2024 CMOS Congress - Scientific Sessions

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Theme 1: Plenaries

Theme 2: Extremes

2010 Severe and Extreme Convective Storms : Detection, Prediction, Climatology and the Future

Convenors:
John Hanesiak (University of Manitoba)
David Sills (Western University)

Many of Canada's most costly natural disasters are caused by severe and extreme convective storms. Insured losses from these storms are increasingly reaching the billion dollar mark. Anthropogenic climate change may significantly alter the probability of such disasters occurring in the future. This session will focus on severe and extreme convective storms and their hazards (tornadoes, downbursts, hail, heavy rainfall), and in particular their detection, prediction, historical climatology and possible future climatology. This includes a wide range of possible topics, from event case studies and verification statistics to climatological trend analyses and modelling future changes to storms and/or hazards. The session aims to highlight new insights that improve our physical understanding of, and our detection and prediction capabilities for, such events. A 30-min invited presentation will lead off the session.

2020 Extreme Precipitation: Past, Present, Future

Convenors:
Neil Tandon (York University)
John Gyakum (McGill University)
Megan Kirchmeier-Young (Environment and Climate Change Canada)
Xander Wang (University of Prince Edward Island)

As we have seen repeatedly in the news, extreme precipitation events are impacting many regions across Canada and around the globe, often contributing to devastating floods. The extreme precipitation leading up to the 2014 Alberta floods and the atmospheric rivers that hit British Columbia in 2021 are just some of the countless examples. Understanding extreme precipitation events is imperative for improved climate change projections and climate change adaptation. This session welcomes contributions addressing the range of topics relevant to

extreme precipitation, including long-term changes, variability, physical drivers, climate change attribution, prediction, observing methods, modelling and impacts. These studies might examine events in the distant past, more recent events or projected future events. We encourage submissions of theoretical modelling studies as well as analyses of observations and model output. Regional case studies are welcomed, as well as studies examining extreme precipitation characteristics and mechanisms aggregated over larger spatial scales and longer temporal scales.

2030 Advancing research on marine extremes

Convenors:
Amber Holdsworth (Institute of Ocean Science)
Hayley Dosser (Institute of Ocean Science)

Anthropogenic greenhouse gas emissions are altering conditions across the global ocean, driving more frequent and extreme ocean states of anomalously high temperature, low oxygen, and/or low pH (acidification). Multiple ecosystem stressors occurring concurrently or consecutively can adversely affect marine biota to a greater extent than a single stressor in isolation. This session will highlight recent advances in research on marine extremes, for either single or multiple stressors. We welcome experimental, observational, and modelling investigations of marine extremes and their impacts for both open ocean and coastal waters. Of particular interest are studies focused on developing and implementing clear and consistent definitions of extremes that allow for comparisons between regions and on varying time scales. We welcome insights into improving monitoring programs, with a focus on better characterizing the ranges and distributions of relevant variables, investigating ecological responses to extremes, and assessing how such programs can support modelling efforts. We encourage studies that consider the past and current states of the ocean as well as those that consider future projections.

2040 Weather and Climate Extremes - General

Convenors:
Elizaveta Malinina (Environment and Climate Change Canada)
Nathan Gillett (Environment and Climate Change Canada)

This session is for topics related to extremes that are not covered by other sessions in Theme 2.

Theme 3: Climate System

3010 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 Nino/Southern Oscillation (ENSO), atmospheric circulation patterns, tropical-extratropical interaction and teleconnections, polar and stratospheric processes, and impacts of these processes on predictability and predictions. We welcome contributions on extended- and long-range weather forecasts, especially those related to extreme events, 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.

3020 Atmosphere, Ocean, and Climate Dynamics

Convenors:
Mike Waite (University of Waterloo)
Marek Stastna (University of Waterloo)
Ron McTaggart-Cowan (Environment and Climate Change Canada)

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

3030 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.

3040 Climate - Community, Service and Education

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 education, community science and data collection, data dissemination, and other activities such all studies related to climate services and communicating climate change-related risks.

Theme 4: Ocean

4010 Coastal Oceanography and Inland Waters

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

In the context of the overarching theme, "Extreme Events in a Changing Climate," this session aims to provide a comprehensive exploration of all aspects of monitoring and modelling physical and biogeochemical processes in coastal domains, shelf seas, estuaries, and inland waters. Topics include, but are not limited to, coastal physical oceanography, storm surges, tsunamis, estuarine dynamics, hydrology and hydrodynamics of large lakes, as well as the mixing and dispersion of materials. Contributions related to both observational and modelling aspects of biogeochemistry in coastal and inland waters are welcome. Papers can focus on improving our knowledge of physical and biogeochemical conditions over coastal and inland waters in the past and present climate, and/or on predictions of changes and extremes in marine conditions in response to climate change.

4020 Ocean and Ecological Studies in the Seasonally Ice-Covered Coastal Waters of Nunatsiavut and the Labrador Sea

Convenors:
Matthew G. Asplin (ASL Environmental Sciences)
May Wang
Eric Oliver
Rodd Laing

Climate change is affecting the Subarctic area of Labrador and the marine ecosystem of the Labrador Sea. Nunatsiavut, a self-governing Inuit territory in northern Labrador, is witnessing rapid climate change that is increasingly impacting the lives and well-being of Labrador Inuit residing in coastal communities. Rising temperatures and a significant reduction in sea ice, up to 75% since 1968, are affecting safe travel over the land, including water and ice. The historical lack of scientific data collection in this region, particularly regarding ocean physical and biophysical data, is being addressed through an expanding network of ocean science projects led by collaborative efforts between academia and indigenous researchers. The Nunatsiavut

Government is also actively involved in expanding ocean and environmental stewardship initiatives.

There is a growing recognition within academia and government research circles of the profound Inuit knowledge of the ocean, sea ice, weather, and climate in the region. Initiatives are underway to integrate Inuit and Western scientific knowledge, aiming to develop climate change and environmental management plans that prioritize the safe and sustainable access of Labrador Inuit to their lands and resources. This session invites contributions showcasing results from both past and ongoing projects in the marine system science domain within this region. These findings aim to inform Nunatsiavut community members and other stakeholders about anticipated future changes in the marine environment, contributing to the overall goal of marine stewardship.

4030 Ocean - Theoretical to applied science

Convenors: TBA

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.

4040 Ocean - Community, Service and Education

Convenors: TBA

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 education, community science and data collection, data dissemination, and other activities such as forecasting and communicating oceanographic-related risks.

Theme 5: Atmosphere

5010 Atmosphere - Theoretical to applied science

Convenors: TBA

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.

5020 Atmosphere - Community, Service and Education

Convenors: TBA

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 education, community science and data collection, data dissemination, and other activities such as forecasting and communicating weather-related risks.

Theme 6: Earth Observation, Data and AI

6010 Satellite Earth Observation: A unique view of our planet and a critical need for Canada

Convenors:
Kaley Walker (University of Toronto)
Matt Arkett (Environment and Climate Change Canada)

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. Resourceful, Resilient, Ready: Canada's Strategy for Satellite Earth Observation provides a plan for Canada to more effectively leverage satellite earth observation (SEO) to address key priorities, including climate change mitigation and adaptation. This strategy will help to inform Canada's plans for SEO for the next decade and ensure Canada will maximize utilization and benefits of SEO. 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.

6020 Data modelling and reproducible processes

Convenor:
Rick Danielson (Fisheries and Oceans Canada)

This session invites contributions on data modelling and reproducible science that yield insight into processes of an atmospheric, oceanic, or hydrologic nature. All sources of data (theoretical, numerical, observational, and combined products) and processes covering any range of scales are of interest. Methods that employ any modelling language are welcome, as are general reviews and perspectives on data modelling in related scientific fields. We especially prompt submissions on:
- Reproducible workflows, open repositories, and collaborative efforts
- Discovery of patterns in big data and their connection to processes
- Machine learning of parameterizations intended as embedded process models

- Methods of verification, including proposals that address simplified or complex models
- Metrological challenges of traceability in weather/climate data
- Calibration and validation using familiar geophysical datasets as a reference.

6030 Advances and Applications of Artificial Intelligence (AI) in Meteorology

Convenors:
Miguel Tremblay (Environment and Climate Change Canada)
Ann Dacres (Environment and Climate Change Canada)

We invite the meteorological community to contribute to an exciting session on the integration of Artificial Intelligence (AI) in meteorology. This session aims to explore how AI, especially Machine Learning (AI/ML) and high-performance computing, is revolutionizing modern meteorology.

Potential Topics : * AI in Weather Forecasting Enhancement: * Application of AI algorithms to improve the accuracy of weather forecasts. * Case studies on the integration of AI in national meteorological services. * Climate Change Modeling with AI: * The role of AI in predicting long-term climatic trends. * Using machine learning to understand and mitigate the effects of climate change. * Public Engagement and Weather Information Dissemination: * AI-driven platforms for better communication of meteorological information to the public. * Social media and AI in raising awareness about meteorological events. * Innovations in Meteorological Data Collection: * The use of AI to enhance the quality and scope of meteorological data collection. * Innovations in sensor technology and data acquisition methods driven by AI.

Additional Topics to Explore: * The use of AI for the forecasting, management, and impact analysis of environmental emergencies, including natural disasters and extreme meteorological phenomena. * Data-driven modeling in meteorology. * Hybridization of meteorological models. * AI/ML for immediate forecasting (Nowcasting). * Improvements in S2S (sub-seasonal to seasonal) forecasts. * Operationalization of AI/ML. * Ethical and responsible AI. * Improving AI literacy.

6040 Leveraging Artificial Intelligence for Enhanced High-Resolution Regional Climate Modeling of Extreme Events under Climate Change

Convenors:
Yanping Li (University of Saskatchewan)
Fei Huo (Western University)
Zhenhua Li (Western University)

The economic losses from weather-related extremes have been rising steadily under climate change, which causes global concerns. Specifically, extreme precipitation is expected to surge more than mean precipitation. Recognizing the significance of high-resolution modeling in understanding extreme events under climate change, especially at local and regional scales, there is a growing emphasis on its role in providing more accurate forecasts of climate variability impacts on extreme weather conditions. Artificial Intelligence (AI) methods have progressively augmented traditional weather and climate modeling, aiming to address substantial challenges in climate science. AI offers promising potentials in refining predictions of increasingly frequent extreme weather events driven by climate change at much lower computation cost than traditional models. Machine learning enables the handling of vast, complex datasets, facilitating analysis and comprehension of high-resolution climate data. Additionally, deep learning applications can help forecast disruptive and damaging extreme rainfall events under future climate conditions. Considering these advancements, we cordially invite presentations discussing AI methodologies and their enhanced contributions to high-resolution regional climate modeling of extreme events under climate change.

Theme 7: Modelling

7010 Towards development of Canada's Digital Twin of the Ocean: Observations, Modelling, Forecasting, Analyses and Applications

Convenors:
Youyu Lu (Fisheries and Oceans Canada, Maritimes)
Nancy Soontiens (Fisheries and Oceans Canada, Newfoundland)
Di Wan (Fisheries and Oceans Canada, Pacific)
Hui Shen (Fisheries and Oceans Canada, Maritimes)

Data and knowledge from ocean observations, modelling, prediction, and analyses support a great range of applications, such as fishery and ecosystem protection and management, safe navigation, search and rescue, and climate change adaptation etc. Impacts and outcomes of these activities would be amplified by the application of an international framework for Digital Twins of the Ocean (DTO). In Canada, there is a tremendous amount of activity relevant to DTO development in 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, including the various activities under the United Nations Decade of Ocean Science for Sustainable Development. 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 (data, models, technology and knowledge);
3) present achievements in research and development; and
4) discuss collaboration opportunities.

The session will consist of a mixture of invited and contributed presentations, and in both oral and poster formats.

7020 Developing Ocean Modelling Capacity in Canada

Convenors:
Paul Myers (University of Alberta)
Susan Allen (University of British Columbia)
Juliana Marson (University of Manitoba)
Frederic Dupont (Fisheries and Oceans Canada)

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.

7030 Collaborative Earth System Modelling in Canada

Convenors:
Paul Kushner (University of Toronto)
Matthew Toohey (University of Saskatchewan)
Clint Seinen (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.

7040 Simulation of weather and climate extremes using regional climate models

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

Regional climate models, in both parameterized and resolved convection modes, can simulate weather and climate extremes more realistically than global models. Several scientific questions can be asked about these extremes. What are the different types of extreme? How does climate change influence them? How can we assess the quality of simulated extremes with limited observations? What influence do model configurations have on extremes? How can large ensembles of regional models be used to explore extremes? How can we compare extremes from different types of models (including regional models)? This session invites contributions based on regional modeling, which address both the above questions and any other related scientific questions.

Theme 8: Multidisciplinary

8010 Changing Arctic: Science and Policy Studies

Convenor:
Matthew G. Asplin (ASL Environmental Sciences)
Shannon Nudds (Fisheries and Oceans Canada)

This interdisciplinary session aims to showcase recent scientific findings related to the rapidly evolving Arctic and northern environment. Significant changes have occurred in the physical environment of the Arctic in recent decades, particularly in the cryosphere, oceanography, hydrology, and meteorology. Various scientific approaches are being employed to understand the underlying causes of these changes. The session will explore the application of scientific results in addressing policy issues, particularly those related to the federal government and Indigenous-led management initiatives.

The relevance of Arctic research and its implications for the future is of great importance. This is especially timely for informing northern communities, the public, and contributing to a range of policy issues in this strategically significant part of Canada. The session welcomes contributions from research, scientific, and policy activities that are either nearing Completion, currently underway, or in the planning stage.

8020 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.

8030 Multidisciplinary - Community, Service and Education

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 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.