluate model skill in simulating the antecedent thermodynamic and kinematic environment evolution associated with this event and to identify pathways for improving future severe weather forecasts. We evaluate ERA5 reanalysis and ECCC's Regional Deterministic Prediction System (RDPS) against collocated RAOB observations at 1200 and 0000 UTC. Results indicate that both models exhibited pronounced thermodynamic deficiencies, including large cold and dry biases throughout the troposphere and significant underrepresentation of convective instability. At 0000 UTC, both models substantially underestimated CAPE relative to observations, indicating failure to capture

the magnitude of buoyancy necessary to support tornadic supercell development. Additionally, the mid-level thermodynamic structure, including the elevated mixed layer (EML), was poorly represented in both model analyses. Kinematically, ERA5 more accurately reproduced large-scale flow fields, exhibiting lower full-profile vector wind RMSE, whereas RDPS better represented the low-level (0–1 km) wind structure but showed larger errors aloft. Overall, deficiencies in representing the mid-level thermodynamic structure and lower- to mid-tropospheric flow evolution contributed to the underprediction of severe-weather potential. These findings highlight the need for improved representation of mesoscale thermodynamic profiles and low-level shear environments in operational forecasting systems for tornadic supercells over the Canadian Prairies.

Session 3013 Part 3

Convenors:

Jinyu Sheng, Dalhousie University

Susan Allen, University of British Columbia

Guoqi Han, DFO

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.

The proposed session will link strongly to “3. Oceans and Ice in a Changing Climate”. 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 in marine conditions over coastal and inland waters, including the Canadian Arctic waters, due to the climate change.

**Session: 3013 Coastal Oceanography and Inland Waters -
Part 3 Océanographie côtière et eaux intérieures - Partie
3**

**02/06/2026
12:30**

ID: 12785 Contributed abstract

**Oceanographic conditions to understand aggregation zone in
Hermitage Bay, Newfoundland**

*Andry Ratsimandresy*¹, *Olivia Gibb*², *Shannon Cross*³, *Zhaoshi Lu*⁴, *Matthew Grandy*⁵

- 1 Fisheries and Oceans Canada
- 2 Fisheries and Oceans Canada
- 3 Fisheries and Oceans Canada
- 4 Fisheries and Oceans Canada
- 5 Fisheries and Oceans Canada

Presented by / Présenté par: *Andry Ratsimandresy*

Contact: andry.ratsimandresy@dfo-mpo.gc.ca

Hermitage Bay, a fjord-like embayment on Newfoundland's South Coast, extends 24 km inland along its northeastern channel; the channel is approximately 2 km wide at the mouth and reaches depths of up to 460 m. The bay supports several commercial activities, including salmon aquaculture, Atlantic cod fishing, and snow crab harvesting, and also serves as a migration corridor for wild salmon.

Concerns about salmon lice species present in the channel - capable of affecting both farmed and wild salmon populations - have increased the need to understand the environmental conditions that promote their survival and the pathways through which they may be transported by local circulation.

In this study, we investigate the oceanographic dynamics of Hermitage Bay's channel to evaluate the potential for particle accumulation, including biological (e.g., larvae) and anthropogenic (e.g., debris, microplastics) materials. We analyze surface drifter trajectories and time series of temperature, salinity, and current profiles collected at two sites along the bay's axis to identify the physical drivers of the circulation. These dynamics are then used to compute particle transport and identify potential aggregation zones. The resulting insights can inform site selection for aquaculture operations to reduce lice exposure risk and can support assessments of waste accumulation within the bay.

**Session: 3013 Coastal Oceanography and Inland Waters -
Part 3 Océanographie côtière et eaux intérieures - Partie
3**

**02/06/2026
12:42**

ID: 12773 Contributed abstract

The Hudson Bay water budget and the role of Hudson Strait transport
*Zijun Liu*¹, *Hamed Ibrahim*²

¹ University of Toronto, Department of Civil & Mineral Engineering, Toronto, ON, Canada

² University of Toronto, Department of Civil & Mineral Engineering, Toronto, ON, Canada; University of Toronto, School of the Environment, Toronto, ON, Canada; University of Toronto, Department of Physics, Toronto, ON,

Presented by / Présenté par: *Zijun Liu*

Contact: zijun.liu@mail.utoronto.ca

The Hudson Strait plays a critical role in regulating water and salt exchange between Hudson Bay and the Atlantic Ocean, yet its contribution to the Hudson Bay mass balance is not well known. Simulation experiments in a Regional Ocean Modeling System (ROMS) over the period 2000–2020 were performed to analyze this water balance. Results show persistent outflux through the strait, accounting for 68.4% of total annual precipitation plus runoff. The outflowing current is primarily concentrated in the southern part of the strait and dominated by the upper 200 m. The vertical structure reveals a two-layer exchange pattern, with surface-intensified outflow and a compensating inflow at depth. Precipitation and river runoff are the dominant water sources to Hudson Bay, contributing 1.129 mm/day and 0.369 mm/day, respectively. Outflux through the Hudson Strait and evaporation are the main sinks, contributing 1.024 mm/day and 0.480 mm/day, respectively. Time series analysis shows that precipitation over Hudson Bay peaks in early autumn, evaporation attains its annual maximum in July in response to radiation forcing, and runoff displays a bimodal distribution characterized by a primary peak in June and a secondary maximum in October. The timing of the dominant June runoff peak, preceding the autumn precipitation maximum, suggests that snowmelt-driven freshwater release rather than concurrent rainfall controls the early-summer discharge, while the secondary October peak reflects a delayed hydrological response to enhanced late-season precipitation. The long-term mean vertically integrated salt flux is effectively zero, as it represents the sole pathway for salt exchange, and Hudson Bay salinity remains stable on interannual timescales.

**Session: 3013 Coastal Oceanography and Inland Waters -
Part 3 Océanographie côtière et eaux intérieures - Partie
3**

**02/06/2026
12:54**

ID: 12811 Contributed abstract

**Comparison of HF radar surface current measurements and coastal
ocean models off of Nova Scotia**

*Graigory Sutherland*¹, *Joshua Turner*²

¹ ECCC

² ECCC

Presented by / Présenté par: *Graigory Sutherland*

Contact: graigory.sutherland@ec.gc.ca

Accurately characterizing coastal surface currents is essential for marine navigation, oil spill response, and ecosystem management. In regions where they are available, High-Frequency (HF) radar systems provide direct, near real-time observations of surface currents at high spatial and

temporal resolution, making them invaluable tools for operational oceanography. Ocean circulation models, by contrast, estimate surface currents using physical equations and atmospheric forcing, with the potential to fill observational gaps and provide future forecasts. This study presents a systematic comparison between HF radar surface currents off the coast of Nova Scotia and surface currents from the Canadian Ice Ocean Prediction System (CIOPS-E). Our findings highlight where and when models effectively replicate observed currents, pointing to areas where model refinements or assimilation of radar data could enhance forecast accuracy. These results support best practices for integrating HF radar and model data to improve real-time ocean surface current monitoring for science, operational, and emergency response applications.

**Session: 3013 Coastal Oceanography and Inland Waters -
Part 3 Océanographie côtière et eaux intérieures - Partie
3**

**02/06/2026
13:06**

ID: 12763 Contributed abstract

**Observations and Analysis of sea ice over the Greenland Sea from an
Autonomous Aerial Vehicle (UAV)**

*Alexandra Stephens*¹, *Darrian Shue*², *Kent MOORE*³, *Yuhong He*⁴, *Peter Ge*⁵

¹ University of Toronto

² University of Toronto

³ University of Toronto

⁴ University of Toronto

⁵ University of Toronto

Presented by / Présenté par: *Alexandra Stephens*

Contact: gwk.moore@utoronto.ca

The Greenland Sea is a key region for studying ocean–ice interactions that influence the Atlantic Meridional Overturning Circulation (AMOC), a major system of currents that regulates climate by transporting warm surface water northward and returning cold, dense water at depth. As the Arctic warms, reduced sea ice cover alters how much heat the ocean loses to the atmosphere. Understanding sea ice motion and structural characteristics in this region can provide valuable insight into these exchange processes and how they are affected by climate change. However, most existing analyses rely on satellite imagery that captures only broad-scale information on sea ice characteristics. Fine-grained studies of sea ice that resolve individual ice floes remain limited. To address this gap, a UAV capable of capturing visible and thermal imagery was deployed during the Resilient Northern Overturning in a Warming Climate (ROVER) expedition on the RV Kronprins

Haakon in February 2025. This marks the first time high-resolution AUV imagery of sea ice has been collected in this region. Twelve flights were conducted over a 16-day period, resulting in more than 7,500 images. Computer vision techniques, including convolutional neural networks, were employed to extract and track sea ice features at small scales, with a particular focus on thermal drone imagery, complemented by visible-spectrum drone and satellite observations where feasible. Using precisely georeferenced GPS data, feature tracking captured the motion of the ice floes.

**Session: 3013 Coastal Oceanography and Inland Waters -
Part 3 Océanographie côtière et eaux intérieures - Partie
3**

**02/06/2026
13:18**

ID: 12827 Contributed abstract

**Processes shaping habitat conditions within a nearshore region of
British Columbia's central coast.**

*Wiley Evans*¹ , *Justin Del Bel Belluz*² , *Drew Jordison*³ , *Trevor Michalchuk*⁴ , *Kim Bedard*⁵ , *Jonathan Bergshoeff*⁶ , *Chris Mackenzie*⁷ , *Lydia Pollock*⁸ , *Danja Currie-Olsen*⁹ , *Sam Albers*¹⁰ , *Colleen Kellogg*¹¹ , *Alex Hare*¹²

¹ Hakai Institute

² Hakai Institute

³ Hakai Institute

⁴ Hakai Institute

⁵ Hakai Institute

⁶ Hakai Institute

⁷ Hakai Institute

⁸ Hakai Institute

⁹ Hakai Institute

¹⁰ Hakai Institute

¹¹ Hakai Institute

¹² Hakai Institute

Presented by / Présenté par: *Wiley Evans*

Contact: wiley.evans@hakai.org

The processes that shape habitat conditions, including the manifestations of hypoxia and carbonate mineral corrosivity, are important to constrain within ecologically-significant coastal settings. This is because these settings are inherently more vulnerable to changing ocean climate, resulting from long-term biogeochemical trends (deoxygenation and ocean acidification) and variations in the dominant physical (e.g., wind forcing and freshwater input)

and biological processes (e.g., organic matter production and remineralization) occurring in these regions. Here, we utilize physical, biogeochemical and biological datasets collected from oceanographic surveys, gliders and a mooring to constrain the dominant processes shaping episodes of low oxygen and low calcite saturation state within an ecologically-significant nearshore region of British Columbia's central coast. We have observed low oxygen and corrosive conditions for calcite within subsurface waters during multiple years in this region. A variety of analytical methods were employed that reveal: (1) corrosive conditions stem from the balance of conservative mixing and biogeochemical processes, (2) subsurface water mass character is heavily influenced by the seasonal and inter-annual variation of source waters to the region, and (3) patterns of surface ocean productivity can directly influence source water character during spring and support higher export in the late summer when adverse conditions manifest. These results enhance our understanding of the processes shaping habitat conditions within this region, and can serve as an analog for other nearshore settings where patterns of source water character and surface ocean productivity compound to manifest biogeochemical extremes.

Session 4071 Part 1

Convenors:

Chris Derksen, Climate Research Division, ECCC

Elizabeth Bush, Climate Research Division, ECCC

The first edition of Canada's Changing Climate Report, released in 2019, was the first comprehensive national science assessment of past and future changes in climate in Canada. This session will provide a forum for presenting findings from the second edition of Canada's Changing Climate Report, planned for release in May 2026. In a world of rapid climate change and with a rapid expansion in the amount of published scientific research on climate change in Canada, up-to-date syntheses and assessments of this scientific knowledge are important for both informing action on climate change and for generating a collective understanding of the problem. Canada's Changing Climate Report 2026 is the outcome of a major, collaborative, multi-year assessment process designed to provide timely, robust evidence about both past and future changes in climate in Canada. This edition draws primarily on new science produced by the Canadian research community and is informed by new observations, improved datasets, a better understanding of the climate system, and new modelling of future changes in climate across Canada since the first edition released in 2019. The content of CCCR2026 also reflects an intention to include more topics that are important to Canadians and people living in Canada, to make the report more accessible to a variety of audiences, and to better bridge the gap between scientific assessments and adaptation planning. This session will include presentations directly based on assessment material and we invite other relevant submissions.

**Session: 4071 Canada's Changing Climate Report 2026:
findings from the new national climate science
assessment - Part 1 Rapport sur les changements
climatiques au Canada 2026 : conclusions de la nouvelle
évaluation nationale des sciences du climat - Partie 1**

**02/06/2026
12:30**

ID: 12647 Contributed abstract

Overview of Canada's Changing Climate Report 2026

*Elizabeth Bush*¹, *Kevin Anderson*², *Ashley Ehrman*³, *Chris Derksen*⁴

¹ Environment and Climate Change Canada

² Environment and Climate Change Canada

³ Environment and Climate Change Canada

⁴ Environment and Climate Change Canada

Presented by / Présenté par: *Elizabeth Bush*

Contact: Elizabeth.Bush@ec.gc.ca

Canada's Changing Climate Report 2026 (CCCR2026) is structured to deliver content on past and future changes in Canada's climate that is accessible to different audiences. A key element of this approach is to provide a hierarchy of information with increasing levels of technical detail. A set of 15 headline statements were developed to convey the overarching conclusions from the report in a concise and engaging way to encourage audiences to delve into the report to learn more. These 15 headline statements are clustered under three themes: 1. Warming and warming-driven changes in climate, 2. Changes in extremes, and 3. Changes specific to freshwater, snow and ice, oceans, and the carbon cycle in Canada. The headline statements represent conclusions from the report about which the authors have at least high confidence. These conclusions emerged from and are supported by the chapter specific key findings. This presentation will provide an overview of the assessment report, and an introduction to the conclusions of the report by focusing on the 15 headline statements. It will also briefly describe the assessment process. It will be followed by a series of presentations on findings from specific chapters.

**Session: 4071 Canada's Changing Climate Report 2026:
findings from the new national climate science
assessment - Part 1 Rapport sur les changements
climatiques au Canada 2026 : conclusions de la nouvelle
évaluation nationale des sciences du climat - Partie 1**

**02/06/2026
12:42**

ID: 12621 Contributed abstract

Key Findings from Chapter 2 of the 2026 Canada's Changing Climate

Report

*Xiaolan L. Wang*¹, *Francis W. Zwiers*², *Megan Kirchmeier-Young*³,
*Yang Feng*⁴, *Nathan Gillett*⁵, *Budong Qian*⁶

¹ Climate Research Division, Environment and Climate Change Canada

² Pacific Climate Impacts Consortium, University of Victoria

³ Climate Research Division, Environment and Climate Change Canada

⁴ Climate Research Division, Environment and Climate Change Canada

⁵ Climate Research Division, Environment and Climate Change Canada

⁶ Agriculture and Agri-Food Canada

Presented by / Présenté par: *Xiaolan L. Wang*

Contact: Xiaolan.Wang@ec.gc.ca

Chapter 2 of the 2026 Canada's Changing Climate Report (CCCR2026) provides a synthesis of past changes in climate across Canada, as well as their causes, drawing on the assessments in this chapter and in chapters 4 to 9. It also includes a detailed assessment of past changes in average surface air temperature, precipitation, and near-surface wind speed. It also briefly considers some derived variables, including heating and cooling degree days, growing season length, estimated snow amounts and freezing precipitation frequency. In addition, this chapter pays special attention to the sources of historical climate information required to view today's climate in the context of past climatic conditions in Canada. The chapter does this by focusing on direct climate observations provided by meteorological instruments and observers, as well as the information derived from those observations with the help of weather and climate models. This presentation focuses on key findings related to observed changes in average surface air temperature, precipitation, and surface wind speed. Key findings from the synthesis section are presented by the authors of Chapters 4–9.

**Session: 4071 Canada's Changing Climate Report 2026:
findings from the new national climate science
assessment - Part 1 Rapport sur les changements
climatiques au Canada 2026 : conclusions de la nouvelle
évaluation nationale des sciences du climat - Partie 1**

**02/06/2026
12:54**

ID: 12826 Contributed abstract

Overview of future changes in Canadian climate

*Nathan Gillett*¹, *Damon Matthews*², *Cindy Chu*³, *Blair Greenan*⁴,
*Megan Kirchmeier-Young*⁵, *Yongxiao Liang*⁶, *Michael Sigmund*⁷,
*Julie Mireille Thériault*⁸

¹ Environment and Climate Change Canada

² Concordia University

- ³ Fisheries and Oceans Canada
- ⁴ Fisheries and Oceans Canada
- ⁵ Environment and Climate Change Canada
- ⁶ Environment and Climate Change Canada
- ⁷ Environment and Climate Change Canada
- ⁸ Université du Québec à Montréal

Presented by / Présenté par: *Nathan Gillett*

Contact: nathan.gillett@ec.gc.ca

Chapter 3 of Canada's Changing Climate Report 2026 summarizes future projected changes in climate across Canada. In the near term, Canada will continue warming at close to twice the global rate, with an increase of about 0.9°C (0.2–1.6°C) from 2021 to 2040 in all emissions scenarios. Trends already observed, towards more frequent hot extremes, earlier peak streamflow, warmer and more acidic waters around the coasts, and increasing area burned by wildfire, are projected to continue. The duration of snow, sea ice, and lake ice cover in Canada will shorten with every increment of global warming. Climate change in Canada will intensify through the century if emissions continue on a path approximately consistent with current global climate policies. In 2081–2100, average warming across Canada relative to 1850–1900 is projected to reach 5.0°C (3.8–6.6°C), and precipitation is projected to increase by 13% (9–18%). The intensity and frequency of heavy precipitation are projected to increase. Glaciers in western Canada are projected to lose more than 75% of their mass, and permafrost thaw in northern Canada will continue. If emissions continue to rise throughout the century, which would reflect a scenario in which current global climate policies are rolled back or fail to mitigate global emissions, climate change in Canada would intensify even more strongly. By contrast, most aspects of Canada's climate would stabilize in the second half of this century if global CO₂ emissions immediately start to decline and reach net zero in the 2070s. Under such a scenario, Canadian temperatures are projected to warm by only about 0.8°C between the 2021–2040 and 2081–2100 periods.

**Session: 4071 Canada's Changing Climate Report 2026:
findings from the new national climate science
assessment - Part 1 Rapport sur les changements
climatiques au Canada 2026 : conclusions de la nouvelle
évaluation nationale des sciences du climat - Partie 1**

**02/06/2026
13:06**

ID: 12769 Contributed abstract

Large-scale atmosphere-ocean processes affecting Canadian climate

*Michael Sigmond*¹, *Karen Smith*², *Russell Blackport*³, *Alex Cannon*⁴, *William Merryfield*⁵, *Rachel White*⁶, *Bin Yu*⁷

¹ Canadian Centre for Climate Modelling and Analysis, Environment and Climate Change Canada

² University of Toronto Scarborough

3

4

5

6

7

Presented by / Présenté par: *Michael Sigmond*

Contact: Michael.Sigmond@ec.gc.ca

Chapter 4 of CCCR26 assesses changes in thermodynamic and dynamical processes and phenomena in the atmosphere and ocean that influence regional changes in Canadian climate. Changes that are due to thermodynamic processes are generally robust and well understood, and include Arctic amplification (a phenomenon that largely explains why past and projected Canadian warming is faster than the global average), projected increases in the intensity and frequency of atmospheric rivers, projected increases in environmental conditions that favour the development of thunderstorms, and projected increases in average and maximum rain rates associated with Atlantic hurricanes affecting Canada. Changes that are due to dynamical processes are more uncertain, due to the large impact of internal climate variability on dynamical processes and to the disagreement among models about many aspects of the projected changes. Climate models generally project a poleward shift of the jet stream and associated weather patterns, but changes are small and depend on the region and season. The El Niño–Southern Oscillation has been and will remain the dominant source of climate variability in western Canada in the 21st century. While climate models consistently show that by the end of the century, the effect of ENSO on winter climate fluctuations will extend into central and eastern Canada, these changes are uncertain due to systematic climate model biases. The Atlantic Meridional Overturning Circulation is projected to weaken, which will slightly weaken future warming over eastern and northern Canada, while a substantially larger cooling influence associated with a possible shutdown of this ocean current in this century cannot be ruled out.

**Session: 4071 Canada's Changing Climate Report 2026:
findings from the new national climate science
assessment - Part 1 Rapport sur les changements
climatiques au Canada 2026 : conclusions de la nouvelle
évaluation nationale des sciences du climat - Partie 1**

**02/06/2026
13:18**

ID: 12855 Contributed abstract

Carbon cycle chapter in the CCCR 2026

Vivek Arora ¹ , Sophia Johannessen ² , James Christian ³ , Elyn Humphreys ⁴ , Debby Ianson ⁵ , Joe Melton ⁶ , Ray Nassar ⁷ , Kirsten Zickfeld ⁸

¹ Environment and Climate Change Canada

² Fisheries and Oceans Canada

³ Fisheries and Oceans Canada

⁴ Carleton University

⁵ Fisheries and Oceans Canada

⁶ Environment and Climate Change Canada

⁷ Environment and Climate Change Canada

⁸ Simon Fraser University

Presented by / Présenté par: Vivek Arora

Contact: vivek.arora@ec.gc.ca

Chapter 9 of the Canada's Changing Climate Report (CCCR) 2026 assesses the role of the natural carbon cycle in regulating atmospheric carbon dioxide (CO₂) and explains how anthropogenic emissions from fossil fuels and land use change have disrupted the natural cycle and driven global climate change. The natural carbon cycle regulates atmospheric CO₂ concentration, which remained between ~170 and ~300 ppm for ~800,000 years before the industrial period. Atmospheric CO₂ has risen rapidly during the industrial era to a global surface annual average value of 423 ppm by 2024. Current global anthropogenic GHG emissions are ~57 Gt CO₂/yr (for year 2023). Canada (which was the 10th highest emitter in 2023), produced ~1.4% of global GHG emissions. Canada's GHG emissions for 2023 (694 Mt CO₂-eq/yr) are approximately 10% lower than their 2007 peak, despite continued growth in Canada's population and economy.

At global scale, less than half of the emitted CO₂ remains in the atmosphere, because land and oceans absorb the rest. The excess CO₂ in the atmosphere causes most of the warming, with additional contributions from other greenhouse gases and aerosols. The chapter also highlights the near-linear relationship between cumulative CO₂ emissions since the preindustrial era and global temperature change. Consistent with this relationship, the global temperature will stabilize when net CO₂ emissions reach zero and emissions of non-CO₂ greenhouse gases decline substantially.

This chapter also assesses the carbon sink over land and ocean in Canada for two primary purposes. First, the size of these sinks helps to elucidate Canada's contribution to the global carbon budget. Second, estimating natural CO₂ exchanges concurrently with Canada's greenhouse gas (GHG) emissions provides an important context for evaluating avoided emissions and assessing the atmospheric CO₂ removal potential of nature-based climate solutions (NBCS). Canadian land ecosystems have historically functioned as a carbon sink, but emissions associated with wildfires and

other disturbances are weakening this capacity. The ocean within Canada's exclusive economic zone generally also remains a net carbon sink, although the oceanic uptake rate is expected to slow, as warming continues and the ocean becomes more acidic.

Lastly, the chapter acknowledges that although NBCS offer numerous co-benefits, their capacity for carbon storage remains limited and temporary. Deep reductions in fossil fuel emissions are essential for long-term climate mitigation.

Session 4081 Part 1

Convenor:

Reinel Sospedra-Alfonso, ECCC

Related to scientific studies and/or information sharing about the climate, including studies on slowly varying aspects of the Earth's systems, as well as past and future conditions, using various approaches.

This session covers many topics, including, but not limited to, theoretical research, model development, databases, diagnostic methods, climate projections, data analysis and artificial intelligence.

**Session: 4081 Climate - Theoretical to applied science -
Part 1 Climat - De la théorie à la science appliquée - Partie
1**

**02/06/2026
12:30**

ID: 12780 Contributed abstract

Spatially resolved climatology of upland plateaus on the Canadian Prairies

*Abigail Dah*¹, *Charles L. Curry*²

¹ Pacific Climate Impacts Consortium

² Pacific Climate Impacts Consortium

Presented by / Présenté par: *Abigail Dah*

Contact: cc@uvic.ca

There has been a growing demand worldwide for high-resolution, gridded climatological station data and related products. In particular, there are now several such datasets covering the entirety of Canada. The ability of these datasets to capture regional-scale patterns of seasonal temperature and precipitation, along with the gross influences of physiography on land climate is well known. However, their rendering of smaller, landscape-scale climatological features is less studied.

In this work, we evaluated the small-scale climate in the vicinity of four landforms (ranging in height from ~600 to 1000 masl, and horizontal scale from ~100-300 km), as represented in three high-quality gridded climatological products of different horizontal resolution: Western Canada PRISM (~2 km), ERA5-Land (~10 km) and Daymet (1 km). The variables considered were precipitation, daily minimum (TN) and daily maximum temperature (TX), and particular attention was paid to the dependence of each variable on elevation.

All three products feature increasing precipitation with elevation year-round, with Daymet being the most sensitive, reflecting the orographic enhancement of rainfall for even these modest prominences. For temperature, the relationship is more complex, and varies by dataset, variable and season. In summer, the TX-elevation relation is close to linear with negative slopes, consistent with the usual lapse rate behaviour, but with TN displaying shallower slopes. In winter, the relationship is again linear in most cases but with positive slope for WCan-PRISM (up to +15°C km⁻¹) and ERA5-Land (+2°C km⁻¹), indicating temperature inversions. By contrast, Daymet displays no inversions year-round for any of the landforms. Since temperature inversions are common and well-documented over much of Canada in winter, this suggests that the other two datasets, despite their coarser resolution, more realistically represent certain aspects of the climate. In summary, this work demonstrates the value of high-resolution, station-based gridded datasets for small-scale climatological studies, even at landscape scales.

**Session: 4081 Climate - Theoretical to applied science -
Part 1 Climat - De la théorie à la science appliquée - Partie**

1

**02/06/2026
12:42**

ID: 12698 Contributed abstract

The Impact of Climate Change on the Annual Cycle of Freeze–Thaw Events in Eastern North America

*Martin Leduc*¹, *Travis Logan*²

¹ Ouranos

² Ouranos

Presented by / Présenté par: *Martin Leduc*

Contact: leduc.martin@ouranos.ca

Freeze–thaw events are a common phenomenon occurring mostly during spring and fall in the midlatitudes. Accumulated over the years, these events inflict stress to infrastructures, and when occurring unexpectedly, they can be devastating for agriculture and other biological systems. In this study, the annual cycle of freeze–thaw days is analyzed over eastern North

America in terms of its current climatology and projected changes using near-surface air temperature from a set of bias-adjusted phase 6 of the Coupled Model Intercomparison Project (CMIP6) global climate projections. For the shared socioeconomic pathway (SSP3-7.0) emissions scenario, the results show marked changes in the seasonality of freeze–thaw days toward 2070–2100, with southern Canada and northern United States showing an advance of the freeze–thaw season by about 2 weeks in the spring, and a delay of a similar duration in the fall. For the same regions, freeze–thaw days could become much more frequent during winter, and less frequent during fall and spring. As for their annual number, freeze–thaw days are projected to decrease significantly in the southern part of the United States due to the projected decrease in the number of frost days. For Canada and the northern part of the United States, the annual number of freeze–thaw days is projected to remain nearly constant due to a compensation between the projected increase in thaw days and the decrease in frost days. Overall, these changes in the climatological characteristics of freeze–thaw days are key aspects to consider in climate change adaptation strategies.

**Session: 4081 Climate - Theoretical to applied science -
Part 1 Climat - De la théorie à la science appliquée - Partie
1**

**02/06/2026
12:54**

ID: 12781 Contributed abstract

Reconstructing 2000 years of Antarctic climate variability using climate modes

*Cassandra Chanen*¹, *Anais Orsi*²

¹ University of British Columbia

² University of British Columbia

Presented by / Présenté par: *Cassandra Chanen*

Contact: cchanen@eoas.ubc.ca

Antarctica plays a crucial role in the global climate system. In order to understand contemporary trends in Antarctic climate, these trends need to be examined in the context of long-term natural variability. Antarctic climate variability over long timescales is poorly characterized relative to other regions due to a shorter instrumental record and low spatial coverage. We propose a new method for reconstructing Antarctic climate from ice-core isotope records by using climate modes. Climate modes are a well-established method of describing dominant patterns of climate variability. By describing the relationship between leading pressure modes and other key climatic variables (temperature, d18O and precipitation) this method enables the simultaneous reconstruction of the time evolution of multiple

**Session: 4081 Climate - Theoretical to applied science -
Part 1 Climat - De la théorie à la science appliquée - Partie
1**

**02/06/2026
13:06**

ID: 12618 Contributed abstract

**Characterizing the Sensitivity of Downwelling Longwave Radiation to
Clouds and Surface Temperature in the Tropical Western Pacific**

*Maelyn Kaya*¹, *Yi Huang*²

¹ McGill University

² McGill University

Presented by / Présenté par: *Maelyn Kaya*

Contact: maelyn.kaya@mail.mcgill.ca

Downwelling longwave radiation (DLR) is a key component of the surface energy budget. Long-term observations of DLR therefore improve understanding of the radiative drivers of climate change. This includes cloud feedbacks, which represent a major source of uncertainty in climate models. Recent analyses of DLR at the Southern Great Plains (SGP) identified a negative surface longwave cloud feedback, where decreases in low cloud cover over land in a warming climate reduced DLR. Similar work at the North Slope of Alaska (NSA) found a positive cloud feedback, where an enhanced greenhouse effect from thick low-level clouds and greenhouse gases increased DLR and dampened surface cooling. These results suggest that the mechanisms governing longwave cloud feedbacks are regime dependent. The Tropical Western Pacific (TWP), characterized by abundant atmospheric water vapour, remains understudied in this context. This study investigates how clouds modulate the sensitivity of DLR to surface temperature in the mid-infrared window over the TWP. We also assess the roles of atmospheric water vapour, carbon dioxide and ozone in shaping the resulting longwave cloud feedbacks. We analyze long-term spectrally resolved DLR measurements from the Atmospheric Emitted Radiance Interferometer (AERI) deployed at three TWP sites, with collocated meteorological observations. Observations are classified by sky condition to enable comparisons between clear- and cloudy-sky regimes. Weighted linear regression is applied to quantify the sensitivity of mid-infrared DLR to near-surface air temperature and to examine long-term trends across specific spectral bands, including carbon dioxide, ozone, and water vapour absorption bands, and the mid-infrared window. Controlled perturbation experiments are conducted using the MODerate Resolution TRANsmiission (MODTRAN6) radiative transfer model to assess the relative roles of water vapour, clouds, and greenhouse gases. By extending observational constraints on longwave cloud feedbacks to the tropical

regime, this work will help inform efforts to reduce uncertainty in climate model projections.

Session 5060

Convenors:

Daniel L. Peters, Environment and Climate Change Canada

Yonas B. Dibike, Environment and Climate Change Canada

Water bodies across Canada - including wetlands, lakes, and rivers - are undergoing significant and complex change/shifts in hydrology, geochemistry, and aquatic ecology due to accelerating climate change, land-use alterations, and increasing anthropogenic pressures. These changes are affecting the timing and quantity of water availability, water quality, and the overall health and functioning of aquatic ecosystems.

Canadian hydrological systems are strongly shaped by temperature-dependent processes. The formation, growth, and ablation of seasonal snow and ice cover regulate the timing, duration, and magnitude of streamflow and water levels. For instance, ice-jam induced high water levels often represent the extreme end of flood magnitude and dynamics; thus, underscoring the need to explicitly analyze both ice-affected and open-water conditions when assessing hydrological change. Moreover, the timing and rate of the spring snow/ice melt exert a major influence on subsequent flows, levels and the overall hydrological response of a system. The hydrology is also closely linked to water quality and aquatic ecology, which respond to these temperature-driven changes in interconnected ways.

The goal of this session is to bring together scientists engaged in the assessment and modelling of climate- and natural resource development-driven changes in flow and water level regimes across Canada. By fostering interdisciplinary dialogue, we aim to advance the data, models and research needed to guide effective mitigation and adaptation strategies, ensure sustainable water resources, and support environmental flow frameworks that restore and protect riverine and floodplain ecosystems.

Topics of interest include: Cold-regions hydrology in rivers, lakes, and wetlands; Extreme hydrological events, including ice-jam and open-water floods, as well as droughts; Relationships between hydrology, water quality and aquatic ecosystems; Water management strategies for environmental flows, ecosystem restoration, and anthropogenic uses (eg, hydropower generation, resource extraction).

Session: 5060 Hydrological Change in Canada: Impacts on Water Quantity, Quality and Aquatic Ecology
Changements hydrologiques au Canada : impacts sur la quantité et la qualité de l'eau et sur l'écologie aquatique

**02/06/2026
12:30**

Modeling and Evaluating the Sensitivity of River-Ice Thickness to a Warming Climate in the Mackenzie River Basin

*Yonas Dibike*¹, *Ethan James*², *Laurent de Rham*³, *Daniel Peters*⁴

¹ Environment and Climate Change Canada, Watershed Hydrology and Ecology Research Division

² Environment and Climate Change Canada, Watershed Hydrology and Ecology Research Division

³ Environment and Climate Change Canada, Watershed Hydrology and Ecology Research Division

⁴ Environment and Climate Change Canada, Watershed Hydrology and Ecology Research Division

Presented by / Présenté par: *Yonas Dibike*

Contact: yonas.dibike@ec.gc.ca

Climate warming is altering river-ice regimes across northern basins, with implications for hydraulics, ecosystems, infrastructure, and communities. In this study, we modeled river-ice thickness at hydrometric stations throughout the Mackenzie River Basin (MRB) using the Stefan equation driven by daily mean air temperatures from the Canadian Surface Reanalysis (CaSR 3.1) for 1980–2024. Cumulative freezing degree-days (CFDD) were derived from 10-km gridded temperature fields, and site-specific Stefan coefficients (α) were estimated via linear regression between measured and simulated ice thickness. The model showed strong performance, with high explained variance (R^2) and close agreement with observations. Basin-wide temperature records revealed significant warming trends in annual and seasonal air temperatures, accompanied by declining CFDD. When propagated through the ice-thickness model, these trends resulted in decreasing annual maximum ice thickness and earlier timing of maximum ice development in several sub-basins. Sensitivity analyses further demonstrated a clear reduction in maximum ice thickness under incremental warming. Overall, this basin-scale assessment indicates that river-ice formation in the MRB is already undergoing climate-driven change and is likely to continue thinning under future warming. The findings underscore the value of integrating high-resolution reanalysis data with physically based models to evaluate climate sensitivity in large northern river systems.

Understanding Uncertainty in Snow Water Equivalent Across the Nechako River Basin, British Columbia

*Hadi Sanikhani*¹, *Stephen Déry*²

¹ University of Northern British Columbia

² University of Northern British Columbia

Presented by / Présenté par: *Hadi Sanikhani*

Contact: sdery@unbc.ca

Snow water equivalent (SWE) is a critical indicator of water availability in snow-dominated basins of western Canada and a major source of uncertainty for seasonal water-resource planning. This study provides a basin-scale assessment of SWE variability across the Nechako River Basin, British Columbia, using long-term reanalysis data together with available in situ observations. Monthly and seasonal SWE records from 1950–2024 were compiled from ERA5-Land and compared with station measurements to evaluate consistency in magnitude, timing, and interannual variability. Results show pronounced spatial heterogeneity in annual and peak SWE across sub-basins, reflecting strong elevation and climatic gradients. Basin-wide analyses indicate substantial year-to-year variability in peak SWE and shifts in timing, with earlier peak dates generally occurring at lower elevations. Seasonal relationships between SWE and large-scale climate variability were explored using correlation and composite approaches. Preliminary analyses suggest that phases of major climate modes influence both the magnitude and timing of seasonal snow accumulation, contributing to uncertainty in spring runoff generation. These findings highlight the importance of understanding spatial and temporal SWE variability for water-supply forecasting, hydropower operations, and ecosystem management in northern British Columbia. This study provides a basin-scale synthesis of SWE patterns and potential climate drivers across the Nechako Basin and helps better characterize spatial and climatic controls on SWE variability and associated hydrological uncertainty in snow-dominated systems.

Session: 5060 Hydrological Change in Canada: Impacts on Water Quantity, Quality and Aquatic Ecology

Changements hydrologiques au Canada : impacts sur la quantité et la qualité de l'eau et sur l'écologie aquatique 02/06/2026 12:54

Assessing snowpack conditions and climate patterns to inform future snow monitoring in Alberta

*Alida Thiombiano*¹, *Brandi Newton*², *Babak Farjad*³

- ¹ Alberta Environment and Protected Areas
- ² Alberta Environment and Protected Areas
- ³ Alberta Environment and Protected Areas

Presented by / Présenté par: *Alida Thiombiano*

Contact: alida.thiombiano@gov.ab.ca

Snowpack in Alberta's eastern slopes is a critical source of water for the Peace, Athabasca, North Saskatchewan, and South Saskatchewan river systems. Because these headwater regions supply much of the province's surface water, understanding snow accumulation and melt is essential for managing water availability under a changing climate. Alberta's snow monitoring network, which combines manual snow course surveys with continuous automated measurements, provides long-term records that capture both natural variability and emerging climate-driven shifts in snowpack. Snow processes are highly sensitive to temperature and precipitation, and future climate projections indicate shorter winters and altered precipitation regimes, posing increasing risks to water security in snow-dominated watersheds. Navigating this uncertainty requires monitoring strategies informed by both historical observations and plausible future conditions. Our study integrates observed snowpack measurements with regionally downscaled historical and future climate datasets to develop snow- and climate-related indicators for characterizing conditions and examining climate-snowpack interactions across Alberta. Using these indicators, we will assess the vulnerability of past snowpack conditions under future climate scenarios and evaluate how well the current monitoring network captures the range of expected climate variability. We will present the spatial and temporal patterns revealed by these indicators and discuss implications for the design and effectiveness of Alberta's snow monitoring network. By linking historical snowpack behavior with projected climate conditions, this research will provide insights to support proactive future planning of snow monitoring in Alberta, which is essential for ensuring reliable seasonal water supply forecasting.

Session: 5060 Hydrological Change in Canada: Impacts on Water Quantity, Quality and Aquatic Ecology

Changements hydrologiques au Canada : impacts sur la quantité et la qualité de l'eau et sur l'écologie aquatique **02/06/2026**
13:06

ID: 12768 Contributed abstract

Encountering Uncertainties During Development of the Canadian River Ice Bulletin (CRIB)

*Laurent de Rham*¹, *Daniel Peters*², *Yonas Dibike*³, *Barrie Bonsal*⁴, *Benoit Turcotte*⁵, *Adrienne Tivy*⁶, *Aranildo Lima*⁷

¹ Environment and Climate Change Canada

- 2 Environment and Climate Change Canada
- 3 Environment and Climate Change Canada
- 4 Environment and Climate Change Canada
- 5 Yukon University
- 6 Environment and Climate Change Canada
- 7 Environment and Climate Change Canada

Presented by / Présenté par: *Laurent de Rham*

Contact: laurent.derham@ec.gc.ca

River ice is a prominent feature of the Canadian landscape, documented for centuries. While long-term, national-scale analyses have been conducted by research groups and government departments over the past decades, these efforts remain sporadic, producing discrete deliverables without continuous updates or delivery of open, comprehensive datasets on ice timing across Canada's waterways. To address this gap, the proposed Canadian River Ice Bulletin (CRIB) will compile and annually report the first and last days of ice-affected flow at a network of Water Survey of Canada (WSC) and Centre d'expertise hydrique du Québec (CEHQ) hydrometric stations. These dates are derived from the "B" (or "R") data flag in publicly available discharge records, based on expert hydrometeorologist interpretation, with multiple levels of approval during the ~2-year lag to final publication. A Python-based workflow is presented to ingest and process data from WSC and CEHQ sources, generating a consistent 39-year river ice climatology (September 1, 1985 to August 31, 2024) across 297 locations. Trend results show no significant change in river ice timing (first B date, last B date, duration) at the majority of sites, with an east-west contrast evident. Uncertainties discussed include the prescription of B data flags, the finalized geographical distribution of CRIB gauges, and challenges from missing, intermittent, or absent ice-affected flow conditions. Animations of timing trends are developed to educate and engage Canadians on winter's profound influence on our rivers. The open, transparent Python workflow supports a future "one-click" solution for continuous annual CRIB updates on river ice in the Canadian environment.

Session: 5060 Hydrological Change in Canada: Impacts on Water Quantity, Quality and Aquatic Ecology Changements hydrologiques au Canada : impacts sur la quantité et la qualité de l'eau et sur l'écologie aquatique

**02/06/202
6 13:18**

ID: 12839 Contributed abstract

The Importance of Including Spring Ice-Jam Flood Extents in Developing an Environmental Flow Assessment Approach for Cold Regions Deltaic Ecosystems – A Case Study of the Peace-Athabasca Delta

*Daniel Peters*¹, *Nigel Van Nieuwenhuizen*², *Spyros Beltaos*³,

¹ Environment and Climate Change Canada

² Environment and Climate Change Canada

³ Environment and Climate Change Canada

⁴ Laval University

⁵ Environment and Climate Change Canada

Presented by / Présenté par: *Daniel Peters*

Contact: daniel.peters@ec.gc.ca

The Peace-Athabasca Delta (PAD) is a deltaic environment formed at the confluence of the Peace, Athabasca and Birch rivers with Lake Athabasca in western Canada. The biologically and culturally rich delta is a Ramsar Convention wetland site of international importance and an Outstanding Universal Value component of the Wood Buffalo National Park (WBNP), identified as a UNESCO World Heritage Site. Although the PAD has been a focus of scientific inquiry, the systematic mapping of historical spring ice-jam induced floodwater extents has yet to be carried out. Knowledge of when, how, and where water moves over the deltaic landscape is necessary to inform an environmental flow assessment framework.

The goal of this presentation is to showcase the importance of including spring ice-jam flood extents in developing an environmental flow assessment approach for cold regions deltaic ecosystems. Specifically, an approach to classify satellite imagery (eg, LandSat and/or RadarSat) into three categories (snow/ice, water on ice, & water) at a time near the maximum floodwater extent generated from ice jam events across the PAD will be outlined. Satellite image classifications are verified using expert knowledge, ground observations, and aerial surveys. The time series of spatial flood extents will provide historical baseline hydrological data to identify water conditions required to sustain the PAD ecosystem.

Session 2035 Part 5

Convenors:

Elizaveta Malinina, Environment and Climate Change Canada

Neil Tandon, York University

Nathan Gillett, Environment and Climate Change Canada

Extreme events in weather and climate pose significant risks to lives, ecosystems, and economies, often resulting in devastating losses and long-term impacts. Nevertheless, current knowledge of extremes and how they are evolving in a changing climate is associated with a high degree of uncertainty, often arising from short historical records, incomplete process understanding, or model biases. This session invites contributions addressing all aspects of weather and climate extremes, including but not limited to studies covering uncertainties in

physical mechanisms, observations, predictions or projections of extremes, and their communication. We welcome submissions examining extremes of varying durations (from hours to months) and types, including heatwaves, wildfires, extreme precipitation, wind-related events, hydrological extremes (e.g., floods and droughts), and oceanographic extremes (e.g., storm surges, coastal flooding, and marine heatwaves). Submissions may focus on historical changes, event attribution, future projections, or any other extremes-related topic.

**Session: 2035 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 5 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 5**

**02/06/2026
13:50**

ID: 12714 Contributed abstract

**Simulation of layered Arctic mixed-phase clouds using prognostic
aerosols in the P3 microphysics scheme**

*Melissa Cholette*¹, *Zhipeng Qu*², *Alexei Korolev*³, *Zen Mariani*⁴,
*Zane Dedekind*⁵, *Caroline Jouan*⁶, *Jason Milbrandt*⁷, *Hugh
Morrison*⁸

¹ ECCC

² ECCC

³ ECCC

⁴ ECCC

⁵ ECCC

⁶ CICERO

⁷ ECCC

⁸ NSF NCAR

Presented by / Présenté par: *Melissa Cholette*

Contact: melissa.cholette@ec.gc.ca

Arctic mixed-phase clouds, composed of supercooled liquid droplets and ice crystals, form under a wide range of thermodynamic conditions, from moist air over open water to colder air over sea ice or land. They occur at low and mid-level altitudes with varying horizontal and vertical extents and can persist from hours to several days. Their properties and lifetime strongly influence Arctic temperature and impact the global radiation budget.

Simulating these clouds in atmospheric models is challenging due to both their formation across diverse conditions and parameterization limitations. Ice is often produced too rapidly at the expense of liquid droplets, aerosol-dependent ice nucleation is oversimplified, and particle size distributions and key microphysical processes such as riming and aggregation are not adequately represented. Resolving thin cloud layers also requires fine vertical resolution and accurate representation of low-level inversions,

surface fluxes, and turbulent mixing.

To investigate these clouds, high-resolution (1 km) simulations were conducted with the Global Environmental Multiscale (GEM) model over the Canadian Arctic, testing different configurations of the Predicted Particle Properties (P3) microphysics scheme. The updated P3 version predicts concentrations of both ice- and water-nucleating aerosols instead of assuming fixed aerosol numbers for cloud and ice formation. Simulated results on January 19, 2026, are evaluated against aircraft/surface observations taken at Inuvik, NWT, and observations from EarthCARE, which captured multiple layers of mixed-phase clouds that day.

Results show that prognostic aerosols improve the representation of mixed-phase clouds around 4–5 km height as well as the thin liquid layer at cloud top compared to the fixed-aerosol P3 configuration. It is found that the implementation of an aerosol-dependent (rather than temperature-dependent) ice nucleation parameterization significantly modifies the simulated ice properties, affecting vapor competition between phases and allowing the liquid layer to persist.

**Session: 2035 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 5 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 5**

**02/06/2026
14:02**

ID: 12818 Contributed abstract

Tropical Cyclones Act as Scrubbers of Aerosols in the Upper Atmosphere

*Mohammad Ashraf Modares*¹, *Morgan O'Neill*²

¹ University of Toronto

² University of Toronto

Presented by / Présenté par: *Mohammad Ashraf Modares*

Contact: m.ashrafmodares@mail.utoronto.ca

Tropical Cyclones (TCs) channel planetary boundary layer air to the upper atmosphere through deep convective towers in their eyewall and rainbands, which change the distribution of heat, moisture, and chemicals in the vicinity of TCs. Aerosols affect TCs by acting as cloud condensation nuclei (CCN), and are also affected by them, by being rained and washed out. In this study, we use the output of a global high-resolution atmospheric simulation with interactive chemistry to understand how TC-aerosol interactions change the spatial distribution of different aerosols in the upper troposphere and lower stratosphere. We show that TCs form a large, contiguous clean plume of low hydrophilic aerosol in the TC outflow region (100-300 hPa). This relative deficit of hydrophilic aerosols, including sulfate aerosol relevant

to solar radiation management proposals, is found to be a function of TCs' intensity. This apparent cleaning effect is unique to TCs among tropical convection. The clean plume can serve as a tracer of TC outflow, as it extends far beyond the visible cloud shield.

**Session: 2035 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 5 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 5**

**02/06/2026
14:15**

ID: 12685 Contributed abstract

Flash Oral

Detecting and attributing sweet cherry (*Prunus avium* L.) extreme temperature risk to climate change in British Columbia, Canada

*Elizabeth Houghton*¹, *Denise Neilsen*², *Yongxiao Liang*³, *Adam Monahan*⁴

¹ University of Victoria

² Agriculture and Agri-Food Canada

³ Environment and Climate Change Canada

⁴ University of Victoria

Presented by / Présenté par: *Elizabeth Houghton*

Contact: elizabeth.anne.houghton@gmail.com

Sweet cherry production in British Columbia, Canada, is concentrated in the Okanagan Valley region. Recent cold snaps and extreme heat events that have caused significant crop losses in this region highlight the need to quantify current and future climate-related risks to sweet cherry production. This study applies an event attribution framework to assess the influence of anthropogenic climate change on cold injury and heat risk to sweet cherry production across the Okanagan and adjacent Similkameen regions and evaluates changes in the timing of sweet cherry phenology. Large-ensemble climate simulations (CanESM2) of daily maximum and minimum temperatures are applied to temperature-based sweet cherry phenology and cold hardiness models; these models predict dynamic cold injury thresholds and periods of increased heat sensitivity for event detection. Findings suggest that cold injury events are less likely under anthropogenic climate change than under natural forcing only and that both the likelihood and frequency of cold injury will decline under future warming. In contrast, heat damage events are predicted to be more likely under anthropogenic climate change than under natural forcing alone and their likelihood and frequency are expected to increase with future warming. Delays in fulfilling cold temperature requirements for dormancy release, along with advances in bud break, bloom, and harvest timing under future climate warming are also projected. Overall, a decrease in projected cold injury risk may be beneficial to cherry growers; however, increasing heat damage risk and shifts in phenological timing may introduce new challenges.

**Session: 2035 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 5 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 5**

**02/06/2026
14:20**

ID: 12615 Contributed abstract

Flash Oral

**Monitoring Extreme Climate and Hydrometeorological Events: The
MECHE Observatory**

*Stephen Déry*¹, *Julie Thériault*²

¹ University of Northern British Columbia

² Université du Québec À Montréal

Presented by / Présenté par: *Stephen Déry*

Contact: sdery@unbc.ca

Climate and hydrometeorological extremes in western Canada are on the rise, often leading to natural hazards with catastrophic impacts such as floods, droughts and wildfires. Yet few, if any, meteorological observatory is dedicated to investigating the occurrence and characteristics of extreme climate and hydrometeorological events on the west-central coast of British Columbia (BC). The Monitoring Extreme Climate and Hydrometeorological Events (MECHE) observatory aims to monitor extreme climate and hydrometeorological events in this region, filling key information gaps. MECHE is a joint effort between UNBC and UQAM initiated in 2023 to develop a comprehensive meteorological observatory encompassing two sites: UNBC's Northwest campus in Terrace, within BC's Skeena Watershed and Huckleberry Mine in BC's upper Nechako Watershed. This presentation will summarize the overarching objective for MECHE, the study area, the instrumentation deployed at both sites and hydrometeorological data being collected. A summary of the strategy for data management and sharing will conclude the presentation.

**Session: 2035 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 5 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 5**

**02/06/2026
14:25**

ID: 12786 Contributed abstract

Flash Oral

**Overview of the Cloud to Aquifer Natural Observatories (CANO)
network**

*Julie Thériault*¹, *Marie Larocque*², *François Anctil*³, *Alejandro di
Luca*⁴, *Paul del Giorgio*⁵, *Manuel Helbig*⁶, *Audrey Maheu*⁷,

- 1 UQAM
- 2 UQAM
- 3 U Laval
- 4 UQAM
- 5 UQAM
- 6 Dalhousie U
- 7 UQO
- 8 U Laval
- 9 U Montréal
- 10 U Laval

Presented by / Présenté par: *Julie Thériault*

Contact: julie.theriault@uqam.ca

Extreme weather events such as droughts, floods, and ice storms are increasing in frequency and intensity across Canada. Understanding how climate change alters the water cycle and triggers these hazards is therefore critical and requires harmonized methodologies and strong collaboration among researchers. Hence, the Cloud to Aquifer Natural Observatories (CANO) network was recently funded by the Canada Foundation for Innovation Funds to monitor the water from the atmosphere to the aquifer over Eastern Canada. CANO aims to advance integrated observations of the water cycle through four main objectives: 1) quantifying atmospheric water fluxes, 2) characterizing hydrological processes at the land surface and in aquatic environments, 3) investigating soil and groundwater flow processes, and 4) assessing water cycle interactions and responses to environmental change. To do so, a multidisciplinary team of scientists with expertise in atmospheric science, hydrology, hydrogeology, biogeochemistry, and Earth system modelling is establishing a state-of-the-art network to monitor the water cycle across seven river basins over eastern Canada. Four observatories are located in Quebec (Kenauk, Covey Hill, Forêt Montmorency, and Bernard River), two are in the province of New Brunswick (Iroquois river and Acadia Research Forest), and one is in the province of Nova Scotia (Major Lake). Some of the observatories build on existing long-term research sites, enabling rapid deployment and targeted investigation of key scientific questions. By combining monitoring (from clouds to groundwater) with high-resolution modelling (atmosphere, surface, and subsurface), CANO will generate unique datasets to trace water pathways across all phases of the water cycle and support improved strategies for managing water-related risks under a changing climate.

ID: 12843 Contributed abstract

Flash Oral

The Adaptable Earth Observation System in the Saint Lawrence River Valley

*John Gyakum*¹, *Julie Thériault*², *Yi Huang*³, *Véronique Meunier*⁴,
*Eve Bigras*⁵

¹ McGill University

² University of Quebec at Montreal

³ McGill University

⁴ McGill University

⁵ McGill University

Presented by / Présenté par: *John Gyakum*

Contact: john.gyakum@mcgill.ca

A multi-institutional infrastructure project, entitled the Adaptable Earth Observation System (AEOS), has been completed in January 2026.

AEOS consists of seven meteorological stations situated throughout Canada's Saint Lawrence River Valley. Each of these "Climate Sentinel" stations is fully instrumented to measure near-surface properties including: temperature at eight different heights to 10 m, winds, snow, humidity, visibility, precipitation, radiation and carbon dioxide. Additionally, these stations include profiling equipment such as micro rain radars (MRR) and ceilometers. The AEOS also includes Atmospheric Emitted Radiance Interferometers (AERIs) that are installed in Montreal and Mont-Saint-Hilaire and two Halo scanning doppler lidars are installed on either side of the Saint-Lawrence river to monitor air pollution in Montreal downtown core.

This mesoscale network is anchored by a new building housing the Earth Observation System-Laboratory, located at McGill University's Gault Nature Reserve in Mont-Saint-Hilaire, Quebec. This building serves as an operational base for meteorological deployment including a radiosonde sounding launch site, and a mobile laboratory deployment site.

In addition to the fixed deployments, AEOS includes two mobile laboratories, portable radiosonde systems, a portable Micro Rain Radar, a Halo scanning doppler lidar and Atmospheric Emitted Radiance Interferometers (AERIs).

The combination of a fixed mesoscale network and mobile-deployment capabilities has provided the foundation for several field programs that have had research foci including mixed-phase precipitation, validation of satellite- and aircraft-based remotely sensed data, Saint-Lawrence River Valley frontal structures, and Montreal-region greenhouse gas concentrations.

Examples of these research projects' successes will be shown.

Session 2053 Part 3

Convenors:

Milena Dimitrijevic, Environment and Climate Change Canada

Syed Husain, Environment and Climate Change Canada

Related to scientific studies and/or information sharing about the atmosphere, including weather, meteorology, clouds and precipitation, air quality, atmospheric dynamic and extreme events, using various approaches.

This session covers many topics, including, but not limited to, theoretical research, model development, observation techniques, real-time monitoring, databases, diagnostic methods, data analysis and artificial intelligence.

Session: 2053 Atmosphere - Theoretical to applied science - Part 3 Atmosphère - De la théorie à la science appliquée - Partie 3

**02/06/2026
13:50**

ID: 12653 Contributed abstract

In Situ Measurements and Computational Fluid Dynamics Analysis of Greenhouse Gas Dispersion in Downtown Montréal

*Quinn Dyer-Hawes*¹, *Djordje Romanic*², *Yi Huang*³, *John Gyakum*⁴, *Peter Douglas*⁵, *Regina Gonzalez Moguel*⁶, *Jacob Asomaning*⁷, *John Stix*⁸, *Margaret Kalacska*⁹, *Keyvan Ranjbar*¹⁰, *Leonid Nichman*¹¹, *Felix Vogel*¹²

¹ McGill University

² McGill University

³ McGill University

⁴ McGill University

⁵ McGill University

⁶ McGill University

⁷ McGill University

⁸ McGill University

⁹ McGill University

¹⁰ National Research Council Canada

¹¹ National Research Council Canada

¹² Environment and Climate Change Canada

Presented by / Présenté par: *Quinn Dyer-Hawes*

Contact: quinn.dyer-hawes@mail.mcgill.ca

Cities are hotspots of greenhouse gas (GHG) emissions and associated air pollution, which are then dispersed by highly localized wind conditions. Study of urban GHGs and pollution is crucial to quantify their spatial and temporal variability. We investigate these dispersion dynamics and the distribution of GHGs in downtown Montréal, Canada, with a combination of multiplatform field measurements and computational fluid dynamics (CFD) for the day of 21 February 2024. Atmospheric conditions were sampled with aircraft flights and radiosondes, while carbon dioxide (CO₂) and methane (CH₄) were measured with aircraft, drone, and fixed location Picarro GasScouter. In addition to presenting unique field measurements, we propose a novel domain shape to account for rotating wind direction with height and test for appropriate initialization conditions. Reynolds-averaged Navier-Stokes simulations using both incompressible and compressible solvers are performed to study thermal and stability effects on resulting GHG distributions. These GHG emissions are modeled with the inclusion of emissions from vehicles, large government buildings, and the McGill University power plant. While the incompressible solver finds excellent agreement in the concentration of CO₂ at the location of the downtown Picarro GasScouter, the compressible solver significantly underpredicts the concentration. This finding, along with the underprediction of both CO₂ and CH₄ as compared with drone measurements, suggests that key GHG emission sources are missing from the model. Of those included, vehicle emissions dominate local concentrations of CO₂. We then use the model to evaluate the impact of the specific urban morphology on GHG distributions, finding areas prone to poor air quality. Finally, comparisons are made with the OCO-2 satellite for column-averaged dry-air mole fractions of CO₂, as CFD models have the potential to serve as validation for GHG measuring satellites and in inversion modeling. Studies such as this are important in the further improvement of urban sustainability and health.

Session: 2053 Atmosphere - Theoretical to applied science - Part 3 Atmosphère - De la théorie à la science appliquée - Partie 3

**02/06/2026
14:02**

ID: 12654 Contributed abstract

Measurements of Reactive Pollutant Dispersion of Traffic Emissions from an Intersection in Downtown Montréal and Their Modeling using Large Eddy Simulation

*Quinn Dyer-Hawes*¹, *Djordje Romanic*², *Yi Huang*³, *John Gyakum*⁴, *Peter Douglas*⁵, *Parisa Ariya*⁶, *Jacob Asomaning*⁷, *Devendra Pal*⁸, *Alessio Fortin*⁹, *Arya Toghraei*¹⁰, *Erin Eves*¹¹, *Dustin Fraser*¹²

¹ McGill University

² McGill University

- 3 McGill University
- 4 McGill University
- 5 McGill University
- 6 McGill University
- 7 McGill University
- 8 McGill University
- 9 McGill University
- 10 McGill University
- 11 McGill University
- 12 McGill University

Presented by / Présenté par: *Quinn Dyer-Hawes*

Contact: quinn.dyer-hawes@mail.mcgill.ca

Vehicles are responsible for a significant amount of pollution and greenhouse gases (GHGs) emitted in urban areas, which are detrimental to both human health and the Earth's climate. Traffic-related air pollution is comprised of nitrogen dioxide (NO₂), volatile organic compounds (VOCs), particulate matter of diameter less than 2.5 μm (PM_{2.5}), and carbon dioxide (CO), with ozone (O₃) forming due to related chemical reactions. Furthermore, carbon dioxide (CO₂) and methane (CH₄) emissions also originate from vehicles, indicating the multifaceted impacts resulting from vehicle usage. The dispersion of these species is a complex process, especially in urban areas, with highly localized wind conditions, photochemical reactions, vehicle-induced turbulence, and vegetation all having major effects. A computational fluid dynamics (CFD) approach is taken to investigate each of these aspects for a real intersection in downtown Montréal, using compressible large eddy simulation to resolve the turbulent flow and thermal effects. This model is initialized with a nearby sounding and then validated against in-situ measurements of wind flow and NO₂, O₃, VOC, PM_{2.5}, CO, CO₂, and CH₄ concentrations. These measurements were taken on the morning of 10 February 2026, at the peak of morning traffic (07:30–08:30 am local time) along the section of Sherbrooke Street West along the McGill University campus. Cameras captured vehicle flow rates to accurately determine the level of emissions during this time. The validated model is used to identify regions of dangerous air quality, especially important given the area's heavy pedestrian usage. With high resolution modeling such as this, it is possible to estimate exposure levels to traffic-related air pollution, necessary for risk assessment studies. Additionally, GHG and pollution concentrations can better be separated into local and background components, helping with identification of significant emission sources.

ID: 12667 Contributed abstract

CHARACTERIZATION OF HAILSTORM ENVIRONMENTS IN ALBERTA HAIL ALLEY

*Eric Ayitah*¹, *John Hanesiak*², *David Walker*³, *Mateusz Taszarek*⁴,
*Julian Brimelow*⁵

¹ University of Manitoba

² University of Manitoba

³ University of Manitoba

⁴ Adam Mickiewicz University

⁵ Western University

Presented by / Présenté par: *Eric Ayitah*

Contact: ayitahe@myumanitoba.ca

Alberta Hail Alley experiences most of Canada's damaging hailstorms, yet the environments supporting different hail sizes and storm modes remain poorly quantified. This study characterizes hailstorm environments associated with 91 Northern Hail Project events (55 non-supercell and 36 supercell storms) observed in central Alberta between 2022 and 2025. ERA5 proximity soundings were used to derive more than 300 convective parameters using the ThundeR v1.4 package. Composite skew-T, hodographs and vertical profiles of storm relative winds were generated for supercell and non-supercell cases producing different hail sizes. A Random Forest-based variable selection method (VSURF) was applied, followed by linear and multivariate discriminant analysis, to identify the most important thermodynamic, kinematic, and composite parameters separating

(i) supercell from non-supercell storms and

(ii) sub-severe, severe, and significant-severe hail environments.

Preliminary results indicate that parameters such as Supercell Composite Parameter, various bulk wind shear parameters, equilibrium level temperature, most-unstable entrainment maximum wind shear, among others, show the strongest skill in discriminating supercell and non-supercell environments. Bunkers right-motion tends to be a very good proxy for Alberta severe hail producing supercells, whereas, real non-supercell storm motions tend to move between Bunkers right-motion and the "normal" storm motion vector. Height of -5oC isotherm, equilibrium level temperature, bulk shear between 1 km and 8 km, among others, strongly discriminate environments associated with hail severity. The 1 to 8 km bulk wind shear significantly discriminate storm environments producing severe and significant-severe hail. These findings provide a region-specific, data-driven basis for refining hail guidance in Canadian forecast operations and for

improving future hail risk assessments in Alberta Hail Alley. Keywords: Hailstorm, Hail Alley, Alberta, Hail Environments.

Session: 2053 Atmosphere - Theoretical to applied science - Part 3 Atmosphère - De la théorie à la science appliquée - Partie 3

**02/06/2026
14:26**

ID: 12722 Contributed abstract

WRF simulations of Mountain Waves and Foehn winds in the lee of the Alborz mountains

*Peter Taylor*¹, *Piyush Teeloku*², *Yongsheng Chen*³, *Jeff Sepehri*⁴

¹ York University

² York University

³ York University

⁴ York University

Presented by / Présenté par: *Peter Taylor*

Contact: pat@yorku.ca

Foehn winds occur quite frequently in coastal areas NE of the Alborz mountains in Iran when tropospheric winds are from the SW. They may also be dependent on tropospheric stratification, and the tropopause height. Five examples of 2021 Foehn events in the lee of the Alborz mountains have been described in a recent thesis by Sepehri (2022). Further analysis of these cases, making use of upwind radiosonde profiles (Kermanshah, Iran), indicates that mountain waves may play an important role. To investigate this, we have modelled a selection of Sepehri's cases, plus days on which Foehn were not reported, using WRF hindcasts which were run, on CAC machines, using three nested domains at grid resolutions of 27, 9 and 3 km. The initial and boundary conditions were from GFS Final Analysis and a 6h spin-up time was allowed. Sample results will be presented.

Several authors have linked Foehn and Chinook winds to mountain wave effects associated with stratified flows over topography. However, many reviews highlight other Foehn mechanisms such as upwind blocking or cloud processes, although papers involving mountain waves are cited. Baines (Topographic Effects in Stratified Flows, 1995, 2022) nicely illustrates possible mountain wave impacts via laboratory tank flow experiments on criteria for various forms of boundary-layer flow separation over simple 2D topographies. We consider that orographic waves and lack of boundary-layer flow separation at the top or part way down the lee slope may be major factors in cases of Foehn conditions in the lee of the Alborz mountains. Our WRF simulations confirm this. Similar situations can arise with Chinooks in the lee of the Rocky Mountains.

ID: 12796 Contributed abstract

Ground-Based Cameras from the Global Meteor Network for Contrail Model Validation

*Emily Tracey*¹, *Luc Busquin*², *Denis Vida*³, *Lisa Schielicke*⁴,
*Liam Schultz*⁵, *Jerome Busquin*⁶, *Maadhyam Rana*⁷, *Dan*
*Ndabihayimana*⁸, *Andrew Wang*⁹, *Andrew Shum*¹⁰, *Boris*
*Tchatchoua Ngassam*¹¹, *Karan Kapoor*¹²

¹ Western University

² ContrailCast

³ Western University

⁴ Western University

⁵ Western University

⁶ ContrailCast

⁷ University of Waterloo

⁸ Western University

⁹ University of Waterloo

¹⁰ University of Waterloo

¹¹ Western University

¹² University of Waterloo

Presented by / Présenté par: *Emily Tracey*

Contact: etracey4@uwo.ca

Contrail cirrus is responsible for an estimated 1-2% of all anthropogenic radiative forcing, but this estimate carries significant uncertainty (~70%). If contrails could be predicted accurately, a proposed mitigation strategy involves redirecting aircraft to avoid ice-supersaturated regions where persistent contrails form. To improve contrail predictions, direct observations validate and constrain atmospheric models. Ground-based cameras bridge the spatial resolution gap left by satellite observations, allowing us to observe contrail formation and attribute contrails to specific flights.

We present first results from a large-scale dataset of flight-attributed contrails observed by a network of ground-based cameras: the Global Meteor Network (GMN). Contrails were detected and segmented from camera timelapses using machine learning algorithms, automatically associated with flights from Automatic Dependent Surveillance–Broadcast (ADS-B) flight data, and compared to the Contrail Cirrus Prediction (CoCiP) model.

We analyze observations from autumn of 2025 in three regions with varying climates: Europe, Southern Ontario, and the Southwest United States. Persistent contrail observations are not well predicted by CoCiP, which early results suggest stem from insufficient vertical resolution to capture vertically thin ISSRs and a limited number of measurements of humidity in the upper troposphere. This ground-truth data provides validation to help improve contrail models and physical properties such as width, altitude, and lifetime which works toward reducing the uncertainty of contrails' climate impact.

Session 3040

Convenors: Jared Penney

Related to scientific studies and/or information sharing about the ocean, including studies in physical, chemical, and biological oceanography, ocean waves and storm surge using various approaches.

This session covers many topics, including, but not limited to, theoretical research, model development, observation techniques, real-time monitoring, databases, diagnostic methods, data analysis and artificial intelligence.

Session: 3040 Ocean - Theoretical to applied science
Océan - De la théorie à la science appliquée

02/06/2026
13:50

ID: 12666 Contributed abstract

**Detecting and Analyzing Kauai Beacon Acoustic Transmissions on
Ocean Networks Canada Hydrophones**

*David Hughes*¹

1

Presented by / Présenté par: *David Hughes*

Contact: dv632369@dal.ca

Acoustic tomography can be used to remotely monitor basin-scale ocean properties. In 2023 the Kauai Beacon (KB) began transmitting an acoustic signal six times daily, every fourth day across the north Pacific from the Hawaiian Island of Kauai. The signal has been detected off the continental United States and near Wake Island at approximately 4000 km range. Bottom mounted Ocean Networks Canada (ONC) hydrophones, off the British Columbia coast, have received the signal at a distance of 4100 km, providing an opportunity to study long-range propagation in the northeast Pacific Ocean. The signal is detected using a matched filter to extract the maximum-length sequence encoded transmission from the below the ocean's background noise. Of the five ONC sensor locations, the signal was

only detected on the Barkley Canyon hydrophones and shows a single arrival peak. Observed trends in travel time, signal-to-noise ratio, and receive level, coincide with seasonal changes. The travel time variations can be analyzed to give the sound speed and temperature of the ocean integrated over the acoustic ray paths. Observations of travel time and receive level were compared to a raytracing model (BELLHOP) and a range-dependent Parabolic Equation (RAM-PE) propagation model respectively. The results show that increased sea surface temperatures decreased the width of the Sound Fixing And Ranging (SOFAR) acoustic channel. Under these conditions, the acoustic rays experienced warmer temperatures and longer travel times as they concentrate around the slow sound speed of the SOFAR channel. This study establishes methods of acoustically monitoring ocean conditions in the northeast Pacific using existing infrastructure.

Session: 3040 Ocean - Theoretical to applied science
Océan - De la théorie à la science appliquée

02/06/2026
14:02

ID: 12830 Contributed abstract

Impacts of Slow Profiling Speeds on Microstructure Turbulence
Estimates: Insights from a Beaufort Sea Glider Mission

*Shumin Li*¹, *Stephanie Waterman*², *Jean-philippe Juteau*³, *Anneke ten Doeschate*⁴

¹ The University of British Columbia

² The University of British Columbia

³ Rockland Scientific Inc.

⁴ Rockland Scientific Inc.

Presented by / Présenté par: *Shumin Li*

Contact: shumini@eoas.ubc.ca

Autonomous ocean gliders are increasingly used to measure small-scale turbulence, but our knowledge is limited on their performance in atypical flight behaviours, especially under extremely low-turbulence conditions, e.g., the deep Arctic Ocean. This information is particularly important in guiding glider operations in order to accurately estimate turbulence properties using microstructure shear data. In September 2024, a two-week mission in the Beaufort Sea deployed a Slocum glider equipped with Rockland Scientific MicroRider microstructure sensors to investigate turbulence characteristics in the Arctic environment. The glider exhibited highly variable flight behaviour, including a large variation in profiling speed (5–50 cm/s). This condition deviates from standard “well-behaved” glider flight, offering a rare opportunity to examine the limits of established turbulence processing methods. In particular, prolonged periods of slow downcasts (< 20 cm/s) posed a major challenge for deriving reliable

turbulent kinetic energy dissipation rates, leading to highly inflated dissipation rates of turbulent kinetic energy (epsilon) and causing marked asymmetries between up- and downcast estimates. The root cause of this problem is verified not to be from the errors in the estimates of glider profiling speed, nor violations in fundamental turbulent physics. The most likely explanation is found to be related to a low-frequency contamination, possibly due to electronic or mechanical noise, that is not accounted for in the empirical noise model. This work highlights challenges in turbulence characterization from slow-moving gliders. Similar limitations may also apply to other slow-moving platforms, e.g., microstructure floats.

Session: 3040 Ocean - Theoretical to applied science
Océan - De la théorie à la science appliquée

02/06/2026

14:14

ID: 12756 Contributed abstract

Using a Non-Stationary Tidal Model to Provide River Input for a Coastal Ocean Model of the Bay of Fundy

*Stephanne Taylor*¹, *Michael Dunphy*², *Maxim Krassovski*³

¹ Fisheries and Oceans Canada, Bedford Institute of Oceanography

² Fisheries and Oceans Canada, Institute of Ocean Sciences

³ Fisheries and Oceans Canada, Institute of Ocean Sciences

Presented by / Présenté par: *Stephanne Taylor*

Contact: stephanne.taylor@dfo-mpo.gc.ca

River discharge is a key component to coastal ocean modelling, but can be logistically difficult in areas where tidal signals propagate far inland. Modelling long river extents is not practical when the focus is on the ocean circulation, and coupling a full river model is complex. Non-stationary tidal analysis (NS TIDE) can be used to exploit the relationship between upstream hydrological predictors and downstream deterministic tidal signals to generate a mixed tidal-fluvial water level signal at a convenient location for use in coastal ocean modelling systems. Our case study of the Wolastoq (Saint John river) shows that this approach is viable even in a macrotidal area with highly complex river-ocean interactions. This framework is well-suited to use in operational ocean modelling efforts where short-term river forecasts are needed.

Session: 3040 Ocean - Theoretical to applied science
Océan - De la théorie à la science appliquée

02/06/2026

14:26

ID: 12754 Contributed abstract

Validating a Novel Intersection-Based Method for Drifter Velocity

Reconstruction

*Nancy Soontiens*¹, *Heather Andres*², *Jennifer Holden*³

¹ Fisheries and Oceans Canada

² Fisheries and Oceans Canada

³ Fisheries and Oceans Canada

Presented by / Présenté par: *Nancy Soontiens*

Contact: nancy.soontiens@dfo-mpo.gc.ca

While oceanic drifters provide essential data on currents and temperatures, comparing their Lagrangian movement to the Eulerian fixed grids used by most ocean models remains a challenge. To bridge this gap, we present a novel method that projects drifter trajectories onto a reference grid by calculating velocity based on where tracks intersect gridlines. We validated this approach using a perfect model framework, employing synthetic tracks from an ocean circulation model to reconstruct the original velocity fields. The performance was benchmarked against established gridding techniques, with specific attention paid to sensitivity regarding deployment distribution and data density. We observed that error metrics, specifically the root mean square error (RMSE), increase as data density decreases. However, these errors generally plateau when the effective release separation reaches 4–5 times the grid spacing. Notably, this stabilization was not observed in an area sampling near-shore currents on the Labrador Shelf.

Session: 3040 Ocean - Theoretical to applied science

Océan - De la théorie à la science appliquée

02/06/2026

14:38

ID: 12766 Contributed abstract

Flash Oral

Current and future changes in the interannual variability of the Gulf of St. Lawrence SST

*David Xu*¹, *Hamed Ibrahim*²

¹

² University of Toronto

Presented by / Présenté par: *David Xu*

Contact: davidxudx1@gmail.com

Interannual sea surface temperature (SST) variability in the Gulf of St. Lawrence during the period 2011-2050 was investigated using an ensemble mean of 11 CMIP6 models of experimental variant r1i1p1f1, regridded and interpolated to 25 km resolution. Mean absolute deviation (MAD), the

measure of variability, was calculated yearly and monthly to obtain the average annual and monthly variability in each of the 4 decades: 2011-2020, 2021-2030, 2031-2040, and 2041-2050. Relative to the reference decade (2011-2020), the Gulf average annual MAD decreased during the second and third decades by 0.003 and 0.04 °C respectively, but increased in the fourth decade by 0.048 °C. The months with the highest Gulf average monthly MAD were June (0.462 °C) and May (0.380 °C) during the reference decade and August (0.435 °C) and September (0.398 °C) in the fourth decade. This change indicates a shift in peak variability from late spring/early summer to late summer/early fall over the period of study. In addition, 2-metre air temperature, latent heat, sensible heat, and radiative flux (upwelling/downwelling shortwave/longwave) time series were correlated with SST to examine the strength of their respective relationships. Air temperature and downwelling longwave radiation are identified as major drivers of SST, with an increasing strength of correlation over the period of study. The findings indicate a changing pattern of variability in the region that is significantly influenced by both the temperature and emissivity of the atmosphere overlying the Gulf.

Session 4072 Part 2

Convenors:

Chris Derksen, Climate Research Division, ECCC
Elizabeth Bush, Climate Research Division, ECCC

The first edition of Canada's Changing Climate Report, released in 2019, was the first comprehensive national science assessment of past and future changes in climate in Canada. This session will provide a forum for presenting findings from the second edition of Canada's Changing Climate Report, planned for release in May 2026. In a world of rapid climate change and with a rapid expansion in the amount of published scientific research on climate change in Canada, up-to-date syntheses and assessments of this scientific knowledge are important for both informing action on climate change and for generating a collective understanding of the problem. Canada's Changing Climate Report 2026 is the outcome of a major, collaborative, multi-year assessment process designed to provide timely, robust evidence about both past and future changes in climate in Canada. This edition draws primarily on new science produced by the Canadian research community and is informed by new observations, improved datasets, a better understanding of the climate system, and new modelling of future changes in climate across Canada since the first edition released in 2019. The content of CCCR2026 also reflects an intention to include more topics that are important to Canadians and people living in Canada, to make the report more accessible to a variety of audiences, and to better bridge the gap between scientific assessments and adaptation planning. This session will include presentations directly based on assessment material and we invite other relevant submissions.

ID: 12677 Contributed abstract

Changes in Canada's Water Cycle

*Barrie Bonsal*¹, *Julie Thériault*²

¹ Environment and Climate Change Canada

² Université du Québec à Montréal

Presented by / Présenté par: *Barrie Bonsal*

Contact: Elizabeth.Bush@ec.gc.ca

Chapter 5 of Canada's Changing Climate Report 2026 assessed past and future climate-related changes in components of the water cycle that impact freshwater availability in Canada. Climate warming has and will continue to impact surface and sub-surface freshwater across Canada, mainly by affecting precipitation and evaporation, two main components of the water cycle, as well as by shrinking the cryosphere. The greatest effects are on streamflow, where past and future changes involve increases during winter and decreases during summer. These seasonal flow changes, along with earlier and smaller spring freshets caused by warming, are resulting in changing streamflow regimes from more nival to pluvial. Surface water in the form of lakes and wetlands is also being affected by warming, but the changes are more varied. Future recharge of groundwater aquifers is projected to occur earlier in the year; however, groundwater is expected to remain one of the more resilient freshwater resources in a changing climate. In terms of hydroclimatic extremes, meteorological and agricultural droughts are projected to increase in frequency and intensity, mainly across central and southern Canada during summer. Streamflow-related floods are driven by multiple factors, with complex interactions among these drivers. Projected increases in extreme precipitation are anticipated to increase the occurrence of future flash flooding events.

In summary, the most identifiable effect of an altered water cycle involves a shift in the timing of many processes—such as snowmelt, spring freshet, groundwater aquifer recharge, ice-free dates, and snowmelt-related floods to earlier in the spring. In addition, Canada's water cycle has and will continue to be altered by increases in precipitation, changes in the proportion of rainfall versus snowfall, increased warm-season evaporation from both the land surface and open water, and greater potential for flash flooding and summer drought. These changes will require adaptive measures and integrated water management approaches to ensure water security and resilience in the face of a changing climate.

ID: 12674 Contributed abstract

Changes in the Canadian Cryosphere

*Lawrence Mudryk*¹, *Stephan Gruber*², *Lead Author Team (11) and
Contributing Author Team (32)*³

¹ Environment and Climate Change Canada

² Carleton University

³

Presented by / Présenté par: *Lawrence Mudryk*

Contact: lawrence.mudryk@ec.gc.ca

Chapter 6 of Canada's Changing Climate Report 2026 assessed past and future climate-related changes in the Canadian cryosphere.

The cryosphere plays many vital roles in the Earth's physical climate system. Historical quantities of ice and snow have helped to regulate the global climate, maintain sea levels, keep carbon fluxes between the ground and atmosphere in balance, and provide established timing and quantities of freshwater for billions globally. Global temperature increases threaten all of these established balances. Canada is one of the few countries with especially extensive coverage of many cryospheric components giving us an important role in the stewardship of these resources, and a responsibility to help to preserve them.

Overall changes assessed in the report are consistent with other cold regions globally. Over the past four to six decades, the portion of Canadian land and water covered by snow and ice has decreased and the ground has been frozen for fewer days annually. Glaciers in Canada have thinned and retreated, while permafrost has warmed and lost ground ice. Sea ice of all types has declined across the Canadian Arctic and Hudson Bay regions. These changes are largely climate-driven, and they are all expected to intensify with further increases in global average temperature. Along with details of the above changes we will also synthesize some of the key knowledge advancements assessed in this recent edition of the report compared to the previous one.

ID: 12632 Contributed abstract

Changes in the Oceans Around Canada

*Blair Greenan*¹, *Roberta Hamme*², *Mercè Casas-Prat*³, *Charles Hannah*⁴, *Thomas James*⁵, *Li Zhai*⁶

¹ Fisheries and Oceans Canada

² University of Victoria

³ Environment and Climate Change Canada

⁴ Fisheries and Oceans Canada

⁵ Natural Resources Canada

⁶ Fisheries and Oceans Canada

Presented by / Présenté par: *Roberta Hamme*

Contact: rhamme@uvic.ca

The oceans slow the rate of climate-driven atmospheric warming by absorbing heat and carbon dioxide; however, this absorption results in the ocean warming, acidifying, and increasing global sea level. As part of Chapter 7 of Canada's Changing Climate Report 2026, we assess and quantify these past and future ocean changes from published observations and models of the oceans around Canada.

The sea surface has warmed in all regions since the mid-20th century, with the greatest changes occurring in summer in southern Atlantic Canada and throughout eastern Canada, including Hudson Bay. Rising ocean temperatures have led to more frequent and intense marine heatwave events in both Atlantic and Pacific Canadian coastal regions, and have resulted in sea ice decline which has driven increased wave heights in the Arctic. The oceans around Canada are rapidly absorbing carbon dioxide from the atmosphere, causing ocean acidification. Beneath the surface, dissolved oxygen levels have been declining over the last several decades in many regions around Canada accompanied by an increase in hypoxic events. Both ocean warming and melt of ice on land have driven global sea-level rise. At specific locations along Canada's coastlines, sea levels have either risen or fallen as local vertical land motion either adds to or subtracts from the global sea-level rise. Particularly large rates of relative (local) sea level rise are observed in Atlantic Canada and the western Arctic with lower rates in British Columbia. Relative sea level is actually falling in Hudson Bay and the eastern Arctic.

All these historical trends in ocean warming, marine heat waves, carbon uptake, acidification, and sea level are projected to continue through the 21st century, with more frequent and intense extreme events. However, the

lower the emissions that can be achieved, the slower the rates of these changes will be.

**Session: 4072 Canada's Changing Climate Report 2026:
findings from the new national climate science
assessment - Part 2 Rapport sur les changements
climatiques au Canada 2026 : conclusions de la nouvelle
évaluation nationale des sciences du climat - Partie 2** **02/06/2026
14:26**

ID: 12639 Contributed abstract

Changes in extremes

*Alex Cannon*¹, *Alejandro Di Luca*², *Megan Kirchmeier-Young*³,
*Elizaveta Malinina*⁴, *David Sills*⁵, *Rachel White*⁶

¹ ECCC

² UQAM

³ ECCC

⁴ ECCC

⁵ Western University

⁶ UBC

Presented by / Présenté par: *Alex Cannon*

Contact: acannon@gmail.com

In this presentation, we will highlight key findings from Chapter 8 of the upcoming Canada's Changing Climate Report, which assesses how weather and climate extremes have evolved across Canada and how they are expected to change with continued warming. We will show that hot extremes and heat stress have increased in most regions, while cold extremes have declined, largely as a result of human influence. Extreme precipitation, short-duration rainfall, and heavy snowfall in northern Canada have intensified and become more frequent in many areas, with further increases projected in the future. We will also discuss the lengthening of the fire season across most regions and the projected worsening of fire weather conditions as temperatures rise. In addition, droughts are expected to become more frequent and severe in central and southern Canada. Along the coasts, extreme sea-level events and marine heatwaves have increased and are projected to intensify, particularly in regions experiencing sea-level rise and declining sea ice. Finally, we will examine how rainfall-driven flooding and compound coastal flooding are expected to become more frequent and more intense.

Session 4082 Part 2

Convenor:

Related to scientific studies and/or information sharing about the climate, including studies on slowly varying aspects of the Earth's systems, as well as past and future conditions, using various approaches.

This session covers many topics, including, but not limited to, theoretical research, model development, databases, diagnostic methods, climate projections, data analysis and artificial intelligence.

**Session: 4082 Climate - Theoretical to applied science -
Part 2 Climat - De la théorie à la science appliquée - Partie
2** **02/06/2026
13:50**

ID: 12614 Contributed abstract

Flash Oral

**Multi CMIP6 Model Analysis of Atmospheric Radiative Heating Rates
Changes**

*Carola Barrientos-Velasco*¹, *Yi Huang*², *Ivy Tan*³

¹

² Department of Atmospheric and Oceanic Sciences, McGill University,
Montreal, QC, Canada

³ University of Colorado Boulder, Boulder, CO, USA

Presented by / Présenté par: *Carola Barrientos-Velasco*

Contact: carola.barrientos-velasco@mcgill.ca

Analyses of radiative heating variability at the surface (SFC), top-of-the-atmosphere (TOA), and the vertical structure of atmospheric heating rates complement the understanding of the Earth's radiative budget and provide valuable information for climate model intercomparison studies.

This study examines variations in atmospheric radiative heating rates using several experimental protocols from the Coupled Model Intercomparison Project 6 (CMIP6) for the global climate models CNRM-CM6-1, MRI-ESM2-0, BCC-CSM2, IPSL-CM6A-LR, MIROC6, and CanESM5-1. These include the "amip" experiment, which sets sea surface temperature (SST), sea ice concentration, greenhouse gases, and radiative constituents to their observed present-day values; the "amip-4xCO2" experiment, which quadruples atmospheric CO2 concentration relative to the amip set-up; and the "amip-p4K" experiment, which uniformly increases SST by 4 K.

Additionally, changes in atmospheric radiative heating rates are decomposed using radiative kernels to capture key features and identify the primary contributors to the total radiative heating rate, such as surface and

atmospheric temperature, cloud fraction, water vapour, and surface albedo. The analysis is further examined in detail over the Arctic's near-surface inversion layer, considering annual and seasonal analyses.

**Session: 4082 Climate - Theoretical to applied science -
Part 2 Climat - De la théorie à la science appliquée - Partie
2**

**02/06/2026
13:55**

ID: 12729 Contributed abstract

Flash Oral

**Nudging CESM to Understand Local and Global Climate Effects of
Vegetation Change**

*Camden Opfer*¹, *Marysa Lague*²

¹ University of British Columbia, Vancouver

² University of British Columbia, Vancouver

Presented by / Présenté par: *Camden Opfer*

Contact: cmopfer@student.ubc.ca

Many past studies have evaluated the climatic effects of vegetation on global climate by applying deforestation or afforestation on a regional (e.g. boreal, mid-latitude, Amazon Rainforest) or global scale. These large-scale experiments show not only local climate impacts of vegetation change, but also teleconnections— responses of climate in remote regions. This work takes a generalized approach to quantifying, and distinguishing between local and remote effects of vegetation change across the entire world's land surface. By manipulating an Earth system model to suppress atmospheric circulation changes, we quantify the local atmospheric response to vegetation change and identify regions where vegetation change is likely to trigger teleconnections. This supports a broader goal: determining where natural and anthropogenic vegetation change would have the largest local and remote climate impacts.

We use the Community Earth System Model (CESM) to produce pairs of land-atmosphere simulations, each with one simulation using modern vegetation distribution and another with complete, global removal of vegetation. In the first pair of simulations, the atmosphere is allowed to fully interact with the surface. In the second pair, the atmospheric circulation in the devegetated simulation is nudged towards the atmospheric state of the control, suppressing large-scale circulation responses while allowing local, lower-atmospheric responses to vegetation change. The third pair of simulations are forced with the atmospheric data of the control simulation, disallowing atmospheric feedbacks of any kind, and isolating the land-only response to vegetation change. These three CESM simulations, therefore, distinguish between vegetation's impact on combined local and global climate, local effects in the low atmosphere, and land-only impacts.

In addition to the applied science goal of this work, the nudging configuration of CESM— such as the choice of variables and height ranges to nudge— is experimented with, probing the relevance of these parameters to climate model behaviour and scientific results.

**Session: 4082 Climate - Theoretical to applied science -
Part 2 Climat - De la théorie à la science appliquée - Partie
2** **02/06/2026
14:00**

ID: 12736 Contributed abstract

Flash Oral

Assessing Biases in CLASSIC from Missing Urban Parameterization

*Tommy Duong*¹, *Adam Monahan*², *Carsten Abraham*³, *Gesa Meyer*⁴

¹ University of Victoria

² University of Victoria

³ Environment and Climate Change Canada

⁴ Environment and Climate Change Canada

Presented by / Présenté par: *Tommy Duong*

Contact: tommyduong108@outlook.com

Global urban expansion is projected to continue, with over 70% of the global population expected to live in urban environments in the coming decades. While climate models have begun approaching city-scale resolutions capable of resolving the regional effects of urban environments, they typically lack representations of these effects. Missing representation of urban areas limits the capacity of models to make climate change projections of urban-induced phenomena such as urban heat islands and limits their ability to investigate the local and regional impacts of urban areas on climate.

We use the Canadian Land Surface Scheme including Biogeochemical Cycles (CLASSIC), the land component of the Canadian Earth System Model (CanESM), to compare surface fluxes simulated by the current operational version of the model against a network of urban flux tower measurements with varying degrees of urban surface coverage in their measurement footprint. This comparison determines systematic surface flux biases caused by missing urban parameterizations and quantifies the level of urban surface coverage at which urban parameterization in CLASSIC becomes necessary. We find that surface flux biases tend to increase with increasing urban surface coverage. Particularly, latent heat fluxes exhibit the largest biases across all degrees of urban surface coverage, which is consistent with the different surface properties expected from the difference in vegetation coverage at these sites. We also find that modelled biases in

surface fluxes exhibit clear seasonal and diurnal signals across sites.

**Session: 4082 Climate - Theoretical to applied science -
Part 2 Climat - De la théorie à la science appliquée - Partie
2**

**02/06/2026
14:05**

ID: 12740 Contributed abstract

Flash Oral

**Foudre et feux de forêt au Canada : identification et évaluation avec le
Modèle Régional Canadien du Climat (MRCC6/GEM5).**

*Abdel Aziz Tagsinmanebe Konseibo*¹, *Philippe Gachon*², *Yan
Boulanger*³

¹ ESCER/UQAM

² ESCER/UQAM

³ RNCan

Presented by / Présenté par: *Abdel Aziz Tagsinmanebe Konseibo*

Contact: konseibo.abdel_aziz_tagsinmanebe@courrier.uqam.ca

Les feux de forêt déclenchés par la foudre représentent une composante majeure du régime des feux au Canada, mais leur représentation dans les modèles climatiques régionaux demeure encore peu documentée. Ce travail présente des résultats préliminaires issus de l'analyse combinée des observations de foudre du réseau Oragélect d'Hydro-Québec et de simulations du Modèle régional canadien du climat (MRCC6/GEM5), utilisé notamment en mode "convection-explicite".

L'analyse des observations confirme un cycle diurne et une variabilité temporelle de l'activité de la foudre au Québec qui sont cohérentes avec les activités des systèmes convectifs de méso-échelle. En effet, l'activité électrique au sein des nuages se concentre principalement entre juin et août, avec un maximum en juillet. Le cycle diurne montre un pic d'activité en après-midi et un minimum en fin de matinée, reflétant le rôle dominant de la convection diurne estivale.

L'évaluation préliminaire des simulations du MRCC6/GEM5 met en évidence une variabilité importante des performances du modèle selon les variables analysées (précipitation, CAPE et indice Lightning Threat), ainsi que selon la période de l'année et la région considérée. Les résultats révèlent également une différence marquée entre les simulations à 12 km et à 2,5 km de résolution. À 12 km, la foudre simulée présente des oscillations horaires importantes suggérant une représentation instable ou incohérente des processus convectifs ou microphysiques. Ce comportement disparaît dans les simulations à 2,5 km, ce qui suggère une amélioration de la représentation des processus physiques à très haute résolution, possiblement liée à une meilleure simulation des hydrométéores solides ou

des profils de vitesse verticale.

Ces résultats préliminaires soutiennent l'hypothèse d'une valeur ajoutée en mode convection-explicite pour le diagnostic de la foudre. Une analyse plus approfondie de la capacité des modèles climatiques régionaux à représenter l'activité électrique atmosphérique au Canada est donc planifiée.

**Session: 4082 Climate - Theoretical to applied science -
Part 2 Climat - De la théorie à la science appliquée - Partie 2** **02/06/2026
14:10**

ID: 12849 Contributed abstract

Flash Oral

Modelling extreme climate events with machine learning downscaling techniques

*Nadiya Shore*¹, *Adam Monahan*²

¹ University of Victoria

² University of Victoria

Presented by / Présenté par: *Nadiya Shore*

Contact: nadiyashore@uvic.ca

As extreme climate events grow in severity and frequency with climate change, research aims to improve modelling capabilities. To understand the relationship between large-scale climate change and local extreme events, low-resolution climate models must be downscaled to high-resolution weather fields relevant to regional scales. Due to the high computational expense of physics-based downscaling models, new approaches, including machine learning techniques, are being employed. Under the ClimatEx project, this research uses machine learning downscaling models to study extreme climate events. A stochastic Generative Adversarial Network (GAN) generates an ensemble of downscaled climate fields conditioned on low-resolution climate models, aiming to gain insight into the spatial dependence of these extremes and to evaluate the GAN's ability to reproduce them. The focus is on the tails and near-tails of the distributions of variables important to extreme events, such as temperatures and precipitation, as well as their dependence across space. Additionally, high-impact concurrent extreme events, when both temperature and precipitation are in their extremes, are analyzed with multivariate statistics. Upper temperature extremes are well captured over space and in summer months, while lower extremes struggle during the winter. Highly variable weather variables including precipitation benefit from the stochastic nature of these GANs, as do their tails. This work aims to develop operational products that can inform local adaptation strategies as well as address scientific questions about the dependence of extreme climate events.

Session 5051 Part 1

Convenors:

Kaley Walker, University of Toronto

Adam Bourassa, University of Saskatchewan

Satellite Earth observation (SEO) provides a unique global perspective on our planet's atmosphere and surface, including the oceans, land, vegetation, ice, and snow. Current and planned satellite missions from Canada and international agencies have provided and will provide a wealth of new information about the Earth system and that can be used to investigate a wide range of environmental and scientific questions.

This session encourages contributions from across the full SEO value chain, upstream, midstream and downstream, to illustrate the activities currently underway in Canada, involving industry, academia and government. This includes new measurement technologies and techniques, both passive and active; mission development; 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.

Session: 5051 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 1 Observation de la Terre par satellite : une vue unique de notre planète et un besoin essentiel pour naviguer vers notre avenir - Partie 1

**02/06/2026
13:50**

ID: 12753 Contributed abstract

MOPITT: A Retrospective

*James Drummond*¹

1

Presented by / Présenté par: *James Drummond*

Contact: james.drummond@dal.ca

MOPITT was launched aboard the NASA Terra satellite on 18 December 1999. In early 2025, despite the best efforts of NASA and the instrument teams, it was ultimately decided that one instrument needed to be turned off to benefit the remaining instruments aboard Terra. MOPITT was turned off on 9 April 2025 at 3:20 pm EDT, ending a 25-year continuous record of carbon monoxide.

The story of MOPITT began nearly 40 years ago, in 1987, with an idea. Between then and now, there have been many successes and challenges,

and much exasperation and heartache. In this presentation, I will discuss the background (processes, people, and pratfalls) of how this Canadian instrument evolved from a simple idea into a nearly forty-year saga.

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 satellite is funded and operated by NASA, and the Canadian Space Agency funds the MOPITT instrument and operations.

Session: 5051 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 1 Observation de la Terre par satellite : une vue unique de notre planète et un besoin essentiel pour naviguer vers notre avenir - Partie 1

**02/06/2026
14:02**

ID: 12776 Contributed abstract

The legacy of the OSIRIS mission and potential future opportunities

*Doug Degenstein*¹, *Adam Bourassa*²

1

2

Presented by / Présenté par: *Doug Degenstein*

Contact: doug.degenstein@usask.ca

The Canadian built OSIRIS instrument onboard the Swedish satellite Odin has now entered its 23rd year of data collection. Unfortunately, all good things must come to an end and OSIRIS will cease operation later in 2026. This talk will highlight the successes achieved and challenges faced through the more than 25 years of observations. OSIRIS started life as an instrument designed to help understand processes associated with ozone depletion and became so much more. The twenty five year data records form the backbone of many merged, long term data records used by scientists and ultimately policy maker worldwide. Although the OSIRIS time series, the longest ever collected by a limb looking, satellite borne instrument, will soon come to an end, the University of Saskatchewan team is involved in initiatives to provide continuity of data collection. This talk will end with a description of our OSIRIS-3, a low cost, highly-sensitive follow-on to OSIRIS designed to continue the OSIRIS data records from a CubeSat platform.

Session: 5051 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 1 Observation de la Terre par satellite : une vue unique de notre planète et un besoin essentiel pour

**02/06/2026
14:14**

ID: 12798 Contributed abstract

An update on WildFireSat: Canada's operational wildfire monitoring mission

*Mark de Jong*¹, *Alan Cantin*², *Morgan Crowley*³, *Denis Dufour*⁴,
*Colin McFayden*⁵, *Dan Thompson*⁶, *Joshua Johnston*⁷

¹ NRCan

² NRCan

³ NRCan

⁴ CSA

⁵ NRCan

⁶ NRCan

⁷ NRCan

Presented by / Présenté par: *Mark de Jong*

Contact: mark.dejong@nrcan-rncan.gc.ca

Wildland fire is an essential component of the Earth system; however, it poses a significant management challenge in Canada. Fires and their smoke emissions can have considerable societal, economic, and environmental costs, and continuing with a business-as-usual approach to fire management will be insufficient in the face of a changing climate. In Canada, innovative technologies – including novel EO missions, like the WildFireSat Canadian Operational Mission - will form an important part of the solution to the fire management challenge.

The WildFireSat Mission is the world's first government owned operational satellite system designed specifically for monitoring wildland fires. Set to launch in 2029 and with a nominal 5-year lifetime, the mission is a collaboration between the Canadian Space Agency, Natural Resources Canada and Environment and Climate Change Canada. The mission will deliver comprehensive situational awareness to wildfire managers and decision-makers in near-real-time, and support smoke and air quality forecasting services. WildFireSat has been designed in a 'bottom up' fashion driven by user needs, with early and ongoing knowledge exchange with provincial and territorial fire management agencies and other end users to meet critical gaps in existing satellite-based fire monitoring in Canada. A contract for the satellite design phase of the mission was announced in February 2025. This talk will provide an update on the status of the mission in 2026, with details on the mission and payload design, along with an overview of the proposed scientific data products that will be made available operationally.

ID: 12820 Contributed abstract

The Arctic Observing Mission (AOM): An update on progress and plans

*Ray Nassar*¹, *Alec Casey*², *Matt Arkett*³, *Chris Sioris*⁴, *Joseph Mendonca*⁵, *Joel Bedard*⁶, *John Evans*⁷, *Dan-Tam Nguyen*⁸, *Shen-En Qian*⁹, *Alexander Trishchenko*¹⁰, *Mary-Anne Fobert*¹¹

¹ Environment and Climate Change Canada (ECCC)

² Environment and Climate Change Canada (ECCC)

³ Environment and Climate Change Canada (ECCC)

⁴ Environment and Climate Change Canada (ECCC)

⁵ Environment and Climate Change Canada (ECCC)

⁶ Environment and Climate Change Canada (ECCC)

⁷ Canadian Space Agency (CSA)

⁸ Canadian Space Agency (CSA)

⁹ Canadian Space Agency (CSA)

¹⁰ Natural Resources Canada (NRCan)

¹¹ Natural Resources Canada (NRCan)

Presented by / Présenté par: *Ray Nassar*

Contact: ray.nassar@ec.gc.ca

The Arctic Observing Mission (AOM) is a satellite mission concept under consideration by the Government of Canada (GoC). AOM would consist of two satellites in a highly elliptical orbit (HEO) formation to enable meteorology, climate, air quality and space weather observations over northern regions, reaching beyond the usable viewing range of geostationary (GEO) satellites. AOM aligns well with GoC strategic priorities and objectives, including advancing Canadian-European partnership.

AOM completed Phase 0 studies in 2025. The recommended configuration of AOM includes a meteorological imager, an infrared sounder and a space weather instrument suite on each satellite. Meteorological imager observations would improve nowcasting and Numerical Weather and Environmental Prediction (NWEF) over the Arctic and adjacent northern mid-latitude regions, while also supporting other environmental applications. An imaging Fourier transform spectrometer (IFTS) with multiple infrared (IR) sounding bands is also under consideration. Near and shortwave-IR IFTS bands would provide observations of column CO₂, CH₄, and CO and solar induced fluorescence (SIF) spanning the sunlit portion of the diurnal cycle.

Mid- and longwave-IR bands on the IFTS would provide enhanced vertical information on temperature, humidity, wind, ozone and multiple other trace gases (during day and night). These northern hyperspectral IR observations from the AOM IFTS would support applications in meteorology, air quality and climate science/monitoring, which are complementary to other international missions. AOM space weather observations would support operational auroral forecasting and other space weather applications, enhancing our understanding of solar-terrestrial interactions.

AOM is envisioned to be implemented as a Canadian-led international mission. Partnership with the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) on both the space segment (payloads, bus) and ground segment (data reception, data processing and dissemination) is seen as important for AOM's success. This presentation will provide an overview of AOM status, plans and progress.

Session: 5051 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 1 Observation de la Terre par satellite : une vue unique de notre planète et un besoin essentiel pour naviguer vers notre avenir - Partie 1 **02/06/2026 14:38**

ID: 12697 Contributed abstract

A new Canadian radar satellite mission to retrieve snow water equivalent

*Benoit Montpetit*¹, *Chris Derksen*², *Vincent Vionnet*³, *Marco Carrera*⁴, *Franck Lespinas*⁵, *Nicolas Leroux*⁶, *Julien Meloche*⁷

¹ Environment and Climate Change Canada

² Environment and Climate Change Canada

³ Environment and Climate Change Canada

⁴ Environment and Climate Change Canada

⁵ Environment and Climate Change Canada

⁶ Environment and Climate Change Canada

⁷ Environment and Climate Change Canada

Presented by / Présenté par: *Benoit Montpetit*

Contact: benoit.montpetit@ec.gc.ca

Melt water from seasonal snow supports many economic sectors, ensures the health and well-being of communities, and sustains ecosystems. Snow also contributes to many costly hazards like floods, droughts, and avalanches. The current lack of information on how much water is stored as snow (snow water equivalent, SWE), and how it varies in space and time, limits the hydrological, climate, and weather services provided by

Environment and Climate Change Canada (ECCC). To address this knowledge gap, ECCC and the Canadian Space Agency (CSA) are working in partnership to advance the scientific and technical readiness for a Ku-band synthetic aperture radar (SAR) mission presently named the 'Terrestrial Snow Mass Mission' – TSMM. Ku-band backscatter measurements are sensitive to SWE through the volume scattering of the signal by the snowpack. Radar measurements are also well known to be able to discriminate between wet and dry snow conditions. An observing concept capable of providing dual-polarization (VV/VH), moderate resolution (500 m), wide swath (~250 km), and high duty cycle (~25% SAR-on time) Ku-band radar measurements at two frequencies (13.5; 17.25 GHz) is under development. This Canadian radar mission will provide weekly coverage of the northern hemisphere with Ku-band SAR data, and coupled with modeled data, will provide daily snow water equivalent data to assist hydrological applications and decision-making.

In this presentation, we will review recent progress at ECCC to advance the science readiness for the mission, covering all components of the product development workflow including physical snow modeling, radiative transfer model simulations of Ku-band radar backscatter, SWE retrieval development, and data assimilation experiments. We will also provide an update on programmatic considerations and potential pathways for mission implementation.

Session 6010 POSTER SESSION

Poster Abstracts with links to most Posters:

The Canadian Meteorological and Oceanographic Society Congress poster session brings together researchers and practitioners advancing our understanding of the atmosphere, oceans, climate system, and cryosphere. Spanning disciplines from meteorology and physical oceanography to climate science and sea-ice processes, the session highlights innovative observations, modelling approaches, and applied research addressing some of Canada's most pressing environmental challenges. The interdisciplinary nature of the work showcased reflects the growing need to understand coupled Earth systems across temporal and spatial scales, particularly in the context of rapid environmental change in the Arctic and coastal regions. Through collaboration across academia, government, and industry, these contributions support improved forecasting, environmental stewardship, and resilience in a changing climate.

**Session: 6010 POSTER SESSION
AFFICHES**

**02/06/2026
15:10**

ID: 12659 Contributed abstract

Poster Order: [2010P01](#)

Future contributions of atmospheric rivers to precipitation across

British Columbia, Canada

*Ahmed Shalaby*¹, *Stephen Déry*², *Aseem Sharma*³

¹ University of Northern British Columbia

² University of Northern British Columbia

³ Future Forest Ecosystems Centre, Forest Ecosystems and Analytics Branch, BC Ministry of Forests

Presented by / Présenté par: *Ahmed Shalaby*

Contact: sdery@unbc.ca

Atmospheric rivers (ARs) are major drivers of precipitation and precipitation extremes along the west coast of North America, with particularly strong impacts over British Columbia (BC), Canada. Many studies have investigated projected increases in AR strength under a warming climate. In this study, future changes in AR climatology—including variations in frequency, intensity, duration, and spatial extent, will be assessed by applying an Atmospheric River Detection Tool (ARDT) to a multi-model ensemble of CMIP6 simulations under the SSP2-4.5 and SSP5-8.5 emission scenarios. We then investigate projected changes in AR-associated impacts on both precipitation and precipitation extremes over BC.

Extreme-value probability analysis will be used to quantify shifts in the likelihood, magnitude, and return periods of AR-related extreme precipitation. This work provides insights into evolving AR-related hydroclimatic risks in BC, with implications for flooding, water resources, and snowpack sustainability.

**Session: 6010 POSTER SESSION
AFFICHES**

**02/06/2026
15:10**

ID: 12620 Contributed abstract

Poster Order: [3010P01](#)

Interaction of Tides with Recurring Polynya in Pangnirtung Fjord

*Shiliang Shan*¹, *Charles Hannah*², *Arnoldo Valle-Levinson*³

¹ Royal Military College of Canada; Queen's University

² Fisheries and Oceans Canada, Institute of Ocean Sciences

³ University of Florida

Presented by / Présenté par: *Shiliang Shan*

Contact: Shiliang.Shan@rmc.ca

Polynyas (nonlinearly shaped openings enclosed in sea ice) are vital

components of both physical and biological systems in ice-covered seas. Little is known about polynya-tide interactions in fjords, particularly in the Pangnirtung Fjord, a seasonally ice-covered fjord located on the southern Baffin Island, Nunavut, Canada. The Fjord is home to an indigenous community of about 1500 people, and it connects to Cumberland Sound via a shallow sill (~20 m). A small (4km x 2km) recurring polynya has been observed near the sill location. The large tidal range in the Fjord (up to 6.7 m) suggests a need to test the tidally forced polynya hypothesis in which tidal flows over the sill inject heat to the surface waters. However, the lack of observations in this remote location has so far prevented a quantitative investigation of the polynya-tide interaction. In this study, we demonstrate the new technological capacity of the SWOT (Surface Water and Ocean Topography) mission for high-resolution mapping of small recurring polynya in an Arctic fjord. We achieve this using daily data during the 1-day-repeat (calibration/validation) orbit phase from the KaRIn instrument (Ka-band wide-swath synthetic aperture Radar Interferometer) on board the SWOT satellite. We compare and validate the SWOT's daily sea surface heights and ice conditions with tide-gauge derived water levels and Sentinel-2/MODIS optical images, respectively. Our analysis seems to support the tidally forced polynya hypothesis in the Pangnirtung Fjord.

**Session: 6010 POSTER SESSION
AFFICHES**

**02/06/2026
15:10**

ID: 12680 Contributed abstract

Poster Order: [3010P02](#)

The Influence of Taylor Columns on Ocean Dynamics and Sea Ice in the Chukchi Sea

*Spenser Ross*¹, *Kent Moore*², *Yarisbel Garcia-Quintana*³, *Clark Pennelly*⁴, *Paul Myers*⁵, *Robert Pickart*⁶

¹ University of Toronto

² University of Toronto

³ University of Toronto, University of Alberta

⁴ University of Alberta

⁵ University of Alberta

⁶ Woods Hole Oceanographic Institution

Presented by / Présenté par: *Spenser Ross*

Contact: spenser.ross@utoronto.ca

The Chukchi Sea contains two distinct shoals, Herald and Hannah. A previous study has identified Taylor Columns over these shoals and their role in slowing sea ice retreat. Building on this work, we use passive microwave satellite imagery and, for the first time, a high-resolution ice-ocean coupled model to further investigate the formation and impacts of

these Taylor Columns. As a result of their presence, currents are diverted around the shoals. This diversion traps colder stagnant water over the shoals during the melt season. This leads to ice melt being delayed by up to several weeks in early summer. These ice concentration anomalies are more pronounced over Herald Shoal as a result of its simpler topography compared to Hannah Shoal. As Arctic temperatures rise and the melt season begins earlier, the timing of preferential ice cover over the shoals shifts earlier in the summer, altering ice availability for regional ecosystems.

**Session: 6010 POSTER SESSION
AFFICHES**

**02/06/2026
15:10**

ID: 12851 Contributed abstract

Poster Order: [3040P01](#)

The sensitivity of modelled Beaufort Gyre structure to different mixing prescriptions

*Aidan Parfett*¹, *Stephanie Waterman*², *An Nguyen*³, *Jeff Scott*⁴

1

² University of British Columbia

³ Oden Institute

⁴ MIT

Presented by / Présenté par: *Aidan Parfett*

Contact: aparfett@eoas.ubc.ca

Representing Arctic Ocean stratification in coarse-resolution ocean models is a challenge, especially in the western Arctic which features distinctive layered water masses and freshwater storage in the Beaufort Gyre. Yet, stratification is a key control on Arctic Ocean circulation, as well as heat and freshwater distributions. Although many factors contribute to the modelled stratification, parameterizations of vertical mixing processes are generally recognized as an important source of model stratification biases.

In this study, we examine model representations of both stratification and vertical mixing processes in the Beaufort Gyre in detail with the goal of gaining insight into the relative roles of the different mixing parameterizations in setting overall vertical mixing fluxes of heat and salt and ultimately model stratification in this critical region. A key innovation in our approach is the breakdown of the individual contributions of each vertical mixing parameterization employed to the total diffusivity and net diffusive fluxes; in this work, we diagnose the individual contributions of the background diffusivity, and GM-Redi. We compare this breakdown in two different Arctic Ocean regional models: the R1 ASTE state estimate in which prescribed diffusivities have spatial variation and an intermediate complexity prognostic model based on MITgcm in which these diffusivities are set to constant values.

Our results present a novel view of how the different mixing parameterizations contribute to the vertical mixing of heat and salt, thus identifying which parameterizations are key controls on the modelled stratification in different water mass layers and regions of the Beaufort Gyre region. Ultimately, they suggest ways in which prescribed diffusivities may be set to deliver more accurate representations of Beaufort Gyre stratification.

**Session: 6010 POSTER SESSION
AFFICHES**

**02/06/2026
15:10**

ID: 12761 Contributed abstract

Poster Order: [3040P02](#)

Investigating variability in thermohaline staircases and their role in vertical fluxes in the Beaufort Gyre from highly resolved measurements

*Katerina Benevides*¹, *Stephanie Waterman*², *Shumin Li*³, *Mary-Louise Timmermans*⁴, *Bill Williams*⁵

¹ Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia, Vancouver, BC, Canada

² Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia, Vancouver, BC, Canada

³ Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia, Vancouver, BC, Canada

⁴ mary-louise.timmermans@yale.edu

⁵ Fisheries and Oceans Canada, Institute of Ocean Sciences, Sidney, BC, Canada

Presented by / Présenté par: *Stephanie Waterman*

Contact: me@katbenevides.com

Thermohaline staircases in the upper Atlantic Water (AW) layer of the Beaufort Gyre represent a key double-diffusive process influencing vertical heat, salt, and density transport. We investigate where and when staircases occur, characterize their structural variability, and assess how environmental conditions control their presence or absence. Using high-resolution microstructure observations collected over a 15-day period by a turbulence-sensing glider in summer 2024, we identify two distinct periods of staircase absence amidst generally prevalent staircases. Staircase properties, including interface temperature jumps ($\Delta T = 0.01^\circ\text{C}$), mixed layer thickness ($\Delta z = 2\text{m}$), and interface density ratios (R_ρ decreasing with depth), align with canonical double-diffusive expectations.

Environmental controls differ between case studies: in one, staircases are

absent in regions of large R_p despite similar turbulence, in the other, elevated turbulent dissipation (ϵ) suppresses staircases where background stratification would otherwise allow layering. Parameterized staircase heat fluxes peak consistently between 300-425 m and are comparable to or exceeded by background turbulent heat fluxes depending on local turbulence, highlighting the variable role of staircases in vertical heat transport.

The results in this study demonstrate that staircase occurrence and efficiency are jointly controlled by background stratification and turbulence, with implications for mixing processes in the Arctic Ocean. Future work will extend these analyses to salt and buoyancy fluxes, assess flux variability across regions, and explore temporal coherence in staircase transitions to refine understanding of environmental controls and double-diffusive contributions to vertical transport.

**Session: 6010 POSTER SESSION
AFFICHES**

**02/06/2026
15:10**

ID: 12691 Contributed abstract

Poster Order: [4030P01](#)

Évaluation des occurrences de pluie verglaçante dans l'ouest du Canada

*Amelie Sauvageau*¹, *Julie Mireille Thériault*², *Dominique Paquin*³

¹ UQAM

² UQAM

³ Ouranos

Presented by / Présenté par: *Amelie Sauvageau*

Contact: sauvageau.amelie@uqam.ca

La pluie verglaçante est un phénomène météorologique à fort impact au Canada, responsable de perturbations majeures des transports, des infrastructures et des réseaux électriques. Sa représentation dans les modèles climatiques régionaux demeure un défi, en raison de sa forte dépendance à la structure thermique verticale de l'atmosphère, aux conditions de surface et à la topographie locale.

Ce projet vise à évaluer la capacité des simulations climatiques régionales à reproduire la distribution spatiale, la fréquence et les caractéristiques des événements de précipitations verglaçantes en Amérique du Nord, avec un accent particulier sur l'ouest du Canada. Les sorties des modèles sont comparées à des observations de longue durée à l'échelle des stations météorologiques.

Les précipitations verglaçantes diagnostiquées dans les simulations climatiques régionales sont comparées à des observations de stations afin

d'évaluer les biais liés à la fréquence, à la saisonnalité et à la distribution spatiale des événements de pluie verglaçante. L'analyse examine également l'influence de l'altitude et du choix des points de grille du modèle sur la représentation de ces événements.

Ce travail contribue à une meilleure interprétation des simulations climatiques pour l'évaluation des risques liés à la pluie verglaçante et à l'analyse de leur évolution future dans un contexte de changements climatiques.

**Session: 6010 POSTER SESSION
AFFICHES**

02/06/2026

15:10

ID: 12845 Contributed abstract

Poster Order: [4030P02](#)

Evaluation of Surface Turbulent Fluxes in Multiple CRCM6-GEM5 Simulations Using AmeriFlux Data over North America

*Kaliana Létourneau*¹, *Alejandro Di Luca*², *Tim Whittaker*³

¹ UQAM

² UQAM

³ UQAM

Presented by / Présenté par: *Kaliana Létourneau*

Contact: letourneau.kaliana@courrier.uqam.ca

Climate models are systematically evaluated to assess their representation of climate processes and to build confidence in future projections, with the ultimate goal of identifying deficiencies and improving model performance. In this presentation, we will present results from an evaluation of multiple configurations of the Canadian Regional Climate Model (CRCM6-GEM5) in simulating surface turbulent fluxes—specifically sensible and latent heat fluxes—using observations from 27 AmeriFlux stations across North America. The assessment relies on a hierarchy of error metrics, ranging from simple mean bias to more complex regime-based errors that make use of other surface variables (friction velocity and stability). The results indicate that (a) the choice of land surface model strongly influences the simulation of surface turbulent fluxes; (b) using a lower limit for the Obukhov length instead of a lower limit for the near-surface wind speed has a small but noticeable impact on the surface turbulent fluxes; and (c) the formulation of the stability function and the roughness length have minimal influence on the surface turbulent fluxes. Overall, these findings help clarify which model components most strongly control surface–atmosphere exchanges and provide guidance for targeted model development.

Session: 6010 POSTER SESSION

02/06/2026

ID: 12725 Contributed abstract**Poster Order: [4040P01](#)****Temperature outcomes of enhanced rock weathering deployment scenarios constrained by soil albedo measurements and UVic Earth system climate model simulations***Isabel Dove*¹, *Jonathan Spence*², *Sasha Wilson*³, *Kirsten Zickfeld*⁴¹ Simon Fraser University² University of Alberta³ University of Alberta⁴ Simon Fraser University**Presented by / Présenté par:** *Isabel Dove*Contact: isabel_dove@sfu.ca

Enhanced rock weathering (ERW) is a carbon dioxide removal (CDR) strategy involving spreading silicate rock powder on croplands to speed up the natural weathering process, whereby CO₂ reacts with rainwater and silicate minerals to form bicarbonate ions which are eventually transported to and stored in the ocean. While ERW can potentially sequester gigatons of CO₂ per year and therefore help achieve the Paris Agreement goal of limiting global warming to well below 2 °C, the biogeophysical effects of cropland soil amendment are possibly significant yet poorly constrained. For example, decreased soil albedo from spreading dark rock powder (e.g. basalt) on croplands might counteract cooling from CO₂ drawdown. On the other hand, light rocks such as wollastonite skarn might enhance cooling by increasing soil albedo. Here we investigate temperature outcomes of various ERW deployment scenarios with an Earth system climate model of intermediate complexity (the UVic ESCM) constrained by albedo values measured from soil amended with varying amounts and types of rock powder. We find that, with aggressive application rates of 25 or 50 tonnes of rock dust per hectare on global cropland, ERW-induced cooling is slightly counteracted by ~5% with basalt and enhanced by ~20% with wollastonite. At basalt application rates of 10 tonnes ha⁻¹ or below, changes to soil albedo and thus temperature outcomes are negligible. Our work, conducted under the interdisciplinary CanCO₂Re initiative to assess the role for CDR technologies in meeting Canada's net-zero targets, demonstrates that non-CO₂ effects of CDR deployment strategies should be considered in order to meet temperature goals.

ID: 12822 Contributed abstract

Poster Order: [4040P02](#)

Investigating the impact of Insect Driven Disturbances on a Southern Ontario Watershed's Carbon and Water dynamics using the MESH-CLASSIC model

*Daniel Mutton*¹, *M. Altaf Arain*^{1 2}, *Dan Princz*^{2 3}, *Bruce Davison*^{2 4}

¹ School of Earth, Environment & Society, McMaster University

² School of Earth, Environment & Society, McMaster University

³ National Centre for Hydrology, Environment and Climate Change Canada

⁴ National Centre for Hydrology, Environment and Climate Change Canada

Presented by / Présenté par: *Daniel Mutton*

Contact: muttond@mcmaster.ca

MESH-CLASSIC is a coupled hydrologic and biogeochemical model comprising the Modelisation Environnementale Communautaire Surface and Hydrology system (MESH) and the Canadian Land Surface Scheme Including Biogeochemical Cycles (CLASSIC) models. MESH-CLASSIC was coupled for investigating the interactions between catchment-scale hydrologic and biogeochemical processes under natural and human disturbance regimes in changing climate. To improve model capabilities, we have incorporated an insect infestation module into the MESH-CLASSIC to represent the three most common infestation types in North America including spongy moth defoliation (BD), spruce budworm defoliation (NLD) and pine beetle tree killer (NLK). The performance of MESH-CLASSIC's infestation module was then evaluated on three eddy covariance flux tower sites across North America. In addition, model simulations were performed at the Big Creek catchment in Southern Ontario, Canada. When run at the columnar level, the carbon flux simulations closely match with observations across infestation type. When run in distributed mode, the model revealed a number of interesting phenomena about the impact of insect infestation on streamflow, soil moisture, and evapotranspiration. The inclusion of the insect infestation module vastly improved the simulation of fluxes at these tower sites, tracking the long-term recovery of forest after the infestation. This work will help to address the need to incorporate infestation dynamics into land-surface and terrestrial ecosystem models as infestations are becoming more common and even endemic to some parts of North America – and thus contribute to the development of the LSM of the Canadian Earth System Model (CLASSIC). By developing the next generation of coupled hydrologic and ecosystem model, this work will help to investigate the full dynamics of infestation impacts on forest carbon and water cycles and their feedbacks at the catchment scale.

ID: 12681 Contributed abstract**Poster Order: 4040P03****Representing the effects of land cover change on cloud coverage in the UVic ESCM using machine learning***Pierre Etienne Banville*¹, *Kirsten Zickfeld*²¹ Simon Fraser University² Simon Fraser University**Presented by / Présenté par:** *Pierre Etienne Banville*Contact: peb1@sfu.ca

Forestation is a prominent carbon dioxide removal strategy, yet its full impact on climate remains uncertain, particularly at mid-latitudes. Forestation also has biogeophysical effects, such as changes in albedo, surface roughness and evapotranspiration rates, which can influence cloud coverage, particularly low-level clouds, both locally and at remote locations. While earth system models are essential for assessing these non-local responses, their coarse resolution limits their ability to represent the small-scale processes governing cloud formation. In this study, we develop a machine learning model to improve the representation of the effects of forestation on low-level cloud cover in the University of Victoria Earth System Climate Model (UVic ESCM). The model is trained on ERA5 data (European Centre for Medium-Range Weather Forecasts Reanalysis v5) using only land-surface and near-surface atmospheric variables available in the UVic ESCM. We compare the performance of random forests, XGBoost (a gradient-boosted decision tree method that builds trees sequentially to correct predecessor errors), and neural networks in predicting low-level cloud cover, and select a final model based on predictive skill and computational efficiency. Finally, the selected model is applied offline to UVic ESCM output from scenarios with differing land-cover configurations to evaluate its ability to represent forestation-related changes in low-level cloud cover. In future work, the model will be integrated within the UVic ESCM, allowing cloud cover to respond dynamically to land-cover and surface-atmosphere changes during simulations. This enhancement will allow future simulations to assess both local and remote effects of forestation on low-level cloud coverage. A clearer understanding of the influence of forestation on cloud coverage is crucial for refining estimates of its biogeophysical effects, and ultimately, of its net climate benefits.

Session: 6010 POSTER SESSION**AFFICHES****02/06/2026****15:10****ID: 12622** Contributed abstract**Poster Order: [5040P01](#)**

Comparing Concentration Weighted Trajectory (CWT) Mapping

Techniques with Satellite Measurements of NO₂ in Toronto, Canada

Samir Singh ¹ , Mark Gordon ² , Costas Armemakis ³ , Debora Griffen ⁴ , Neda Kolahi ⁵

1

2

3

4

5

Presented by / Présenté par: Samir Singh

Contact: samirhsingh@gmail.com

We examine the spatial variations of NO₂ concentrations across the urban area surrounding Toronto, Canada, derived from satellite and air-quality station measurements. Spatial maps from air-quality stations were produced by linearly tracing their hourly concentration measurements backward in time, using local, hourly wind speed and direction observations. Two mapping techniques from this methodology were employed: the CWT (concentrated-weighted trajectory) and the CPF (conditional probability function), using absolute and relative concentrations (above a certain threshold), respectively. Satellite column measurements were taken from TEMPO (Tropospheric Emissions: Monitoring of Pollution), and TROPOMI (TROPospheric Monitoring Instrument), then converted into surface level concentrations. All maps were generated on a 41 x 32 km grid with 250m resolution, centered at 43.70°N, 79.39°W. The agreement between satellite-derived measurements (TEMPO vs. TROPOMI) is very strong ($R^2 = 0.84$), consistent with the agreement between the mapping technique relationships (CWT vs. CPF, $R^2 = 0.89$). Comparing the TEMPO and TROPOMI measurements, key regions of similar concentrations were identified as the Northeast, Don Valley Parkway, and Downsview Airpark. All relationships were based on long-term averages. Although some similarities between the ground-level and satellite measurement maps are observed, such as higher concentrations in west Toronto and lower concentrations over Lake Ontario, an overall linear relationship was not apparent, with $R^2 < 0.01$ for both the CWT vs. TROPOMI and TEMPO fits, respectively. Major differences between the ground-level and satellite concentrations included a discernible westward concentration gradient in the satellite maps, not evident in the mapping techniques, and elevated concentrations over Highway 401 (North America's busiest Highway) observed in the mapping techniques, though not apparent in both TEMPO and TROPOMI observations. Based on these results, we recommend that future work further investigate the causes of concentration discrepancies in urban areas between back-trajectory and satellite-based mapping techniques.

ID: 12739 Contributed abstract

Poster Order: [5040P02](#)

Aerosol layer height intercomparisons and evaluation of satellite-measured plume heights

*Javeria Rizwan*¹, *Debra Wunch*², *Debra Griffin*³, *Hai Zhang*⁴,
*Victoria Pinnegar*⁵

¹ University of Toronto

² University of Toronto

³ Environment and Climate Change Canada

⁴ National Oceanic and Atmospheric Administration

⁵ Environment and Climate Change Canada

Presented by / Présenté par: *Javeria Rizwan*

Contact: jb.rizwan@utoronto.ca

Aerosol layer height (ALH) is useful for aviation and air quality alerts, as well as for improving air quality forecasting related to wildfires. Some satellite sensors can measure ALH, such as the Tropospheric Emissions: Monitoring of Pollution (TEMPO) Instrument. TEMPO is a geostationary sensor over North America that was launched in 2023. It measures ALH hourly during daylight hours, providing enhanced spatial and temporal coverage over North America relative to previous satellite instruments. However, TEMPO aerosol products have not yet undergone comprehensive validation, and little is known about its data quality. In this work, early TEMPO ALH data are evaluated through comparisons to ground-based ceilometer measurements in Canada. Aerosol layer top and base heights were derived using ceilometer measurements from East Trout Lake (Saskatchewan), Stony Plain (Alberta), and Squamish (British Columbia). Preliminary validation results, including agreement statistics and case study analyses, are presented. ALH has also been measured by the Tropospheric Monitoring Instrument (TROPOMI), which has provided aerosol measurements since 2018. Additionally, aerosol layer information is retrieved from the high-spectral-resolution Atmospheric Lidar (ATLID) on the recently launched Earth Cloud, Aerosol and Radiation Explorer (EarthCARE). In this work, ceilometer data at these three stations are compared to TEMPO, TROPOMI, and EarthCARE to evaluate data quality and filtering as well as to explore satellite inter-comparisons for TEMPO validation. Future work will include additional comparisons of TEMPO ALH to ALH retrievals from TROPOMI and EarthCARE across North America.

ID: 12784 **Contributed abstract**

Poster Order: [5040P03](#)

Intercomparison of Surface-Level Formaldehyde Concentration from Model, Satellite, and Ground-Level Open-Path Measurements

*Cameron Power*¹, *Aldona Wiacek*², *Debora Griffin*³

¹ Saint Mary's University

² Saint Mary's University

³ Environment Climate Change Canada

Presented by / Présenté par: *Cameron Power*

Contact: cameron.power@smu.ca

Formaldehyde (HCHO) is a key photochemically active trace gas in the troposphere that strongly influences atmospheric oxidative capacity, air quality, and human health. As an intermediate product in the oxidation of volatile organic compounds (VOCs), HCHO serves as an effective proxy for VOC emissions and can be remotely sensed from space. We compare surface-level HCHO concentrations in Halifax, Nova Scotia, derived from three sources: 1) Open-Path Fourier Transform Infrared (OP-FTIR) measurements, 2) satellite observations, and 3) modelled concentration outputs. The OP-FTIR dataset is comprised of surface measurements taken from two measurement locations, across the Halifax Harbour and at Saint Mary's University Atmospheric Observatory. The satellite data used in this comparison is the TROPOMI Offline HCHO Level 2 product, filtered for observations spanning 44.2 N – 45.0 N and 64.5 W – 63.0 W, covering Halifax, Nova Scotia, and vicinity. To derive a surface concentration from the column satellite measurement, the ratio of model vertical column density (VCD) to model surface concentration is used to scale the observed TROPOMI VCD. Modelled concentration values are obtained from the operational version of the Global Environmental Multi-scale - Modelling air quality and Chemistry (GEM-MACH) air quality forecasting model. We evaluate monthly Pearson correlation coefficient (R) and mean bias, defined as OP-FTIR minus model or satellite, spanning 2018 – 2023, which includes 24 months with overlapping observations across all datasets. Spatial and temporal averaging criteria are assessed to compare satellite-derived surface HCHO concentrations with ground-based OP-FTIR measurements. In comparisons between OP-FTIR and GEM-MACH outputs, 13 months exhibit statistically significant ($p < 0.05$) correlations of $0.3 < R < 0.9$, with a mean bias of ~ 0.16 ppb (OP-FTIR > GEM-MACH). OP-FTIR and satellite-derived surface concentration comparisons yield 0 – 6 comparison months, depending on averaging criteria, with statistically significant ($p < 0.05$) correlations of $0.3 < R < 0.9$, and a corresponding mean bias of 0.7 ppb – 1 ppb (OP-FTIR > TROPOMI). Results from 2025, including recent TEMPO surface HCHO, will also be shown.

**Session: 6010 POSTER SESSION
AFFICHES**

**02/06/2026
15:10**

ID: 12616 Contributed abstract

Poster Order: 5100P1

The CMOS Science Council: The Path to Scientific Excellence

*Serge Desjardins*¹

1

Presented by / Présenté par: *Serge Desjardins*

Contact: sergio.desjardins1@gmail.com

This non-scientific presentation discusses the proposed strategic approach to achieving scientific excellence within our national scientific society dedicated to the advancement of atmospheric, oceanographic, and related sciences. The current approach can be summarized as follows: bringing strategic thinking about science within our society to the governance level. Our scientific society, a non-profit organization based on the voluntary commitment of its members, is currently governed according to a horizontal organizational model composed of several committees. However, this horizontal administrative structure tends to limit the central role of science as the driving force behind its scientific thinking, which is nevertheless the primary mission of the society. The main role of the CMOS Science Council, acting at the governance level, will be to support the coordination of the Society's scientific activities and provide guidance on new scientific challenges that may require special attention within the Society. This presentation takes a closer look at the strategic thinking that led to the proposal to create this science council, detailing its structure, its constituent elements, its links with other CMOS committees, and its tools, such as its scientific thematic framework. It also highlights the council's key role in organizing the annual Congress and unveils the vision of synergy that this council will bring both within the CMOS and outside it.

**Session: 6010 POSTER SESSION
AFFICHES**

**02/06/2026
15:10**

ID: 12634 Contributed abstract

Poster Order: [6010P1](#)

Downward Propagation of Geomagnetic Storm Effects in the Middle Atmosphere: A SD WACCM X Case Study of the March 2015 Event

*Sahar Barzegar*¹, *Samaneh Sabetghadam*², *Jeff Sepehri*³

¹ University of Tehran, Institute of Geophysics

² University of Tehran, Institute of Geophysics

³ York University

Presented by / Présenté par: *Jeff Sepehri*

Contact: JSepehri@Yorku.CA

The impact of geomagnetic storms on the upper atmosphere is well established, but their potential to influence the middle and lower atmosphere remains debated. Using the Specified Dynamics Whole Atmosphere Community Climate Model with thermosphere and ionosphere eXtension (SD WACCM X), we investigate the global atmospheric circulation response to the St. Patrick's Day geomagnetic storm of 17–18 March 2015. The model, constrained by reanalysis in the lower atmosphere, provides a realistic representation of the storm period while capturing the full vertical extent from the surface to ~500 km. We apply transformed Eulerian mean diagnostics to quantify the residual circulation and its anomalies. During the storm, significant perturbations appear in the thermosphere and upper stratosphere, with anomalous residual vertical velocities reaching ± 0.1 Pa/s and meridional velocity anomalies of several m/s. These signals are most pronounced at high latitudes and are statistically significant at the 95% confidence level. Overlaying zonal wind anomalies reveals a strong coupling between the mean flow and wave forcing. Time-height cross-sections at 60°N and 60°S show that the anomalies descend from the upper atmosphere into the stratosphere within 2–3 days after storm onset, suggesting a downward influence likely mediated by gravity-wave breaking and changes in planetary wave propagation. Eliassen Palm flux divergence anomalies confirm that wave-mean flow interaction is a key driver of the circulation changes. Our results provide evidence that geomagnetic storms can perturb the middle atmosphere circulation on short timescales, highlighting the importance of whole atmosphere coupling for understanding space weather impacts on the terrestrial atmosphere.

**Session: 5070 Managing Hydrometeorological Risks in
an Uncertain World Gérer les risques
hydrométéorologiques dans un monde incertain**

**04/06/2026
13:18**

ID: 12728 Contributed abstract

Poster Order: [12728](#)

**Evaluating Census Tract Level Flood Risks in the Greater Toronto
Hamilton Area using CMIP6 derived Extreme Precipitation Indices**

*Naharin Zannat*¹, *M. Altaf Arain*²

¹ McMaster University

² McMaster University

Presented by / Présenté par: *Naharin Zannat*

Contact: zannatn@mcmaster.ca

Intensity and frequency of extreme precipitation events and associated flood risks are projected to increase under future climate change. Highly urbanized catchments with extensive impervious surfaces like the Greater Toronto and Hamilton Area (GTHA) may experience severe flooding during extreme precipitation events. While regional flood plain mapping and watershed scale hydrologic studies are well established in the region, fewer studies have explicitly incorporated projected changes in extreme precipitation as flood triggers or spatial framework of flood risks at the Census tract level in GTHA.

This study developed an index-based flood risk assessment that integrates projected changes in maximum 1-day, and maximum 5-day precipitation derived from a multi model Intergovernmental Panel on Climate Change (IPCC), Coupled Model Intercomparison Project Phase 6 (CMIP6) ensemble data. Baseline and mid-century extreme precipitation indices are calculated for the two different future climate change scenarios i.e. the Shared Socioeconomic Pathways, SSP 2-4.5 and SSP5-8.5. Projected changes in these indices are interpreted as indicators of amplified flooding risk. Projected indices for both climate scenarios are combined with terrain and land surface-based conditioning parameters including curve number, flow accumulation, elevation to construct a climate conditioned hazard index across the GTHA. Area weighted metrics are used to represent variability of hazard within each census tract. Tract level future flood risk indices are generated by integrating socio demographic exposure and vulnerability factors. The preliminary ensemble results indicate a mean mid-century increase of approximately 11-12% in maximum 1-day precipitation and 9-13% in maximum 5-day precipitation across the GTHA, which is expected to increase relative flood risk in this highly urbanized region. This study will help in strategic planning and resilience prioritization in the GTHA and broader Great Lakes region under changing climate.

Day 3 – 3 June 2026

Session: 1030 Plenary - Navigating Uncertainty in the AI Era of Weather Forecasting
Plénière - Faire face à l'incertitude à l'ère de l'IA dans le domaine des prévisions météorologiques

03/06/2026
11:00

ID: 12865 Invited plenary speaker

Navigating Uncertainty in the AI Era of Weather Forecasting
Faire face à l'incertitude à l'ère de l'IA dans le domaine des prévisions

¹ Environment and Climate Change Canada

Presented by / Présenté par: *Christopher Subich*

Contact: csubich@gmail.com

YouTube Recording: https://youtu.be/VPv_kO2mnTU

The emergence of artificial intelligence in numerical weather prediction has fundamentally disrupted atmospheric science, promising rapid and even unprecedented gains in both computational efficiency and forecast accuracy. However, this revolution also presents challenges at nearly every stage of national weather centres' forecast production chains. Speaking from the perspective of medium-range global atmospheric forecasting, this plenary explores how the meteorological community and Environment and Climate Change Canada (ECCC) are navigating these uncharted waters across three distinct fronts: scientific, operational, and institutional.

Scientifically, we face the challenge of predicting a chaotic atmosphere using unexplainable models. Early AI systems learned to minimize error by "hedging their bets" and smoothing out extreme events. Researchers are now actively working to characterize and mitigate this structural uncertainty. We will explore how native ensemble generation, adjusted loss functions that target realism, and physically informed neural architectures like PARADIS force AI models to generate realistic forecasts that capture dangerous extremes.

Operationally, life-safety organizations cannot simply deploy "black boxes." We examine ECCC's pragmatic approach to safe AI adoption, utilizing spectral nudging to pilot traditional physics-based systems with AI guidance while retaining the essential, high-resolution, and physically consistent outputs that clients and the public depend upon.

Finally, we address the institutional and computational uncertainty looming over the field. AI inverts the traditional compute paradigm, shifting the "heavy lifting" from steady, CPU-based operational runs to massive, "bursty," GPU-heavy model training. As tech giants leverage immense capital to hyperscale their models, we will discuss the "resolution ratchet," the hard limits of historical training data, and the future of sovereign modelling in the AI era.

L'émergence de l'intelligence artificielle dans les prévisions météorologiques numériques a bouleversé en profondeur les sciences de l'atmosphère, promettant des gains rapides et même sans précédent tant en termes d'efficacité de calcul que de précision des prévisions. Néanmoins, cette révolution présente des défis à pratiquement toutes les étapes de la chaîne de production des prévisions des centres météorologiques nationaux. Du point de vue des

prévisions atmosphériques mondiales à moyen terme, cette plénière se penche sur la façon dont la communauté météorologique d'Environnement et Changement Climatique Canada (ECCC) navigue en eaux inconnues sur trois fronts distincts : scientifique, opérationnel et institutionnel.

Sur le plan scientifique, nous faisons face au défi de prédire une atmosphère chaotique au moyen de modèles inexplicables. Les premiers systèmes d'IA ont appris à minimiser les erreurs en « couvrant leurs arrières » et en atténuant les événements extrêmes. Les chercheurs cherchent maintenant activement à caractériser et à atténuer cette incertitude structurelle. Nous examinerons comment la génération d'ensembles natifs, les fonctions de perte ajustées visant à garantir le réalisme et les architectures neuronales fondées sur la physique comme PARADIS obligent les modèles d'IA à établir des prévisions réalistes qui tiennent compte des phénomènes extrêmes dangereux.

Sur le plan opérationnel, les organismes chargés de la sécurité des personnes ne peuvent pas se contenter de déployer des « boîtes noires ». Nous examinons l'approche pragmatique d'ECCC envers l'adoption d'IA sûres, en recourant à la technique du « spectral nudging » pour piloter des systèmes traditionnels fondés sur la physique au moyen de l'IA, tout en conservant les résultats essentiels, à haute résolution et physiquement cohérents auxquels les clients et le public sont attachés.

Enfin, nous abordons les incertitudes institutionnelles et computationnelles qui pèsent sur ce domaine. L'IA renverse le paradigme informatique traditionnel, en transférant les « tâches les plus exigeantes » des exécutions opérationnelles régulières, basées sur le processeur, vers des entraînements de modèles à grande échelle, par « rafales », faisant largement appel au processeur graphique. Tandis que les géants du Web misent sur l'immense capital pour faire évoluer leurs modèles à très grande échelle, nous évoquerons le « mécanisme à cliquet », les limites intrinsèques des données d'entraînement historiques et l'avenir de la modélisation souveraine à l'ère de l'IA.



Time: Wednesday June 3, 2026 11:00 – 11:55 EDT

Title: *Navigating Uncertainty in the AI Era of Weather Forecasting*

Speaker: Dr. Christopher Subich (Meteorological Research Division of Environment and Climate Change Canada (ECCC))

Bio: Dr. Christopher Subich is a Research Scientist in the Meteorological Research Division of Environment and Climate Change Canada (ECCC), where he has worked since 2012. His research focuses on atmospheric numerical weather prediction, specializing in both the application of artificial intelligence to global forecasting and high-order numerical methods for geophysical fluid dynamics. Recently, his work has centered on bridging the gap between machine learning and operational meteorology through the development of sharpness-preserving

loss functions and AI-guided spectral nudging systems. He holds a Ph.D. in Applied Mathematics from the University of Waterloo and currently serves as an Associate Editor for *Monthly Weather Review* and *Atmosphere–Ocean*.

Session 2021 Part 1

Convenors:

Simon-Philippe Breton, Canadian Meteorological Center, ECCC
Vikram Khade, Canadian Meteorological Center, ECCC

We invite the meteorological community to contribute to an exciting session on the integration of Artificial Intelligence (AI) into meteorology. This session aims to explore how AI, in particular machine learning (AI/ML) and high performance computing, is revolutionising modern meteorology.

Potential topics:

- Data-driven modelling in meteorology: Examples of fully data-driven models offering new insights into the understanding of meteorological phenomena.
- Hybridization of models: Fusion of data-driven approaches and traditional physical models for more accurate and robust weather forecasting.
- AI/ML for nowcasting: Innovation in very short-term forecasting, using AI to improve the speed and accuracy of forecasts.
- Improvements in S2S forecasting: Use of innovative statistical methods and AI/ML to refine sub-seasonal to seasonal predictions.
- Operationalisation of AI/ML: Discussion on how to make AI/ML technologies more accessible and useful for daily weather forecasting and decision support.
- Ethical and responsible AI: Importance of developing and using AI ethically and responsibly in meteorological research.
- Improving AI Literacy: Encouraging AI adoption by improving AI understanding and skills within the meteorological community.
- AI/ML in data assimilation : Use of AI/ML to augment/replace components of data assimilation systems (4DVar, EnVar, Ensemble based DA etc.)
- AI/ML applications in climate and environmental sciences : Use of AI/ML in climate projections, estimation of green house gases and climate change, climate change mitigation strategies, environmental impact/adaptation, policy formulations.
- AI applications in renewable energies : Use of AI/ML to improve forecasts for renewable energies.

In order to align this session with the “Navigating Uncertainty” theme of the conference, we encourage presentations that demonstrate how artificial intelligence can be used to characterize, quantify, or manage uncertainty in the context of measurements, forecasts, and projections in meteorology and climatology. Contributions that illustrate the application of AI to monitoring, reducing, or communicating uncertainty, as well as interdisciplinary approaches—including those integrating social sciences—are welcome.

ID: 12709 Contributed abstract

On the use of Artificial Intelligence in the Nowcasting and High-Impact Weather Research Program

*Dominique Brunet*¹

1

Presented by / Présenté par: *Dominique Brunet*

Contact: Dominique.Brunet@ec.gc.ca

In this presentation, I summarize recent research activities related to the nowcasting and post-processing of severe convective weather (SCW) using artificial intelligence and machine learning (AI/ML). I first present the Integrated Canadian Hail Database and identify other important datasets for training and validating machine learning algorithms. I then showcase internal and external collaborations on lightning, hail and tornado diagnostics from re-analysis data, on hail nowcasting using radar and satellite data, and on precipitation nowcasting. Going beyond severe weather nowcasting, I also introduce some recent work on AI-based wind downscaling. I conclude the presentation with a general framework based on three fundamental post-processing tasks: bias-correction, downscaling, SCW diagnostics, and three fundamental nowcasting tasks: SCW detection, extrapolation (i.e. prediction) and blending.

Session: 2021 Advances and applications of artificial intelligence in meteorology - Part 1 Progrès et applications de l'intelligence artificielle en météorologie - Partie 1

**03/06/2026
12:42**

ID: 12738 Contributed abstract

Integrating MRMS Radar Products and Random Forest Method for Hail Detection and Nowcasting in Canada

*Chris Jing*¹, *Dominique Brunet*², *Sudesh Boodoo*³

¹ Environment and Climate Change Canada

² Environment and Climate Change Canada

³ Environment and Climate Change Canada

Presented by / Présenté par: *Chris Jing*

Contact: chris.jing@ec.gc.ca

Severe convective thunderstorms account for three of the seven costliest extreme weather events in Canada, including two hailstorms. In Alberta, insured damage from hail between 2020 and 2024 amounts to \$6 billion according to the Insurance Bureau of Canada (IBC). Reliable nowcasting with early warnings of hail hazards is crucial for reducing societal and economic damage. However, it remains a challenge due to the limitations of existing numerical weather prediction (NWP) models in resolving storm-scale features and processes. We investigated the Random Forest (RF) machine learning (ML) method to nowcast hail occurrence with a lead time of up to one hour. Hail reports from the Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) between 2021 and 2024 are used to select 576 hail days in southern Canada and northern United States. Thunderstorm reports without hail observations over the selected hail days are compiled as null reports from a Meteorological Aerodrome Report/Special (METAR/SPECI) archive. The hail nowcasting ML model analyzed a pool of 25 candidate predictors spatially and temporally sampled from the Multi-Radar Multi-Sensor System (MRMS). The ML model comprises two RF binary classifiers that can predict, respectively, the probability of hail occurrence and the probability of severe hail (diameter greater than 25 mm) for five lead times of 0, 15, 30, 45, and 60 minutes. The ML model is deployed and assessed for two severe thunderstorm events in 2025. The ML model reaffirmed several reflectivity-based hail predictors of significance, such as Echo Top and Vertically Integrated Liquid (VIL). It demonstrated skills in nowcasting hail for the next 60 minutes with a 60%–75% probability of detection (POD) for hail occurrence and a 25%–35% false alarm rate (FAR) for severe hail. Future improvements are proposed by incorporating satellite-based products, convective parameters derived from NWP, and storm-tracking algorithms.

Session: 2021 Advances and applications of artificial intelligence in meteorology - Part 1 Progrès et applications de l'intelligence artificielle en météorologie **03/06/2026**
- Partie 1 **12:54**

ID: 12744 Contributed abstract

The Development of a Deep Learning Model to Identify and Track Severe Thunderstorms Over Canada.

*Kyle Ziolkowski*¹, *Ivan Kraskov*², *Carlos Jabbour*³

¹ ECCC-MSB / DSB

² ECCC-DSB

³ ECCC-DSB

Presented by / Présenté par: *Kyle Ziolkowski*

Contact: kyle.ziolkowski@ec.gc.ca

Severe thunderstorms can cause widespread damage to property and impact local economies. These include large hail, severe wind gusts, tornadoes and flash flooding. Operational meteorologists use various tools to monitor severe thunderstorms in real time. Weather surveillance radars are the primary tool for monitoring changes in thunderstorm intensity and are used alongside other tools such as lightning detection networks, numerical weather prediction models, and satellite imagery. Recently, AI/Machine Learning has entered the field of severe thunderstorm detection and prediction and have shown to assist forecasters in tracking of severe weather. Here, we introduce a multimodal Convolutional Long Short-Term Memory (ConvLSTM) model that is designed to identify and track severe thunderstorms over Canada using GOES satellite data and Canadian Lightning Detection Network data as inputs. Variational dense optical flow data is also experimented with and is provided as an auxiliary input to the model. CNN models were also trained to provide a baseline comparison to the ConvLSTM model for severe thunderstorm intensity tracking.

Session: 2021 Advances and applications of artificial intelligence in meteorology - Part 1 Progrès et applications de l'intelligence artificielle en météorologie - Partie 1

**03/06/2026
13:06**

ID: 12853 Contributed abstract

Climate-Specific Performance of Bayesian-Optimized Hybrid Machine Learning Models for Short-Term Wind Forecasting in Contrasting Mountain Terrains

*Jeff Sepehri*¹ , *Amir Baqerzaheh*² , *Parvin Ghafarian*³

¹ York University

²

³ UNBC

Presented by / Présenté par: *Jeff Sepehri*

Contact: JSepehri@Yorku.CA

Accurate short-term wind forecasting in mountainous terrain remains a persistent challenge for numerical weather prediction (NWP) systems due to unresolved sub-grid topographic effects and strongly nonlinear atmospheric processes. This study presents a comparative evaluation of Bayesian-optimized machine learning (ML) frameworks for one-hour lead-time wind speed forecasting across two contrasting mountain environments: Abali station in the Alborz Mountains (Iran) and Pincher Creek in the lee of the Canadian Rockies (Alberta, Canada).

One year of hourly meteorological observations—including temperature, relative humidity, pressure, and wind vectors—was used to develop a rigorous preprocessing pipeline. Wind speed and direction were

transformed into zonal (u) and meridional (v) components to preserve vector continuity and physical consistency. A suite of forecasting models was assessed: ARIMA, Persistence (naïve baseline), Support Vector Regression (SVR), XGBoost, and a hybrid XGBoost–SVR ensemble. All model hyperparameters were systematically optimized using Bayesian optimization implemented through the Optuna framework.

Results reveal strong climate-regime dependence in model performance. In the thermally driven mountain–valley circulation regime of Abali, linear approaches (ARIMA) were unable to capture nonlinear flow transitions, producing the largest forecast errors. The Bayesian-optimized hybrid ensemble achieved the best performance ($R^2 = 0.835$; $MAE = 0.514 \text{ m s}^{-1}$), representing a 12.5% improvement over persistence. Conversely, in the high-momentum, synoptically forced environment of Pincher Creek—frequently influenced by Chinook events—the standalone XGBoost model demonstrated superior robustness ($R^2 = 0.597$), effectively handling intermittent high-variance wind fluctuations.

These findings demonstrate that hybrid ML architectures are particularly advantageous in thermally modulated mountain flows, whereas gradient-boosting methods generalize more effectively in synoptically dominated high-wind regimes. The study underscores the importance of climate-specific model selection strategies for improving short-term wind forecasting reliability and supporting wind energy integration in complex terrain

Session: 2021 Advances and applications of artificial intelligence in meteorology - Part 1 Progrès et applications de l'intelligence artificielle en météorologie 03/06/2026 - Partie 1 13:18

ID: 12815 Contributed abstract

Multi Wind Farms Deep Learning Forecasting of Wind Power and Operational Events

*Jean-Sébastien Giroux*¹, *Thomas Forest*², *Mathieu Prévost*³, *Francis Izquierdo-Bernier*⁴, *Guillem Candille*⁵, *Slavica Antic*⁶, *Simon-Philippe Breton*⁷, *Julie Carreau*⁸

¹ Environment and Climate Change Canada

² Polytechnique Montréal

³ Polytechnique Montréal

⁴ Polytechnique Montréal and Environment and Climate Change Canada

⁵ Hydro Québec

⁶ Hydro Québec

⁷ Environment and Climate Change Canada

⁸ Polytechnique Montréal, Mila - Quebec AI Institute, GERAD

Presented by / Présenté par: *Jean-Sébastien Giroux*

In recent years, wind energy has become increasingly attractive due to rapid technological advancements and declining costs. Hydro-Québec plans to leverage these favorable conditions by adding 10,000 megawatts of wind power to the grid by 2035. To ensure efficient operational decision-making and reduce costs in cold-climate conditions, accurate forecasting of both wind and icing is essential, enabling the reliable detection of ramp and icing events.

Due to the high variability of wind and the complex physics governing ice formation, accurately forecasting wind power production at wind farms remains challenging. Deep learning has recently emerged as a promising tool to address this problem, although current results remain limited. Existing studies typically rely on constrained datasets, a small number of wind farms, short forecast horizons, and limited temporal coverage. Moreover, some approaches do not jointly leverage historical power measurements from supervisory control and data acquisition (SCADA) systems with Numerical Weather Prediction (NWP) data. In this study, we employ recurrent neural networks (RNNs) and state-of-the-art deep learning architectures for sequential modeling (Transformers and Mamba) adapted to integrate SCADA and NWP data across three wind farms with distinct topographies, using a 10-year training dataset.

Our results show that incorporating NWP data significantly improves wind power and icing forecasting performance compared with models relying solely on SCADA information, enabling accurate day-ahead hourly forecasts. To assess their operational relevance, we evaluated the ability of these forecasts to detect wind ramp and icing events, demonstrating promising potential for improved management of this intermittent energy resource.

These results have significant implications for the field, demonstrating that state-of-the-art deep learning architectures can support accurate wind farm forecasting and enhanced detection of operationally critical events.

Session 2036 Part 6

Convenors:

Elizaveta Malinina, Environment and Climate Change Canada

Neil Tandon, York University

Nathan Gillett, Environment and Climate Change Canada

Extreme events in weather and climate pose significant risks to lives, ecosystems, and economies, often resulting in devastating losses and long-term impacts. Nevertheless, current knowledge of extremes and how they are evolving in a changing climate is associated with a high degree of uncertainty, often arising from short historical records, incomplete process understanding, or model biases. This session invites contributions addressing all aspects of weather and

climate extremes, including but not limited to studies covering uncertainties in physical mechanisms, observations, predictions or projections of extremes, and their communication. We welcome submissions examining extremes of varying durations (from hours to months) and types, including heatwaves, wildfires, extreme precipitation, wind-related events, hydrological extremes (e.g., floods and droughts), and oceanographic extremes (e.g., storm surges, coastal flooding, and marine heatwaves). Submissions may focus on historical changes, event attribution, future projections, or any other extremes-related topic.

**Session: 2036 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 6 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 6**

**03/06/2026
12:30**

ID: 12828 Contributed abstract

Convection-Resolving Modeling of Canadian Severe Storms

*Lisa Schielicke*¹, *Luna Awad*², *Keya Raval*³, *Prathmesh Mishra*⁴

¹ Western University

² Western University

³ Western University

⁴ Western University

Presented by / Présenté par: *Lisa Schielicke*

Contact: lschieli@uwo.ca

We present a high-resolution modeling study of Canadian severe storms using Cloud Model 1 (CM1), focusing on tornado- and hail-producing convective events. The study is based on a curated dataset of 20 severe weather cases across Canada selected from the Northern Tornadoes Project and the Northern Hail Project. These cases serve as the foundation for convection-resolving simulations. Initial conditions are constructed using thermodynamic profiles derived from ERA5 global reanalysis data. An ensemble of simulations is performed to assess how well the ERA5 vertical profiles represent observed environments and to explore potential limitations of using reanalysis data as ground truth. The ensemble includes the original ERA5 profiles, modified versions of those profiles, different convective initiation approaches, and multiple microphysics schemes. Simulations are carried out on the high-performance computing systems of the Shared Hierarchical Academic Research Computing Network (SHARCNET), part of the Digital Research Alliance of Canada. Key outputs include analysis of storm structure, dynamics, intensity, and evolution, along with comparisons to available observations. Results are visualized through an interactive dashboard. This work provides further insight into the meteorological conditions associated with Canadian severe weather and

continues to develop a reproducible framework for convection-resolving ensemble storm simulations based on regional observational datasets.

**Session: 2036 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 6 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 6**

**03/06/2026
12:42**

ID: 12836 Contributed abstract

Multivariate Separation of Thunderstorm, Weak and Strong Tornado Environments in Canada

*Joanne Kunkel*¹, *John Hanesiak*², *David Walker*³, *Mateusz Taszarek*⁴, *David Sills*⁵

1

2

3

4

5

Presented by / Présenté par: *Joanne Kunkel*

Contact: kunkelj@myumanitoba.ca

Tornado environments in Canada are less well documented than those in the United States, especially regarding what distinguishes weak tornadoes from strong ones and how both compare to non-tornadic thunderstorm days. This study investigates the large-scale and near-storm environments of Canadian thunderstorm days, weak tornadoes, and strong tornadoes using ERA5 reanalysis proximity soundings to compute over 300 convective storm parameters.

Instead of relying on a single parameter like CAPE or shear, we use a multi-step statistical method to identify which environmental variables distinguish the three event types. Then, we apply multivariate analysis to see how these variables combine to separate environments in a physically meaningful way.

At the national level, instability and lapse rates serve as the fundamental difference between tornadic and non-tornadic thunderstorm days. However, the main distinction between weak and strong tornadoes is largely kinematic: strong tornadoes are linked to increased low-level and deep-layer shear, as well as more favourable vertical wind structures. Conversely, environments with weak tornadoes often closely resemble non-tornadic thunderstorm days, especially concerning thermodynamic features.

Provincial analyses reveal both shared and regional influences. The Prairie provinces display stronger shear-driven separation between categories,

while Ontario and Quebec show greater variability in instability-related parameters. Overall, the results indicate that Canadian tornado potential cannot be explained by a single factor; instead, it results from the combined interaction of instability and wind shear.

This work establishes a national framework for understanding Canadian tornado environments and provides insights into why some storms generate weak tornadoes while others produce stronger ones, with implications for severe weather forecasting and risk assessment in Canada. The broader goal is to translate these findings into practical guidance for operational forecasting, helping identify the ranges and combinations of parameters most supportive of strong versus weak tornado potential in Canada.

**Session: 2036 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 6 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 6**

**03/06/2026
12:54**

ID: 12837 Contributed abstract

**Analysis of processes causing damaging winds and hail in the
Brooks, Alberta long-track storm event using observations and high-
resolution simulations**

*Christoph Gatzen*¹, *Morgan Schneider*², *Simon Eng*³, *Jack
Hamilton*⁴, *Lisa Schielicke*⁵, *Connell Miller*⁶, *David Sills*⁷, *Julian
Brimelow*⁸, *John Hanesiak*⁹, *Clinton Macadam*¹⁰, *Gregory Kopp*¹¹

¹ Canadian Severe Storms Lab

² Canadian Severe Storms Lab

³ Canadian Severe Storms Lab

⁴ Canadian Severe Storms Lab

⁵ Canadian Severe Storms Lab

⁶ Canadian Severe Storms Lab

⁷ Canadian Severe Storms Lab

⁸ Canadian Severe Storms Lab

⁹ University of Manitoba

¹⁰ University of Manitoba

¹¹ Canadian Severe Storms Lab

Presented by / Présenté par: *Christoph Gatzen*

Contact: cgatzen@uwo.ca

Wind-driven hail events are particularly damaging and have been responsible for the costliest hail events in Canada in recent years. Storms in Calgary, Alberta (June 2020, July 2021, and August 2024), and Winnipeg,

Manitoba (August 2023), have resulted in hundreds of millions to billions of dollars in insured personal property and commercial business losses. On August 20, 2025, a long-track damaging wind and hail event affected parts of southern Alberta and southern Saskatchewan. The storm formed about 30 km south of Calgary and moved eastwards, affecting the City of Brooks and surrounding agricultural areas. Severe winds, with damage-based estimates of gusts up to 165 km/h, occurred concurrently with large volumes of hail reaching maximum diameters of 40 to 50 mm. Other portions of the track had lower wind speeds but larger hail, with maximum diameters reaching at least 70 mm. Data from the Canadian Mesonet Portal indicate that the path of damaging wind gusts persisted for at least 200 km, with measured peak winds of 148.5 km/h, and the satellite analysis from the Northern Tornadoes Project points to a even longer path approaching 300 km.

In this work, we describe the Brooks long-track damaging wind and hail event that is assumed to be an intense, long-lived hybrid storm type that combines characteristics of a bow echo windstorm and a supercell hailstorm. Following the work of Killion et al. (2025), we use CM1 model simulations to identify processes such as downbursts, mesovortices, and rear inflow jets, that caused the high wind speeds near the ground. Additionally, we identify areas along the storm's path where the combined effect of simulated hail and strong horizontal winds had the most damaging potential.

This case study will support further development of our understanding of the damage potential from different combinations of high winds and hail.

**Session: 2036 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 6 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 6**

**03/06/2026
13:06**

ID: 12731 Contributed abstract

**Changing midlatitude wind extremes in a variable-resolution climate
model**

*Lucas Prates*¹ , *Paul Kushner*² , *Michael Morris*³

¹ University of Toronto

² University of Toronto

³ University of Toronto

Presented by / Présenté par: *Lucas Prates*

Contact: lucas.prates@mail.utoronto.ca

Changes to regional wind extremes under climate change are difficult to predict due to an inability to resolve the relevant submesoscale-to-mesoscale dynamics with traditional Earth system models. With 7 km regional refinement, the variable-resolution version of the National Center for Atmospheric Research Community Earth System Model (VR-CESM) has been shown to skillfully resolve local changes to sensible heat flux and static stability that contribute to the evolution of extreme winds under climate change, thereby producing more reliable projections than its 100 km uniform-resolution counterpart. In this study, we assess the seasonal, diurnal, and dynamical character of extreme wind event events in the Great Lakes region by VR-CESM under present day and year-2090 RCP8.5 conditions. The model projects that the climate-change forced increase to the intensity of cold-season extreme wind events in this region is dominated by a spring season signal. The fastest winds tend to occur in the mid-afternoon following a peak in sensible heat fluxes and during conditions of neutral-to-unstable near-surface thermal stratification. The mechanisms which drive the extreme wind response to the enhanced climate forcing is stratified by wind direction, with southwesterly events demonstrating the most sensitive changes to static stability. This work highlights the importance of considering seasonal, diurnal, and directional effects in studies of midlatitude wind extremes.

**Session: 2036 Weather, Climate, and Environmental
Extremes in Changing Climate - Part 6 Conditions
météorologiques, climatiques et environnementales
extrêmes dans un climat en mutation - Partie 6**

**03/06/2026
13:18**

ID: 12842 Contributed abstract

**Short-term impact of intense warming on snowy catchments in the
Pacific NorthWest**

*Chibuike Onwukwe*¹, *Brian Menounos*², *Peter Jackson*³

¹ University of Northern British Columbia

² University of Northern British Columbia

³ University of Northern British Columbia

Presented by / Présenté par: *Chibuike Onwukwe*

Contact: onwukwe@unbc.ca

Unusually warm, dry conditions prevailed over large regions of the Pacific Northwest and western Canada in late June 2021. Whereas heat stroke fatalities gained prominence during and in the immediate aftermath of the 'Heat Dome' as it was called, catchment-scale responses have scarcely been studied due to sparse observational network. We examined the magnitude of impacts by the Heat Dome on cryospheric processes with the Weather and Research Forecast Model (WRF) run at high resolution (1 km)

and for an entire year to build the snowpack. Strong correlation among observed quick river flow and modeled loss of snow water equivalent (SWE) in particular, conferred confidence in model ability to detect and quantify snow and ice lost during the one-week event from over 120 mountain watersheds, including ungauged areas. On average, 9 % fractional snow cover disappeared, and snow depth thinned by 32 % (0.38 m). Snowlines shifted 20–70 m vertically, and 100–1000 m laterally in 84 % and 77 % basin area, respectively. Mean SWE from ablation of snowpack is 4.24 m (3–7 m in 85 % total area). Watersheds in the lee of mountains and regions with little snowpack before the event were the most sensitive to these impacts. We also analyzed surface flows above critical thresholds, providing insights on natural vulnerability of individual catchments to excessive discharge initiated or predominantly controlled by snowmelt.

Session 2054 Part 4

Convenors:

Milena Dimitrijevic, Environment and Climate Change Canada
Syed Husain, Environment and Climate Change Canada

Related to scientific studies and/or information sharing about the atmosphere, including weather, meteorology, clouds and precipitation, air quality, atmospheric dynamic and extreme events, using various approaches.

This session covers many topics, including, but not limited to, theoretical research, model development, observation techniques, real-time monitoring, databases, diagnostic methods, data analysis and artificial intelligence.

Session: 2054 Atmosphere - Theoretical to applied science - Part 4 Atmosphère - De la théorie à la science appliquée - Partie 4

**03/06/2026
12:30**

ID: 12623 Contributed abstract

An overview of the hourly wind-bias-adjusted precipitation dataset from the ECCC automated surface observation network (CanAdjAutoP)

*Amber Ross*¹, *Craig Smith*², *Hui Wan*³, *Vincent Cheng*⁴

¹ ECCC

² ECCC

³ ECCC

⁴ ECCC

Presented by / Présenté par: *Amber Ross*

Contact: amber.ross@ec.gc.ca

Precipitation measurements from the Environment and Climate Change Canada (ECCC) automated surface observation network are fundamental to weather and climate monitoring, flood and water resource forecasting, hydrological modelling, and climate change assessment. Since the late 1990s, the network has transitioned from manual measurements to automated precipitation gauges, increasing observational frequency and expanding coverage in remote regions. However, this transition has introduced challenges related to the quality and long-term homogeneity of solid precipitation (snow) measurements. As demonstrated in the WMO Solid Precipitation Inter-Comparison Experiment (SPICE), automated gauges tend to underestimate solid precipitation because their design allows wind to deflect light snow particles away from the collector inlet. To address wind-induced bias in the ECCC automated surface network precipitation observations, the Climate Research Division initiated the application of SPICE transfer function adjustments to a subset of 397 automated stations and began publishing the adjusted dataset (CanAdjAutoP) to the Government of Canada Data Portal. The stations selected for adjustment are considered essential for maintaining continuity across multiple historical climate analyses even though the automated observations of precipitation in this dataset only extend back to 2001. Previous versions of CanAdjAutoP applied wind-bias adjustments to single Alter-shielded gauges and excluded (but flagged) data from stations that had transitioned to double Alter-shielded gauges. However, since 2017, the proportion of the network updated to double Alter-shields has increased to nearly 50% and obviously can no longer be omitted. Beginning in 2023, CanAdjAutoP has included a retroactive SPICE transfer function adjustment for the stations that now have a double Alter-shielded gauge. This presentation provides an overview of CanAdjAutoP including recent updates, and discusses the impact that the adjustments have on regional and seasonal precipitation amounts.

Session: 2054 Atmosphere - Theoretical to applied science - Part 4 Atmosphère - De la théorie à la science appliquée - Partie 4

**03/06/2026
12:42**

ID: 12700 Contributed abstract

Transforming Forecast Production: The Weather Elements on Grid (WEonG) System

*Agnieszka Barszcz*¹

1

Presented by / Présenté par: *Agnieszka Barszcz*

Contact: agnieszka.barszcz@ec.gc.ca

The Meteorological Service of Canada (MSC) is actively modernizing how it produces weather forecasts and warnings to better serve Canadians. This transformation is driven by the necessity to adapt to evolving client needs integrate the rapid pace of scientific and technological innovation, including advances in AI and machine learning, and harness the phenomenal growth in the volume of environmental information now available. Output from high-resolution, ensemble, and environmental prediction systems is increasingly accessible, and significant work is underway to bring far more of this information into MSC's routine forecast production process.

A key pillar of this modernization is the Weather Elements on Grid (WEonG) system — a new approach to producing the weather and environmental elements that underpin MSC's forecast programs, including Public, Marine, and Air Quality forecasting. WEonG move away from the legacy point-based approach, making forecast elements available across a full grid and enabling forecasts to be generated at any location in Canada. This improved offering and packaging of post-processed model data is central to MSC's broader service transformation, including efforts to increase automation where appropriate in the forecast production process.

This presentation provides an overview of WEonG and the methods used to produce it, including how the system leverages the full suite of Canadian numerical weather and environmental prediction (NWEp) models and advanced post-processing techniques. By enabling the flexible integration of detailed information, including uncertainty, WEonG makes it easier to tailor products to a wide range of user needs, ultimately delivering better, more timely information to Canadians.

Session: 2054 Atmosphere - Theoretical to applied science - Part 4 Atmosphère - De la théorie à la science appliquée - Partie 4

**03/06/2026
12:54**

ID: 12715 Contributed abstract

Implementing NCWEonG: Grid Based Nowcasting for Improved Short Term Forecasts

*Frédéric Dubuis*¹, *Weiguang Chang*², *Zhiyong Huang*³, *Mary Qian*⁴

¹ Environnement et Changement Climatique Canada

² Environnement et Changement Climatique Canada

³ Environnement et Changement Climatique Canada

⁴ Environnement et Changement Climatique Canada

Presented by / Présenté par: *Frédéric Dubuis*

Contact: frederic.dubuis@canada.ca

The Weather Elements on Grid (WEonG) post-processing system is a transformative project by the Meteorological Service of Canada. It aims to compute weather elements on a grid rather than at station points, thereby enabling new and enhanced forecast services.

As part of the WEonG initiative, the Nowcasting of Weather Elements on Grid (NCWEonG) provides a nowcasting component that has been operational in an experimental status at the Canadian Meteorological Center since May 2024.

NCWEonG assimilates observational and remote sensing data to reduce short term forecast uncertainty. This is particularly important in the case of severe weather, which often evolves rapidly and at a local scale, making it difficult for traditional numerical models to capture. By improving short term guidance, NCWEonG promises to significantly improve the quality of public forecast over the next few hours, while at the same time providing a strong foundation to the development of novel short term forecast services.

NCWEonG begins with an hourly 2D near-surface mesoscale analysis, producing hourly nowcasts of weather elements on a grid at a 2.5 km resolution, extending up to 6 hours. Data from surface stations, GOES satellites, S-band radar, and lightning detection, are then combined with post-processed outputs from ECCO's High Resolution Deterministic Prediction System (HRDPS). Additionally, sub-hourly predictions for cloud and precipitation are generated.

This presentation will provide a detailed overview of the NCWEonG system implementation, examine how the uncertainty of meteorological variables is derived from the strengths, limitations, and spatial coverage of observing instruments, and describe how this uncertainty is propagated forward in time to reconnect with the WEonG model fields beyond the nowcasting timeline.

Session: 2054 Atmosphere - Theoretical to applied science - Part 4 Atmosphère - De la théorie à la science appliquée - Partie 4

**03/06/2026
13:06**

ID: 12848 Contributed abstract

Custom Weather Forecasts Using Terrain-Specific Postprocessing for Inuit Land Users

*Anna Brownlee*¹, *Derek Mueller*², *Joel Bedard*³

¹ Carleton University

² Carleton University

³ Environment and Climate Change Canada

Presented by / Présenté par: *Anna Brownlee*

Contact: annabrownlee@cmail.carleton.ca

Residents of the Canadian High Arctic have consistently called for more accurate and localized weather forecasts. Environment and Climate Change Canada's (ECCC) High Resolution Deterministic Prediction System (2.5 km resolution) does not cover the High Arctic, leaving Inuit communities reliant on the lower-resolution Global Deterministic Prediction System (GDPS) (15 km resolution). Residents have access to postprocessed forecast products - formerly Updatable Model Output Statistics (UMOS), now PROGNOS. However, these forecasts are only available at ECCC weather stations near airports, which are often far from areas of cultural significance. This gap in forecast specificity, compounded by warming trends and changing weather patterns, underscores the need for improved weather services in the Canadian High Arctic. In 2022 and 2023, Carleton University assisted community members in establishing a network of three weather stations near Arctic Bay, Nunavut, at locations chosen by the community. These stations report publicly available real-time weather conditions, addressing the need for timely information at key locations outside the community. However, Inuit still lack accurate forecasts tailored to these locations. In partnership with Ikajutit Hunters and Trappers Association, this project aims to evaluate the accuracy of existing forecasts and develop custom forecasts for the people of Arctic Bay. This will be realized for the three community weather stations and the ECCC station near the airport using forecast post-processing techniques. These methods identify and account for systematic discrepancies between local weather station data and numerical weather predictions. This project uses the Geophysic Model Output Statistic (GMOS) post-processing technique, which implicitly corrects for terrain characteristics such as surface roughness and elevation. These corrections will be applied to key environmental variables, including temperature, humidity, wind speed and wind direction. Improved weather forecasts can increase preparedness for extreme weather events and support travel safety, contributing to food security and cultural practices.

Session: 2054 Atmosphere - Theoretical to applied science - Part 4 Atmosphère - De la théorie à la science appliquée - Partie 4

**03/06/2026
13:18**

ID: 12800 Contributed abstract

Linking winter severity indexes with road maintenance operations using meteorological observations and high-resolution regional climate model simulations

*Jade Séguin*¹, *Amaury Philippe*², *Hadleigh Thompson*³, *Nicolas Morin*⁴, *David Fiset*⁵, *Emilie Godbout*⁶, *Martin Trépanier*⁷, *Julie Thériault*⁸

¹ UQAM

² École Polytechnique Montréal

³ UQAM

⁴ Ministère des transports et mobilité durable du Québec

⁵ Ministère des transports et mobilité durable du Québec

⁶ Ministère des transports et mobilité durable du Québec

⁷ École Polytechnique Montréal

⁸ UQAM

Presented by / Présenté par: *Julie Thériault*

Contact: julie.theriault@uqam.ca

The province of Quebec, Canada, can experience extreme winter conditions with highly variable weather which in turn leads to rapidly changing road conditions impacting ground transportation and road maintenance operations. A winter severity index is introduced to compare winter seasons, evaluate maintenance strategy performance (e.g. salt consumption and operation duration), and improve planning in the context of climate change. Two indices were compared: the air temperature-based Indice Basé Uniquement sur la Température (IBUT), and the Indice Basé sur des Catégories d'Évènements Météorologiques (ICEM), which incorporates multiple meteorological variables such as wind speed and precipitation. This study aims to assess the utility of these winter severity indices for Quebec using observational data from roadside weather stations and very high-resolution regional climate simulations in both historical and warmer climate conditions. Both indices exhibit strong correlations with the quantities of salts and abrasives spread during maintenance operations. The presentation will show the changes in IBUT in warmer and more humid climate conditions and propose a method to diagnose road conditions using very high-resolution regional climate simulations. Overall, these findings will improve our understanding of winter weather impacts on road conditions and support adaptive maintenance planning to limit environmental impacts and optimize budgets in a warming climate.

Session 3021 Part 1

Convenors:

Nancy Soontiens, Fisheries and Oceans Canada

Guoqi Han, Fisheries and Oceans Canada

Youyu Lu, Fisheries and Oceans Canada

Hui Shen, Fisheries and Oceans Canada

Di Wan, Fisheries and Oceans Canada

Floris Goerlandt, Dalhousie University

Digital Twins of the Ocean (DTO) has emerged as a framework to provide a virtual representation of the real ocean for effective monitoring, predicting, and managing complex marine systems, in applications such as fishery and ecosystem protection and management, safe navigation, search and rescue, and climate change adaptation. Internationally, there are fast progresses in all

aspects of DTO development, including the various activities under the United Nations Decade of Ocean Science for Sustainable Development. In Canada, there is a tremendous amount of activity relevant to DTO development, including ocean observations, modelling, prediction, analyses, data management, etc. These activities spread among government departments, academia, and the private sector. To be successful in building DTO for oceans around Canada, there are imminent needs to enhance the knowledge and technology exchanges, coordination and collaboration among management and researchers in various organizations and also with the international community. To this end, this session aims to bring together national and international researchers and managers to 1) share the client needs and plans of relevant projects and activities; 2) review existing resources and challenges (data, models, technology and knowledge); 3) present achievements in research and development, and showcase examples; and 4) discuss collaboration opportunities.

Session: 3021 Towards development of Canada's Digital Twin of the Ocean: Research, Development and Work Examples - Part 1 Vers le développement du jumeau numérique de l'océan canadien : recherche, développement et exemples de travaux - Partie 1 **03/06/2026 12:30**

ID: 12765 Contributed abstract

Ocean Navigator: Operational Lessons Toward a Canadian Digital Twin of the Ocean

*Justin Elms*¹

1

Presented by / Présenté par: *Justin Elms*

Contact: justin.elms@dfo-mpo.gc.ca

The Ocean Navigator is an oceanographic data visualization platform developed within Fisheries and Oceans Canada (DFO), Newfoundland and Labrador Region, since 2017. The platform provides intuitive public access to ocean forecast models, in situ observations, and derived products, translating complex, multi-source datasets into actionable information for users from research, operational groups, and the public.

Although selective in scope, the Ocean Navigator addresses many of the core technical and organizational challenges central to Digital Twin of the Ocean (DTO) initiatives. These include integrating heterogeneous data streams from federal departments, academia, and international programs; harmonizing formats and standards; enabling access to near-real-time forecasts and observations; and supporting users with diverse and sometimes competing requirements.

The platform has evolved into a distributed system comprising automated data pipelines, interoperable services, scalable APIs, and cloud-based infrastructure. Adoption of emerging cloud-native technologies and modern data management practices has improved resilience, performance, and extensibility while reducing operational complexity.

This presentation will highlight practical lessons from nearly a decade of operational development, focusing on data interoperability, system architecture, client experience, and cross-departmental collaboration. These experiences demonstrate how development of purpose-driven oceanographic data platforms can inform broader Canadian DTO development, enhance coordination across sectors, and contribute to scalable, interoperable ocean data systems aligned with international efforts.

Session: 3021 Towards development of Canada's Digital Twin of the Ocean: Research, Development and Work Examples - Part 1
Vers le développement du jumeau numérique de l'océan canadien : recherche, développement et exemples de travaux - Partie 1

**03/06/2026
12:42**

ID: 12711 Contributed abstract

CIOOS: Supporting Data Foundations for Canada's Digital Twin of the Ocean

*Anne-Sophie Ste-Marie*¹, *Shayla Fitzsimmons*², *Mathilde Couturier*³,
*Jordan Watson*⁴

¹ Canadian Integrated Ocean Observing System

² CIOOS Atlantic

³ Observatoire global du Saint-Laurent

⁴ CIOOS Pacific

Presented by / Présenté par: *Jessy Barrette*

Contact: anne-sophie.ste-marie@cioos.ca

Digital Twins of the Ocean (DTO) depend on sustained access to high-quality, interoperable, and well-governed ocean observations. The Canadian Integrated Ocean Observing System (CIOOS) plays a foundational role in this ecosystem by providing open, standardized, and nationally coordinated access to ocean data across Canada's three ocean basins.

Since its launch in 2019, CIOOS has matured from a discovery platform into a core component of Canada's ocean data infrastructure, now supporting thousands of datasets from a broad network of government, academic, Indigenous, and community partners. These holdings span historical and

real-time observations and represent key data inputs required for model initialization, validation, and analysis in Digital Twin of the Ocean initiatives.

This presentation provides a 2026 snapshot of CIOOS from a DTO perspective. We highlight recent advances in national coordination, data harmonization, and service development, including emerging applications of artificial intelligence to improve data discovery, classification, and usability.

We also describe how CIOOS is strengthening links with the modelling and AI communities to better align observational data services with the needs of prediction systems, digital twins, and decision-support tools.

Session: 3021 Towards development of Canada's Digital Twin of the Ocean: Research, Development and Work Examples - Part 1 Vers le développement du jumeau numérique de l'océan canadien : recherche, développement et exemples de travaux - Partie 1

**03/06/2026
12:54**

ID: 12627 Contributed abstract

Sea Ice Variability and Predictability on the Labrador and Newfoundland Shelves: Based on Analyses of Multi-Decadal Hindcast with Canada's Three Oceans Model

*Xianmin Hu*¹, *Youyu Lu*², *Li Zhai*³, *Nancy Soontiens*⁴, *Heather Andres*⁵, *Jinyu Sheng*⁶

¹ Department of Oceanography, Dalhousie University; Bedford Institute of Oceanography, Fisheries and Oceans Canada

² Bedford Institute of Oceanography, Fisheries and Oceans Canada

³ Bedford Institute of Oceanography, Fisheries and Oceans Canada

⁴ Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada

⁵ Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada

⁶ Department of Oceanography, Dalhousie University

Presented by / Présenté par: *Xianmin Hu*

Contact: xianmin.hu@gmail.com

Sea ice on the Labrador and Newfoundland Shelves represents the southernmost seasonal extension of polar ice in the western North Atlantic. It forms in early winter, typically beginning in December, reaches its maximum extent in March, and retreats rapidly through late spring. The presence and variability of this ice cover influence regional hydrography, water mass transformation, and ecosystem structure, while also exerting substantial socio economic impacts on navigation, fisheries, offshore operations, and coastal communities.

Based on analyses of a hindcast simulation over 60 years with the Canada's Three Oceans (CTO) model, we quantify the seasonal,

interannual and decadal variations of sea ice in this region, and investigate the forcing mechanisms of the variability that facilitate predictability. We first examine the simulated ice concentration, thickness/volume and quantify the dynamic (advective) and thermodynamic contributions to the regional ice-volume budget. Next, we use the exceptionally low-ice winter of 2010–2011 as a case study to identify the mechanisms driving the extreme anomalies. Building on these diagnostics, we assess key sources of predictability, including upstream sea-ice inflow, large-scale ocean–atmosphere preconditioning, pre-seasonal air temperature anomalies, and the influence of wind forcing throughout the cold season.

Session: 3021 Towards development of Canada's Digital Twin of the Ocean: Research, Development and Work Examples - Part 1 Vers le développement du jumeau numérique de l'océan canadien : recherche, développement et exemples de travaux - Partie 1

**03/06/2026
13:06**

ID: 12803 Contributed abstract

Presenting a real-time ocean acidification and hypoxia monitoring application

*Yayla Sezginer*¹, *Taimaz Bahadory*², *Jordan Watson*³

¹ Canadian Integrated Ocean Observing System

² Canadian Integrated Ocean Observing System

³ Canadian Integrated Ocean Observing System

Presented by / Présenté par: *Yayla Sezginer*

Contact: yayla.sezginer@cioospacific.ca

The coastal waters of British Columbia are warming, acidifying, and losing oxygen as global and regional emissions continue to rise. These changes pose increasing risks to coastal communities, fisheries, aquaculture, and marine ecosystems. In response, the BC Ocean Acidification and Hypoxia (OAH) Action Plan has identified a critical need for accessible, near real-time information on essential ocean variables to support adaptive management and informed decision-making. To meet this demand, the Canadian Integrated Ocean Observing System (CIOOS) Pacific Region is developing an OAH monitoring web-application for interactive data analysis and on-the-go data visualization. The web application integrates an in-situ sensor network with hourly regional ocean model outputs to provide near real-time coverage of seawater pH, dissolved oxygen, temperature, salinity, and aragonite (Ω_{arag}) and calcite (Ω_{calc}) saturation states across multiple depth layers in the Salish Sea and Southern Shelf regions of British Columbia. Beyond real-time conditions, the platform includes historical records, climatological averages, and model evaluations to contextualize anomalies and support operational and policy decisions. Through

collaboration with regional partners, this combination of observations and model simulations in a unified interface contributes toward a regional digital twin framework for coastal ocean monitoring. During this active development phase, we are engaging end-users and data providers to enhance the functionality, interoperability, and reach of the upcoming OAH app.

Session: 3021 Towards development of Canada's Digital Twin of the Ocean: Research, Development and Work Examples - Part 1
Vers le développement du jumeau numérique de l'océan canadien : recherche, développement et exemples de travaux - Partie 1

**03/06/2026
13:18**

ID: 12817 Contributed abstract

Digital Twins of the Ocean as enablers for Safe and Sustainable Maritime Operations

*Floris Goerlandt*¹, *Madhulika Bhati*², *Ronald Pelot*³

¹ Dalhousie University

² Dalhousie University

³ Dalhousie University

Presented by / Présenté par: *Floris Goerlandt*

Contact: floris.goerlandt@dal.ca

Digital Twins of the Ocean (DTOs) are enhancing our understanding and capacity to manage complex ocean systems. DTOs function as virtual representations of the ocean's physical, chemical, and biological properties, drawing on observational data and ocean models to monitor conditions, simulate scenarios, and support decision-making. As maritime activity intensifies, through increased traffic density, offshore energy development, opening of new areas for maritime transport such as the Arctic, and new hazards and threats arising from these, the prospects of integrated and forward-looking approaches to manage these risks becomes more pressing. DTOs can be functionally extended into Digital Twins of Ocean Industries (DTOIs) by incorporating models that represent human activities and engineered systems operating in the marine and ocean environment. Such extensions allow the coupling of environmental dynamics with operational and technical models of human activities. Depending on the management objective, relevant modelling layers may include maritime vessel operability models, Search and Rescue simulation models, underwater noise propagation models, and oil spill drift and fate models. In principle, also representations of human decision-making and organizational performance can be added as modeling layers.

By integrating these layers within a shared computational architecture, DTOIs can enable real-time data assimilation, operational monitoring,

scenario testing, and risk-informed evaluation of both routine operations and low-probability, high-consequence events. This creates opportunities for anticipatory safety management, improved emergency preparedness and response, and more transparent assessment of trade-offs between safety, environmental protection, and economic objectives.

The presentation elaborates the concept of DTOIs in relation to DTOs, and discusses their potential role in advancing safe, resilient, and sustainable maritime operations under conditions of increasing system complexity and uncertainty.

Session 4041 Part1

Convenors:

Michael Morris, University of Toronto

Paul J. Kushner, University of Toronto

Neil Swart, Environment and Climate Change Canada

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 pose barriers to their development, application, and analysis without 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 submissions 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. Areas of interest include atmospheric/ocean model process and parameterization development (including sea-ice modelling), short-lived climate forcers and geoengineering/climate intervention, carbon cycle modelling (including climate change mitigation approaches such as atmospheric carbon dioxide removal), land-surface model development and application, and sea-ice/land-ice modelling. We invite submissions covering 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 continue the discussion concerning challenges and opportunities for collaboration between universities, government laboratories, and the private sector; and the scientific results emerging from such collaborations.

**Session: 4041 Collaborative Earth System Modelling in
Canada - Part 1 Modélisation collaborative du système
Terre au Canada - Partie 1**

**03/06/2026
12:30**

ID: 12789 Invited session speaker

**Coming soon to a computer near you: aerosol microphysics with
PAM**

*Ruth Digby*¹, *Luke Fraser-Leach*², *Knut von Salzen*³

1

2 University of Toronto

3 Canadian Centre for Climate Modelling and Analysis; University of
Washington

Presented by / Présenté par: *Ruth Digby*

Contact: ruth.digby@ec.gc.ca

The Collaborative Platform for CanESM (CP4C) brings the Canadian Earth System Model (CanESM) to Canada's research community. We are delighted to announce that CanESM5.1-PAM is now live on CP4C! PAM is CanESM's advanced aerosol microphysics model and offers many improvements over the default bulk model for those who are interested in aerosol research. This talk will introduce PAM and its many capabilities, and provide inspiration for future projects by highlighting a number of recent research applications.

**Session: 4041 Collaborative Earth System Modelling in
Canada - Part 1 Modélisation collaborative du système
Terre au Canada - Partie 1**

**03/06/2026
12:42**

ID: 12809 Contributed abstract

**The Collaborative Platform for CanESM (CP4C) – Progress in 2025-26
and an Invitation to Participate**

*Michael Morris*¹, *Paul Kushner*², *Neil Swart*³

1 University of Toronto

2 University of Toronto

3 Environment and Climate Change Canada

Presented by / Présenté par: *Michael Morris*

This presentation will summarize our ongoing work on CP4C, which is a computational platform developed in partnership with Environment and Climate Change Canada (ECCC) to enable use of the Canadian Earth System Model (CanESM) in the academic community. In its fifth year of development, CP4C continues to provide reliable resources and access to CanESM for several active earth system modelling projects. A major milestone from this year was extending support for running CanESM to multiple computing platforms across Canadian universities. This talk will highlight the resources available through CP4C and invite the community to make use of them for their research. Other CP4C activities this year include bringing additional model configurations to CP4C, developing usage policies, and hosting training activities. We will discuss these advancements and highlight ongoing research activities within CP4C. Our efforts are continuing to foster collaboration with ECCC in R&D activities focused on CanESM.

**Session: 4041 Collaborative Earth System Modelling in
Canada - Part 1 Modélisation collaborative du système
Terre au Canada - Partie 1**

**03/06/2026
12:54**

ID: 12679 Contributed abstract

**Regional aerosol forcing in coordinated earth system model
experiments**

*Luke Fraser-Leach*¹, *Paul Kushner*², *Neil Swart*³, *Knut von
Salzen*⁴

¹ University of Toronto

² University of Toronto

³ Environment and Climate Change Canada

⁴ University of Washington

Presented by / Présenté par: *Luke Fraser-Leach*

Contact: luke.fraserleach@mail.utoronto.ca

Anthropogenic aerosol forcing will decrease in the coming decades as nations with heavily polluted air act to improve their air quality. The forcing associated with such an aerosol emission reduction is not well quantified, and resulting responses in atmospheric and oceanic circulation are correspondingly uncertain. To better understand and quantify these changes, we have performed a set of simulations with the Canadian Earth System Model (CanESM) in which aerosol emissions are strongly reduced

over the next three decades, following the scenarios defined by the Regional Aerosol Model Intercomparison Project (RAMIP). The output has been submitted to the RAMIP group for publication as part of Coupled Model Intercomparison Project Phase 6 Plus (CMIP6Plus). Here, we present the implementation and verification of the RAMIP scenarios in CanESM, and compare the climate response to RAMIP forcing in CanESM to that in other models. We then use the RAMIP dataset to understand how aerosol emissions from different regions have varying efficiency in forcing a surface temperature response.

Session: 4041 Collaborative Earth System Modelling in Canada - Part 1 Modélisation collaborative du système Terre au Canada - Partie 1

**03/06/2026
13:06**

ID: 12708 Contributed abstract

Extreme Precipitation Events in CanAM: (In)sensitivity Experiments on the Relative Importance of Resolved vs. Parameterized Rainfall

*Adam Morgan*¹, *Neil Tandon*²

¹ York University

² York University

Presented by / Présenté par: *Adam Morgan*

Contact: agmorgan@my.yorku.ca

Extreme precipitation events (EPEs) are expected to become more frequent and severe as our planet warms. In the interest of flood-resilient infrastructure planning, Earth system models should be able to robustly describe the general features of EPEs in a changing climate. However, in 2024 Ali and Tandon [doi.org/10.1029/2023JD040146] showed that many models strongly over-represent the contribution of resolved precipitation, rather than parameterized (convective) precipitation, to EPEs. The presence of this “precipitation partitioning” issue even in high-resolution models suggests that the parameterization of convection plays a key role in obtaining reliable simulations of EPEs. In this talk, we will discuss some recent experiments with the Canadian Atmosphere Model (CanAM) version 5.1 aimed at quantifying the sensitivity of precipitation partitioning during EPEs to the parameters of the convective closure scheme. While CanAM’s partitioning of annual mean precipitation in the tropics is known to exhibit strong dependence on closure parameters, we will show that the partitioning for tropical EPEs is nearly constant as the closure parameters vary over several orders of magnitude. From there, we discuss some potential explanations for this insensitivity: in particular, we’ll address whether strong surface pressure gradients may be causing the over-representation of resolved precipitation in EPEs. Time-permitting, we’ll outline a tentative

program for repeating our experiments on atmospheric models other than CanAM.

**Session: 4041 Collaborative Earth System Modelling in
Canada - Part 1 Modélisation collaborative du système
Terre au Canada - Partie 1**

**03/06/2026
13:18**

ID: 12801 Contributed abstract

**HAWC-SEC: The Canadian Space Agency's (CSA) High Altitude Water-
vapour and Clouds (HAWC) mission Sampler and Emulator for the
Canadian Earth System Model, CanESM**

*Paul Kushner*¹ , *Michael Morris*² , *Jason Cole*³ , *Kaley Walker*⁴ ,
*Matthew Toohey*⁵ , *Neil Swart*⁶

¹ University of Toronto

² University of Toronto

³ ECCC

⁴ University of Toronto

⁵ University of Saskatchewan

⁶ ECCC

Presented by / Présenté par: *Paul Kushner*

Contact: paul.kushner@utoronto.ca

Observational simulators in Earth System Models (ESMs) mimic instrument sampling to enable like-for-like comparison of model fields against satellite and sub-orbital remote sensing products. Simulators enable satellite and sub-orbital observations to be effectively used in the development of ESMs' physical parameterizations of clouds, aerosols, and cloud-aerosol-radiative interactions. In this presentation, we will outline plans for "HAWC-SEC", the Canadian Space Agency's (CSA) High Altitude Water-vapour and Clouds (HAWC) mission Sampler and Emulator for the Canadian Earth System Model, CanESM. This project has recently received three years of support from CSA through the research opportunities in HAWC suborbital, science, and application development activities (ROHSSA) funding stream.

HAWC-SEC will realize the potential of like-for-like model/remote-sensing comparisons by developing satellite, suborbital, and site samplers for CanESM, implementing current emulator work from the HAWC instrument development teams into CanESM, and exploring parametrization applications with CanESM, all in support of HAWC space-based and sub-orbital science. A well-documented and extensible HAWC-SEC application programming interface with good training will greatly increase Canadian

capacity in space science applications for earth observations. The presentation will invite broad participation and discussion of paths forward for this community project.

Session 5052 Part 2

Convenors:

Kaley Walker, University of Toronto

Adam Bourassa, University of Saskatchewan

Satellite Earth observation (SEO) provides a unique global perspective on our planet's atmosphere and surface, including the oceans, land, vegetation, ice, and snow. Current and planned satellite missions from Canada and international agencies have provided and will provide a wealth of new information about the Earth system and that can be used to investigate a wide range of environmental and scientific questions.

This session encourages contributions from across the full SEO value chain, upstream, midstream and downstream, to illustrate the activities currently underway in Canada, involving industry, academia and government. This includes new measurement technologies and techniques, both passive and active; mission development; 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.

Session: 5052 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 2
Observation de la Terre par satellite : une vue unique de notre planète et un besoin essentiel pour naviguer vers notre avenir - Partie 2

**03/06/2026
12:30**

ID: 12689 Contributed abstract

A 25-year review of the performance and operation of MOPITT

*Paul Jeffery*¹, *James R. Drummond*², *Jiansheng Zou*³, *Kaley A. Walker*⁴

¹ University of Toronto

² Dalhousie University

³ University of Toronto

⁴ University of Toronto

Presented by / Présenté par: *Paul Jeffery*

Contact: paul.jeffery@mail.utoronto.ca

Launched in December 1999 aboard National Aeronautics and Space Administration's (NASA's) Terra satellite, the Measurements Of Pollution In The Troposphere (MOPITT) instrument began routine operations in March 2000. Designed to continuously monitor carbon monoxide (CO) globally, MOPITT was a nadir-viewing correlation radiometer that measured upwelling infrared radiation. Employing both length modulator cells (LMCs) and pressure modulator cells (PMCs), MOPITT was capable of producing both CO profile and column estimates. The mission was originally intended to operate for five years, but it remained operational for over two decades, with MOPITT generating the longest global record of CO in history. After more than 25 years in orbit, Terra's power limitations necessitated turning off MOPITT in April 2025, bringing the mission to an end.

In this presentation, we will review the performance of MOPITT's major subsystems over its lifetime. Core subsystems include cryocoolers, LMCs, PMCs, and detectors. We will demonstrate how these systems supported MOPITT's long-term success and the lessons that can be learned from its design.

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 satellite is funded and operated by NASA, and the Canadian Space Agency funds the MOPITT instrument and operations.

Session: 5052 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 2
Observation de la Terre par satellite : une vue unique de notre planète et un besoin essentiel pour naviguer vers notre avenir - Partie 2 03/06/2026
12:42

ID: 12735 Contributed abstract

Highlights of Validation and Science from the Canadian Atmospheric Chemistry Experiment

*Kaley Walker*¹, *Paul S. Jeffery*², *Laura N. Saunders*³, *Patrick E. Sheese*⁴, *Jiansheng Zou*⁵

¹ University of Toronto

² University of Toronto

³ University of Toronto

⁴ University of Toronto

⁵ University of Toronto

Presented by / Présenté par: *Kaley Walker*
Contact: kwalker@atmosp.physics.utoronto.ca

Since February 2004, the Canadian-led Atmospheric Chemistry Experiment (ACE) mission on board the SCISAT satellite has been making routine measurements of the Earth's atmosphere. 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: 5052 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 2
Observation de la Terre par satellite : une vue unique de notre planète et un besoin essentiel pour naviguer vers notre avenir - Partie 2

03/06/2026
12:54

ID: 12752 **Contributed abstract**

Characterization of MAESTRO Aerosol Extinction Measurements

*Jiansheng Zou*¹, *C. Thomas McElroy*², *James Drummond*³, *Kaley Walker*⁴, *Paul Jeffrey*⁵

¹ University of Toronto

² York University

³ Dalhousie University

⁴ University of Toronto

⁵ University of Toronto

Presented by / Présenté par: *Jiansheng Zou*

MAESTRO (Measurement of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation) is a dual UV (ultraviolet) and Visible-NIR (visible-near-infrared) spectrometer aboard the Canadian satellite SciSat and has operated nominally for more than 22 years. Recently, MAESTRO version 4.5 NO₂ and O₃ volume-mixing-ratio profile data were released; however, the aerosol extinction product is still under development. An initial assessment of the MAESTRO aerosol data showed that aerosol extinction is overestimated compared with measurements from other instruments, such as the ACE Imagers, SAGE III/M3M, and SAGE III/ISS. To investigate this issue, MAESTRO Level 1 transmittance data were compared with transmittances derived from those instruments. The results show that MAESTRO transmittance data are generally underestimated, particularly at low altitudes (< 20 km). The discrepancies depend on both altitude and wavelength: the lower the altitude, the larger the difference; and the shorter the wavelength, the larger the difference. To identify the root cause, the projected positions of the MAESTRO slits on the solar disk during occultations were analyzed. The analysis shows that the slits shift towards the lower boundary of the solar disk during sunset events. The gradual displacement of the incoming irradiance source away from the sun centre is a major factor contributing to the underestimation of MAESTRO transmittances and, consequently, to the overestimation of aerosol extinction. This will allow us to better understand and characterize the MAESTRO aerosol data in preparation for their future release. The Canadian Space Agency funds MAESTRO and the SciSat satellite.

Session: 5052 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 2 Observation de la Terre par satellite : une vue unique de notre planète et un besoin essentiel pour naviguer vers notre avenir - Partie 2

**03/06/2026
13:06**

ID: 12819 Contributed abstract

Comparison of v5.3 ACE-FTS CO₂, CH₄, and N₂O data with in situ balloon-borne and aircraft measurements

*Stephanie Gu*¹, *Kaley Walker*², *Laura Saunders*³, *Bianca Baier*⁴, *Christoph Gerbig*⁵, *Olivier Membrive*⁶, *Steven Wofsy*⁷

¹ University of Toronto

² University of Toronto

³ University of Toronto

⁴ NOAA Global Monitoring Laboratory

⁵ Max Planck Institute for Biogeochemistry

⁶ Meteo France

Presented by / Présenté par: *Stephanie Gu*

Contact: stephanie.gu@mail.utoronto.ca

Long-lived greenhouse gases such as carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) have significant global warming potentials. Measurements of these gases are essential for monitoring the climate and understanding long-term trends, as well as for initializing and evaluating chemistry-climate models. The Atmospheric Chemistry Experiment Fourier Transform Spectrometer (ACE-FTS) is a high-spectral-resolution infrared spectrometer onboard the Canadian satellite SCISAT. For over two decades, ACE-FTS has been providing altitude-resolved profiles of dozens of atmospheric constituents, including CO₂, CH₄, and N₂O. It is essential to assess the quality of satellite data products and quantify biases through comparisons with complementary measurements, including those from in situ sensors. This presentation will discuss results from comparisons between v5.3 ACE-FTS CO₂, CH₄, and N₂O data with correlative balloon-borne (AirCore) and aircraft (CARIBIC, HIPPO, ATom) measurements in the upper troposphere and lower stratosphere. ACE-FTS CO₂ agrees with all four comparison datasets within 6% but exhibits an altitude-dependent bias. ACE-FTS is biased low at 7.5 km, and above 8 km, ACE-FTS is consistently biased high, with the largest bias observed in the tropopause region. ACE-FTS CH₄ generally agrees well (within 4%) with all four comparison datasets, and no apparent systematic biases were noted. ACE-FTS N₂O was found to agree well (within 5%) with measurements from HIPPO-QCLS and ATom-QCLS.

Session: 5052 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 2 Observation de la Terre par satellite : une vue unique de notre planète et un besoin essentiel pour naviguer vers notre avenir - Partie 2

03/06/2026
13:18

ID: 12859 Contributed abstract

Investigating the Natural Variability of Water Vapour in the UTLS for Satellite Comparisons

*Han Szeptycki*¹, *Kaley Walker*²

¹

² University of Toronto

Presented by / Présenté par: *Han Szeptycki*

Contact: han.szeptycki@mail.utoronto.ca

Validation is an important part of any satellite mission, often done by direct comparison with well-established measurements. It is necessary to be able to understand how various factors will contribute to differences between the measurements, so that one can properly assess the data quality of the instrument being validated. One important factor is natural variability, which describes the differences between coincident measurements of a trace gas that are due to the “mismatch” in the state of the atmosphere at the different times or locations. Building off previous work that has been done to quantify the natural variability of trace gases in the stratosphere (Sheese et al., 2021; Laeng et al., 2022), this project aims to investigate the natural variability of water vapour in the upper troposphere and lower stratosphere (UTLS). This work will inform future comparison studies that will be done for the SHOW (Spatial Heterodyne Observations for Water) instrument as part of HAWC (High-altitude Aerosols, Water vapour and Clouds), an upcoming Canadian satellite mission. Using the HAWC orbital simulator, a series of synthetic measurements are generated, and model simulations are sampled at the locations and vertical levels of the synthetic measurement. The Nature Run Collection is a 7 km global mesoscale simulation run with the NASA Goddard Earth Observing System Model (GEOS-5). This 2-year simulation provides a high resolution picture of water vapour in the atmosphere, capturing scales of variability relevant for the SHOW measurements. By sampling this model, the natural variability of the water vapour is calculated for a range of spatial and temporal distances from SHOW measurement locations, and evaluated for different seasons, latitude bands and altitudes. Developing a better understanding of the variability of water vapour in the UTLS will help inform future suborbital campaigns and comparison studies for the HAWC satellite mission.

Session 2010

Convenors:

Tamar Richards-Thomas (University of Regina)

Stephen Déry (University of Northern British Columbia)

Atmospheric rivers are becoming more frequent, intense and impactful, in a warmer world, serving as major contributors to extreme weather and hydrological events. This trend highlights the need for a comprehensive and enhanced scientific understanding of these phenomena. However, the complex atmospheric-oceanic interactions that shape atmospheric river evolution, formation, and landfall can introduce considerable uncertainty in predicting their outcomes.

This session examines the dynamics, potential predictability, and emerging solutions designed to understand atmospheric river hazards. Discussions will include the dynamical mechanisms, such as large-scale circulation patterns, moisture transport processes, and orographic influences, that drive the evolution and strength of atmospheric rivers and compound the effects of natural hazards.

The prediction and risk management of atmospheric rivers present unique

challenges due to their complex dynamics interconnected with hydrological responses, meteorological processes, and climate change. This session will also address the strengths and limitations of current forecasting efforts and tools, explore sources of uncertainty, and challenges in translating atmospheric predictions into actionable decision-making strategies for water management resources, flood preparedness, and hazard mitigation.

Session: 2010 Dynamics and Impacts of Atmospheric Rivers: Challenges and Solutions for Prediction and Risk Management
Dynamique et impacts des rivières atmosphériques : défis et solutions pour la prévision et la gestion des risques

**03/06/2026
13:50**

ID: 12626 Contributed abstract

EDARA and S-EDARA: Comprehensive Datasets for Atmospheric River Detection and Impact Assessment

*Ruping Mo*¹

1

Presented by / Présenté par: *Ruping Mo*

Contact: ruping.mo@ec.gc.ca

Atmospheric rivers (ARs) are critical components of the global water cycle, responsible for extreme precipitation events and significant hydrological impacts. We present EDARA (ERA5-based Dataset for Atmospheric River Analysis), a high-resolution spatiotemporal dataset that employs a novel detection algorithm to identify and characterize ARs globally. Built upon the ERA5 reanalysis, EDARA provides enhanced spatial and temporal resolution compared to existing AR datasets, enabling detailed climatological analysis and revealing new insights into AR frequency, intensity, and lifecycle characteristics.

To facilitate comprehensive impact assessment, we introduce S-EDARA (Supplement to EDARA for Impact Assessment), which augments the original dataset with crucial impact-related variables including precipitation, surface winds, and other hazard metrics associated with AR events. This supplementary dataset bridges the gap between AR detection and quantitative impact evaluation, enabling researchers to directly link atmospheric river characteristics to their environmental and societal consequences.

Together, EDARA (<https://doi.org/10.1038/s41597-024-03679-1>) and S-EDARA (<https://doi.org/10.3390/data11020036>) provide the climate research community with an integrated framework for investigating AR dynamics and their impacts across multiple scales. The datasets support

diverse applications including extreme event attribution, climate model validation, water resource planning, and understanding AR variability under changing climate conditions. The combination of improved detection methodology and impact-relevant variables positions these datasets as valuable tools for advancing our understanding of atmospheric rivers and their role in the Earth system.

Session: 2010 Dynamics and Impacts of Atmospheric Rivers: Challenges and Solutions for Prediction and Risk Management
Dynamique et impacts des rivières atmosphériques : défis et solutions pour la prévision et la gestion des risques

**03/06/2026
14:02**

ID: 12721 Contributed abstract

Atmospheric River Event Over Southwestern BC - December 2025

*Ken Dosanjh*¹

¹ ECCC - MSC - PSD-West

Presented by / Présenté par: *Ken Dosanjh*

Contact: baljit.sekhon@ec.gc.ca

A strong and persistent atmospheric river (AR) event impacted southwestern British Columbia between December 8–10, 2025, resulting in prolonged heavy rainfall, flooding, and significant infrastructure disruption. The presentation looks at the synoptic meteorological conditions, hydrological data, and observed impacts from the event. Antecedent conditions included below-normal precipitation in November, followed by rapid basin saturation in early December, preconditioning the region for enhanced runoff efficiency. The AR comprised two main pulses, delivering up to 185.6 mm of rain at Hope Airport and freezing levels exceeding 2000 m, promoting extensive rain-on-snow processes and snowmelt. Multiple rivers across the Fraser Valley and southwestern interior reached or surpassed 20-year peak flow return periods, with the Pasayten River recording a 50–100-year event. Major highways sustained extensive damage from flooding, debris flows, and landslides, while agricultural and low-lying areas suffered losses to livestock and property. Emergency declarations and evacuations occurred across affected communities. The analysis discusses the meteorological drivers, hydrologic responses, and mitigation challenges posed by AR events.

Session: 2010 Dynamics and Impacts of Atmospheric Rivers: Challenges and Solutions for Prediction and Risk Management
Dynamique et impacts des rivières atmosphériques : défis et solutions pour la prévision et

**03/06/2026
14:14**

Characteristics of three flood events generated by landfalling atmospheric rivers in British Columbia since 2021

*Duane Darren Noel*¹, *Stephen Déry*², *Pascale Biron*³, *Jeannine-Marie St-Jacques*⁴

¹ Concordia University

² University of Northern British Columbia

³ Concordia University

⁴ Concordia University

Presented by / Présenté par: *Duane Darren Noel*

Contact: duane.noel@mail.concordia.ca

Flood frequencies have increased substantially worldwide, creating significant challenges for governments and stakeholders. Western Canada recently faced several destructive floods, most notably in southwestern British Columbia (BC) in November 2021 where a 100-year flood caused insured damages exceeding \$675 million. In BC, intense rainfall and rain-on-snow (ROS) events are factors in generating floods. However, recent atmospheric river (AR) events suggest that precipitation from ARs may intensify flood generating mechanisms. Here, we examined characteristics of the November 2021, October 2024 and December 2025 floods in southwestern BC and northern Washington. We computed the integrated water vapour transport (IVT) to detect ARs making landfall at Vancouver Island (49°N, 125°W). Then, we compared peak daily streamflow timing to ROS frequencies (≥ 10 mm snow water equivalent, ≥ 10 mm rainfall, and $> 1^\circ\text{C}$ surface air temperature) and runoff rates during AR landfall to determine ARs' contribution to flooding. November 2021 and December 2025 floods were driven by successive AR events, resulting in ROS events exceeding 40% frequency during AR category 3 (November 2021) and AR category 4 (December 2025) landfall. Fewer ROS events occurred during AR category 4 landfall in October 2024, suggesting that these floods were rainfall-induced. Furthermore, we compared the distributions of total precipitation, surface runoff, and surface air temperature using Mann-Whitney U test to detect distribution changes among flood events. November 2021 and October 2024 floods had significant differences in total precipitation and surface air temperature distributions ($p < 0.05$). October 2024 and December 2025 floods had similar results ($p < 0.05$). These results show that successive AR events can induce floods by excessive rainfall, and by triggering more frequent ROS events leading to rapid snowmelt and surface runoff. Without monitoring of large-scale atmospheric systems and antecedent climate conditions, communities will remain at risk for flooding in a changing climate.

ID: 12767 Contributed abstract

Atmospheric River Dynamics: What Can Water Vapor Age Tell Us About the Moisture Transport Leading to Extreme Precipitation

*Philippe Boulanger*¹, *Robert Fajber*²

¹ McGill University

² McGill University

Presented by / Présenté par: *Philippe Boulanger*

Contact: philippe.boulanger@mail.mcgill.ca

Atmospheric rivers (ARs) are thought to drive extreme precipitation in the northern extratropics. They are associated with violent weather and high precipitation that can lead to floods in populous coastal areas. Moreover, their frequency and intensity is expected to increase with climate change. An important question about ARs is whether they are being supplied primarily from remote subtropical regions, or whether they are recycling water vapor by evaporating and precipitating as they travel northward. This would help, for example, understand the necessary physics to capture AR dynamics in climate models.

In a previous paper, we implemented water vapor (WV) age tracers in a global circulation model to resolve the WV age spectrum and the age of precipitation in both space and time. In this study, we use our novel tracers to test how the mean WV age and the mean age of precipitation can be used to investigate the dynamics behind ARs. We use column integrated water vapor (CWV) wave activity and precipitation (Lu et al., 2017) to track AR features, and show that the mean WV age at the surface and the mean age of precipitation is well correlated to CWV wave activity in wintertime extreme precipitation events over the North Atlantic and Pacific. This result, combined with composite images and an estimated advective time scale from the subtropics, can show how during winter, long range moisture transport by ARs, raises the age of precipitation and surface WV age above seasonal average.

In summary, our results show how our tracers of WV age, which could be implemented relatively simply into more complex climate models, give us a new straightforward tool to analyse the lengthscale WV travels in the atmosphere, helping us understand the dynamics behind WV transport, and its impact on the water cycle with climate change.

ID: 12644 **Contributed abstract**

Beyond Plumes: Diverse Atmospheric Rivers and Hydrologic Risk in the Fraser River Basin

*Tamar Richards-Thomas*¹, *Aseem Sharma*², *Stephen Déry*³

¹ Geography and Environmental Studies, University of Regina, Regina, Saskatchewan, Canada

² Future Forest Ecosystems Centre, Forest Ecosystems and Analytics Branch, BC Ministry of Forests, Kamloops, British Columbia, Canada

³ Geography, Earth and Environmental Sciences, University of Northern British Columbia, Prince George, British Columbia, Canada

Presented by / Présenté par: *Tamar Richards-Thomas*

Contact: tamar.richards-thomas@uregina.ca

Atmospheric Rivers (ARs) are concentrated moisture plumes that transport intense water vapor from the North Pacific Ocean to British Columbia's (BC's) coast. During landfall, this moisture penetrates inland to major watersheds, including the Fraser River Basin (FRB). The FRB is Canada's fifth largest watershed, covering approximately 240,000 km², where two-thirds of BC's population resides. This study selected 18 ARs from the Scripps Institution of Oceanography Reanalysis One Atmospheric River (SIO-R1 AR) catalogue, including BC's costliest natural disaster, the mid-November 2021 flood event. This study aims to develop a comprehensive system for categorizing ARs, using three key factors: flavour (e.g., wet, windy, and both), landfall location, and season along with key hydrometeorological impacts that influence the FRB's hydrology.

Seven cool-windy ARs are characterized by strong integrated horizontal winds ($IV > 8 \times 10^4 \text{ kg m}^{-1} \text{ s}^{-1}$) and low integrated water vapour ($IWV < 20 \text{ kg m}^{-2}$). Conversely, seven warm-moist ARs exhibit higher IWV ($> 20 \text{ kg m}^{-2}$) and weaker winds, while four ARs exhibit both high moisture ($20 < IWV < 40 \text{ kg m}^{-2}$) and strong windy ($IV \approx 0.8\text{--}1.2 \times 10^5 \text{ kg m}^{-1} \text{ s}^{-1}$). Warm-moist ARs have record high river discharge percentiles (90th–100th) despite minimal precipitation, on average ($< 20 \text{ mm}$), driven by elevated 2-m air temperature (up to 20 °C) and intense snowmelt (up to 60 mm) in the Coast and Rocky Mountains. Cool-windy ARs can centuple mountain snow water equivalent with limited snowmelt than wet ARs, thereby impacting hydrology and various ecosystems. Understanding the ARs' diverse characteristics is critical for improving hazard forecasting and

strengthening climate resilience and water resources within specific watersheds.

Session 2022 Part 2

Convenors:

Simon-Philippe Breton, Canadian Meteorological Center, ECCC

Vikram Khade, Canadian Meteorological Center, ECCC

We invite the meteorological community to contribute to an exciting session on the integration of Artificial Intelligence (AI) into meteorology. This session aims to explore how AI, in particular machine learning (AI/ML) and high performance computing, is revolutionising modern meteorology.

Potential topics:

- Data-driven modelling in meteorology: Examples of fully data-driven models offering new insights into the understanding of meteorological phenomena.
- Hybridization of models: Fusion of data-driven approaches and traditional physical models for more accurate and robust weather forecasting.
- AI/ML for nowcasting: Innovation in very short-term forecasting, using AI to improve the speed and accuracy of forecasts.
- Improvements in S2S forecasting: Use of innovative statistical methods and AI/ML to refine sub-seasonal to seasonal predictions.
- Operationalisation of AI/ML: Discussion on how to make AI/ML technologies more accessible and useful for daily weather forecasting and decision support.
- Ethical and responsible AI: Importance of developing and using AI ethically and responsibly in meteorological research.
- Improving AI Literacy: Encouraging AI adoption by improving AI understanding and skills within the meteorological community.
- AI/ML in data assimilation : Use of AI/ML to augment/replace components of data assimilation systems (4DVar, EnVar, Ensemble based DA etc.)
- AI/ML applications in climate and environmental sciences : Use of AI/ML in climate projections, estimation of green house gases and climate change, climate change mitigation strategies, environmental impact/adaptation, policy formulations.
- AI applications in renewable energies : Use of AI/ML to improve forecasts for renewable energies.

In order to align this session with the “Navigating Uncertainty” theme of the conference, we encourage presentations that demonstrate how artificial intelligence can be used to characterize, quantify, or manage uncertainty in the context of measurements, forecasts, and projections in meteorology and climatology. Contributions that illustrate the application of AI to monitoring, reducing, or communicating uncertainty, as well as interdisciplinary approaches—including those integrating social sciences—are welcome.

ID: 12720 Contributed abstract

Using Computer Vision for Present Weather Detection from Highway and Airport Cameras

*Sean Eugene Chua*¹, *Robert Crawford*², *Dominique Brunet*³

1

2

3

Presented by / Présenté par: *Sean Eugene Chua*

Contact: Dominique.Brunet@ec.gc.ca

Accurate real-time monitoring of present weather is fundamental for the safety and efficiency of aviation and ground transportation. Human Weather Observation Systems (HWOS), which depend on trained observers stationed at airports, remain the gold standard for measuring precipitation type and fog occurrence. However, HWOS coverage is highly sparse, with observers present at only a limited number of airports. Automated Weather Observation Systems (AWOS), equipped with present weather and visibility sensors, are distributed at over 100 sites across Canada but still lack the coverage required by weather forecasters. To supplement these gaps, Environment and Climate Change Canada's weather forecasters rely on remote webcam networks positioned along highways and at airports; however, relying on human forecasters to manually monitor and review several thousands of individual image feeds for changing weather conditions is labor-intensive and operationally inefficient. This work proposes a computer vision pipeline designed to automate the visual identification of present weather conditions, such as precipitation types and low visibility, directly from existing highway and airport cameras. As a first step, we developed a ResNet architecture trained on a dataset of NavCanada cameras co-located with manual Meteorological Aerodrome Reports (METAR) to detect rain, snow, or clear conditions. To ensure robust performance, we conducted a series of validation experiments on different camera networks. We then expanded our work by re-training the ResNet architecture for different present weather conditions, while augmenting the raw image inputs with ancillary information from automated surface weather stations. By extracting meteorological information from raw images, our system reduces the need for time-consuming manual review of images and offers a fast, automated, and cost-effective way to flag locations with potentially interesting weather conditions.

ID: 12757 Contributed abstract

On the Completion of AI-Based Weather Models

*Antonin Paquette-Rufiange*¹, *Julie Carreau*²

¹ Polytechnique Montréal

² Polytechnique Montréal

Presented by / Présenté par: *Antonin Paquette-Rufiange*

Contact: antonin.paquette-rufiange@polymtl.ca

Numerical weather prediction (NWP) aims to predict the state of the atmosphere as accurately as possible, providing both weather forecasts and climate projections. A well-known limitation of NWP models is their high computational demand, which requires access to powerful and expensive supercomputers. Recently, a significant shift is occurring in weather forecasting, driven by advancements in artificial intelligence (AI).

Given their key advantages, such as high accuracy for large-scale phenomena and storm trajectories, as well as extremely fast forecast computation, AI-based weather forecasting models cannot be dismissed as a passing trend. However, these models also have some limitations. In addition to lacking physical consistency, they provide a limited range of meteorological variables (e.g., precipitation may be unavailable or insufficiently accurate), which restricts their use in regular weather service offerings. We consider the meteorological variables predicted by AI emulators as the primary variables (e.g. temperature and geopotential at specific levels). The meteorological variables of interest not predicted by these AI emulators are coined secondary variables (e.g. dew-point temperature and total cloud cover).

In this presentation, we explore the possibility to recover the secondary variables from the primary variables via simple and parsimonious data-driven models. To this end, we develop nodal models trained on subsets of the ERA5 dataset. The generalization capacities of the model are assessed via:

- An analysis of the errors and their spatio-temporal correlation;
- The computation of the Structural Similarity Image Metric (SSIM) and Power Density Spectrum;
- A sensitivity analysis of the secondary variables to identify the relevant primary variables

These analyses reveal that some secondary variables can be accurately

recovered via our simple proposed approach, whereas some are significantly smoothed. The presence of strong spatial correlations in the errors indicate the necessity to consider spatial models. Finally, the sensitivity analysis demonstrates that only a handful of primary variables are important to predict the considered secondary variables. These findings provide some guidelines for the development of operational AI-based weather emulators.

Session: 2022 Advances and applications of artificial intelligence in meteorology - Part 2 Progrès et applications de l'intelligence artificielle en météorologie - 03/06/2026
Partie 2 14:14

ID: 12746 Contributed abstract

Two-decade spatiotemporal variations in ground-level ozone over Ontario, Canada

*Zhou Zang*¹, *Jane Liu*², *Erjia Ge*³, *Yi Zhang*⁴

¹ Department of Geography and Planning, University of Toronto

² Department of Geography and Planning, University of Toronto

³ Dalla Lana School of Public Health, University of Toronto

⁴ Department of Geography and Planning, University of Toronto

Presented by / Présenté par: *Zhou Zang*

Contact: joey.zang@mail.utoronto.ca

Ground-level ozone (O₃) remains a persistent air quality concern in Ontario, Canada's most populous province. To investigate the long-term trend and spatially explicit details of O₃ concentrations over Ontario, here we construct a dataset of maximum daily 8-hour average O₃ (MDA8 O₃) at high spatial and temporal resolutions (daily, 10 km) over 2004-2023, through development of a two-step model facilitated by machine learning technology. In the model development, we hypothesized and realized that accounting for transboundary influences can enhance the accuracy of O₃ estimation in Ontario. Validation against in-situ measurements confirmed the hypothesized high accuracy of the dataset (R²= 0.82, RMSE = 4.99 ppb), outperforming the traditional model and two existing datasets. The dataset reveals pronounced spatiotemporal heterogeneity in surface MDA8 O₃ concentration, which is low in northern Ontario but high in southern Ontario, especially in southwest Ontario. Seasonally, the provincial mean MDA8 O₃ is in a peak in spring and in a trough in autumn, while the summertime MDA8 O₃ in southwestern Ontario can be even higher, suggesting regional differences in the dominant O₃ sources. From 2004 to 2023, MDA8 O₃ shows no significant trend in the entire Ontario but a significantly (-0.1 ppb/year, p<0.05) across southern Ontario, over where, there is a clear seasonal contrast in MDA8 O₃ trend that significantly

increases in winter but decreases in summer. Our analysis suggests that in summer, reductions in local O₃ precursor emissions have effectively lowered O₃ across southern Ontario, which partially offsets the meteorological-driven increase in O₃. Furthermore, the days exceeding the World Health Organization (WHO) O₃ guideline range from 10-80 days in southern Ontario, with a frequency decreased by 1-4 days (up to 15%) per year over 2004-2023. This MDA8 O₃ dataset offers a valuable resource for further research in environmental health, air quality, and O₃ impact on agriculture.

**Session: 2022 Advances and applications of artificial intelligence in meteorology - Part 2 Progrès et applications de l'intelligence artificielle en météorologie - 03/06/2026
Partie 2 14:26**

ID: 12660 Contributed abstract

Is Indigenous Modelling a reference for the descriptive statistical model?

*Rick Danielson*¹

¹ Fisheries and Oceans Canada

Presented by / Présenté par: *Rick Danielson*

Contact: rick.danielson@dfo-mpo.gc.ca

Regardless of the precise mathematical definition of a model (McCullagh 2002), Hand (1996) offers the distinction between mechanistic models that seek to represent empirical phenomena and models that seek merely to describe. Rosen (1993) claims that excellent mathematics is sometimes attached to impoverished mechanistic models. Perhaps the computational limits of mechanistic Earth System modelling is an example (Balaji 2021), where ecosystems may be difficult to include. Rosen also notes that modelling is sometimes patterned on extant mathematics, but is there a reference for the descriptive model of statistics? Perhaps we have not identified its mathematical expression, but Bartlett et al. (2012) offer Two-Eyed Seeing as a way to advance ecological Earth System science. We ask if Two-Eyed Seeing is also a well established Indigenous reference for the descriptive statistical model.

Balaji, V.: Climbing down Charney's ladder: machine learning and the post-Dennard era of computational climate science. *Phil. Trans. Roy. Soc. A* 379, 1-14 (2021) <https://doi.org/10.1098/rsta.2020.0085>

Bartlett, C., Marshall, M., Marshall, A.: Two-Eyed Seeing and other lessons learned within a co-learning journey of bringing together Indigenous and mainstream knowledges and ways of knowing. *J. Environ. Stud. Sci.* 2, 331–340 (2012) <https://doi.org/10.1007/s13412-012-0086-8>

Hand, D.J.: Statistics and the theory of measurement. J. Royal Statist. Soc. Series A: Statistics in Society 159, 445-473 (1996)
<https://doi.org/10.2307/2983326>
McCullagh, P.: What is a statistical model? Ann. Stat. 30, 1255-1310 (2002)
<https://doi.org/10.1214/aos/1035844977>
Rosen, R.: On models and modeling. Appl. Math. Comp. 56, 359-372 (1993) [https://doi.org/10.1016/0096-3003\(93\)90128-2](https://doi.org/10.1016/0096-3003(93)90128-2)

Session 3022 Part 2

Convenors:

Nancy Soontiens, Fisheries and Oceans Canada
Guoqi Han, Fisheries and Oceans Canada
Youyu Lu, Fisheries and Oceans Canada
Hui Shen, Fisheries and Oceans Canada
Di Wan, Fisheries and Oceans Canada
Floris Goerlandt, Dalhousie University

Digital Twins of the Ocean (DTO) has emerged as a framework to provide a virtual representation of the real ocean for effective monitoring, predicting, and managing complex marine systems, in applications such as fishery and ecosystem protection and management, safe navigation, search and rescue, and climate change adaptation. Internationally, there are fast progresses in all aspects of DTO development, including the various activities under the United Nations Decade of Ocean Science for Sustainable Development. In Canada, there is a tremendous amount of activity relevant to DTO development, including ocean observations, modelling, prediction, analyses, data management, etc. These activities spread among government departments, academia, and the private sector. To be successful in building DTO for oceans around Canada, there are imminent needs to enhance the knowledge and technology exchanges, coordination and collaboration among management and researchers in various organizations and also with the international community. To this end, this session aims to bring together national and international researchers and managers to 1) share the client needs and plans of relevant projects and activities; 2) review existing resources and challenges (data, models, technology and knowledge); 3) present achievements in research and development, and showcase examples; and 4) discuss collaboration opportunities.

**Session: 3022 Towards development of Canada's
Digital Twin of the Ocean: Research, Development and
Work Examples - Part 2 Vers le développement du
jumeau numérique de l'océan canadien : recherche,
développement et exemples de travaux - Partie 2**

**03/06/2026
13:50**

ID: 12777 Contributed abstract

Towards Digital Twin of the Ocean for Marine Conservation off east

coast of Canada

Hui Shen ¹ , Gordana Lazin ² , Patrick Upson ³ , Michael Casey ⁴ , Rémi Daigle ⁵ , Youyu Lu ⁶

¹ DFO Maritimes Science

² DFO Maritimes Science

³ DFO Maritimes Science

⁴ DFO Maritimes Science

⁵ DFO Maritimes Science

⁶ DFO Maritimes Science

Presented by / Présenté par: *Hui Shen*

Contact: Hui.Shen@dfo-mpo.gc.ca

Canada's marine conservation target includes a number of marine protected areas, ecological significant areas, marine refugees etc. It is a complex network, and there are various challenges and knowledge gaps for efficient management. By applying the digital twin concept, we report on the recent development of a Digital Twin of the Ocean (DTO) off east coast of Canada, for marine conservation, a platform developed to provide tools and capabilities to connect oceanographers with biologists, to extract data for information, to compile information for decision making. The platform enables ocean state reporting (baseline, variations, extremes, and future changes) in the Marine Conservation Areas. It also enables network comparison among MPAs, which helps decision-making on prioritization of monitoring efforts. Technically, it is a data wrangling platform which enables data pipeline (ocean modelling products, observations), data analysis, visualization, and information extraction. It connects ocean data products with state-of-the-art data analysis method, generating informative indicators for the reporting of oceanographic conditions within marine protected areas. Further development will target on expanding beyond Marine Conservation areas and building up capacity for investigating "what-if" scenarios.

Session: 3022 Towards development of Canada's Digital Twin of the Ocean: Research, Development and Work Examples - Part 2 Vers le développement du jumeau numérique de l'océan canadien : recherche, développement et exemples de travaux - Partie 2

**03/06/2026
14:02**

ID: 12814 Contributed abstract

Challenges in modelling and predicting interannual and longer-term changes of ocean variations in the Northwest Atlantic, with implication for ecosystem and fishery applications

Youyu Lu ¹ , Li Zhai ² , Xianmin Hu ³ , David Brickman ⁴ , Hui Shen ⁵

- ¹ Bedford Institute of Oceanography, Fisheries and Oceans Canada
- ² Bedford Institute of Oceanography,
- ³ Bedford Institute of Oceanography, Fisheries and Oceans Canada, Maritimes Region
- ⁴ Bedford Institute of Oceanography, Fisheries and Oceans Canada
- ⁵ Bedford Institute of Oceanography, Fisheries and Oceans Canada

Presented by / Présenté par: *Youyu Lu*

Contact: Youyu.Lu@dfo-mpo.gc.ca

Prediction of ocean condition changes at various space-time scales is of great value to ecosystem and fishery applications. However, the predictability, or accuracy in prediction, varies in different regions due to different complexity of ocean dynamics. Here we identify challenges in modelling and predicting ocean condition changes in the Northwest Atlantic, in particular on the Scotian Shelf, at interannual and longer time scales. This is elucidated through inter-comparison of sea levels during 1993-2023 from tide gauge and altimeter observations, and four ocean models. These include two models covering Canada's Three Oceans without data assimilation, and two global ocean models including data assimilation, at $\frac{1}{4}$ or $\frac{1}{12}$ -degree horizontal resolutions. For the Northwest Atlantic, only the $\frac{1}{12}$ -degree global ocean reanalysis with advanced data assimilation (GLORYS12v1) possesses skills for coastal sea level variations at time scales longer than 20 months. The low skills of the other three models are attributed to the influence of strong nonlinear dynamics, in particular the interaction of Labrador Current and Gulf Stream near the Tail of Grand Banks. Further evaluation reveals that ocean temperatures from GLORYS12v1 are in good agreement with observation, hence can be applied to study ecosystem and fishery variations in the past few decades. However, reliable predictions for future changes in the region may need innovative methods (e.g., ensemble prediction and/or Machine Learning) to overcome the challenges of nonlinear dynamics.

Session: 3022 Towards development of Canada's Digital Twin of the Ocean: Research, Development and Work Examples - Part 2
Vers le développement du jumeau numérique de l'océan canadien : recherche, développement et exemples de travaux - Partie 2

03/06/2026

14:26

ID: 12661 Contributed abstract

A nonlinear mapping of climate projections toward observations across the Canadian marine conservation network

*Rick Danielson*¹, *Erin McKee*², *Brendan Detracey*³, *Marc Skinner*⁴, *Blair Greenan*⁵, *Ellen Kenchington*⁶, *Zeliang Wang*⁷

¹ Fisheries and Oceans Canada

- 2 Fisheries and Oceans Canada
- 3 Fisheries and Oceans Canada
- 4 Fisheries and Oceans Canada
- 5 Fisheries and Oceans Canada
- 6 Fisheries and Oceans Canada
- 7 Fisheries and Oceans Canada

Presented by / Présenté par: *Rick Danielson*

Contact: rick.danielson@dfo-mpo.gc.ca

A calibration of Coupled Model Intercomparison Project (CMIP6) ocean data was conducted in support of ecosystem approaches that encompass marine protected areas and their networks. The Global Ocean Reanalysis and Simulation (GLORYS12) was taken as the historical reference for each of 22 CMIP6 models. Neural networks with a single hidden layer were trained to adjust four emissions scenario projections of variables like temperature and salinity at the surface and bottom. Training at a spatial resolution of 1/12-degree narrowed the difference between each CMIP6 model and GLORYS12, with apparent impacts on downscaling and bias correction. Preservation of CMIP6 model trends for 2015-2100 was sought in part by limiting the number of neural network parameters. Prior to training, a well known resorting of monthly data was employed, along with Gaussian perturbations of either CMIP6 or GLORYS12 to balance their variance. Reduced variance among CMIP6 projections revealed that training toward GLORYS12 mimics a GLORYS12 nudging toward historical ARGO profiles.

Session 4042 Part 2

Convenors:

Michael Morris, University of Toronto

Paul J. Kushner, University of Toronto

Neil Swart, Environment and Climate Change Canada

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 pose barriers to their development, application, and analysis without 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 submissions 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. Areas of interest include atmospheric/ocean model process and parameterization development (including sea-ice modelling), short-lived climate forcings and geoengineering/climate intervention, carbon cycle modelling (including climate change mitigation approaches such as atmospheric carbon dioxide removal), land-surface model development and application, and sea-ice/land-ice modelling. We invite submissions covering 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 continue the discussion concerning challenges and opportunities for collaboration between universities, government laboratories, and the private sector; and the scientific results emerging from such collaborations.

**Session: 4042 Collaborative Earth System Modelling in
Canada - Part 2 Modélisation collaborative du système
Terre au Canada - Partie 2**

**03/06/2026
13:50**

ID: 12805 Contributed abstract

**What can measuring water vapor age teach us about the water cycle in
a general circulation model?**

*Robert Fajber*¹, *Boulangier Phillippe*²

¹ Atmospheric and Oceanic Sciences, McGill University

² Atmospheric and Oceanic Sciences, McGill University

Presented by / Présenté par: *Robert Fajber*

Contact: robert.fajber@mcgill.ca

One important uncertainty of climate change is the rate of acceleration in the global water cycle. While the Clausius-Clapeyron equation predicts a 7% rise in atmospheric moisture per degree of warming, climate models suggest globally averaged precipitation only changes 1% to 3% per degree of global warming (the hydrologic sensitivity). This discrepancy can be explained by a 4% to 6% increase in water vapor age (WVA) per degree of warming. These global changes are usually understood in context of changes in the tropical updraft, however, this cannot be directly assessed with global estimates.

In this work, we present a novel passive tracers for calculating the WVA spectrum in a General Circulation Model (GCM), which resolves the temporal and spatial variability of WVA distribution, and allows us to

calculate the mean age of precipitation (MAP) as well. We have demonstrated our technique by implementing these tracers in an idealized GCM (Isca) which we then perturb with global SST anomaly experiments.

The globally averaged mean WVA and mean age of precipitation (MAP) was 7.11 and 5.56 days respectively. Under global SST increases the mean WVA increased by 5.11%/K and MAP increased by 3.91 %/K. In the tropical updraft zone water WVA increased only weakly, while in the subtropical descent zones the increases are much larger. This results are contrary to the usual interpretation of WVA which assumes that it is (i) equivalent to MAP, and (ii) mostly controlled by the tropical updraft. This proof of concept study demonstrates that WVA tracers could be a useful tool in model development for understanding hydrologic sensitivity and the dynamics of the water cycle.

**Session: 4042 Collaborative Earth System Modelling in
Canada - Part 2 Modélisation collaborative du système
Terre au Canada - Partie 2**

**03/06/2026
14:02**

ID: 12856 Contributed abstract

Quantifying the Surface Energy and Water Balance Impacts of Forestation Using an Earth System Multi-Model Ensemble

*Christine Leclerc*¹, *Kirsten Zickfeld*²

¹ Simon Fraser University

² Simon Fraser University

Presented by / Présenté par: *Christine Leclerc*

Contact: leclerc@sfu.ca

Forestation has gained prominence as a nature-based climate solution considering international commitments to limit global warming to well-below 2°C above pre-industrial levels through carbon dioxide removal. In addition to sequestering carbon dioxide from the atmosphere, forestation affects energy and water fluxes between the land surface and atmosphere, ultimately impacting the hydrologic cycle. Using multi-model ensemble of Earth system model simulations for forestation and baseline scenarios from the sixth phase on the Coupled Model Intercomparison Project wherein all forcings except land use change are identical, we examine forestation impacts on surface energy and water balance across five climatically diverse study regions. Surface and planetary albedo, turbulent heat fluxes, and longwave radiation fluxes are altered with implications for surface temperature change where tree cover increase is $\geq 10\%$ of grid cell area. Surface temperature decreases in the tropics and subtropics while slight warming occurs in the highest latitude study region, consistent with previous studies. Evapotranspiration (ET) and precipitation (P) increase in all study

regions. P partitioned into ET increases and available water (P-ET) decreases in most study regions. Decreased runoff (R) follows P-ET decrease. Runoff ratio (R/P) decreases in all study regions, whereas subsurface soil moisture increases in some study regions, with implications for water management. Shifting transpiration-to-evapotranspiration ratio plays a key role in these anomalies. Our findings highlight the need to consider hydrologic cycle impacts when implementing forestation as a climate solution.

**Session: 4042 Collaborative Earth System Modelling in
Canada - Part 2 Modélisation collaborative du système
Terre au Canada - Partie 2**

**03/06/2026
14:14**

ID: 12683 Contributed abstract

**Reduced evapotranspiration from plant responses to increased
CO₂ drives a vertical redistribution of lower tropospheric water
vapour**

*Marysa Lague*¹, *Gregory Quetin*²

¹ University of British Columbia

² University of California Santa Barbara

Presented by / Présenté par: *Marysa Lague*

Contact: marysa.lague@ubc.ca

Independent of its effects as a greenhouse gas, increased CO₂ allows plants to transpire less for the same amount of photosynthesis. The plant physiological effect of CO₂ generally leads to a widespread reduction in terrestrial evapotranspiration in Earth system models as a result of stomatal closure. We use a tracer-enabled Earth system model to track how increased CO₂ impacts the distribution of atmospheric water vapour from land sources vs. ocean sources, isolating the radiative and physiological impacts of the increased CO₂. We find that the physiological response to CO₂ reduces the fraction of land-sourced water vapour over continental regions, but does not reduce the total amount of water vapour over the continents. Rather, the warming driven by reduced evapotranspiration drives increased ocean evaporation, which is transported over continental regions by the atmospheric circulation. However, this reduction in land-sourced vapour dries the lower troposphere (below 800 hPa), while the increase in ocean-to-land vapour transport increases water vapour concentrations from 800-600 hPa over land (particularly in the tropics). This vertical redistribution of water vapour leads to a reduction in downwards longwave radiation over continental regions. This reduction in downwards longwave radiation is roughly 10% of the magnitude of the increase in downwards longwave radiation attributable to the atmospheric warming driven by stomatal closure. This work shows that while the dominant effect

of the physiological response to CO₂ on climate is that of surface and atmospheric warming driven by the reduced evapotranspiration, this warming effect is modestly damped by a vertical redistribution of water vapour (a strong greenhouse gas) over continental regions.

**Session: 4042 Collaborative Earth System Modelling in
Canada - Part 2 Modélisation collaborative du système
Terre au Canada - Partie 2**

**03/06/2026
14:26**

ID: 12793 Contributed abstract

**Quantifying the Effect of Assimilating Leaf Area Index on
Evapotranspiration within the Soil, Vegetation, and Snow Land
Surface Model**

*Charlie Ballantyne*¹, *Aaron Berg*², *Marco Carrera*³, *Claudia
Wagner-Riddle*⁴

¹

² University of Guelph

³ Environment and Climate Change Canada

⁴ University of Guelph

Presented by / Présenté par: *Charlie Ballantyne*

Contact: cballa01@uoguelph.ca

Evapotranspiration represents a major influence on atmospheric behaviour; however, the Soil, Vegetation, and Snow (SVS) Land Surface Model, which is currently under development at Environment and Climate Change Canada (ECCC), has been shown to underestimate total evapotranspiration rates and overestimate the control of soil moisture dynamics on evapotranspiration, in turn causing inaccuracies in model projections. The exact reasons for this are complex, stemming from a combination of a simplified representation of soil moisture and vegetation dynamics. For example, leaf area index (LAI) presents a major control on evapotranspiration, however LSMs often use simplified representations of annual LAI cycles, such as generalized monthly averages of LAI based on vegetation type with no inter-year variation. In order to improve upon this, a variety of methods have been developed to assimilate LAI observations. This study seeks to explore whether assimilating LAI will improve the representation of evapotranspiration within SVS. SVS was run in point form at the University of Guelph's lysimeter site at the Elora Research Station. Assimilated LAI values were derived from monthly averages of LAI collected from hyperspectral drone data during the summers of 2021-2023. SVS estimates of evapotranspiration will then be compared to lysimeter observations from the study site. Based on similar studies, the expected results are that assimilating LAI will improve model estimates of

evapotranspiration by bringing the model more in line with reality.

**Session: 4042 Collaborative Earth System Modelling in
Canada - Part 2 Modélisation collaborative du système
Terre au Canada - Partie 2**

**03/06/2026
14:38**

ID: 12718 Contributed abstract

**Influence of Explicit Tropospheric VOC Chemistry on the Top-of-
Atmosphere Net Radiation Budget: Differences Between Two
Preindustrial CESM2 Chemistry Configurations**

*Noah Stanton*¹, *Neil Tandon*²

¹ York University

² York University

Presented by / Présenté par: *Noah Stanton*

Contact: nstant@my.yorku.ca

The representation of volatile organic compound (VOC) chemistry in earth system models directly impacts aerosol formation. Earlier research has shown that explicit VOC chemistry produces significant impacts on climate compared to an implicit “SOAG scheme” approach that prescribes a bulk gas phase precursor to SOA formation [c.f. <https://doi.org/10.5194/acp-23-9191-2023>]. In this study, we examine the change in top-of-atmosphere net radiation (ΔR_{TOA}) between two chemistry configurations of the Community Earth System Model version 2 under preindustrial conditions using fixed sea surface temperature (fSST) simulations. The 150-year fSST simulations used the following configurations: 1) WF, with explicit VOC chemistry in the troposphere, and 2) MF, with a SOAG scheme in the troposphere. First, we computed $\Delta R_{TOA} = R_{TOA,WF} - R_{TOA,MF}$ due to explicit VOC chemistry to be $0.45 \pm 0.036 \text{ Wm}^{-2}$. Additional analysis establishes that this ΔR_{TOA} is mostly accounted for by direct aerosol effects, which are likely driven by widespread SOA reductions in the accumulation mode and associated decreases in aerosol optical depth (AOD). Similarly, earlier studies have found widespread SOA reductions in response to explicit VOC chemistry, but precise reasons for these reductions remain unclear. Next, we calculated the globally averaged difference in total AOD, finding reductions of ~6%. SOA AOD decreased by about 5%, corresponding to roughly 80% of total AOD reduction. Finally, to assess the full climate response, 250-year simulations using fully coupled versions of WF and MF (called “WC” and “MC”) were performed. WC produces a $0.40 \pm 0.012 \text{ K}$ higher baseline of mean surface temperature (GMST), as expected given the positive ΔR_{TOA} . This result contrasts with an earlier study by the same authors which produced nearly unchanged GMST. We discuss the reasons for this contrast, along with our greater confidence in the results of this study. A

Session 4061 Part 1

Convenors:

Megan Hartwell, Canadian Centre for Climate Services, ECCC

Trevor Murdock, Canadian Centre for Climate Services, ECCC

Climate services operate at the interface between climate science and real-world decision making. Climate service providers endeavour to communicate relevant climate information to decision makers, while also communicating the limitations of the information, the uncertainty in the data and its applications. The inherent and unavoidable uncertainty in climate projections makes it tempting to either oversimplify the information or to include everything causing info overload. Climate services plays the vital role of bridging the chasm between confidence and confusion.

Demand is at an all-time high for reliable and usable climate data, information and guidance in ways that are relevant and usable to potential users. This is driven by an increase in the explicit consideration of future climate in many activities such as climate risk disclosures; assessments of climate impacts, vulnerabilities, and risks; adaptation plans; and consideration of future climate in disaster risk reduction.

The goal of this session is to encourage those in the climate field to share their experiences in creating and communicating robust, tailored climate information, data products, and guidance, for delivery to practitioners, researchers, and local communities. We also welcome users of climate information and climate data to share their experiences and findings, highlight how climate service providers have met or not met their needs, and identify ways in which climate services offerings could be expanded to improve their ability to build resilience to a changing climate.

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 and climate scientists
- Translation of technical climate information into a usable format
- Examples of successful application of climate information, particularly for climate change adaptation

**Session: 4061 Climate services and the confidence-
confusion chasm - Part 1 Les services climatiques et le
fossé entre confiance et confusion - Partie 1**

**03/06/2026
13:50**

ID: 12832 Contributed abstract

A brief history of climate services

*Trevor Murdock*¹

¹ Canadian Centre for Climate Services

Presented by / Présenté par: *Trevor Murdock*

Contact: trevor.murdock@ec.gc.ca

A long time ago, in a climate far, far away...

It is a time of discovery. Climate scientists strive to understand how people across society can use future climate projections instead of historical data alone.

As climate services advance, visionary alliances have united many disciplines under the banners of adaptation, resilience, and climate risk assessment. Rebellion against uncertainty has flourished. A network of climate service providers expands across the country. These knowledge translators have equipped decision-makers with tools to combat the growing menace of maladaptation.

Now, as the 60th annual CMOS annual congress convenes, the brave attendees embark on a hyper-time journey through the history of climate services in Canada. Exploring the rise of data portals and the emergence of user-driven approaches, they follow the saga of advancements in climate models and science inputs. Yet only in understanding user needs and tailoring products to meet those needs can the rebels achieve their quest to render future projections useful, usable, and used...

May the Ensemble Median be with you.

In this talk, we will walk through the history of climate services in Canada, highlighting the importance of iteration and continual learning in seeking to “bridge the gap of the confidence-confusion chasm” as institutions including codes and standards bodies as well as individuals from a wide range of professions seek to change the way they work to explicitly consider future climate projections.

Session: 4061 Climate services and the confidence-confusion chasm - Part 1 Les services climatiques et le fossé entre confiance et confusion - Partie 1

**03/06/2026
14:02**

ID: 12719 Contributed abstract

From Start to Finish: Development of useful and usable climate

services products.

Elaine Barrow ¹

¹ ECCC

Presented by / Présenté par: *Elaine Barrow*

Contact: elaine.barrow@ec.gc.ca

Climate service providers are tasked with providing climate data and information that can be used to make informed decisions, manage risks and help build resilience to climate change. These decisions are often associated with real costs, so it is important that climate services users have confidence in the data or guidance being used to inform those decisions. Climate service providers work with a wide range of individuals, businesses, governments and other organisations, as well as with a range of levels of climate literacy, so how do we go about developing products that can be confidently used by all? Drawing from examples from the Canadian Centre for Climate Services and from experiences developing features and content for the web portal ClimateData.ca, this presentation will outline, from start to finish, the steps involved in developing useful and usable climate data and guidance products.

Starting with the identification of user needs, this presentation will use real world examples to demonstrate how climate service providers identify and/or develop relevant datasets, develop appropriate guidance products, and make both data and guidance available to users in an easy-to-use way. The presentation will also describe the importance of engagement with users in each step of this process to support the development of fit-for-purpose datasets, plain language guidance, and easy access to climate services products.

Session: 4061 Climate services and the confidence-confusion chasm - Part 1 Les services climatiques et le fossé entre confiance et confusion - Partie 1

**03/06/2026
14:14**

ID: 12799 Contributed abstract

Streamlining Climate Products Delivery: Lessons Learned from the 1991-2020 Canadian Climate Normals

Chantale Cerny ¹ , *Diana Nguyen* ² , *Philip Jarrett* ³

¹ Environment and Climate Change Canada

² Environment and Climate Change Canada

³ Environment and Climate Change Canada

Presented by / Présenté par: *Chantale Cerny*

Contact: Chantale.Cerny@ec.gc.ca

The production of the Canadian Climate Normals is increasingly challenged by evolving observation networks, data availability and the need to adhere to product requirement rules. In 2024, the Meteorological Service of Canada (MSC) published the 1991-2020 Canadian Climate Normals on its Historical Climate Data website for 450 locations across the country. The Normals include 30-year averages, normal-period extremes, and long-term extremes. Compared with previous editions, significant adaptations to the production process were required, resulting in a decrease in the number of available locations, element changes, and as well as the introduction of composite stations by joining records to create 30-year data series. Lessons learned from this latest Normals production ascertained that these pressures will continue to remain for future productions, highlighting that adaptability is necessary. As part the Government of Canada's recent efforts to streamline program delivery, this presents opportunities to not only revamp the Canadian Climate Normals, but to better coordinate approaches used across other similar climate and engineering products utilizing in-situ surface observations. As we navigate through emerging uncertainties, the advent of Artificial Intelligence (AI) and automation will be explored, with a goal to optimize processes and accelerate delivery, while maximizing products' relevance, usability, and continuity in alignment with network monitoring capacities.

Session: 4061 Climate services and the confidence-confusion chasm - Part 1 Les services climatiques et le fossé entre confiance et confusion - Partie 1

**03/06/2026
14:26**

ID: 12791 Contributed abstract

From Uncertainty to Insight: The Power of Climate Services

*Katie Pearson*¹, *Sarah Rayfield*², *Sonya Nakoneczny*³

¹ ECCC

² ECCC

³ ECCC

Presented by / Présenté par: *Katie Pearson*

Contact: katie.pearson@ec.gc.ca

In this presentation, we explore the challenges and benefits of multidisciplinary collaboration on the delivery of user-driven climate services. We will draw on examples from a national climate service provider that is working in partnership with users, data developers and regional

service providers, to make climate information more accessible and applicable for Canadians.

A key role of climate service providers is translating climate data and projections into usable information for adaptation decision making. By integrating engagement, education, and outreach into program delivery, climate services can bridge the confidence–confusion chasm—combining scientific expertise with user comprehension and application, moving beyond one-way dissemination of supply-led technical outputs towards demand-driven services and products.

A multidisciplinary approach also enhances innovation. Different disciplines question assumptions in unique ways, leading to more creative problem solving and better risk assessment. It supports effective communication by translating complex climate information into formats tailored for communities, industry, and government. This is further enhanced through collaboration and partnership reflecting scientific and technical rigour, local context, and clear pathways to action. We will show how these benefits lead to more impactful, actionable climate services.

**Session: 4061 Climate services and the confidence-
confusion chasm - Part 1 Les services climatiques et le
fossé entre confiance et confusion - Partie 1**

**03/06/2026
14:38**

ID: 12699 Contributed abstract

CCCR2026 – From scientific findings to practical application

*Teah Lizee*¹, *Trevor Murdock*², *Isabelle Charron*³

¹ ECCC

² ECCC

³ Ouranos

Presented by / Présenté par: *Teah Lizee*

Contact: teah.lizee@ec.gc.ca

This presentation will discuss how Chapter 10: Climate services and using climate information in Canada's Changing Climate Report 2026 (CCCR2026) supports practitioners in using climate information from CCCR2026 and elsewhere in a practical context. For more information on the findings of CCCR2026, see session 4070.

In a changing climate, adaptation requires a shift from relying solely on past-climate information to incorporating climate projections. Requirements and incentives to consider future climate in building codes, standards and funding programs are becoming more common, pushing new users to find,

understand and use climate information for the first time. While climate projections are a powerful tool, there are challenges associated with their wide-scale and immediate adoption. In addition, the current landscape of climate information is a deep ocean of resources, which can muddy the waters for users seeking authoritative climate information. Accessible and plain language future climate information is needed to guide users towards good data and best practices.

Chapter 10 bridges the gap between the assessment of Canada's physical climate and the use of that information in practice. We'll explore some common considerations for selecting and using climate projections to highlight different aspects of climate data to understand. We'll also provide an overview of the hazard tables included in the report, which can be a familiar categorization framework for users to understand climate projections and specific indices. Overall, this work aims to facilitate and encourage the uptake of future climate information in evidence-based decision-making. This translation of research into more actionable information at regional and local scales provides a good starting point for understanding how to best use currently available climate information.

Session 5053 Part 3

Convenors:

Kaley Walker, University of Toronto

Adam Bourassa, University of Saskatchewan

Satellite Earth observation (SEO) provides a unique global perspective on our planet's atmosphere and surface, including the oceans, land, vegetation, ice, and snow. Current and planned satellite missions from Canada and international agencies have provided and will provide a wealth of new information about the Earth system and that can be used to investigate a wide range of environmental and scientific questions.

This session encourages contributions from across the full SEO value chain, upstream, midstream and downstream, to illustrate the activities currently underway in Canada, involving industry, academia and government. This includes new measurement technologies and techniques, both passive and active; mission development; 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.

Session: 5053 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 3
Observation de la Terre par satellite : une vue unique de notre planète et un besoin essentiel pour naviguer vers notre avenir - Partie 3
03/06/2026 13:50

Enabling next generation observations of aerosols, water vapour and clouds in the UTLS region with the HAWC satellite mission

*Jeffery Langille*¹, *Adam Bourassa*², *Doug Degenstein*³, *Jean-Pierre Blanchet*⁴, *Kaley Walker*⁵, *Yi Huang*⁶

¹ Dalhousie

² USask

³ USask

⁴ UQAM

⁵ University of Toronto

⁶ McGill

Presented by / Présenté par: *Jeffery Langille*

Contact: jalangil@dal.ca

Optical remote sensing from space-based and sub-orbital platforms is transforming our understanding of Earth's atmosphere; however, important gaps remain in our knowledge of key atmospheric constituents and processes. In the upper troposphere–lower stratosphere (UTLS), significant uncertainties persist regarding the spatial and temporal variability of water vapour, aerosols, and clouds, driven in part by the limited sensitivity and resolution of current observing systems. Addressing these gaps requires next-generation observing systems that deliver improved spatial and temporal resolution, enhanced information content, and the synergistic use of multiple sensors.

These needs motivate the Canadian-led High-altitude Aerosols, Water Vapour, and Clouds (HAWC) satellite mission, a Canadian climate mission that will combine observations from three innovative instruments: the Aerosol Limb Imager (ALI), the Spatial Heterodyne Observations of Water (SHOW), and Thin Ice Clouds in the Far Infrared Emissions (TICFIRE). Together, these instruments are designed to provide unprecedented sensitivity and spatial resolution for measurements of aerosols, water vapour, and clouds in the UTLS. This talk will present an overview of the HAWC mission, its scientific objectives, and the planned data products, along with a brief update on mission status and timeline. Current efforts to advance the scientific return of the mission will also be discussed.

Session: 5053 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 3 Observation de la Terre par satellite 03/06/2026 : une vue unique de notre planète et un besoin essentiel pour naviguer vers notre avenir - Partie 3 14:02

ID: 12760 Contributed abstract

Broadband radiative closure assessment for the EarthCARE mission

*Jason Cole*¹, *Howard Barker*², *Carla Salas Molar*³, *Zhipeng Qu*⁴
*, Meriem Kacimi*⁵

¹ Climate Research Division, Environment and Climate Change Canada, Toronto, Canada

² Meteorological Research Division, Environment and Climate Change Canada, Toronto, Canada

³ GMV, Madrid, Spain

⁴ Meteorological Research Division, Environment and Climate Change Canada, Toronto, Canada

⁵ Meteorological Research Division, Environment and Climate Change Canada, Toronto, Canada

Presented by / Présenté par: *Jason Cole*

Contact: Jason.Cole@ec.gc.ca

Following launch of EarthCARE in May 2024 and its subsequent commissioning phase, profiles of aerosol, cloud, and precipitation are being produced continuously by applying retrieval algorithms to observations made by single and multiple (i.e., synergistic) sensors. Input to these algorithms include measurements from EarthCARE's cloud-profiling radar (CPR), atmospheric backscatter lidar (ATLID), and passive multi-spectral imager (MSI). Retrieved properties, along with additional geophysical variables related to surface and atmospheric conditions, are then input into broadband (BB) 1D and 3D radiative transfer (RT) models. Radiances and fluxes computed by these RT models are compared to commensurate measurements made by EarthCARE's BB radiometer (BBR), thus defining a continuous radiative closure assessment of EarthCARE retrievals. This presentation focusses on 1D and 3D forward RT calculations, radiative closure methodology, and the current state of radiative closure using one year's worth of observations made by EarthCARE.

Session: 5053 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 3
Observation de la Terre par satellite : une vue unique de notre planète et un besoin essentiel pour naviguer vers notre avenir - Partie 3

**03/06/2026
14:14**

ID: 12612 Contributed abstract

Far-infrared radiation trend in the Arctic

*Han Haung*¹, *Yi Huang*²

¹ McGill University

² McGill University

Presented by / Présenté par: *Han Haung*

Contact: han.huang2@mcgill.ca

The Arctic climate is strongly regulated by radiative processes in a cold and dry atmosphere, where more than 50% of the thermal emission occurs at far-infrared wavelengths (FIR, >15 μ m). Although the Arctic occupies only a small fraction of the Earth's surface, recent changes in its energy budget play a disproportionate role in the global energy imbalance. Recent studies identified an emerging trend in outgoing longwave radiation (OLR) in the Arctic. Here we use global climate model and radiative transfer simulations to examine the spectral OLR trends in the past and future decades. The results suggest that strong atmospheric warming and weak water vapor dampening are the key factors leading to the Arctic OLR trend, which is most detectable in the FIR region. These results identify and quantify climate change signals that can be verified by future satellite measurements, such as HAWC/TICFIRE.

Session: 5053 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 3
Observation de la Terre par satellite : une vue unique de notre planète et un besoin essentiel pour naviguer vers notre avenir - Partie 3

**03/06/2026
14:26**

ID: 12782 Contributed abstract

Recent EarthCARE Validation Results from the ECALOT Campaign

*Zhipeng Qu*¹, *Paloma Borque*², *Keyvan Ranjbar*³, *Cuong Nguyen*⁴, *Zen Mariani*⁵, *Lei Liu*⁶, *Benjamin Riot-Bret cher*⁷, *Rapha l Peroni*⁸, *Alexei Korolev*⁹, *Howard Barker*¹⁰, *Jason Cole*¹¹, *Meriem Kacimi*¹²

¹ Environment and Climate Change Canada

² National Research Council Canada

³ National Research Council Canada

⁴ National Research Council Canada

⁵ Environment and Climate Change Canada

⁶ McGill University

⁷ McGill University

⁸ Universit  du Qu bec   Montr al

⁹ Environment and Climate Change Canada

¹⁰ Environment and Climate Change Canada

¹¹ Environment and Climate Change Canada

Presented by / Présenté par: *Zhipeng Qu*

Contact: zhipeng.qu@ec.gc.ca

As part of ESA's global calibration and validation (cal/val) initiative for the EarthCARE mission, the EarthCARE Commissioning Cal/Val Campaign in Ottawa (ECALOT) was conducted from October 2024 to March 2025 to characterize continental fall and winter conditions over south-central Canada. The campaign's primary objective was to conduct coordinated underflights of EarthCARE, collecting airborne and ground-based observations to calibrate and assess the satellite's Level 1 and Level 2 products. ECALOT utilized the National Research Council Canada Convair-580 research aircraft, which was instrumented with W- and X-band radars (NAWX), 355 nm lidars, a Far-Infrared Radiometer (FIRR-2) and a suite of in situ cloud microphysics and aerosol probes, providing critical measurements for validating EarthCARE products. These airborne observations were supplemented by ground-based instruments from Environment and Climate Change Canada and McGill University near Ottawa Airport, along with two additional climate sentinel sites in the Montreal region, operated by McGill University and Université du Québec à Montréal. Each of these three sites features an Atmospheric Emitted Radiance Interferometer (AERI) observing downwelling infrared radiation.

This presentation provides an overview of the ECALOT campaign and summarizes recent validation results, including Level 1 CPR and ATLID measurements, Level 2 single-instrument, composite and synergistic cloud and aerosol retrievals, as well as radiative closure assessment using both airborne and surface-based observations. It also presents scientific findings that integrate EarthCARE and ECALOT observations to improve numerical weather prediction models.

Session: 5053 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 3 Observation de la Terre par satellite : une vue unique de notre planète et un besoin essentiel pour naviguer vers notre avenir - Partie 3

**03/06/2026
14:38**

ID: 12844 Contributed abstract

Spatio-Temporal frequency analysis of cloud radiance in the thermal and far infrared and implication for the development of the TICFIRE mission

*Liviu Ivanescu*¹, *Yann Blanchard*², *Raphaël Peroni*³, *Maud Leriche*⁴, *Melissa Cholette*⁵, *Jean-Pierre Blanchet*⁶

- ¹ Université du Québec à Montréal (UQAM)
- ² Université du Québec à Montréal (UQAM)
- ³ Université du Québec à Montréal (UQAM)
- ⁴ Université du Québec à Montréal (UQAM)
- ⁵ Environment and Climate Change Canada (ECCC)
- ⁶ Université du Québec à Montréal (UQAM)

Presented by / Présenté par: *Liviu Ivanescu*

Contact: ivanescu.liviu@uqam.ca

Clouds modulate the Earth's radiation budget across a wide range of spatial and temporal scales, yet their variability in the far-infrared (FIR; 15–100 μm) remains largely undocumented due to the absence of dedicated observations. In the context of developing the Thin Ice Clouds and Far InfraRed Emissions (TICFIRE) satellite radiometer, we assess the capability to detect spatial and temporal variations of Top-Of-Atmosphere (TOA) radiance and to constrain acceptable sampling strategies.

We selected a spatially complex cloudy scene observed by Landsat and generated a high-resolution atmospheric state using the Global Environmental Multiscale Model (GEM). These fields were used to initialize non-hydrostatic simulations with the Meso-NH mesoscale model, providing enhanced horizontal and vertical resolution as well as high-frequency temporal variability over several hours. Synthetic TOA radiances were then produced with an end-to-end instrument simulator representative of TICFIRE.

From these datasets, spatial and temporal power spectral densities (PSD) of cloud radiance are computed to characterize the dynamical behavior of small-scale variability that may be attenuated or missed by the instrument. We further evaluate the impact of the instrumental Modulation Transfer Function (MTF) on high spatial frequencies and explore correction strategies, as well as the acceptable time lag between satellite observations. These results provide quantitative guidance for mission trade-offs and demonstrate the scientific value of FIR measurements for understanding cloud–radiation interactions and small-scale cloud dynamics.

Day 4 – 4 June 2026

c'est important

ID: 12866 Invited plenary speaker

What We Don't Know, and Why It Matters

Ce que nous ignorons, et pourquoi c'est important

*Katharine Hayhoe*¹

¹ Texas Tech University

Presented by / Présenté par: *Katharine Hayhoe*

Contact:

Uncertainty is central to atmospheric and ocean science. From chaotic circulation systems to future climate projections, our disciplines are skilled at characterising these uncertainties and communicating the risks they represent.

Yet today, the most consequential uncertainties we face are not those embedded into the physics of the climate system. Rather, they are the uncertainties inherent to the human decisions and systems that are driving unprecedented change. What happens over this century depends critically on how quickly we reduce emissions, how sustainably we manage our resources, how we adapt to impacts already underway, and how societies respond to risk.

Drawing on insights from behavioral and cognitive science, Dr. Hayhoe will explore why information alone rarely drives action and what scientists can do to ensure our work more effectively informs decisions that ultimately determine our shared future. Navigating uncertainty, it turns out, is as much a human challenge as it is a scientific one.

L'incertitude est au centre des sciences de l'atmosphère et de l'océan. Qu'il s'agisse des systèmes de circulation chaotiques ou des projections climatiques futures, nos disciplines sont en mesure de caractériser ces incertitudes et de communiquer les risques qu'elles représentent.

Et pourtant, aujourd'hui, les incertitudes les plus importantes auxquelles nous sommes confrontés ne sont pas celles inhérentes à la physique du système climatique. Il s'agit plutôt des incertitudes inhérentes aux décisions et aux systèmes humains qui sont à l'origine de changements sans précédent. Ce qui se passera au cours de ce siècle dépendra essentiellement de la rapidité avec laquelle nous réduirons les émissions, de la manière dont nous gérerons nos ressources de façon durable, de la façon dont nous nous adapterons aux effets déjà observables, et de la manière dont les sociétés réagiront face aux risques.

S'inspirant des perspectives découlant des sciences comportementales et

cognitives, Madame Hayhoe examinera pourquoi l'information à elle seule ne suffit guère à susciter l'action, et ce que les scientifiques peuvent faire pour que nos travaux éclairent plus efficacement les décisions qui, en fin de compte, déterminent notre avenir commun. Il s'avère que faire face à l'incertitude est autant un défi humain qu'un défi scientifique.



Time: Thursday June 4, 2026

11:00 – 11:55 EDT

Title: *What We Don't Know, and Why It Matters*

Speaker: Dr. Katharine Hayhoe (Chief Scientist for The Nature Conservancy and a Distinguished Professor at Texas Tech University)

Bio: Katharine Hayhoe is an atmospheric scientist who studies how climate change impacts us and how we can effectively respond. She is globally recognized as a United Nations Champion of the Earth and an Oxfam Sister of the Planet, and has been named to TIME's 100 Most Influential People, Foreign Policy's 100 Leading Global Thinkers, and FORTUNE's World's Greatest Leaders.

Katharine is known for her ability to translate complex climate issues into accessible public discourse. She publishes a weekly [Talking Climate](#) newsletter, hosted the PBS Digital Series, [Global Weirding](#), and writes for broad range of outlets, from TIME to Good Housekeeping. Her [TED talk](#), "The most important thing you can do to fight climate change: talk about it" has more than 4 million views and her [most recent book](#) is "Saving Us: A Climate Scientist's Case for Hope and Healing in a Divided World."

Currently, she is the Chief Scientist for The Nature Conservancy and holds the positions of Horn Distinguished Professor and the Political Science Endowed Professor in Public Policy and Public Law at Texas Tech University. Katharine earned her B.Sc. in Physics from the University of Toronto and her M.S. and Ph.D. in Atmospheric Science from the University of Illinois. She is a fellow of the American Geophysical Union, the American Academy of Arts & Sciences, the Canadian Meteorological and Oceanographic Society, and the American Scientific Affiliation, and serves on advisory boards for organizations such as Netflix, UBS, and the Smithsonian National Museum of Natural History. In recognition of her contributions to science communication and engagement, she has received a number of awards and four honorary doctorates.

Session 2023 Part 3

Convenors:

Simon-Philippe Breton, Canadian Meteorological Center, ECCC

Vikram Khade, Canadian Meteorological Center, ECCC

We invite the meteorological community to contribute to an exciting session on the integration of Artificial Intelligence (AI) into meteorology. This session aims to explore how AI, in particular machine learning (AI/ML) and high performance computing, is revolutionising modern meteorology.

Potential topics:

- Data-driven modelling in meteorology: Examples of fully data-driven models offering new insights into the understanding of meteorological phenomena.
- Hybridization of models: Fusion of data-driven approaches and traditional physical models for more accurate and robust weather forecasting.
- AI/ML for nowcasting: Innovation in very short-term forecasting, using AI to improve the speed and accuracy of forecasts.
- Improvements in S2S forecasting: Use of innovative statistical methods and AI/ML to refine sub-seasonal to seasonal predictions.
- Operationalisation of AI/ML: Discussion on how to make AI/ML technologies more accessible and useful for daily weather forecasting and decision support.
- Ethical and responsible AI: Importance of developing and using AI ethically and responsibly in meteorological research.
- Improving AI Literacy: Encouraging AI adoption by improving AI understanding and skills within the meteorological community.
- AI/ML in data assimilation : Use of AI/ML to augment/replace components of data assimilation systems (4DVar, EnVar, Ensemble based DA etc.)
- AI/ML applications in climate and environmental sciences : Use of AI/ML in climate projections, estimation of green house gases and climate change, climate change mitigation strategies, environmental impact/adaptation, policy formulations.
- AI applications in renewable energies : Use of AI/ML to improve forecasts for renewable energies.

In order to align this session with the “Navigating Uncertainty” theme of the conference, we encourage presentations that demonstrate how artificial intelligence can be used to characterize, quantify, or manage uncertainty in the context of measurements, forecasts, and projections in meteorology and climatology. Contributions that illustrate the application of AI to monitoring, reducing, or communicating uncertainty, as well as interdisciplinary approaches—including those integrating social sciences—are welcome.

Session: 2023 Advances and applications of artificial intelligence in meteorology - Part 3 Progrès et applications de l'intelligence artificielle en météorologie 04/06/2026 - Partie 3 12:30

ID: 12619 Contributed abstract

Uncertainty-Aware Graph and Diffusion Models for Multi-Domain Wind Farm Downscaling

¹ University of Victoria

² Veer Renewable

³ University of Victoria

⁴ University of Victoria

Presented by / Présenté par: *Tianxia Jia*

Contact: tianxiajia@uvic.ca

Accurate wind farm planning requires layout-dependent downscaling of atmospheric forcing to turbine-level wake deficit and power. While deterministic CNN and GNN surrogates can emulate WRF efficiently, they provide limited information about uncertainty and model confidence. This talk presents a probabilistic framework that combines graph neural networks for layout-aware modelling with diffusion-based generative models for uncertainty quantification. Conditional diffusion models are used to generate ensemble turbine-level power fields, and are compared against deterministic CNN and GNN models.

Session: 2023 Advances and applications of artificial intelligence in meteorology - Part 3 Progrès et applications de l'intelligence artificielle en météorologie - Partie 3

**04/06/2026
12:42**

ID: 12821 Contributed abstract

From Research to Operations: Real-Time Deep Learning Wind Downscaling Across a Sub-Continental Grid

Jean-Sébastien Giroux¹ , Lei Liu² , Simon Corbeil-Létourneau³ , Stavros Antonopoulos⁴ , Julie Carreau⁵ , Simon-Philippe Breton⁶

¹ Environment and Climate Change Canada

² Environment and Climate Change Canada

³ Environment and Climate Change Canada

⁴ Environment and Climate Change Canada

⁵ Polytechnique Montréal, Mila - Quebec AI Institute, GERAD

⁶ Environment and Climate Change Canada

Presented by / Présenté par: *Jean-Sébastien Giroux*

Contact: girj2625@usherbrooke.ca

The spatial resolution used in meteorological forecasting systems is often too coarse to capture mesoscale wind behaviors, while increasing resolution is computationally expensive. Deep learning (DL)-based downscaling offers

an efficient approach to better represent these processes, some of which are responsible for wind ramp events. DL methods have the advantage of low computational cost during operational use, enabling the rapid generation of high-resolution (HR) forecasts from low-resolution (LR) inputs. However, due in part to the novelty of artificial intelligence and differences between research and operational environments, integrating DL models efficiently into production systems remains challenging, despite promising scientific results.

Building on a deep learning (DL) downscaling methodology recently published in *Artificial Intelligence for the Earth Systems*, we assembled a multidisciplinary team of artificial intelligence researchers, software developers, and meteorological experts to transition this research into real-time operational use at Environment and Climate Change Canada (ECCC). To achieve this, the team addressed several challenges, including scaling the training dataset from gigabytes (GBs) to terabytes (TBs) to maximize data utilization; partitioning the domain into sub-domains to enable neural network (NN) training over large areas without exceeding GPU memory limits while reconstructing the final domain without artifacts; optimizing NN hyperparameters for models requiring days to train; and developing methodologies for annual model retraining to adapt to evolving weather conditions and maintain strong downscaling performance.

This work highlights practical engineering considerations required for reliable deep learning (DL) systems in operational meteorology and provides guidance for bridging the gap between research innovation and operational forecasting practice.}

Session: 2023 Advances and applications of artificial intelligence in meteorology - Part 3 Progrès et applications de l'intelligence artificielle en météorologie - Partie 3

**04/06/2026
12:54**

ID: 12813 Contributed abstract

The Meteorological Service of Canada's operationalisation of PROGNOS, a statistical and machine learning post-processing framework.

*Christian Saad*¹, *Stavros Antonopoulos*², *Jonathan Baik*³, *Yves Chartier*⁴

¹ Environment and Climate Change Canada

² Environment and Climate Change Canada

³ Environment and Climate Change Canada

⁴ Environment and Climate Change Canada

Presented by / Présenté par: *Christian Saad*

Contact: christian.saad@ec.gc.ca

In 2018, the PROGNOS project was first introduced to the CMOS community as a promising Meteorological Service of Canada (MSC) initiative to renew an older and more costly operational statistical post-processing infrastructure. This more versatile and modular framework is intended to facilitate research, development and operationalisation of statistical and machine learning applications to adjust for systematic biases in forecasts of surface air temperature, dew point temperature (1.5 meters), wind speed and direction (10 meters) as well as other significant weather and environmental elements at observation station locations. Fast forward to the summer of 2025, PROGNOS v1.0 is implemented operationally with 24/7 support to numerically post-process forecasts derived from the MSC's global, regional and high-resolution deterministic systems (GDPS, RDPS and HRDPS) in replacement of UMOs. A similar operational application of PROGNOS to pollutant concentrations forecasted by the regional air quality deterministic prediction system (RAQDPS) is also planned for 2026. Increased temporal resolution, spatial coverage as well as automated metadata management processes are amongst the first gains observed since its implementation. Product accessibility has also been enhanced by dissemination to the NinJo Workstation, Datamart and eventually GeoMet. Initial feedback from forecast meteorologists and other users have been key to identifying several opportunities for improvement, some of which are already underway. In addition to applying traditional regression approaches for real time post-processing of surface weather forecasts, current R&D activities include experimenting with neural network techniques such as Long Short-Term Memory (LSTM) and with gradient boosting approaches to improve horizontal visibility as well as moderate to strong wind speed forecasts.

Session 2040

Convenors:

Blake Barber Meteorological Service of Canada (MSC)

Erik de Groot, Meteorological Service of Canada (MSC)

As Canada faces increasingly complex meteorological and climate-related risks, improving weather services has become a central priority across the Canadian weather enterprise. In alignment with the Congress theme "Navigating Uncertainty," this session, led by the Meteorological Service of Canada (MSC), will highlight ongoing efforts to improve weather services in Canada.

The session will feature MSC's current service-modernization activities—spanning improvements in alerting, forecasting, communication, and user-centered design

Objectives

- Present MSC's service improvement efforts within the context of a changing weather enterprise and fiscal realities

- Encourage sharing of innovative tools, services, and communication strategies that enhance the delivery of weather information.

Session: 2040 Improving Weather Services Across the Weather Enterprise Améliorer les services météorologiques dans l'ensemble du secteur météorologique

**04/06/2026
13:50**

ID: 12861 Contributed abstract

Update from the Meteorological Service of Canada

*Doris Fortin*¹, *Cecile Siewe*²

¹ Meteorological Service of Canada

² Meteorological Service of Canada

Presented by / Présenté par: *Doris Fortin*

Contact: doris.fortin@ec.gc.ca

The Meteorological Service of Canada (MSC) is the official source of hydro-meteorological information in Canada, providing weather, water, ice, air quality, climate and environmental services. These include accurate and timely weather and environmental information, early notifications, and impact-based warnings to support Government of Canada departments, public authorities, emergency management organizations and many others in making decisions that protect the health, safety, and economic well-being of Canadians. This presentation will highlight recent initiatives implemented by the MSC, recent progress related to artificial intelligence and machine learning and future transformation activities to respond to the evolving needs of users and stakeholders.

Session: 2040 Improving Weather Services Across the Weather Enterprise Améliorer les services météorologiques dans l'ensemble du secteur météorologique

**04/06/2026
14:02**

ID: 12657 Contributed abstract

Update on the Meteorological Service of Canada's Convective Alert Modernization project

*Thomas Anderson*¹

¹ Environment and Climate Change Canada

Presented by / Présenté par: *Thomas Anderson*

The Convective Alert Modernization (CAM) project is expected to go live in spring 2026 with aims to modernize the production and delivery of convective warnings in Canada. By shifting from predefined zones to forecaster-defined free-form polygons, CAM's primary goal is to reduce areal over-alerting. Additionally, forecaster workflow has been greatly improved with the addition of storm-specific description phrases. These phrases are generated semi-automatically in both official languages which reduces translation delays and gets critical information into the public's hands faster, allowing them to make decisions sooner. This presentation will showcase updates to ECCC dissemination platforms, highlight anticipated reductions in areal alerting and explore impacts to Alert Ready. Finally, we will outline validation efforts planned for summer 2026.

Session: 2040 Improving Weather Services Across the Weather Enterprise Améliorer les services météorologiques dans l'ensemble du secteur météorologique

**04/06/2026
14:14**

ID: 12646 Contributed abstract

Engaging Canadians in Transformation: A User-Centered Rollout of Weather Information for Next-Generation Services (WINGS)

*Alyssa Charbonneau*¹

¹ ECCC

Presented by / Présenté par: *Alyssa Charbonneau*

Contact: alyssa.charbonneau@ec.gc.ca

The Meteorological Service of Canada (MSC) is engaged in transforming how we deliver our services to protect people in Canada from the impacts of weather-related hazards. As we enhance our focus on critical areas of decision support and alerts, we are modernizing the underlying data and delivery of our scheduled weather forecasts. Through this redesign we are building features that will help users navigate uncertainty when dealing with weather hazards and impacts. We are shifting from forecaster-modified text forecasts to a suite of complementary forecast products that will deliver detailed high resolution weather elements, weather insights with contextual information, and text-based regional forecasts.

As MSC prepares for this transition, we have launched a structured testing program accompanied by focused public outreach. This presentation will outline the phased approach of our beta-test rollout to introduce new forecast components to the public. We will also detail our feedback

framework, including targeted online questionnaires, interactive usability sessions, and focus groups designed to capture user sentiment, priorities, and challenges. By harnessing this feedback, MSC will refine WINGS to deliver user-driven, actionable forecasts that meet Canadians' real-world needs.

Session: 2040 Improving Weather Services Across the Weather Enterprise Améliorer les services météorologiques dans l'ensemble du secteur météorologique

**04/06/2026
14:26**

ID: 12613 Contributed abstract

ECCC – dissemination systems update

*Stephanie Tremblay*¹

1

Presented by / Présenté par: *Stephanie Tremblay*

Contact: stephanie.Tremblay-Therrien@ec.gc.ca

Environment and Climate Change Canada's Meteorological Service of Canada (MSC) is Canada's authoritative source for weather information and remains committed to ensuring that Canadians have easy and reliable access to timely weather forecasts, alerts, and critical weather-related information. MSC's public platforms, including the WeatherCAN app and the weather.gc.ca website, serve as crucial tools for empowering individuals, communities, and organizations to make informed decisions regarding weather and safety.

This presentation will showcase recent advancements to these dissemination platforms, aimed at providing an enhanced and more accessible user experience. Highlights include updates to the WeatherCAN app, which has been a trusted tool since its launch in 2019, offering Canadians seamless access to mobile weather updates. The app and the website now features enhanced map layers, displaying key data such as lightning and precipitation type, as well as the introduction of the new Risk-Tiered Weather Alerting System deployed in November 2025. This new system delivers clear and categorized alerts, enabling users to better understand and respond to different levels of weather-related risks.

Session: 2040 Improving Weather Services Across the Weather Enterprise Améliorer les services météorologiques dans l'ensemble du secteur météorologique

**04/06/2026
14:38**

ID: 12717 Contributed abstract

MSC AniMet: A User Friendly Tool for Exploring and Animating Open Weather Data

*Frédéric Dubuis*¹, *Alexandre Leroux*²

¹ Environnement et Changement Climatique Canada

² Environnement et Changement Climatique Canada

Presented by / Présenté par: *Frédéric Dubuis*

Contact: frederic.dubuis@canada.ca

The sharing of meteorological information between data providers, private companies, public services, and other stakeholders is essential to strengthening communication and improving our collective understanding of atmospheric phenomena. By enabling broad access to reliable, up to date weather data, such collaboration generates significant added value for both scientific research and operational decision making.

To support this objective, the Meteorological Service of Canada has developed MSC AniMet, a lightweight and user friendly tool that enables users to explore and visualize MSC Open Data weather information, as well as generate customized weather and climate animations for any region worldwide.

The platform can be used to showcase a wide range of weather events, including storms, heat waves, forest fire smoke, hurricane trajectories, air quality episodes, extreme wind gusts, and more. In total, MSC AniMet provides access to 16,000 weather, climate and water layers from MSC Open Data's GeoMet APIs, as well as data from ECMWF's ecCharts, NOAA's NCEP, NRCan, and other organizations.

This presentation will demonstrate how the AniMet tool operates from a user perspective and will illustrate, through practical examples, the advantages it offers for enhancing the sharing, visualization, and communication of meteorological data and information.

Session 3030 Part 1

Convenors:

Paul Myers (University of Alberta)

Youyu Lu (DFO – BIO)

Susan Allen (University of British Columbia)

Greg Smith (ECCC)

David Greenberg (DFO – BIO retired)

Frederic Dupont (ECCC),

Juliana Marson (University of Manitoba)

Inge Deschepper (University of Alberta)

Tahya Weiss-Gibbons (University of Alberta)

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.

Session: 3031 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 1 Discussions sur le développement, l'évaluation et l'analyse des modèles de circulation océanique et biogéochimiques ou du développement des capacités de modélisation océanique au Canada - Partie 1 **04/06/2026 12:30**

ID: 12629 Contributed abstract

A First Canadian Global Ocean Reanalysis: Reconstruction of Water Mass Properties and Mesoscale Circulation Variability Over the Last 30+ Years

*Gregory Smith*¹, *Francois Roy*², *Andrew Peterson*³, *Paolo Mauriello*⁴, *Rebecca Hamel*⁵, *Alain Caya*⁶, *Sergey Skachko*⁷, *Audrey-Anne Gauthier*⁸, *Kamel Chikhar*⁹, *Dorina Surcel Colan*¹⁰

¹ ECCC

² ECCC

³ ECCC

⁴ UNISA

⁵ ECCC

⁶ ECCC

⁷ ECCC

⁸ ECCC

⁹ ECCC

¹⁰ ECCC

Presented by / Présenté par: *Gregory Smith*

Contact: Gregory.Smith@ec.gc.ca

The Global Ice Ocean Prediction System (GIOPS) has been running operationally at the Canadian Centre for Meteorological and Environmental Prediction (CCMEP) for over 10 years providing 1/4°-resolution daily global analyses. These analyses are used to initialize medium-range (GDPS), monthly (GEPS) and seasonal (CanSIPS) coupled forecasts. The latter two require historical analyses to assess forecast error, motivating the production of a GIOPS reanalysis. An additional need for a GIOPS reanalysis is to provide a training dataset for machine learning emulators. A first 1993-2025 reanalysis has been produced using the latest (pre-operational) version of GIOPS. The reanalysis assimilates all available altimeter measurements, profile data from the CORA dataset and the CMC L4 SST reanalysis product. Atmospheric forcing is provided by ERA5. An important difference with respect to the operational system is the lack of a direct constraint on sea ice concentration. A second version of the reanalysis with blending toward a new sea ice & SST reanalysis produced with the CMC MIDAS analysis system is in development.

Preliminary assessment of the reanalysis shows minimum overall drift and fairly stable error statistics. A comparison of eddy properties with CMEMS reanalysis products (GLORYS2v4, GLORYS12, CGLORS, ORAP5) demonstrates that the GIOPS reanalysis provides a more accurate reconstruction of the mesoscale variability than two of the GREP products. Inconsistency in the number of profile data hinders the efficacy of the large-scale water mass bias correction procedure. A new approach is developed to use virtual Argo profiles based on the EN4 dataset in the pre-Argo period to provide more consistent water mass properties.

Future plans in terms of a pan-Canadian regional reanalysis will be discussed.

Session: 3031 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 1 Discussions sur le développement, l'évaluation et l'analyse des modèles de circulation océanique et biogéochimiques ou du développement des capacités de modélisation océanique au Canada - Partie 1

**04/06/2026
12:42**

ID: 12751 Contributed abstract

Development of the Canadian Three Oceans Downscaling System (CanTODS)

*Jonathan Izett*¹, *James Christian*², *Nicolas Lambert*³, *William Merrifield*⁴, *Elise Olson*⁵, *Natasha Ridenour*⁶, *Geoff Stanley*⁷, *Neil Swart*⁸

¹ Canadian Centre for Climate Modelling and Analysis (CCCma)

² Fisheries and Oceans Canada (DFO) and Canadian Centre for Climate Modelling and Analysis (CCCma)

³ Canadian Centre for Climate Modelling and Analysis (CCCma)

⁴ Canadian Centre for Climate Modelling and Analysis (CCCma)

⁵ Canadian Centre for Climate Modelling and Analysis (CCCma)

⁶ Canadian Centre for Climate Modelling and Analysis (CCCma)

⁷ Canadian Centre for Climate Modelling and Analysis (CCCma)

⁸ Canadian Centre for Climate Modelling and Analysis (CCCma)

Presented by / Présenté par: *Jonathan Izett*

Contact: jonathan.izett@ec.gc.ca

The Canadian Centre for Climate Modelling and Analysis (CCCma), in collaboration with Fisheries and Oceans Canada (DFO) and university partners (University of Alberta, University of Victoria), is developing a Canadian Three Ocean Downscaling System (CanTODS). The development of this model configuration will provide consistent, higher-resolution physical and biogeochemical ocean climate projections and seasonal to decadal predictions for the northern Pacific, Arctic, and northern Atlantic oceans, providing actionable data about future ocean states for decision-making in support of Canadian climate adaptation strategies. Initially developed at $\frac{1}{4}$ -degree resolution, CanTODS will utilize a modified eORCA grid at $\frac{1}{12}$ -degree resolution. Eventually, CanTODS will be coupled with the Canadian Regional Climate Model (CanRCM) to produce a Canada-focused regional Earth-System Model (CanRESM). Initial development has included integrating the CanTODS system within existing modelling infrastructure used by the Canadian Earth System Model (CanESM) and developing a downscaling pipeline. This shared infrastructure allows for complete internal consistency with CanESM. We have also had to answer the question: how large does our domain need to be to accurately simulate Canadian oceans? The answer to this question competes with the need to respect computational constraints. The presentation will provide an overview of CanTODS, an update on development and evaluation to date, technical issues involved in the transition to $\frac{1}{12}$ -degree, and a discussion of the location of the open boundaries of our domain in the Pacific and Atlantic oceans.

Session: 3031 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 1 Discussions sur le développement, l'évaluation et l'analyse des modèles de circulation océanique et biogéochimiques ou du développement des capacités de modélisation océanique au Canada - Partie 1

**04/06/2026
12:54**

ID: 12823 Contributed abstract

Preliminary results from the Canadian Three Oceans Downscaling System (CanTODS)

*Natasha Ridenour*¹, *Jonathan Izett*², *Neil Swart*³, *James Christian*⁴, *Nicolas Lambert*⁵, *William Merryfield*⁶, *Elise Olson*⁷, *Geoff Stanley*⁸

¹ Environment and Climate Change Canada

² Environment and Climate Change Canada

³ Environment and Climate Change Canada

⁴ Fisheries and Ocean Canada

⁵ Environment and Climate Change Canada

⁶ Environment and Climate Change Canada

⁷ Environment and Climate Change Canada

⁸ Environment and Climate Change Canada

Presented by / Présenté par: *Natasha Ridenour*

Contact: Natasha.Ridenour@ec.gc.ca

The Canadian Centre for Climate Modelling and Analysis (CCCma), in collaboration with Fisheries and Oceans Canada and academic partners (University of Alberta and University of Victoria), is developing the Canadian Three Oceans Downscaling System (CanTODS), based on the NEMO modelling system v4.2 and integrating ocean biogeochemistry models originally developed for the Canadian Earth System Model. The development of this model configuration is motivated by the need to have consistent, high resolution climate projection data for Canada's three oceans. Applications of CanTODS include seasonal to decadal prediction, and production of boundary conditions for higher resolution regional models, as well as the ability to provide actionable data for decision making. Longer term, we plan to couple CanTODS with the Canadian Regional Climate Model (CanRCM) to produce a Canada-focused regional earth-system model. For CanTODS to reach its full potential, this project requires collaboration and expertise from modellers throughout the country, with the long-term vision being a shared community model system.

We present our downscaling pipeline for boundary conditions, and atmospheric and river discharge forcing from the global CanESM model configuration. Details on producing downscaled river discharge forcing for higher resolution domains will be discussed. We present preliminary results of downscaled CMIP6 CanESM5.1 model simulations to the ¼ degree CanTODS domain as an intermediate step toward downscaling at 1/12-degree resolution.

**biogeochemical models or Developing Ocean
Modelling Capacity in Canada - Part 1 Discussions sur
le développement, l'évaluation et l'analyse des
modèles de circulation océanique et biogéochimiques
ou du développement des capacités de modélisation
océanique au Canada - Partie 1**

ID: 12810 **Contributed abstract**

A New Ensemble Ocean Analysis System for ECCC

*Kenneth Andrew Peterson*¹, *Gregory C. Smith*², *Kamel Chikhar*³,
*Dorina Surcel-Colan*⁴, *Francois Roy*⁵

¹ ECCC

² ECCC

³ MSC

⁴ MSC

⁵ ECCC

Presented by / Présenté par: *Kenneth Andrew Peterson*

Contact: kandrewpeterson@yahoo.ca

The representation of uncertainty in estimates of the current state of the ocean from observations is acknowledged to be of critical importance. Users have a need to know when and where estimates of ocean temperature, salinity and currents have a high degree of certainty, or uncertainty. Often, probabilistic measures of state variables, or derivatives of state variables are preferable to deterministic measures. Accurately accounting for variability that is not constrained by observation in analysis and subsequent forecasts is necessary to avoid forecast error, and ensemble analysis and forecasting is a proven method to account for this. A new ensemble analysis system, based upon the existing deterministic Global Ice Ocean Prediction System (GIOPS) of ECCC, is into the final stages of development. We will present some of the improved skill measures coming from this new system, and explore some further improvement that will likely follow through feeding back the estimation of model error available from ensemble methods into the data assimilation problem.

Session 3032 Part 2

Convenors:

Paul Myers (University of Alberta)

Youyu Lu (DFO – BIO)

Susan Allen (University of British Columbia)

Greg Smith (ECCC)

David Greenberg (DFO – BIO retired)

Frederic Dupont (ECCC),
Juliana Marson (University of Manitoba)
Inge Deschepper (University of Alberta)
Tahya Weiss-Gibbons (University of Alberta)

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.

Session: 3032 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 2 Discussions sur le développement, l'évaluation et l'analyse des modèles de circulation océanique et biogéochimiques ou du développement des capacités de modélisation océanique au Canada - Partie 2 **04/06/2026 13:50**

ID: 12617 Contributed abstract

A wave-ice interaction prototype for the Arctic

*Frederic Dupont*¹, *Jérémy Baudry*², *Dany Dumont*³, *Oleksandr Huziy*⁴, *Smith Gregory*⁵, *Jean-Philippe Paquin*⁶, *Sarah MacDermid*⁷, *Charles-Edouard Lizotte*⁸, *Benjamin Ward Soucy*⁹, *Philippe Blain*¹⁰, *François Roy*¹¹, *Mathieu Plante*¹²

¹ ECCC

² UQAR-ISMER

³ UQAR-ISMER

⁴ ECCC

⁵ ECCC

⁶ ECCC

⁷ ECCC

⁸ UQAR-ISMER

- ⁹ ECCC
- ¹⁰ ECCC
- ¹¹ ECCC
- ¹² ECCC

Presented by / Présenté par: *Frederic Dupont*

Contact: frederic.dupont@ec.gc.ca

The Canadian Operational Network of Coupled Environmental Prediction Systems (CONCEPTS) has developed a coupled atmosphere-ice-ocean framework named the Canadian Arctic Prediction System (CAPS) which runs twice daily for a two-day forecast. As part of this development work, we were tasked to investigate the impact of adding wave-ice interactions on the representation of the marginal ice zone, one of the identified weaknesses of the present system. In order to advance this work, we developed a small prototype where WaveWatch III is coupled to NEMO4-CICE6 via the OASIS coupler. Two interaction processes are included: the fracturing of sea ice by wave action and the radiation stress pushing sea ice away. The ice fracture scheme functions as a redistribution operator applied to the floe size and thickness distribution, using the wave-induced strain spectrum acting on sea-ice. Preliminary results will be presented using the CREG025 configuration, highlighting aspects to consider during the next development phases as other key wave-ice interactions processes are still missing.

Session: 3032 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 2 Discussions sur le développement, l'évaluation et l'analyse des modèles de circulation océanique et biogéochimiques ou du développement des capacités de modélisation océanique au Canada - Partie 2 **04/06/2026 14:02**

ID: 12730 Contributed abstract

On the effects of tidal forcing in Baffin Bay's freshwater variability

*Luiz Henrique Oliveira da Silva*¹, *Juliana Marson*², *Paul Myers*³

¹ University of Manitoba

² University of Manitoba

³ University of Alberta

Presented by / Présenté par: *Luiz Henrique Oliveira da Silva*

Contact: dasilvh@myumanitoba.ca

In regional models at eddy-permitting resolution, explicit representation of tides has been shown to enhance the simulation of ocean currents, vertical mixing, and stratification in the Arctic Ocean and its marginal seas compared with no-tides simulations. However, the effects of tidal forcing on freshwater distribution in these regions remains incompletely understood. Here, we evaluate the role of tidal forcing on the spatial and temporal distribution of freshwater thickness and content in Baffin Bay using six simulations from the Nucleus for European Modelling of the Ocean (NEMO) version 3.6. Our ensemble comprises control experiments, simulations with tidal forcing, and with combined tidal and mixed layer submesoscale eddy parameterizations, forced with two atmospheric reanalysis datasets through the period 2002-2017. Our results shows that the absence of tidal forcing modifies Baffin Bay's freshwater variability, basin-scale circulation, and sea ice conditions. For example, no-tides simulations overestimate freshwater thickness in the upper layers, exhibit shallower winter mixed layer depth, and reverse the net cross-shelf volume and freshwater transport along the west Greenland shelf break. These findings highlight the necessity of including tidal forcing when investigating Baffin Bay upper ocean to accurately represent freshwater variability, with implications for understanding Baffin Bay's local dynamics, its role in the Arctic-Atlantic exchanges, as well as in climate variability.

Session: 3032 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 2 Discussions sur le développement, l'évaluation et l'analyse des modèles de circulation océanique et biogéochimiques ou du développement des capacités de modélisation océanique au Canada - Partie 2

**04/06/2026
14:14**

ID: 12787 Contributed abstract

Impact of Ocean Sub-Surface Observations on Coupled Atmosphere-Ocean 15 day Predictions

*Kenneth Andrew Peterson*¹, *Gregory C. Smith*², *Kamel Chikhar*³, *Xingxiu Deng*⁴, *Yosuke Fujii*⁵

¹ ECCC

² ECCC

³ MSC

⁴ MSC

⁵ Japanese Meteorological Agency

Presented by / Présenté par: *Kenneth Andrew Peterson*

Contact: kandrewpeterson@yahoo.ca

The Ocean Predict SynObs Project seeks to extract maximum benefit from multiple ocean observing systems to ocean prediction by investigation the impact of various components of the ocean observing network through Observing System Experiment (OSE) observation withholding experiments. Environment and Climate Change Canada, through its Global Ice Ocean Prediction System (GIOPS) has performed ocean analysis withholding various aspects of the ocean observing system. This abstract will explore the impacts of ocean sub-surface observations through an ocean analysis where Argo profiling floats have been withdrawn. We will investigate the impacts on 15-day coupled atmosphere-ocean prediction by exploring how initializing the coupled system utilizing an ocean analysis with no knowledge of Argo sub-surface observations changes the forecast.

Session: 3032 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 2 Discussions sur le développement, l'évaluation et l'analyse des modèles de circulation océanique et biogéochimiques ou du développement des capacités de modélisation océanique au Canada - Partie 2

**04/06/2026
14:26**

ID: 12771 Contributed abstract

Hindcasting the spring phytoplankton bloom on the Newfoundland shelf from 1998 to 2017

*Jared Penney*¹, *Changheng Chen*², *Nancy Soontiens*³, *Frédéric Cyr*⁴, *David Bélanger*⁵, *Aaron Adamack*⁶

¹ Fisheries and Oceans Canada

² Fisheries and Oceans Canada

³ Fisheries and Oceans Canada

⁴ Center for Fisheries and Ecosystem Research, Fisheries and Marine Institute, Memorial University

⁵ Fisheries and Oceans Canada

⁶ Fisheries and Oceans Canada

Presented by / Présenté par: *Jared Penney*

Contact: jared.penney@dfo-mpo.gc.ca

The timing of the spring phytoplankton bloom on the Newfoundland shelf experiences significant interannual variation due to variation in environmental conditions. Given the impact of bloom timing on higher trophic levels, we seek to better understand the factors influencing the bloom, particularly under changing environmental conditions where past markers of bloom timing (e.g., timing of sea ice retreat) may no longer be applicable. In this presentation we discuss the ongoing development of a

one-dimensional coupled biogeochemical-physical nutrient-phytoplankton-zooplankton-detritus (NPZD) model of the spring phytoplankton bloom at long-term monitoring Station 27 (47.55°N, 52.59°W), with a specific focus on its ability to hindcast the spring bloom over the 1998-2017 period. We present a suite of simulations running each year from January to July, which are initialized using physical and biogeochemical profiles sampled as part of the Atlantic Zone Monitoring Program (AZMP). Meteorological forcing is provided by historical observational weather records, while salinity forcing is implemented through a nudging towards the GLORYS12 reanalysis product's daily mean salinity profiles. Simulation results are compared to chlorophyll-a concentrations obtained from in situ sampling and derived from ocean colour satellite products. Preliminary analyses show that, when compared to satellite-derived bloom initiation dates, the interannual variability of the bloom timings is reasonably well-represented by the model, but that the model's initiation dates are consistently delayed by up to several weeks compared to observations. In the absence of further changes to the physical component of the model, this systematic delay may be reduced by further tuning of the modelled phytoplankton's biological parameters, particularly those concerning growth and mortality.

Session: 3032 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 2 Discussions sur le développement, l'évaluation et l'analyse des modèles de circulation océanique et biogéochimiques ou du développement des capacités de modélisation océanique au Canada - Partie 2

**04/06/2026
14:38**

ID: 12749 Contributed abstract

5

Using a model to quantify our knowledge of PBDEs in the Salish Sea

*Susan Allen*¹, *Vicente Valenzuela*², *Roger Francois*³

¹ University of British Columbia

² University of British Columbia

³ University of British Columbia

Presented by / Présenté par: *Susan Allen*

Contact: sallen@eoas.ubc.ca

Sun et al. (2023) showed remarkably high levels of PBDEs in the Strait of Georgia years after their manufacture had been banned. Their initial calculations showed a full year inventory in the water column. This result is surprising given that these compounds are very particle reactive, and the particles sink to the bottom within a day. Sun et al. (2023) proposed that particle resuspension must be a significant source back to the water

column. To quantify this hypothesis, we built a Lagrangian model of PBDEs for the Salish Sea using SalishSeaCast for the currents and mixing.

Included are both the free (colloidal) phase of the PBDEs and the particle attached phase. Absorption and desorption, sinking and resuspension are modelled. It is relatively easy to parameterize a model that maintains one year of inventory in the water column. However, the model shows a much larger spatial dispersal of the PBDEs and comparing to the original observations suggests that the inventory must be much larger. We will present the model, discuss the dichotomy, suggest reasons behind it and show the use of models in quantitatively testing hypotheses.

Session 4043 Part 3

Convenors:

Michael Morris, University of Toronto

Paul J. Kushner, University of Toronto

Neil Swart, Environment and Climate Change Canada

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 pose barriers to their development, application, and analysis without 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 submissions 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. Areas of interest include atmospheric/ocean model process and parameterization development (including sea-ice modelling), short-lived climate forcings and geoengineering / climate intervention, carbon cycle modelling (including climate change mitigation approaches such as atmospheric carbon dioxide removal), land-surface model development and application, and sea-ice/land-ice modelling. We invite submissions covering 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 continue the discussion concerning challenges and opportunities for collaboration between

universities, government laboratories, and the private sector; and the scientific results emerging from such collaborations.

**Session: 4043 Collaborative Earth System Modelling in
Canada - Part 3 Modélisation collaborative du système
Terre au Canada - Partie 3**

**04/06/2026
12:30**

ID: 12794 Contributed abstract

CanESM6 and CMIP7

*Neil Swart*¹, *The CanESM development team*²

¹ Canadian Centre for Climate Modelling and Analysis

²

Presented by / Présenté par: *Neil Swart*

Contact: neil.swart@ec.gc.ca

The Canadian Earth System Model is a comprehensive coupled climate model developed at the Canadian Centre for Climate Modelling and Analysis. Previous versions of CanESM have made significant contributions to the Coupled Model Intercomparison Project (CMIP) phase 5 and 6, and have been widely used for climate science and service applications in Canada and internationally. Here we present the significant development undertaken over the past seven years to create the next major model version, CanESM6. Major advances in the new model include: updating to NEMO4.2 for the ocean including the SI3 sea-ice model, incorporating the CLASSIC land surface scheme; improvements to the atmospheric physics package, and a major update from a spectral dynamical core to the GEM semi-Lagrangian dynamical core. Global simulations with the GEM core use the Yin Yang grids, which required developing a new approach to conservative coupling that is essential for climate applications. We will present an overview of the model, as well as an assessment of changes in skill and performance relative to the previous model, CanESM5, as well as plans for contributing CanESM6 to the CMIP7 exercise. In addition to CanESM6, the CCCma intends to submit CanESM5-1 based simulations to CMIP7, which opens the opportunity for collaboration with the broader community via the Collaborative Platform for CanESM (CP4C).

**Session: 4043 Collaborative Earth System Modelling in
Canada - Part 3 Modélisation collaborative du système
Terre au Canada - Partie 3**

**04/06/2026
12:42**

ID: 12759 Contributed abstract

Implementing microphysics scheme P3 in CanESM6-0-MR

*Mathieu Lachapelle*¹, *Jason Cole*², *Knut Von Salzen*³, *Frederick Chosson*⁴, *Mélissa Cholette*⁵, *Jason Milbrandt*⁶

¹ Canadian Centre for Climate Modelling and Analysis, Environment and Climate Change Canada, Victoria, British Columbia, Canada

² Canadian Centre for Climate Modelling and Analysis, Environment and Climate Change Canada, Victoria, British Columbia, Canada

³ Canadian Centre for Climate Modelling and Analysis, Environment and Climate Change Canada, Victoria, British Columbia, Canada

⁴ Atmospheric Numerical Weather Prediction Research Section, Environment and Climate Change Canada, Dorval, Québec, Canada

⁵ Meteorological Research Division, Environment and Climate Change Canada, Toronto, Ontario, Canada

⁶ Meteorological Research Division, Environment and Climate Change Canada, Toronto, Ontario, Canada

Presented by / Présenté par: *Mathieu Lachapelle*

Contact: mathieu.lachapelle@ec.gc.ca

The Predicted Particle Properties (P3) microphysics scheme has been implemented in a developmental version of the 1-degree (medium resolution) version of the Canadian Earth System Model version 6, CanESM6-0-MR, with the objective to improve the representation of clouds and stratiform precipitation. Currently, clouds are represented by two prognostic variables and precipitation is treated diagnostically. In contrast, P3 explicitly represents both clouds and precipitation using two prognostic variables for liquid hydrometeors and with four prognostic variables for solid hydrometeors, which enables the representation of complex interaction between aerosols, cloud particles concentration, and microphysical processes.

P3 is currently used operationally in the GEM-based High Resolution Deterministic Prediction System (HRDPS) which uses a horizontal resolution of 2.5 km as well as in 1-km grid spacing experimental systems. To adapt P3 for use in a lower-resolution model, several adjustments to P3 are used including sub-stepping within each CanESM6-0-MR 30-minute model time step and incorporating a statistical sub grid cloud fraction parameterization. At this early stage of incorporating P3 in CanESM6-0-MR, simulations using prescribed sea surface temperatures and sea-ice climatologies show promising results. Climatologies are similar to the original model with indications of improved representation of cloud and precipitation distributions as P3 is further integrated with other relevant atmospheric physics in CanESM.

ID: 12790 Contributed abstract

Evaluation of the Interactive Iceberg Module in NEMO for Inclusion in CanESM

*Duo Yang*¹, *Neil Swart*², *Geoff Stanley*³

¹ ECCC

² ECCC

³ ECCC

Presented by / Présenté par: *Duo Yang*

Contact: duo.yang@ec.gc.ca

Calved mass from ice shelves and glaciers enters the ocean in the form of icebergs, which gradually erode and melt along their trajectories. Icebergs contribute a major component of the freshwater flux to the ocean, accounting for up to 50% in Greenland and more than 50% in Antarctica. In the Canadian Earth System Model version 5 (CanESM5), however, icebergs are not explicitly represented. Instead, glacier coverage is prescribed, and snow accumulating at glacier points is compacted until a threshold is reached, beyond which any excess is immediately routed to runoff (Swart et al., 2019).

To address this limitation, we have initiated a project to test and evaluate the interactive iceberg module embedded in NEMO4, which is coupled to SI3. Several sensitivity experiments, conducted relative to a control experiment, have been performed for nearly 3000 years, substantially longer than in previous studies we have examined, allowing the system to reach equilibrium. The experiments are initialized using calving rates along the Antarctic coastline. The impact of icebergs is evident both locally, in the Southern Ocean, and remotely, in the subpolar North Atlantic, affecting sea surface temperature (SST), sea surface salinity (SSS), sea ice, mixed layer depth, and temperature and salinity structures, possibly through changes in the meridional overturning circulation and Antarctic Circumpolar Current. A near-term approach to incorporating the iceberg module in CanESM is also proposed in this project, in contrast to coupling with an ice sheet or ice shelf model, and related development work is underway.

**Session: 4043 Collaborative Earth System Modelling in
Canada - Part 3 Modélisation collaborative du système
Terre au Canada - Partie 3**

**04/06/2026
13:06**

ID: 12829 Contributed abstract

Ocean alkalinity enhancement experiments in the Canadian Earth

System Model

*Krysten Rutherford*¹, *Neil Swart*², *James Christian*³, *Elise Olson*⁴

¹ Environment and Climate Change Canada

² Environment and Climate Change Canada

³ Fisheries and Oceans Canada, Environment and Climate Change Canada

⁴ Environment and Climate Change Canada

Presented by / Présenté par: *Krysten Rutherford*

Contact: krysten.rutherford@ec.gc.ca

Marine carbon dioxide removal (mCDR) technologies have been increasingly proposed as approaches for limiting atmospheric CO₂ growth. Ocean alkalinity enhancement (OAE), one such form of mCDR, adds alkaline minerals to the surface ocean to increase its capacity to take up and store atmospheric CO₂. Originally proposed decades ago, OAE is currently being studied across scales and using various methodologies to address questions surrounding both the safety and efficacy of potential alkalinity additions to the ocean. Global Earth system models (ESMs) are a useful complement to local and regional studies when addressing questions related to effectiveness of OAE; global ESMs provide the most complete picture of the Earth system impacts and spatially variable efficiency of mCDR. Here, we present initial results from deploying OAE within the Canadian Earth System Model version 5.1. For the experiments presented, we follow the Carbon Dioxide Removal Model Intercomparison Project (CDRMIP) protocol, which prescribes an alkalinity addition of 0.15 Pmol per year to the entire surface ocean between 60S and 70N on the SSP585 emission pathway with interactive CO₂ in the atmosphere. Further, we apply the same protocol to emission pathways SSP126 and SSP245. While this is an idealized experimental set up, this study provides an alkalinity addition scenario to test the potential of OAE and will be compared with other ESMs that were contributed to the Coupled Model Intercomparison Project Phase 6 (CMIP6) following the same CDRMIP experimental protocol, which will help constrain the uncertainty associated with OAE deployment. The results presented will be an important contribution to conversations around the deployment of OAE, both in Canada and abroad.

Session: 4043 Collaborative Earth System Modelling in Canada - Part 3
Modélisation collaborative du système Terre au Canada - Partie 3

**04/06/2026
13:18**

ID: 12741 Contributed abstract

National-Scale MESH–CLASS Implementation for Collaborative Earth System Modelling in Support of Canada’s National Adaptation Strategy (NAS)

¹ ECCC

² ECCC

³ ECCC

⁴ ECCC

⁵ University of Calgary

⁶ University of Calgary

Presented by / Présenté par: *Zelalem Tesemma*

Contact: zelalem.tesemma@ec.gc.ca

Abstract

Reducing uncertainty in land–atmosphere coupling remains a priority for Canadian Earth System Model (ESM) development, particularly across cold regions that dominate national hydroclimate variability and climate risk. We present a national-scale implementation of the MESH-CLASS land surface and hydrological modelling framework across Canada and its major transboundary basins, undertaken through a coordinated academic–government collaboration between the University of Calgary and Environment and Climate Change Canada (ECCC). This work supports Canada’s National Adaptation Strategy (NAS) by strengthening the hydrological modelling foundation required for climate risk assessment, water security analysis, and adaptation planning. The model-agnostic configuration approach—emphasizing standardized geofabric construction, reproducible workflows, harmonized forcing datasets, and shared version control—enables interoperability across modelling systems and facilitates integration with Canadian ESM development environments. The modelling domain is constructed using the MERIT-Basins geospatial fabric product, providing a consistent, high-resolution representation of drainage connectivity and routing aligned with federal large-domain hydrological standards. Within this coordinated framework, we conducted benchmarking analyses to evaluate available national and global datasets for land cover, soil properties, and model parametrization and to quantify their impact on model performance across diverse hydroclimatic conditions. Preliminary results indicate that soil hydraulic characterization, vegetation structural representation, and sub-grid heterogeneity parameterization exert dominant controls on seasonal water and energy flux partitioning, particularly in snow-dominated and permafrost-influenced regions. Refining the hydrological model inputs substantially improves overall model skill, yielding more accurate streamflow timing and magnitude, enhanced snow water equivalent simulations, and a more consistent representation of other key internal model variables. This collaboration between the University of Calgary and Environment and Climate Change Canada (ECCC) advances the development, strengthening, and evaluation of Canada’s Earth system

Session 4062 Part 2

Convenors:

Megan Hartwell, Canadian Centre for Climate Services, ECCC

Trevor Murdock, Canadian Centre for Climate Services, ECCC

Climate services operate at the interface between climate science and real-world decision making. Climate service providers endeavour to communicate relevant climate information to decision makers, while also communicating the limitations of the information, the uncertainty in the data and its applications. The inherent and unavoidable uncertainty in climate projections makes it tempting to either oversimplify the information or to include everything causing info overload. Climate services plays the vital role of bridging the chasm between confidence and confusion.

Demand is at an all-time high for reliable and usable climate data, information and guidance in ways that are relevant and usable to potential users. This is driven by an increase in the explicit consideration of future climate in many activities such as climate risk disclosures; assessments of climate impacts, vulnerabilities, and risks; adaptation plans; and consideration of future climate in disaster risk reduction.

The goal of this session is to encourage those in the climate field to share their experiences in creating and communicating robust, tailored climate information, data products, and guidance, for delivery to practitioners, researchers, and local communities. We also welcome users of climate information and climate data to share their experiences and findings, highlight how climate service providers have met or not met their needs, and identify ways in which climate services offerings could be expanded to improve their ability to build resilience to a changing climate.

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 and climate scientists
- Translation of technical climate information into a usable format
- Examples of successful application of climate information, particularly for climate change adaptation

**Session: 4062 Climate services and the confidence-
confusion chasm - Part 2 Les services climatiques et le
fossé entre confiance et confusion - Partie 2**

**04/06/2026
12:30**

ID: 12707 Contributed abstract

Strategic Support for Effective Outreach

Rachel Malena-Chan ¹

¹ ECCC

Presented by / Présenté par: *Rachel Malena-Chan*

Contact: Rachel.Malena-Chan@ec.gc.ca

Strong messaging is the foundation of effective science communication. How can we improve our connections with users, clients, and audiences? One proven approach is to build capacity for creativity and strategic storytelling among climate service providers. The benefits of climate services may not reach the right audiences without outreach that resonates, risking the effectiveness of our services. Crafting a compelling story requires strategic support and a team-based approach.

To help bridge the confidence-confusion chasm, the Canadian Centre for Climate Services (CCCS) began hosting “Story Support Hour”, a weekly drop-in where team members can collaborate and discuss best practices for communicating climate messages. This gathering is open to anyone on the CCCS team who is working on a presentation, an article, a social media post, or a multi-media project, such as video or audio learning tools. It is also open to those who are looking to refine their messaging for outreach or training audiences.

This session introduces the thinking behind Story Support Hour, the design and results of this ongoing practice, and provides examples of the strategic support offered during these meetings. Through this overview, we demonstrate the value of storytelling and make the case for using a narrative lens across climate services. We explore the benefits of consistently providing a low-barrier way to foster creativity among climate service teams, and we offer reflection questions to help you consider how you might build capacity for strategic storytelling within your own team.

Session: 4062 Climate services and the confidence-confusion chasm - Part 2 Les services climatiques et le fossé entre confiance et confusion - Partie 2

**04/06/2026
12:42**

ID: 12712 Contributed abstract

From climate data to relatable narratives – Storytelling through ClimateData.ca

Frances Delaney ¹

1

Presented by / Présenté par: *Frances Delaney*

Communicating climate data and information in ways that resonate beyond technical audiences remains a persistent challenge in climate services. At the Canadian Centre for Climate Services (CCCS), the Outreach team works to bridge this gap by transforming complex climate data into accessible, engaging, and meaningful narratives for Canadians.

In a changing climate, adaptation requires widespread understanding of impacts and projections, not only for scientists and decision-makers, but across sectors and communities. Effective outreach must go beyond presenting data; it must connect projections to lived experience. Through the News page on ClimateData.ca, CCCS uses storytelling to link climate projections with familiar topics such as wine, outdoor skating, and Christmas trees.

Because climate data is relevant to countless decisions, it is not realistic to cover every sector directly. Focusing on widely recognizable topics allows us to reach a general audience as well as professionals who see parallels with their own work. This approach gives specialists an accessible entry point into the datasets and methods they may need for risk assessment or adaptation planning.

This presentation will explore how climate indices (e.g., projected changes in growing degree days, frost-free season length, and temperature thresholds) can be reframed into relatable narratives that preserve scientific rigor. It will outline the News article development process, from ideation and identifying a compelling hook, to selecting appropriate datasets and visualizations, to crafting clear and accurate messaging.

Three case studies will be highlighted to demonstrate how climate data can be contextualized within familiar Canadian experiences, helping audiences see both the risks and adaptive opportunities associated with future climate conditions.

By sharing lessons learned and practical approaches to science communication, this presentation aims to contribute to broader discussions at CMOS on climate services.

Session: 4062 Climate services and the confidence-confusion chasm - Part 2 Les services climatiques et le fossé entre confiance et confusion - Partie 2

**04/06/2026
12:54**

ID: 12847 Contributed abstract

Strengthening Ontario's Flood History: Exploring Missingness and Uncertainty in Disaster Data With Machine Learning

¹ University of Toronto, Department of Computer Science

² University of Toronto, Department of Computer Science

Presented by / Présenté par: *Dylan Van Bramer*

Contact: dylan.vanbramer@mail.utoronto.ca

Flood records are essential data artifacts for climate scientists and government practitioners, yet the existing disaster database for Ontario is incomplete. High-frequency, low-impact events considered too minor for formal recording produce significant undercounted damages, and events occurring in sparsely populated areas often go unrecorded for reasons of geography and infrastructure rather than insignificance. Climate risk models and adaptation plans built on this incomplete record inherit these blind spots, embedding a misplaced certainty that motivates the need for a more robust, uncertainty-informed flood record.

To produce this more robust historical record, we aggregate multimodal data by watershed: combining climate data (daily streamflow and precipitation gauge readings) with historical newspaper archives queried for flood mentions. Using positive-unlabeled machine learning — where known flood events serve as positive instances and unverified periods remain unlabeled — we train models to recognize the spatiotemporal signatures of climatic and meteorological conditions leading to significant damage-causing hazards. Machine learning allows us to identify the "footprint" of a flood without requiring rigid meteorological thresholds, since this pattern varies widely across seasons and geographies.

While introducing machine learning into this workflow introduces additional uncertainty, it forces practitioners to reckon with the inherent absences embedded in any disaster database. Rather than seeking to eradicate this uncertainty, we produce an incrementally more complete record alongside an explicit analysis of its patterns of missingness. Drawing on concepts from the disaster literature, including magnitude bias and population density bias, we examine how these gaps reflect existing biases in whose flood experiences are formally recorded. Organizing this analysis around watershed boundaries adds physical grounding to the record, and brings us closer to a flood history that more honestly reflects the true distribution of past events. Such a record bridges the needs of climate scientists seeking historical signal and practitioners building resilience in a changing Ontario.

**Session: 4062 Climate services and the confidence-
confusion chasm - Part 2 Les services climatiques et le
fossé entre confiance et confusion - Partie 2**

**04/06/2026
13:06**

ID: 12758 Contributed abstract

Using CRPSS as a skill metric to support decision-making for S2D forecasts

Hayley Dosser ¹ , Julia Vellella ² , Jacinthe Racine ³ , William Merryfield ⁴

¹ ECCC

² ECCC

³ ECCC

⁴ ECCC

Presented by / Présenté par: Hayley Dosser

Contact: hayley.dosser@ec.gc.ca

Seasonal to decadal (S2D) forecasts are most useful when accompanied by skill metrics quantifying the past performance of the prediction system. However, skill has been identified by forecast users as a major source of confusion and frustration. S2D forecasts from Environment and Climate Change Canada are now available on ClimateData.ca, accompanied by Continuous Ranked Probability Skill Scores (CRPSS). Described by Palmer and Richardson (2014) as "...perhaps the simplest single measure of the overall value of a forecasting system for decision-making", this skill metric is designed for probabilistic forecasts and captures information about both the sharpness and reliability of the prediction system. Here we describe this skill metric, explain why it was chosen, and outline how it is being communicated on the public-facing web portal. We discuss best practices for calculating CRPSS in the context of S2D forecasts. Finally, we explore how decision-makers can leverage CRPSS to understand the potential economic value of using these forecasts consistently over time.

Session: 4062 Climate services and the confidence-confusion chasm - Part 2 Les services climatiques et le fossé entre confiance et confusion - Partie 2

**04/06/2026
13:18**

ID: 12624 Contributed abstract

Challenges in Precipitation Data Homogenization and Trend Assessment

Xiaolan L. Wang ¹ , Yang Feng ² , Francis W Zwiers ³ , Vincent Y. S. Cheng ⁴

¹ Climate Research Division, Environment and Climate Change Canada

² Climate Research Division, Environment and Climate Change Canada

³ Pacific Climate Impacts Consortium, University of Victoria

⁴ Climate Research Division, Environment and Climate Change Canada

Presented by / Présenté par: *Xiaolan L. Wang*

Contact: Xiaolan.Wang@ec.gc.ca

This presentation draws on a series of recent studies focused on quality control and homogenization of precipitation data, as well as the assessment of precipitation trends. Precipitation is intermittent in both time and space, and highly variable spatially and across scales. Precipitation amounts are non negative and follow a non Gaussian distribution, with daily data containing many zero precipitation days. These characteristics necessitate specialized approaches for detecting and adjusting inhomogeneities. In particular, a paired set of procedures is required to detect changepoints in monthly precipitation data, while a different procedure must be used to detect changepoints and homogenize daily precipitation series. Even quality control of precipitation data benefits from a paired approach: both the original and log transformed series must be examined for quality issues and changepoints.

This presentation highlights the challenges encountered in producing Version 2 of the Canadian Homogenized Precipitation Dataset, including a comparison with the earlier version and an assessment of sampling uncertainty. The latter includes evaluating the representativeness of the station network configuration and quantifying the impacts of missing data.

Session 4063 Part 3

Convenors:

Megan Hartwell, Canadian Centre for Climate Services, ECCC

Trevor Murdock, Canadian Centre for Climate Services, ECCC

Climate services operate at the interface between climate science and real-world decision making. Climate service providers endeavour to communicate relevant climate information to decision makers, while also communicating the limitations of the information, the uncertainty in the data and its applications. The inherent and unavoidable uncertainty in climate projections makes it tempting to either oversimplify the information or to include everything causing info overload. Climate services plays the vital role of bridging the chasm between confidence and confusion.

Demand is at an all-time high for reliable and usable climate data, information and guidance in ways that are relevant and usable to potential users. This is driven by an increase in the explicit consideration of future climate in many activities such as climate risk disclosures; assessments of climate impacts, vulnerabilities, and risks; adaptation plans; and consideration of future climate in disaster risk reduction.

The goal of this session is to encourage those in the climate field to share their experiences in creating and communicating robust, tailored climate information,

data products, and guidance, for delivery to practitioners, researchers, and local communities. We also welcome users of climate information and climate data to share their experiences and findings, highlight how climate service providers have met or not met their needs, and identify ways in which climate services offerings could be expanded to improve their ability to build resilience to a changing climate.

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 and climate scientists
- Translation of technical climate information into a usable format
- Examples of successful application of climate information, particularly for climate change adaptation

Session: 4063 Climate services and the confidence-confusion chasm - Part 3 Les services climatiques et le fossé entre confiance et confusion - Partie 3

**04/06/2026
13:50**

ID: 12797 Contributed abstract

Clear communication of climate information

*Megan Hartwell*¹, *Tristin Tanton*²

¹ ECCC

² MacEwan University

Presented by / Présenté par: *Megan Hartwell*

Contact: megan.hartwell@ec.gc.ca

Planning for the future requires the use of future climate data. The historical climate is not representative of the climate we live in today, much less the one that will exist 30 years from now. This is especially true in northern Canada, where the temperature is rising three times as fast as the global average. A workshop in the Cree Nation of Chisasibi, in northern Quebec, gathered members of the Cree Nation Government's Climate Advisory Committee and community members to discuss adaptation to the changing climate in the years to come. The community members have heard about the changes in the climate from their Elders, seen it themselves in their communities and on their land, and are now preparing for further changes in climate.

To assist in this planning for the future, the Canadian Centre for Climate Services, the Cree Nation Government, the Cree Board of Health and Social Services, and Cambium Indigenous Professional Services, prepared a booklet outlining the projected changes in climate in a plain language and culturally relevant way. This presentation will showcase the booklet and its

development process, including the framing of seasonal changes in a meaningful way to Cree participants, and development of pictographs and plain language statements to communicate this information and the inherent uncertainty in the climate projections.

Session: 4063 Climate services and the confidence-confusion chasm - Part 3 Les services climatiques et le fossé entre confiance et confusion - Partie 3

**04/06/2026
14:02**

ID: 12807 Contributed abstract

Comparing climate data in northern Canada to inform climate change adaptation

*Ruth Moore*¹, *Nicole Loeb*², *Teah Lizee*³

¹ Environment and Climate Change Canada

² The University of Manitoba

³ Environment and Climate Change Canada

Presented by / Présenté par: *Ruth Moore*

Contact: rmoore@eoas.ubc.ca

The Canadian Centre for Climate Services (CCCS) supports climate change adaptation in Canada by providing high-quality climate data and tools. There is a need for tailored data to aid decision-making in northern Canada and sparse station data, and regional challenges complicate this effort. This project aims to enhance CCCS's ability to provide guidance on the fitness-for-purpose of climate datasets in Canada's North.

This comparative study examines both historical data and future climate projections at the local level in northern Canada to provide guidance about the various datasets available that could be used for climate change adaptation. Approximately 15 communities (locations) with different environmental conditions and varying levels of data availability were selected for analysis in collaboration with CCCS's northern partners. Datasets used in this study include weather observations, adjusted historical datasets, reanalysis, reanalysis driven regional climate models, ClimateNA, global climate models (GCMs) and downscaled GCMs.

Temperature and precipitation-based variables and indices for each dataset were analyzed and compared at a local level. Results are being used to develop guidance about suitable datasets for use in adaptation studies, datasets to use in the absence of station observations, and limitations associated with climate data or the methodologies used for dataset development.

Most of the output of this project will be available in plain language to

ensure accessibility for a wide audience, in addition to a technical report. This work will support the CCCS' Service Delivery's Northern and Indigenous team and the CCCS's northern partners in their work. This talk will give an overview of this project with preliminary results and expected project outcomes.

**Session: 4063 Climate services and the confidence-
confusion chasm - Part 3 Les services climatiques et le
fossé entre confiance et confusion - Partie 3** 04/06/2026
14:14

ID: 12726 Contributed abstract

Developing a climate metric to inform permafrost decision-making

*Dhouha Ouali*¹, *Trevor Murdock*²

¹ ECCC

² ECCC

Presented by / Présenté par: *Dhouha Ouali*

Contact: dhouha.ouali@ec.gc.ca

Future projections of permafrost are particularly relevant for Canada, where permafrost covers approximately half of the land area. With continued and projected warming, permafrost thaw is expected, creating significant risks for buildings, transportation networks, northern communities, and natural systems, with impacts extending beyond the Canadian North. Despite continuous advances in permafrost science, a critical gap remains in delivering accessible, location-specific, and decision-relevant information that supports planning and adaptation. This gap reflects the complexity of processes governing permafrost formation and thaw. Multiple interacting factors are important, including climate, soil, geotechnical properties, geology, and land cover.

We present a first-order diagnostic framework designed to support users in assessing changes in future climate conditions that may indicate the potential for changes to permafrost. The approach applies an equilibrium permafrost suitability model that constrains permafrost suitability as a function of mean annual air temperature (MAAT), linking global warming levels to potential long-term permafrost loss.

In this talk, we will present results from the relatively straightforward task of generating future permafrost projections, along with our plans for the more challenging part of translating these projections into guidance that supports informed decision-making while minimizing the risk of misuse or maladaptation. This work contributes to the development of climate services for northern and permafrost-affected regions, improving the ability of communities, practitioners, and policymakers to plan for a changing climate.

ID: 12795 Contributed abstract

Climate Data for Contaminated Sites: A User-Tailored Application

*Eva Gnegy*¹, *Teah Lizee*², *Laura Van Vliet*³

¹ Environment and Climate Change Canada

² Environment and Climate Change Canada

³ Environment and Climate Change Canada

Presented by / Présenté par: *Eva Gnegy*

Contact: evagnegy@gmail.com

As demand for national-scale climate risk assessments grows, so does the need to communicate complex climate projections in ways that are accessible and actionable for non-specialist audiences. These assessments must account for significant geographic diversity across the country, with dozens of climate indices that can be difficult to navigate and interpret. A concrete example of what tailoring climate information for a large-scale national program might look like in practice will be presented.

The Federal Contaminated Sites Action Plan (FCSAP) is a federal program coordinating the assessment and remediation of thousands of contaminated sites across Canada. Site managers across several federal departments and agencies, and the consultants and contractors they work with, need reliable climate information to inform decisions.

Since 2020, the Canadian Centre for Climate Services (CCCS) has collaborated with FCSAP to integrate climate change information into contaminated site management. In 2025, and in direct response to user feedback gathered through ongoing engagement with the FCSAP community, CCCS developed the FCSApp: a custom web application that consolidates and simplifies access to site-level climate data. Built with a user-friendly interface, the app is designed to guide users through the process of interpreting climate data for site-level decision-making, and includes a climate hazards lens to contextualize site-relevant risks, colour-coded indicators to improve interpretation of projected changes, and downloadable PDFs aligned with FCSAP reporting templates.

Using FCSAP as a case study, this presentation explores how climate information can be developed and delivered through a user-informed process to meet the needs of a specific community, including a live demo of the FCSApp and a discussion of the design process behind it.

ID: 12625 Contributed abstract

**Observed changes in Canada's snowfall as inferred from precipitation
and daily mean temperatures**

*Budong Qian*¹, *Xiaolan L. Wang*², *Francis W Zwiers*³, *Yang Feng*⁴

¹ Science and Technology Branch, Agriculture and Agri-Food Canada

² Climate Research Division, Environment and Climate Change Canada

³ Pacific Climate Impacts Consortium, University of Victoria

⁴ Climate Research Division, Environment and Climate Change Canada

Presented by / Présenté par: *Xiaolan L. Wang*

Contact: Xiaolan.Wang@ec.gc.ca

Limited long-term snowfall observations make it difficult to document how snowfall is changing across Canada. Proxy snowfall measures derived from more plentiful temperature and precipitation may therefore be helpful. We consider simple partitioning of daily precipitation into rainfall and snowfall based on whether temperature is above or below either 0°C or a station specific threshold. Using daily mean temperature and the fixed 0°C threshold resulted in more accurate estimates of annual and seasonal snow-day number and water equivalent snowfall amount than using daily maximum or daily minimum temperature. Using station-specific thresholds further improved estimation accuracy. Trends estimated from these proxy snowfall indices well match those estimated from observed snowfall data for periods and locations when both are available. The median annual proxy snowfall amount in Canada derived from homogenized daily precipitation and temperature data decreased 2.5% per decade over 1949-2023 south of 60°N and increased 0.5% per decade north of 60°N. Seasonally, annual proxy snowfall amount has changed most rapidly in winter, declining 2.6% per decade in southern Canada and increasing 3.6% per decade in northern Canada. This simple approach improves prospects for the continuation of long-term snowfall monitoring in Canada by exploiting long-term daily precipitation and temperature data.

Session 5040

Convenors:

Debora Griffin (Environment and Climate Change Canada)

Chris McLinden (Environment and Climate Change Canada)

Mark Gordon (York University)

Satellite Earth Observations (SEO) have significantly advanced the monitoring,

use of large diesel trucks and excavators, large discrepancies in total NO_x emissions occur. Looking across all (TROPOMI) detectable mines suggests this mobile source, reporting of which to a national database is not required, leads to an underestimate of 30-40% as compared to the total suggested by NPRI alone.

Session: 5040 Satellite Earth Observations for understanding atmospheric composition and fluxes
Observations satellitaires de la Terre pour comprendre la composition et les flux atmosphériques 04/06/2026
14:02

ID: 12684 Contributed abstract

Spatiotemporal Variations of CO, HCHO, and NO₂ in Canadian Boreal Forest Wildfire Plumes during 2023-2025 Wildfire Seasons using TROPOMI

*Tadhg Hearne*¹, *Debora Griffin*², *Joseph Hung*³, *Sarah Toshiko Moser*⁴, *Kimberly Strong*⁵

¹ Department of Physics, University of Toronto, Ontario, Canada; Terahertz Technology Research Center, National Institute of Information and Communication Technology, Tokyo, Japan

² Air Quality Division, Environment and Climate Change Canada, Ontario, Canada

³ Department of Physics, University of Toronto, Ontario, Canada

⁴ Air Quality Research Division, Environment and Climate Change Canada, Ontario, Canada; Department of Physics and Astronomy, University of Waterloo, Ontario, Canada

⁵ Department of Physics, University of Toronto, Ontario, Canada

Presented by / Présenté par: *Tadhg Hearne*

Contact: t.hearne@utoronto.ca

Wildfires in Canada significantly impact atmospheric chemistry and public health. Biomass burning produces carbon monoxide (CO), nitrogen dioxide (NO₂), and formaldehyde (HCHO), among other species, and can lead to ozone (O₃) formation. Our research uses a 1-D advection model and a Gaussian-flux method to calculate enhancement rates of CO, HCHO, and NO₂ for Canadian boreal forest wildfires from the summers of 2023, 2024, and 2025 using satellite data. Enhancement rates for each species were calculated along the length of the plume using single-overpass TROPOMI measurements and MODerate resolution Imaging Spectroradiometer (MODIS) fire radiative power (FRP). The spatial variation of enhancement rates as a plume aged downwind was analysed and spatial variations confirmed CO emission primarily from the fire centre, with HCHO and NO₂ primarily resulting from secondary formation in the plume. Analysis of spatial and temporal

variations of enhancement ratios of vertical column density enhancements for 26 boreal wildfire plumes were examined for HCHO/NO₂ ratios. Ratios provided insight into impacts of surface-level ozone formation sensitivity to NO₂ and volatile organic compound concentrations as the plume aged downwind. These results can help evaluate chemical transport modelling of species evolution within a wildfire plume using TROPOMI data. Lastly, the diurnal variation of CO emission rates was studied for 38 fire plumes as they aged. Using plume age to convert emission rates to local emission, TROPOMI data were consistent with similar changes in fire intensity observed in Geostationary Operational Environmental Satellite (GOES) FRP over the diurnal cycle of a fire from smouldering to flaming phases. Temporal changes in emission rates also showed strong correlation with variation in GOES FRP, which could provide a novel way to calculate diurnal changes in emission coefficients with a single TROPOMI overpass. This research can also be used for advanced wildfire plume detection.

Session: 5040 Satellite Earth Observations for understanding atmospheric composition and fluxes
Observations satellitaires de la Terre pour comprendre la 04/06/2026
composition et les flux atmosphériques 14:14

ID: 12664 Contributed abstract

Comparing Eddy Covariance CO₂ Fluxes with Satellite-Derived Vegetation Productivity Using Flux Footprint Analysis at the Borden Forest

*Mirko De Marchi*¹, *Mark Gordon*², *Ralf Staebler*³, *Richard Bello*⁴,
*Baoxin Hu*⁵

¹ York University

² York University

³ ECCC

⁴ York University

⁵ York University

Presented by / Présenté par: *Mirko De Marchi*

Contact: mirkod2002@gmail.com

Eddy covariance towers provide temporally continuous measurements of ecosystem-atmosphere carbon exchange, yet their spatial representativeness remains a limitation for regional carbon monitoring. Remote sensing offers spatially continuous measurements of vegetation structure and productivity, allowing evaluation of forest canopy carbon exchange. This study investigates the relationship between eddy covariance CO₂ fluxes and satellite-derived vegetation productivity in a temperate mixed forest at the Borden Forest Research Station. Satellite products from NASA are used to quantify vegetation greenness and productivity. A two-

dimensional Lagrangian flux footprint model is applied to estimate the upwind surface area contributing measured fluxes, and satellite observations are spatially aggregated across the flux footprint to generate representative values for the upwind source area contributing to tower source area. The analysis evaluates how well satellite indicators of vegetation activity represent short-term variability in ecosystem carbon uptake and release, with particular attention to spatial heterogeneity within the flux source region. By comparing footprint-weighted satellite observations with tower measurements, this work assesses the potential for satellite data to extend localized flux observations to broader forested regions.

Session: 5040 Satellite Earth Observations for understanding atmospheric composition and fluxes
Observations satellitaires de la Terre pour comprendre la composition et les flux atmosphériques **04/06/2026**
14:26

ID: 12775 Contributed abstract

Machine Learning Representation of Surface Ozone Using Satellite Observations

*George Gerges*¹, *Debora Griffin*², *Mark Shephard*³, *Christopher Sioris*⁴, *Chris McLinden*⁵

¹ Environment Canada and Climate Change

² Environment Canada and Climate Change

³ Environment Canada and Climate Change

⁴ Environment Canada and Climate Change

⁵ Environment Canada and Climate Change

Presented by / Présenté par: *George Gerges*

Contact: george.gerges@ec.gc.ca

Ozone (O₃) at the Earth's surface is one of the most important air pollutants and has adverse effects on ecosystems and human health. Ozone formation occurs through nonlinear interactions between nitrogen oxides, volatile organic compounds, meteorology, and transport, where accurate predictions will be most difficult during brief episodes when ozone levels are elevated.

In this study, we evaluate machine learning (ML) methods to estimate daily surface ozone concentrations across North America with the aim of providing continent-wide continuous maps that fill spatial gaps between existing monitoring stations to enhance near-real-time ozone assessment. An integrated multi-parameter dataset spanning 2018–2024 was developed using satellite observations (NO₂ and HCHO) from TROPOMI, meteorological fields, MODIS land products, and ground-based ozone

tradespace explores polarization error level, wavelength range, and knowledge of albedo to determine which combination of parameters will give the best information for lowest cost.

Session 5054 Part 4

Convenors:

Kaley Walker, University of Toronto
Adam Bourassa, University of Saskatchewan

Satellite Earth observation (SEO) provides a unique global perspective on our planet's atmosphere and surface, including the oceans, land, vegetation, ice, and snow. Current and planned satellite missions from Canada and international agencies have provided and will provide a wealth of new information about the Earth system and that can be used to investigate a wide range of environmental and scientific questions.

This session encourages contributions from across the full SEO value chain, upstream, midstream and downstream, to illustrate the activities currently underway in Canada, involving industry, academia and government. This includes new measurement technologies and techniques, both passive and active; mission development; 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.

Session: 5054 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 4 Observation de la Terre par satellite : une vue unique de notre planète et un besoin essentiel pour naviguer vers notre avenir - Partie 4

**04/06/2026
12:30**

ID: 12668 Contributed abstract

Overview of MODIS and VIIRS Surface Products Produced at CCRS/CCMEO over Canada

*Alexander Trishchenko*¹

1

Presented by / Présenté par: *Alexander Trishchenko*
Contact: alexander.trichtchenko@nrcan-rncan.gc.ca

An overview of publicly available, national-scale satellite datasets produced at CCMEO/CCRS, NRCAN from MODIS and VIIRS sensors will be presented. These include surface albedo, NDVI, warm season (April-September) snow/ice probability maps, minimum snow/ice extent and several others. The issues of continuity between MODIS and VIIRS, as well

as METImage global imager recently launched on Metop/SG-A1 spacecraft will be discussed.

This work is supported through the project on high-frequency Long-Term Satellite Data Records, as part of the Cumulative Effects and the Status and Trends Mapping Programs at CCRS/CCMEO, NRCan.

References:

1. Trishchenko, A.P., S. Ghayourmanesh, C. Ungureanu, 2025: Weekly NDVI Composites from VIIRS over Canada. https://data.eodms-sgdot.nrcan-rncan.gc.ca/public/CCRS/Trishchenko_AAFC/.
2. Trishchenko, A, P. 2025. CCRS MODIS albedo over Canada at 250-m resolution and 10-day intervals. Registry of Open Data on AWS <https://registry.opendata.aws/ccrsmodisalbedo>.
3. Trishchenko, A.P., 2025: 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>
4. Trishchenko, A.P. and C. Ungureanu, 2024: Cumulative Changes in Minimum Snow/Ice Extent over Canada and Northern USA for 2000–2023. *Canadian Journal of Remote Sensing*, 2024, 50(1), 2371359. <https://doi.org/10.1080/07038992.2024.2371359>
5. Trishchenko, A.P., and C. Ungureanu. 2021. Minimum snow/ice extent over northern circumpolar landmass in 2000-2019: How much snow survives the summer melt? *Bulletin of the American Meteorological Society*, Vol. 102(No. 4): pp. E748–E764. <https://doi.org/10.1175/BAMS-D-20-0177.1>
6. Trishchenko, A.P., 2019: Clear-sky composites over Canada from visible infrared imaging radiometer suite: Continuing MODIS time series into the future. *Canadian Journal of Remote Sensing*, 45:3-4, 276-289, <https://doi.org/10.1080/07038992.2019.1601006>.

Session: 5054 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 4 Observation de la Terre par satellite : une vue unique de notre planète et un besoin essentiel pour naviguer vers notre avenir - Partie 4

**04/06/2026
12:42**

ID: 12692 Contributed abstract

Detection and Discrimination of Marine Oil Spills and Look-alike Phenomena in Synthetic Aperture Radar Imagery

*Xudong Huang*¹, *Biao Zhang*², *William Perrie*³, *Jinyu Sheng*⁴

¹ Dalhousie University

² Dalhousie University

³ Bedford Institute of Oceanography

Presented by / Présenté par: *Xudong Huang*

Contact: xudong.huang@dal.ca

Marine oil spills and look-alike phenomena, such as biogenic slicks, low-wind areas, rain cells, and sea ice, are manifest as dark patches in wide-swath synthetic aperture radar (SAR) imagery, posing significant challenges for reliable detection and discrimination. To address this problem, we propose the Multi-class Dark Object Detection Network (MDODNet), a dedicated framework for simultaneous detection and classification of these dark formations. MDODNet was trained and validated on a curated dataset of 11,040 annotated dark patches extracted from 2,192 Sentinel-1 VV-polarization SAR images, with annotations cross-validated using multi-source auxiliary data. The network design enhances feature representation through deeper layers and multi-scale feature fusion, while detection robustness is achieved via an anchor-based detection head optimized with “Focal and Efficient Intersection over Union” loss. Experimental results show strong detection performance, achieving average precisions of 87.04% for biogenic slicks, 93.28% for low-wind areas, 88.82% for oil spills, 90.04% for rain cells, and 89.16% for sea ice. For oil spill cases, detected regions are further refined using the UNet++ model to precisely delineate oil spill boundaries. Case studies demonstrate the strong generalization ability of MDODNet across diverse SAR datasets, underscoring its potential as a reliable and intelligent tool for operational marine oil spill monitoring.

Session: 5054 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 4
Observation de la Terre par satellite : une vue unique de notre planète et un besoin essentiel pour naviguer vers notre avenir - Partie 4 04/06/2026 12:54

ID: 12723 Contributed abstract

Enhancing the VIIRS cloud-mask from M- to I-band spatial resolution

*Shaheen Ghayourmanesh*¹, *Alexander Trishchenko*²

¹ Natural Resources Canada

² Natural Resources Canada

Presented by / Présenté par: *Shaheen Ghayourmanesh*

Contact: shaheen.ghayourmanesh@nrcan-rncan.gc.ca

The VIIRS sensors onboard Suomi-NPP and JPSS constellation provide global imagery that supports continuation of the monitoring capacity

established during the MODIS era. At the Canada Centre for Remote Sensing (CCRS), NRCan, we operate a processing chain that transforms VIIRS swath measurements into Canada-wide map products consistent with those derived from MODIS. VIIRS I-band observations are reprojected to a 250-m grid and M-band observations to a 500-m grid, providing daily inputs for snow/ice mapping, clear-sky surface reflectance, albedo and NDVI composites. Commonly available VIIRS cloud-mask products are delivered at moderate (M) resolution, which can miss small cloud structures, blur cloud boundaries over heterogeneous terrain and near shorelines. Additionally, accurate snow/ice and cloud discrimination during the melt season, as well as nighttime cloud detection, remains challenging. For consistency with our MODIS processing, we developed a Scene Identification (SceneID) technique using VIIRS I-bands as a reference. The method uses top-of-atmosphere reflectances and a sequence of spectral threshold tests, tuned for VIIRS. It also generates the cloud-shadow mask. Results and applications of the new VIIRS SceneID will be presented and discussed.

This work is supported through the project on high-frequency Long-Term Satellite Data Records as part of the Cumulative Effects and Status and Trends Mapping Programs at CCRS/CCMEO, NRCan.

Session: 5054 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 4 Observation de la Terre par satellite : une vue unique de notre planète et un besoin essentiel pour naviguer vers notre avenir - Partie 4

**04/06/2026
13:06**

ID: 12652 Contributed abstract

Satomaly: A LSTM based tool to detect anomalies in satellite data

*Vikram Khade*¹, *Alain Beaulne*², *David Lobon*³

¹ MSC, ECCC

² MSC, ECCC

³ MSC, ECCC

Presented by / Présenté par: *Vikram Khade*

Contact: vikram.khade@ec.gc.ca

Monitoring observations is a critical component of operational data assimilation systems, especially for detecting anomalies. The Meteorological Service of Canada (MSC) is developing Satomaly, an AI based tool for data checking, demonstrated here on IASI spectral infrared radiances. Satomaly detects anomalies in time series of these statistical quantities: average and standard deviation of innovations (observations

minus prior), data counts, and bias correction, each calculated using values aggregated within six hour assimilation windows for the operational Global Deterministic Prediction System.

Currently, MSC uses a Fixed Threshold (FT) methodology to automatically detect anomalies in assimilated observation statistics. This technique uses the previous 22 days' average and standard deviation to set limits; values outside these bounds are flagged as anomalies. As an initial development step, we generated 22 day time series samples of statistical quantities over four years. Without an expert labeled time series, we used the FT based dataset to train a Long Short Term Memory (LSTM) network, a type of Recurrent Neural Network, independently over a few IASI channels to predict the current value from the previous 22 days. Comparing predictions with actual values allowed anomaly identification. To evaluate Satomaly, we used the FT technique as baseline and calculated the confusion matrix. Using appropriate thresholds, Satomaly detected all anomalies without misses, though with a few false alarms.

Short to medium term plans include refining training to all IASI channels, deploying Satomaly in real time in a simulated operational environment, and improving detection relative to the FT technique. Once validated, Satomaly will be extended to other satellite instruments and products. Periodic retraining will also be assessed. Further goals include adapting the tool to all observation types and detecting anomalies in long term evolutionary trends.

Session: 5054 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 4 Observation de la Terre par satellite : une vue unique de notre planète et un besoin essentiel pour naviguer vers notre avenir - Partie 4

**04/06/2026
13:18**

ID: 12772 Contributed abstract

Vertical Profile of Freezing Rain: Satellite Observations in W-Band

*Sabrina Kirk*¹ , *Julie Mireille Thériault*²

¹ Université du Québec à Montréal (UQAM)

² Université du Québec à Montréal (UQAM)

Presented by / Présenté par: *Sabrina Kirk*

Contact: kirk.sabrina@courrier.uqam.ca

Since the launch of the first precipitation radar in space in 1997, cloud vertical profiles of rain and snow events have been extensively studied. Yet, despite the potential catastrophic consequences of freezing rain on society, as seen with the 1998 Great Ice Storm, very few studies have concentrated

on the detection of freezing rain events from space. With its large latitude coverage, $\pm 82^\circ$, and its W-band cloud profiling radar able to detect lighter precipitation, the CloudSat satellite mission is uniquely suited to the task. Freezing rain occurrences identified with the Integrated Surface Database in North America between July 2006 and April 2011 are used along with associated CloudSat profiles. Through an analysis of up to 128 CloudSat vertical profiles, we show that, between 1.2 and 6 km above sea level, most (> 90 %) freezing rain vertical profiles have a radar reflectivity factor of 5 to 12 dBZe. Thus, freezing rain profiles have a higher radar reflectivity factor compared to snow vertical profiles (-15 to 8 dBZe), especially above 2.5 km. With ancillary temperature data from the European Centre for Medium-Range Weather Forecasts, we find that most of the vertical profiles are linked to the melting process, the rest being linked to the supercooled warm-rain process. Cloud phase data from CloudSat and CALIPSO is used to validate the freezing rain process identification. Freezing rain criteria based on those results could be used to find the global distribution of freezing rain events, separated according to their formation process.

Session: 5054 Satellite Earth Observation: A unique view of our planet and a critical need for navigating our future - Part 4 Observation de la Terre par satellite : une vue unique de notre planète et un besoin essentiel pour naviguer vers notre avenir - Partie 4 **04/06/2026 13:30**

ID: 12665 Contributed abstract

Multidecadal Open-Water Trends in the Northwest Passage from Satellite and Canadian Ice Service Data

*Alexander Trishchenko*¹, *Yi Luo*²

¹ Canada Centre for Remote Sensing, NRCan

² Canadian Ice Service, ECCC

Presented by / Présenté par: *Alexander Trishchenko*

Contact: alexander.trichtchenko@nrcan-rncan.gc.ca

We analyzed six satellite-based sea ice concentration (SIC) datasets over the Northwest Passage, which provides the shortest route between the Atlantic and Pacific Oceans in the Canadian High Arctic. The datasets include a novel MODIS SIC dataset produced at the Canada Centre for Remote Sensing, operational ice charts from the Canadian Ice Service, passive microwave SIC from the National Snow and Ice Data Center, and the European Organisation for the Exploitation of Meteorological Satellites based on DMSP/AMSR-E/AMSR2 observations. The data cover the period since 1979. The maps of open-water days each year was calculated using a threshold $SIC \leq 15\%$. A six-dataset average time series was also constructed to quantify biases among the datasets. The analysis was

conducted for the entire NWP region as well as along seven primary marine shipping routes.

The study will present results regarding consistency among various sources of SIC data, as well as analysis of multidecadal trends in open-water duration and associated near-surface thermodynamic conditions derived from climate data. The findings provide an updated assessment of navigability in the NWP and contribute to improved understanding of long-term Arctic sea ice variability.

This work is supported through the project on high-frequency Long-Term Satellite Data Records as part of the Cumulative Effects and the Status and Trends Mapping Program at CCRS, NRCan.

References:

Trishchenko, A.P., and Y. Luo, 2021. Landfast Ice Mapping Using MODIS Clear-Sky Composites: Application for the Banks Island Coastline in Beaufort Sea and Comparison with Canadian Ice Service Data. *Canadian Journal of Remote Sensing*, 47(1), pp. 143-158, <https://doi.org/10.1080/07038992.2021.1909466> .

Trishchenko, A.P., V.E. Kostylev, Y. Luo, C. Ungureanu, D. Whalen, J. Li, 2022. Landfast ice properties over the Beaufort Sea region in 2000-2019 from MODIS and Canadian Ice Service data. *Canadian Journal of Earth Sciences*. Volume 59 (11), pp. 847 – 865. <https://doi.org/10.1139/cjes-2021-0011>.

Session 5070

Convenors:

Philippe Gachon & Bernard Motulsky, University of Québec in Montréal
Claude Masse & Johanne St-Cœur, Meteorological Service of Canada, ECCC
Jacques Lavigne, Améthyste communications

Our planet's climate system is approaching a critical and potentially irreversible tipping point due to the continuous rise in greenhouse gas concentrations. Yet, this evolution unfolds within pervasive uncertainty: uncertainty about the magnitude and speed of changes, their cascading impacts on natural and human systems, and society's adaptive capacity. Recent decades and years have seen accelerated warming, particularly in Arctic and subarctic regions such as Canada, accompanied by increasingly occurrence and intense hydrometeorological extremes and hazards. These hazards interact with demographic growth and economic development, amplifying vulnerabilities and exposures in unpredictable ways.

To tackle these complex issues and turning uncertainty into opportunity to work under crossed disciplines and breaking silos, various research networks have been developed, as the RIISQ (InterSectoral Flood Network of Québec), both in Canada and abroad. Then, this session is an excellent opportunity to bring together various experiences and expertise, and invites contributions addressing

key issues in climate risk management, namely:

- Characterization and predictability of hydrometeorological hazards under uncertainty
- Strategies to reduce vulnerability and enhance resilience
- Governance and risk management frameworks adaptable to evolving scenarios and disruptive climate futures
- Risk communication and stakeholder engagement in uncertain contexts

Session: 5070 Managing Hydrometeorological Risks in an Uncertain World Gérer les risques hydrométéorologiques dans un monde incertain

**04/06/2026
12:30**

ID: 12702 Contributed abstract

Risk Assessment and Communication Framework (RACF) and Emergency Management applied to a recent case study of a snow squall event in Simcoe County between December 29th and January 1st

Grant Durfey (Simcoe County Emergency Management), Eric Tomlinson (Environnement and Climate Change Canada)

*Grant Durfey*¹, *Eric Tomlinson*²

¹ Simcoe County

² Meteorological Service of Canada, Environment and Climate Change Canada

Presented by / Présenté par: *Eric Tomlinson*

Contact: eric.tomlinson@canada.ca

The Risk Communication Assessment Framework and Impact Based Forecasting are at the forefront of how meteorologists are aiming to adapt their messages to better improve communication to partners and the public. However, uncertainty can be an important limiting factor in how forecasts are interpreted from the perspective of the meteorologist and the partner. As a follow up to Claude Masse's presentation on the RCAF playbook, in this case study focusing on a recent snowsquall event in Simcoe County (Ontario) around the turn of the new year, namely from December 29th 2025 to January 1st 2026, we will examine how risk assessment was perceived from the standpoint of a meteorologist and from the standpoint of an emergency manager from Simcoe County. We will go through the sequence of events, more precisely at the Early Notification (EN) messaging that was sent out in the leadup to the snow squalls, and how messaging was interpreted by emergency management officials. The purpose of this exercise will be to demonstrate the two different ways of thinking between a forecaster that aims to forecast the impacts of an event whilst dealing with uncertainty, and the emergency management that needs

to plan for the consequences.

**Session: 5070 Managing Hydrometeorological Risks in
an Uncertain World Gérer les risques
hydrométéorologiques dans un monde incertain**

**04/06/2026
12:42**

ID: 12825 Contributed abstract

**La communication des risques dans un contexte d'incertitude et de
bouleversements climatiques : l'ossature de la résilience climatique**

*Philippe Gachon*¹, *Bernard Motulsky*², *Éric Martel*³

¹ Université du Québec à Montréal

² Université du Québec à Montréal

³ Ville de Pincourt

Presented by / Présenté par: *Philippe Gachon*

Contact: gachon.philippe@uqam.ca

Les caractéristiques des aléas hydrométéorologiques, dont l'occurrence, la durée, l'intensité et la récurrence sont affectées par les bouleversements climatiques, transforment profondément notre rapport au territoire et à la sécurité. Inondations fluviales, crues soudaines, ruissellements urbains et refoulement d'égouts surviennent plus fréquemment et parfois hors saison, mettant à rude épreuve des infrastructures conçues pour des régimes hydrologiques d'un autre temps. Dans ce contexte, la communication des risques demeure trop souvent un « dernier recours » ou est réalisée dans la précipitation : on prévient tard, on explique peu, on ne fait pas obstacle à la désinformation et l'on peine à transformer l'information en action durable. Or, communiquer ne consiste pas seulement à transmettre des données et des informations; c'est aussi préparer, outiller, relier les savoirs, partager la connaissance et soutenir la décision. La communication devient alors un maillon inéluctable de toute la chaîne que peut représenter une planification inclusive sociale; et complémentaire aux ouvrages physiques et aux règlements, conditionnant leur acceptabilité et leur efficacité. Elle se fait également à partir d'une relation de confiance entre les parties prenantes, celle-ci devant reposer sur des données probantes et des informations clairement présentées, qu'elles soient de nature scientifique ou pratique voire traditionnelle. Cette présentation fournira un exemple d'un aléa hydrométéorologique majeur, soit la tempête Debby survenue en août 2024 dans le sud du Québec, et examinera comment une municipalité durement touchée a mis en place diverses mesures de rétablissement et un exercice de communication afin de réduire les conséquences advenant qu'un autre événement ne survienne dans l'avenir. Elle terminera par des recommandations sur la communication des risques d'inondation afin de servir de base au développement de la résilience territoriale et sociétale, voire de la culture du risque dans le contexte des bouleversements

**Session: 5070 Managing Hydrometeorological Risks in
an Uncertain World Gérer les risques
hydrométéorologiques dans un monde incertain**

**04/06/2026
12:54**

ID: 12705 Contributed abstract

**Risk Assessment and Communication Framework (RACF) and
Emergency Management in an Increasingly Uncertain Environment**

*Claude Masse*¹

¹ Meteorological Service of Canada, Environment and Climate Change
Canada

Presented by / Présenté par: *Claude Masse*

Contact: eric.tomlinson@ec.gc.ca

National meteorological services are increasingly transitioning toward Impact-Based Forecasting (IBF) and Early Notification (EN) systems to provide decision-relevant, actionable information beyond traditional hazard forecasts. This evolution reflects the growing need to support emergency managers and communities facing more frequent and complex high-impact weather events.

Within this context, the Meteorological Service of Canada (MSC), part of Environment and Climate Change Canada (ECCC), has advanced this shift through the development of a Canadian Risk Assessment and Communication Framework (RACF). The RACF is grounded in principles of continuous risk communication and value creation, emphasizing the integration of scientific information with decision-making needs throughout the emergency management cycle.

In November 2025, ECCC launched RiTA (Risk-based Tiered Alerting), marking a transition away from fixed meteorological thresholds toward a risk-informed, tiered alerting system. This approach recognizes that the value of warnings depends not only on forecast accuracy, but also on how uncertainty is interpreted, communicated, and incorporated into operational decisions.

Building on Golding's Warning Value Chain, this presentation explores how uncertainty evolves from scientific model variability into interpreted and communicated risk. It argues that failures often arise not from forecast error itself, but from breakdowns in translating uncertainty into decision-relevant guidance. The framework will be illustrated through a case study of a significant snow squall/blizzard event affecting Simcoe County just prior to New Year 2026.

ID: 12857 Contributed abstract

**Exploring Tornado Experience Through Thematic and Social Network
Analysis: A Qualitative Study of disaster response and recovery
following the 2021 Barrie EF2 Event**

*Jennifer Spinney*¹

1

Presented by / Présenté par: *Jennifer Spinney*

Contact: jspinney@yorku.ca

People in Ontario communities experience severe weather in complex ways. On July 15, 2021 an EF2 tornado with winds reaching 210 km/hr tore through the city of Barrie, Ontario, and for a variety of reasons, residents experienced differing degrees of anticipation, preparation and response, differing impacts and also differing recovery trajectories. Recovery from tornado disaster is a process contingent upon multiple factors coming together to produce successful outcomes. From anthropologists Tierney and Oliver-Smith (2012) we know that recovery is an adaptive process, one that is strongly influenced by the relative power in societies, pre-disaster conditions, severity of disaster impact, the effectiveness of initial response actions, the quality of governance systems, institutional capacity, and systems for the provision of post-disaster recovery assistance. These factors contribute to non-linear, uneven recovery experiences, including those that are interrupted, stalled altogether, or inclusive of multiple displacements.

Supplementing survey work carried out by Instant Weather Group on the event, this presentation shares results of a qualitative research study that explored disaster experience leading up to, during and after the 2021 Barrie tornado, including hazard awareness and response, structural and other impacts, as well as strategies used to cope and recover, from the perspective of Barrie residents and public officials. Underpinned by theories of disaster recovery and aided by thematic and social network analysis of semi-structured interview data with 11 residents and seven public officials, results underscore the importance of communication, teamwork and collaboration, understanding local needs, and established relationships for enhancing social support and creating more effective tornado response and recovery in and for communities.

The presentation will conclude with resident-informed strategies to reduce vulnerability and enhance resilience in the face of tornado disasters.

ID: 12728 Contributed abstract

**Evaluating Census Tract Level Flood Risks in the Greater Toronto
Hamilton Area using CMIP6 derived Extreme Precipitation Indices**

*Naharin Zannat*¹, *M. Altaf Arain*²

¹ McMaster University

² McMaster University

Presented by / Présenté par: *Naharin Zannat*

Contact: zannatn@mcmaster.ca

Intensity and frequency of extreme precipitation events and associated flood risks are projected to increase under future climate change. Highly urbanized catchments with extensive impervious surfaces like the Greater Toronto and Hamilton Area (GTHA) may experience severe flooding during extreme precipitation events. While regional flood plain mapping and watershed scale hydrologic studies are well established in the region, fewer studies have explicitly incorporated projected changes in extreme precipitation as flood triggers or spatial framework of flood risks at the Census tract level in GTHA.

This study developed an index-based flood risk assessment that integrates projected changes in maximum 1-day, and maximum 5-day precipitation derived from a multi model Intergovernmental Panel on Climate Change (IPCC), Coupled Model Intercomparison Project Phase 6 (CMIP6) ensemble data. Baseline and mid-century extreme precipitation indices are calculated for the two different future climate change scenarios i.e. the Shared Socioeconomic Pathways, SSP 2-4.5 and SSP5-8.5. Projected changes in these indices are interpreted as indicators of amplified flooding risk. Projected indices for both climate scenarios are combined with terrain and land surface-based conditioning parameters including curve number, flow accumulation, elevation to construct a climate conditioned hazard index across the GTHA. Area weighted metrics are used to represent variability of hazard within each census tract. Tract level future flood risk indices are generated by integrating socio demographic exposure and vulnerability factors. The preliminary ensemble results indicate a mean mid-century increase of approximately 11-12% in maximum 1-day precipitation and 9-13% in maximum 5-day precipitation across the GTHA, which is expected to increase relative flood risk in this highly urbanized region. This study will help in strategic planning and resilience prioritization in the GTHA and broader Great Lakes region under changing climate.

Session 5080

Convenors:

Caroline Floyd, CatIQ

Laura Twidle, CatIQ

Canadian catastrophes are on the rise. Each year, the insured cost of severe weather events in Canada tops 2 billion dollars – sometimes much more – as homeowners and businesses face damage from hail, flood, wind, and fire. The overall economic toll, encompassing items such as lost business revenue, un- or underinsured property, and damage to infrastructure – is significantly larger, and significantly harder to quantify.

Attempting to bend down the risk curve for Canadians is a difficult proposition, with underlying difficulties in data availability and collection, inconsistent support from governments, and the challenge of motivating a broad social change against the backdrop of uncertain future conditions. Asking people and communities to protect themselves from a flood that is certain to occur tomorrow may be relatively straightforward; asking them to prepare for a 1-in-100 storm may engender a very different response. Changing trends in extreme weather both exacerbate that issue and make it even more pressing to address.

This session will welcome speakers working in the risk and resilience space, with an emphasis on applied and social science. Topics we hope to explore include mapping natural perils in Canada; what do we know (and not know) about climate change's impacts on exposure of the built environment to hail, wildfire, and flood? How are the economic impacts of 'natural disasters' changing with time? What avenues are available to both mitigate risks, and protect the natural environment? What links are there between vulnerable populations and increased risks? And how can we advocate for governments, communities, and individuals to steps to take to mitigate their own risk(s) when there is inherent uncertainty in forecasts and climate outlooks?

Session: 5080 Bolstering Resilience in Uncertain Times

Renforcer la résilience en période d'incertitude

04/06/2026

13:50

ID: 12710 Contributed abstract

Catastrophic Loss Trends in Canada

*Caroline Floyd*¹, *Laura Twidle*²

1

2

Presented by / Présenté par: *Caroline Floyd*

Contact: vortmax@gmail.com

2025's severe weather events across Canada didn't pack the record-shattering punch of their 2024 counterparts, but delving into the data reveals that even a "quiet year" carries an increasingly heavy cost for Canadians.

Natural and human-caused disasters, known as "catastrophes", or CATs, in the insurance industry, cost billions of dollars every year in Canada. Identifying pain points and preparing for more frequent, more severe extreme weather events is key to reducing impacts on Canadians. Insured loss data in combination with climate data and mitigation techniques can help frame important discussions between policy-makers, industry, and private citizens. Where are existing risks increasing, and where are new risks emerging? How do these compare to risks in other regions with developed insurance markets, and what is unique to the Canadian landscape?

This presentation reviews 2025's catastrophes and puts them in context with events from recent years in Canada and abroad. We will highlight emerging trends from the past ~six years of data, using information collected by Catastrophe Indices and Quantification Inc. (CatIQ) and parent company PERILS AG, including a look at urban interface fires, severe convective storms, and flooding.

Session: 5080 Bolstering Resilience in Uncertain Times Renforcer la résilience en période d'incertitude

**04/06/2026
14:02**

ID: 12641 Contributed abstract

Probabilistic Assessment of Tornado Hazard to Wind Energy Infrastructure in Canada.

*Aubert Lamy*¹

¹ McGill University

Presented by / Présenté par: *Aubert Lamy*

Contact: aubert.lamy@mail.mcgill.ca

Canada is expanding wind energy as part of its transition away from fossil fuels. Wind turbines operate reliably in most conditions, but they remain exposed to severe convective storms. Recent observations show that Canada may experience over 100 tornadoes annually, and a single event can cost millions of dollars in damage. As wind farms become more widespread, understanding this risk becomes increasingly important.

Assessing tornado hazard is not straightforward. Tornado intensity is typically inferred from damage surveys rather than direct wind

measurements, and the near-surface wind field is difficult to observe in detail. This project combines historical tornado records with physically based simulations of tornado wind fields to estimate how often wind farms may experience damaging winds. The framework emphasizes how uncertainty in wind structure and event occurrence influences long-term risk estimates.

The analysis produces probabilistic risk metrics, including return-period curves and occurrence losses, allowing both frequent moderate losses and rare, high-impact events to be evaluated. This distinction is particularly relevant for insurers and infrastructure planners, who must prepare for infrequent but costly “1-in-100-year” type events with limited historical data. By applying vulnerability functions to spatial exposure maps of wind farms, this analysis translates atmospheric hazard into long-term risk measures that support more informed investment and planning decisions. As renewable energy production accelerates, incorporating extreme wind hazard into financial and infrastructure planning can help reduce unforeseen costs and strengthen the resilience of Canada’s energy transition.

Session: 5080 Bolstering Resilience in Uncertain Times Renforcer la résilience en période d'incertitude

**04/06/2026
14:14**

ID: 12862 Contributed abstract

4050 Quantifying Climate Change Impacts on Infrastructure: Insights from Three Canadian Case Studies

*Charles-Antoine Gosselin*¹, *Pineau Pierre-Olivier*², *Pier-André Bouchard St-Amant*³

¹ WSP Canada

² HEC Montréal

³ ENAP

Presented by / Présenté par: *Charles-Antoine Gosselin*

Contact: charles-antoine.gosselin@wsp.com

This session presents three recent studies that advance methodologies for assessing the impacts of climate change on public infrastructure in Canada. Together, they illustrate how integrated economic and risk-based approaches can better inform adaptation planning and investment decisions across key infrastructure sectors.

Study 1 – Energy Systems and Climate Risk in Québec

The first study examines the economic vulnerability of Québec’s energy assets to climate risks, highlighting the need for adaptive planning across

energy production, transmission, and distribution systems. The analysis emphasizes how compound and interacting hazards can significantly alter risk profiles and investment priorities. The modeling framework used to assess the economic consequences of multi-hazard interactions will be introduced, with a particular focus on the dynamic interactions between vegetation, freezing rain, and wind, and their implications for asset reliability and system resilience. The sub-segment will be concluded by discussing next steps and the implications of decarbonization pathways for climate resilience, emphasizing the need to align mitigation strategies with infrastructure adaptation objectives.

Study 2 – Transportation Infrastructure under Climate Change

The second study focuses on transportation infrastructure, demonstrating how climate-induced stressors threaten asset longevity, maintenance costs, and service performance. We will introduce the methodology used to model transportation asset inventories under climate change, and will present a synthesis of key impacts affecting major transportation asset classes. Preliminary results, with a focus on methodological refinements and implications for long-term infrastructure management will be addressed.

Study 3 – National Cost–Benefit Analysis of Climate Adaptation

The third study presents a national cost–benefit analysis of climate change impacts on public infrastructure in Canada (Prepare, or Repair Report, by the Canadian Climate Institute), underscoring the rapidly escalating financial burden of climate-related damages—now amounting to billions of dollars annually. The study identifies the economic conditions under which adaptation investments deliver the greatest benefits.

Charles-Antoine Gosselin will present the main results of the recent Canadian Climate Institute study, Prepare or Repair, prepared by WSP Canada, highlighting key findings on avoided costs, adaptation timing, and decision-making under uncertainty.

Conclusion

Taken together, these studies underscore the importance of robust, sector-specific cost–benefit metrics to guide infrastructure planning and prioritize adaptation investments. Without improved evaluation tools, Canada risks underinvesting in resilience, exacerbating social and regional inequalities, and missing opportunities for sustainable and inclusive growth.

The session invites discussion on methodological innovations, data challenges, and policy implications for infrastructure planning in a rapidly changing climate

Program Committee / Comité de programme

Matthew Asplin
Stephen Déry
Serge Desjardins
Gordon Griffith (CMOS Executive Director)
Martin Leduc
Qing Liao (CMOS Office Manager)

Plenary Team / Équipe des plénières

Adam Monahan
Nancy Soontiens
Julie Thériault

Volunteers / Nos bénévoles

Cassandra Chanen
Shreya Dev
Lynn Engel
Polina Erofeeva
Karen Garcia Perdomo
Kayla Joachim
Lyna Karkri
Bethany Klein
Duane Darren Noel
Solace Purtill
Sanchia Sehan
Youssif Shaaban
Manleen Singh
Ehsan Taghizadehghoozhd
Myla Weiman

INTRODUCTION

- Atmospheric rivers (ARs) are major drivers of precipitation and precipitation extremes along the west coast of North America, with particularly strong impacts over British Columbia (BC), Canada (Sharma and Déry, 2020).
- Global ARs are projected to increase in intensity in a warming climate (Zhang et al., 2024).

OBJECTIVES

- To apply a modified version of the Atmospheric River Detection Tool (ARDT) from Guan and Waliser (2015) on CMIP6 multi-model simulations under the extreme SSP5-8.5 scenario.
- To evaluate projected changes in AR-associated precipitation contributions to fall season (September-October-November, SON) precipitation over British Columbia in a changing climate.

DATA AND METHODS

- Focused on fall seasons (SON), as a preliminary analysis period with ERA5-Land precipitation data as baseline climatology.
- Extracted (u , v , q) from ERA5 reanalysis and three high-resolution CMIP6 models (see Table 1) to compute Integrated Water Vapor Transport (IVT) and Integrated Water Vapor (IWV).
- Applied the Atmospheric River Detection Tool (Guan and Waliser, 2015) to ERA5 for evaluation and to CMIP6 simulations for a historical period (1979-2010) and the late 21st century period (2069-2100) future projections.
- Developed AR-landfalling catalog for BC coastal stations, as shown as red dots on the domain map (Figure 1).
- Used high-resolution (0.25°) CMIP6-CORDEX North America precipitation data to quantify AR-associated precipitation contribution as Sharma & Déry (2020), Gershunov et al., (2017).

STUDY AREA

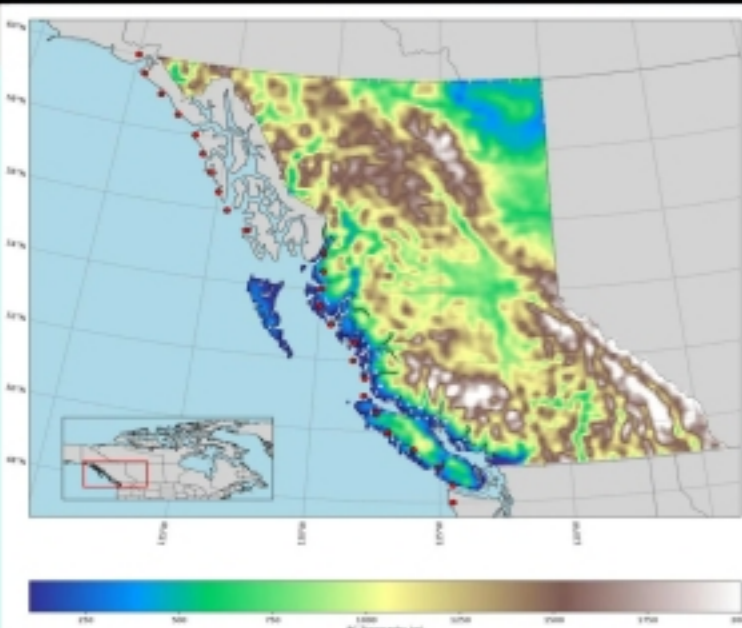


Figure 1: Study domain of British Columbia (BC), Canada. The main panel shows the topography of BC, highlighting the complex terrain that strongly influences regional precipitation patterns. The inset map displays Canada, with a red rectangle indicating the location of BC within the national context. Red dots represent the designated coastal stations for the AR landfalling catalog.

RESULTS

- Figure 2 shows that the future multi-model ensemble projects an intensification of coastal precipitation under a high emission scenario. This is consistent with the thermodynamic expectation of enhanced moisture transport in a warmer atmosphere. It is noteworthy that the CMIP6 ensemble is generally wetter than ERA5-Land.
- Positive and strong precipitation trends toward the late 21st century encompass most of the domain with strongest trends in northern British Columbia (Figure 3).
- All three CMIP6 models consistently project an increase in Atmospheric River-associated precipitation contribution to SON seasonal precipitation under SSP5-8.5 (Figure 4).
- Despite differences in spatial patterns, the models agree on a strong positive signal, indicating that ARs will play a more dominant role in future precipitation. This enhancement is likely driven by increased atmospheric moisture under warming conditions (Figure 4).

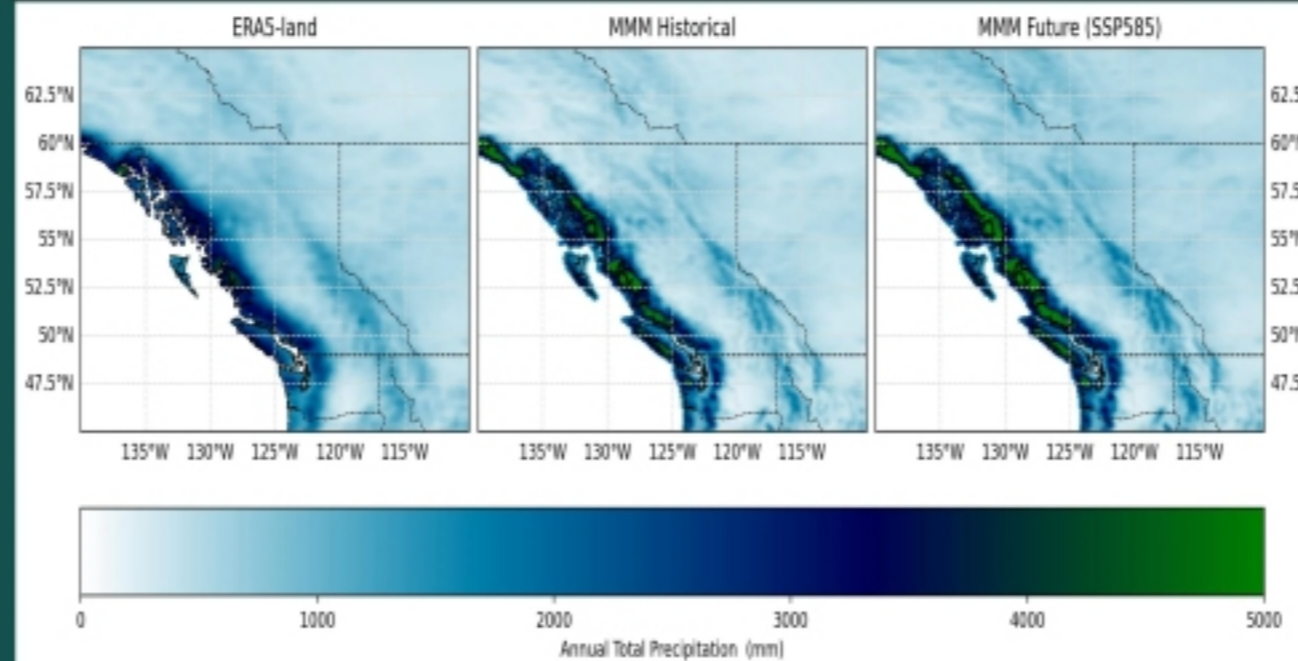


Figure 2: Mean annual precipitation over British Columbia from (a) ERA5-Land reanalysis, (b) historical multi-model mean (MMM) ensemble, and (c) future SSP5-8.5 MMM ensemble. The MMM ensembles represent the averaged response across the selected CMIP6 models. The comparison highlights differences between observed and simulated precipitation patterns, as well as projected changes under a high-emissions scenario by the late 21st century.

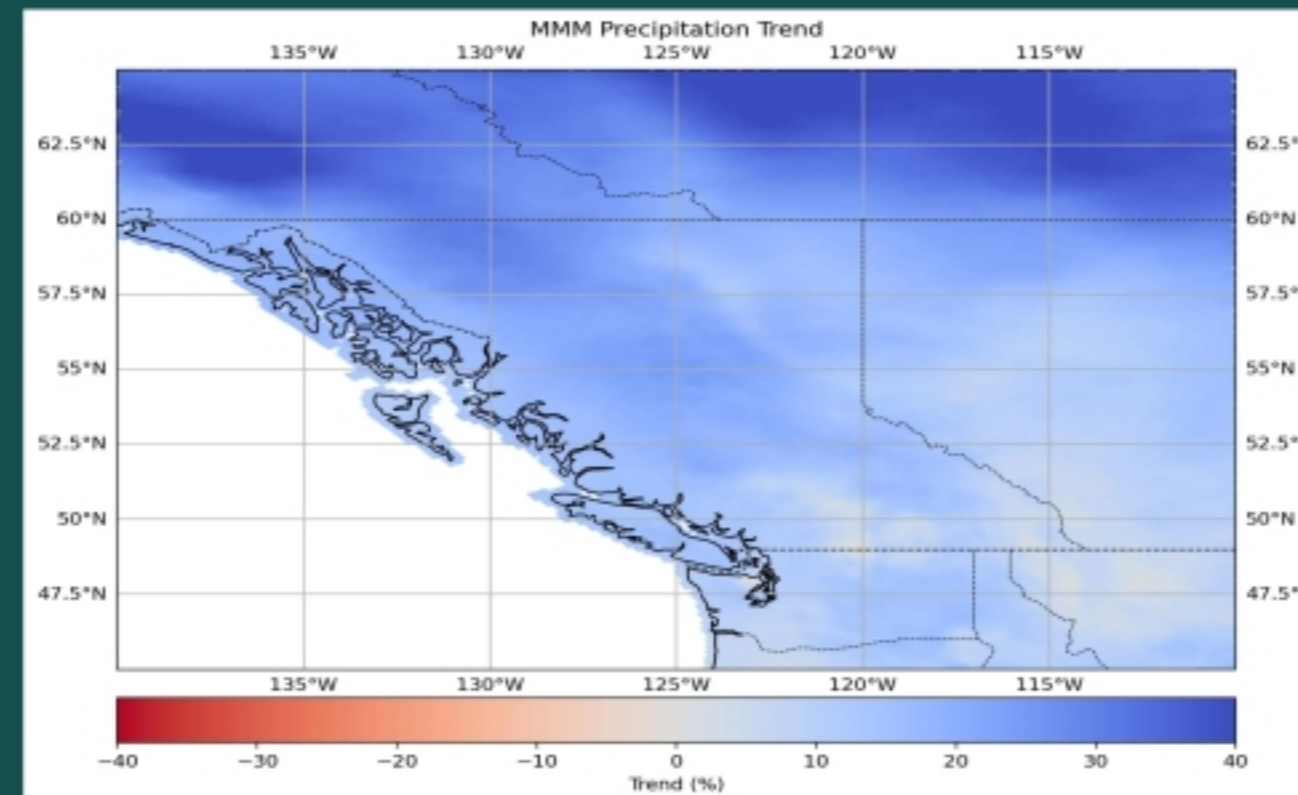


Figure 3: Spatial distribution of projected changes in annual precipitation (%) over British Columbia, calculated as the relative difference between the late 21st century (SSP5-8.5) and the historical period. Positive values indicate increasing precipitation, while negative values indicate drying. The patterns highlight regions of intensification and variability in future precipitation under a warming climate.

| CMIP6 models | Spatial Resolution | Frequency | Atmospheric Variables | CMIP6 members |
|---------------|--------------------|-----------|-----------------------|------------------------------|
| EC-Earth3 | 0.7°×0.7° | daily | u, v, hus | r1i1p1f1, Historical, ssp585 |
| EC-Earth3-CC | 0.7°×0.7° | daily | u, v, hus | r1i1p1f1, Historical, ssp585 |
| MPI-ESM1-2-HR | 0.9°×0.9° | daily | u, v, hus | r1i1p1f1, Historical, ssp585 |

Table 1: Selected CMIP6 high resolution models that has the corresponding high resolution daily precipitation datasets. Where u is wind zonal component; v is meridional components; and hus is the specific humidity. All variables are defined on 8 atmospheric pressure levels. r1i1p1f1 is CMIP6 model's experiment id.

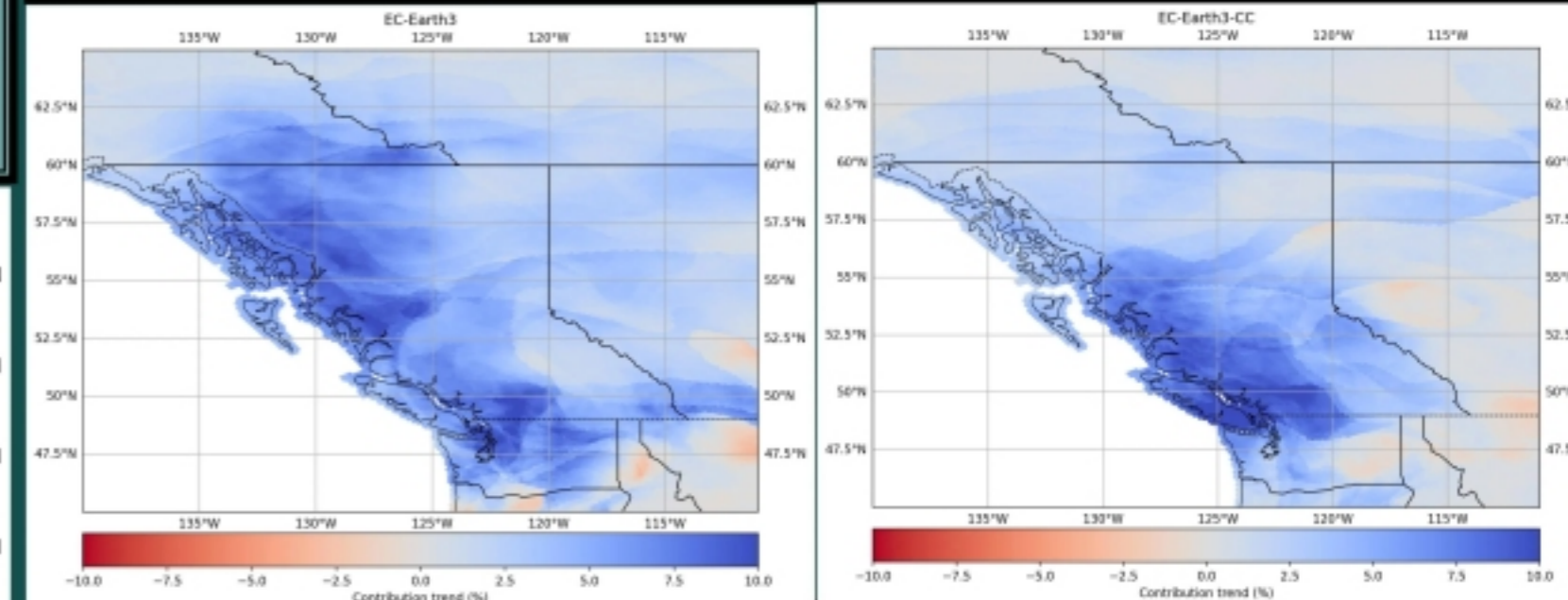


Figure 4: Projected change in AR-associated precipitation contribution to SON total precipitation ratio (%), computed as a difference between the late 21st century and the historical period under SSP5-8.5 scenario, for three CMIP6 models: (a) MPI-ESM1-2-HR, (b) EC-Earth3, and (c) MPI-ESM1-2-HR. AR-associated precipitation contribution is defined as the ratio of total seasonal precipitation attributed to ARs to the total seasonal precipitation.

FINAL REMARKS

- Applying an AR detection algorithm offers flexibility in domain, resolution, and model application compared to ARTMIP.
- The results suggest a shift toward greater dependence on ARs for seasonal (SON) precipitation across BC by 2100.

ACKNOWLEDGEMENTS

This work was supported by the Government of British Columbia (Ministry of Forests). We acknowledge the PAVICS-Uranos data platform and the Copernicus Climate Data Store for providing access to the datasets used in this study.

REFERENCES

Gershunov, A., Shulgina, T., Ralph, F. M., Lavers, D. A., and Rutz, J. J. 2017: Assessing the climate-scale variability of atmospheric rivers affecting western North America, *Geophysical Research Letters*, 44, 7900–7908, doi: 10.1002/2017GL074175.
 Guan, B., and Waliser, D. E. 2015: Detection of atmospheric rivers: Evaluation and application of an algorithm for global studies: *Journal Geophysical Research: Atmospheres* 120, 12514–12535. <https://doi.org/10.1002/2015JD024257>
 Sharma, A. R., and Déry, S. J. 2020: Contribution of atmospheric rivers to annual, seasonal, and extreme precipitation across British Columbia and southeastern Alaska, *Journal of Geophysical Research: Atmospheres*, 125(9), e2019JD031823, doi: 10.1029/2019JD031823.
 Zhang, L., Zhao, Y., Cheng, T. F., and Lu, M. 2024: Future changes in global atmospheric rivers projected by CMIP6 models, *Journal of Geophysical Research: Atmospheres*, 129, e2023JD039359. <https://doi.org/10.1029/2023JD039359>

Interaction of Tides with Recurring Polynya in Pangnirtung Fjord

Shiliang (Dan) Shan^{1,2}, Charles Hannah³, Arnoldo Valle-Levinson⁴

¹Royal Military College of Canada; ²Queen's University; ³Fisheries and Oceans Canada; ⁴University of Florida

1. Introduction

Polynyas are nonlinearly shaped openings enclosed in sea ice (Figure 1, Hannah et al., 2009). They are vital components of both physical and biological systems in ice-covered seas while also presenting challenges and risks to shipping and ice travel.



Figure 1. Polynyas in the Arctic (Hannah et al., 2009).

Little is known about polynya-tide interactions in fjords, particularly in the Pangnirtung Fjord (Figure 1), a seasonally ice-covered fjord located on the southern Baffin Island, Nunavut, Canada. The Fjord is home to an indigenous community of about 1500 people, and it connects to Cumberland Sound via a shallow sill (~20 m). A small (4km x 2km) recurring polynya has been observed near the sill location. The large tidal range in the Fjord (up to 6.7 m) suggests a need to test the tidally forced polynya hypothesis in which tidal flows over the sill inject heat to the surface waters (Figure 2). However, the lack of observations in this remote location has so far prevented a quantitative investigation of the polynya-tide interaction. In this study, we demonstrate the new technological capacity of the Surface Water and Ocean Topography mission (Morrow et al., 2019; SWOT, 2023) for mapping of small polynya in an Arctic fjord.

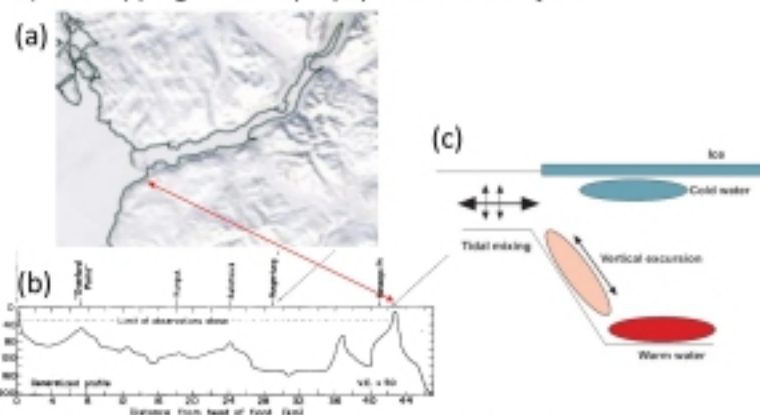


Figure 2. (a) Polynyas in the Pangnirtung Fjord shown by a MODIS image. (b) Depth profile of the Fjord (Gilbert 1978). (c) Conceptual model of tidal effects (Hannah et al., 2009).

2. Methods

- MODIS True-Color Optical Images:** We utilized MODIS true-color optical images to visually confirm the presence and extent of the polynya in Pangnirtung Fjord. A polynya index was developed based on the grayscale values of these images to quantify its temporal and spatial variations.
- SWOT Satellite Data:** A unique 100-day dataset from the SWOT satellite's 1-day-repeat calibration/validation orbit phase (March 30 to July 9, 2023) was employed. This dataset provided high-resolution measurements to estimate the size of the polynya and to characterize the complex interactions between the polynya and tides.
- Historical Tide Observations:** Historical tidal data from Pangnirtung Fjord were collected for harmonic analysis. These observations served as the basis for predicting tidal water levels during the study period.

3.1 Results: MODIS

Daily MODIS images from March to July 2023 confirmed the presence of a recurring polynya in Pangnirtung Fjord (Figure 3). Zoomed-in images revealed that the polynya consistently forms over the shallow sill, as indicated by the 30-meter depth contour (red lines in Figure 4).

To quantify the size and variability of the polynya, a polynya index was developed using the grayscale values of the MODIS images (Figure 5). This index allowed for an objective assessment of polynya extent over time.

An increase in the polynya's size in early May coincided with the transition from neap to spring tides, supporting the hypothesis that spring tides may drive polynya formation.

Cloud cover, however, significantly impacted the observations, with clear skies occurring on only 25% of the days during the study period, limiting the number of usable true-color optical images for analysis.

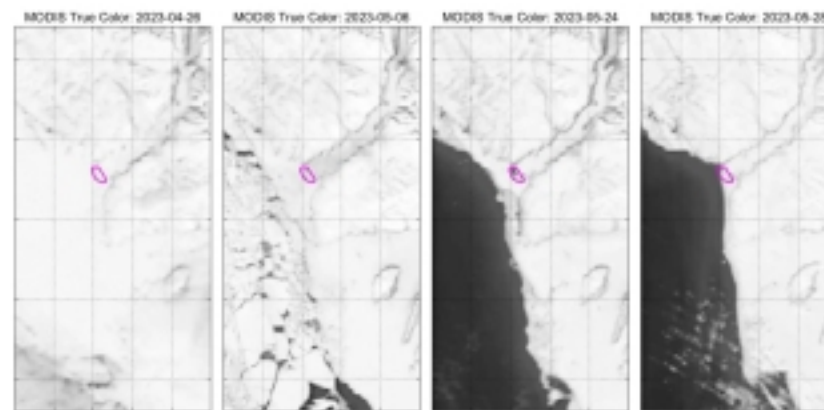


Figure 3. Selected MODIS images in April and May 2023 showing the presence of a recurring polynya in Pangnirtung Fjord.

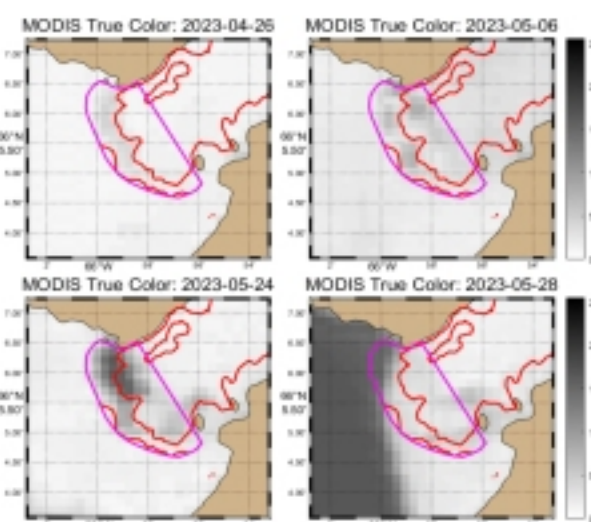


Figure 4. Zoomed-in MODIS images highlighting the polynya formation over the shallow sill in Pangnirtung Fjord, with the 30-m depth contour indicated by red lines.

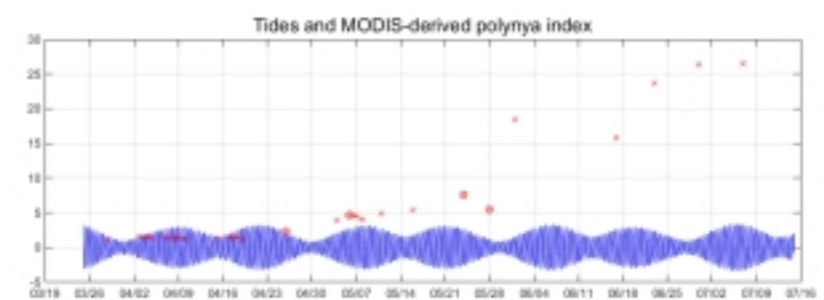


Figure 5. Polynya index (red crosses) represents the average grayscale values within the magenta polygon of MODIS images. The spring-neap tidal cycles in the Fjord (blue line) are derived from harmonic analysis predictions.

3.2 Results: SWOT

Unlike MODIS optical images, which are often obstructed by cloud cover, the Ka-band Radar Interferometer (KaRIn) data from the SWOT satellite provides cloud-penetrating daily 2D observations. The spatial variation of the normalized radar cross-section (σ_0) from KaRIn closely matched polynya patterns in MODIS true-color images, with continuous daily σ_0 observations capturing the detailed evolution of the polynya in Pangnirtung Fjord (Figure 6):

- 03-29: 100% ice
- 04-23: Polynya onset at spring tide
- 04-29: Polynya peak, at neap tide
- 05-04: Polynya size increases
- 05-24: during the next spring tide
- 05-29: Ice break-up

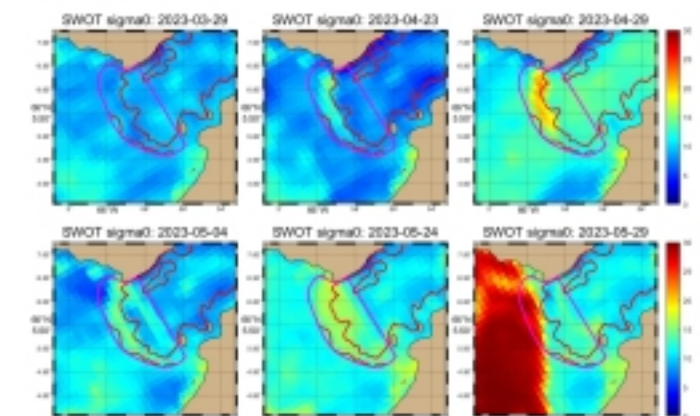


Figure 6. Selected SWOT images showing the recurring polynya.

A preliminary analysis of the SWOT-derived polynya index indicates that the polynya in Pangnirtung Fjord is tidally forced (Figure 7). A comparison of the polynya index with the spring-neap tidal cycle in 2023 suggests that the onset and peak phases of the polynya were 180° out of phase with the tidal cycle.

This out-of-phase response of sea ice to tidal forcing is likely due to the complex interaction between tidal forcing, oceanic heat flux, and ice mechanics. The peak of spring tides triggers the weakening and melting of sea ice by increasing mechanical stress on the ice due to enhanced tidal currents (Morse et al., 2006) and by drawing warmer subsurface waters toward the surface (Smith et al., 1990). This suggests that the peak of spring tides are strong enough to exceed the critical threshold required for ice breakup and initiate the onset of polynya.

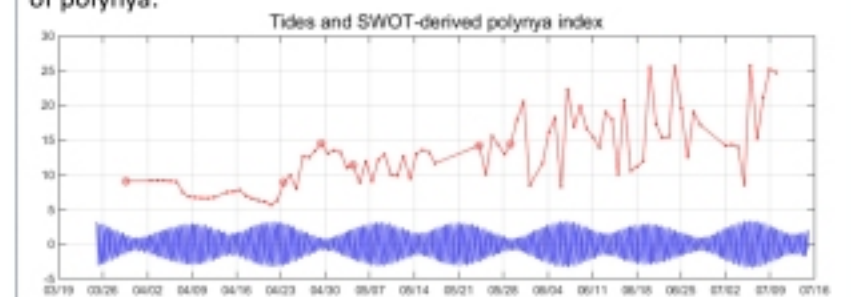


Figure 7. Polynya index (red) derived from the σ_0 SWOT data.

4. Conclusions

- The σ_0 data from the SWOT satellite, combined with MODIS optical imagery, provide valuable insights into the evolution of the polynya in Pangnirtung Fjord.
- Our analysis shows that the onset and peak phases of the polynya are about 180° out of phase with the spring-neap tidal cycle.
- We are developing a coupled ice-ocean model for the Fjord to examine this lagged response and assess the role of tides to polynya formation and maintenance, with a focus on tidal mixing and vertical tidal excursion parameters.

Contact

Shiliang (Dan) Shan
Royal Military College of Canada
Queen's University
Kingston, Ontario, Canada
Email: shan@rmc.ca

Acknowledgements

We acknowledge the support of the CDARP program at RMC and the Natural Sciences and Engineering Research Council of Canada (NSERC).



References

- Gilbert, R. (1978). Observations on oceanography and sedimentation at Pangnirtung Fjord, Baffin Island. *Atlantic Geology*, 14(1), 1-10.
- Hannah, C. G., Dupont, F., & Durphy, M. (2009). Polynyas and tidal currents in the Canadian Arctic Archipelago. *Arctic*, 63-95.
- Morrow, R., et al. (2019). Global observations of fine-scale ocean surface topography with the Surface Water and Ocean Topography (SWOT) mission. *Frontiers in Marine Science*, 6, 232.
- Morse, B., Ringö, B., Stander, E., Robert, J. L., Messier, D., & Thanh-Quach, T. (2006). Growth and decay of estuary ice cover. *Journal of Cold Regions Engineering*, 20(3), 70-94.
- Smith, S. D., Muench, R. D., & Pease, C. H. (1990). Polynyas and leads: An overview of physical processes and environment. *Journal of Geophysical Research: Oceans*, 95(C6), 9461-9479.
- Surface Water Ocean Topography (SWOT). 2023. SWOT Level 2 KaRIn Low Rate Sea Surface Height Data Product, Version 1.0. Ver. 1.0. P.O.DAAC, CA, USA. Dataset accessed 2024-02-01 at <https://doi.org/10.5067/SWOT-SSH-1.0>.



The Influence of Taylor Columns on Ocean Dynamics and Sea Ice in the Chukchi Sea



Spenser Ross, G.W.K. Moore, Yarisbel Garcia-Quintana, Paul Myers, Clark Pennelly, and Robert S. Pickart
Contact: Spenser.ross@utoronto.ca



Introduction

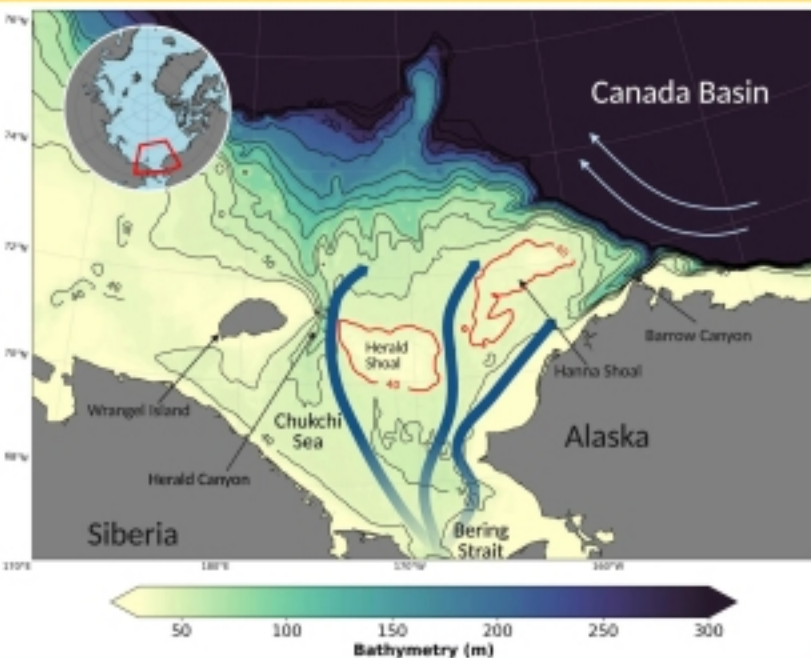


Figure 1. Bathymetry of the Chukchi Sea and surrounding region based on the 2021 version of the General Bathymetric Chart of the Oceans (GEBCO). Thick blue arrows show the main pathways of Pacific water inflow.

- The Chukchi Sea is a shallow, mostly flat basin located between Alaska and Siberia with much of the seafloor at a depth of around 50 m. Two prominent shoals, Herald and Hanna, rise to approximately 40 m.
- Pacific water inflow takes three main pathways from the Bering Strait through the Chukchi Sea. The flow is diverted around the shoals and through the canyons as pictured in Figure 1.
- Due to their geometry and length scale, stagnant columns of water, or Taylor columns, tend to form over the shoals of the Chukchi Sea (Martin and Drucker 1997).
- These Taylor columns trap cold water over the shoals and can cause a delay in ice melt in the early summer. As shown in Figure 2, ice often persists over Herald Shoal while the ice retreats on either side.
- The shoals are important ecological regions as their retention of cold, nutrient-rich water and resilient ice cover provide a significant foraging and haulout area for many Arctic marine animals (Grebmeier et al. 2006, MacCracken 2012, Jay et al. 2012, Clarke et al. 2013).

Methods

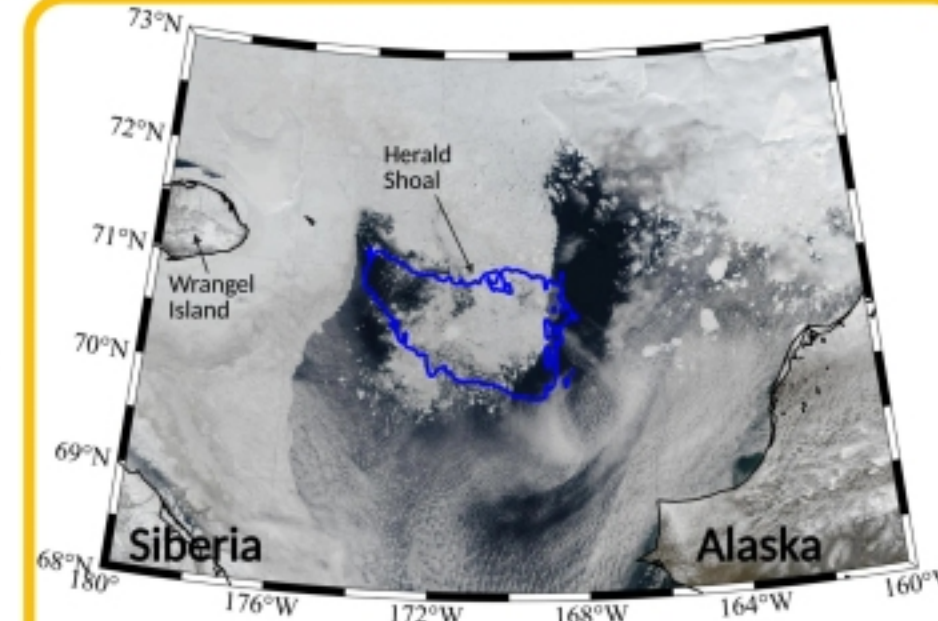


Figure 2. MODIS true colour image showing ice cover in the Chukchi Sea. The image is from June 16, 2018. The 40m isobath is indicated in blue and highlights Herald Shoal.

- For this investigation, we use ocean current and temperature data from a regional ice-ocean coupled model (NEMO-LIM2) between 1994-1998. We use the ARC60 configuration with 1/60° horizontal resolution.
- The model is forced by ERA5 atmospheric variables producing outputs at 1-day intervals at a ~1km horizontal resolution in the region.
- With this data, we examine the timing of sea ice retreat in the Chukchi Sea with particular focus on its two prominent shoals.

Results

- Figure 3 demonstrates that the ice edge curls over Herald Shoal in early June. The ice retreat over the shoal is delayed by over a week compared to the adjacent areas.
- Figure 4a shows that the strongest currents are diverted around the two shoals and stagnant water is apparent over most of each shoal.
- Flow over the shoal is stagnant compared to its sides and is near uniform with depth (Figure 4b).
- Figure 5 shows that columns of relatively colder water persist over the shoal, especially the eastern side.

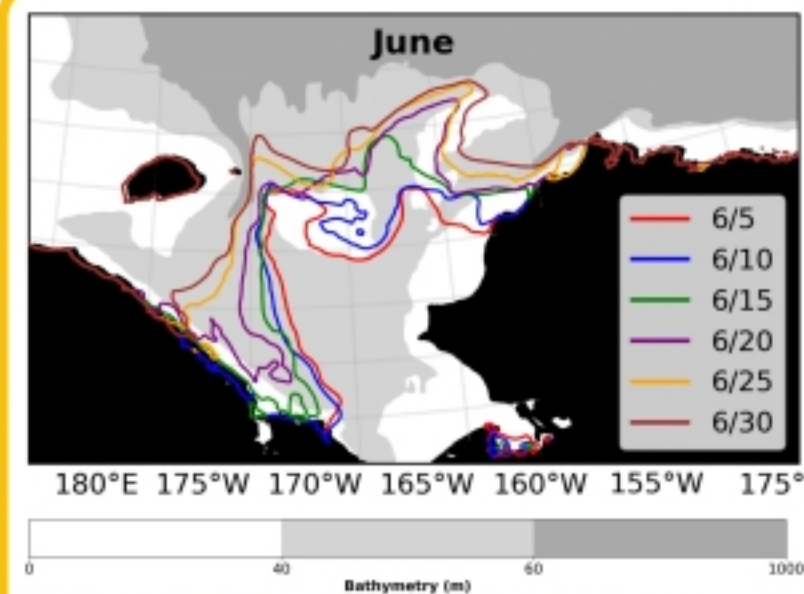


Figure 3. Mean 5-day ARC60 ice edge contours for June, averaged between 1994-1998. The ice edge is defined as the 15% ice concentration contour. The bathymetry is shaded with waters shallower than 40m in white, highlighting the shoals.

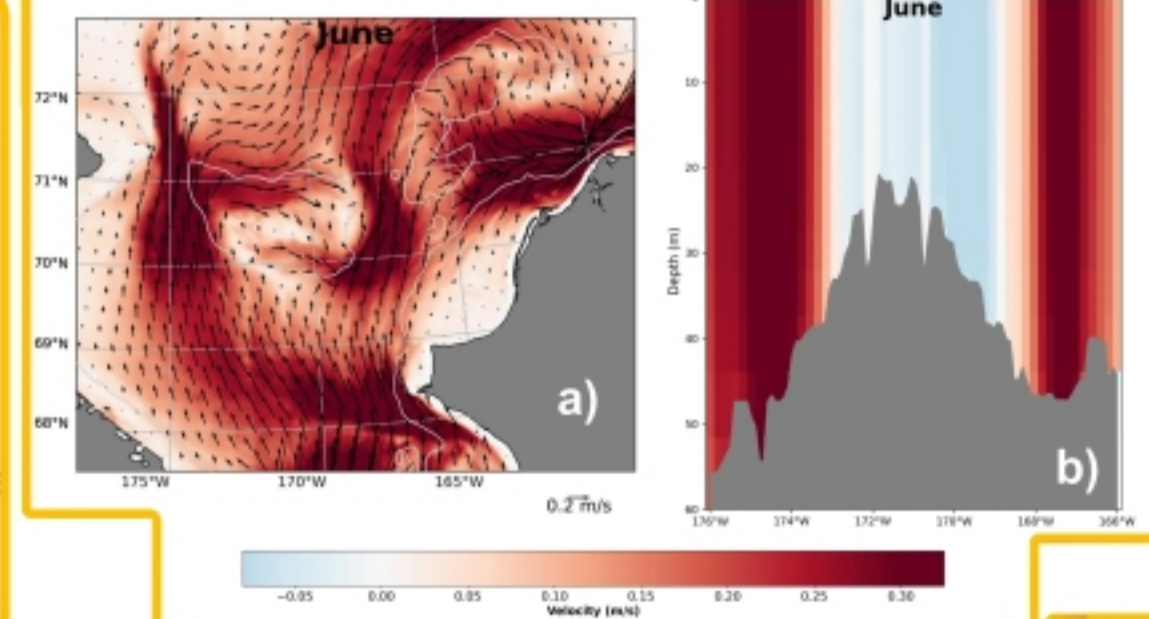


Figure 4. Mean June surface (a) and meridional (b) velocity from the ARC60 simulation. The data is averaged between 1994-1998. The light grey contours outline the shoals (a). The grey masking shows Herald Shoal (b).

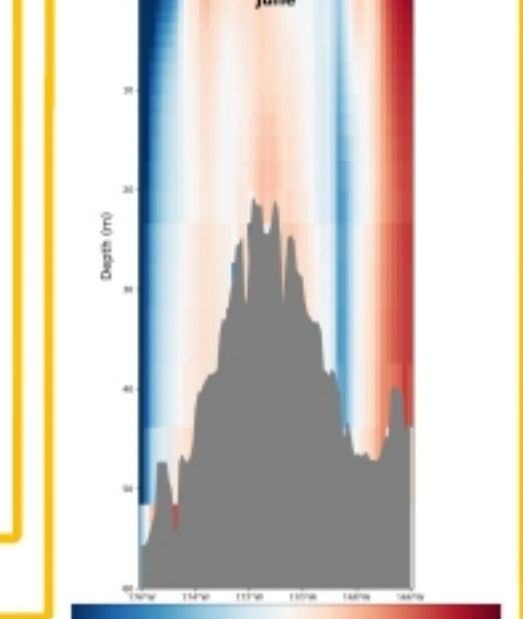


Figure 5. Mean June ocean temperature anomaly (°C) with depth over Herald Shoal from ARC60. The anomaly is calculated with respect to the mean temperature at each depth level from 1994-1998.

Conclusions

- The prominent currents in the Chukchi Sea are diverted around the shoals leaving stagnant water above them.
- This stagnant water is evidence of Taylor columns which form over Herald and Hanna Shoal, trapping cold water and delaying ice melt by over a week in the early summer.
- The trapped cold water can be over 0.25 °C cooler than the water surrounding Herald Shoal.
- Prolonged ice cover and cool nutrient rich waters make the shoals significant ecological hotspots which may become more important as Arctic sea ice declines.

References and Acknowledgements

- Chuanmin Hu, Werdell, J., O'Reilly, J., Feng, L., Zhongping Lee, Franz, B., Bailey, S., & Proctor, C. (2023). Chlorophyll a, v1.0. NASA Algorithm Publication Tool. <https://doi.org/10.5067/JCQB8QALDOYD>
- Clarke, J. T., C. L. Christman, A. A. Bowser, and M. C. Ferguson. 2013. Distribution and Relative Abundance of Marine Mammals in the Northeastern Chukchi and Western Beaufort Seas, 2012.
- Grebmeier, J. M., L. W. Cooper, H. M. Feder, and B. I. Sirenko. 2006. Ecosystem dynamics of the Pacific-influenced northern Bering and Chukchi Seas in the Amerasian Arctic. *Progress in Oceanography* 71:331-361.
- Gurvan, M., Boardalé-Badie, R., Boutier, P., Bricaud, C., Brucianeri, D., Calvert, D., Chamut, J., Clement, E., Goward, A., Delrosso, D., Ethé, C., Flavoni, S., Graham, T., Haric, J., Iovino, D., Lea, D., Lévy, C., Lovato, T., Martin, N., ... Vancoppenolle, M. 2017. NEMO ocean engine. In *Notes du Pôle de modélisation de l'Institut Pierre-Simon Laplace (IPSL) (v3.6-patch, Number 27)*. Zenodo. <https://doi.org/10.5281/zenodo.3248739>
- Jay, C. V., A. S. Fischbach, and A. A. Kochnev. 2012. Walrus areas of use in the Chukchi Sea during sparse sea ice cover. *Marine Ecology Progress Series* 468:1-13.
- MacCracken, J. G. 2012. Pacific Walrus and climate change: observations and predictions. *Ecology and Evolution* 2:2072-2090.
- Martin, S. and R. Drucker. 1997. The effect of possible Taylor columns on the summer ice retreat in the Chukchi Sea. *Journal of Geophysical Research* 102:10473-10482.
- Meier, W. N., Fetterer, F., Windnagel, A. K. & Stewart, J. S. 2021. NOAA/NSIDC Climate Data Record of Passive Microwave Sea Ice Concentration. (G02202, Version 4). [Data Set]. Boulder, Colorado USA. National Snow and Ice Data Center. <https://doi.org/10.7265/cfms-265>.
- National Geophysical Data Center. 2006. 2-minute Gridded Global Relief Data (ETOPO2) v2. National Geophysical Data Center, NOAA. doi:10.7289/V5J1012Q.
- Vancoppenolle, M., Bouillon, S., Fichefet, T., Goosse, H., Lecomte, O., Mondes Marquesa, M. A., and Mader, G. 2012. The Louvain-la-Neuve sea ice model, *Notes du pôle de modélisation, Institut Pierre-Simon Laplace (IPSL)*, Paris, France, no. 31, ISSN No 1288-1619.
- We acknowledge the use of imagery from the Worldview Snapshots application (<https://www.earthdata.nasa.gov>), part of the Earth Science Data and Information System (ESDIS).

1. Background and Study Objectives

Background

- The Beaufort Gyre is a wind-driven downwelling gyre in the Arctic Ocean which stores a significant amount of freshwater and is important for global climate [1].
- The size, strength, location, water properties & stratification of the Beaufort Gyre shows large inter-model spread and bias in climate models (e.g. [2], [3], [4])
- Misrepresentations in vertical mixing thought to be key cause [2],[5]

Study Objectives

- understand the relative roles of different vertical mixing parameterizations in setting stratification structure in 2 Arctic Ocean models with distinctive diffusivity prescriptions
- diagnose and compare the vertical heat and salt fluxes in the Beaufort Gyre due to the parameterizations of:
 - Vertical mixing due to background turbulence (hereafter 'Background')
 - The vertical projection of eddy-induced mixing along sloping isopycnals (hereafter 'Redi_i')
- In the following models:
 - an observationally-constrained state estimate with spatially-varying diapycnal and isopycnal diffusivities set by the optimization calculation; and
 - an intermediate-complexity prognostic ocean general circulation model with constant diffusivities

2. Methodology

- We diagnose vertical fluxes of heat and salt in two non-eddying Arctic Ocean models:
 - Arc36:**
 - A 1° resolution intermediate complexity prognostic model based on MITgcm [6]
 - Arctic Subpolar gyre sTate Estimate (ASTE):**
 - A ½° resolution data assimilative model based on MITgcm [7]

1. Prescribed Diffusivities

- Vertical mixing parameterized in both models using the KPP scheme [7], a background diffusivity κ_{BG} , and a GM-Redi [8,9] with an along-isopycnal eddy diffusivity κ_R :
 - Arc36:**
 - constant diffusivities in depth and horizontal space ($\kappa_{BG} = 6.6 \times 10^{-6} \text{ m}^2 \text{ s}^{-1}$, $\kappa_R = 500 \text{ m}^2 \text{ s}^{-1}$)
 - ASTE:**
 - Spatially-varying diffusivities in depth and horizontal space (values and patterns set by optimization procedure) (Figure 1).
 - κ_{BG} an order of magnitude larger in Arc36 than ASTE in the Basin
 - κ_{BG} is an order of magnitude larger towards shelf-slope than Basin in ASTE
 - κ_R has distinctive peak in the halocline on the shelf slope in ASTE

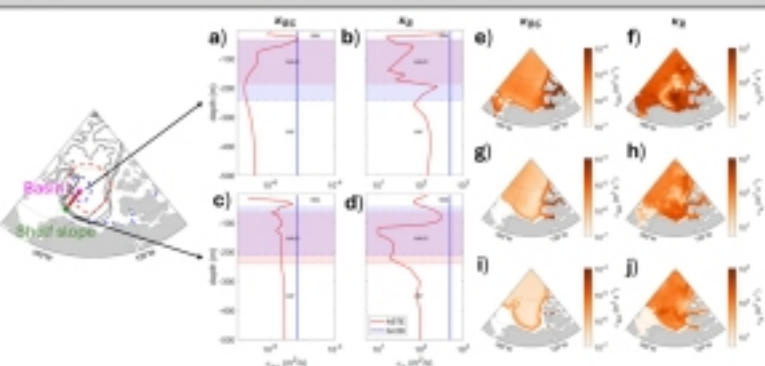


Figure 1: Vertical profiles of (a,c) background diffusivity, ' κ_{BG} ' and (b,d) isopycnal eddy diffusivity, ' κ_R ' in (red) ASTE vs. (blue) Arc36. Boundaries between the surface mixing layer (SML), halocline (HAL) and Atlantic Water layer (AW), defined based on the time-mean depth of the mixing layer defined by the KPP parameterization and a local maximum in the time-mean stratification profiles respectively, are indicated by dashed horizontal lines for each model. Depth-slice maps of the horizontal variability in (e,g,i) background diffusivity κ_{BG} and (f,h,j) isopycnal eddy diffusivity κ_R in ASTE averaged over the layers as indicated.

2. Beaufort Gyre Representation

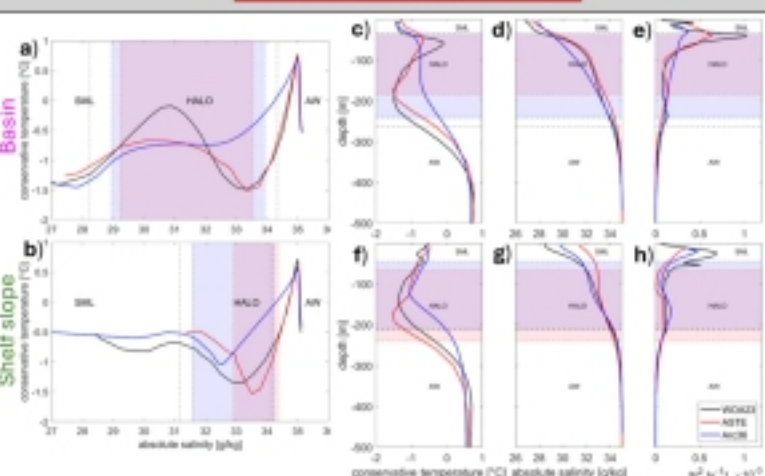


Figure 2: a), b) Temperature-Salinity diagrams for representative time-mean profiles from (a) the deep basin vs. (b) the shelf-slope. Time-averaged (c,f) temperature, (d,g) salinity and (e,h) stratification, N^2 for the (c,d,e) deep basin location and (f,g,h) shelf-slope location for (red) ASTE vs. (blue) Arc36. World Ocean Atlas (WOA, 2023) data is shown in black. Water column layers are delineated and labelled as in Fig. 1.

- Basin**
 - Key Similarities:
 - temperature maximum associated with Pacific Summer Water and AW
 - stratification maximum at the bottom of SML
 - Key Differences:
 - Arc36 fails to represent the subsurface temperature minimum associated with the cold halocline layer
 - Arc36 fails to differentiate between strong haline stratification in upper Pacific Water and weaker stratification in the lower Pacific Water
- Shelf Slope**
 - Key Similarities:
 - stratification maximum at the bottom of SML and HALO
 - AW temperature maximum
 - Key Differences:
 - weaker upper ocean haline stratification in ASTE
 - stronger stratification in the halocline in Arc36

3. Results: Flux magnitudes

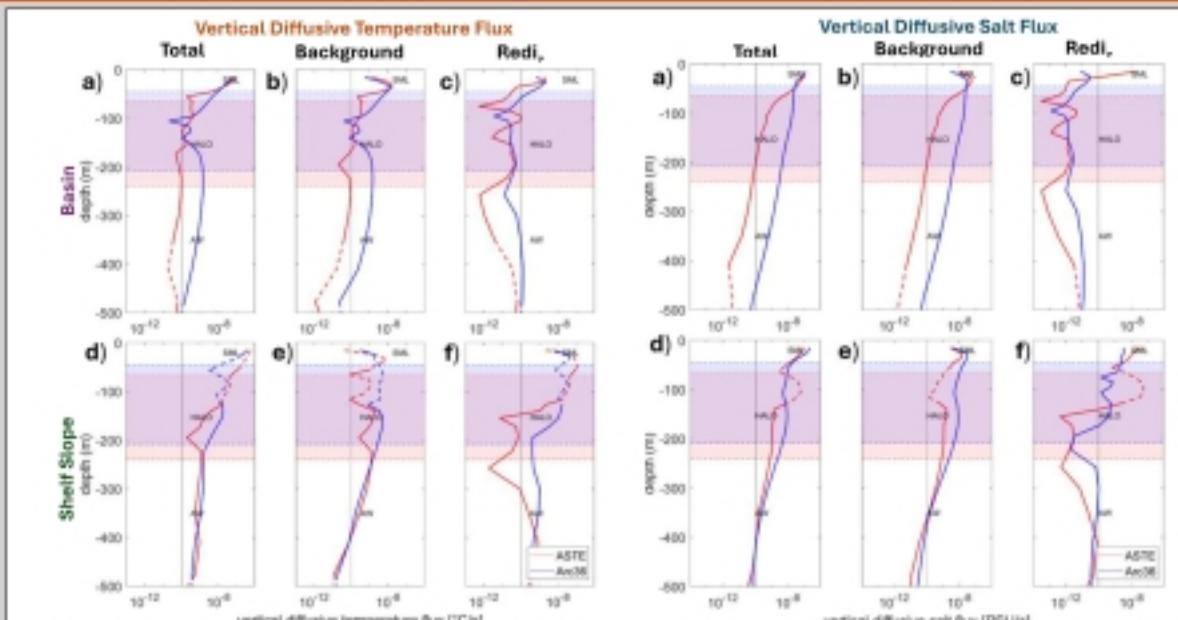


Figure 3: A comparison of the vertical diffusive fluxes of (left) temperature and (right) salt for (red) ASTE and (blue) Arc36. Dashed lines indicate up-gradient flux.

Flux Magnitudes

- Temperature Flux:**
 - Basin**
 - Key Similarities:
 - magnitude in upper HALO
 - Key Differences:
 - Arc36 larger than ASTE by order of magnitude in lower HALO & AW
 - Shelf Slope**
 - Key Similarities:
 - magnitude in AW & upper HALO
 - Key Differences:
 - Arc36 larger than ASTE by order of magnitude in lower HALO
- Salt Flux:**
 - Basin**
 - Key Similarities:
 - depth structure
 - Key Differences:
 - Arc36 larger than ASTE by order of magnitude in HALO & AW
 - Shelf Slope**
 - Key Similarities:
 - Magnitude in AW
 - Key Differences:
 - ASTE larger than Arc36 by order of magnitude in upper HALO
 - Smaller in lower HALO

Flux Breakdown

- Salt Flux:**
 - Basin**
 - Key Similarities:
 - Background is dominant flux above lower AW
 - Key Differences:
 - important up-gradient Redi_i flux in HALO in ASTE only
 - Shelf Slope**
 - Key Similarities:
 - Background is dominant flux in lower HALO & upper AW
 - Key Differences:
 - important up-gradient Redi_i flux in upper HALO in ASTE only
- Temperature Flux:**
 - Basin**
 - Key Similarities:
 - Background is dominant flux below upper HALO
 - Key Differences:
 - important Redi_i flux contributions in HALO

4. Understanding the Upgradient Redi_i Flux

- Given the challenges of modelling the halocline stratification (Figure 2f), we want to understand the cause and implication of upgradient salt fluxes in this layer
- To do so, we break down the Redi_i salt flux into two components:

$$H = -\kappa_R \sigma_x \frac{dS}{dx}$$

$$V = -\kappa_R \frac{dS}{dz} \sigma_z^2$$

Where $\sigma_x = -\left(\frac{d\sigma}{dS}\right)$ is the isopycnal slope towards the basin.

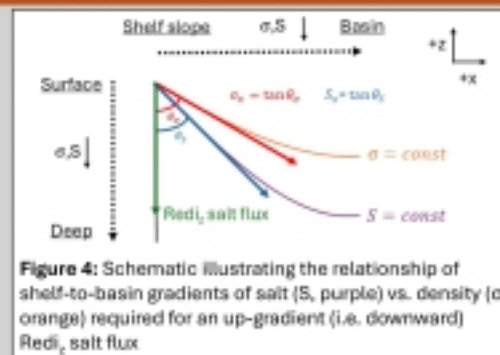


Figure 4: Schematic illustrating the relationship of shelf-to-basin gradients of salt (S, purple) vs. density (σ , orange) required for an up-gradient (i.e. downward) Redi_i salt flux

- Density is **almost** completely determined by salinity at this latitude $\rightarrow \text{sign}\left(\frac{d\sigma}{dz}\right) = \text{sign}\left(\frac{dS}{dz}\right) + \frac{dS}{dz} \cdot \frac{d\sigma}{dS} < 0 \rightarrow H < 0, V > 0$
- Redi_i < 0 (upgradient flux) $\rightarrow H > V \rightarrow S_x > \sigma_x$ where $S_x = -\left(\frac{dS}{dx}\right)$ is the salt slope

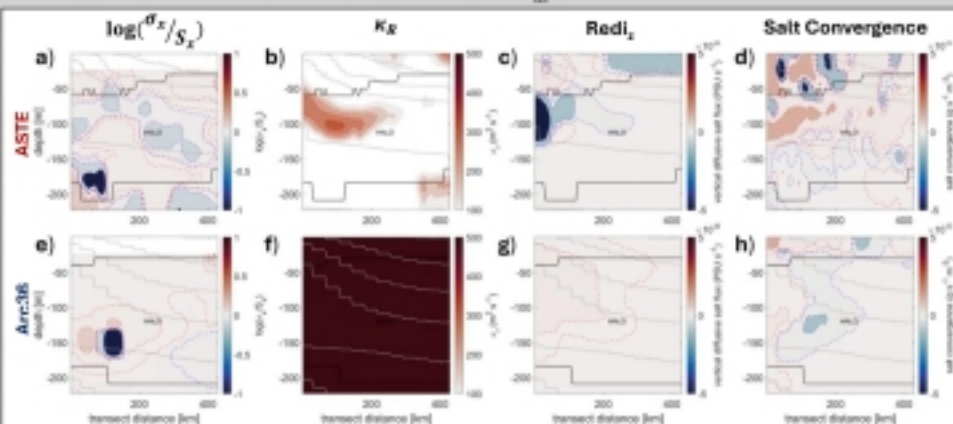


Figure 5: Transect plots from shelf slope point to Basin showing the relative magnitude of the density (σ_x) and salt (S_x) slopes in the x-direction, κ_R , the vertical projection of eddy induced mixing along the sloping isopycnals (Redi_i), and the salt convergence due to the Redi scheme in both models.

- region of larger salt than density slopes in the halocline in ASTE not present in Arc36 (Fig 5. a,e)
- this combined with a relatively large κ_R in this region creates a significant up-gradient Redi_i salt flux in ASTE not seen in Arc36 (Fig 5. b,f,c,g)
- salt convergence in upper HALO from downgradient Redi_i flux in ASTE erodes stratification below convergence & re-stratifies above (Fig 5. d)
- same process represented less significantly in Arc36 due to no strong downgradient Redi_i fluxes (Fig 5. h)

5. Conclusions

- In the Beaufort Gyre:
 - parameterized **background turbulence** is the primary mechanism of vertical mixing of heat and salt in the **basin** in both Arc36 and ASTE
 - This mixing is an order of magnitude larger in Arc36 than ASTE, leading to erosion of vertical stratification structure in the basin
 - vertical mixing due to **background turbulence** and **eddy-induced isopycnal stirring** are important on the **shelf slope** in both Arc36 and ASTE
 - background turbulence is elevated in ASTE in comparison to the basin
 - eddy-induced stirring is elevated in Arc36 and ASTE in comparison to the basin
 - eddy-induced stirring is significant to the total vertical flux of salt in the upper Halocline in ASTE but not Arc36
 - upgradient salt fluxes due to eddy-stirring in upper halocline on the shelf slope present in ASTE not Arc36
 - stratifies Halocline, SML interface & erodes stratification in lower Halocline in ASTE

6. Next Steps

- consider the relevance of upgradient salt fluxes by eddy stirring identified here in the real-world system and consider the implications of changing temperature and salt gradients on this mixing mechanism

7. References

[1] Timmermans, M., & Toole, J. M. (2022). *Annu. Rev. Mar. Sci.*, 75(1), 223–248.
 [2] Shu, Q., et al. (2023). *Geosci. Model Dev.*, 16(9), 2539–2563.
 [3] Athanase, M., et al. (2025). *J. Geophys. Res.: Oceans*, 130, e2024JC021873.
 [4] Mulijwik, M., et al. (2023). *J. Climate*, 36, 1727–1748.
 [5] Khosravi, N., et al. (2022). *Earth's Future*, 10, e2021EF002282
 [6] Marshall, J., et al. (2017). *Ocean Model*, 111, 1–8
 [7] Large, W. G., et al. (1994). *Rev. Geophys.*, 32(4), 363–403
 [8] Redi, M. H. (1982). *J. Phys. Oceanogr.*, 12(10):1154–1158
 [9] Gent P. R. & McWilliams J. C. *J. Phys. Oceanogr.*, 20(1):150–155, 1990

Investigating variability in thermohaline staircases and their role in vertical fluxes in the Beaufort Gyre from turbulence-scale measurements

Katerina Benevides¹, Stephanie Waterman¹, Shumin Li^{1,2}, Mary-Louise Timmermans³, and Bill Williams⁴

¹Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia, Vancouver, BC, Canada

²Rockland Scientific International Inc., Victoria, BC, Canada

³Department of Earth and Planetary Sciences, Yale University, New Haven, CT, USA

⁴Institute of Ocean Sciences, Department of Fisheries and Oceans Canada, Sidney, BC, Canada

Motivation & Study Goals

- the presence of thermohaline staircases signal that vertical fluxes of heat and salt are controlled by double-diffusive convection; in this regime, we expect weak upward transports of heat and downward transports of salt that act to reinforce stratification [1,2]
- observations in the Atlantic Water (AW) thermocline in the Beaufort Gyre [e.g. 3,4] show that staircases are widespread & persistent on large space & time scales, however recent numerical & laboratory studies [e.g. 5,6] suggest staircases may exhibit important small-scale transient behaviour in response to both internal variability & external forcing
- of special interest is the role of mechanical turbulence in modulating staircase presence, structure & fluxes [e.g. 7,8]; understanding how staircases & turbulence interact may be important to understanding how mixing in the Arctic Ocean may change with ongoing climate change
- in 2024, we collected ~200 profiles in the Beaufort Gyre closely resolved in space & time and at turbulence-scale resolution - the dataset provides a unique opportunity to explore:
 - variability in where/when staircases occur on short time & space scales
 - how background stratification and/or mechanical turbulence intensity may control staircase presence/absence
 - the relative roles of staircases vs. mechanical turbulence in net vertical heat & buoyancy fluxes

Data & Methods

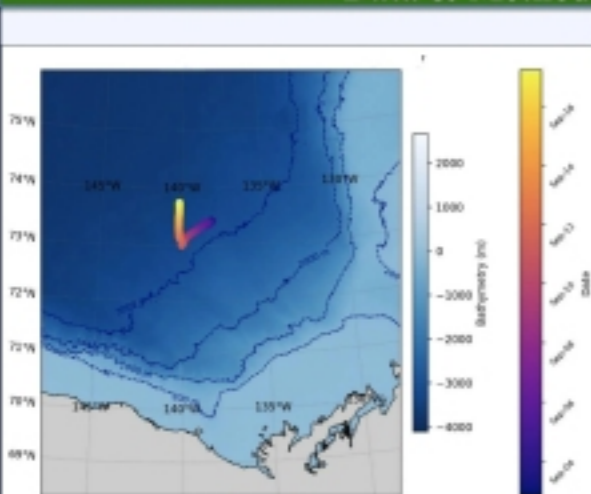
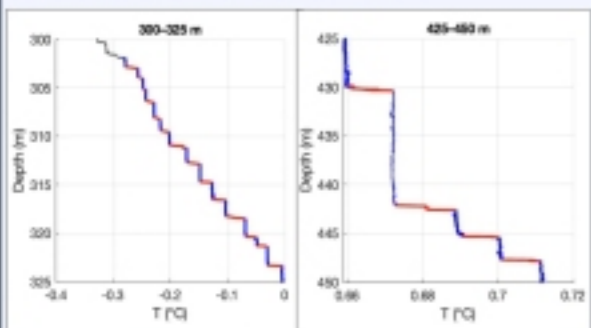


Fig. 1: Glider track in the Beaufort Gyre coloured by date. Bathymetry (contours) is from GEBCO [9].



- ~200 vertical profiles from the near-surface to ~800 m depth in the deep Beaufort Gyre collected over 15 days in September 2024 by a turbulence-sensing glider (Fig. 1)
- we observe thermohaline staircases in microstructure temperature observations collected at 512 Hz (corresponding to ~1-mm vertical resolution for slow downcast profiles); we detect staircase structures using a combination of a peak-finding technique and gradient ratio criteria [10, 11] (Fig. 2)
- we also characterize mechanical turbulence intensity using microstructure shear observations following best practices recommendations [12] (Fig. 3)
- we characterize background thermal and haline stratification using glider CTD measurements collected at 0.5 Hz (~0.25 m vertical resolution for slow downcast profiles)

Fig. 2 (left): Detected mixed layers (blue) and interfaces (red) associated with thermohaline staircases in two different depth ranges inside the upper Atlantic Water thermocline as indicated.

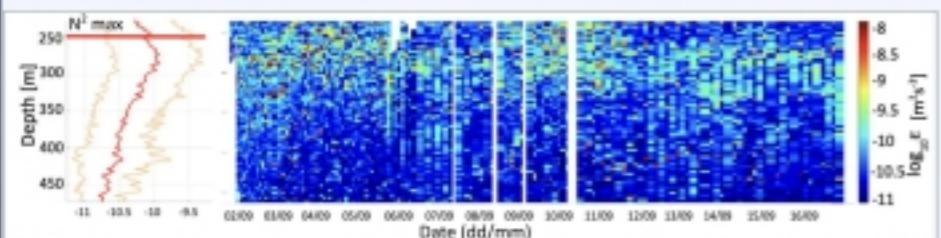


Fig. 3: Characterizations of observed background shear-driven turbulence intensity, expressed in terms of the microstructure shear-derived turbulent kinetic energy dissipation rate (ϵ) within the upper AW layer. (Left) Transect-mean vertical profile, with the red line indicating the mean depth of the subsurface stratification maximum. (Right) Depth-time transect along the glider track showing variations in ϵ over the observed period.

Acknowledgments

We gratefully acknowledge the support of the Joint Ocean Ice Study (JOIS) and the Beaufort Gyre Observing System (BGOS) programs, the Canadian-Pacific Robotic Ocean Observing Facility (C-PROOF), and the scientists, technicians and crew of CCGS Louis S. St. Laurent, for enabling this glider deployment. We especially thank Chris Payne, Paul Macoun, Sarah Zimmermann, Seth Fleming-Alho, Tetjana Ross and Jody Klymak for their invaluable contributions towards making the glider mission a success.

Next Steps

- examine staircase presence/absence transitions: track how staircases form, evolve, and disappear in the data to better understand the dynamics of these transitions
- test various staircase parameterizations: explore alternative parameterizations for staircase fluxes to see how robust the parameterized estimates are in this data
- make turbulence-based staircase flux estimates: analyze turbulent signals inside staircase mixed layers as an independent way to estimate staircase fluxes

Result 1: Staircase Prevalence

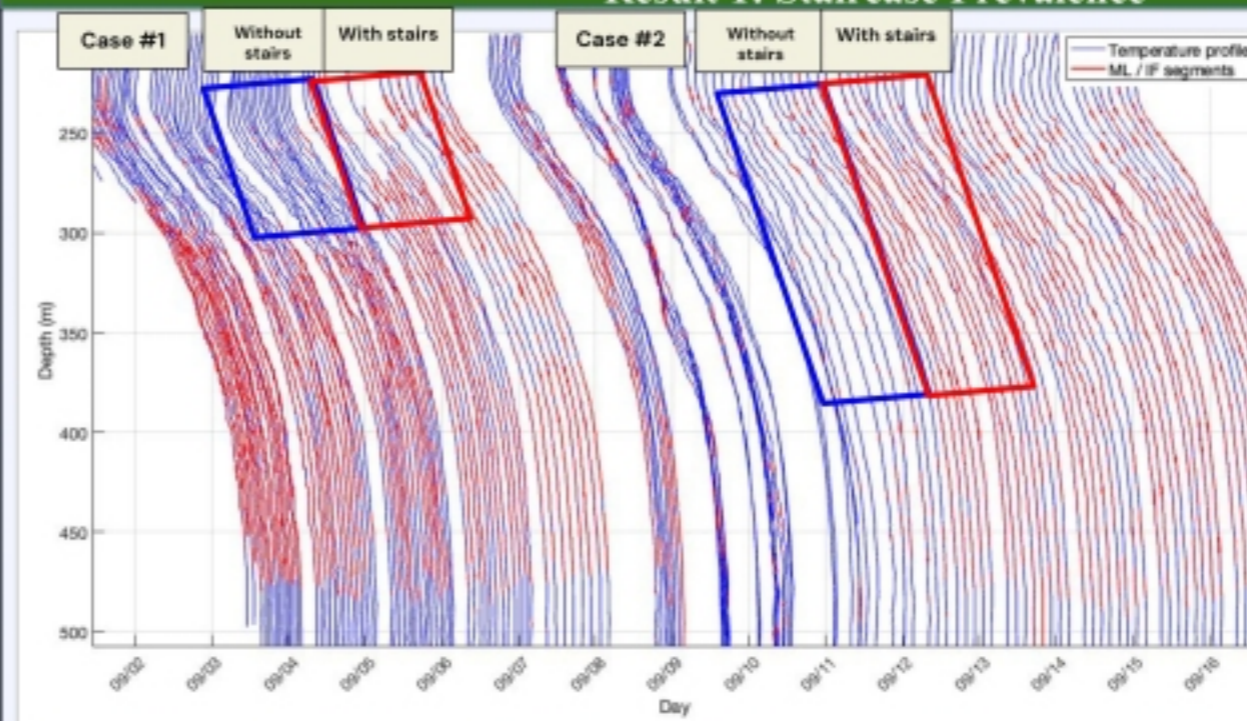


Fig. 4: Microstructure temperature profiles as a function of time, highlighting the depth range in and around the upper AW thermocline. Depth-time regions corresponding to two case studies, comparing background conditions, heat & buoyancy fluxes during periods and depth ranges with and without staircases, are also indicated.

Blue boxes highlight periods of staircase absence, while red boxes highlight periods of staircase presence. Profile colors indicate the same, with staircases overlaid in contrasting colors for clarity

- staircase features are present throughout the upper AW thermocline in most profiles
- there are 2 notable periods of staircase absence:
 - between ~250 and ~300 m depth from 02/09 – 06/09
 - between ~275 and ~400 m depth from 09/09 – 12/09

Result 2: Environmental Controls

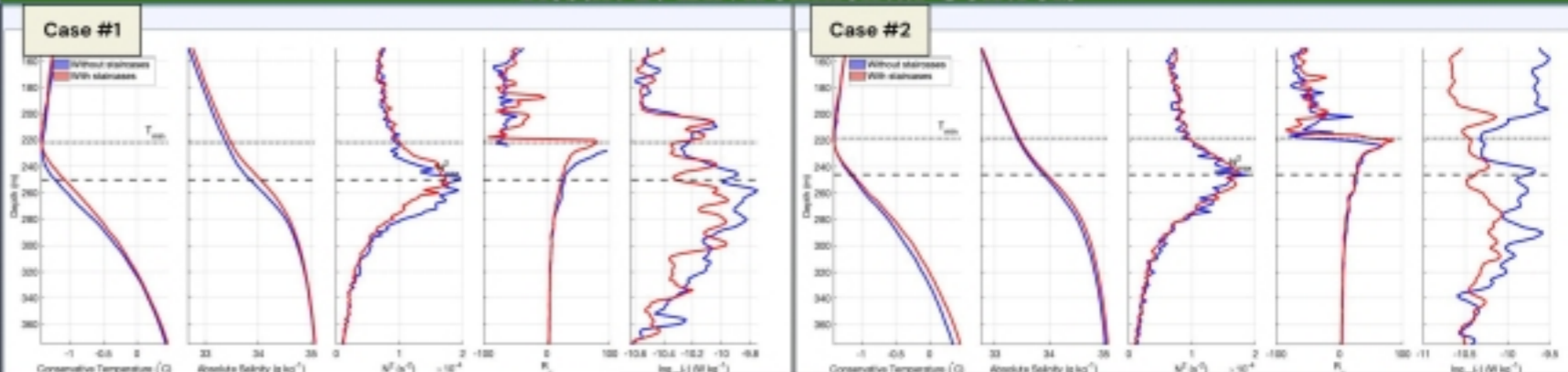


Fig. 5: Mean vertical profiles of temperature, salinity, buoyancy frequency (N^2), bulk density ratio (R_ρ), and turbulent kinetic energy dissipation rate (ϵ) for two case studies. The red lines represent the mean vertical structure of these properties in regions with staircase structures, while the blue line represents the mean vertical structure in regions without staircase structures.

- in case 1, periods of staircase absence vs. presence differ in background stratification: when stairs are absent, due to the presence of a cold, fresh intrahaline eddy above, there is stronger thermal & haline stratification and a larger density gradient ratio that is less susceptible to staircase formation (average $R_\rho = 27$ when stairs are absent vs. 21 when stairs are present)
- in case 2, periods of staircase absence vs. presence differ in mechanical turbulence intensity: when stairs are absent, mechanical turbulence levels are 2 times larger on average

Result 3: Implications for Vertical Heat & Buoyancy Fluxes

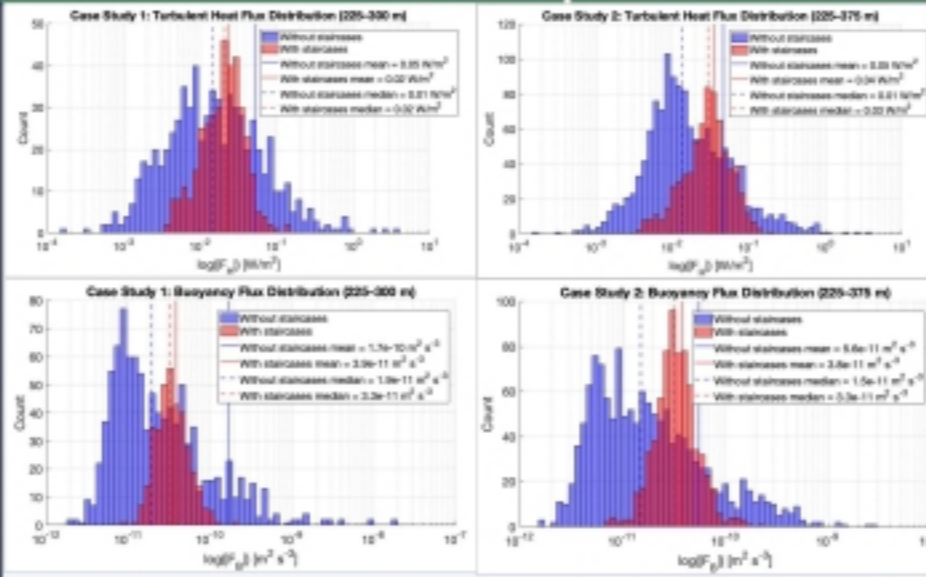


Fig. 6: Histograms comparing estimates of heat flux (top) and buoyancy flux (bottom) in case studies 1 and 2.

- to consider the implications of staircase presence/absence on net vertical fluxes we estimate vertical heat & buoyancy fluxes via:
 - the Kelley 1990 parameterization for fluxes associated with thermohaline staircases [13] when/where staircases are present
 - the Osborn 1980 parameterization for mechanical turbulent fluxes [14] when/where staircases are absent
- we find:
 - staircase flux estimates have a narrow distribution with similar mean and median values; in contrast, mechanical turbulent flux estimates have high-end outliers that make the mean value significantly larger than the median
 - mean fluxes of heat when stairs are present vs. absent are the same order for both cases
 - mean flux of buoyancy when stairs are absent is two orders of magnitude larger than when stairs are present for case 1 and order of magnitude smaller for case 2
 - as buoyancy fluxes are up-gradient when stairs are present and down-gradient when stairs are absent, these results imply relative prevalence of staircase presence vs. absence is consequential for stratification

Summary

- well-resolved profiles in the deep Beaufort Gyre over 15 days show a widespread prevalence of thermohaline staircases in the upper AW thermocline with 2 notable periods of staircase absence
- comparable periods of staircase absence vs. presence differ 1. in their background stratification: staircases are absent when the background density gradient ratio is elevated due to an eddy above; 2. in their mechanical turbulence levels: staircases are absent when mechanical turbulent intensity is elevated;
- periods of staircase presence vs. absence are inconsequential for net vertical fluxes of heat but are consequential for net buoyancy fluxes as when staircases are absent, buoyancy fluxes below the pycnocline are larger and counteract stabilizing fluxes associated with staircases

References

[1] Rienecker, M. M., & Held, B. J. (2001). Salt fingers across a density interface. *Deep Sea Research and Oceanographic Abstracts*, 48(1), 589-611.

[2] Rabbe, T. (2008). Double-Diffusive Convection. Lecture 30. Proceedings Volume 2008 - "Prospects and Challenges in QO'07: 2008 Progress in Geophysical Fluid Dynamics".

[3] Timmermans, M.-L., Toole, J., & Rothfeld, R. (2008). In-situ profiler observations of the double-diffusive staircase in the Canada Basin thermocline. *Journal of Geophysical Research: Oceans*, 113(C11), C09002.

[4] Shields, M. C., Timmermans, M.-L., Carpentier, L. R., & Toole, J. M. (2017). Spatial variability of the Arctic Ocean's double-diffusive staircase. *Journal of Geophysical Research: Oceans*, 122(1), 980-994.

[5] Konoike, S., Uchida, T., & Rienecker, M. M. (2018). The influence of shear on double-diffusive and settling-driven instabilities. *Journal of Fluid Mechanics*, 849, 902-926.

[6] Wu, S.-R., Zhou, S.-G., Dai, X.-R., & Su, Y.-Z. (2019). Evolution of staircase structures in diffusive convection. *Journal of Visualized Mathematics*, 19(1), 183-193.

[7] Brown, J. M., & Rabbe, T. (2022). Diffusive Staircases in Shear: Dynamics and Heat Transport. *Journal of Physical Oceanography*, 52(9), 1920-1938.

[8] Ma, Y., & Polzin, K. K. (2022). Thermohaline staircase formation in the diffusive convection regime: A theory based upon stratified turbulence asymptotics. *Journal of Fluid Mechanics*, 931, 94.

[9] GEBCO Compilation Group (2024) GEBCO 2024 Grid 30. <https://www.gebcobio.org/2024/04/04/gebcobio-2024-grid-30/>

[10] Lorenz, T., Carpentier, L. R., Spence, M., Gunkel, R. D., Schurath, M., & Wobbe, A. (2021). Interface structure and fluxes in a natural double-diffusive system. *Journal of Geophysical Research: Oceans*, 126(11), 4080-4106.

[11] Schefele, R., Pavlenko, R., Sarin, T., & Wobbe, A. (2021). Double Diffusion in Saline Powell Lake, British Columbia. *Journal of Physical Oceanography*, 51(11), 2393-2398.

[12] Lueck, R., He, L., Budeus, C., Dingemans, M., Kollermann, P., Jochum, R., Jørgensen, S.-E., Scholten, S.-A., Schulz, K., & Stevens, C. (2021). Best practices recommendations for measuring dissipation rates from shear profiles. *Frontiers in Marine Science*, 7, 634127.

[13] Kelley, D. (1990). Fluxes through diffusive staircases. *A New Journal of Science*, 113(20), 110-117.

[14] Osborn, T. R. (1980). Estimates of the Local Rate of Vertical Diffusion from Observation Measurements. *Journal of Physical Oceanography*, 10(1), 83-89.

On the evaluation of freezing rain over western North America using an ensemble of regional climate projections

1. MOTIVATION

- Freezing rain is a high-impact winter hazard in Canada, affecting transportation, infrastructure, and power systems.
- Reliable projections require confidence in the model's historical occurrence, spatial structure, and regional controls.
- McCray et al. (2022) assessed projected freezing-rain changes over North America, but complex mountainous regions still require targeted evaluation before national-scale application.

2. OBJECTIVE

Evaluate whether Canadian Regional Climate Model version 5 simulations driven by CMIP6 global climate models reproduce observed freezing-rain occurrence over western Canada before using the ensemble for future projections.

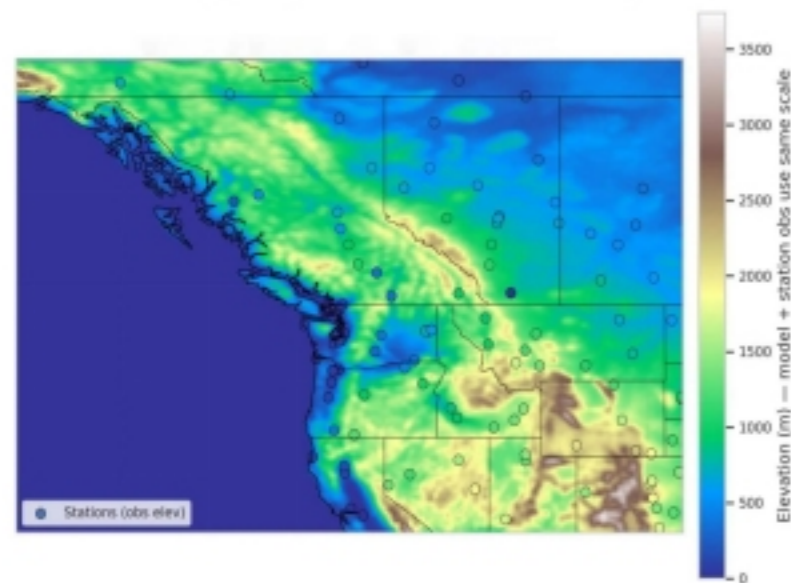
3. DATA AND METHODS

Model simulations

- Reference: ERA5-driven CRCM5 evaluation simulation.
- Ensemble: CMIP6-driven CRCM5 simulations over western North America.
- Domain: 141°W–103°W, 37°N–71°N; diagnostics every 3 h.

Diagnostic algorithms

- Bourgouin (2000): melting/refreezing energy-area method.
- Ramer (1993): top-down temperature and humidity diagnosis.
- Baldwin et al. (1994): decision-tree / thermal-layer diagnostic.



Evaluation dataset

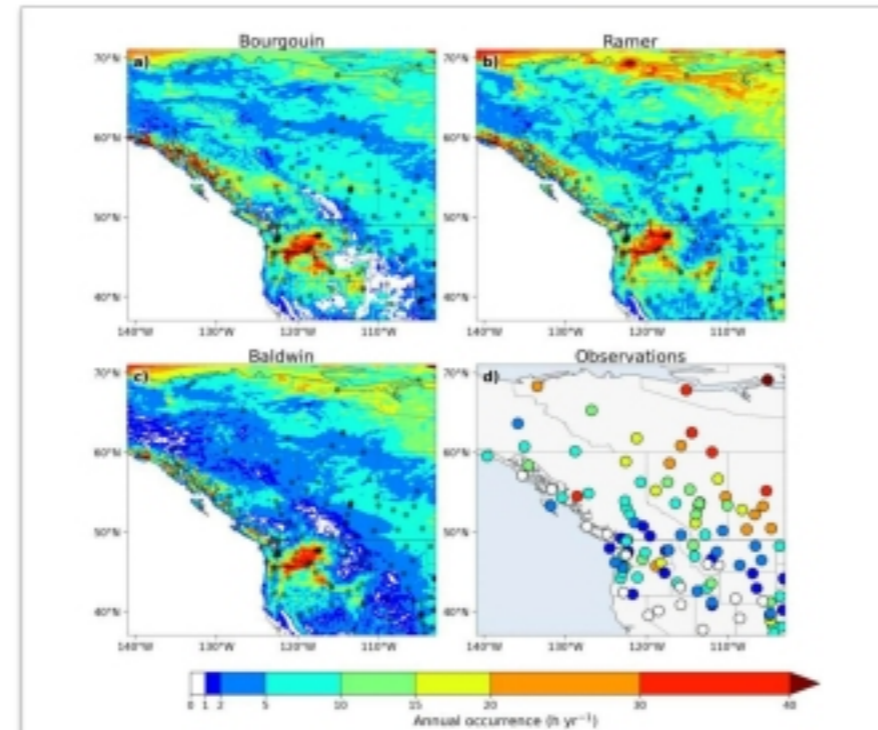
- Hourly Integrated Surface Database (ISD) station observations, 1979–2020; occurrence only (NOAA/NCEI, n.d.).

Analysis metrics

- Nearest grid point retained after 1×1, 2×2, and 3×3 tests.
- Annual/monthly occurrence; bias = model – observations.
- Δz = model-grid elevation – station elevation.
- Coastal stations are <75 km from the coast; farther stations are inland.

4. REFERENCE SIMULATION EVALUATION

A. Spatial occurrence and station comparison

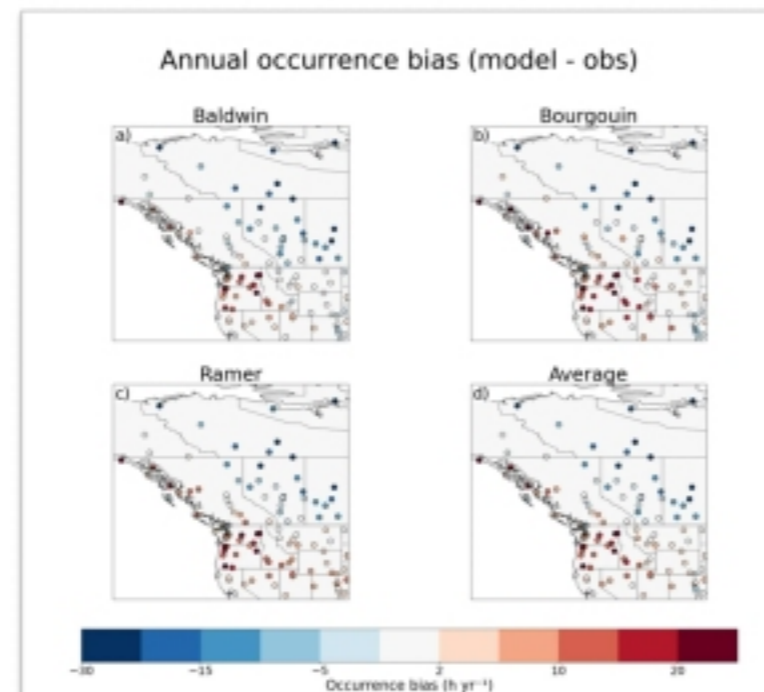


Occurrence maps

- Broad terrain-related structure is coherent with observations.
- Occurrence magnitude differs among algorithms.

- Diagnostics preserve similar spatial structures, but occurrence magnitudes and station biases vary by method.

B. Bias, grid selection, and terrain controls

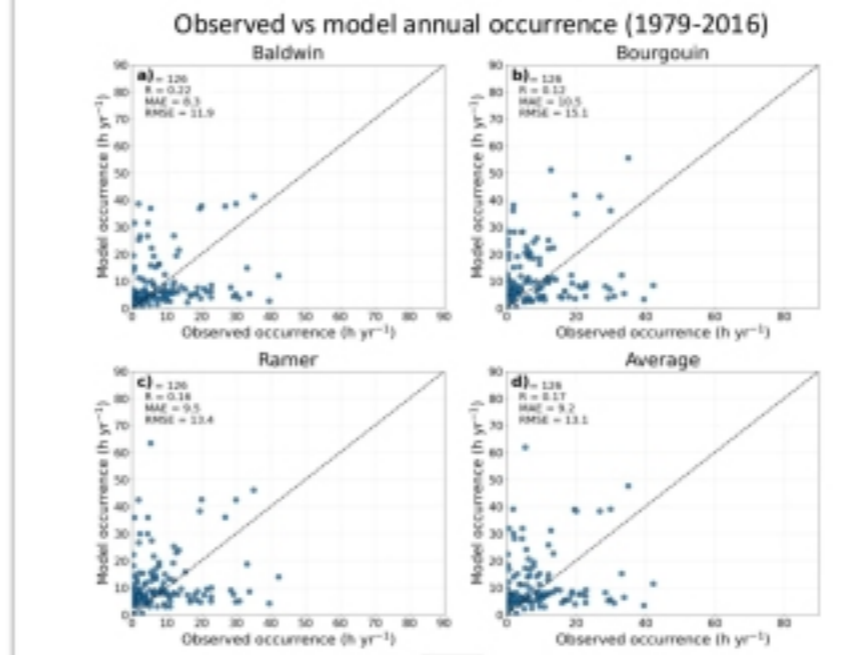


Bias maps

- Positive bias appears along the Pacific coast
- Underestimation appears inland/east of the Continental Divide.

Preliminary interpretation

- Underestimation appears in Alberta and east of the Continental Divide; overestimation appears along the Pacific coast of British Columbia and in the northwestern U.S.
- Mean station bias is about +8 h yr⁻¹ and the median is near +5.5 h yr⁻¹, with a positive-skewed distribution.
- Bias increases where model grid elevation differs from station elevation, with stronger effects at coastal stations.



Station comparison

- Substantial spread remains, especially at low-occurrence stations.
- Method choice changes station bias.

5. PROJECTIONS

Preliminary projection workflow

- Evaluate historical simulations against the ERA5-driven reference and stations.
- Compute future changes by scenario, period, driving GCM, and diagnostic algorithm.
- Report occurrence, amount, seasonality, and event-scale metrics separately.
- Amounts are compared among model diagnostics because station accumulations are unavailable.

| Purpose | Dataset / analysis level |
|------------|---|
| Reference | ERA5-driven CRCM5 evaluation simulation |
| Historical | CMIP6-driven CRCM5 ensemble |
| Future | Scenario-period changes, 2015–2100 |

6. CONCLUSION

- CRCM5 reproduces part of the broad spatial structure of freezing-rain occurrence in complex terrain.
- Diagnostic choice and station-grid elevation mismatch remain major sources of uncertainty.
- Western Canada provides a terrain-focused evaluation step before extending projections nationally.

7. NEXT STEPS

- Finalize data consistency and unit checks.
- Add historical ensemble occurrence, amount, bias, and RMSE maps.
- Add projected changes in occurrence, amount, seasonal cycle, and event metrics.
- Quantify uncertainty from algorithm, driving GCM, and scenario.

8. REFERENCES AND ACKNOWLEDGEMENTS

- Baldwin, M. R., Treadon, R., & Contorno, S. (1994). Precipitation type prediction using a decision tree approach with NMC's mesoscale Eta model. Preprints, 10th Conference on Numerical Weather Prediction, AMS, 30–31.
- Bourgouin, P. (2000). A method to determine precipitation types. *Weather and Forecasting*, 15, 583–592.
- Ramer, J. (1993). An empirical technique for diagnosing precipitation type from model output. Preprints, 5th International Conference on Aviation Weather Systems, AMS, 227–230.
- McCray, C. D., Paquin, D., Thériault, J. M., & Bresson, É. (2022). A multi-algorithm analysis of projected changes to freezing rain over North America. *Journal of Geophysical Research: Atmospheres*, 127, e2022JD036935.
- Paquin, D., McCray, C. D., Gauthier, C. B., Giguère, M., Asselin, O., Bourgault, P., Labonté, M.-P., & Matte, D. (2025). The Ouranos CRCM5-CMIP6 ensemble. *Scientific Data*, 12, 1984.
- NOAA/NCEI. (n.d.). Integrated Surface Database (ISD). National Centers for Environmental Information.

Acknowledgements / funding: Funding was provided by the Data Climate Center. CRCM5 simulations were provided by Ouranos.

1. Introduction

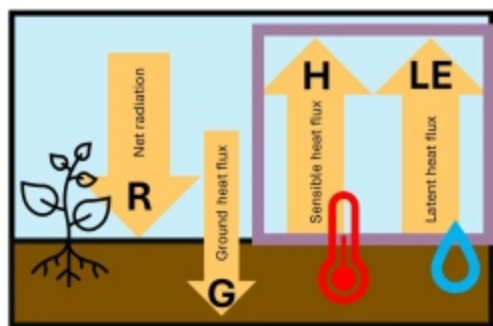


Figure 1. Earth's simplified energy budget.

- Motivation** to study surface turbulent fluxes
- If the latent heat flux (LE) replaces the sensible heat flux (H), global surface temperature decreases. The opposite increases global surface temperature. (Ban-Weiss, 2011)
 - The sum of the fluxes is part of Earth's energy budget

Research question: How well do the CRCM6-GEM5 simulations reproduce surface turbulent fluxes based on a hierarchy of error metrics?

4. Main Results and Discussion

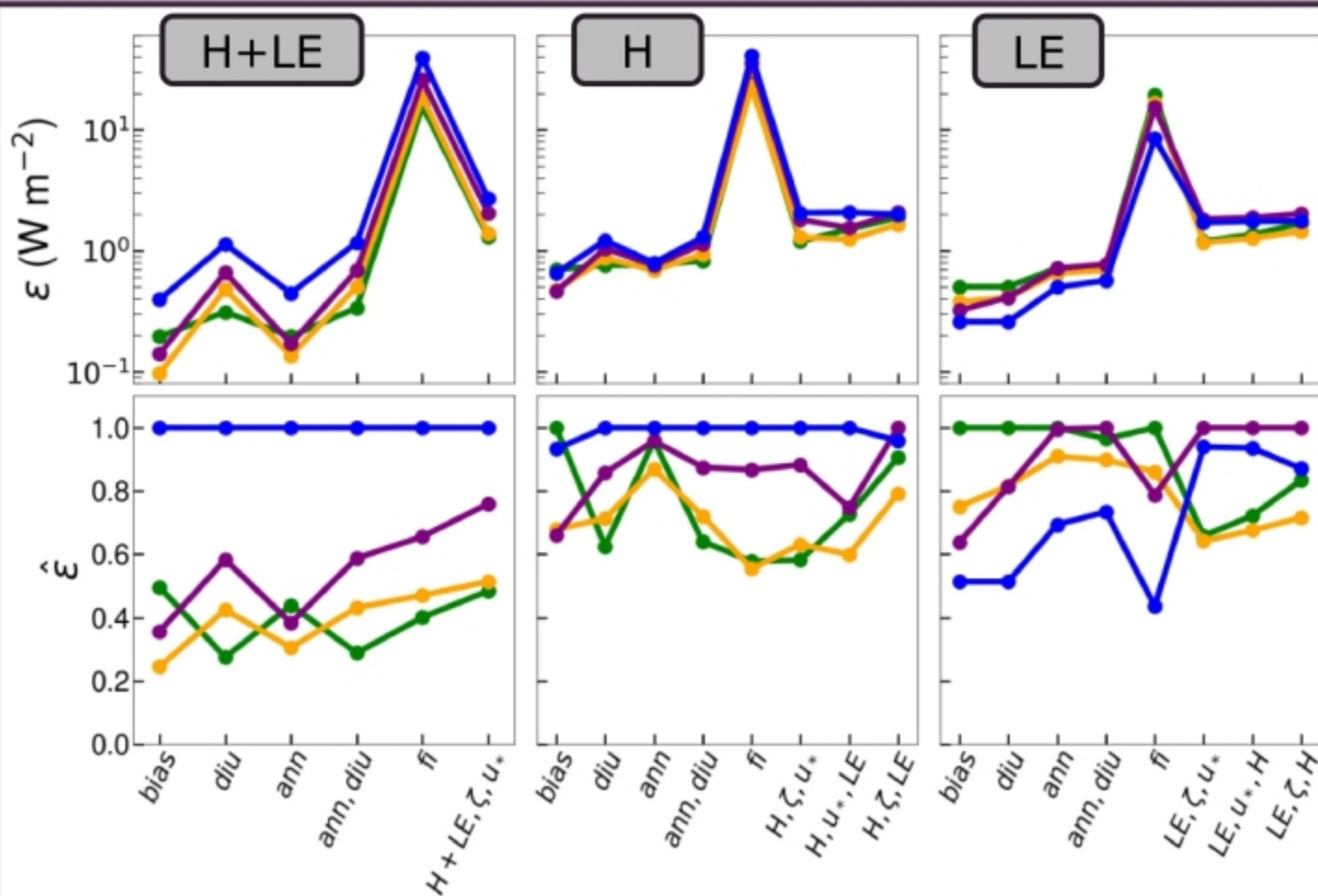


Figure 4. Combined errors (ϵ) and combined normalized errors ($\hat{\epsilon}$) for the surface turbulent fluxes.

2. Data

Four **simulations** from the latest version of the CRCM6-GEM5 model (Roberge et al., 2024)

- GEM5.0.2:** $u \geq 0,1 \text{ m s}^{-1}$
- C:** Land surface model CLASS
- Roughness length (z_0^c) from CLASS**
- GEM5.1.1:** $u \geq 0,01 \text{ m s}^{-1}$, $L \geq 20 \text{ m}$
- Iz0:** Roughness length (z_0^i) from ISBA
- I:** ISBA for land surface model

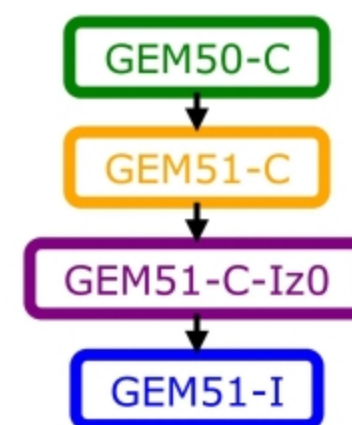


Figure 2. Nodes represent simulation configurations and connections indicate a single degree of change in the configuration.

Observations

- 27 AmeriFlux stations
- Mesures eddy covariance
- From 2015-2020, with minimum 1 year of data

All data are available on [Borealis](#).

Figure 3. CORDEX-NA domain with 27 stations used. Reproduced from Whittaker et al., 2025.



Performance and sensitivity

- GEM version (GEM50-C \rightarrow GEM51-C): Moderate sensitivity. GEM50-C performs best globally, especially for LE.
- Roughness length values (GEM51-C \rightarrow GEM51-C-Iz0): Moderate sensitivity. GEM51-C performs best for every single error metric except ϵ_{bias} and ϵ_{fi} .
- Land surface model (GEM51-C-Iz0 \rightarrow GEM51-I): High sensitivity. GEM51-I performs better for LE, but worse for H and H+LE.

3. Methods

Based on the work of Whittaker et al. (2025)

A hierarchy of error metrics:

- Bias: $\epsilon_{bias} = sim - obs$
- Diurnal: ϵ_{diu}
- Annual: ϵ_{ann}
- Annual and diurnal: $\epsilon_{ann,diu}$
- Frequency-intensity: ϵ_{fi}
- Interaction (with surface roughness ζ and friction velocity u_*): $\epsilon_{\Phi,\chi,\psi}^{tot} = frequency + flux + interaction$

Where $\Phi = \{H + LE, H, LE\}$ are the surface turbulent fluxes.

5. Conclusions

- The performance and ranking of the simulations depend on the choice of the error metric selected, especially for the single surface turbulent fluxes.
- Simulations improving a single turbulent flux (e.g., LE) do not necessarily imply an overall improvement of the turbulent heat fluxes (i.e., H+LE) because of error compensation.
- Simulations using the land surface model CLASS perform better than those using ISBA, particularly for the combined surface turbulent fluxes H+LE.

References

- Ban-Weiss, G. A., Bala, G., Cao, L., Pongratz, J., & Caldeira, K. (2011, sep). Climate forcing and response to idealized changes in surface latent and sensible heat. *Environmental Research Letters*, 6 (3), 034032. Retrieved from <https://dx.doi.org/10.1088/1748-9326/6/3/034032>
- Roberge, F., Di Luca, A., Laprise, R., Lucas-Picher, P., & Thériault, J. (2024, February). Spatial spin-up of precipitation in limited-area convection permitting simulations over North America using the CRCM6/GEM5.0 model. *Geoscientific Model Development*, 17 (4), 1497-1510. Retrieved from <https://gmd.copernicus.org/articles/17/1497/2024/> doi: 52110.5194/gmd-17-1497-2024
- Whittaker, T., Luca, A. D., Roberge, F., & Winger, K. (2025). Evaluating Near-Surface Wind Speeds Simulated by the CRCM6-GEM5 Model Using AmeriFlux Data Over North America. *Journal of Advances in Modeling Earth Systems*, 17 (3), e2024MS004666. doi: 10.1029/2024MS004666

Temperature outcomes of enhanced rock weathering deployment scenarios constrained by soil albedo measurements and UVic Earth system climate model simulations

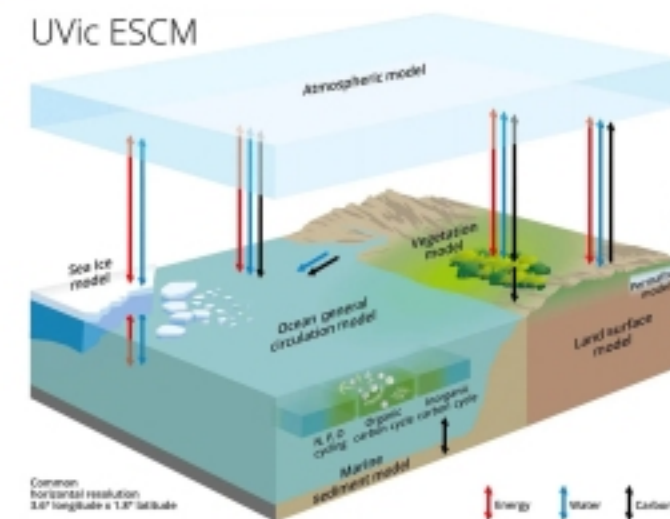
Isabel Dove¹, Jonathan Spence²,
Sasha Wilson², Kirsten Zickfeld¹
¹Simon Fraser University
²University of Alberta

Introduction

- Given current emissions trajectories, gigatonne-scale deployment of carbon dioxide removal (CDR) is necessary to achieve the temperature goal of the Paris Agreement.
- Enhanced rock weathering (ERW) is a CDR strategy involving spreading silicate rock powder on croplands.
- Silicate minerals react with CO₂, forming bicarbonate ions that are transported by rivers to the ocean, where carbon is stored.
- Outstanding questions regarding carbon cycle and biogeophysical effects due to global-scale ERW deployment.

What are the temperature outcomes of different ERW deployment scenarios?

UVic Earth System Climate Model



- Intermediate complexity model
- Increased weathering flux parameter to represent ERW

Figure from Mengis et al. (2020)

Scenario-Dependent Climate Outcomes

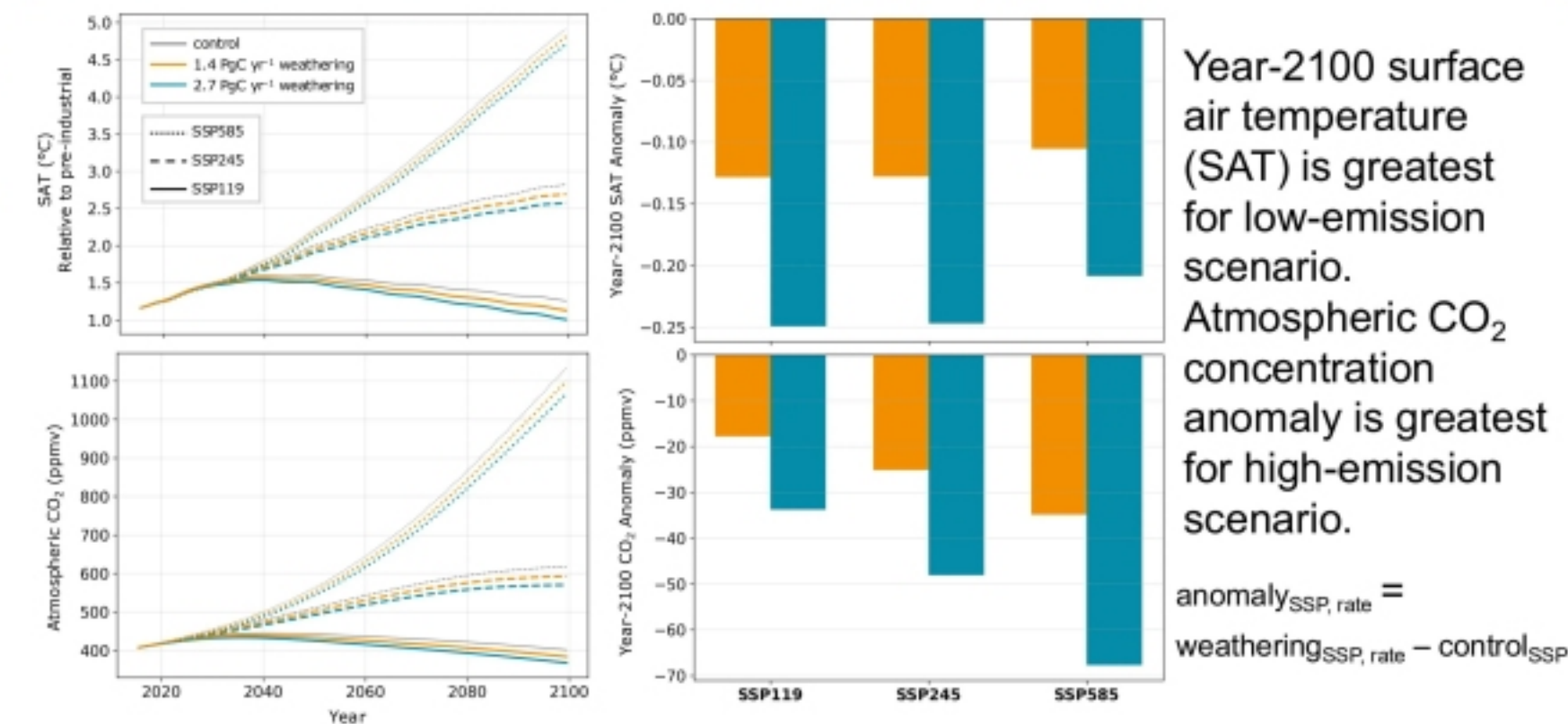
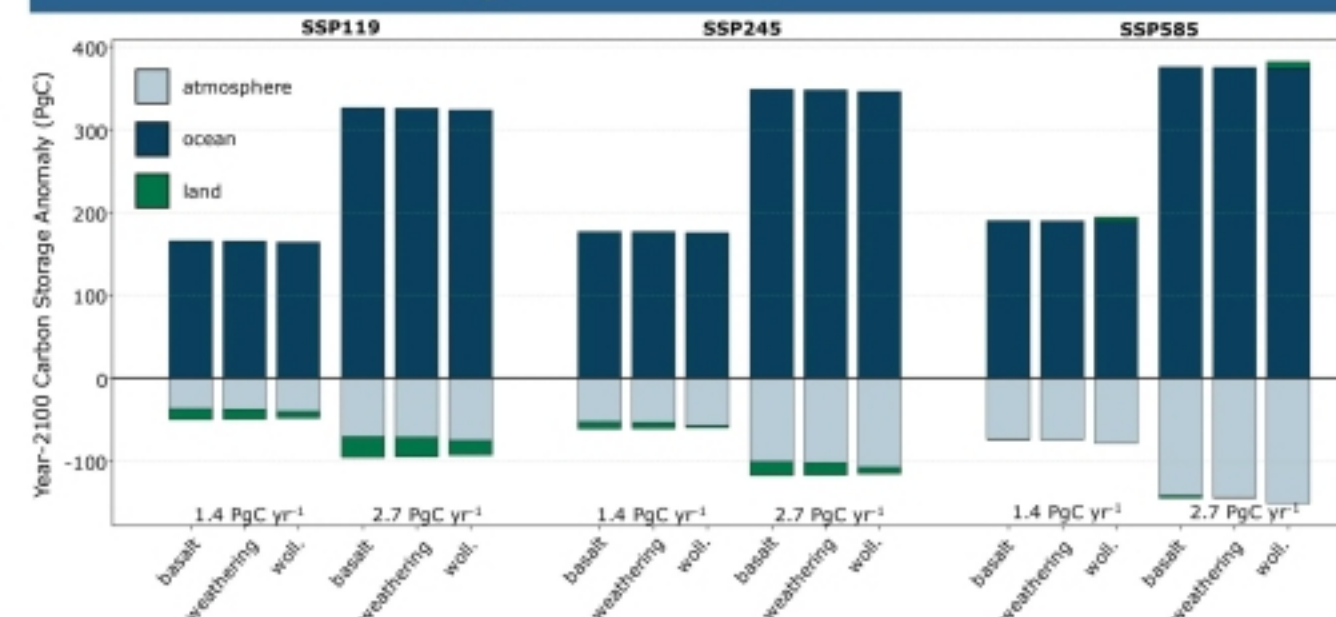


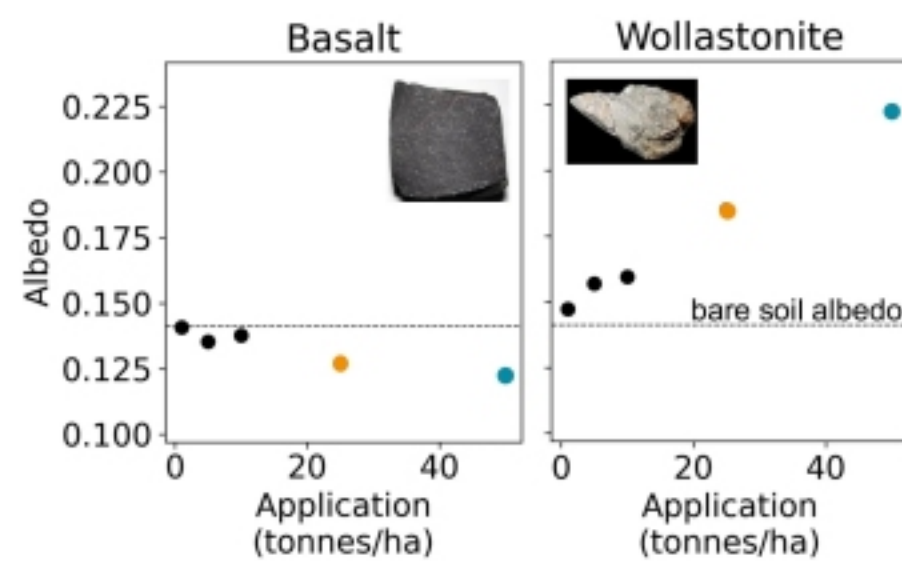
Table 1: ERW simulations

| SSPs 1-1.9, 2-4.5, 5-8.5 | | | |
|--|----------------------------------|--------------------------|---------------------------------|
| Control | No ERW | | |
| 1.4 PgC yr ⁻¹ (5 GtCO ₂ yr ⁻¹) | Weathering (no albedo change) | Basalt (lower albedo) | Wollastonite (higher albedo) |
| 2.7 PgC yr ⁻¹ (10 GtCO ₂ yr ⁻¹) | Weathering (no albedo change) | Basalt (lower albedo) | Wollastonite (higher albedo) |

Carbon Cycle Response to ERW



Soil Albedo Measurements



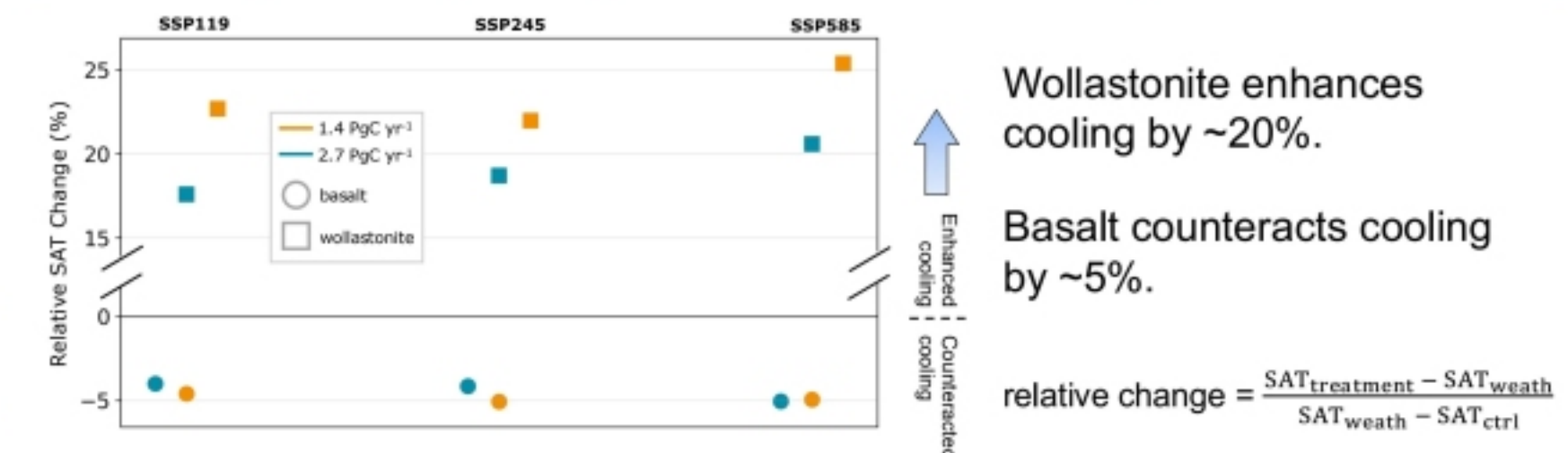
CDR Implementation

- Rock powder applied to global cropland (1.5 Gha)
- Assume weathering efficiency of 1.8 t C ha⁻¹ (Kantola et al., 2023; Baek et al., 2023)

$$25 \text{ t ha}^{-1} \rightarrow 1.4 \text{ PgC yr}^{-1} \text{ (5 GtCO}_2 \text{ yr}^{-1})$$

$$50 \text{ t ha}^{-1} \rightarrow 2.7 \text{ PgC yr}^{-1} \text{ (10 GtCO}_2 \text{ yr}^{-1})$$

Soil Albedo Impacts Year-2100 Temperature



Conclusions

- 100s PgC stored in the ocean and 10s PgC lost from the land. Land losses are greatest in low-emission scenarios.
- ERW is most effective at removing CO₂ in high-emission scenarios, but has a greater temperature impact in low-emission scenarios.
- Altered soil albedo impacts temperature outcomes, with greater relative impact at lower deployment rates.

Investigating the impact of Insect Driven Disturbances on a Southern Ontario Watershed's Carbon and Water dynamics using the MESH-CLASSIC model

Daniel Mutton^{1,2}, M. Altaf Arain^{1,2}, Dan Princz³, Bruce Davison³

¹ School of Earth, Environment, and Society, McMaster University, Hamilton, Ontario, Canada. ² McMaster Hydrometeorology & Climatology Group, McMaster University, Hamilton, Ontario. ³ National Hydrology Research Centre, Environment and Climate Change Canada, Saskatoon, Saskatchewan, Canada.

Objectives:

- Develop an insect infestation module for MESH-CLASSIC to simulate insect disturbances for the three most common types of infestation type in North America.
- 1. Broadleaf defoliators (forest tent caterpillar, spongy moth)
- 2. Needleleaf defoliators (spruce budworm)
- 3. Needleleaf Killers (mountain pine beetle)
- Test model performance at both the columnar and the distributed (mosaic) scale against a real infestation event.
- Identify carbon and water fluxes most severely impacted, what is the relationships between the insect infestation and hydrology.



Table 1: Landcover breakdown and associated MESH-CLASSIC PFT classification for the Big Creek catchment

| Landcover super-class | MESH-CLASSIC PFT | Big Creek Land Cover (%) |
|-----------------------|------------------------|--------------------------|
| Grasslands | C3 & C4 Grass | 0.82 |
| Shrubland | C3 & C4 Grass | 1.72 |
| Needleleaf Forest | NDE-ENF | 1.46 |
| Broadleaf Forest | NDE-ENF & BDL-DCD-COLD | 55.20 |
| Mixed Forest | BDL-DCD-COLD | 3.50 |
| Wetlands | C3 & C4 Grass | 0.22 |
| Agriculture | C3 & C4 Crops | 72.58 |
| Water | | 0.27 |
| Urban and Barren | | 4.42 |

Study Area (Big Creek):

- Small (573 km²) Agriculturally dominated catchment located in Southern Ontario.
- Broadleaf and Mixed forest coverage becomes more common in the south of the catchment.
- Experienced significant infestation of Spongy Moths (BLD) in 2021.

Study Area (CA-TPD):

- 90-year old deciduous forest.
- Located east of Big Creek.
- Flux tower (CA-TP4) located on site.

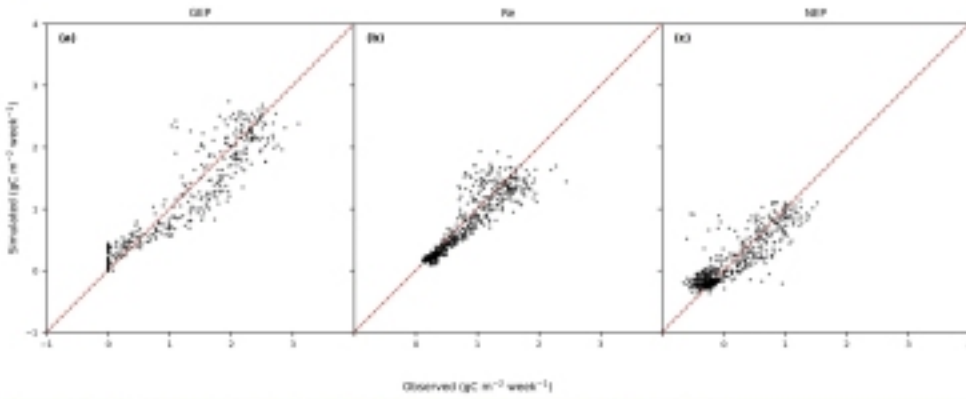


Figure 1 (above): Scatter plot showing the relationship between the three carbon fluxes at Ca-TPD

Summary of Carbon Results:

- Model does well simulating change to GEP and NEP.
- Model accurately represents timing of infestation and reflush. Although it seems to over-emphasize the magnitude of the reflush.
- Year-of-infestation statistics improve with module enabled, overall statistics show no significant improvement.
- Site correctly becomes a carbon source rather than sink during the year of infestation.
- Distributed model accurately simulated most extreme impact over grids with higher forest cover.

Summary of Water Results:

- Evapotranspiration decreases with infestation.
- Lateral flow and through-flow increase during infestation.
- Minor increase in streamflow and soil moisture during the year of infestation.
- Impacts extend past infestation year, although dramatically reduce in severity.

Table 2: Performance statistics for CA-TPD with and without infestation module enabled; and only during the infestation year and over a 10-year period.

| Flux | RMS | r | MBE | RE |
|---|------|------|--------|-------|
| No infestation occurred (2021) | | | | |
| GEP | 0.44 | 0.91 | 0.21 | 0.49 |
| Re | 0.23 | 0.81 | -0.07 | 0.86 |
| NEP | 0.40 | 0.91 | 0.26 | -0.52 |
| Infestation occurred (2021) | | | | |
| GEP | 0.21 | 0.85 | -0.005 | 0.89 |
| Re | 0.26 | 0.92 | -0.14 | 0.71 |
| NEP | 0.51 | 0.89 | 0.11 | 0.19 |
| No infestation occurred (10 years) | | | | |
| GEP | 0.52 | 0.94 | -0.05 | 0.5 |
| Re | 0.25 | 0.9 | -0.06 | 0.86 |
| NEP | 0.5 | 0.82 | -0.01 | 0.71 |
| Infestation occurred (10 years) | | | | |
| GEP | 0.3 | 0.95 | -0.03 | 0.88 |
| Re | 0.25 | 0.9 | -0.07 | 0.85 |
| NEP | 0.5 | 0.85 | -0.004 | 0.73 |

Conclusions:

- Insect infestation module captured timing well.
- Resulted in a better fit for the year of the infestation.
- Accurately captured major changes experienced by the stand and catchment.
- Clear relationship between infestation and hydrology observed.
- Empirical representation of infestation suitable for historic simulations.

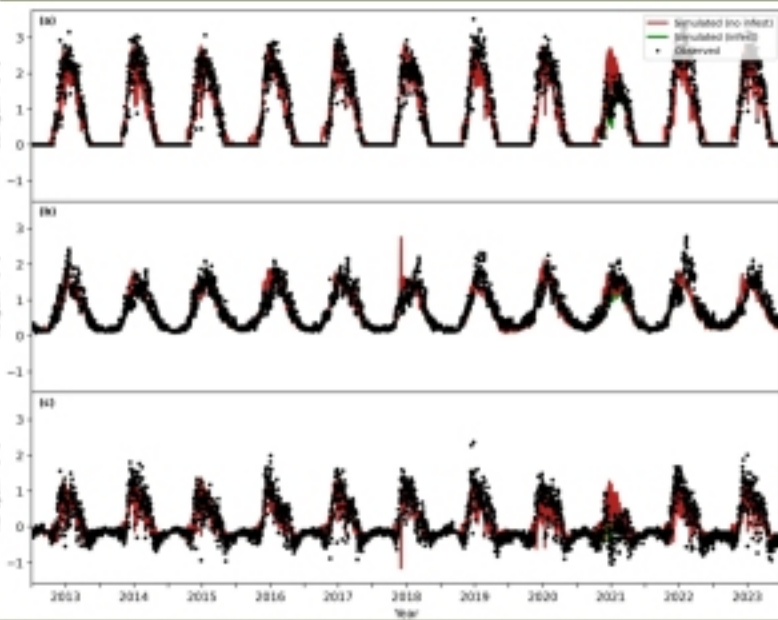


Figure 3 (above): Timeseries of the three carbon fluxes over the 10-year study period. Simulation with the infestation module enabled are green, and without the module are red.

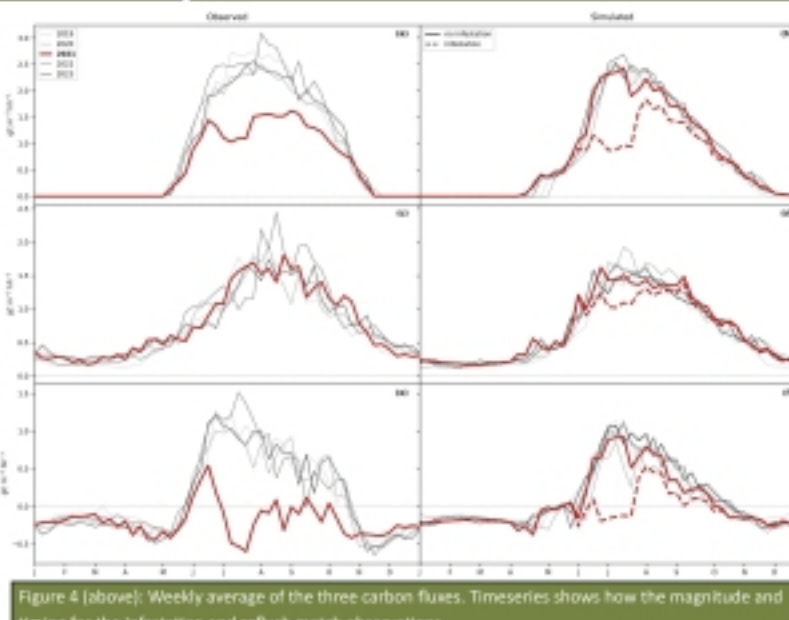


Figure 4 (above): Weekly average of the three carbon fluxes. Timeseries shows how the magnitude and timing for the infestation and reflush match observations

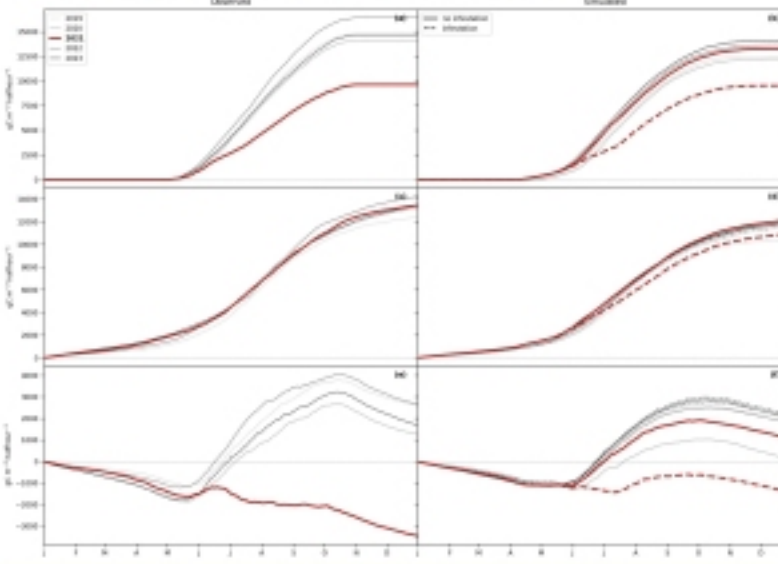


Figure 5: Yearly cumulative carbon fluxes, the red-coloured year is the year of the infestation (2021).

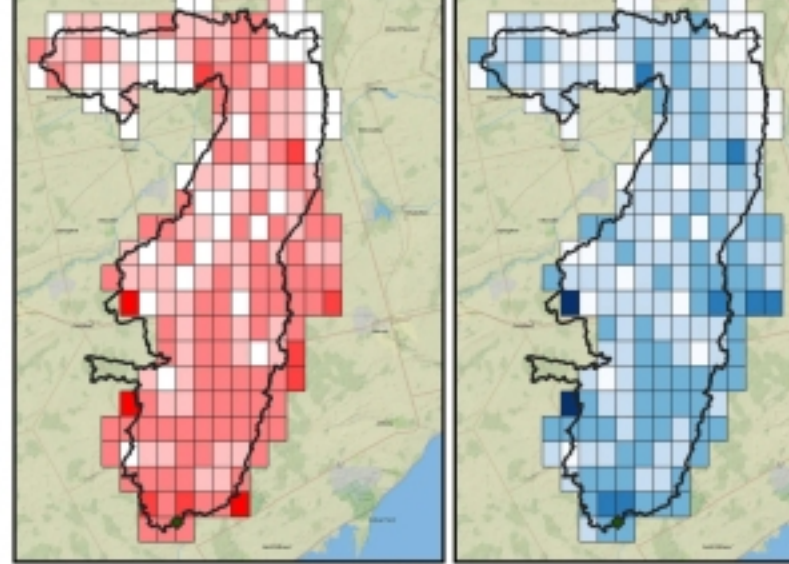


Figure 6: Spatial map showing the percentage (%) difference in GEP and ET at the Big Creek catchment during the infestation year. In both cases the difference is a measurement of loss.

GLOBAL WATER FUTURES
SOLUTIONS TO WATER THREATS
IN AN ERA OF GLOBAL CHANGE

McMaster University

Contact: Daniel Mutton
muttond@mcmaster.ca

Comparing Concentration Weighted Trajectory (CWT) Mapping Techniques with Satellite Measurements of NO₂ in Toronto, Canada



Samir Singh¹, Mark Gordon¹, Costas Armenakis¹, Debora Griffin², Neda Kolahi¹

¹ Earth & Space Science, York University, Toronto, Canada

² Air Quality Research Division, Environment and Climate Change Canada, Toronto, Canada



1. Introduction

Previous studies have analyzed air pollution in Toronto:

- Jeong et al. (2020): Used HYSPLIT to deduce long-range sources of pollutants in Toronto, from long term air-pollution measurements.
- Jerret et al. 2007, Weichenthal et al. (2016), Sharisingh et al. (2021), employed a Land Use Regression (LUR) model to map pollutant spatial distributions via short-term measurements

Elevated levels of ambient pollution pose numerous risks to human health & wellbeing. With the aim of better understanding the local patterns of NO₂ in the city, we employ **direct measurements** from **ground-level** and **satellite** observations to locally analyze and **map the spatial distributions of pollutants in Toronto**, and **identify potential hotspots and sinks** providing a direct observation-based alternative using longer-term measurements.

Spatial variations of NO₂ were mapped in Toronto using **14 ground-level air quality (AQ) stations**, and **satellite measurements from TEMPO** (Tropospheric Emissions: Monitoring of Pollution) and **TROPOMI** (TROPOspheric Monitoring Instrument)



Sample air-quality station for a location in Downtown Toronto. Owned by the Ontario Ministry of Environment, Conservation and Parks (Air-Quality Ontario, n.d.) (left). Map of air-quality stations showing lines connecting the airport stations used for their corresponding wind measurements (right), with sample AQ station shown in orange.

3. Mapping Techniques from AQ Stations

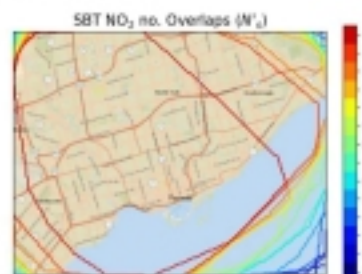
We employ two mapping techniques (back-trajectories) from long-term ground level observations (dating as far back as 1998), to linearly trace pollutants measurements backwards in time based on local hourly wind speed and direction

First mapping technique, based on the concentration weighted trajectory method (CWT)

1. Calculates the **average concentration** per 10° wind direction, at each site.
2. **Linearly traces** the average concentration 2-hours backwards in-time
3. **Linearly interpolates** to fill in the gaps
4. **Repeats** for each site, calculates a **weighted-average** of overlapping grids, where weights are assigned based on no. observations per site, known as the **Superimposed Back-Trajectory (SBT)** (see Figure 1, example for just 3 sites). Given by equation below, where S sites are used, and N'_s is the number of observations at the s^{th} site.
5. **Removed values** with less than 11 overlapping maps (see Figure below) to eliminate discontinuities and clutter.

Second mapping technique, based on **conditional probability function (CPF)** technique, uses ratio of threshold (>75 percentile) instead.

$$SBT(x, y) = \frac{\sum_{s=1}^S BT_s(x, y) N'_s}{\sum_{s=1}^S N'_s}$$



2. Satellite Methodology

| | TROPOMI | TEMPO |
|-----------------------------|---|--|
| Temporal Range & Resolution | Beginning of May 2018 to end of April 2023. Bypass time 13:30 LST (Ialongo et al., 2020) | All of 2024. Daytime measurements (7-17 LST) |
| Spatial Resolution | 3.5 x 7km before Aug 6, 2019, 3.5 x 5.5 km proceeding (Ialongo et al., 2020) | Level 2 has resolution 2km x 4.75km, level 3 with resolution 2 x 2km resolution. |
| Mapping Methodology | Measurements assigned to nearest defined grid point (250m) resolution, spatially expanded depending on acquisition date | Measurements assigned to nearest grid-point, (since points were at fixed 0.02° coordinates), overlapping measurements averaged, then linearly interpolated to fill in missing values |
| Filters Applied | Data Quality (> 0.75/1), Solar Zenith Angle (< 70°), Cloud Fraction (< 0.3) | None |

Conversion to surface concentration (ppb)

$$[x_1] = \frac{[c]M_{\text{air}}RT}{N_aP} \frac{(10^4)}{(\text{BLH})}$$

Where $[c]$ is the measured satellite concentration in molecules/cm², M_{air} is the molar mass of air (28.96 g/mol), R is the dry gas constant (0.287 J/K g), BLH is the boundary layer height (m), and P and T are the near-surface pressure (Pa) and temperature (°K) respectively. $[x_1]$ is the converted concentration in ppb, and the factor of 10⁴ converts cm⁻² to m⁻², **BLHs from ERA5** (0.25° x 0.25° resolution) (Climate Data Store, n.d.) **temperature and pressure from ECCC station in downtown Toronto** (Government of Canada, n.d.).

4. Spatial Distribution Relationships

Distinct locations for regions such as NE, DVP, Highway 427, Pearson Airport are apparent in the TROPOMI vs. TEMPO relationship

Despite **no linear relationship** between mapping techniques and satellite measurements, smaller regions such as NE, Highway 427, DT, DVP have weak to moderate relationships, and are also located in distinct regions on the graph. (CWT vs. TEMPO for example)

Strongest relationship between mapping techniques (shows taking averages is a very similar operation to frequency of counts above a certain threshold).

Similarities within the satellites and mapping techniques but not between them.

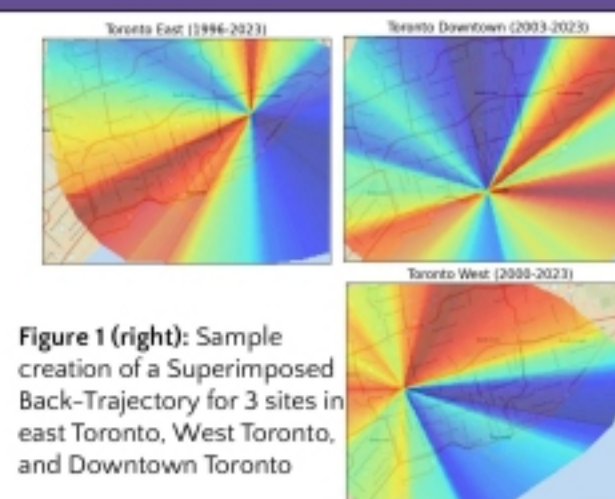
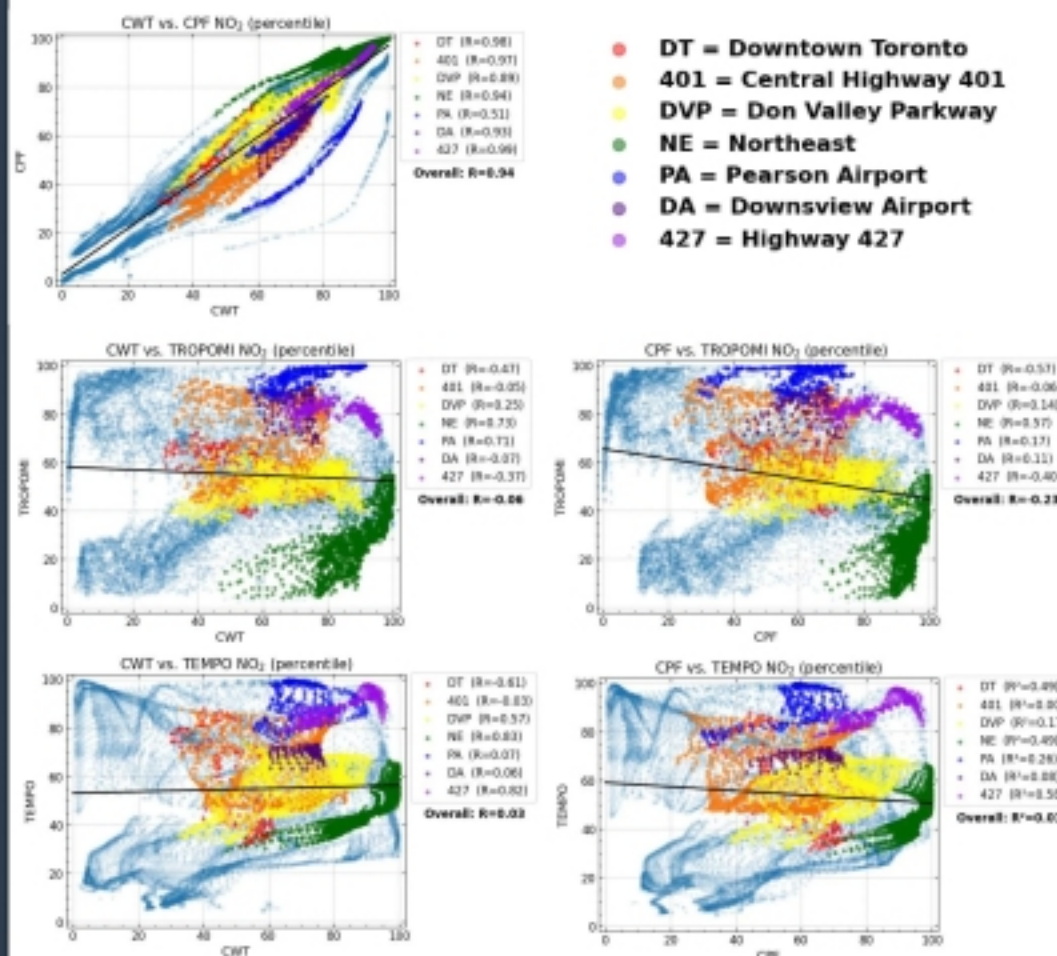
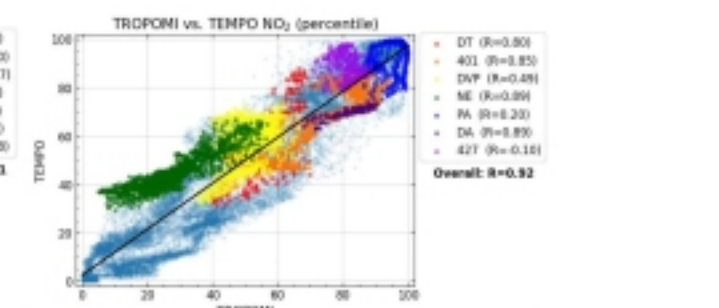


Figure 1 (right): Sample creation of a Superimposed Back-Trajectory for 3 sites in east Toronto, West Toronto, and Downtown Toronto

Percentiles used instead of absolute concentrations, for comparisons as all methodologies can be normalized in the same manner to evaluate relative locations of hotspots, sinks, and spatial gradients



5. Mapped Results

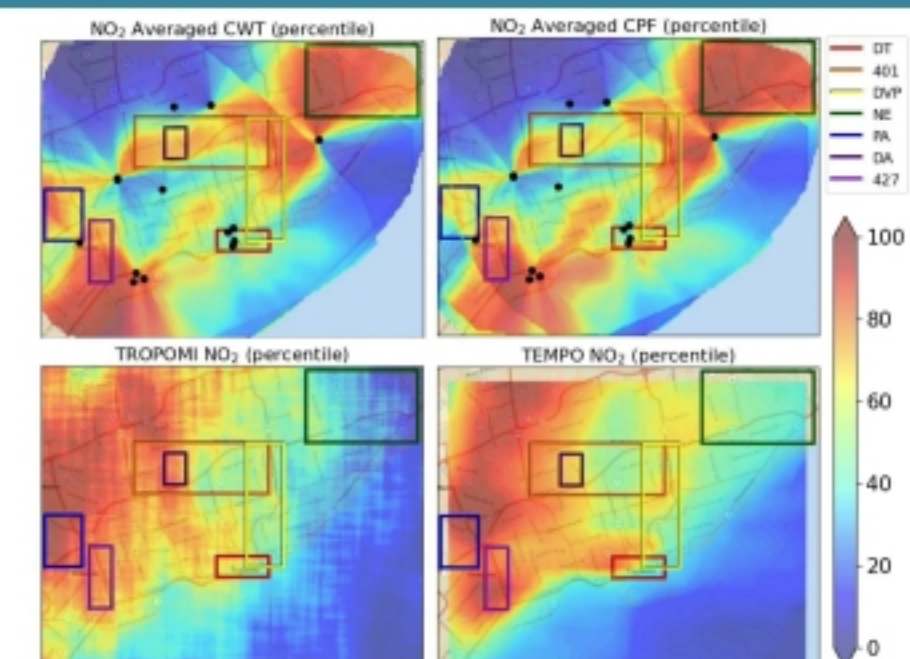


Figure 2: Spatial Distributions from the CWT, CPF, TROPOMI and TEMPO satellite. Locations of 14 AQ stations (marked with black dots). Specific regions are outlined as boxes.

Back-Trajectories

1. Show **elevated concentrations** over HWY401 (Canada's busiest highway) (not observed in satellites)
2. Show **high concentrations** in NE Toronto (not observed in satellites)
3. Show **high concentrations** over HWY 427 (also similar to TEMPO)
4. Show **low concentrations** in NW Toronto (opposite compared to satellite results)

Satellite measurements

1. **High concentrations** in West Toronto, more specifically over Pearson Airport (similar to CWT)
2. **Lowest concentrations** over Lake Ontario (somewhat denoted in mapping techniques)

Mapping techniques from air-quality stations have many disadvantages:

1. **Assumes constant mixing ratio** (fails to take into account sources, or photochemical changes along trajectory)
2. **Takes wind speed and direction** from airports (sometimes considerable distance between airport and site, not accounting for topography changes, or urban meteorology).
3. **Relatively sparse station coverage**

Satellites directly measures concentrations at location, BUT:

1. **Total column measurements**
2. **Adjusted to surface concentration** using BLH, and temperature and pressure, however, **assumes all column pollutants are below BLH**

6. Conclusion

Since the goal was to map spatial variations, and identify potential hotspots, the BLH corrected satellite measurements should be considered more representative of surface & near-surface level spatial distributions since most column NO₂ is already below the BLH. Considerable discrepancies between the satellite and back-trajectory maps is most likely from the sparsity of stations and the assumptions made with the back-trajectory methodology

Future work could employ more real-time ground level measurements (including wind) to potentially decrease the disparity between back-trajectories and satellite concentrations in urban areas

7. References

1. Toronto Downtown station information. Government of Ontario. n.d.
2. Ialongo, L., Vito, H., Eskes, H., Steiner, J., & Dawson, J. (2020). Comparison of Tropospheric Monitoring Instrument (TROPOMI) NO₂ product with ground-based observations in Helsinki and first societal applications. *Atmospheric Measurement Techniques*, 13(11), 205-218.
3. Jeong, C.-H., Tran, A., Huang, A., Hilber, N., Wang, J. M., Herod, D., Dobak-Zlotynska, E., Celis, V., & Evans, G. J. (2020). Long-term analysis of PM_{2.5} from 2004 to 2017 in Toronto: composition, sources, and radiative potential. *Environmental Pollution*, 261, 114852. <https://doi.org/10.1016/j.envpol.2020.114852>
4. Jerret, M., Aram, M. A., Karanajic, P., Beckerman, B., Coats, D., Gilbert, N. L., Brook, J. R., Fehsenfeld, N., & Fehsenfeld, M. M. (2007). Modeling the intraday variability of ambient traffic pollution in Toronto, Canada. *Journal of Environmental and Earth System Health, Part A*, 7(5-6), 200-212.
5. Sharisingh, K. K., Brook, J. R., Mhade, C. M., & Evans, G. J. (2021). Characterizing long-term NO₂ concentration variations across a large metropolitan area through spatiotemporal level set regression modeling of mobile measurements. *Environmental Research*, 198, 111818.
6. Weichenthal, S., Van Ryn, K., Dolan, A., Siddiqui, M., & Hatzopoulos, M. (2019). Characterizing the spatial distribution of ambient sulfate particles in Toronto, Canada: a land use regression model. *Environmental Pollution*, 250, 243-248.

Aerosol Layer Height Intercomparisons and evaluation of satellite-measured plume heights

Javeria Rizwan¹, Debra Wunch¹, Debora Griffin², Hai Zhang³, Victoria Pinnegar²

¹ University of Toronto, ² Environment and Climate Change Canada, ³ National Oceanic and Atmospheric Administration

INTRODUCTION

The height of wildfire smoke, called aerosol layer height (ALH), is an important parameter that determines the transport and spatial extent of wildfire pollutants. Due to the episodic and variable nature of fires, measurements of ALH with high temporal and spatial resolution is crucial.

The Tropospheric Emissions: Monitoring of Pollution (TEMPO) mission is a geostationary satellite over North America, measuring since August 2023 [1]. TEMPO measures ALH hourly during daylight from the Oxygen-B band. With finer spatial and temporal resolution than earlier satellites, it can improve plume-height estimates for North American wildfire impact studies. However, TEMPO ALH lacks comprehensive validation. This work presents preliminary comparisons of TEMPO ALH to ground-based measurements in Canada.

COMPARISON DATA

Ceilometers are weak lidars capable of measuring backscattered light with high temporal (30 s) and vertical resolution (10 m). We used ECCC ceilometer data from East Trout Lake, SK, collected during the 2025 biomass-burning season. Wildfire plumes appear as aerosol layers that cause enhanced backscatter measured by the ceilometer, as shown in Figure 1. The TEMPO cloud mask distinguishes clouds from aerosols. TEMPO ALH was filtered to include points where:

- Aerosol Optical Depth at 550 nm (AOD550) ≤ 5
- Data Quality Flag (DQF) ≤ 1
 - 0 = highest quality, 1 = acceptable

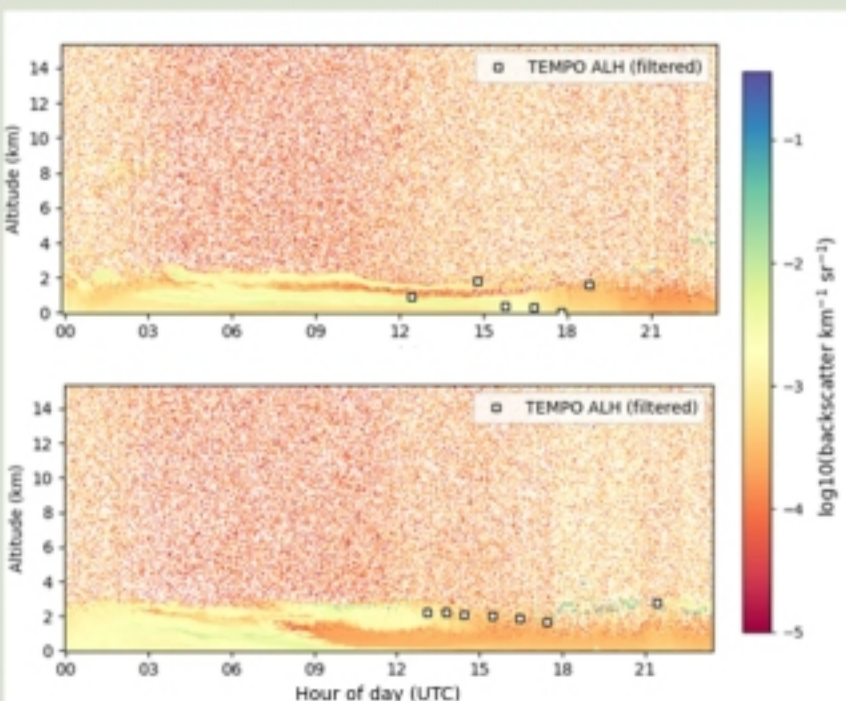


Figure 1: Ceilometer-measured backscatter timeseries at East Trout Lake (UTC-6) with co-incident TEMPO ALH measurements, taken on July 2 (top) and July 30, 2025 (bottom). Co-incident TEMPO ALH measurements are those taken within 15 km of East Trout Lake.

CASE STUDY

The East Trout Lake laboratory experienced active wildfires in its vicinity in Summer 2025. Figure 1 shows ceilometer backscatter and TEMPO ALH for two days in 2025. TEMPO ALH within 15 km of the ceilometer were compared. Aerosol layers appear as backscatter enhancements (e.g. yellow features); TEMPO often reports ALH near the top or middle of the layer. On July 2 ($\approx 12:00$ and $15:00$ UTC) two layers are seen: at 12:00 TEMPO picks the top of the lower layer, at 15:00 it picks the top of the upper layer.



Figure 2: Map showing East Trout Lake, SK, in the boreal forest; ECCC ceilometers at Stony Plain, AB and Squamish, BC.

DEFINING ALH FROM CEILOMETER

Figures 3-4 show example ceilometer backscatter profiles. For each TEMPO measurement we use a 10-minute average profile to reduce noise and define ALH from the mean. Several ceilometer-derived ALH definitions were tested:

- “Top” height: defined by threshold method; the top height is the highest layer where the measured backscatter exceeds $0.0015 \text{ km}^{-1} \text{ sr}^{-1}$
- “Base” height: defined as the lowest layer where the measured backscatter exceeds $0.0015 \text{ km}^{-1} \text{ sr}^{-1}$
- “Mid” height: the mean of the top and base height
- “Max” height: the altitude of maximum measured backscatter
- “Weighted” height: defined as

$$\frac{\sum_i \beta_i z_i}{\sum_i \beta_i}$$

where β_i is the mean measured backscatter at level i , z_i is the altitude, and the sum is over i for $z_i = 0 \text{ km}$ to $z_i = 6 \text{ km}$. The range is restricted due to light attenuation from the ceilometer causing noisy signal at higher altitudes.

Of these, **TEMPO ALH measurements best correlated with the weighted height definition.** This height represents the weighted average height in the case of several aerosol layers in a single column.

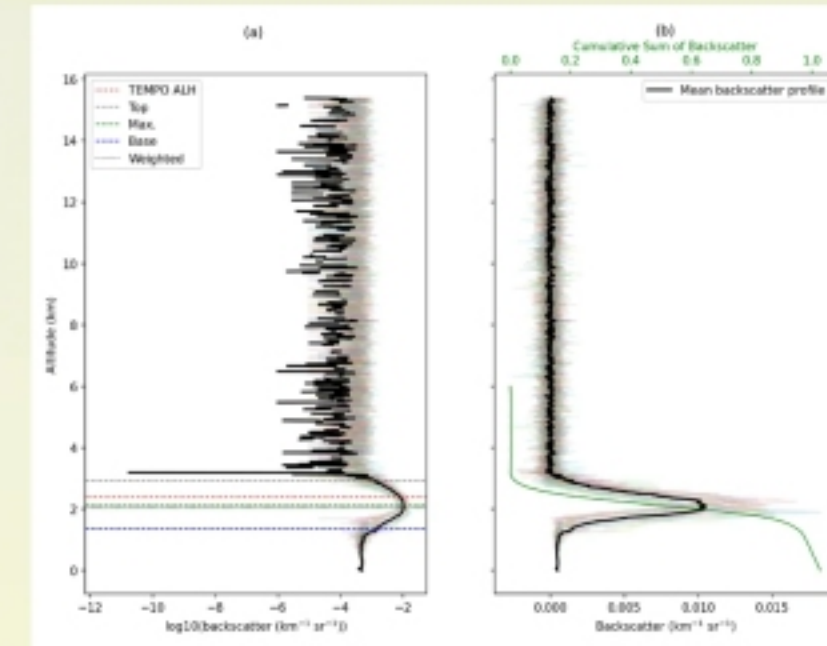


Figure 3: Example of a backscatter profile showing as single aerosol layer. TEMPO measured ALH near the laboratory on June 25, 2025, at 14:53:18 UTC. The spaghetti plots show the ceilometer-measured backscatter profiles taken within 5 minutes of the TEMPO overpass (20 total profiles). The mean profile is taken to decrease noise, shown in black. The mean profile is used to define ALH from the ceilometer. (a) Backscatter profiles in \log_{10} with TEMPO and ceilometer ALH indicated with horizontal lines. (b) The same profiles plotted in linear space.

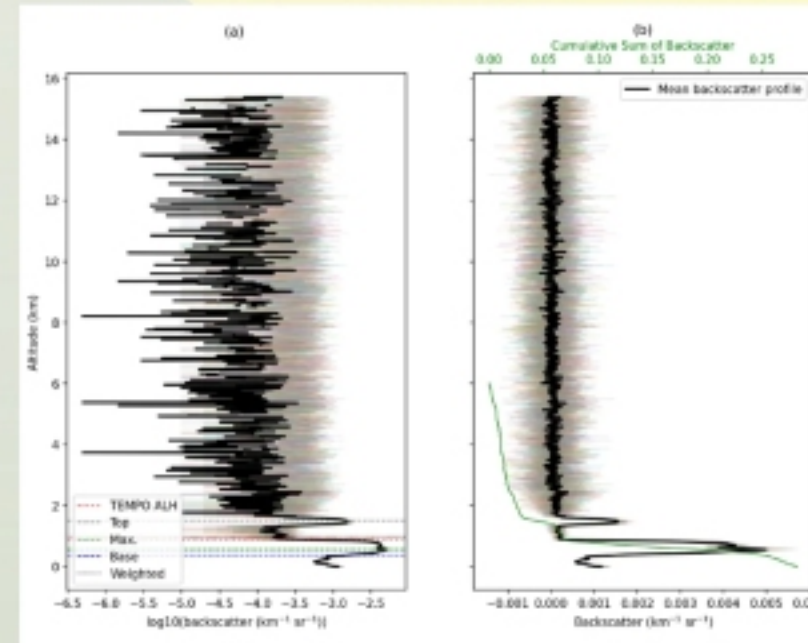


Figure 4: The same as Figure 3 for a backscatter profile showing two aerosol layers. Figure (b) shows the linear backscatter as a function of altitude, with the cumulative sum of the backscatter indicated in green. The sum is taken from 6 km downward. The cumulative sum is used to indicate the aerosol load in the column. Aerosol layers are associated with peaks in backscatter signal, corresponding to sharp increases in the cumulative sum profile. We consider the ceilometer to have detected an aerosol layer if the cumulative sum exceeds 0.2 at any level.

PRELIMINARY COMPARISONS RESULTS

TEMPO measurements within 15 km of East Trout Lake were compared to the co-incident weighted backscatter height from the ceilometer for Summer 2025. Due to strong light attenuation, ceilometers are often unable to detect atmospheric features above 5-6 km. Ceilometer data is used for comparisons to TEMPO measurements for ALH less than 5 km in this work.

The distribution and statistical comparisons of TEMPO and the ceilometer measurements is shown in Figure 5. TEMPO shows good correlation with the ceilometer with $R = 0.75$ with a high bias of 0.53 km compared to the ceilometer.

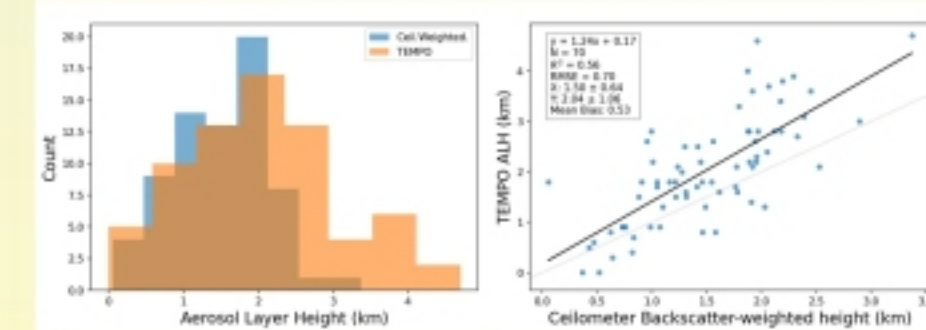


Figure 5: Left: distribution of TEMPO ALH with co-incident ceilometer measurements. Right: preliminary comparison statistics. Black shows the line of best fit, and gray shows the 1:1 line.

CONCLUSIONS AND NEXT STEPS

Preliminary comparisons of TEMPO ALH to ground-based measurements at East Trout Lake show promising results. TEMPO ALH shows good correlation for aerosol layers lower than 5 km. Further comparisons are being conducted with ECCC ceilometers are located at Stony Plain, Alberta and Squamish, British Columbia (Figure 2). For evaluation of aerosol layers above 5 km, other comparison datasets must be considered.

The Micro-Pulse Lidar Network (MPLNET) provides detailed vertical profiles at stations across North America with better vertical range than low-cost ceilometers. Comparisons of ALH from MPLs with TEMPO are being conducted. The MPL backscatter measurements at Stony Plain will be compared to the co-located ceilometer to evaluate the quality of the ceilometer data.

Finally, satellite inter-comparisons will be used to validate TEMPO’s performance across North America. TEMPO ALH will be compared to Tropospheric Monitoring Instrument (TROPOMI), which has been measuring ALH since 2018 [2]. TROPOMI measures ALH from the Oxygen-A band. In addition, the Atmospheric Lidar (ATLID) on the recently-launched EarthCARE mission provides detailed vertical profiles of aerosol features in the atmosphere, detecting the top and base heights of several aerosol layers [3]. Comparisons of TEMPO ALH to co-incident ATLID measurements will be valuable for validating and understanding which aerosol layers TEMPO measures.

References

- [1] Hai Zhang, Shobha Kondragunta, and Pubu Ciren. “TEMPO Aerosol Optical Depth and Aerosol Layer Height Retrieval Algorithm”. In: *Journal of Geophysical Research: Atmospheres* 130.18 (Sept. 2025), e2025JD044082. issn: 2169-8996. doi: 10.1029/2025JD044082. url: https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2025JD044082
- [2] Swadhin Nanda et al. “A first comparison of TROPOMI aerosol layer height (ALH) to CALIOP data”. In: *Atmospheric Measurement Techniques* 13.6 (June 2020), pp. 3043–3059. issn: 1867-1381. doi: 10.5194/amt-13-3043-2020. url: https://amt.copernicus.org/articles/13/3043/2020/
- [3] Tobias Wehr et al. “The EarthCARE mission – science and system overview”. In: *Atmospheric Measurement Techniques* 16.15 (Aug. 2023), pp. 3581–3608. issn: 1867-1381. doi: 10.5194/amt-16-3581-2023. url: https://amt.copernicus.org/articles/16/3581/2023/

Intercomparison of Formaldehyde Concentrations from Ground-Level Open-Path, Surface Model, and Surface Satellite Data

Cameron Power¹, Aldona Wiacek¹, Debora Griffin²
¹Saint Mary's University ²Environment Climate Change Canada

Motivation & Data Overview

Formaldehyde (HCHO) serves as an effective proxy for VOC activity and is an indicator of the atmosphere's oxidation capacity. While surface measurements of HCHO are scarce it is observable from space-borne instruments and routinely simulated in atmospheric forecast models. This study compares surface-level HCHO concentrations in Halifax, Nova Scotia, derived from three sources, spanning 30 non-consecutive months during 2018-2025:

- Surface concentrations derived from continuous Open-Path Fourier Transform Infrared (OP-FTIR) spectral measurements at Halifax Harbour (HH) and the SMU Atmospheric Obs. (SAO)
- Surface concentrations are derived by scaling satellite vertical column density (VCD) using model VCD and surface concentration (McLinden et al., 2014) for two satellites
 - TROPOMI HCHO Version 2 (daily, sun-synchronous polar orbit)
 - TEMPO Version 3 and 4 products (hourly, during daylight, geostationary orbit)
- Modeled surface concentrations from the operational version of GEM-MACH

| Data Source | Spatial Resolution | Temporal Resolution | Accuracy | Precision (Pmolec = 10 ¹⁵) |
|-------------|-------------------------------------|--|-----------------------------------|--|
| OP-FTIR | 400 – 1200 m path avg. | 1-4 minutes | ~ ppb | 50-100% |
| GEM-MACH | 10 x 10 km ² grid box | Hourly (15-minute integration step) | -- | -- |
| TROPOMI | 5.5-7.5 x 3.5 km ² pixel | Instantaneous Daily at ~ 13:30 Local Time | 40% - 80% (pre); 20% - 40% (post) | ~ 9 Pmolec/cm ² (post-launch) |
| TEMPO | 2 x 4.75 km ² pixel | Instantaneous Hourly During Daylight Hours | < 30% (pre-launch) | ~ 5 Pmolec/cm ² (post-launch) |



- TROPOMI:**
- Sun-synchronous orbit
 - Measurement per day
- TEMPO:**
- Geostationary orbit
 - Measurement per sunlight hour

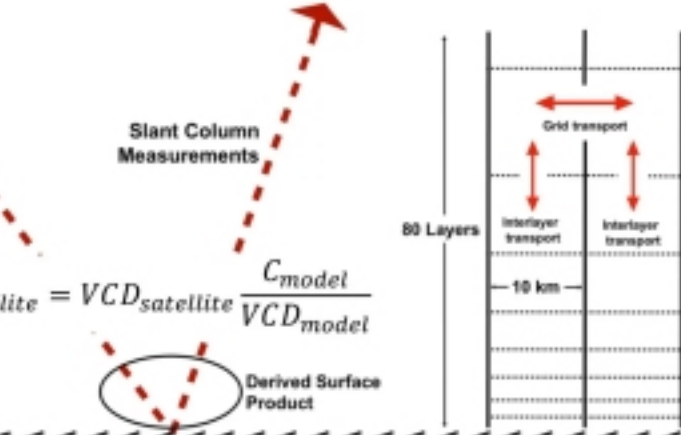


Figure 1: Overview of intercomparison study including (top) geographic locations of surface measurement sites with GEM-MACH grid shown in black and (bottom) physical measuring and simulating methods of datasets in study.

Spatial and Temporal Data Filtering Criteria

Surface – OP-FTIR spectral measurements: High-frequency OP-FTIR HCHO concentrations are down sampled from minutely to hourly resolution to match GEM-MACH output frequency. Concentrations are retrieved from ~1 km-path-average spectra and are not constrained to be positive; negative concentrations are possible when target abundances are low or interfering species (primarily water) are high (Power et al., 2025, AMT).

Surface – GEM-MACH: Nearest grid cell and overlapping hour was used to compare to hourly-mean OP-FTIR concentrations.

Surface – TROPOMI: To investigate the impact of spatial averaging on the comparison, observations were averaged in concentric boxes centered around SAO (44.63 N and 63.58 W), with side lengths of 10 km, 20 km, 30 km, 40 km (optimal), 50 km, 60 km and 75 km. Given the short lifetime of HCHO, OP-FTIR measurements within 3 hours (1.5 was tested) of the satellite overpass time were averaged for coincident data.

Surface – TEMPO: Two spatial averages of TEMPO data were investigated: a dataset using the nearest TEMPO value to SAO (44.63 N and 63.58 W), and one using an average of all TEMPO values within 20 km (optimal) of SAO. These spatial averages were compared to OP-FTIR measurements averaged within 30 minutes of the hourly TEMPO measurement.

Results 1 – Monthly Correlations

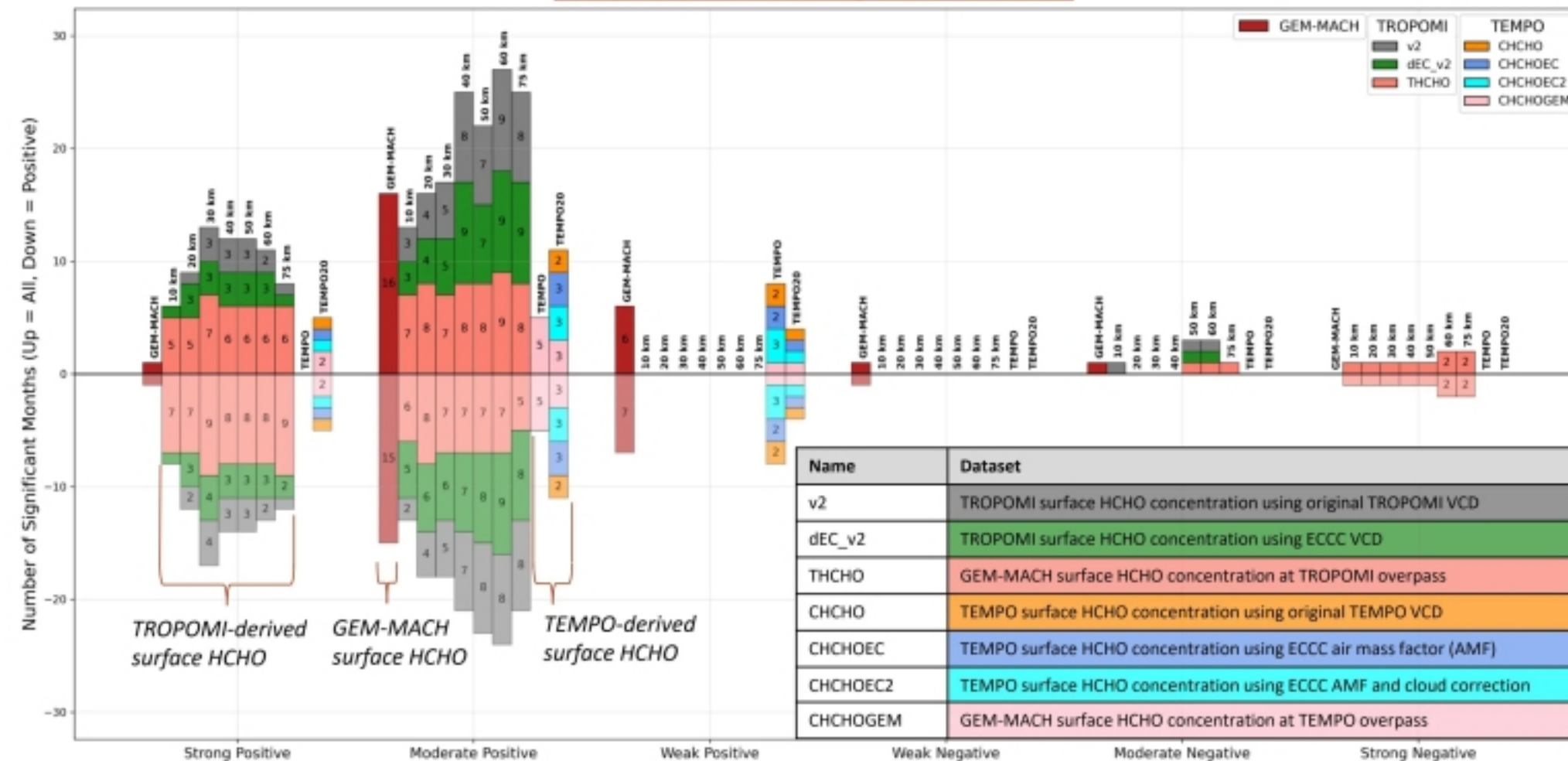


Figure 2: Comparison of significant ($p < 0.05$) monthly Pearson correlation strengths between OP-FTIR HCHO and 1) GEM-MACH surface HCHO 2) TROPOMI-derived surface HCHO based on averages in 10 km, 20 km, 30 km, 40 km, 50 km, 60 km, and 75 km boxes centered on SAO, and 3) TEMPO-derived surface HCHO based on nearest pixel and an average within 20 km of SAO. (top) All OP-FTIR HCHO retrievals results used in analysis and (bottom) only positive retrieval results used in analysis. Weak, moderate, and strong correlations defined as $r < 0.3$, $0.3 < r < 0.7$, and $r > 0.7$, respectively.

OP-FTIR – GEM-MACH: Of the 30 months with overlapping data, statistically significant correlations were obtained for 25 (all retrievals) or 24 (only positive retrievals) months, with only minor differences in correlation strengths due to the filtering for positive versus negative OP-FTIR concentrations. Correlation strengths in all retrievals (or positive retrievals) were moderate-positive in 16 (or 15) months and weak-positive in 6 (or 7) months, with a mean correlation of ~0.39 (or ~0.38). Unfiltered OP-FTIR HCHO data is most highly correlated with GEM-MACH surface HCHO.

OP-FTIR – TROPOMI: The smallest averaging areas (10x10 km², 20x20 km², 30x30 km²) lead to notably fewer overall significant correlation months using both original TROPOMI and ECCC-adjusted datasets (30% - 60% reduction w.r.t. 40x40 km²). The largest averaging areas (50x50 km², 60x60 km², 75x75 km²) show fewer strong-positive and more moderate-negative correlation months. The strongest and most positive correlations result from using unfiltered OP-FTIR surface HCHO and TROPOMI-derived surface HCHO averaged over 40x40 km², with mean correlations over statistically significant comparison months of ~0.71 and ~0.73 for original TROPOMI and ECCC-adjusted datasets. Curiously, when GEM-MACH is sampled only at TROPOMI overpass times, correlations with OP-FTIR show more strong-positives, but also some moderate-negatives and strong-negatives.

OP-FTIR – TEMPO: Data overlap is limited to 6 months (Jul-Dec 2025). The nearest TEMPO pixel dataset provides fewer comparison months, 2 – 3 depending on version, all of which are weak positive correlations. The 20-km average ECCC-adjusted datasets both provide 5 comparison months, with 1 strong, 3 moderate, and 1 weak positive correlation, while the unadjusted TEMPO dataset has 4 comparison months (1 strong, 2 moderate, and 1 weak positive correlation). Filtering OP-FTIR data has no impact on correlations due to the low abundance of negative retrieval results in 2025 (~ 2.3%). The mean correlation between OP-FTIR and all TEMPO-derived surface HCHO datasets increases from 0.17 - 0.21 for nearest pixel to 0.53 – 0.56 for 20-km average. GEM-MACH sampled only at TEMPO overpass times has mostly moderate-positive correlations to OP-FTIR.

Results 2 – Time Series and Bias

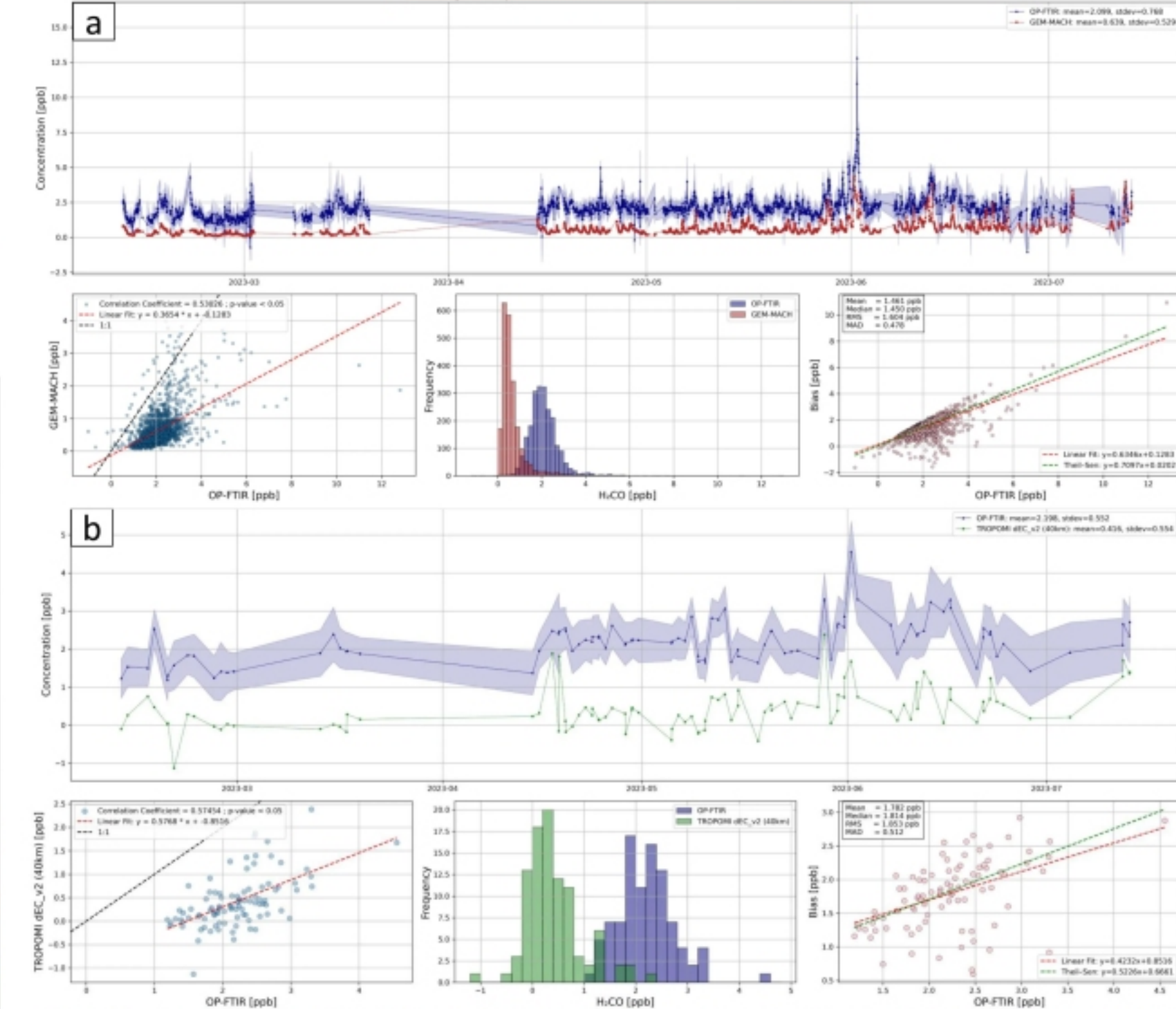


Figure 3: Comparison of coincident OP-FTIR HCHO vs (a) GEM-MACH surface HCHO and (b) 40x40 km² TROPOMI-derived (ECCC-adjusted) surface HCHO in 2023. (top) Timeseries comparison of HCHO concentration, with shaded region around OP-FTIR data representing standard deviation of resampled data. (bottom-left) Correlation scatter of datasets, including the best-fit regression line (red) and 1:1 reference line (black dashed). (bottom-middle) Histogram distribution of HCHO concentration for each dataset. (bottom-right) Scatter of HCHO bias (OP-FTIR – dataset) vs. OP-FTIR HCHO, including the linear regression line (red) and Theil-Sen regression line (green).

OP-FTIR – GEM-MACH: Timeseries (Figure 3a, a subset of all data) exhibit similar temporal variability and trends (R=0.53). OP-FTIR mean and standard deviation are both higher (see timeseries legend and histogram), albeit GEM-MACH concentrations are truncated at 0 ppb. A mean bias of ~1.5 ppb increases with OP-FTIR concentration (see linear fit and Theil-Sen (outlier-robust) panel), possibly due to i) a mismatch between SAO's urban location and the larger GEM-MACH grid cell (Figure 1), and ii) low or missing emissions of HCHO and its precursors in GEM-MACH.

OP-FTIR – TROPOMI: Timeseries (Figure 3b, a subset of all data) exhibit similar temporal variability and trends (R=0.57). While the standard deviation is similar (see timeseries legend and histogram), TROPOMI concentrations (not truncated to zero) are lower than OP-FTIR. A mean bias of ~1.8 ppb increases as a function of OP-FTIR concentration, persisting at ~0.75 ppb when [OP-FTIR] = 0 ppb. This is likely influenced by the well-known reduction in TROPOMI's column averaging kernel near the surface (Vigouroux et al., 2020, De Smedt et al., 2021), but a high bias of OP-FTIR cannot be ruled out.

Key Takeaways

Comparisons yielded the strongest correlations when using unfiltered surface OP-FTIR data, TROPOMI-derived surface data averaged over a 40x40 km² domain with a ±3 hour temporal window, and TEMPO-derived surface data averaged within a 20-km radius with the hourly OP-FTIR time window matched. Correlations are largely moderate and strong but OP-FTIR is higher than both GEM-MACH (~1.5 ppb) and TROPOMI (~1.8 ppb). OP-FTIR also has higher variability than GEM-MACH.



Downward Propagation of Geomagnetic Storm Effects in the Middle Atmosphere: A SD WACCM X Case Study of the March 2015 Event



Sahar Barzegar¹, Samaneh Sabetghadam¹, Jeff (Jafar) – Sepehri^{2*}
¹ Institute of Geophysics, University of Tehran, Tehran, Iran
² PhD Candidate, York University, Toronto, ON, CA_ Supervisor: Professor Peter Taylor

Motivation

- Storm impacts are well-known in the upper atmosphere
- Downward coupling remains downward debated
- Goal: detect short-timescale influence

Case Study

- The March 2015 geomagnetic storm changed upper-atmosphere winds.
- Storm effects moved downward into the middle atmosphere in 2–3 days.
- Gravity waves helped carry the storm effects downward.

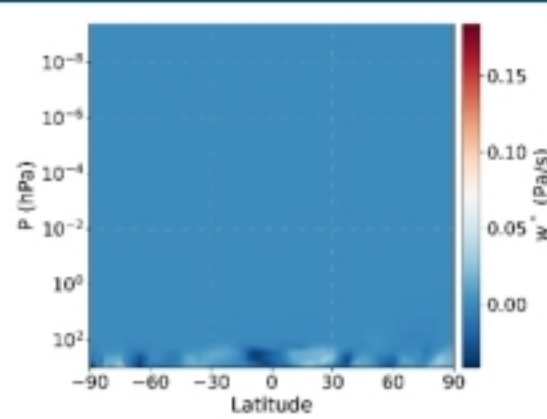
Model & Methods

- SD-WACCM-X (surface to ~500 km)
- Nudged to MERRA-2 below 50 km
- TEM diagnostics: v^* , w^* , EP flux

Key Result: w^*

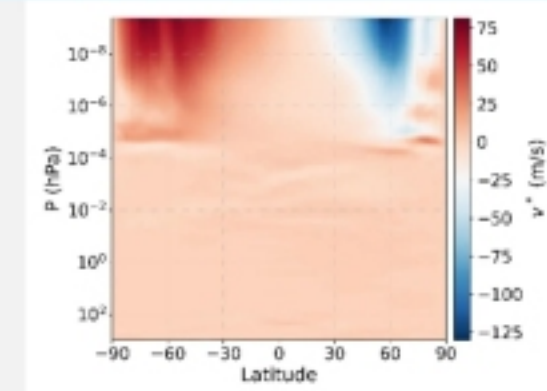
Residual vertical velocity (w^*) during the storm (17–18 March 2015), showing no significant anomaly, indicating a minimal vertical circulation response to geomagnetic forcing.

- No significant vertical response
- Vertical circulation unchanged



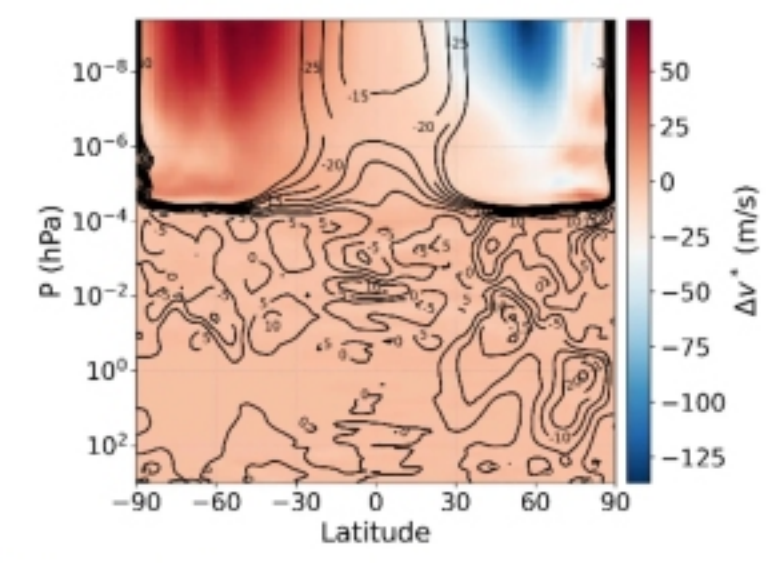
Key Result: v^*

Residual meridional velocity (v^*) during the storm (17–18 March 2015), showing a pronounced high-latitude dipole with enhanced southward flow in the Northern Hemisphere and northward flow in the Southern Hemisphere, indicating a strong storm-time circulation response.



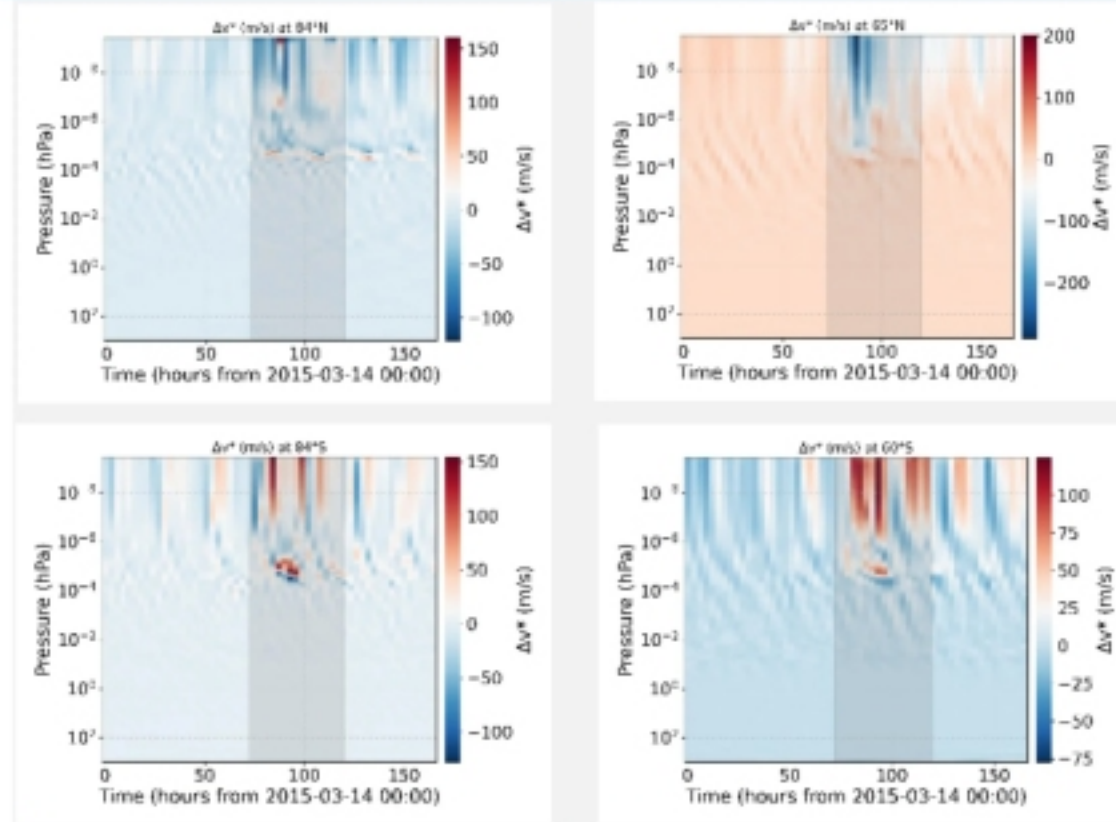
- Strong high-latitude dipole
- NH southward, SH northward
- Above $\sim 10^{-4}$ hPa

Downward Propagation



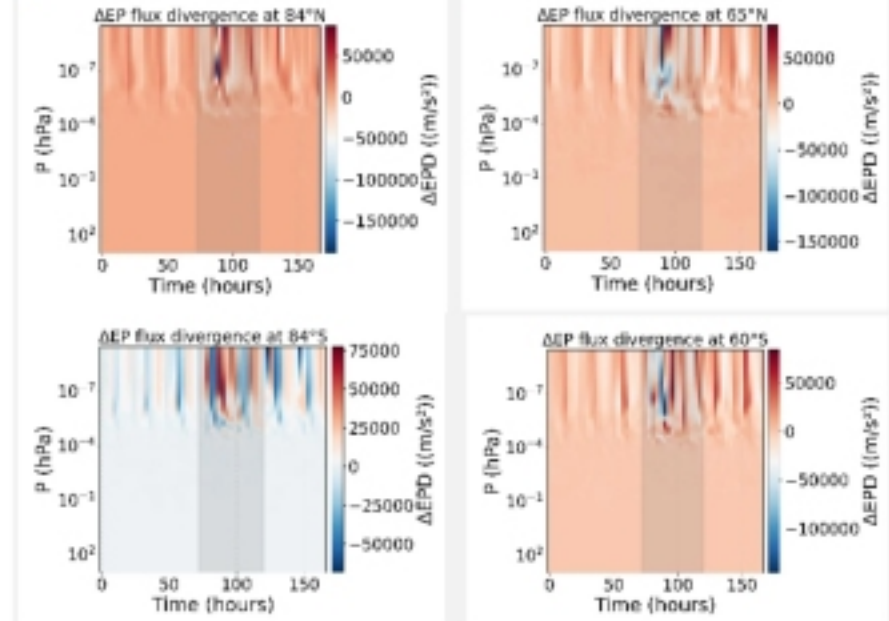
- ### Storm-Time Circulation & Wind Response.
- Storm-time Δv^* with zonal wind anomalies
 - Strong high-latitude dipole above ~ 110 km ($p < 10^{-4}$ hPa)
 - NH: enhanced southward flow | SH: enhanced northward flow
 - Zonal wind closely aligned with circulation \rightarrow strong coupling
 - Indicates ion-neutral interaction during geomagnetic forcing
 - Represents the upper-atmosphere source region of the disturbance

Wave Forcing



- ### Storm-Time Circulation & EP Flux Response
- Storm-time Δv^* with associated zonal wind anomalies
 - Strong high-latitude dipole above ~ 110 km ($p < 10^{-4}$ hPa)
 - NH: enhanced southward flow | SH: enhanced northward flow
 - Zonal wind tightly aligned with circulation \rightarrow strong dynamical coupling
 - Indicates ion-neutral interaction under geomagnetic forcing
 - Upper-atmosphere source region of the disturbance
 - EP flux divergence anomalies consistent with circulation changes

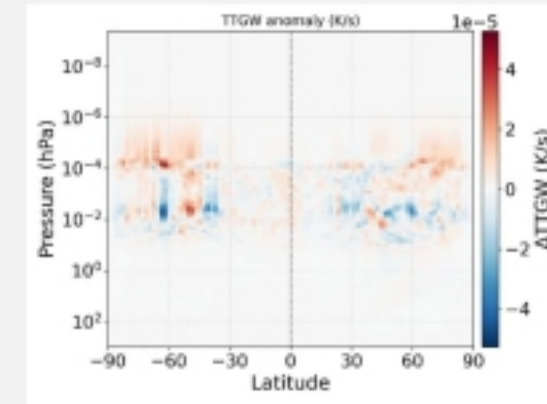
Gravity Waves



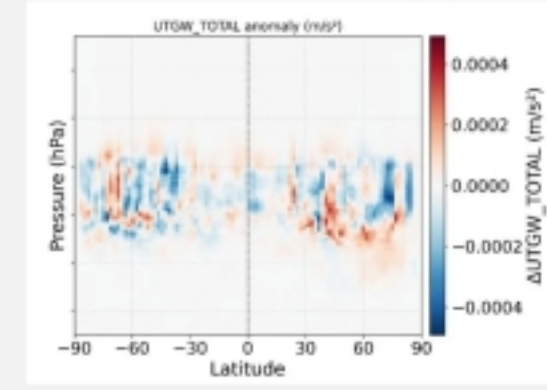
- ### High-Latitude Storm-Time Response.
- Strongest storm-time signals at 85° and 65° in both hemispheres
 - Clear anomalies during 17–18 March
 - Opposite responses between NH and SH (dipole structure)
 - Peak intensity near the poles; still organized at 65° Confirms a predominantly high-latitude-driven atmospheric response
 - Consistent patterns across both hemispheres, supporting earlier results

Mechanism

Storm \rightarrow Waves \rightarrow Breaking \rightarrow EP Flux \rightarrow Circulation \rightarrow Downward Signal



- ### Gravity-wave thermal forcing (TTGW).
- Shows how gravity waves modify atmospheric heating during the storm
 - Strong anomalies concentrated at high latitudes
 - Most pronounced in the mesosphere and lower thermosphere (~ 50 – 120 km)
 - Both positive and negative signals indicate localized heating and cooling
 - Storm impact is strongest near the poles
 - Effects are vertically confined to a specific altitude range



- ### Gravity-wave momentum forcing (UTGW_TOTAL).
- Shows how gravity waves change wind by adding or removing momentum
 - Strongest effects at high latitudes
 - Same altitude range as panel (a)
 - Positive values = stronger eastward forcing
 - Negative values = stronger westward forcing
 - Gravity waves help drive circulation changes during the storm

Conclusion

- Meridional circulation is strongly affected
- Vertical motion unchanged
- Clear top-down coupling

Implications

- Space weather affects the middle atmosphere
- Potential weather impacts

INTRODUCTION

Intensity and frequency of extreme precipitation events and associated flood risks are projected to increase under future climate change [1]. In Canada, observed trends already indicate an increase in heavy rainfall events, with further intensification expected in the future [3].

Highly urbanized catchments with extensive impervious surfaces like the Greater Toronto and Hamilton Area (GTHA) may experience severe flooding during extreme precipitation events. While regional flood plain mapping and watershed scale hydrologic studies are well established in the region, fewer studies have explicitly incorporated projected changes in extreme precipitation as flood triggers or spatial framework of flood risks at the Census tract level in GTHA.

This study addresses this gap by evaluating flood risk at the census tract level, enabling a more localized understanding of spatial variability in risk under current and future climate conditions.

Specifically, the study aims:

- To assess census tract-level Pluvial flood risk by integrating hazard, vulnerability, and exposure components under current climate conditions; and
- To evaluate how projected changes in extreme precipitation (CMIP6 SSP2-4.5 and SSP5-8.5) influence the spatial distribution of flood risk across mid century (2041-2070).

METHODOLOGY

Mid century flood risk at the census tract level in the GTHA was assessed using an index-based approach following the IPCC risk framework, where risk is conceptualized as a function of hazard, vulnerability, and exposure [1].

- Hazard:** Historical 100-year return period precipitation depths for both 1-day and 5-day durations were used as baseline flood-triggering condition. Future climate impacts were incorporated by applying amplified precipitation depth derived from projected changes in mid century maximum 1 day (Rx1day) and maximum consecutive 5 days (Rx5day) precipitation. Precipitation depths were then converted into runoff depths using the NRCS-CN approach [2]. Runoff convergence potential was characterized using slope and curvature. These hazard indicators were integrated to generate Flood Hazard Indices for historical and future conditions.
- Vulnerability:** A Vulnerability Index was constructed using socio-demographic indicators including age dependency, housing condition, language barrier, median household income, and income inequality (Gini index). All indicators were normalized using min-max scaling and aggregated using an equal-weight composite index approach.
- Exposure:** Total population count, population density, and private dwellings data were used to represent the exposure of people and built assets.
- Risk:** The final Flood Risk Index was calculated using the equation:

$$\text{Risk} = \text{Hazard} \times \text{Vulnerability} \times \text{Exposure}$$

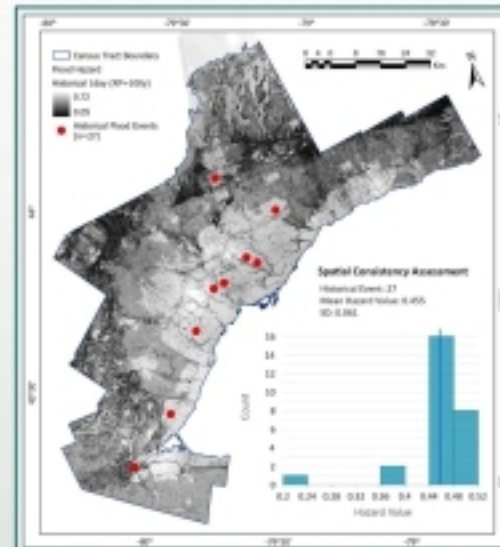


Figure-1: Flood Hazard Index map under historical conditions with observed flood events and spatial consistency assessment. A mean hazard score of 0.455 (SD = 0.061) indicates that observed flood events were generally associated with areas identified as flood-prone by the hazard index

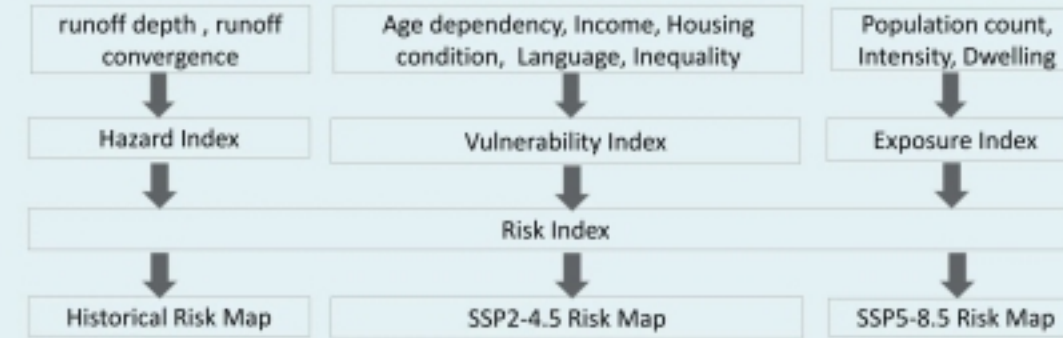


Figure-2: Flowchart Showing the simplified Workflow of the Study

RESULTS (Flood Risk Index)

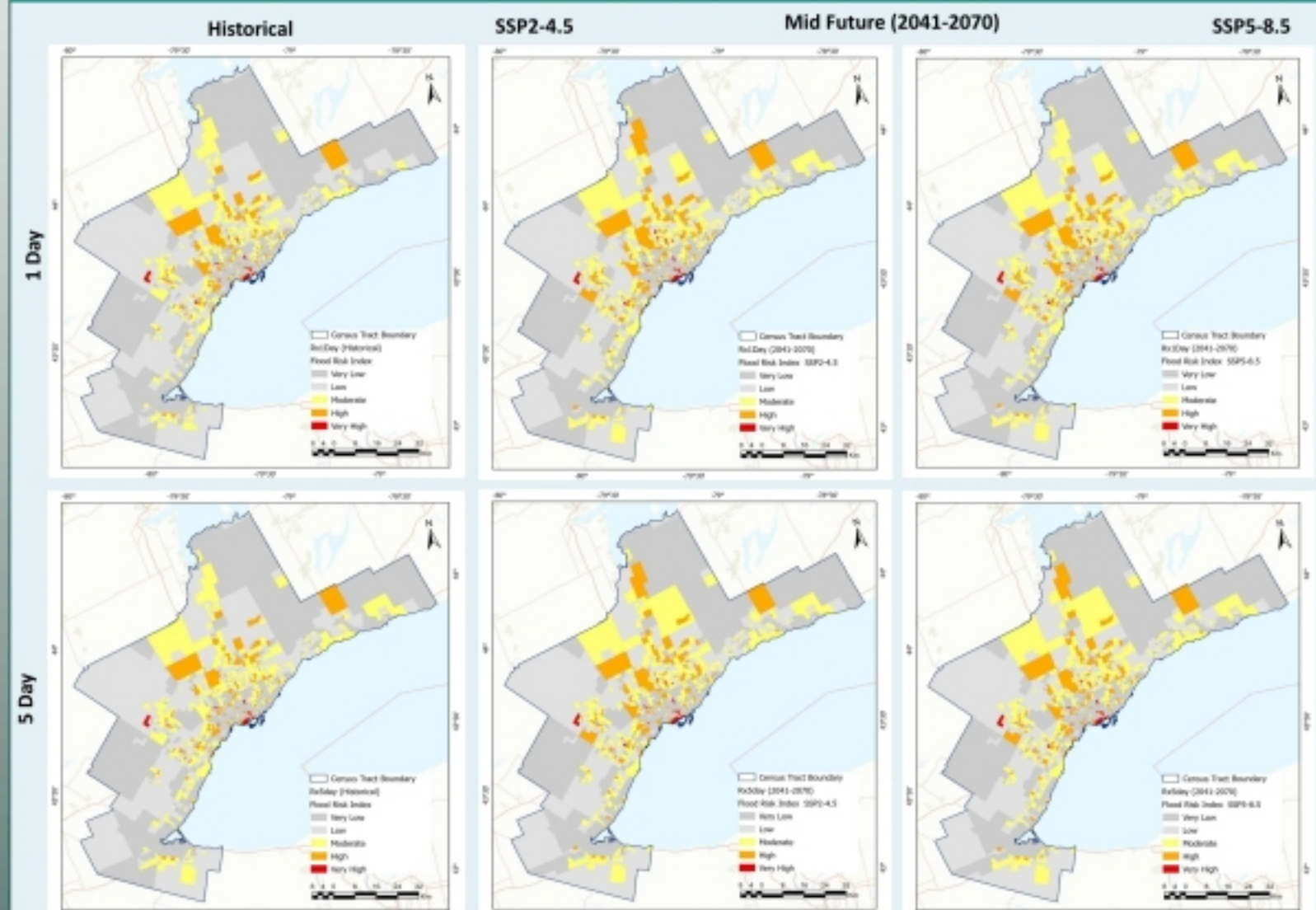


Figure-3: Census tract-level Flood Risk Index under historical and projected mid-century (2041-2070) climate scenarios for a 100-year return period event

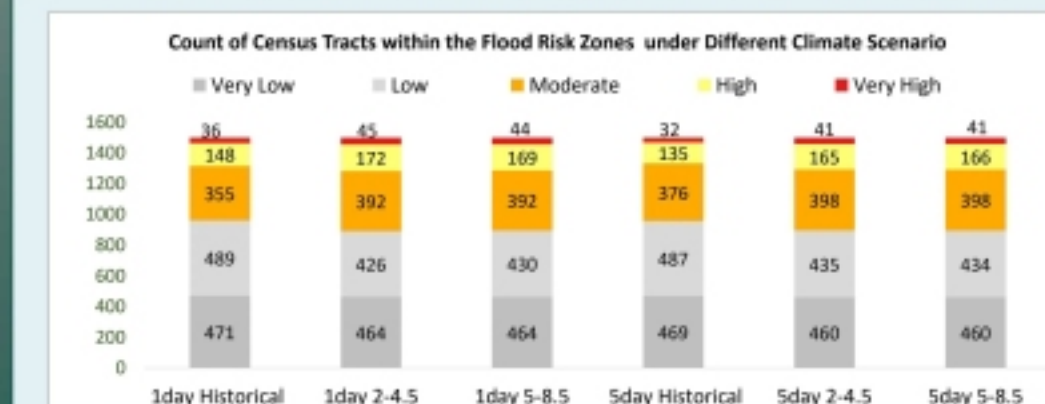


Figure-4: Distribution of census tract counts across Flood Risk categories under historical and projected mid-century climate scenarios for 1-day and 5-day precipitation conditions.

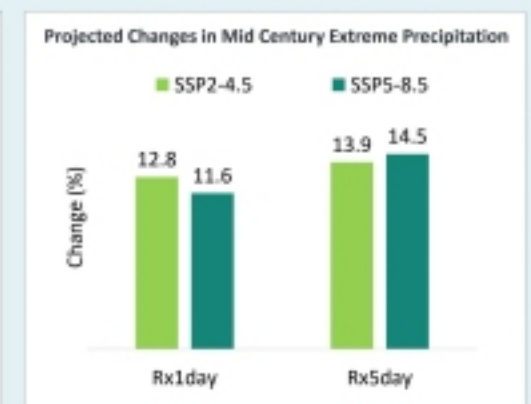


Figure-5: Ensemble mean percentage changes in projected extreme precipitation indices (Rx1day and Rx5day) relative to the historical baseline.

RESULT Continued

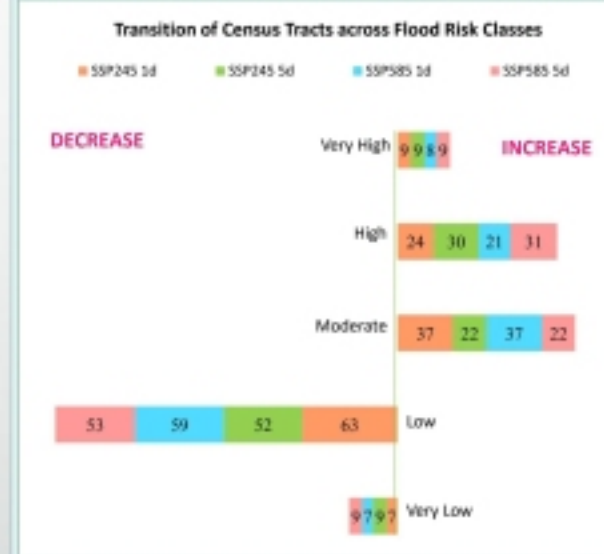
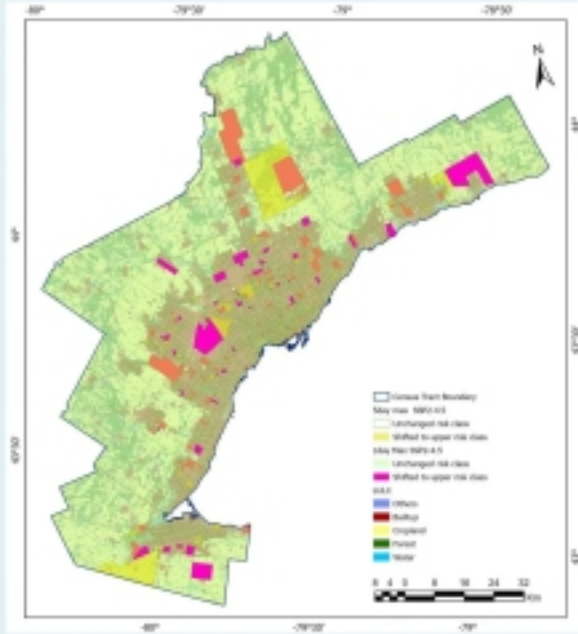


Figure-6: Changes in census tract distribution across flood risk categories under projected mid-century climate scenarios relative to historical conditions. Reductions in lower-risk categories and corresponding increases in Moderate to Very High-risk classes indicate a redistribution of census tracts toward elevated flood risk conditions under SSP2-4.5 and SSP5-8.5 scenarios.

Figure-7: Map showing spatial distribution of census tracts transitioning to higher flood risk classes under SSP2-4.5 during mid-century. Pink indicates shifts under the 1-day scenario, yellow indicates shifts under the 5-day scenario, and orange indicates census tracts showing increased risk under both scenarios.



CONCLUSIONS

- Projected changes in mid-century (2041-2070) extreme precipitation showed increases in both SSP2-4.5 and SSP5-8.5 scenario, with Rx1day increasing by 11.6–12.8% and Rx5day increasing by 13.9–14.5% relative to historical conditions.
- Flood Risk Index maps showed spatial variability across the GTHA, with Moderate risk as the dominant category under both historical and future scenarios.
- Moderate to very high-risk classes were mostly concentrated within the central urbanized areas of the GTHA, whereas peripheral regions are largely represented by Very Low and Low risk classes.
- Future scenarios showed increase in Moderate, High, and Very High-risk categories.
- Under the 1-day scenarios, Moderate risk census tracts increased from 355 to 392, High risk census tracts increased from 148 to 169–172, and Very High-risk census tracts increased from 36 to 44–45. Similar increases were observed for the 5-day scenarios.
- Spatial patterns under SSP2-4.5 further suggested that several census tracts in peripheral areas will come under higher risk class in the mid future (2041-2070).

REFERENCES

[1] IPCC, 2022: *Climate Change 2022: Impacts, Adaptation, and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Lössche, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA, 3056 pp., doi:10.1017/9781009325844.

[2] United States Department of Agriculture, Natural Resources Conservation Service. (2021). *Chapter 2: Estimating runoff volume and peak discharge*. In *Part 650 engineering field handbook: National engineering handbook* (Title 210, 2nd ed.). U.S. Department of Agriculture. [USDA NRCS Chapter 2.PD](#)

[3] Zhang, X., Flato, G., Kirchmeier-Young, M., Vincent, L., Wan, H., Wang, X., Rong, R., Fyfe, J., Li, G., Xie, P., et al. (2019): Changes in Temperature and Precipitation Across Canada; Chapter 4 in Bush, E. and Lemmen, D.S. (Eds.) *Canada's Changing Climate Report*. Government of Canada, Ottawa, Ontario, pp 112-193.