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2020-2021 Arctic Winter Seasonal Climate Outlook for Temperature and Precipitation

WRITTEN BY CMOS BULLETIN SCMO ON JANUARY 28, 2021. POSTED IN ARCTIC, CLIMATE, OCEANS, WEATHER, WHAT'S CURRENT.

– By contributors from Environment and Climate Change Canada, Arctic and Antarctic Research Institute (Russia), Hydrometeorological Centre of Russia, the Norwegian Meteorological Institute, the Finnish Meteorological Institute, World Meteorological Organization, Climate Prediction Center, National Oceanic and Atmospheric Administration (USA), National Oceanic and Atmospheric Administration, International Arctic Research Center (IARC, USA) –

Arctic Climate Forum Consensus Statement (Continued)

HIGHLIGHTS

The combination of an Arctic meridional atmospheric circulation (north-south) and high ocean surface heating this summer (JJA: June, July, August 2020) was the main driver of this past season's temperature, precipitation and sea ice anomalies. Above normal temperatures forecast for all Arctic regions, this winter (November 2020 to January 2021) will continue to have implications for sea-ice over that time period.

Temperature: The summer 2020 average surface air temperatures were above normal for most of the Arctic domain, with Eastern Siberia observing record-breaking temperatures. Above normal temperatures are expected to continue across the majority of the Arctic this winter.

Precipitation: High spatial variability between wetter and drier than average conditions was observed across the Arctic during JJA 2020. Wetter than normal conditions are expected across the majority of the Arctic region this winter.

UNDERSTANDING THE CONSENSUS STATEMENT

This consensus statement includes: a seasonal summary and forecast verification for temperature and precipitation for previous 2020 Arctic summer season (June, July, and August 2020); an outlook for the upcoming 2020-2021 Arctic winter season (November

2020, December 2020, and January 2021). Figure 1 shows the regions that capture the different geographic features and environmental factors influencing temperature/precipitation.

Figure 1: Regions used for the seasonal summary and outlook of temperature and precipitation

The temperature and precipitation forecasts are based on eleven WMO Global Producing Centers of Long-Range Forecasts (GPCs-LRF) models and consolidated by the WMO Lead Centre for Long Range Forecast Multi-Model Ensemble (LC-LRFMME). In terms of models' skill (i.e. the ability of the climate model to simulate the observed seasonal climate), a multi-model ensemble (MME) approach essentially overlays all of the individual model performances. This provides a forecast with higher confidence in the regions where different model outputs/results are consistent, versus a low confidence forecast in the regions where the models don't agree. The MME approach is a methodology well-recognized to be providing the most reliable objective forecasts.

TEMPERATURE

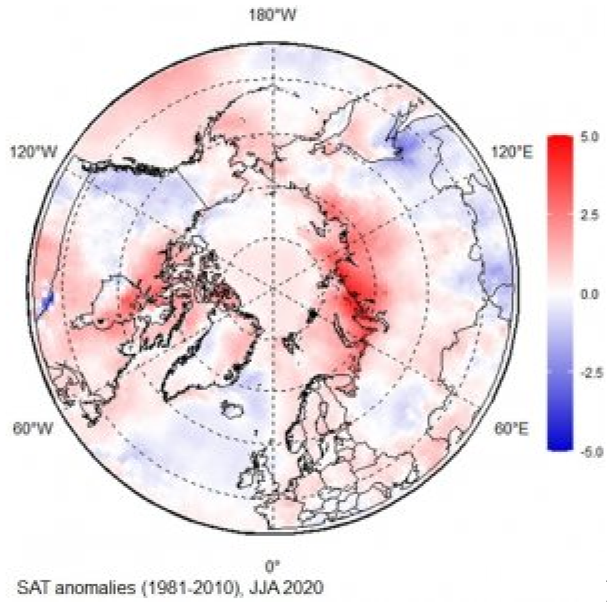

Figure 2: June, July, and August (JJA) 2020 surface air temperature (SAT) anomaly based on the 1981-2010 reference period. Red indicates warner than normal termperatures, and blue indicates cooler than normal temperatures. Map produced by the Arctic and Antarctic Research Institute http://www.aari.ru. Data source: ERA5.

Summary for June, July, and August 2020:

The June, July, and August (JJA) 2020 average surface air temperatures in the Arctic north of 65°N was above normal over most of the region, including Western and Eastern Siberia, the Chukchi and Bering region, and the central part of the Canadian Arctic (red areas in Figure 2). A persistent high atmospheric pressure over the Central Arctic and Eastern Siberia regions through the summer, combined with low atmospheric pressure over the Alaska and Western Canada region (ERA5, not shown here), led to several heat waves in Eastern Siberia in June and July 2020 and record high temperatures in Eastern Siberia (+38 °C at Verkhoyansk on 20 June). In turn, this atmospheric pattern resulted in slightly below normal surface air temperatures over Western Canada and a portion of the Norwegian Sea (light blue areas in Figure 2).

The JJA 2020 temperature forecast was verified by subjective comparison between the forecast (Figure 3, left) and re-analysis (Figure 3, right), region by region. A re-analysis is produced using dynamical and statistical techniques to fill gaps when meteorological observation are not available.

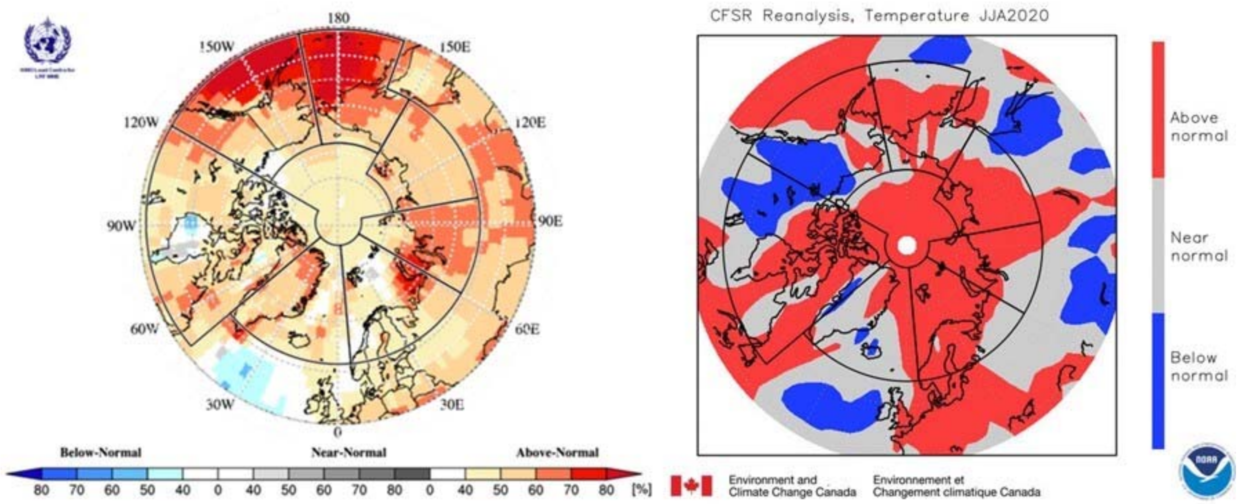

Figure 3: Left) Multi-model ensemble (MME) probability forecast for surface air temperatures: June, July, and August 2020. Three categories: below normal (blue), near normal (grey), above normal (red); no agreement amongst the models is shown in white. Source: www.wmolc.org. Right): NCAR (National Center for Atmospheric Research) Climate forecast System Reanalysis (CFSR) for air temperature for June, July, and August 2020.

Above-normal surface air temperatures over the Eastern Nordic and Eastern Siberia regions were accurately forecast for the JJA 2020 season (Figure 3, Table 1). The forecast accuracies were moderate over the Western Siberia and Chukchi and Bering regions, but the observed above-normal temperatures over the northern part of Western Siberia were accurately forecasted. On the other hand, the observed below to near-normal temperatures over Alaska, Canada, and the Western Nordic regions (grey areas on Figure 3, right) were not accurately forecasted. As a general conclusion, the multi-model ensemble forecast was accurate for approximately 60% of the Arctic territory.

Table 1. June, July, August 2020: Regional Comparison of Observed and Forecasted Arctic Temperature

Regions (see Figure 1)	MME Temperature Forecast Agreement	MME Temperature Forecast	NCAR CFSR Reanalysis (observed)	MME Temperature Forecast Accuracy
Alaska and Western Canada	Moderate	Above normal	Below to above normal	Low
Central and Eastern Canada	Low to moderate	Above normal	Below to above normal	Low
Western Nordic	Moderate	Above normal	Near normal	Low
Eastern Nordic	Moderate	Above normal	Above normal	High
Western Siberia	Moderate	Above normal	Above normal in the northern region	Moderate
Eastern Siberia	Moderate	Above normal	Above normal	High
Chukchi and Bering	High	Above normal	Near normal in the west and central	Moderate
Central Arctic	Low to moderate	Above normal	Above normal	High

Outlook for winter 2020-2021:

Surface air temperatures during winter 2020 (NDJ: November 2020, December 2020, and January 2021) are forecast to be above normal across the majority of the Arctic regions (yellow, orange and red areas in Figure 4). The confidence of the forecast is low to moderate over Alaska, Canada, Eastern Siberia, and the Chukchi and Bering regions (yellow and orange areas in Figure 4, Table 2), and high over the Eastern Nordic, Western Siberia, and Central Arctic regions (dark red areas in Figure 4, Table 2). The multi-model ensemble did not agree over central Alaska and most of Greenland (white areas in Figure 4).

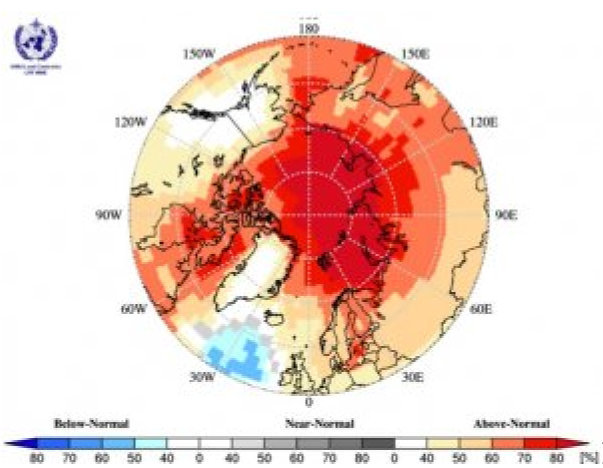

Figure 4: Multi model ensemble probability forecast for surface temperature for November 2020, December 2020, and January 2021. Three categories: below normal (blue), near normal

(grey), above normal (red) and no agreement amongst the models (white). Source: www.wmolc.org.

Table 2. Winter (NDJ) 2020-2021 Outlook: Regional Forecasts for Arctic Temperatures

Region (see Figure 1)	MME Temperature Forecast Agreement*	MME Temperature Forecast
Alaska and Western Canada	Low	Above normal
Central and Eastern Canada	Moderate	Above normal
Western Nordic	Low	Above normal
Eastern Nordic	High	Above normal
Western Siberia	High	Above normal
Eastern Siberia	Moderate	Above normal
Chukchi and Bering	Moderate	Above normal
Central Arctic	High	Above normal

*: See non-technical regional summaries for greater detail

PRECIPITATION

Summary for June, July, and August 2020:

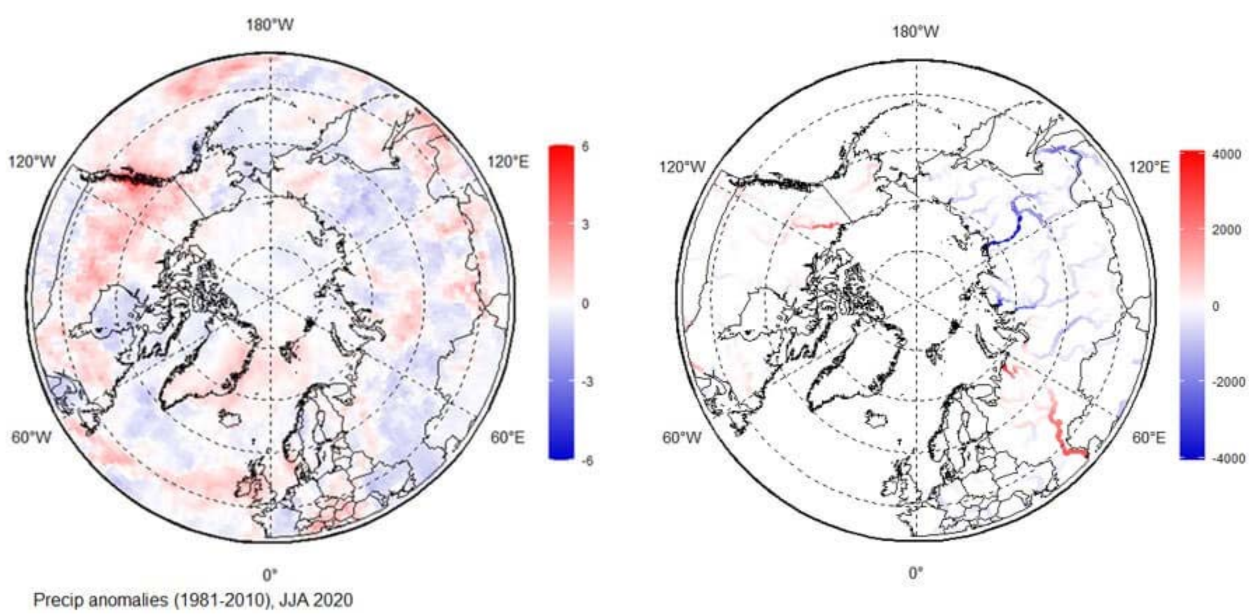

Figure 5. June, July, and August (JJA) 2020 precipitation anomaly based on the

1981-2010 reference period (left), and July 2020 river discharge anomalies based on 2000-2019 reference period (right). Red indicates wetter (left) or greater river flow (right) than normal conditions, while blue indicates drier (left) or lesser river flow (right) than normal conditions. Map produced by the Arctic and Antarctic Research Institute http://www.aari.ru. Data source: ERA5.

Wetter than average conditions were observed during June, July, and August 2020 (JJA) 2020 over the Western Nordic, and Alaska and Western Canada regions (red areas in Figure 5, left). On the other hand, the majority of the Eastern and Western Siberia regions, along with the Chukchi and Hudson Bay area, experienced drier than average conditions (blue areas in Figure 5, left). The impacts of wetter/drier regions were reflected in the JJA 2020 Arctic rivers discharge: lesser drainage than normal is seen in Ob', Enisey and Lena rivers, and further eastward (blue areas in Figure 5, right), while the Mackenzie and Yukon rivers experienced greater discharge than normal over that same time period (red areas in Figure 5, right). The snow extent in May-September 2020 was lower than normal, with extreme negative anomalies (no snow) observed in most of Siberia and Alaska (Rutgers Glob SnowLab- https://climate.rutgers.edu/snowcover/). Positive anomalies (more snow) were observed in May in parts of Scandinavia, Eastern Canada, and in September in Northern Canada (not shown here).

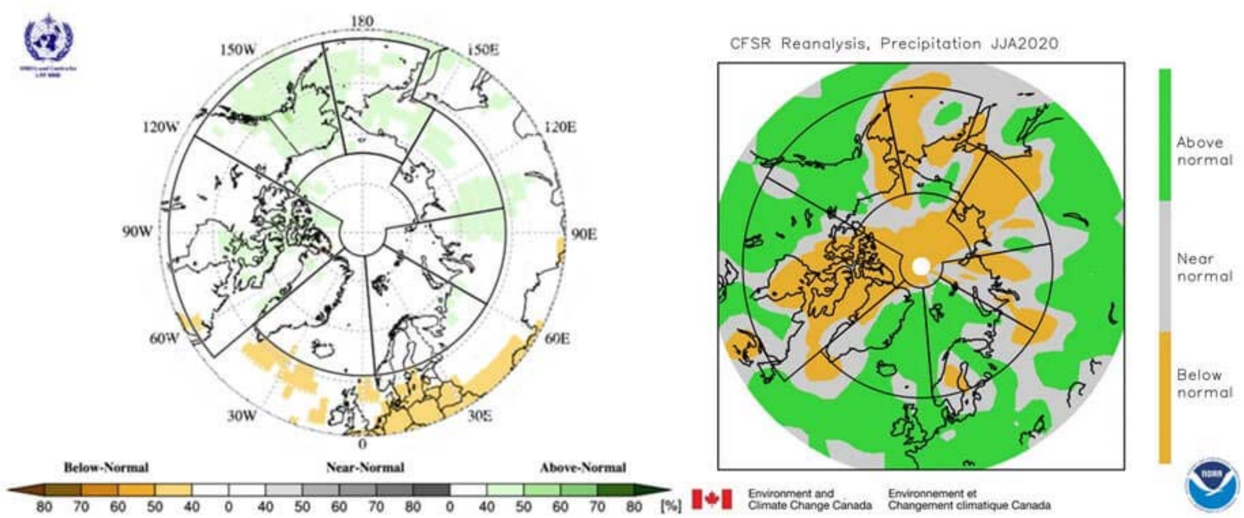

Figure 6: Left) Multi-model ensemble (MME) probability forecast for precipitation: June, July, and August 2020. Three categories: below normal (brown), near normal (grey), above normal (green); no agreement amongst the models is shown in white. Source: www.wmolc.org. Right): NCAR CFSR for precipitation for June, July, and August 2020.

The JJA 2020 precipitation forecast was verified by subjective comparison between the forecast (Figure 6, left) and re-analysis (Figure 6, right), region by region. As for temperature, precipitation re-analysis is produced using statistical techniques to fill gaps when meteorological observations are not available.

Table 3. June, July, August 2020: Regional Comparison of Observed and Forecasted Arctic Precipitation

Regions (see Figure 1)	MME Precipitation Forecast Agreement	MME Precipitation Forecast	NCAR CFSR Reanalysis (observed)	MME Precipitation Forecast Accuracy
Alaska and Western Canada	Low	Above normal (Alaska only)	Above to below normal	Low
Central and Eastern Canada	Low	Above normal	Above to below normal	N/A
Western Nordic	No agreement	No agreement	Above normal	N/A
Eastern Nordic	No agreement	No agreement	Above normal	N/A
Western Siberia	Low	Above normal (eastern part only	Below to near normal	Low
Eastern Siberia	Low	Above normal	Below to near normal	Low
Chukchi and Bering	Low	Above normal	Below to near normal	Low
Central Arctic	Low	Above normal (near Canada only)	Mostly below normal	Low

Overall, the accuracy of the JJA 2020 precipitation forecast was low. Indeed, the observed below to near-normal precipitation over the majority of the Arctic was not accurately forecast for the JJA 2020 season (Figure 6, Table 3). In addition, there was no agreement amongst the models over the Western Nordic, Eastern Nordic, and the majority of the Western Siberia regions (predominance of white areas over those regions). As a general conclusion, the multi-model ensemble forecast was not accurate for JJA 2020.

Outlook for winter 2020-2021:

Precipitation during winter 2020-2021 (NDJ: November 2020, December 2020, and January 2021) is forecast to be above normal over the majority of the Arctic region. Forecast confidence is primarily low (light green areas in Figure 7, Table 4), with the exception of the northern parts of the Western and Eastern Siberia regions, and parts of the Central Arctic region, where forecast confidence is moderate (dark green areas in Figure 7, Table 4). The multi-model ensemble did not agree over the majority of the Western Nordic region (white areas in Figure 7).

Table 4. Winter (NDJ) 2020-2021 Outlook: Forecasted Arctic Precipitation by Region

Region (see Figure 1)	MME Precipitation Forecast Agreement*	MME Precipitation Forecast
Alaska and Western Canada	Low	Above normal
Central and Eastern Canada	Low	Above normal
Western Nordic	No agreement	No agreement
Eastern Nordic	Low	Above normal
Western Siberia	Moderate	Above normal
Eastern Siberia	Moderate	Above normal
Chukchi and Bering	Low	Above normal
Central Arctic	Moderate	Above normal

*: See non-technical regional summaries for greater detail closed.

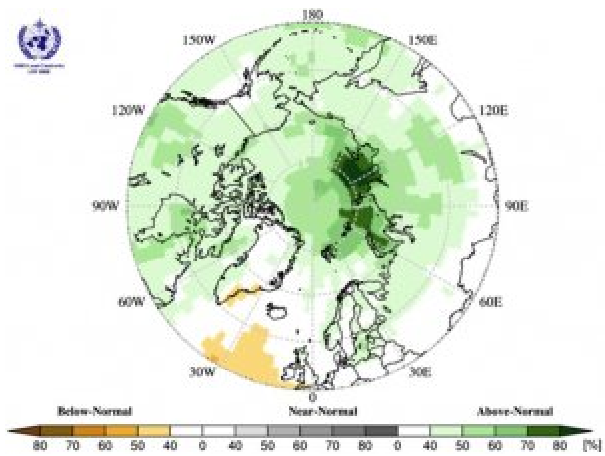

Figure 7: Multi model ensemble probability forecast for precipitation for November 2020, December 2020, and January 2021. Green indicates wetter conditions, orange drier conditions and white, no agreement amongst the models. Source: www.wmolc.org.

Background and Contributors

This Arctic seasonal climate outlook was prepared for ACF-6. Contents and graphics were prepared in partnership with the Russian, United States, Canadian, Norwegian, Danish, Finnish, Swedish, and Icelandic meteorological agencies and contributions of the former JCOMM Expert Team on Sea-ice, former CCI/CBS Inter-Programme Expert Team on Regional Climate Activities, the GCW, the IICWG, and with input from AMAP.

The ArcRCC-Network, a collaborative arrangement with formal participation by all the eight Arctic Council member countries, is in demonstration phase to seek designation as a WMO RCC-Network, and its products and services are in development and are experimental. For more information, please visit https://arctic-rcc.org/acf-fall-2020

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Acronyms:
ArcRCC-Network: Arctic Regional Climate Centre Network https://www.arctic-rcc.org/
ACF: Arctic Climate Forum
AMAP: Arctic Monitoring and Assessment Programme
CCl: WMO Commission for Clilmatology/
CBS: WMO Comission for Basic Systems
GCW: Global Cryosphere Watch
GPCs-LRF: WMO Global Producing Centres Long-Range Forecasts
IICWG: International Ice Charting Working Group
IOC: Intergovernmental Oceanographic Commission
JCOMM: Joint WMO/IOC Technical Commission on Oceanography and Marine Meteorology
LC-LRFMME: WMO Lead Centre for Long Range Forecast Multi-Model Ensemble
NCAR: National Center for Atmospheric Research
NCAR CFSR: National Center for Atmospheric Research Climate Forecast System Reanalysis
NOAA/NWS/NCEP/CPC: National Oceanic and Atmospheric Administration/National Weather Service/National Centers for Environmental Prediction/Climate Prediction Center (United States of America)
MME: Multi-model ensemble
RCC: WMO Regional Climate Centre
RCOF: Regional Climate Outlook Forum
WMO: World Meteorological Organization

Prévisions saisonnières de l’hiver arctique 2020-2021: Température et Précipitations

WRITTEN BY CMOS BULLETIN SCMO ON FEBRUARY 26, 2021. POSTED IN ARCTIQUE, ATMOSPHÈRE, CLIMAT, OCÉANS, QUOI DE NEUF.

– Par des contribueurs de l’Environnement et Changement climatique Canada, l’Université du Québec à Montréal, l’Institut de l’Arctique et de l’Antarctique, l’Institut météorologique norvégien, l’Institut météorologique finlandais, l’Organisation météorologique mondiale, , le Centre de prévision du climat de l’Agence américaine d’observation océanique et atmosphérique, et le Centre de recherche international de l’arctique. –

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Déclaration de consensus du Forum sur le climat de l’Arctique (suite)

FAITS SAILLANTS

La combinaison d’une circulation atmosphérique méridienne de l’Arctique (nord-sud) et du réchauffement de la surface de l’océan cet été (JJA : juin, juillet, août 2020) est le principal facteur à l’origine des anomalies de température, de précipitations et de glace de mer de la saison passée. Les températures supérieures à la normale prévues pour toutes les régions arctiques cet hiver (de novembre 2020 à janvier 2021) continueront d’avoir des répercussions sur la glace de mer pendant cette période.

Température : *Les températures moyennes de l’air en surface lors de l’été 2020 ont été supérieures à la normale dans la plupart des régions arctiques, des records de températures ayant notamment été battus en Sibérie orientale. On s’attend à ce que les températures continuent d’être supérieures à la normale dans la majorité de l’Arctique cet hiver.*

Précipitations : *Une forte variabilité spatiale entre des conditions plus humides et des conditions plus sèches que la moyenne a été observée à travers l’Arctique en JJA 2020. On s’attend à des conditions plus humides que la normale dans la majorité de l’Arctique cet hiver.*

Greetings from the new Bulletin editor

WRITTEN BY CMOS BULLETIN SCMO ON FEBRUARY 5, 2021. POSTED IN NEWS & EVENTS, OTHER, WHAT'S CURRENT.

Thank you, CMOS Bulletin readers, for welcoming me as the new editor of the Bulletin! As I'm sitting at my home in Tiohtiá:ke/Montreal watching the snow fall, I'm able to reflect on how, in a year that been full of chaos, the topics that we work on—weather, climatology, hydrology, oceans—continue to be more important than ever. All of us who study the Earth's systems know that these systems are marked by change. And in a year that has been pierced with change, I have to wonder if rather than being remarkable, the past year has just been the beginning for what the climate crisis has in store. The rapid spread of viruses, civil unrest, extreme weather, wildfires, and growing inequality are all symptoms of the climate emergency that have long been predicted. And while many of us have been the ones predicting these crises, many of us also admit that we, as scientists, want to do more to address these crises and create a world that is centred around climate justice.

The pandemic has forced us to change the way that we work and conduct science. I see this as an opportunity for us to adapt our work, our research and our advocacy to fulfil the needs of the changing world. Meanwhile, movements such as the most recent popular uprising for Black lives and the Land Back movement have helped opened the doors for critical conversations that many scientists have for too long ignored—

conversations such as how our work relates to environmental racism or colonialism, and how we can improve equity in the sciences.

I am so excited to be taking on the role of editor at this time of change and to be in a role where I can help facilitate important conversations between scientists (and non-scientists). As a recent graduate from McGill University with a B.Sc. in atmospheric science and an M.Sc. in micrometeorology, the Bulletin is an exciting way for me to combine my loves of both science and communications. As an active scientist, I will be splitting my time working for the Bulletin with working at the University of Montreal where I research land surface-atmosphere interactions at high latitudes under the influence of rapidly changing permafrost and climate conditions. In my free time, I'm an avid gardener/farmer and volunteer with several Indigenous-led environmental organizations.

I look forward to getting to better know the CMOS community and to working with everyone who is open to engaging.

Sincerely,

Haley Alcock

CMOS Bulletin Editor / Rédactrice en chef du bulletin de la SCMO
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Message de la nouvelle rédactrice en chef du bulletin de la SCMO

WRITTEN BY CMOS BULLETIN SCMO ON FEBRUARY 26, 2021. POSTED IN AUTRES, NOUVELLES ET ÉVÉNEMENTS, QUOI DE NEUF.

Chers lecteurs et lectrices du bulletin de la SCMO, je vous remercie de m'accueillir comme nouvelle rédactrice en chef du bulletin! Assise chez moi à Tiohtiá:ke/Montréal en train de regarder la neige tomber, je suis en mesure de réfléchir au fait que les sujets sur lesquels nous travaillons (météorologie, climatologie, hydrologie, océans) continuent d'être plus importants que jamais en cette année cataclysmique. Tous ceux et toutes celles d'entre nous qui étudions les systèmes de la Terre savons qu'ils sont marqués par le changement. Et en cette année fortement éprouvée par le changement, je ne peux m'empêcher de me demander si, au lieu d'être seulement particulière, l'année passée n'a pas tout simplement été le début de ce que nous réserve la crise climatique. La propagation rapide de virus, les troubles civils, les phénomènes météorologiques extrêmes, les feux de forêt et les inégalités grandissantes sont tous des symptômes de l'urgence climatique qui ont été prévus de longue date. Et alors que nombre d'entre nous avons prédit ces crises, nous sommes aussi nombreux à admettre que nous, les scientifiques, voulons en faire plus pour lutter contre elles et créer un monde axé sur la justice climatique.

La pandémie nous a obligés à changer notre façon de travailler et de mener des recherches scientifiques. J'y vois une occasion pour nous d'adapter notre travail, nos recherches et notre plaidoyer pour répondre aux besoins du monde qui évolue. Des mouvements tels que les derniers soulèvements populaires en faveur du respect de la vie des Noirs et le mouvement pour la restitution des terres ont aidé à ouvrir la porte à des débats critiques que de nombreux scientifiques ont ignorés pendant trop longtemps, des débats notamment sur la manière dont notre travail est lié au racisme environnemental ou au colonialisme, et sur la façon dont nous pouvons améliorer l'égalité dans les sciences.

Je suis si heureuse de me voir confier le rôle de rédactrice en chef en ces temps de changement et d'être à un poste où je peux contribuer à animer d'importantes discussions entre scientifiques (et non-scientifiques). Récemment diplômée de l'Université McGill où j'ai obtenu un baccalauréat en sciences atmosphériques et une maîtrise en sciences de la micrométéorologie, je vois le bulletin comme un moyen idéal de combiner mes deux passions : la science et les communications. Scientifique active, je partagerai mon temps entre mon travail pour le bulletin et mes activités à l'Université de Montréal où j'effectue des recherches sur les interactions entre la surface terrestre et l'atmosphère dans les Territoires du Nord-Ouest sous l'influence du changement rapide des conditions du pergélisol et du climat. Dans mon temps libre, j'aime beaucoup me consacrer au jardinage et à l'agriculture et je suis bénévole avec des Indigneous-led initiative climatique

Je me réjouis d'avance de faire plus ample connaissance avec la communauté de la SCMO et de travailler avec quiconque est ouvert à la communication.

Cordialement,

Haley Alcock

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Black History Month for the Sciences

WRITTEN BY CMOS BULLETIN SCMO ON FEBRUARY 10, 2021. POSTED IN ATMOSPHERE, CLIMATE, OCEANS, OTHER, WEATHER, WHAT'S CURRENT.

On May 25, 2020, Amy Cooper—a white Canadian woman—called the police on Christan Cooper—a black birdwatcher—after he asked her to leash her dog in an on-leash part of Central Park, New York City. From this incident rose Black Birders Week, an event organized by BlackAFinSTEM with the goal of increasing the viability of Black scientists in natural sciences and of highlighting the unique challenges and dangers faced by Black folks participating in outdoor activities.

Black Birders Week sparked the BlackinX movement and was fueled by the police killings of Geoge Floyd (which happened on the same day as the Central Park incident), Breonna Taylor, and countless other Black and Indigenous people in the U.S., Canada, and around the world. Today, there are BlackinX groups or hashtags representing nearly every discipline of science, including Black in Geoscience, Black in Marine Science, Black in Engineering, Black in Science Communication, #BlackinAtmosphere, #BlackinClimate, #BlackMeteorologists, Black in Science Policy, and #BlackinHydrosphere. All of these groups are working hard to uplift the work of Black scientist around the world.

For Black History month, many of these groups will be blessing us with science-related Black history social media posts, articles, events, and more. The sciences—in particular, the Earth sciences—may have along way to go to in creating equitable opportunities for people of colour but the immense work done by BlackinX movement is giving us a huge shove in the right direction.

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Le Mois de l'histoire des Noirs pour les sciences

WRITTEN BY CMOS BULLETIN SCMO ON FEBRUARY 26, 2021. POSTED IN ATMOSPHÈRE, AUTRES, CLIMAT, MÉTÉO, OCÉANS, QUOI DE NEUF.

Le 25 mai 2020, Amy Cooper, une femme canadienne blanche, a appelé la police quand Christian Cooper, un ornithologue amateur noir, lui a demandé de mettre son chien en laisse dans une partie de Central Park, à New York, où c'était obligatoire. À la suite de cet incident est née la Black Birders Week, un événement organisé par BlackAFinSTEM dans le but d'augmenter les chances de succès des personnes noires dans les sciences naturelles et de souligner les défis et les dangers uniques auxquels elles font face lorsqu'elles participent à des activités de plein air.

La Black Birders Week a été à l'origine du mouvement BlackinX, attisé par les homicides imputables à la police dont ont été victimes George Floyd (dont le décès s'est produit le même jour que l'incident de Central Park), Breonna Taylor et d'innombrables autres personnes noires et autochtones aux États-Unis, au Canada et partout dans le monde. Aujourd'hui, des groupes ou des mots-clics BlackinX représentent à peu près toutes les disciplines scientifiques, notamment Black in Geoscience Black in Geoscience (pour les sciences de la Terre), Black in Marine Science(pour les sciences de la mer), Black in Engineering (pour l'ingénierie), Black in Science Communication (pour la communication scientifique), #BlackinAtmosphere (pour l'atmosphère), #BlackinClimate (pour le climat), #BlackMeteorologists (pour la météorologie), Black in Science Policy (pour les politiques scientifiques), and #BlackinHydrosphere(pour l'hydrosphère).Tous ces groupes travaillent dur pour promouvoir le travail des scientifiques noirs partout dans le monde.

À l'occasion du Mois de l'histoire des Noirs, bon nombre de ces groupes nous feront l'honneur de nous présenter des publications sur les médias sociaux, des articles, des événements, etc. concernant l'histoire des Noirs en lien avec la science. Le monde des sciences, en particulier des sciences de la Terre,a encore sans doute un long chemin à parcourir pour offrir l'égalité des chances aux gens de couleur, mais le mouvement BlackinX nous permet de franchir un énorme pas dans le bon sens.

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Canada’s Top Ten Weather Stories of 2020

WRITTEN BY CMOS BULLETIN SCMO ON FEBRUARY 19, 2021. POSTED IN ATMOSPHERE, CLIMATE, WEATHER, WHAT'S CURRENT.

– By David Phillips –

This article was first published by Environment and Climate Change Canada.

Prologue 2020

Canada is warming at nearly twice the global rate with parts of western and northern Canada warming three or four times the global average. Sea ice in the North is thinning and shrinking, and our unique ice shelves are crumbling into pieces. While Canada is still the snowiest country, less snow is falling across the south. White Christmases’ are less frequent and less white. Frost-free days are increasing, and our growing season is longer, but so too is the length and severity of the wildfire season. Weather systems are moving slower, leaving more time to make an impact. When it rains it often rains harder and longer. Records continue to topple like never before, often dramatically shattering previous records. So-called unprecedented events are becoming common, happening back-to-back, not decades apart. Our “Goldilocks” weather is not so sure any more with conditions being either too hot or too cold and too wet or too dry.

Scientists have made a clear link between climate change and extreme weather events that include heat waves, wildfires, some flooding and sea ice loss, and strong possibilities for linkages to heavy rain, icing, drought and storminess. As Canadians continue to experience more extreme weather, these top news events will simply, decades from now, be called “normal”. As the Top Ten Weather Stories of 2020 bear out, exceptional weather which we thought was futuristic is occurring here and now. It is playing out in our backyards, in our communities and in our country. What 2020 showed, through smoky skies in British Columbia, frequent hurricanes in the East, and vanishing ice in the North, climate change occurring elsewhere outside of Canada is also having an increasingly greater impact on the health and well-being of Canadians at home.

Introduction

What an unsettling 2020 it was, as the world faced the largest public health crisis in over a century. The COVID-19 pandemic was certainly the top-news story with the lives lost, economic damage and societal unrest felt by the world's billions. At times, the need to quarantine and social distance was made more challenging owing to the weather. Towards the end of the year in the midst of a second and third wave, the virus morbidity statistics were horrific and pandemic fatigue was taking over. However, there was hope that effective vaccines would soon make the dire threat go away. There is no vaccine for extreme weather only sustainable planning, preparedness and a rapid response.

Across Canada, 2020 was another year of destructive and impactful weather. Property damage from weather cost Canadians millions of dollars and the economy billions. Based on preliminary estimates compiled by Catastrophe Indices and Quantification Inc. (CatIQ), there were nine major catastrophic weather events, with total insured loss estimates approaching $2.5 billion. But that was only a fraction of total property losses and infrastructure costs from major and nuisance weather costing billions more.

Calgary rarely misses a ranking on the top ten weather list and this year it was again Number 1 from a billion-dollar hailer that pummelled the city on June 13. Alberta captured two of the year's three top weather events with a second disaster in Fort McMurray when ice-choked rivers flooded downtown at the end of April. Of concern, six of the ten most expensive recent weather disasters in Canada have occurred in Alberta. Wildfires across Canada, especially in British Columbia were near-record low in terms of area burned. However, climate-induced wildfires in California and the United States Northwest spread smoke northward into British Columbia and Alberta forcing millions to gasp through foul, dirty air for nearly two terrible weeks in September. Warm waters in the Atlantic Ocean, the Caribbean Sea and the Gulf of Mexico along with a favourable atmospheric circulation led to a record number of named storms (30) in the North Atlantic. In Canada, eight storms entered our response waters but the deadly and crippling storms in the south largely spared us. Teddy was the most powerful tropical storm to affect Canada, but it was no Dorian or Juan.

An accurate count of tornadoes is never possible anywhere, but we are getting better in Canada with more extensive monitoring and surveillance. Nationally, 77 tornadoes were documented including a potential record 42 in Ontario, although Canada's most powerful twister occurred at Scarth, Manitoba on August 7. Spring was largely a no-show in parts of southern Canada, but when summer did come, it was the summer of summers from Victoria Day to Labour Day. In Eastern Canada, it was one of between the fourth and seventh the warmest summers in 73 years, part of a global heatwave that stretched from Siberia in Russia to Death Valley in the United States. Summer wasn't finished with the East in September. A lengthy and much welcomed warm interlude occurred in November and lasted more than a week when hundreds of high-temperature records were broken and often smashed. At the same time, an early winter with cold temperatures and snow prevailed across western Canada and the North. For Newfoundland and Labrador, it was snowpocalypse with record-breaking snowfalls in January in St. John's and in November in Happy Valley-Goose Bay. In St. John's on January 17, it was a true "Snowmageddon" lockdown prompting officials to call in the Canadian Armed Forces. At summer's halfway point in August, stormy weather marred the civic long weekend in both east and west when powerful supercell storms inflicted extensive property damages and power outages, costing insurers over $50 million in Alberta alone.

From a list of 100 significant weather happenings across Canada in 2020, events were ranked from one to ten based on factors that included the degree to which Canada and Canadians were impacted, the extent of the area affected, economic and environmental effects and the event's longevity as a top news story.

Top ten weather events in 2020 countdown

10. August long-weekend storms: East and West

The civic long weekend in August featured some nasty summer weather in both southern Alberta/Saskatchewan and in Ontario. First, in the East, a low-pressure system crossed through central Ontario late August 1 through August 2. The warm front associated with the system brought significant tropical-sourced moisture between 50 and 70 mm from Windsor to the Greater Toronto Area and Niagara, and along the north shore of Lake Ontario. Rainfall in Barrie totalled between 80 and 90 mm, more than the average monthly total, and the highest of any August one-day rainfall in history and the most one-day amount for any month in 25 years. A couple of volunteer observers reported in excess of 100 mm of rain in Western Ontario. The storm system spawned four tornadoes with winds clocking between 130 and 190 km/h. A weather chaser spotted a weak tornado north of Mitchell. In Camden East, strong tornadic and straight-line winds uprooted dozens of trees, some century-old, or broke them off at mid-trunk. In addition, winds lifted shingles from roofs, cracked windows and felled hydro lines and poles. The roof of the Camden East municipal building was torn off and several streets were fully blocked by downed trees. Another tornado touched down in Kinmount near Peterborough where estimated winds approached 190 km/h.

In the West on August 2 and 3, pulses of energy in the midst of hot and humid air destabilized the atmosphere, resulting in several robust storms, featuring large tennis- and baseball-sized pulverizing hailstones. Strong thunder cells also produced damaging wind gusts and heavy rainfall that triggered localized flash flooding. Large hailstones inflicted extensive property damage in Crossfield, Alberta near Carbon, from Cremona to Drumheller, and at a campground northwest of Calgary. Winds in excess of 100 km/h inflicted damage to trees and dwellings in Killam, southeast of Edmonton and at Forestburg. In Macklin, Saskatchewan storm winds took down trees and power lines and tore off a hotel roof. Hail cracked several windows and windshields, damaged siding on several buildings in town and scarred golf course greens. Costs of this August hailstorm in Alberta and Saskatchewan included 4,000 insurance claims totalling $55 million in property losses. Amidst the storm, three non-damaging tornadoes occurred including one at Youngstown and two near Dorothy, Alberta.

9. Fall in Canada – winter in the West and summer in the East

Across much of the Prairies residents welcomed unseasonably warm weather during the first week of November, but with an eye on a powerful storm lining up to the West. From November 7 to 9, the summery interlude came to a dramatic end with the arrival of a slow-moving, moisture-laden Colorado low from the American northwest. Strong winds with gusts up to 85 km/h ushered in the storm and combined with falling temperatures to produce wind chill values of -22. Moreover, the storm featured a mixture of heavy snow and rain and/or a congealment of ice pellets and freezing rain, prompting lockdown conditions from southwestern Alberta (south of Calgary) through central and southern Saskatchewan, and into northwestern Manitoba. It was mostly snow in Alberta and central Saskatchewan with record-breaking amounts drifting and blowing about in sudden whiteout conditions. Saskatoon, Prince Albert and Kindersley, Saskatchewan took the biggest hit with 50 hours of snowfall (30 to 47 cm), much of it blowing around. Maple Creek and Swift Current, Saskatchewan were buried in 2-metre drifts. In southeastern Saskatchewan and in southern Manitoba prolonged periods of freezing rain and ice pellets kept snowfall totals down but added to the treacherous driving conditions. Residents were prepared for the well-publicized winter blast, but, the wintery nightmare created significant impacts with damage to leafed trees and power lines. Travel was nearly impossible and dangerous with suddenly reduced visibility. New snows made most surfaces icy and slippery. Local businesses, community centres and schools closed early or never opened at the beginning of the week as dense snow-choked streets and highways.

In contrast, at the end of October and in early November, southern parts of Ontario and Quebec had a taste of winter with the season's first snowfall and biting frosts. But summer weather made a quick return with an unprecedented long stretch of record-breaking high temperatures across Ontario, parts of southern Quebec, and eventually into Atlantic Canada beyond Remembrance Day. Over a remarkable stretch of eight days, 200 daily high-temperature records were set from Ontario to Newfoundland with some readings eclipsing the previous record by several degrees. The November "heatwave" also followed a cooler than normal September and October with no 30°C readings, which made it even more special. Persistent southwesterly winds were delivered by the push from a Bermuda High positioned further north and west over the northeastern United States and the pull from the jet stream located along a line between Hudson Bay and central Labrador much further north than would normally be the case. From shovels to golf clubs, the extraordinary warmth had no adverse economic impacts. The gorgeous weekend of November 7 and 8 was aglow in the sunshine, with record warmth and completely dry. Undoubtedly, the best "summer" weekend in the East this year occurred in November. It was an atmospheric gift at a time of the year when temperatures typically hover near freezing, skies are overcast and gloomy, and there are more wet days than dry ones. On November 9, the temperature in Collingwood, Ontario soared to 26°C — one of the highest temperatures ever in the province for November and the warmest November day in 60 years. Even more remarkable than the record warmth was the long stretch of nice days, not a one- or two-day wonder, but lasting a week or more. Temperatures were reminiscent of the middle to late September or what Atlanta Georgia would experience in mid-November. And when it came to an eventual end, it was a gradual downward trend not the dramatic way it began. Among the records set in such places as Windsor, Toronto, Ottawa and Montréal and several other locations were: multiple mean daily maximum and minimum temperature records; the warmest November day ever; latest date in the year when the temperature topped 20°C or more; and the longest consecutive stretch of days above 15°C so late in the year. For some hopefuls in the East, it could only mean that winter would be a week shorter than expected.

8. Frigid spring helps Canadians self-isolate

It is often said that spring is reluctant to arrive in Canada. In 2020, spring was not late; it went missing. Following a mild winter, the weather turned cold across most of southern Canada in March and persisted for another two months. At times, negative temperature anomalies were extraordinary, reaching as much as -22 degrees in parts of Alberta at the end of March. Most of the blame goes to the polar vortex which for most of the winter remained at home, circulating the North Pole before sagging southward in March bringing with it an expansive cold air mass. More than 80% of Canada had a colder-than-normal spring. April was especially cold and cruel being the sixth coldest April in 73 years in the Prairies and southeastern Canada. April felt like late-November with double-digit negative highs and wind chills pushing –35 in central Alberta. The cold spell continued into the first half of May. Temperatures felt more like early March than early May, and Mother's Day more like St. Patrick's Day. May days featured single-digits highs and below-freezing lows, and measurable snow. Temperatures in Winnipeg dipped to a low of -10.3°C on May 11 breaking the previous minimum record of -6.2°C in 1996. Moreover, it was the coldest moment post-May 11 ever since records began in 1878. Ottawa set new record daily low minimum and maximum temperatures on several days at the beginning of May. On May 12, it was -4.6°C shattering the record minimum for the day by 3 degrees and the coldest ever post-May 12 at the airport. May snowfalls plagued many areas of Ontario and Quebec, especially near open lakes, causing them to be snowier than March and April.

The lingering spring-time chill, along with May snows, fit the mood of the nation, frozen in place. In some ways, Mother Nature made it easier for Canadians to self-isolate indoors to prevent the spread of COVID-19. Mother Nature joined with public health officials to keep people dutifully two metres apart in the warmth of their own homes. Further, on May weekends, because people who normally went away to cottages or cabins tended to stay put, there was a slower start to the wildfire season compared to most.

7. The year's most powerful tornado

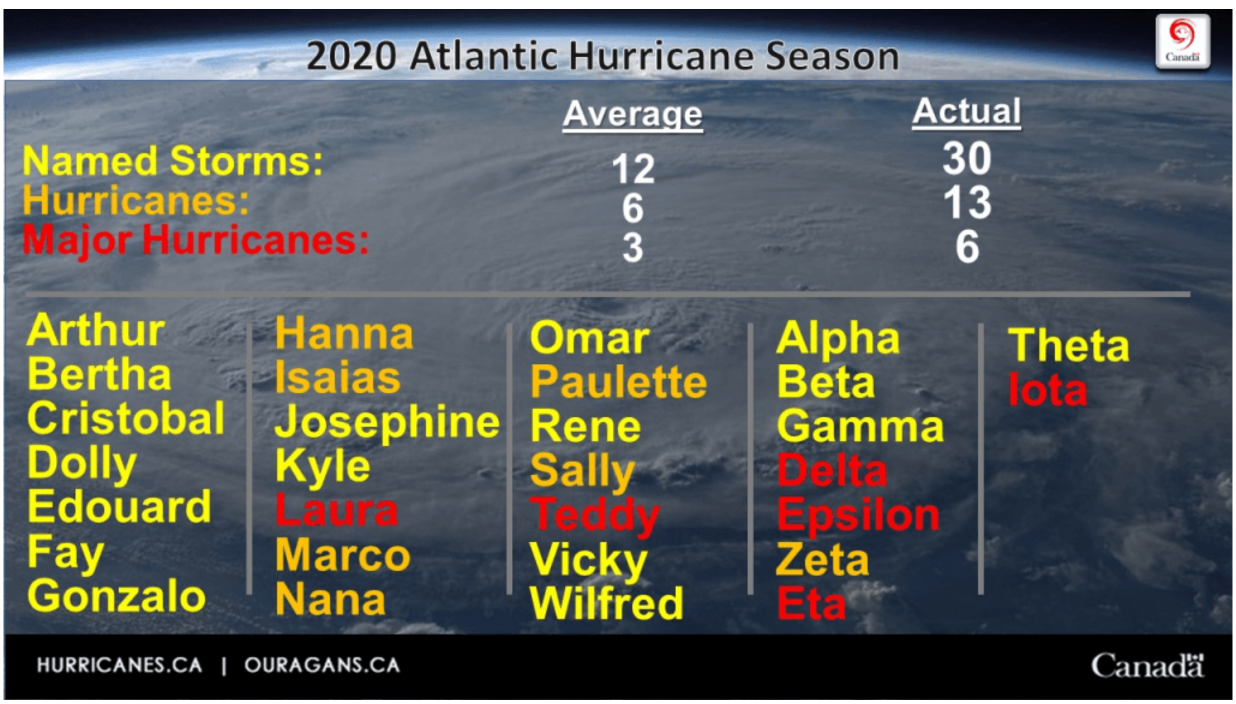

The August 7th Sifton tornado. Photo by Sean Schofer

In a year with at least 77 tornadoes across Canada, the highest-rated and therefore the most powerful tornado occurred on August 7 in southwestern Manitoba near the rural municipalities of Pipestone and Sifton. On August 6, individual storm cells produced large hail, powerful winds and torrential downpours in Alberta. The next day, the low-pressure system shifted eastward posing a threat with large hail, heavy rains, and damaging winds through the afternoon and early evening hours in eastern Saskatchewan and western Manitoba. Environment and Climate Change Canada issued a tornado warning at 7:49 pm and five minutes later a monster funnel cloud filled the sky and grounded as an EF-3 tornado near Scarth, 13 km south of Virden, Manitoba. Violent winds blew over 200 km/h lasting between 10 and 15 minutes, leaving a 9-km long damage trail of farm buildings, chewed up grain silos, crushed steel fertilizer bins, snapped trees, felled powerlines and wooden utility poles, with scattered debris across yards and fields.

A man from the Sioux Valley Dakota Nation witnessed the twister's ferocious strength when winds uprooted a pine tree and tossed it onto his Jeep's roof seriously injuring him. Within seconds, winds blew out the vehicle's windows and started rolling it for 150 m before it settled in a ditch. At the scene, he witnessed the tragic sight of the tornado lifting a pickup truck and tossing it a kilometre away. Police and other first responders found the crushed truck. Tragically, its two teenage occupants from nearby Melita, Manitoba had been ejected and did not survive. The Scarth tornado was the strongest twister recorded in Canada in 2020, reaching wind speeds estimated as high as 260 km/h.

6. Record hurricane season and Canada wasn't spared

Meteorologists predicted another "active" Atlantic hurricane season in 2020, but a record season was more like it! The tally at the official end of the season was 30 named storms, 13 hurricanes of which 6 became major hurricanes– approaching three years' worth of storms in one. Named storms went from Arthur to Wilfred and started again from Alpha to Iota. The "hyper" storm season reflected a warm multi-decadal cycle of high storm activity that began in 1995 and broke the record for the number of named storms in a single season set back in 2005. As forecasters are getting better at detecting even weaker storms, it was no surprise that once again a couple of them showed earlier on the map. For the record sixth year in a row, a named storm formed in the Atlantic basin prior to the official start of the season. Fay was the earliest sixth named storm, forming almost two weeks earlier than Franklin did in 2005. And Eta was an October storm whereas the 2005 Eta storm lasted until January 2006.



The hurricane season began quickly and stayed active right to the end. While a record number of tropical storms swirled their way through the North Atlantic, eight named storms entered the Canadian Hurricane Centre (CHC) Response Zone. None of those storms had nearly the impact of those in the United States, the Caribbean and Central America. By July 10, the remains of an exhausted tropical storm Cristobal combined forces with a system that swept out of the Rockies to bring several hours of wet and breezy weather across Ontario and Québec and into Labrador before dying out near Greenland. Hydro-Québec reported as many as 130,000 power outages in the Laurentian, Montreal and Montérégie areas. The remnants of tropical storm Fay came ashore in New Jersey on July 10 before heading north and east dumping between 50 and 100 mm of rain in Québec. The day before, Fay's moisture fed some hot and humid air sitting over Ontario along with a passing cold front dumping welcomed rain on a dry province. Pockets of extremely heavy rainfall (up to 150 mm) occurred from Kingston to Québec City. Post-tropical storm Isaias made its way through Québec's Eastern Township on August 5 packing strong winds between 75 km/h in Montreal to 90 km/h at Ile d'Orléans and heavy rainfall between 50 and 90 mm in just a few hours and 125 mm in the Charlevoix region. Apart from some breezy hours, a transitioned Isaias left 60,000 Eastern Québecers without power on August 5. Remnant moisture from a weakened Hurricane Laura contributed to a rainfall event along the lower St. Lawrence, the Saguenay, Lac-Saint-Jean, Gaspé and the North Shore in Québec and in the Maritimes at the end of August before tracking across Newfoundland to Labrador. Rainfall amounts between 40 to 70 mm that fell provided welcome water for suffering crops and helped replenish some of the near-empty wells, streams and ponds. Moisture from the remnants of Hurricane Sally fed into a low-pressure system bringing over 100 mm of rain to Eastern Newfoundland, although the peak occurred at Placentia on September 18 and 19 with a whopping storm rainfall total of 206 mm. In mid-October, the remnants of Hurricane Delta added a lot of moisture in Québec to a system coming from the West. Heavy rains above 60 mm fell from Estrie to the Gaspésie.

Teddy was no Dorian or Juan

The season's most impactful tropical storm in Canada, Teddy held few surprises for forecasters as it began its trek south of Bermuda on September 23 making a beeline for Nova Scotia at the beginning of the fall season. Teddy was the earliest 19th named Atlantic storm on record and was a major Category 4 strength south and east of Bermuda before weakening to a ragged but larger post-tropical storm about 12 hours before making landfall about 100 km east of Halifax on September 23. Although Teddy had transformed into a post-tropical storm, its sustained winds stayed at hurricane-force prior to making landfall. Parts of southeastern New Brunswick, eastern P.E.I. and western Nova Scotia received copious amounts of rain. Officials and residents in the Maritimes were well prepared, which lessened the storm's impacts. Unlike Dorian a year before, Teddy's winds were less forceful and the storm moved through more quickly. While no Dorian, Teddy was the most impactful Canadian tropical storm in 2020. That being said, the storm churned up 15-metre waves offshore, dropped over 100 mm of rain in places and produced maximum wind gusts over 130 km/h. Cape Breton Island took the biggest hit with 132 mm of rain and wind speeds of 145 km/h. Halifax received around 100 mm of rain and 80 km/h winds. A maximum significant wave of 12.8 m occurred at an off-shore buoy. Leafed trees created an added risk to downed limbs and power outages. Parks Canada closed some national parks in advance of the storm's arrival and as a precaution some schools were closed, restrictions were put on the Confederation Bridge, and ferry and flight services were curtailed.

5. St. John's "snowmageddon"

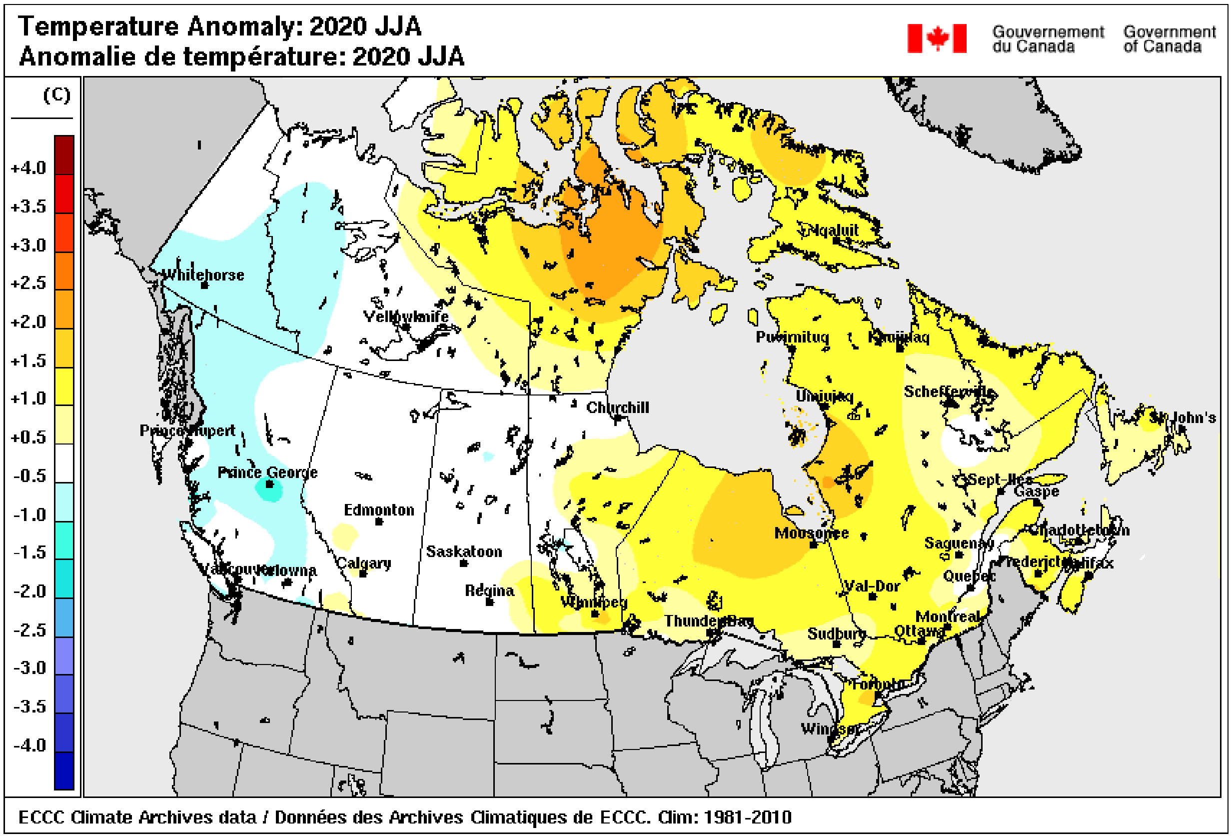
Meteorologists called it a bomb cyclone, where a storm's atmosphere dropped 24 hPa (degrees of pressure) in 24 hours. For townies in St. John's, Newfoundland and Labrador it was "Snowmageddon" – the fiercest blizzard of a lifetime in a city known for its punishing winter storms. On the morning of January 16, a deep low-pressure system situated in western New York tracked through the northeastern United States before continuing onwards to Newfoundland's Avalon Peninsula – a normal track for a mid-winter storm. For much of the next day, the storm deepened and strengthened to "bomb" status, its pressure dropping more than 54 hPa in 48 hours. Snow began falling early on January 17, intensified during the day, before easing up later overnight. Blizzard conditions prevailed for 18 straight hours with visibilities of 200 metres or less. St. John's International Airport broke its historic daily snowfall record with 76.2 cm and had to stay closed for six days. Nearby, Mount Pearl and Paradise reported 90 cm of snow over 28 hours. Snowfall intensity of 10 cm an hour was impressive. The last time St. John's saw something close to 75 cm of snow was in April 1999, when the pre-storm ground was snow bare. The January storm started with 40 cm of snow already sitting on the ground. In fact, for 27 days starting on Christmas Eve there was only one day without snowfall, New Year's Eve, for a total of 220.8 cm in that period. Winds on January 17 were also impressive, reaching hurricane force at 160 km/h along the coast. The deep low and strong winds also generated a significant storm surge with a wave height of 8.7 m on January 18, damaging docks, wharfs and yachts. But it was all about the snow! Most times you couldn't tell if it was snowing or just blowing around. Monster drifts were higher than doorways, which meant people often had to dig from the inside out. The super-sized storm left piles of snow higher than houses. The city was entombed in snowdrifts. There was even an avalanche in the middle of downtown. St. John's, claiming to be the snowiest major city in Canada, earned its reputation and declared a state of emergency along with 11 other nearby communities. This marked the city's first in 36 years – which lasted more than nine days. Another 10 to 20 cm of snow fell over the next days making cleanup efforts even more challenging. That is when 625 Canadian Armed Forces personnel arrived for a week or more to help dig out the city by clearing roads, attending to the elderly and sick and ensuring residents got medical care.


St. John's "snowmageddon"

Plugged narrow streets became an enormous struggle for crews cleaning more than 14,000 km of city roads. Power outages occurred to more than 20,000 hydro customers. All businesses were ordered closed and all vehicles except emergency ones were prohibited from operating. Even government snowplows were taken off the streets. Mail delivery was halted but even when resumed, mailboxes were buried; blood donor clinics closed; even funerals had to be postponed. Homeowners ran out of supplies and lined up at grocery stores five days after the storm ended when they were able to reopen. Insurer costs exceeded $17 million, covering only a fraction of snow removal costs and economic losses. The monster snowstorm on January 17 was the big talk for weeks in the city, but it also made news worldwide from the United Kingdom to Turkey to Australia. With 12 days to go in January, St. John's broke the record for their snowiest January since records began, totalling 166 cm from January 1-19, 2020. No wonder the local townies called it January.

4. Endless hot summer in the East

Following a cold spring with frost and snow in the first half of May, the weather in Central and Eastern Canada soon turned from slush to sweat. The long weekend in May – often the unofficial kick-off of summer – proved prophetic and a trendsetter. In Eastern Canada, it was the summer of summers – coming early and staying warm until almost Labour Day. Overall, it was either the fourth or fifth warmest summer in 73 years and the warmest since 2012. Temperatures started exceeding 30°C on May 25 and humidex values soared close to 40 in Ontario, Quebec and New Brunswick.



On May 27, Montreal hit 36.6°C, its hottest May temperature ever. In fact, it was the second-highest reading ever in Montréal! The only hotter day in 15 decades was 37.7°C on August 1, 1975. In Quebec, 140 temperature records were eclipsed in June, and July saw even more records broken. Incredibly, Sept-Iles touched 36.6°C on June 18th – an all-time record for the area. Before the second week of July, Ottawa had already as many days above 30°C, with four exceeding 35°C, as it would normally see an entire summer. Normally such sizzle occurs once every 10 years, not four times in one summer. July 2020 wasn't the hottest July on record at the Ottawa International Airport, but you'd have to have been alive in 1921 to have experienced a more sweltering one in the city with records dating back almost to Confederation. In eastern and southern Ontario and southwestern Quebec, temperatures remained above normal almost continuously for 60 days from mid-June to mid-August. In Montréal and Ottawa, the average temperature for the hot spell was the highest in 145 years. At Toronto, July featured 15 occasions when nighttime-temperatures stayed above 20°C. Lasting heat also baked parts of the Maritimes. New Brunswick's capital Fredericton had 20 days above 30°C, not the normal nine, and the most in 50 years. In addition, the city recorded 14 days with a maximum between 29° and 30°C. Summerside, Prince Edward Island had ten 30°+days compared to the average of one. The summer warmth at times headed westward to Manitoba. Winnipeg exceeded its hot 30° days by almost twice the usual number. Everywhere in the east, soaring temperatures and thick humid air caused breathing difficulties. As temperatures sizzled, it also meant deteriorating air quality on many days, adding to the high air quality health risk. The summer raised concerns inside long-term care facilities for residents with underlying health conditions facing COVID-19 outbreaks. For other Canadians, usual hot weather shelters such as air-conditioned malls, libraries, recreation centres, movie theatres and public swimming pools were often closed due to COVID-19, adding to the breathing and heat respite challenge.

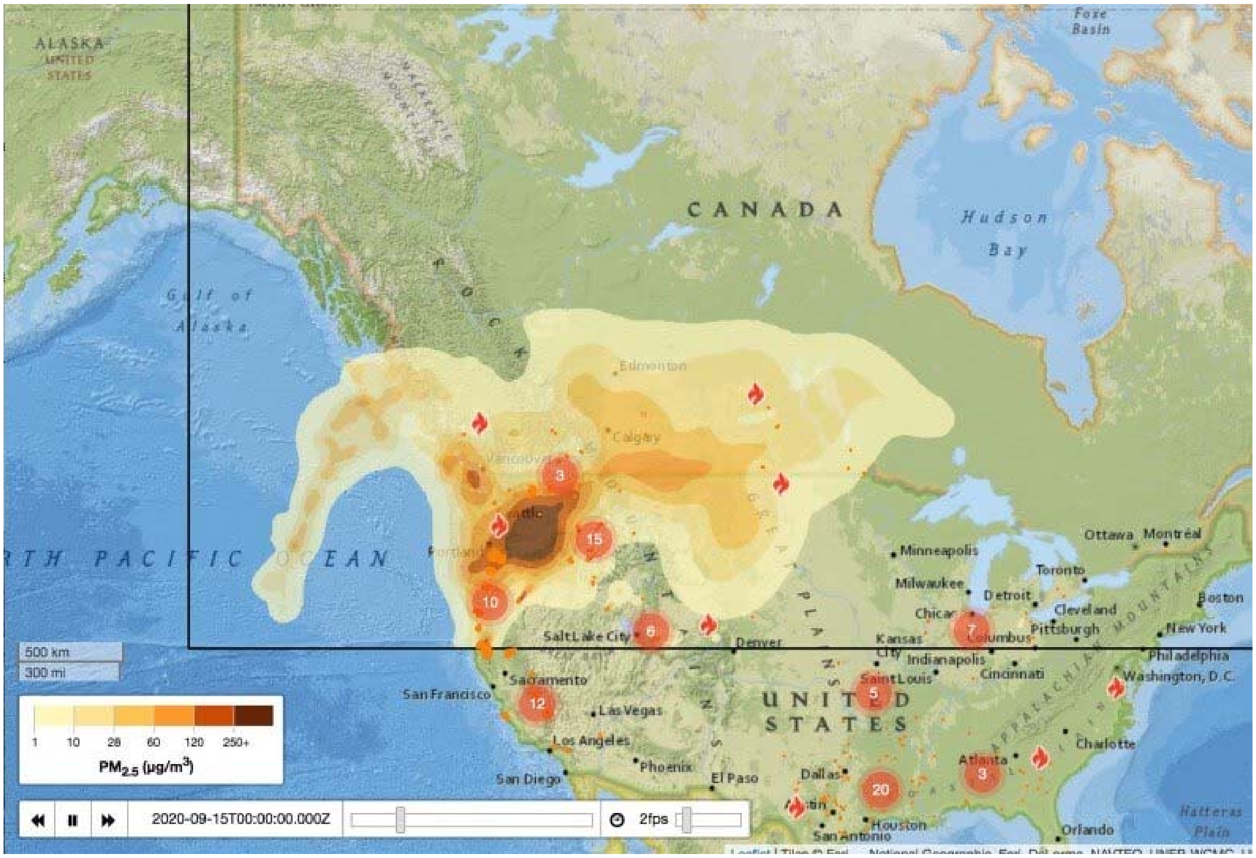
With the kind of summer Ontario had, it was not a surprise that the Great Lakes were as hot as a hot tub. Surface water temperatures ranged between three and five degrees higher than normal except for larger and deeper Lake Superior. According to satellite reconnaissance on July 10, Lake Ontario's average surface temperature reached around 25°C – a record this early in summer and on par with the highest temperatures in any month since satellite data collection began.

3. Fort McMurray's flood of a century

For the second time in four years, residents of Fort McMurray, Alberta were forced out of their homes. This time it was water, not fire. Severe ice jamming on a 25-km stretch of the Athabasca River caused water to back up on the adjacent Clearwater River, flooding much of downtown at the end of April. It was said to be the most significant flooding in more than a century. In a matter of hours on April 26, ice clogging raised water levels on Fort McMurray area rivers between 4.5 and 6 metres. The sheer size of the ice prevented the use of common ice-jam breaking options, such as explosives. Instead, what nature started, nature had to stop. An unprecedented two months of extreme cold as much as 10 degrees below normal, followed by a week of rapid warmth, lots of sunshine and warm rains prompted continued melting of the ice exacerbating the flood but continuing to mitigate it too. For more than a week, 13,000 residents in the lower townsite of Fort McMurray had to evacuate. Another ice jam on the nearby Peace River forced 450 people from their homes in Fort Vermilion, Alberta. Many customers went without power or gas service for nine days. States of local emergency and boil water advisories were in effect in both Fort McMurray and the surrounding municipality adding to the state of emergency declared a month earlier due to COVID-19. Some residents were forced out of their homes after weeks of isolation due to the pandemic. Emergency measures officials did a remarkable job managing evacuations in one of the world's first natural disasters during a public health crisis. In spite of the efforts of thousands of volunteers and workers engaged in bailing and sandbagging to protect infrastructure including the hospital, essential businesses were unreachable in the submerged downtown core, and only a handful of grocery stores remained open, causing a strain on supply. Tragically, a man from the Fort McKay First Nation, about 60 kilometres north of Fort McMurray, drowned after he and another were caught by rising waters of the Athabasca River. Most water damage was to commercial property downtown where 1,230 structures were damaged from both overland flooding and sewer backup. Hundreds of abandoned cars and trucks were completely submerged. Huge ice chunks and piles of silt lay on the golf club and two small bridges on the course were smashed. The Insurance Bureau of Canada estimated the cost of the flooding from nearly 3,000 claims totalled above $562 million with 90% paid out to commercial properties.

2. BC’s September skies: all smoke, no fires

Statistics from the Canadian Interagency Forest Fire Centre reported a second consecutive quiet fire season across British Columbia in 2020 following two of the busiest years ever in 2017 and 2018. The number of fires province-wide this year was down to 629 or a third of the fires in the record year of 2018. Most shocking, burned hectares of woodlands were only 1% of that consumed two years earlier and 4% of the average areal burn over the past decade. Whereas there were only a few home-grown fires, owing to a cooler and wetter spring, there was a record amount of imported wildfire smoke in September. Visible from space, dense smoke plumes from forest fires in the U.S states of Washington, Oregon and California travelled northward into British Columbia’s southern airshed. Residents from Victoria and Vancouver east to Kamloops, Kelowna, and in the Kootenay region faced some of the worst air quality in recorded history and some of the poorest and unhealthiest air in the world. For eight consecutive days in mid-September, about four million British Columbia residents, urban and rural, and young and old smelled smoke and breathed foul air. Special Air Quality Statements were issued by Environment and Climate Change Canada, as air-cleansing rains and pollution-dispersing marine winds were absent in the first half of September. Beautiful British Columbia didn’t look so beautiful! Residents with underlying respiratory and cardiovascular conditions were especially vulnerable, as the fine particulate matter was six times levels registered from the home-grown fires of 2017 and 2018. The long-term health effects for all residents are unknown. Vancouver and Victoria were especially dark and smoky. Vancouver recorded 171 hours of smoke and haze in September with one bout that lasted 120 consecutive hours over four full days from September 12 to 15. Victoria was no less impacted with 195 hours of smoke/haze, including 186 consecutive smoke-filled hours around the 15th of the month. Both cities registered 70% to 80% more smoky hours above their previous record numbers from August 2018.



Around the Labour Day weekend, a high-pressure system building over northern British Columbia produced strong gusty winds over the southern half of the province. The same weather system ushered in a couple of days with record high temperatures warmer-than-normal and pulled in smoke from massive fires burning across the border from the United States. A dense, fog-like shroud turned daylight into smoke-tainted twilight, blue skies to leaden grey with an acrid-burning smell and sunrises an eerie blood red. Smoky skies bulletins for the southwest prevailed for 11 days, compounding a public health crisis already posed by the COVID-19 virus. At times, the thick layer of smoke aloft prevented sunshine from getting in and heating up the ground thus chilling temperatures by 6 to 10 degrees across the West. Around September 18, a fall frontal system from the Gulf of Alaska brought rains and winds to the Coast to start flushing out the smoke and improving breathing. Wildfire smoke wafted across the border into Alberta. Calgary was spared but smoky skies prevailed in southwest Alberta, near the Rockies. Further east, satellite imagery on September 14 and 15 showed plumes of smoke drifting across the country extending as far as Europe. American wildfire smoke moved back into southwest British Columbia on September 30 for a very short time, but the air quality was nowhere as bad as it was earlier in September.

1. Calgary's billion-dollar hailer


Calgary hailstorm. Photo taken by Candeena Langan

Calgary, Alberta endured more than its share of stormy summer weather in 2020. The season featured frequent hailfalls with grapefruit-size stones, powerful wind speeds, tornado scares, dark funnel clouds, lightning-filled skies, torrential rains, and flash flooding. The city lived up to its reputation as the hailstorm capital of Canada. The Insurance Bureau of Canada sees hail as such a threat in the city that it sponsors a cloud-seeding program in order to diminish the size of urban hailstones – a pea-size stone does much less damage than ones the size of tennis balls. The June 13 hailstorm was Canada's costliest and the fourth most expensive insured natural disaster in history with Canadian insurers estimating the dollar value of the 63,000 claims (minus crop losses) at about $1.3 billion. More than 32,000 vehicles were extensively damaged with cracked and smashed windshields with vehicle write-offs totalling $386 million.

As was frequently the case this summer, on June 13 warm, humid air was positioned over Alberta generating multiple rounds of severe thunderstorm cells. With colliding winds at various heights over southern Alberta, the resulting wind shearing kept the large, long-lived thunderstorms going. Around 7 p.m. MDT, a hail core scraped over northeastern Calgary, visibility dropped to half a kilometre, and temperatures fell 5 degrees in less than six minutes. Hail the size of tennis balls and golf-balls ricocheted out of the sky propelled by wind speeds up to 70 km/h. Pounding hail shook houses, broke windows and downed trees. Crashing hail dimpled vehicles and riddled house siding with millions of dents. The violent hailstorm smashed skylights, flattened flowerbeds and turned backyard vegetable gardens into coleslaw. Streets and intersections were flooded, and manhole covers were lifted. In its wake, slushy hail drifts 10 cm deep piled up along highways, and were still evident the next day. Power outages knocked out service to more than 10,000 customers. Train and bus services were suspended due to flooding. Outside the city, the massive hailstorm decimated hundreds of thousands of hectares of young wheat, canola and barley.

Regional weather highlights and runner-up events in 2020

National

- Another "not-cold" year in Canada – 24 in a row
- Quiet Canadian wildfire season
- Arctic Ocean – more water than ice
- Canadian ice shelves melting away

Atlantic Canada

- Rough landing in snowy Halifax
- Winter's first big storm slams Eastern Newfoundland
- Record January snowfall in Sydney
- Newfoundland's stormy February
- Powerful storm brings down a dome in Cape Breton
- Blustery winds punish Maritimes at end of February
- Easter Friday weather bomb
- Flooding again on the Saint John River?

- Foul weather on Mother's Day
- Microburst and century flooding strikes Fredericton
- Spring-summer dryness in the Maritimes
- Big snow in "Big Land"

Québec

- Winter's first storm with all kinds of precipitation
- Snow to celebrate
- February snows gridlock Québecers
- Late February storm and surge at Québec City and eastward
- Late winter flood threat
- Easter weekend features snow, surges and coastal flooding
- Wildfires out of control in the Saguenay
- Microbursts and Québec's first tornado
- Flooding rains and hail inflict major losses
- More tornadoes and flooding in July
- Pre-Thanksgiving hail and wind costs millions

Ontario

- January's weekend storms – three in a row
- Rideau Skateway's 50th season – never fully opens
- Texas storm turns on lake-effect snow engine
- Heavy rains and wind-driven flooding around Victoria Day
- Summer's first heat wave fuels severe thunderstorms
- More tornadoes in Ontario. Perhaps?
- Flash flooding in Toronto's west end closes beaches
- Ontario wildfires confined to Red Lake region
- Dry land farming
- Record number of waterspouts on the Great Lakes
- Three-day rain event across Ontario
- Another year of high Great Lakes water levels
- Summer's last hurrah with storm in October
- Witches of November storm

Prairie Provinces

- Brutal cold, even for the Prairies
- Widespread June wind-hail-rain in Saskatchewan
- West Manitoba June Deluges
- Tornado day in Saskatchewan
- Northern Saskatchewan too wet for grain and rice producers
- Thought to be tornadic, straight-line winds strike Manitoba
- Edmonton rainstorm floods hockey venue
- Calgary's other hailstorm

- Finally, summer heat in the Western Prairies
- Big trough country
- “Great” harvest with some exceptions
- Pre-winter weather chills the second half of October
- Weather dome over the west

British Columbia

- BC’s atmospheric river
- Toughest part of winter in mid-January
- Soggy storm raises water flows and levels
- Vancouver’s big wet and long dry
- May heat not a trend
- Rare Vancouver Island tornado
- Finally, heat returns to the southwest
- Wettest Canadian city becomes soggier
- Quiet wildfire season
- Freshet flooding from spring through fall
- Early winter outbreak
- BC’s “king tide” storm

North

- Yukon cold
- Tuktoyaktuk winds
- Flood concerns in downtown Dawson
- Arctic heat waves
- July showers in Iqaluit
- Wet summer in Yellowknife
- Whitehorse’s record snow and cold

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Les dix événements météorologiques les plus marquants au Canada en 2020

WRITTEN BY CMOS BULLETIN SCMO ON FEBRUARY 26, 2021. POSTED IN ATMOSPHÈRE, CLIMAT, MÉTÉO, QUOI DE NEUF.

– Par David Phillips –

Cet article a été publié pour la première fois par Environnement et Changement climatique Canada.

Introduction

L'année 2020 en aura été une sous le signe de l'instabilité, alors que le monde a fait face à la plus grande crise de santé publique depuis plus d'un siècle. La pandémie de COVID-19 a certainement fait les manchettes, avec les décès, les dommages économiques et les troubles sociaux ressentis par les milliards de personnes dans le monde. Parfois, la mise en quarantaine et la distanciation sociale ont été plus difficiles en raison des conditions météo. Vers la fin de l'année, au milieu d'une deuxième et d'une troisième vague, les statistiques sur la morbidité liée au virus étaient effrayantes et la fatigue liée à la pandémie a pris le dessus. Cependant, on a espoir que des vaccins efficaces permettront de faire disparaître rapidement cette grave menace. Il n'existe toutefois aucun vaccin contre les phénomènes météorologiques extrêmes, et tout repose sur la planification durable, la préparation et l'intervention rapide.

Partout au Canada, 2020 a été une autre année de conditions météorologiques extrêmes, destructrices et coûteuses. Les dommages matériels causés par la météo coûtent des millions de dollars aux Canadiens, et des milliards de dollars à l'économie. D'après les estimations préliminaires compilées par Catastrophe Indices and Quantification Inc. (CatIQ), il y a eu neuf événements météorologiques catastrophiques majeurs cette année, avec des estimations des pertes assurées totales approchant les 2,5 milliards de dollars. Mais cela ne représente qu'une fraction des pertes matérielles et des coûts d'infrastructure attribuables à des phénomènes météorologiques majeurs et nuisibles qui ont coûté des milliards de dollars de plus.

Il est rare que Calgary ne figure pas sur la liste des dix événements météorologiques les plus marquants, et cette année ne fait pas exception. Une tempête de grêle qui a frappé la ville le 13 juin a causé pour un milliard de dollars de dommages, la plaçant ainsi en première position. L'Alberta a enregistré deux des trois événements *météorologiques les plus marquants de l'année, avec une deuxième catastrophe météorologique à Fort McMurray, où des rivières engorgées par la glace ont inondé le centre-ville à la fin d'avril. Fait préoccupant, six des dix catastrophes météorologiques les plus coûteuses au Canada se sont produites en Alberta. Les feux de forêt dans l'ensemble du Canada, en particulier en Colombie-Britannique, ont été presque à leur plus bas niveau en termes de superficie brûlée. Cependant, les feux de forêt causés par le climat en Californie et dans le nord-ouest des États-Unis ont propagé de la fumée vers le nord jusqu'en Colombie-Britannique et en Alberta, forçant des millions de personnes à respirer de l'air sale et vicié pendant près de deux semaines en septembre. Les eaux chaudes de l'océan Atlantique, de la mer des Caraïbes et du golfe du Mexique, combinées à une circulation atmosphérique favorable, ont mené à un nombre record de tempêtes nommées (30) dans l'Atlantique Nord. Au Canada, huit tempêtes ont pénétré dans nos eaux, mais les tempêtes meurtrières et dévastatrices du Sud nous ont en grande partie épargnés. Teddy a été la tempête tropicale la plus puissante à toucher le Canada, mais ce n'était ni Dorian ni Juan.*

Un dénombrement exact des tornades n'est jamais possible, mais nous nous améliorons au Canada grâce à un suivi et à une surveillance élargis. À l'échelle nationale, 77 tornades ont été enregistrées, dont un possible record de 42 en Ontario. La tornade la plus puissante au Canada s'est toutefois produite à Scarth, au Manitoba, le 7 août. Le printemps a été en grande partie absent dans certaines régions du sud du Canada, mais lorsque l'été est arrivé, il s'est prolongé en force de la longue fin de semaine de mai jusqu'à la fête du Travail. Dans l'est du Canada, la saison s'est avérée être entre le quatrième et le septième été le plus chaud en 73 ans, s'inscrivant dans une vague de chaleur mondiale qui s'étendait de la Sibérie en Russie à la vallée de la Mort aux États-Unis. L'été n'avait pas dit son dernier mot dans l'Est en septembre. En novembre, un long et chaud interlude a duré plus d'une semaine, au cours de laquelle des centaines de records de températures élevées ont été battus et souvent fracassés. Parallèlement, un hiver précoce avec des températures froides et de la neige prévalait dans l'ouest du Canada et dans le Nord. À Terre-Neuve-et-Labrador, l'année a été marquée par une avalanche de neige, avec des chutes record, en janvier à St. John's et en novembre à Happy Valley-Goose Bay. À St. John's, le 17 janvier, une tempête monstre a incité les responsables à faire appel aux Forces armées canadiennes. À mi-chemin de l'été, en août, les tempêtes ont assombri la longue fin de semaine du Congé civique, tant à l'est qu'à l'ouest, lorsque de puissantes cellules orageuses ont causé d'importants dommages matériels et des pannes d'électricité, coûtant plus de 50 millions de dollars aux assureurs en Alberta seulement.

Les dix événements météo les plus marquants au Canada en 2020 ont été choisis parmi une liste de 100 événements météorologiques importants et classés en fonction de divers facteurs, notamment leurs répercussions sur le Canada et sa population, l'ampleur de la zone touchée, leurs effets économiques et environnementaux, ainsi que leur durée.

2021 CMOS Tour Speaker: Dr. Katja Fennel

WRITTEN BY CMOS BULLETIN SCMO ON FEBRUARY 10, 2021. POSTED IN NEWS & EVENTS, OCEANS.

Scientific lecture registration info: CMOS Virtual Tour Speaker – February 24, 2021 – Scientific Lecture @ 2:00pm ET

Q & A session registration info: CMOS Virtual Tour Speaker – March 3, 2021 – Q & A Session @ 2:00pm ET

Abstract:

With respect to ocean observation, the 20th century has been described as a century of undersampling. This is especially true for biogeochemical properties and has hampered biogeochemical modelling, a core component of climate projections and assessments of marine ecosystem health. The rapid development of autonomous sampling platforms and biogeochemical sensors over the past two decades, many of them now mature for long-term unattended deployment in the ocean, has ushered in a new era by enabling sustained and cost-effective observation of critically important ocean biogeochemical properties. This presentation will focus specifically on the Biogeochemical (BGC) Argo initiative, an extension of the successful and highly regarded Argo program. Argo relies

on about 2,000 profiling floats drifting freely throughout the global ocean that measures temperature and salinity in the upper 2,000 m of the water column in regular intervals and transmits the resulting observations via satellite in real-time. Exemplary international coordination, quality control and data management and the free availability of the resulting data are hallmarks of the Argo program and have undoubtedly contributed to its success. The BGC Argo extension foresees the addition of 6 biogeochemical sensors measuring oxygen, nitrate, pH, suspended particles, chlorophyll, and light on 1,000 floats with roughly even global distribution. This will allow the oceanographic community to address pressing questions about changes in ocean productivity, carbon update and sequestration, acidification, and deoxygenation and will enable rigorous testing and further evolution of predictive models of ocean biogeochemistry and ecosystem health. By presenting an update on international developments and Canadian contributions to the program, this presentation is first and foremost an invitation to participate and utilize the new observations and resulting products.

Speaker:


Dr. Katja Fennel

Dr. Katja Fennel is Killam Professor in the Department of Oceanography at Dalhousie University. As head of the Marine Environmental Modeling Group, she leads the development of marine ecosystem and biogeochemical models at Dalhousie. In addition to implementing biogeochemical models, Dr. Fennel has developed and applied methods for the assimilation of observations into these models in order to improve their predictive capabilities. She serves her community in various roles including as chair of the Canadian BGC Argo committee, co-chair of the Marine Ecosystem Analysis and Prediction Task Team of OceanPredict, chair of the EGU publications committee, co-editor-in-chief of the journal Biogeosciences and member of several international science advisory bodies including the science team of OceanPredict, the science advisory board of the European Marine Environment Monitoring Service Copernicus, and the Biogeochemical Argo Steering Group.

La Conférencière Itinérante de la SCMO – 2021 – Katja Fennel, PhD

WRITTEN BY CMOS BULLETIN SCMO ON FEBRUARY 26, 2021. POSTED IN NOUVELLES ET ÉVÉNEMENTS, OCÉANS.

Sujet de la présentation (en anglais seulement): Autonomous observing technology ushering in a new era in biogeochemical ocean observation and prediction

Enregistrement de conférence scientifique:: La conférence scientifique – 24 février 2021 @ 2:00pm ET

Pour participer à la session de questions-réponses, veuillez vous inscrire ici: La session de questions-réponses – 3 mars 2021 à 14h (heure normale de l'est) @ 2:00pm ET

Résumé :

En ce qui concerne l'observation des océans, le XXe siècle est décrit comme un siècle de sous-échantillonnage. Cela est particulièrement vrai pour les propriétés biogéochimiques, et la modélisation biogéochimique – un élément essentiel des projections climatiques et des évaluations de la santé des écosystèmes marins – s'en est vue entravée. L'installation rapide de plateformes d'échantillonnage autonomes et de capteurs biogéochimiques au cours des vingt dernières années, dont beaucoup sont maintenant prêts à être déployés à long terme dans l'océan sans surveillance, a ouvert une nouvelle ère en permettant l'observation durable et rentable des propriétés biogéochimiques océaniques de grande importance. Cette présentation portera plus particulièrement sur l'initiative Argo biogéochimie (BGC), une extension du programme Argo, qui a connu un grand succès et est très apprécié. Argo s'appuie sur environ 2 000 flotteurs profilant dérivant librement dans l'océan mondial qui mesurent à intervalles réguliers la température et la salinité dans les 2 000 premiers mètres de la colonne d'eau et transmettent les observations obtenues par satellite en temps réel. Une coordination internationale exemplaire, le contrôle de la qualité et la gestion des données ainsi que l'accès libre aux données obtenues sont des éléments de marque du programme Argo qui ont sans aucun doute contribué à son succès. Pour l'extension d'Argo BGC, on prévoit l'ajout de six capteurs biogéochimiques mesurant l'oxygène, le nitrate, le pH, les particules en suspension, la chlorophylle et la lumière sur 1 000 flotteurs avec une distribution mondiale à peu près égale. Cela permettra au milieu océanographique de répondre aux questions urgentes concernant les changements de la productivité des océans, la mise à jour et la séquestration du carbone, l'acidification et la désoxygénation et permettra de tester rigoureusement et de faire évoluer les modèles de prévision de la biogéochimie des océans et de la santé des écosystèmes.

En présentant une mise à jour sur les développements internationaux et les contributions canadiennes au programme, cet exposé est d’abord et avant tout une invitation à participer et à utiliser les nouvelles observations et les produits qui en découlent.

Conférencière:


Dr. Katja Fennel

Katja Fennel est professeur Killam au département d’océanographie de l’Université Dalhousie. En tant que responsable du groupe de modélisation de l’environnement marin, elle dirige le développement de modèles d’écosystèmes marins et de modèles biogéochimiques à Dalhousie. En plus de mettre en place des modèles biogéochimiques, Mme Fennel a développé et appliqué des méthodes d’assimilation des observations dans ces modèles afin d’améliorer leurs capacités prédictives. Elle sert sa communauté dans divers rôles, notamment en tant que présidente du comité Canadian BGC Argo, co-présidente de l’équipe spéciale d’analyse et de prévision des écosystèmes marins d’OceanPredict, présidente du comité des publications de l’European Geoscience Union, co-rédactrice en chef de la revue Biogeosciences et membre de plusieurs organes consultatifs scientifiques internationaux, dont l’équipe scientifique d’OceanPredict, le conseil consultatif scientifique du service européen de surveillance du milieu marin Copernicus et le groupe directeur Argo biogéochimie.

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Feather Frost or Frost Flowers (Crystallofolia)

WRITTEN BY CMOS BULLETIN SCMO ON FEBRUARY 26, 2021. POSTED IN ATMOSPHERE, WEATHER, WHAT'S CURRENT.

– By Douw Steyn, Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia, Vancouver, BC. –

The attached photographs show an instance of the rare phenomenon of feather frost on a stick. There were instances of this kind of frost all over the forest floor, but only on sticks, logs and stumps, and apparently none on still-living plants.

Figure 1: Feather frost attached to a stick found on the forest floor

I found the frost at 0900 PST on February 9th, 2021 on the forest floor around Fisherman's Trail near the base of Capilano Canyon in North Vancouver at about 75 m ASL. The canyon floor around the trail is in a second-growth mixed coniferous forest (mainly Western Red Cedar, Douglas Fir and Western Hemlock). The temperature on the trail was slightly below freezing. Weather data from the nearby Vancouver International Airport (at 4 m ASL) shows a mostly clear preceding night with temperatures dipping to -8 C, and relative humidity of 55%, indicative of advancing modified arctic air.

Conventional interpretations are that this kind of frost arises from the sap being extruded by swelling near freezing through cracks in the plant. Thus producing sheets of fragile frost which grow through freezing at their base. On that morning, all observed instances of feather frost were on dead plants, mostly twigs and small branches and in some instances, dead but standing stumps. As can be seen from the photographs, the frost was formed in filaments, rather than sheets.


Figure 2: Fragments of feather frost dislodged from the stick in Figure 1 by a gentle shake.

My interpretation is that this particular instance of feather frost was a result of moisture forming the filaments coming from whatever water was in the first few mm of wood, and not from sap. The frost occurred on dead sticks that were generally damp from the previous week's rain. The example shown in Figure 1 was a clearly dead stick found lying on the forest floor. The filaments thus grow outwards from the bottom, unlike other forms of frost that grow from atmospheric moisture and accrete on the tips of dendritic crystals. The relatively low humidity and absence of wind mitigated against frost forming at the ice/air interface.

The frost filaments were extremely fragile. A gentle shake of the stick resulted in clumps filaments dislodging (shown in Figure 2), and drifting lightly to the ground, much like feathers. For this reason, I rather like the term, Feather Frost.

Regular frost needs: sub-zero temperatures; high atmospheric moisture, cooling (to remove latent heat of freezing); light wind to bring in more moisture.

Feather frost needs: sub-zero temperatures; low atmospheric moisture, cooling (to remove latent heat of freezing); no wind (because the filaments are so fragile); a moist, porous substrate.

Amundsen Science Outreach Workshop

WRITTEN BY CMOS BULLETIN SCMO ON MARCH 4, 2021. POSTED IN ARCTIC, NEWS & EVENTS, OCEANS.

Workshop registration info: Amundsen Science Outreach Workshop – March 23, 2021 @ 1:00pm EDT

Amundsen Science is the organization responsible for the management of the scientific mandate of the research icebreaker CCGS Amundsen. In the goal of opening a conversation about the future of the research vessel and democratizing its access, Amundsen Science is hosting an Outreach Workshop on 23 March 2021, at 1:00 PM EDT.

During this online event, the history of the CCGS Amundsen and its role as a National Research Facility will be presented. More precisely, guest speakers will introduce the influence of the Amundsen on Canadian Arctic research, the development of best practices and some example of successful field programs. Moreover, we will pay a tribute to Professor Louis Fortier, the founder of Amundsen Science. Finally, a discussion on the next funding cycle (2023-2029) and the successor to the Amundsen will follow.

Hosted at Université Laval, Amundsen Science manages the vessel's pool of scientific equipment, coordinates the deployment of the icebreaker for science, and provides logistical, financial and technical support to user programs.

Mobilized for science since 2002, the research icebreaker CCGS Amundsen accommodates hundreds of researchers, experts, and students every year participating in innovative and multidisciplinary programs addressing some of the most pressing challenges the Arctic Seas are facing.

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Plumes ou fleurs de gelée blanche (Crystallofolia)

WRITTEN BY CMOS BULLETIN SCMO ON MARCH 5, 2021. POSTED IN ATMOSPHÈRE, MÉTÉO, QUOI DE NEUF.

– Par Douw Steyn, Département des sciences de la Terre, de la mer et de l'atmosphère, Université de la Colombie-Britannique, Vancouver (C.-B.) BC. –

Les photos ci-jointes montrent un exemple du rare phénomène de plumes de gelée blanche sur un bâton. Ce jour-là, le sol de la forêt en était couvert, mais seulement sur les bâtons, les rondins et les souches, et apparemment pas sur les plantes encore en croissance.

Selon les interprétations classiques, ce type de gel est dû au fait que la sève est excrétée par gonflement près du gel à travers les fissures de la plante. Il en résulte des feuilles de gelée fragile qui se développent par le gel à la base. Ce matin-là, toutes les plumes de gelée blanche observées se trouvaient sur des plantes mortes, principalement des brindilles et des petites branches et, dans certains cas, des souches mortes mais debout. Comme on peut le voir sur les photos, le givre s'est formé en filaments, plutôt qu'en feuilles.

Mon interprétation est que ce cas particulier de plumes de gelée blanche provient de l'eau contenue dans les premiers millimètres de bois, et non de la sève. Le givre s'est formé sur des bâtons morts qui sont généralement humides à cause de la pluie de la semaine précédente. L'exemple montré dans la figure 1 est un bâton manifestement mort trouvé sur le sol de la forêt. Les filaments se développent donc vers l'extérieur à partir du bas, contrairement à d'autres formes de gel qui se développent à partir de l'humidité atmosphérique et s'accumulent sur les extrémités des cristaux dendritiques. L'humidité relativement faible et l'absence de vent ont atténué la formation de givre à l'interface glace-air.

Les filaments de givre étaient extrêmement fragiles. Une légère secousse du bâton a permis de déloger les filaments en touffes (voir la figure 2) et de les faire flotter légèrement vers le sol, un peu comme des plumes. C'est pourquoi j'aime bien le terme « plume de gelée blanche ».

***Conditions requises à la formation de givre normal :** températures inférieures à zéro; forte humidité atmosphérique, refroidissement (pour éliminer la chaleur latente du gel); vent léger pour apporter plus d'humidité.*

***Conditions requises à la formation de plumes de gelée blanche :** températures inférieures à zéro; faible humidité atmosphérique, refroidissement (pour éliminer la* *chaleur latente du gel); vent nul (parce que les filaments sont si fragiles); substrat humide et poreux.*

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The 55th CMOS Congress Update: Online from Victoria, BC

WRITTEN BY CMOS BULLETIN SCMO ON MARCH 5, 2021. POSTED IN MEMBERS, NEWS & EVENTS, OTHER.

Climate Change Risk Resilience Response, 31 May – 11 June

Congress 2021 will be presented online from May 31 to June 11, 2021. To facilitate sharing "live" presentations across the five time zones within Canada, the core scientific program activities will be provided from 11:30 AM to 4:00 PM Eastern Time (8:30 AM to 1:00 PM Pacific Time) each day. A Welcome Session for each day will start at 11:00 AM and on some days special events, involving networking and social interactions will continue until 6:00 PM Eastern Time.

Response to The Call for Scientific Papers, which has just closed, resulted in a very large response of nearly 440 abstracts. This response represents the largest number of papers received for a CMOS Congress over the past several years. A detailed Scientific Program is now being prepared by Ken Denman, Scientific Program Chair, which will be posted within the next few weeks. The program will feature over 75 individual scientific sessions for Oral Papers, with five papers to be presented within 90 minute time slots along with time for questions and answers. Up to four scientific sessions will be presented concurrently in each time slot, with two such time slots each day over the 10 weekdays from May 31 to June 11, 2021. About 100 poster papers will also be presented, which will be all be available online at the start of the Congress, and brief oral presentations will be made, in two 90 minute time slots on May 31 and June 2 along with time for questions and answers to the presenters.

Congress 2021 will feature eight **Plenary Speakers (May 31-June 3; June 7-10):**

- Andrew Weaver, Professor, U. Victoria and Former Leader of the BC Green Party, "Title TBA".
- Mark Jaccard, Professor, Simon Fraser University, "Economics of addressing climate change"
- Diane Campbell, Assistant Deputy Minister, Meteorological Service of Canada (MSC), ECCC, "Weather Services in Canada: our history, our future"

- Lisa Loseto, Research Scientist, Arctic Aquatic Research Division, DFO, “What can we learn about changing oceans and adaptation through the lense of Beluga whales”.
- Shawn Marshall, Professor, U. Calgary, and Science Advisor to ECCC, “Title TBA”.
- Paul Snelgrove, Professor, Memorial University, Science Advisor to DFO, “Title TBA”.
- Johanna Wagstaffe, CBC Meteorologist, Vancouver, “Title TBA”.
- Erin Bertrand, Associate Professor, Dalhousie University, “Title TBA”.

The titles and abstracts for each plenary talk will be announced soon.

The **Public Speaker Lecture** will be presented on Wed., June 2 by Gavin Schmidt, Director of NASA’s Goddard Institute for Space Studies in New York, and recently appointed as the NASA Senior Climate Advisor to the White House. Dr. Schmidt will speak on “Can climate modeling keep up with climate change?”

Congress 2021 will celebrate **150 Years of Weather Services in Canada** through Symposium events being organized by MSC/ECCC with the Congress,

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50e anniversaire d'Environnement et Changement climatique Canada
Environment and Climate Change Canada's 50th anniversary
150e anniversaire du Service météorologique du Canada
Meteorological Service of Canada's 150th anniversary

Congress 2021 is presently signing up **Sponsors and Exhibitors** as part of our event. These organizations will be active participants in the Congress with messaging and interactive tools to interact with participants. To learn more about these opportunities, please contact Mr. Oscar Koren (okoren@sympatico.ca) to join our growing list of exhibitors and sponsors. “Early Bird” discounts apply until March 15, 2021.

An active program of **social and networking events** will be part of Congress 2021. The events will include Student Activities, an Awards Ceremony, social networking activities during breaks in the Congress, supported by messaging and interactive tools provided for all participants.

Registration for Congress 2021 will open on-line in mid-March. The low registration fees provide great value to all participants:

(all prices in Cdn. Dollars)	Full Conference	
	"Early Bird" Rate (before May 11, 2021)	Regular Rate
A. CMOS Members		
Full Registration	125	200
Student/Retiree	62.50	100
B. Non-CMOS Members		
Full Registration	225	300
Student/Retiree	135	200
C. ECCC Employees	Free through a Congress 2021 ECCC Corporate Registration with CMOS	

For More Information, please contact:

David Fissel, Local Arrangements Committee Chair (dfissel@aslenv.com)
Matthew Asplin, Local Arrangements Committee Vice-Chair (masplin@aslenv.com)
Ken Denman, Scientific Programme Committee Chair (denmank@uvic.ca)

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Mise à jour : Le 55e Congrès de la SCMO, En ligne depuis Victoria, C-B

WRITTEN BY CMOS BULLETIN SCMO ON MARCH 5, 2021. POSTED IN NOUVELLES ET ÉVÉNEMENTS.

Changement climatique Risque Résilience Réponse, Du 31 mai au 11 juin

Le Congrès sera présenté en ligne du 31 mai au 11 juin 2021. Pour faciliter l'échange de présentations « en direct » dans les cinq fuseaux horaires du Canada, les principales activités du programme scientifique seront fournies chaque jour de 11 h 30 à 16 h, heure de l'Est (8 h 30 à 13 h, heure du Pacifique). Une séance d'accueil pour chaque journée commencera à 11 h. Certains jours, des activités spéciales, y compris du réseautage et des interactions sociales, se poursuivront jusqu'à 18 h, heure de l'Est

La réponse à **la demande d'articles scientifiques**, qui vient tout juste de prendre fin, a donné lieu à un taux de réponse très élevé, soit près de 440 résumés. Cette réponse représente le plus grand nombre d'articles reçu pour un Congrès de la SCMO au cours des dernières années. Un programme scientifique détaillé est maintenant en train d'être préparé par Ken Denman, président du programme scientifique, et sera publié dans les prochaines semaines. Le programme comportera plus de 75 séances scientifiques individuelles pour les articles présentés de vive voix, dont cinq articles seront présentés dans des créneaux de 90 minutes et seront suivis d'une période de questions et réponses. Jusqu'à quatre séances scientifiques seront présentées simultanément dans chaque créneau, soit deux par jour au cours des 10 jours de semaine allant du 31 mai au 11 juin 2021. Une centaine d'articles sous forme d'affiches seront aussi présentés, lesquels seront accessibles en ligne au début du Congrès, et de courtes présentations orales seront effectuées dans le cadre de deux créneaux de 90 minutes le 31 mai et le 2 juin comprenant une période de questions et réponses aux présentateurs.

Le Congrès 2021 comprendra huit conférenciers de séance plénière (31 mai-3 juin; 7 au 10 juin):

- Andrew Weaver, professeur, Université de Victoria et ex-chef du parti vert de la Colombie-Britannique, « titre à annoncer ».
- Mark Jaccard, professeur, Université Simon Fraser, « Aspects économiques de la lutte contre les changements climatiques ».

- Diane Campbell, sous-ministre adjointe, Service météorologique du Canada (SMC), ECCC, « Services météorologiques au Canada : notre histoire, notre avenir ».
- Lisa Loseto, chercheuse scientifique, Division de la recherche sur l'Arctique de POC, « Leçons à retenir du changement des océans et de l'adaptation dans l'optique des bélugas ».
- Shawn Marshall, professeur, Université de Calgary, et conseiller scientifique à ECCC, « titre à annoncer ».
- Paul Snelgrove, professeur, Université Memorial, conseiller scientifique à POC, « titre à annoncer ».
- Johanna Wagstaffe, météorologue à CBC, Vancouver, « titre à annoncer ».
- • Erin Bertrand, professeur agrégé, Université Dalhousie, « titre à annoncer ».

Les titres et résumés de chaque séance plénière seront annoncés sous peu.

La **conférence de l'orateur** sera présentée le mercredi 2 juin par Gavin Schmidt, directeur du Goddard Institute for Space Studies de la NASA à New York, nommé récemment au poste de conseiller climatique principal de la NASA auprès de la Maison-Blanche. L'allocution de M. Schmidt sera « La modélisation climatique peut-elle suivre le rythme du changement climatique? ».

Le Congrès 2021 célébrera **150 années de services météorologiques au Canada** au moyen d'activités du symposium organisées par le SMC/ECCC dans le cadre du Congrès,

150 50
1871 | 2021
1971 | 2021
50e anniversaire d'Environnement et Changement climatique Canada
Environment and Climate Change Canada's 50th anniversary
150e anniversaire du Service météorologique du Canada
Meteorological Service of Canada's 150th anniversary

Le Congrès 2021 procède actuellement à l'inscription des **commanditaires et des exposés** dans le cadre de notre événement. Ces organismes seront des participants actifs du Congrès et proposeront des messages et des outils interactifs afin d'interagir avec les participants. Pour en savoir plus sur ces possibilités, veuillez communiquer avec M. Oscar Koren (okoren@sympatico.ca) pour joindre notre liste croissante d'exposants et de commanditaires. Des rabais pour inscription hâtive s'appliqueront jusqu'au 15 mars 2021.

Un programme actif **d'activités sociales et de réseautage** fera partie du Congrès 2021. Les événements comprendront des activités d'étudiants, une cérémonie de remise de prix, des activités de réseautage social durant les pauses du Congrès, appuyés par des messages et des outils interactifs fournis pour tous les participants.

L'inscription au Congrès 2021 débutera en ligne à la mi-mars Les frais d'inscription peu élevés offrent une excellente valeur à tous les participants.

(Tous les prix sont en dollars canadiens)	Conférence complète	
	Prix pour inscription hâtive (avant le 11 mai 2021)	Prix régulier
A. Membres de la SCMO		
Inscription complète	125 $	200 $
Étudiant/Retraité	62,50 $	100 $
B. Non-membres de la SCMO		
Inscription complete	225 $	300 $
Étudiant/Retraité	135 $	200 $
C. Employés d'ECCC	Gratuit par l'entremise du Congrès 2021 inscription organisationnelle d'ECCC avec la SCMO	

Pour de plus amples renseignements, veuillez communiquer avec :

David Fissel, président du comité local d'organisation (dfissel@aslenv.com)
Matthew Asplin, vice-président du comité local d'organisation (masplin@aslenv.com)
Ken Denman, président du comité du programme scientifique (denmank@uvic.ca)

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Changing CMOS Congresses

WRITTEN BY CMOS BULLETIN SCMO ON MARCH 12, 2021. POSTED IN AVIATION, CLIMATE, MEMBERS, OTHER, WHAT'S CURRENT.

– By David Fissel, David Collins, Matthew Asplin (Members, CMOS Congress 2021 Local Arrangements Committee) and Bob Jones (CMOS Archivist)–

Introduction

As the plans for the 55th CMOS Congress 2021 are being finalized, the changing approach to CMOS Congresses over the recent past is described. The changes for Congress 2020 and Congress 2021 were driven by the COVID-19 pandemic, but there are other factors that will continue to be important for future Congresses long after the pandemic fades into history.

CMOS Congresses, 1967 – 2019

Starting in 1967, the first Congress was held at Carleton University in Ottawa, with about 110 delegates attending. Over the subsequent years, the Congresses changed and evolved with the venues shifting from university campuses to hotel- or community-based conference facilities, the numbers of delegates increasing to about 700 or more in the year's after 2000, and some Congresses held jointly with other scientific societies. "The joint CGU / CMOS Ottawa Congress in 2010 attracted 1000 delegates. In the past two decades, these larger congresses are now the principal source of revenue for the Society, eclipsing membership fees, costs of publications and other revenue sources." (see CMOS History for more information).

After 2010, the number of Congress delegates underwent a slow decline, due in part to restrictions on government scientists for participating in scientific meetings. In 2017, the 51st CMOS Congress was held in Toronto ON (see the photo of delegates in Figure 1). In 2018, the 52nd CMOS Congress was held in Halifax NS, which attracted a total of approximately 660 participants, including 452 paid delegates. In 2019, the CMOS Congress as part of the International Union of Geodesy and Geophysics (IUGG) General Assembly held in Montreal PQ.

Figure 1: A group photograph of some of the approximately 450 delegates to the 51st CMOS Congress in 2017 in Toronto ON

By late winter 2020, the plans for Congress 2020 to be held at the Delta Hotel in Ottawa ON were well advanced, ahead of the scheduled May 24-28, 2020 Congress dates. However, public health restrictions started in mid-March 2020 in response to the COVID-19 pandemic forced the suspension of delegate registrations on March 22, and the cancellation of the in-person Congress on April 3. All abstract fees and any registrations received to date were refunded at this time.

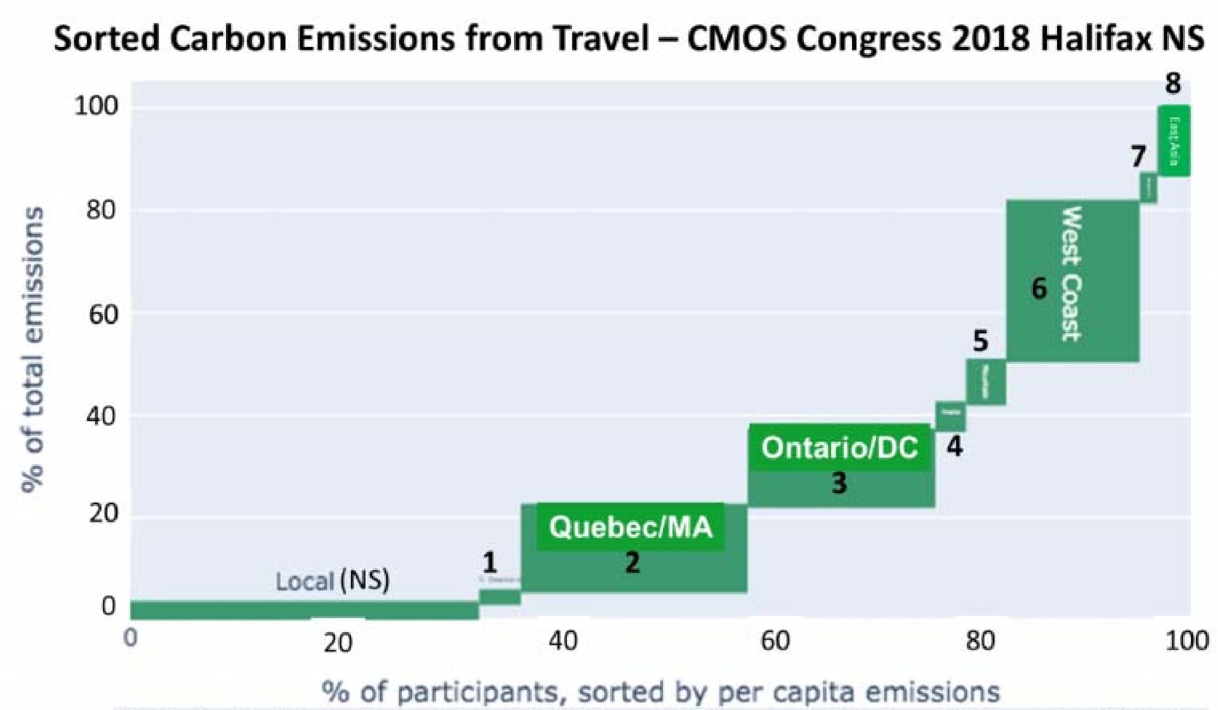
From April into early May, the Scientific Program Committee (SPC) led by Gordon McBean and Len Barrie, along with some key members of the LAC, prepare a new plan for a Virtual Congress 2020. By mid-May, the plans for an Alternate Congress 2020, conducted entirely online, were announced and registrations were open to participants. This virtual Congress was conducted over 11 days from May 26 through to June 15, with a total of 16 different scientific sessions presenting oral scientific talks in 31 ninety-minute time slots using two Zoom Meeting licenses. A total of about 160 scientific papers were presented, which represents about one-half of the number of scientific papers at previous Congresses. The CMOS Awards Ceremony and CMOS Annual General meeting, as well as some other CMOS business and Special Interest Group meetings, were also held online during this time frame. A two hour long CMOS Public Virtual Forum/Panel Discussion on “Coping with Extreme Weather” was presented online on Oct. 8, 2020.
Overall, Congress 2020 was very successful with over 900 people registering for this free Congress. The attendance for each individual scientific session was in the range of 70-160 participants.

Virtual CMOS Congress 2021

Planning for the 55th CMOS Congress 2021 in Victoria BC began in 2018, and the plans for a normal in-person Congress were well advanced by the time of the onset of the pandemic in March 2020. However, as the pandemic situation evolved, the plans for Congress 2021 were re-evaluated and by July 2020, it became clear that the only Congress option that could be planned with any level of certainty was a virtual Congress.

In January 2020, well before the pandemic started, one of the aspirations in planning Congress 2021 was to find ways to reduce the environmental impact of the CMOS Congress. Some analysis was carried out on the largest environmental issue associated with a scientific conference, carbon emissions into the atmosphere, resulting from greenhouse gasses due to delegates travelling to and from the conference.

An analysis of the estimated carbon released, from CO2 emissions only, due to travel for the 2018 CMOS Congress in Halifax is shown in Figure 2. Approximately two-thirds of the 660 participants travelled by air from outside of the host province, including 273 from the rest of Eastern Canada, 119 from Western Canada, 17 from the United States and 33 from overseas. The total carbon emissions, resulting from travel (aeroplane and automobile) is estimated at 230 tonnes. Only 3% of the emissions originated with participants in the host province where travel was only by ground, while the remaining 97% originated from participants, travelling by air, from outside of the host province. A large majority of the participants (76%), who originated in Eastern Canada and the northeast U.S., accounted for only 37% of the carbon emissions, while the remaining 24% of the participants who travelled greater distances, within North America and from overseas, accounted for 63% of the carbon emissions (Figure 2). A similar pattern is seen in the analysis of carbon emissions from a major scientific conference, the 2019 American Geophysical Union (AGU) Fall Meeting who also estimated that the carbon emissions from a fully virtual conference are only about 0.1% of the travel emissions of the in-person AGU conference.



(1) E. Seaboard	(2) Quebec/MA	(3) Ontario/DC	(4) Prairie/AL	(5) Mountain	(6) West Coast	(7) Europe / S. A.	(8) East Asia
Fredericton	Rimouski	Ottawa	Alabama (AL)	Edmonton	Prince George	France	China
Charlottetown	Quebec City	Toronto	Winnipeg	Calgary	Vancouver	Netherlands	Japan
St. John's	Massachusetts	Wash. DC	Nebraska		Victoria	Denmark	
	Montreal	Waterloo	Saskatoon		California	Brazil	
		London			Washington		

Figure 2: A chart of the percentage of CO_2 emissions by originating locations in comparison to the cumulative number of participants, for the CMOS Congress 2018 in Halifax NS. The table below the chart lists the originating locations for air travel to Congress. Of the 660 participants, including paid delegates, complimentary registrations and those on family passes, there were 609 from Canada, 17 from the United States and 33 from overseas (23 from East Asia, 9 from Europe and 2 from South America). CO_2 emissions from air travel were computed using data on specific flight routes obtained from the International Civil Aviation Organization (ICAO) database.

Based on the analysis of carbon emissions arising from the 2018 Congress, ways of reducing the greenhouse gas environmental impacts were being developed, such as the purchase of carbon offsets. However, this environmental impact issue was essentially eliminated when the pandemic situation dictated that the 2021 Congress would have to be a virtual Congress.

The virtual CMOS Congress 2021 is being designed to provide participants with as much functionality as possible from a virtual Congress. The Congress will feature a full Scientific Program including 7 plenary speakers, about 300 oral scientific talks in up to four concurrent sessions, up to 150 e-poster papers, and a Public Speaker, all of which will have Question and Answer discussions. The Congress will also include an Educator's Day, Exhibitors and Sponsors, events with networking interactions, including the CMOS Awards ceremony and an event for Students, and informal one-on-one discussions. To facilitate the five different time zones across Canada, Congress will be extended to a 9 day period with a shorter duration of daily activities.

Congresses Going Forward

CMOS Congress 2022, to be held in Saskatoon SK in the latter part of May 2022, will be jointly held with the Canadian Geophysical Union. Planning is now well underway. Subject to the abatement of the pandemic, it is planned to include extensive in-person activities.

While many functions of in-person Congresses can be replicated within online Congresses, the social and networking interactions among participants are difficult to replicate in a virtual Congress, consisting of informal meetings in small groups or individual person-to-person encounters. This reduction in social interactions is especially challenging for early-career scientists, including graduate students.

Beyond 2022, it would seem that Congresses will continue to evolve. To facilitate the reduction of carbon emissions, it would follow that some portion of future Congresses should be conducted using virtual, online methods. Options to achieve this could include: alternating between an in-person and virtual Congress from one year to another; or having yearly in-person Congresses at a central regional location(s), with remote participation for those who would have to travel large distances to attend.
At present, the CMOS Executive/Council is addressing the planning of future Congresses through the CMOS Congress Committee, as well as from the perspective of the CMOS Strategic Plan, as presently being developed.

Évolution des congrès de la SCMO

WRITTEN BY CMOS BULLETIN SCMO ON MARCH 12, 2021. POSTED IN AUTRES, AVIATION, NOUVELLES ET ÉVÉNEMENTS, QUOI DE NEUF.

– Par David Fissel, David Collins, Matthew Asplin (Members, CMOS Congress 2021 Local Arrangements Committee) and Bob Jones (CMOS Archivist)–

Alors que les plans pour le 55e congrès de la SCMO de 2021 sont en train d'être finalisés, voici comment l'approche suivie pour les congrès de la SCMO a évolué ces derniers temps. Les changements apportés pour les congrès de 2020 et 2021 ont été induits par la pandémie de COVID-19, mais il y a d'autres facteurs, comme la réduction des émissions de carbone et le fait de faciliter le réseautage social, qui continueront à être importants pour les congrès futurs quand la pandémie s'estompera pour rejoindre les rangs de l'histoire.

Le congrès virtuel de la SCMO de 2021 est conçu pour offrir aux participants le maximum de fonctionnalité possible pour un congrès organisé sous cette forme. Le congrès comprendra un programme scientifique complet, avec sept conférenciers de séance plénière, environ 300 exposés scientifiques oraux présentés au cours d'un maximum de quatre séances simultanées, jusqu'à 150 communications affichées en ligne et un orateur, le tout suivi de discussions sous forme de questions-réponses. Au cours du congrès, il y aura également une journée de l'éducateur, des exposants et des commanditaires, des événements mettant en jeu des interactions de réseautage, dont la cérémonie de remise des prix de la SCMO et un événement pour les étudiants, ainsi que des discussions informelles en tête à tête. Afin de tenir compte des cinq fuseaux horaires différents qui existent au Canada, le congrès sera étalé sur une période de 9 jours, avec une durée réduite des activités journalières.

Le congrès de la SCMO de 2022, qui doit avoir lieu dans la dernière partie du mois de mai à Saskatoon, en Saskatchewan, se tiendra conjointement avec l'Union géophysique canadienne. À condition que la pandémie ait régressé, il est prévu d'y inclure de nombreuses activités où les participants seront présents physiquement.

Après 2022, il semblerait que les congrès continueront d'évoluer. Pour faciliter la réduction des émissions de carbone, il s'ensuivrait qu'une certaine part des congrès futurs devrait avoir lieu sous forme virtuelle, en utilisant des moyens en ligne. Voici certaines des options qui pourraient être envisagées pour y parvenir : alterner entre un congrès avec participation physique une année et un congrès virtuel l'année suivante, ou organiser des congrès annuels avec participation physique dans un ou des lieux régionaux centraux, avec une participation à distance pour les personnes qui devraient autrement parcourir de grandes distances pour assister au congrès.

Actuellement, le conseil exécutif et le conseil d’administration de la SCMO se penchent sur la planification des congrès futurs par l’entremise du comité du congrès de la SCMO, ainsi que du point de vue du plan stratégique de la SCMO, tel qu’il est en train d’être élaboré en ce moment.

Registration for the 55th CMOS Congress

WRITTEN BY CMOS BULLETIN SCMO ON MARCH 15, 2021. POSTED IN MEMBERS, NEWS & EVENTS.

Registration for the 55th CMOS Congress hosted by the Vancouver Island Centre is now open!

Registration – CMOS Congress 2021

David Fissel
Chair, Local Arrangements Committee – Victoria Congress 2021

Ken Denman, FRSC
Chair, CMOS 2021 Scientific Programme Committee

Gordon Griffith, P.Eng., ing., FEC
Executive Director – Directeur général
CMOS – SCMO
T: 613-402-4376

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L’inscription au 55e congrès de la SCMO

WRITTEN BY CMOS BULLETIN SCMO ON MARCH 15, 2021. POSTED IN NOUVELLES ET ÉVÉNEMENTS.

L’inscription au 55e congrès de la SCMO organisé par le Centre d’île de Vancouver est maintenant ouverte!

Inscription – Congrès de la SCMO 2021

David Fissel
Chair, Local Arrangements Committee – Victoria Congress 2021

Ken Denman, FRSC
Chair, CMOS 2021 Scientific Programme Committee

Gordon Griffith, P.Eng., ing., FEC
Executive Director – Directeur général
CMOS – SCMO
T: 613-402-4376

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Obituary of Dr. John R. N. Lazier: November 1, 1936 – March 9, 2021

WRITTEN BY CMOS BULLETIN SCMO ON MARCH 19, 2021. POSTED IN MEMBERS, NEWS & EVENTS, OCEANS, OTHER, WHAT'S CURRENT.

– By Blair Greenan, Allyn Clarke and John Loder –

We were saddened to learn of the passing of Dr. John Lazier on March 9, 2021. John was one of the original employees hired in 1960 during the establishment of the Bedford Institute of Oceanography (BIO), which opened in October 1962. He completed his M.Sc. on the physical oceanography of the Jervis Inlet system at the University of British Columbia in 1963. In the late 1960s, John moved to Southampton, UK to pursue his Ph.D. involving studies of internal waves. He returned to Halifax and BIO in October 1970 as a research scientist. John retired in 1994 after 34 years of service and continued to contribute to the broad scientific community as a DFO Emeritus Scientist until 2008.

Early in his career, John was the Chief Scientist on the winter survey of the subpolar North Atlantic Ocean. This work provided the science community with the first truly winter survey of the entire subpolar gyre. The survey data was published as an atlas and was well regarded by international scientists. This also resulted in a classic paper by John on the formation of Labrador Sea Water, which is still being referenced today.

John Lazier (left) accepting the J. P. Tully Medal from Peter Zwack at the 31st CMOS Congress in Saskatoon, SK.

During his career, John made major contributions to our modern understanding of the Labrador Sea and surrounding areas, including the role and variability of deep convection, and the structure and variability of the Labrador Current. These are very important to both Atlantic Canadian waters downstream, and the broader North Atlantic subpolar gyre and global ocean overturning circulation. Through his ongoing and congenial leadership of many BIO ocean expeditions, often involving visiting scientists from other leading oceanographic institutes, John made a key contribution to one of BIO's most significant programs pertaining to the ocean and global climate variability (including programs like the World Ocean Circulation Experiment, WOCE).

John also co-authored a widely respected book with Ken Mann entitled "Dynamics of Marine Ecosystems" which provides a comprehensive overview of the effects of biological–physical interactions in the oceans from the microscopic to the global scale. This book was first published in 1991 and was updated in two more editions over the following fifteen years. The authors received the Government of Canada Merit Award for this work.

John was awarded the J. P. Tully medal in 1997 for his scientific contributions to Canadian oceanography. In addition to his scientific achievements, he is fondly remembered as a congenial colleague and mentor of young scientists, many of whom sailed with him as Chief Scientist.

John was truly a BIO pioneer and a major force in ocean climate studies and we would encourage you to read more about his life here.

En mémoire de Dr. John R. N. Lazier: 1 novembre, 1936 – 9 mars, 2021

WRITTEN BY CMOS BULLETIN SCMO ON MARCH 19, 2021. POSTED IN AUTRES, NOUVELLES ET ÉVÉNEMENTS, OCÉANS, QUALITÉ DE L'AIR, QUOI DE NEUF.

– Par Blair Greenan, Allyn Clarke and John Loder –

Au nom de la direction des sciences à l'Institut océanographique de Bedford (IOB), nous avons appris avec tristesse le décès de M. John Lazier. M. Lazier a été l'un des premiers employés embauchés lors de l'établissement de l'IOB, qui a ouvert ses portes en octobre 1962. Il a pris sa retraite en 1994 après 34 années de service et a continué à contribuer à notre communauté en tant que scientifique émérite jusqu'en 2008.

Au début de sa carrière, M. Lazier exerçait les fonctions de scientifique en chef dans le cadre de l'étude hivernale de l'océan de l'Atlantique Nord subpolaire. Ces travaux ont offert à la communauté scientifique la première véritable étude hivernale de la gyre subpolaire complète. Les données de l'étude ont été publiées en tant qu'atlas et sont tenues en haute estime par les scientifiques internationaux. Elles ont aussi donné lieu à un article classique de M. Lazier sur la formation des eaux de la mer du Labrador qui sert de référence encore aujourd'hui.


John Lazier (left) accepting the J. P. Tully Medal from Peter Zwack at the 31st CMOS Congress in Saskatoon, SK.

Au cours de sa carrière, M. Lazier a largement contribué à parfaire notre compréhension moderne de la mer du Labrador et des zones périphériques, y compris le rôle et la variabilité de la convection profonde, et la structure et la variabilité du courant du Labrador. Ces aspects sont très importants pour l'aval des eaux atlantiques canadiennes et la gyre subpolaire plus vaste de l'Atlantique Nord ainsi que la circulation de renversement des eaux océaniques globale. Grâce à son leadership continu empreint d'amabilité lors de nombreuses expéditions océaniques de l'IOB, auxquelles ont souvent participé des scientifiques invités et d'autres instituts océanographiques de premier plan, M. Lazier a grandement contribué à l'un des plus importants programmes de l'IOB portant sur la variabilité océanique et climatique globale (y compris des programmes comme l'Expérience sur la circulation océanique mondiale [WOCE]).

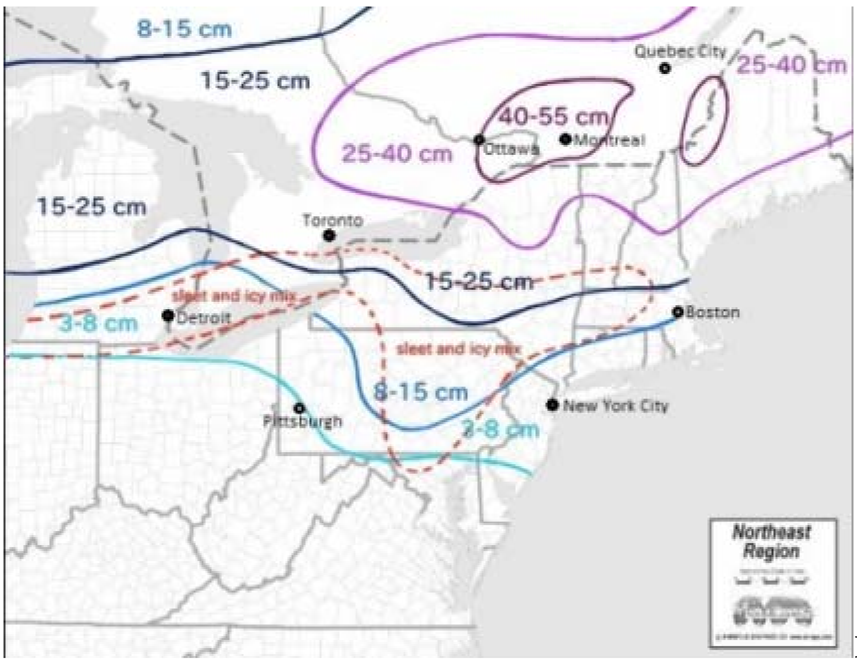
M. Lazier était vraiment un pionnier de l'IOB et une force majeure dans les études des climats océaniques et je vous encourage à en apprendre davantage sur sa vie à here.

The McGill Student Weather Forecasting Club

WRITTEN BY CMOS BULLETIN SCMO ON MARCH 26, 2021. POSTED IN OTHER, WEATHER, WHAT'S CURRENT.

– By Yeechian Low and co-authored by David Wang –

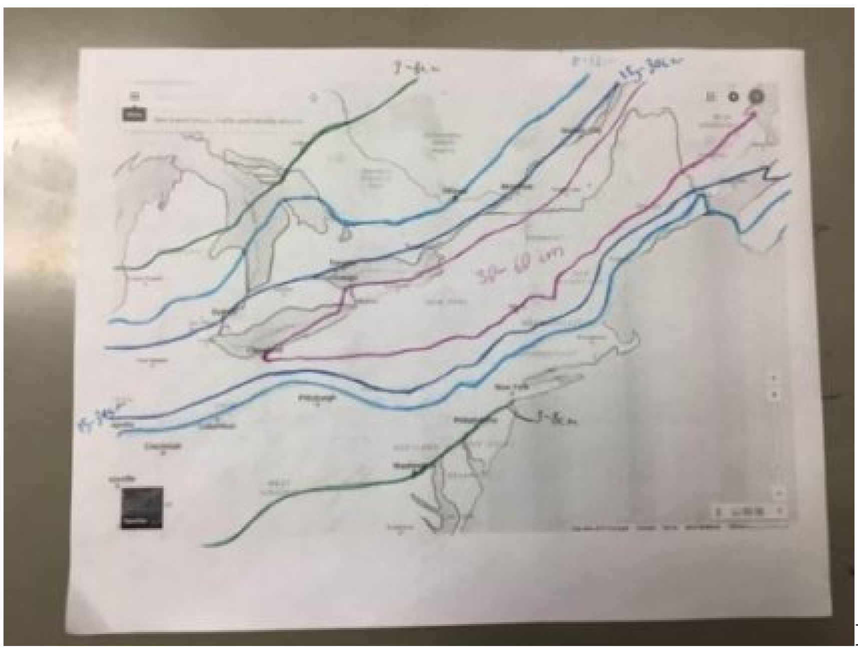
While roller coaster temperatures, blizzards, and severe thunderstorms are dreadful for many, they are reasons for excitement for us, as members of the McGill Weather Forecasting Club (WFC).



Digitally re-drawn version of the snowfall map made during the February 11, 2019 meeting for the snowstorm on February 12-13.

The WFC is comprised of a small group of students who are interested in discussing and forecasting the weather. Although the great majority of members are students majoring or minoring in atmospheric and oceanic science (AOS), we welcome any student interested in weather into the club. We have weekly meetings where we discuss various meteorological concepts and tools for weather forecasting in the framework of the current weather pattern. These meetings are often concluded by the members making weather forecasts of diverse natures together. Types of forecasts include a simple 5-day forecast for Montreal, a storm-total snowfall accumulation map for the Northeast U.S. and southeastern Canada, a detailed description and timeline of a storm affecting Montreal, regional severe thunderstorm and tornado risk, steering and intensity of tropical cyclones, long-range weather patterns, and even seasonal forecasts. At times when the weather is calm in Montreal’s neck of the woods, we also discuss any interesting weather events around the globe.

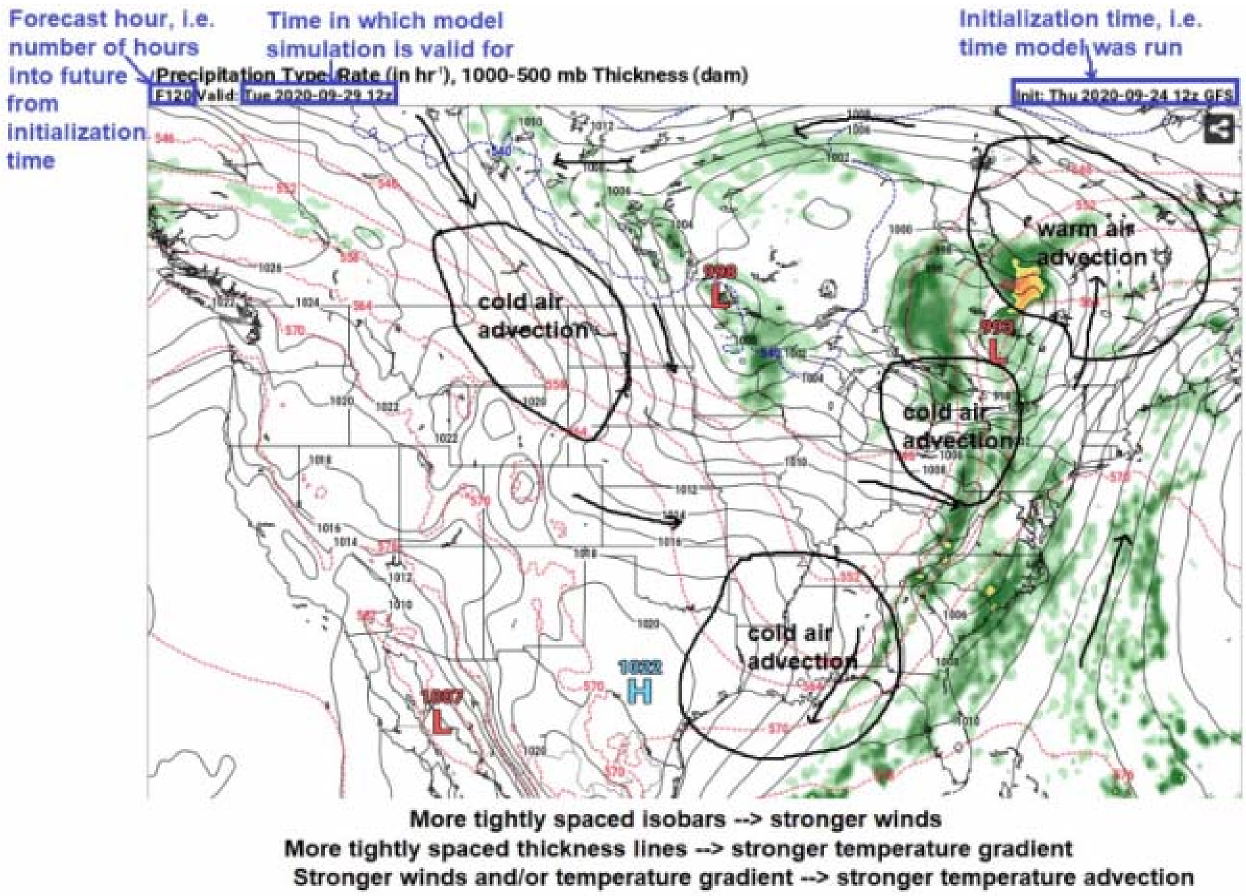
Most AOS classes at McGill focus on the theory and equations behind how the atmosphere and ocean evolves. Other than one class formerly taught by Dr. Eyad Atallah, there is little or no class instruction on operational weather forecasting. Motivated by the interest of some AOS students, Kai Melamed-Turkish (AOS. B.Sc. 2017; M.Sc. 2020) started the WFC with the help of David Wang (AOS. M.Sc. 2014; Ph.D. 2019) and Anthony Di Stefano (AOS. B.Sc. 2016), the president of the Atmospheric and Oceanic Sciences Society of Undergraduates at McGill (AOSSUM). The WFC was intended to be an informal club where members could discuss weather events, track storms, and learn about weather forecasting. I (AOS. B.Sc. 2019) joined the club during my freshman year (Fall 2016) at McGill after learning about it from Kai in an introductory AOS course. Being very passionate about the weather, I knew this was the club for me. After Kai graduated in Spring 2017, David Wang and I co-managed the club, and I became the main leader after David Wang graduated in 2019. Due to the COVID-19 pandemic, I now run WFC meetings through Zoom, and David still joins in and helps me run the club in general.



Hand-drawn preliminary snowfall accumulation map made during the January 16, 2019 meeting for the snowstorm on January 19-20.

Running the club has not only provided me with valuable experience in weather forecasting but also on how to break down and explain various meteorological concepts during the relatively short meetings, especially to members who are first-year or second-year undergraduate students with little experience in weather forecasting. It is a challenge to cater the club to students with different levels of familiarity in meteorology and having new members each year. Running meetings to account for this diversity in skillset has been a learning process!

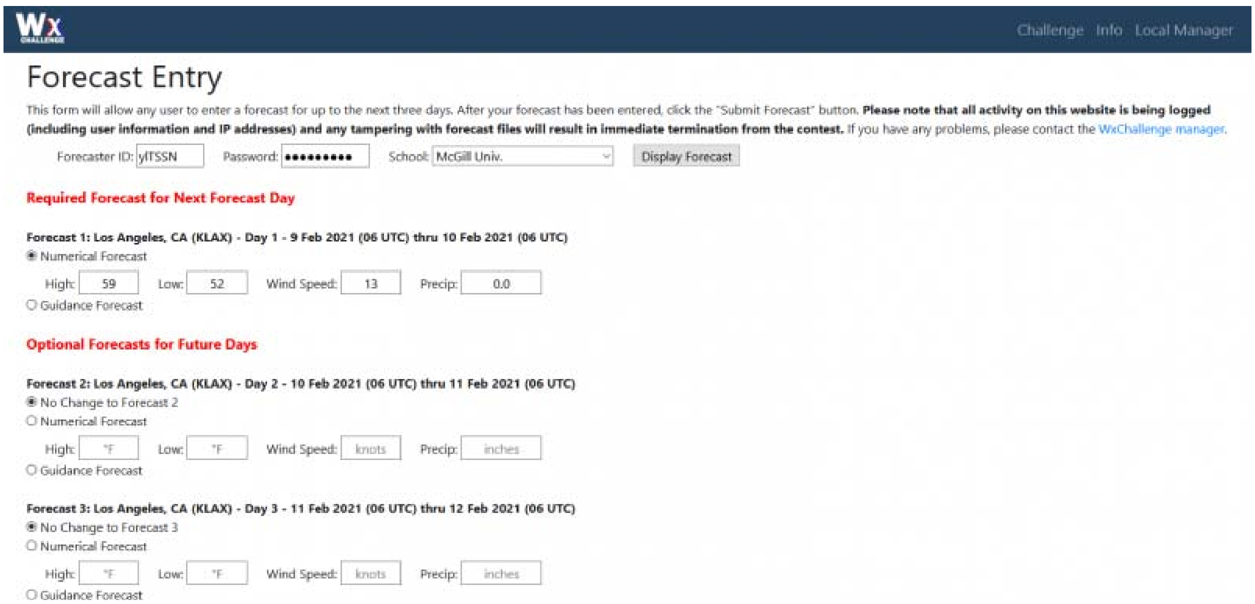
At the beginning of each school year, I probe the new members' familiarity with meteorology based on the AOS courses they have taken and if they have any prior forecasting experience to gauge what I should explain in more detail. The first few meetings are usually devoted to getting members up to speed with understanding and using tools used for weather forecasting. A major tool that we use to make weather forecasts is computer models. Getting comfortable with reading computer weather models, which involves understanding model initialization time, forecast hour, and the different variables shown, is one of the biggest hurdles for new members.



A map I showed to members to help them read a computer weather model.

In addition, several of us in the WFC participate in the WxChallenge, a weather forecasting competition among university students and professors across North America. I am the local manager of McGill's team, a role that goes well with leading the WFC. In the competition, each forecaster submits their forecast for daily high and low temperatures, maximum sustained wind speed, and total precipitation at a location in the U.S. that has routine weather observations. Unlike the forecasts we do during the WFC meetings, the WxChallenge forecasts are done individually. However, we often provide a short briefing about the current and future weather for the location of interest during our weekly meetings. The forecast location changes every two weeks. Five locations are used in the Fall and Spring semesters each.

The competition gives us more valuable opportunity to apply meteorological theories that we learn in class, such as different factors controlling temperature, including temperature advection, radiation, and evaporative cooling, to making real-world weather forecasts. In class, we were only able to apply this knowledge by doing exercises in theoretical, idealized scenarios. Looking at the forecast wind speed and direction, temperature, cloud cover, and precipitation from various computer models are also a major component in making WxChallenge forecasts. However, we do not directly take the model forecast variables as our WxChallege forecasts. Instead, we process model guidance with our prior forecasting experience and known model biases to derive our forecasts.



Me entering my WxChallenge forecast for Los Angeles, CA on February 8, 2021.

Top-performing forecasters for each city over the whole school year receive trophies and in recent years, several McGill forecasters have earned trophies! In fact, the team won a total of eight trophies last year (2019-20), which is a team record and an impressive feat given that we had only six forecasters.

Each location's local weather is different and even those of us who are more experienced still often make mistakes and are always learning from them. The hands-on experience in weather forecasting we've gained from the McGill WFC is as important as learning the meteorological theories in class to succeed in the WxChallenge. All in all being an active member of the McGill WFC has been a valuable and enriching adventure!

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Le club étudiant de météorologie de McGill

WRITTEN BY CMOS BULLETIN SCMO ON MARCH 26, 2021. POSTED IN AUTRES, MÉTÉO, QUOI DE NEUF.

– Par Yeechian Low and David Wang –

Si beaucoup redoutent les fluctuations constantes de températures, les blizzards et les orages violents, c'est une source d'excitation pour nous, les membres du Club de prévisions météorologiques (CPM) de McGill.

Le Club est composé d'un petit groupe d'étudiants qui souhaitent discuter de la météo et faire des prévisions. La plupart des membres sont des étudiants en sciences atmosphériques et océaniques (AOS), mais le Club accueille tous les étudiants qui s'intéressent à la météo. Les membres se réunissent chaque semaine pour discuter de divers concepts et outils météorologiques de prévision du temps dans le cadre du schéma météorologique actuel. Ces réunions se terminent souvent par des prévisions météorologiques de diverses natures faites par les membres. À titre d'exemple, certains ont proposé une simple prévision sur cinq jours pour Montréal, une carte des accumulations totales de neige pour le nord-est des États-Unis et le sud-est du Canada, une description détaillée et chronologique d'une tempête affectant Montréal, le risque d'orages violents et de tornades dans une région, la direction et l'intensité des cyclones tropicaux, les modèles météorologiques à long terme et même les prévisions saisonnières. En temps d'accalmie à Montréal, les étudiants discutent des événements météorologiques intéressants qui se produisent ailleurs dans le monde.

En outre, nous sommes plusieurs à avoir participé au WxChallenge, un concours de prévisions météorologiques entre étudiants et professeurs d'université en Amérique du Nord. C'est une excellente occasion d'appliquer les théories météorologiques apprises en classe, comme les différents facteurs contrôlant la température, dont l'advection de température, le rayonnement et le refroidissement par évaporation, pour faire des prévisions météorologiques dans un contexte réel. En classe, ces connaissances ne sont appliquées que dans le cadre d'exercices de scénarios théoriques et idéalisés.

Les meilleurs prévisionnistes pour chaque ville et pour l'ensemble de l'année scolaire reçoivent un trophée, et ces dernières années, plusieurs d'entre eux représentaient McGill. En effet, l'équipe a remporté un total de huit trophées l'année dernière (2019-2020), ce qui constitue un record d'équipe et un exploit impressionnant étant donné que nous ne comptions que six prévisionnistes.

L'expérience pratique en prévisions météorologiques que nous avons acquise au CPM de McGill est aussi importante que la maîtrise des théories apprises en classe pour réussir le WxChallenge et, à ce titre, être un membre actif du Club a été une aventure précieuse et enrichissante!

#

2020 Eastern Canada Seasonal and Total Precipitation Analysis

WRITTEN BY CMOS BULLETIN SCMO ON MARCH 30, 2021. POSTED IN WEATHER, WHAT'S CURRENT.

– By Richard Leduc, Ph.D., AirMet Science –

Daily precipitation data (mm, water equivalent) have become available by Environment and Climate Change Canada in the AHRDP/HRDPA (Analyse à haute résolution déterministe de précipitation / "High-resolution deterministic precipitation analysis") system for the Canada ensemble at a 2.5km resolution. The area covered is illustrated in Figure 1 and contains 2500 (i, longitude) by 1222 (j, latitude) grid points (3055000 in total). The corners of the area are (-131.09°W, 42.25°N), (-151.06°W, 66.45°N), (-47.7°W, 42.82°N) and (-71.55°W, 29.28°N).

Information on this system is presented in Environment and Climate Change Canada (2018). It should be noted that these data result from an optimal combination of observations (rainfall, radar) and of modelled data and that where there are not observations nearby, simulated data is used; this system has been validated, as discussed in ECCC (2018).

We data obtained the data daily (via ECCC Datamart) since September 2019. Now that 2020 is finished, our objective is to present the quarterly and yearly totals for the east of Canada, that is to say, a good part of Ontario, Quebec, Newfoundland and Labrador, and the Maritimes (Figure 2).

The total quarterlies are presented to alleviate the length of the text, but the monthly totals are available upon request. To assure continuity, the winter total 2019 – 2020 (ie. December 2019 and January and February 2020) are presented.

This brief discussion of the total precipitation in eastern Canada allows us to show:

- *The link between topography and the totals*
- *The spatial and seasonal variability in precipitation*
- *The link between the trajectory of storms and the distribution of precipitation*
- *The latitudinal variation of precipitation a its seasonal variation*

Analyse des Précipitations Saisonnières et Totales dans l'Est du Canada en 2020

WRITTEN BY CMOS BULLETIN SCMO ON MARCH 30, 2021. POSTED IN MÉTÉO, QUOI DE NEUF.

– Par Richard Leduc, AirMet Science –

Introduction

Les données quotidiennes de précipitation (mm, équivalent eau) sont rendues disponibles par Environnement et Changement Climatique Canada dans le système AHRDP/HRDPA (Analyse à haute résolution déterministe de précipitation / "High resolution deterministic precipitation analysis") pour l'ensemble du Canada à une résolution de 2.5 km. Le domaine couvert est illustré à la Figure 1 et comprend 2500 (i, longitude) par 1222 (j, latitude) points de grille (au total 3055000). Les coins du domaine sont (-131.09°W, 42.25°N), (-151.06°W, 66.45°N), (-47.7°W, 42.82°N) et (-71.55°W, 29.28°N).

De l'information sur ce système est présentée dans Environnement et Changement Climatique Canada (2018). Mentionnons que ces données résultent d'une combinaison optimale d'observations (pluviométrie, radar) et de données modélisées et quand il n'y a pas d'observations à proximité, ce sont les données simulées qui sont utilisées; le système a fait l'objet d'une validation, tel que discuté dans ECCC (2018).

Les données sont obtenues quotidiennement de notre part (via le Datamart d'ECCC) depuis septembre 2019. L'année 2020 étant complète nous avons comme objectif de présenter les totaux trimestriels et le total annuel sur la partie est du Canada, soit une bonne part de l'Ontario, le Québec, Terre-neuve et le Labrador et les Maritimes (Figure 2).


Figure 1. Domaine du AHRDP/HRDPA

Les totaux trimestriels sont présentés pour alléger le texte mais les totaux mensuels sont aussi disponibles sur demande. Pour assurer une continuité, le total de l’hiver 2019-2020 (i.e. décembre 2019 et janvier et février 2020) est présenté.

Les sections qui suivent illustrent ces résultats sous forme de cartes d’isohyètes accompagnées d’une courte discussion.

Les résultats pour le reste du Canada sont dans un autre texte.

Total Annuel

Sur le domaine couvert (Figure 2), on dispose des totaux mensuels et annuels pour 1008318 points de grille.

Le Tableau 1 donne la plage couverte par les totaux et quelques résultats statistiques sur l’ensemble des points de grille. Le total trimestriel le plus élevé atteint presque 1110 mm (mars-avril-mai) et le total annuel maximal dépasse 3200 mm. La moyenne annuelle sur l’ensemble du domaine est près de 980 mm.

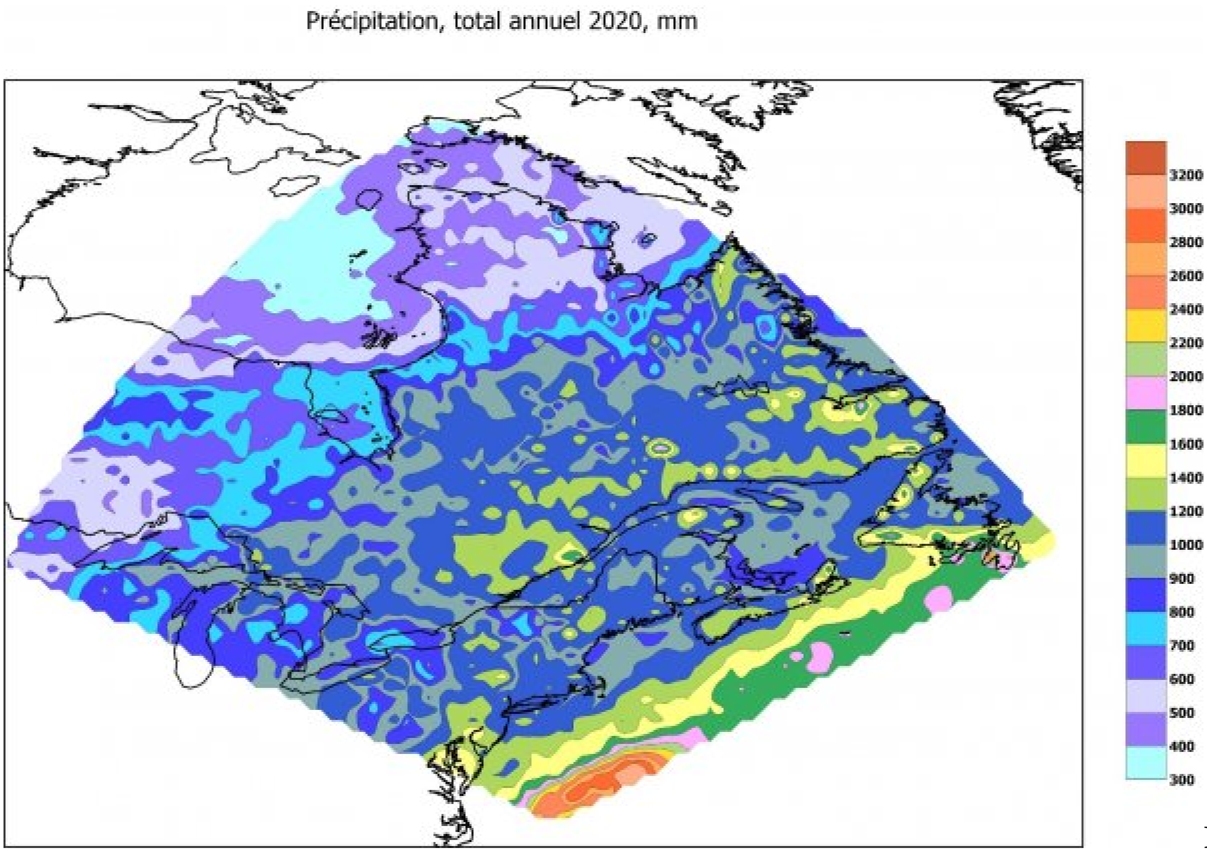

Figure 2. Total annuel 2020 (mm)

En hiver 2019-2020, les totaux sont au plus bas avec une moyenne de 202.84 mm et une médiane de 163.9 mm. L'été (juin-juillet-août) et l'automne (septembre-octobre-novembre) ne sont pas très différents du moins en ce qui concerne la médiane (262.2 mm et 266.4 mm) mais la moyenne est de près de 20 mm plus élevée en automne.

La variation sur la région est plus grande en hiver (65.1%), comme on le verra plus loin, qu'en automne (30.9%). Les résultats sont un peu différents si on considère les mois de janvier, février et décembre 2020 comme saison d'hiver dû à la différence entre décembre 2019 (moyenne de 86.19 mm) et décembre 2020 (moyenne de 102.8 mm).

Les isohyètes du total annuel sont illustrées à la Figure 2. Les plus hautes valeurs sont au large de la côte est aux plus basses latitudes. Au Québec et dans les Maritimes, l'importance de la topographie est particulièrement évidente comme par exemple au nord de la ville de Québec (Parc des Laurentides, 1800 mm), sur la Gaspésie (jusqu'à 1600 mm), à Terre-Neuve (jusqu'à 2500 mm au sud-ouest de St-Jean), sur le Cap-Breton (jusqu'à près de 1800 mm), sur les monts Torngat (jusqu'à 1400 mm, valeur plus élevée que dans le sud du Québec), etc.

TOTAL, mm	MINIMUM	MAXIMUM	MOYENNE	ÉCART-TYPE	MÉDIANE	CV (%)
ANNUEL 2020	301.47	3215.21	979.53	371.50	968.11	37.9
HIVER 2019-2020 DÉCEMBRE 2019 JANVIER-FÉVRIER 2020	34.79	884.43	202.84	132.03	163.93	65.1
MARS-AVRIL-MAI 2020	216.36	1109.54	221.86	132.05	204.63	59.5
JUIN-JUILLET-AOÛT 2020	14.52	965.56	259.98	107.08	262.18	41.2
SEPTEMBRE-OCTOBRE NOVEMBRE 2020	85.81	992.12	278.23	86.00	266.40	30.9
JANVIER-FÉVRIER DÉCEMBRE 2020	38.13	881.40	219.45	142.58	182.16	65.0

Tableau 1. Résultats trimestriels et annuel

Dans le sud du Québec, le total est d'environ 1200 mm et il diminue jusqu'à environ 500 mm dans l'extrême nord-ouest du Québec au-delà de 59°N et près de 615 mm aux environs de Kuujjuaq. Le total approche 1900 mm sur les sommets à environ 55 km à l'est du réservoir Manicouagan; c'est le total le plus élevé du Québec.

Au Labrador, les totaux sont plus élevés dans les secteurs plus accidentés, comme près de Goose Bay (environ 1400 mm) et dans l'extrême nord et un total approche 2000 mm le long de la côte (10 km au sud de l'île Graveyard).

Dans le sud de l'Ontario, près de Toronto, les totaux sont plus bas à environ 800 mm mais près de 1100 mm à la baie Géorgienne dû à l'effet de lac. La région de Sault-Ste-Marie de même que celle à environ 50 km à l'ouest de Wawa ont des totaux qui approchent 1200 mm et Thunder Bay et les environs sont à moins de 600 mm. Sur la portion nord-ouest de la Baie d'Hudson, le total est entre 350 mm et 400 mm.

Décembre 2019 – Janvier 2020 – Février 2020

La saison d'hiver 2019-2020 comprend les mois de décembre 2019 et janvier et février 2020.

Les totaux les plus élevés sont au large de la côte est (Figure 3). Durant ces trois mois, plusieurs tempêtes ont remonté la côte est y déversant de la précipitation puis ont passé sur Terre-Neuve en y laissant d'abondantes précipitations. Phillips (2021) nous en apprend davantage sur la tempête extraordinaire qui a frappé Terre-Neuve le 17 janvier 2020 en y laissant 76.2 cm de neige (et un autre 10-20 cm dans les jours qui suivirent). Dans la partie ouest de Terre-Neuve, au-nord-est Corner Brook par exemple, le total atteint près de 620 mm; au sud de St-Jean les totaux y sont aussi jusqu'à 620 mm.

Au Labrador, sur les sommets près de Goose Bay, le maximum est près de 330 mm et il est près de 260 mm dans l'extrême nord sur les monts Torngat.

Au Cap-Breton, le total maximum approche 660 mm; l'extrême sud-ouest de la Nouvelle-Écosse atteint environ 480 mm.

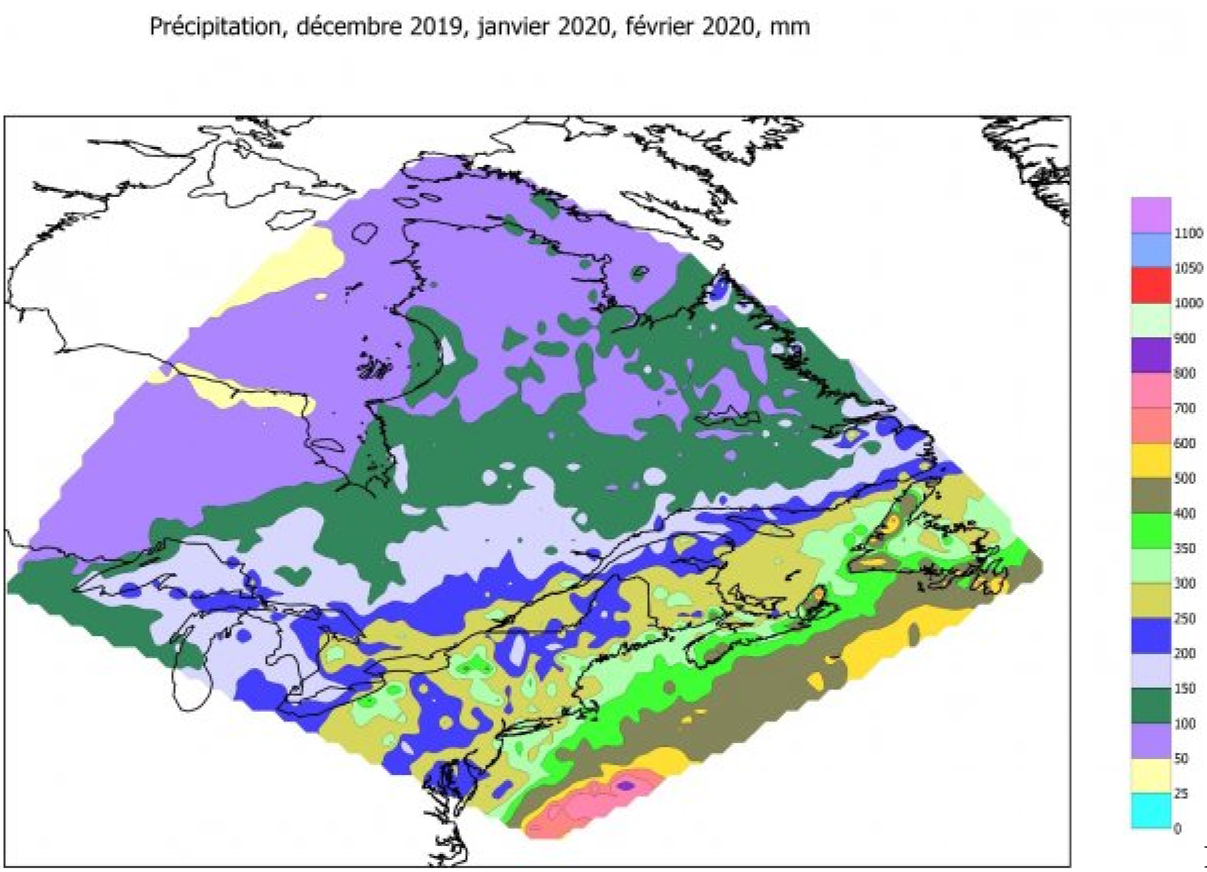

Figure 3. Total décembre 2019 – janvier 2020 – février 2020 (mm)

Dans le sud du Québec, on note des maxima à 300 mm en Gaspésie, au nord de la Ville de Québec (Parc des Laurentides) à 320 mm, valeur la plus élevée du Québec mais suivie de près par la région au nord-ouest de Montréal. Les totaux décroissent avec la latitude jusqu'à environ 100 mm à Kuujjuuaq et au-delà.

La baie Georgienne en Ontario montre un maximum autour de 300 mm grâce à l'effet de lac alors que la région de Toronto est à environ 240 mm. Le nord de Sault-Ste-Marie montre un maximum à environ 250 mm.

Des valeurs plus basses sont notées sur l'ouest de la Baie James et la Baie d'Hudson, à environ 50 mm et moins.

Mars 2020 – Avril 2020 – Mai 2020

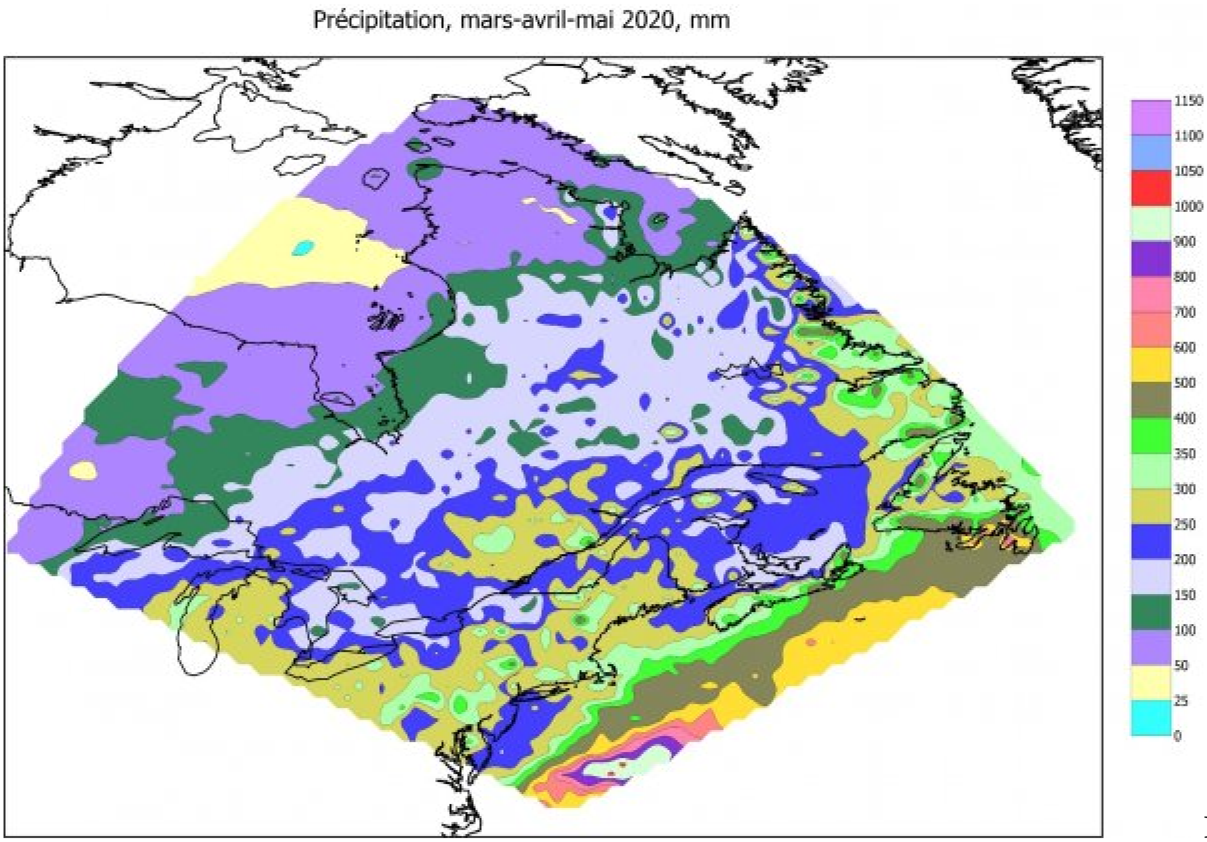

Figure 4. Total mars-avril-mai 2020 (mm)

On note (Figure 4) des totaux plus élevés sur les sommets de Terre-Neuve et du Labrador avec 325 mm aux monts Torngat, près de 570 mm au sud de l'île Graveyard, la côte de la Nouvelle-Écosse (300 mm et plus), la Gaspésie (330 mm), le nord de la ville de Québec (Parc des Laurentides, 420 mm, valeur la plus élevée du Québec). À l'est du réservoir Manicouagan, les maxima atteignent environ 330 mm.

À Terre-Neuve, au sud-ouest de Placentia, les maxima atteignent un peu plus de 770 mm, près de 630 mm aux environs de Marystown et 425 mm au nord-est de Corner Brook.

À Kuujjuaq, le total est à environ 130 mm et on note une zone maximale à près de 215 mm à 50 km au sud-ouest de Quaqtaq; sur l'extrême nord-ouest du Québec, les totaux sont à environ 110 mm.

L'ouest de l'Ontario est sous 150 mm environ et un petit secteur au nord de Toronto est entre 140 mm et 150 mm mais vers l'ouest, au nord de Stratford, le maximum est près de 215 mm; la région au nord de Sault-Ste-Marie est à environ 265 mm.

Juin 2020 – Juillet 2020 – Août 2020

Durant cette période (Figure 5), les totaux varient entre environ 15 mm (pour quelques points de grille à l'extrême nord-ouest) et 965 mm; on précise que 99.5% des points de grille ont un total supérieur à 33 mm.

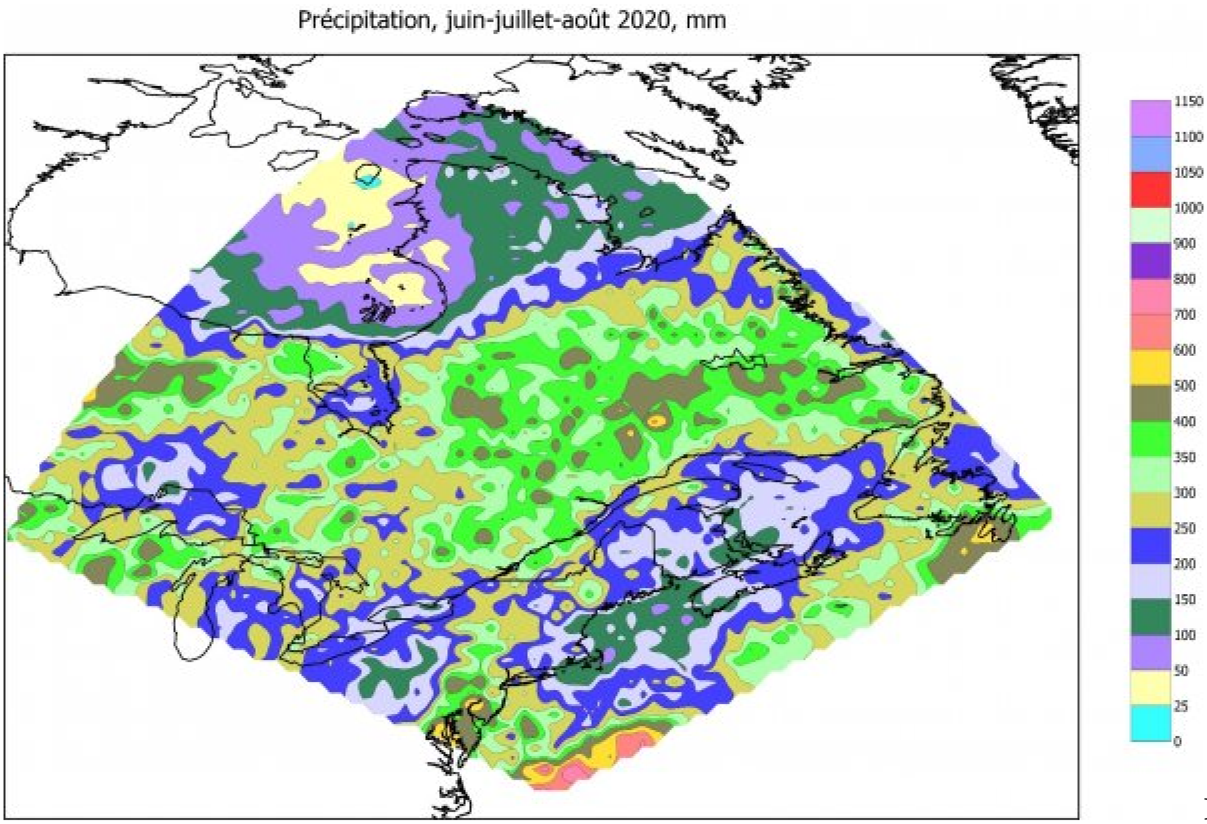

Figure 5. Total juin-juillet-août 2020 (mm)

On note des valeurs plus faibles sur le golfe du St-Laurent autour de 200 mm et la partie sud-est du Nouveau-Brunswick et l'Île-du-Prince-Édouard sont à environ 150 mm. Les sommets à l'est du réservoir Manicouagan atteignent près de 625 mm (total le plus haut du Québec). Le Parc des Laurentides montrent un maximum d'environ 410 mm et les sommets de Gaspésie (au sud de Ste-Anne-des-Monts) sont à environ 375 mm; on note aussi des valeurs plus élevées à l'ouest du Lac-St-Jean (500 mm au maximum).

Les totaux décroissent au nord d'environ 55°N pour atteindre 200 mm à Kuujjuaq et l'extrême nord-ouest du Québec est à 50 mm.

Une large zone avec des valeurs plus élevées (qui atteignent plus de 400 mm à certains endroits) s'étend de Goose Bay vers le sud de la baie James et vers l'ouest autour de 50°N-55°N.

Le sud de l'Ontario a des totaux plus bas, autour de 200-250 mm et la région au nord de Sault-Ste-Marie affiche des valeurs plus élevées jusqu'à environ 360 mm.

Sur Terre-Neuve, les totaux les plus hauts au sud-ouest de St-Jean à près de 575 mm Au Labrador, les sommets au sud de l'île Graveyard atteignent 645 mm.

Malgré ces fluctuations locales, la répartition relativement plus uniforme de la précipitation sur le domaine procure un coefficient de variation plus faible que celui de la saison précédente (41.2% vs 59.5%).

Septembre 2020 – Octobre 2020 – Novembre 2020

C'est durant ces trois mois que le coefficient de variation est à son plus bas (30.9%) possiblement à cause de la couverture étendue de l'isohyète de 300 mm (et plus) qui recoupe une bonne partie du sud du Québec jusqu'à environ 55°N (Figure 6).

Une bande avec des valeurs plus élevées (350 mm et plus) s'étend de Goose Bay jusqu'à la baie James (autour de 50°-55°N).

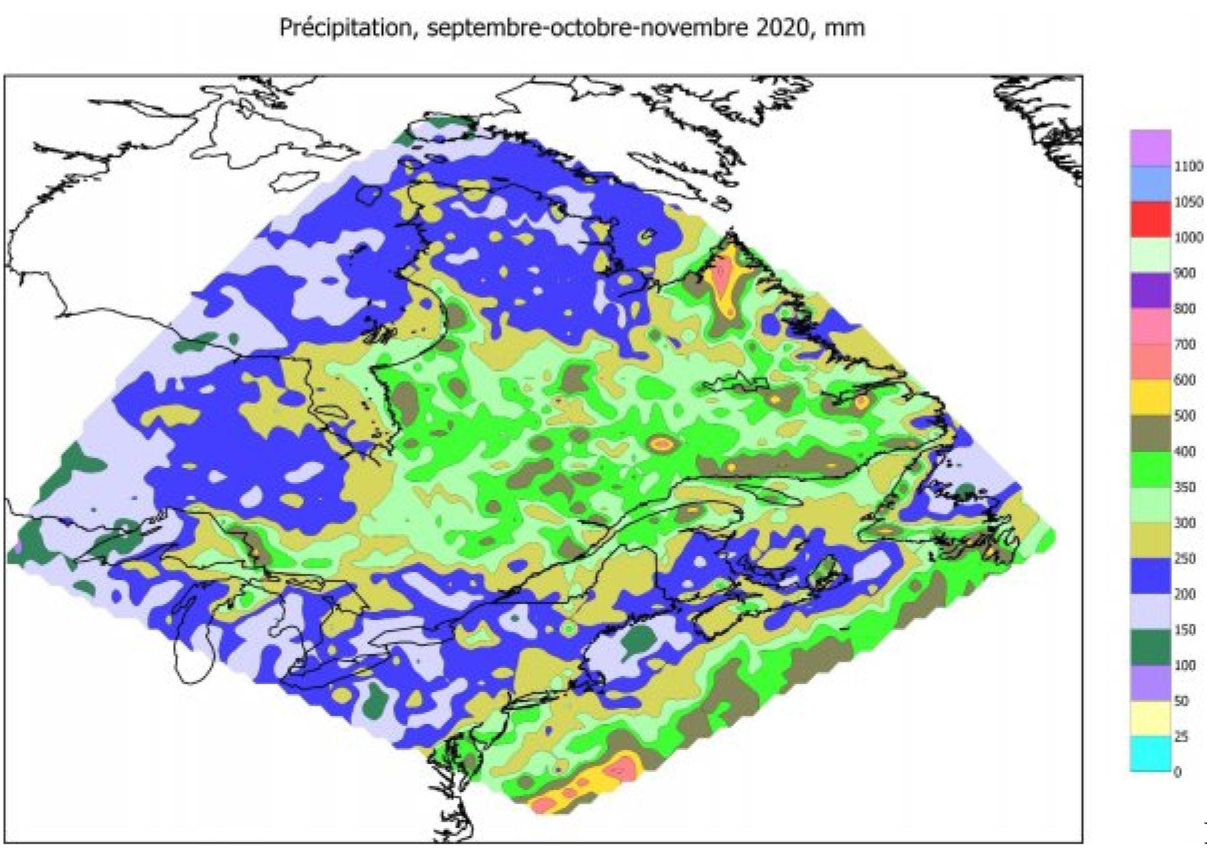

Figure 6. Total septembre-octobre-novembre 2020 (mm)

Les totaux sont élevés sur les sommets de Terre-Neuve (520 mm au sud de Corner Brook), et du Labrador (par exemple près de Goose Bay à 650 mm et au sud de l'île Graveyard à 500 mm), la région au sud-ouest de St-Jean atteint 550 mm, les monts Torngat (plus de 700 mm).

En Gaspésie au sud de Ste-Anne-des-Monts, on atteint 500 mm, le nord de la ville de Québec (Parc des Laurentides) est à 475 mm et les sommets à l'est du réservoir Manicouagan atteignent près de 650 mm et ce sont les plus hautes valeurs du Québec. L'extrême nord-ouest a reçu 200-225 mm et Kuujjuaq est à 250 mm.

Un secteur au nord d'Halifax est à 380 mm et au cap Breton on atteint près de 520 mm.

Dans le sud de l'Ontario, les totaux sont sous 200 mm et au nord de Sault-Ste-Marie on atteint 500 mm. La Baie d'Hudson est aussi à environ 200 mm et c'est durant cette période que les précipitations y sont les plus abondantes.

Compléments

Par ailleurs, il s'avère intéressant de produire quelques résultats simples que rendent possible ces données.

Variation latitudinale

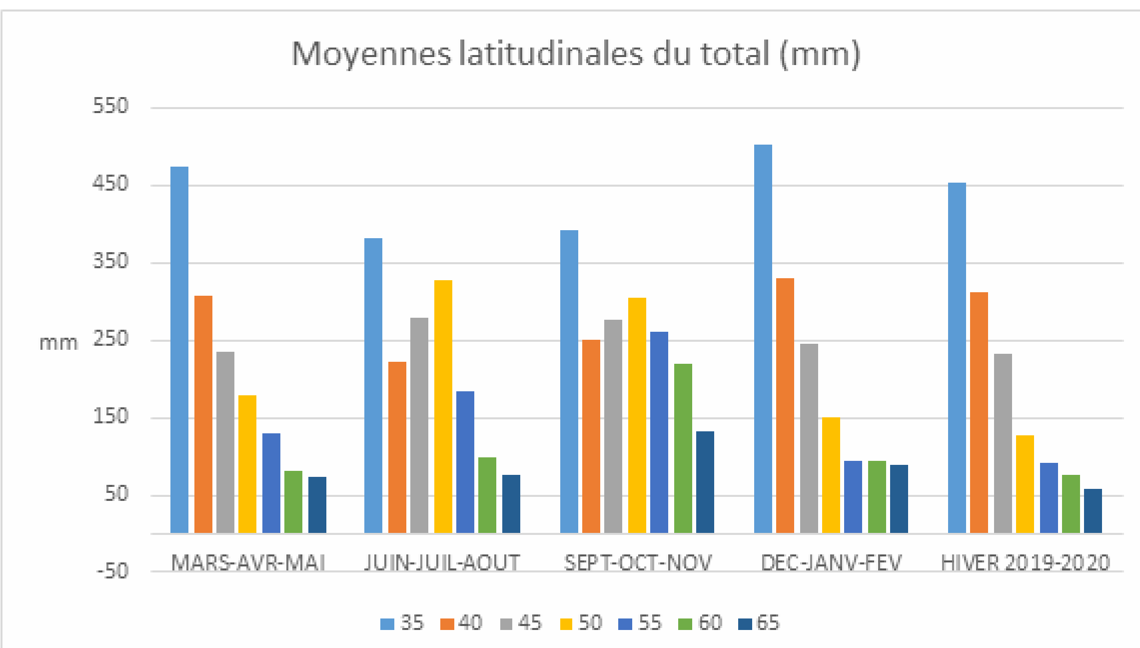

Figure 7. Moyennes latitudinales du total par saison 2020 (mm)

Un exemple est de quantifier la variation latitudinale des totaux par saison (avec décembre, janvier et février 2020 et l'hiver 2019-2020). Les moyennes par bande de latitude de 5° sont illustrées à la Figure 7 et le total annuel à la Figure 8. Comme on l'a vu, les totaux annuels décroissent avec la latitude, le maximum élevé à la plus basse latitude étant associé aux tempêtes le long de la côte EST (tel que montré sur les cartes précédentes).

On peut aussi constater de manière un peu plus directe (que sur les cartes précédentes) l'augmentation des totaux avec la latitude jusqu'aux latitude 50-55°N en juin-juillet-août et moins fortement en septembre-octobre-novembre. En juillet 2020, des tempêtes ont circulé sur une trajectoire autour de 50°N et d'autres ont voyagé du Lac Supérieur vers la baie James et le nord-est vers la baie d'Ungava. Elles seraient à l'origine de l'augmentation de la précipitation durant ce trimestre à ces latitudes. Une analyse plus détaillée dépasse l'objectif de ce travail.

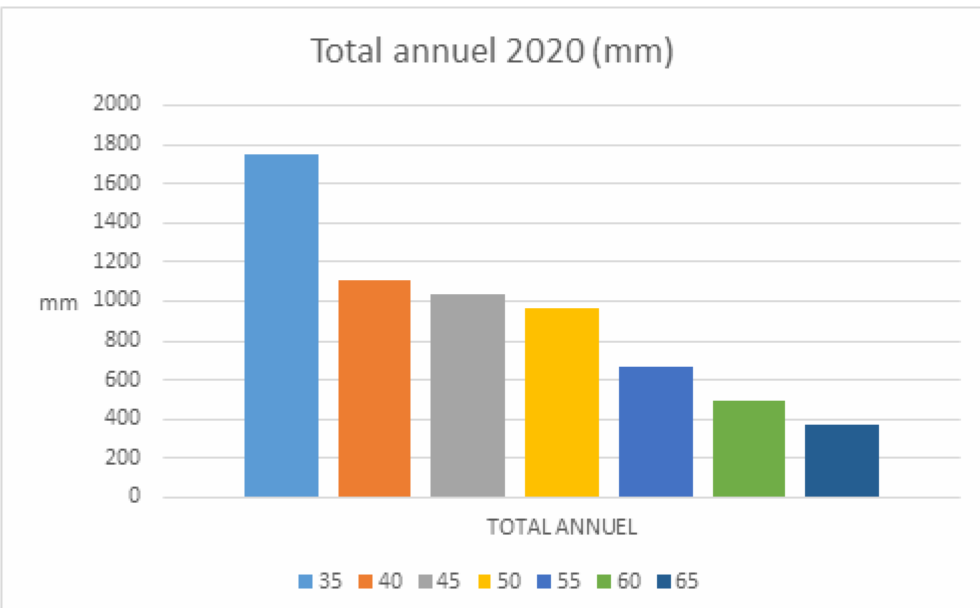

Figure 8. Variation latitudinale du total annuel 2020 (mm)

La décroissance est régulière en mars-avril-mai et pour l'hiver 2019-2020; les 3 mois d'hiver de la même année introduisent une variation différente au-delà de 55°N.

Le total annuel de 2020 décroît de manière régulière (Figure 8); en ne considérant pas les latitudes de 35-40°N, la décroissance moyenne avec la latitude est de -29.6 mm/degré de latitude.

Estimation du volume tombé

Un autre complément obtenu est le volume total d'eau tombé sur le Québec-Labrador en 2020.

Pour ce faire, on a délimité (grossièrement) le contour géographique du Québec incluant le Labrador (excluant le fleuve jusqu'à Québec et le Golfe du St-Laurent) et on a retenu les points de grille à l'intérieur de ce périmètre (311331). Le total tombé (km3) est obtenu par mois et pour l'année.

Le total tombé estimé pour 2020 est de 1944.48 km3; bien que ce volume semble élevé, il est passablement inférieur au volume d'eau du Lac Supérieur (11600 km3) et même du Grand Lac de l'Ours (2236 km3). La moyenne pour l'année répartie sur cette région est d'environ 1000 mm.

Conculsion

Cette brève discussion sur les précipitations totales de 2020 sur la région comprenant un bonne partie de l'Ontario, le Québec, Terre-Neuve et le Labrador et les Maritimes a permis de montrer:

- le lien entre la topographie et les totaux;
- la variabilité spatiale et saisonnière de la précipitation;
- le lien, bien que simplement discuté, entre la trajectoire des tempêtes et la répartition des précipitations;
- la variation latitudinale de la précipitation et sa variation saisonnière.

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Remerciments

Nous remercions Philippe Barnéoud (ECCC) de ses conseils et suggestions qui ont grandement amélioré le texte et Environnement et Changement climatique Canada de rendre ces données disponibles. Nous remercions aussi Pierre-Yves St-Louis (MELCC) pour ces judicieux commentaires.

#

Validating the ability of a glider-mounted fisheries echosounder to measure mesozooplankton concentration throughout the water column

WRITTEN BY CMOS BULLETIN SCMO ON APRIL 12, 2021. POSTED IN OCEANS, WHAT'S CURRENT.

– By Delphine Mossman, M.Sc candidate, University of New Brnuswick –

Despite their diminutive size, zooplankton are among the most important groups of animals on the planet. They are key players in many biogeochemical cycles that affect the globe, act as regulators of phytoplankton populations, and are an important source of food for a host of marine creatures, from small fish to the largest organisms on earth: the baleen whales. There is also a great deal of diversity within the zooplankton community, including adult organisms such as jellyfish, salps, and copepods, but also larval stages of many animals that become nektonic (free swimmer) or benthic (bottom swimers) in adulthood. Because of their diversity in role and species, understanding the abundance and distribution of zooplankton—and how it changes over time—is an essential part of our understanding of the global ocean ecosystem.


Two Calanus finmarchicus, a type of copepods

Unfortunately, measuring zooplankton is not without its difficulties, chief among them being the sheer size of the ocean. It is clearly impossible to sample every cubic meter of the ocean to determine the exact population sizes of zooplankton, and therefore sampling techniques need to be used, but even obtaining a representative sample is a logistical challenge. Zooplankton tend to aggregate in thin, depth-stratified layers not usually visible from the surface. Many sampling techniques have been developed to collect information—net-based tows, optical plankton counters, plankton imaging equipment, and echosounders, to name the most prominent ones—but these are limited in scope by their need to be deployed from a vessel. Vessels are expensive to charter and maintain, and cover relatively small amounts of time and space; indeed most vessel deployments are on the order of days to weeks, covering only one to one hundred square kilometers. The ultimate result of these shortcomings is that zooplankton are some of the most under-sampled organisms in the ocean, despite being some of the most widespread.

The concurrent development of autonomous underwater vehicle (AUV) technology and smaller, lighter, power-saving sensors could be the key to cost-efficient methods of big data collection about zooplankton abundance and distribution. In particular, AUVs propelled by buoyancy engines (a subset of AUVs known as gliders) pair very well with fishery echosounders, which have already been used as a tool for measuring zooplankton concentrations in the water column. However, both hull-mounted and vessel-towed fishery echosounders are limited in the depths they can sample, due to attenuation of the transmitted sound over distance: this constraint has limited their usage in measuring deep layers of zooplankton. Attenuation becomes especially egregious for high frequencies, which are necessary to sample the smallest zooplankton such as copepods. Mounting an echosounder on a glider, on the other hand, uncouples it from this depth limitation, since the glider is free to move up and down in the water column, bringing the echosounder to the deepest plankton layers.

Centropages typicus, a type of copepods

My work focuses on the novel problem of specifically measuring layers of weak scatterers with a glider-mounted fishery echosounder. Previous glider-mounted echosounder studies have focused on measuring larger zooplankton such as krill (euphausiid) species, but this would be the first study to try and use one to measure smaller, weak scatterers deep in the ocean. If this work successfully demonstrates that gliders are capable of accurately measuring zooplankton of a variety of sizes throughout the water column, then it would introduce the ability to collect large amounts of data about zooplankton and oceanic conditions at relatively low cost compared to vessel data collection methods. Gliders can be deployed for weeks to months at a time with minimal human input, covering a vast area of the ocean at a much lower cost than deploying a vessel over the same area. This innovative data collection method would put a significant dent in the zooplankton undersampling problem and potentially lead to novel discoveries in a wide variety of fields from biology to chemical oceanography to ecology by expanding our knowledge of the natural world and some of the most widely distributed animals in it.

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Valider la capacité d’un échosondeur de pêche fixé sur un planeur à mesurer la concentration de mésozooplancton dans toute la colonne d’eau

WRITTEN BY CMOS BULLETIN SCMO ON APRIL 12, 2021. POSTED IN OCÉANS, QUOI DE NEUF.

– Par Delphine Mossman, Candidate de M.Sc., Univesité de Nouveau-Brunswick –

Malgré la petite taille de ses organismes, le mésozooplancton constitue l’un des groupes d’animaux les plus importants de la planète. Il joue un rôle important dans de nombreux cycles biogéochimiques qui ont des répercussions sur la planète, agit comme régulateur des populations de phytoplancton et constitue une source importante de nourriture pour une multitude de créatures marines, des petits poissons aux plus grands organismes de la planète, comme les baleines à fanons. Il est essentiel de comprendre l’abondance et la distribution du zooplancton – ainsi que son évolution dans le temps – afin de comprendre l’écosystème océanique mondial.

Malheureusement, mesurer le zooplancton n’est pas sans difficulté, la principale étant l’immensité de l’océan. De nombreuses techniques d’échantillonnage ont été mises au point pour recueillir des informations (filets, compteurs optiques de plancton, équipement d’imagerie du plancton, échosondeurs, pour ne citer que les plus importantes), mais leur portée est limitée du fait qu’elles doivent être déployées à partir d’un bateau. Les bateaux sont coûteux à affréter et à entretenir, et leur couverture temporelle et spatiale est relativement limitée; la plupart des déploiements de navires sont de l’ordre de quelques jours à quelques semaines et ne couvrent qu’un à cent kilomètres carrés. C’est pourquoi le zooplancton est l’un des organismes les plus sous-échantillonnés de l’océan, bien qu’il soit l’un des plus répandus.

Mes travaux portent sur le problème nouveau de la mesure spécifique de couches de diffuseurs faibles avec un échosondeur de pêche fixé sur un planeur. Fixer un échosondeur – méthode déjà utilisée pour mesurer les concentrations de zooplancton dans la colonne d’eau – sur un planeur (un sous-ensemble de véhicules sous-marins autonomes propulsés par un moteur à flottabilité) permet à ce dernier de se déplacer *librement dans la colonne d'eau, amenant l'échosondeur jusqu'aux couches de plancton les plus profondes. Si les résultats démontrent que les planeurs sont capables de mesurer avec précision le zooplancton de différentes tailles dans toute la colonne d'eau, nous pourrons recueillir de grandes quantités de données sur ces organismes et les conditions océaniques à un coût relativement faible par rapport aux méthodes de collecte de données par bateau. Cette méthode innovante de collecte de données permettrait de résoudre le problème du sous-échantillonnage du zooplancton et pourrait conduire à de nouvelles découvertes dans un grand nombre de domaines, de la biologie à l'océanographie chimique en passant par l'écologie, en élargissant notre connaissance du monde naturel et de certains des animaux les plus répandus.*

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The CCGS Amundsen: A Success Story In Arctic Oceanography

WRITTEN BY CMOS BULLETIN SCMO ON APRIL 21, 2021. POSTED IN NEWS & EVENTS, OCEANS, WHAT'S CURRENT.

– By Charles Brunette, Alice Le Guern-Lepage, Oreste Marquis, Noémie Planat, Antoine Savard and Sandrine Trotechaud (McGill University, Department of Atmospheric and Oceanic Sciences) –

As early career researchers, we are always on the lookout for learning more about the scientific landscape in which we evolve. We are six MSc and PhD students from the sea ice group at McGill University, and our research focuses on the Arctic Ocean. We were naturally interested in the outreach workshop hosted by Amundsen Science on March 23, 2021 and curious to learn more about the future expeditions and research opportunities aboard the Canadian Coast Guard Ship (CCGS) Amundsen. We also wished to deepen our knowledge about the history, the research apparatus and the expedition logistics of this renowned vessel. Organized in the broader context of the Amundsen scientific planning meeting, the outreach workshop aimed at connecting with the public and with different groups of potential users (like us!), and at raising awareness about the impact and the importance of the CCGS Amundsen for Canadian Arctic research. In the following, we summarize the content of the workshop and share a few takeaways.

History of the Amundsen

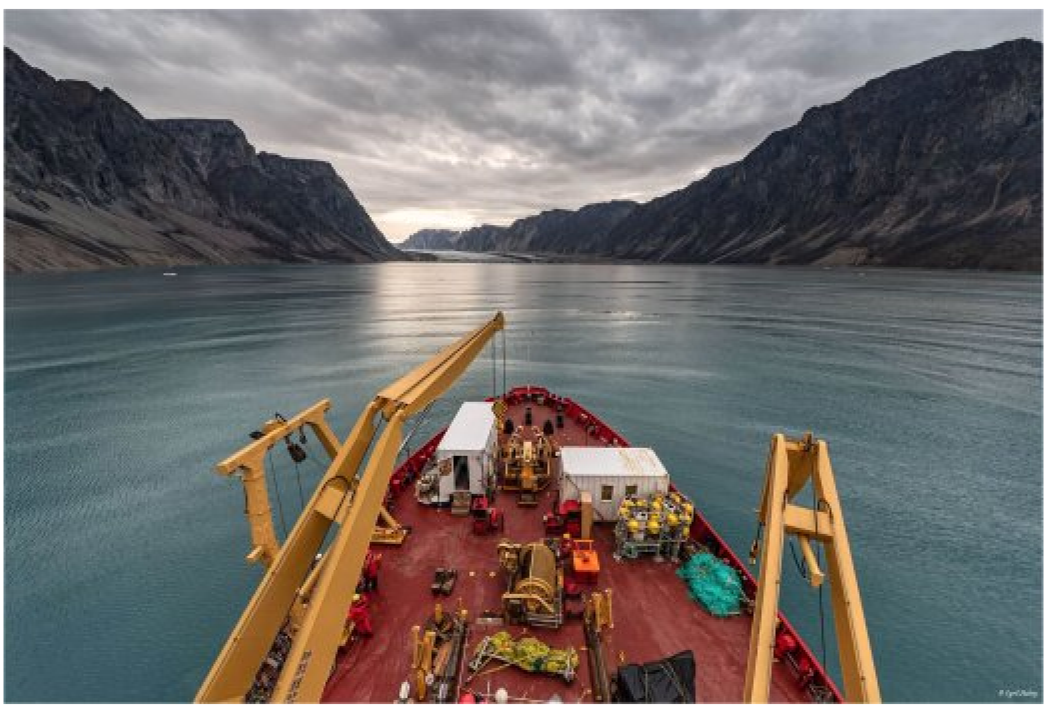
In the 1990s, the absence of Canadian polar research ship infrastructure impelled scientists to deploy ice camps for ocean research, small settlements directly established on the pack ice. While it certainly was a unique experience, it required quite a lot of physical work to maintain the camps, and the number of oceanographers that could go to sea was limited. By design, the camps were also missing on data from the polynyas, which are areas of open water surrounded by sea ice that are of special significance for ecological and oceanographic research. A few ships started being used for science during that time, specifically for studying the North Water Polynya, and the success of these early missions compelled the scientists to explore the western part of the Arctic.

This is where the Amundsen's story begins. A group of 54 researchers from 12 universities, led by the tireless Louis Fortier (1953-2020), brought forward the project of a Canadian icebreaker to NSERC. In March 2001, the Canada Foundation of Innovation (CFI) was allowed to fund the researchers' ship project, and, in the dry docks of Les

Méchins (Québec), the CCGS Amundsen rose from the decommissioned hull of the vessel formerly known as the CCGS Sir John Franklin. By September 2003, the ship, now equipped with state-of-the-art scientific equipment, was ready to start its inaugural year-long voyage with Martin Fortier as chief scientist. The Amundsen was part of over seventeen important expeditions: Canadian Arctic Shelf Exchange Study (CASES-2003), Nunavik Inuit Health Survey (2004, 2007-2008 and 2017), Circumpolar Flaw Lead (CFL), etc.

From the start, a productive collaboration developed between the Amundsen and ArcticNet, who were the primary user for the vessel. Another important collaboration was established with the oil and gas industries. This partnership had the objective to explore the Beaufort sea, although the public concern about oil spills raised ethical questions. By the end of the oil and gas partnership in 2015, the Amundsen team had seized the opportunity to learn how to balance the research interests of different stakeholders, designing expeditions that address the needs of academia, governments, communities, and occasional industrial partners. The several scientific collaborators who have joined the Amundsen adventure these last years have contributed to an increasing diversification of the exchanges onboard.

How it’s done



Since 2002, the Amundsen icebreaker from the Canadian Coast Guard fleet has been devoted to science. Over the years, the close partnership between Amundsen Science and the Canadian Coast Guard established the vessel as a leading force in Canadian

Arctic Research. Amundsen Science is the non-profit organization managing the scientific mandate of the ship. It is also one of the 17 National Research Facilities supported by the Major Science Initiatives Fund of the Canada Foundation for Innovation (CFI). The CFI contributes to 60% of the funding while the remaining 40% relies on external contributions. Dedicated onshore and seagoing personnel from the Canadian Coast Guard play a key behind-the-scenes role in scientific expeditions boarding the CCGS Amundsen by managing the logistics and ensuring the maintenance of the vessel. The close connection to the user community (mainly governmental and academic researchers, but also extending to local communities or external partners) is also important for the Amundsen's accomplishments. Indeed, the Amundsen Science team is driven by the will to understand and address the needs of the user community through several projects such as the Schools on Board Program dedicated to youth involvement, the annual expedition planning workshop, or the Inuit Health Survey (Qanuilirpitaa) across Nunavik.

Amundsen's impacts in the scientific world

The workshop further discussed the instrumental role of the CCGS Amundsen and Amundsen Science in supporting Arctic research in Canada and at the international level. At the national level, the research icebreaker fosters Northern leadership, serving as 'Canada's premier networking platform', in the words of David Barber (U. Manitoba), who went on describing the Amundsen project as an incubator of science for us to understand the Arctic and how it works. As a mobile lab, the icebreaker can connect different communities, and it is a strategic element in the planning of Canadian Arctic research infrastructure projects, such as the soon-to-be Churchill Marine Observatory. Its central role in national research earned the CCGS Amundsen a well-deserved place on our 50$ banknote! The Amundsen also boosts international partnerships, for instance, with its inclusion in the Arctic Research Icebreaker Consortium (ARICE), alongside other flagship vessels such as the R/V Polarstern. Marcel Babin (U. Laval) presented two of these successful collaborative projects, namely the Malina project (Canada-France-USA) that studied terrestrial carbon exports into the Arctic, and the Green Edge project (Canada-France) that investigated the blooming of marine ecosystems in the spring. These large scale and synergetic research projects were described as being the most scientifically productive, using the full capacity of the Amundsen. These several examples illustrate the importance of maintaining strong seagoing polar research capabilities for sustaining productive national and international networks. The Amundsen is not only present in the scientific community, but also in the public one. With projects like Artist on Board and media competitions, the vessel's mission is shared across the world. This last competition gave the opportunity to fifteen journalists from twelve countries around the globe to embark on the Amundsen for a journey in the Arctic.

Future of the Amundsen

The last part of the workshop discussed future plans for the Amundsen. The vessel is now 42 years old and will undergo a complete refit to extend its life for ten more years. The repairs have started in May 2020 and will last until July 2022 (with summer 2021 as an interruption). These repairs will also equip the ship with new instruments to support both Canadian Coast Guard missions and scientific data acquisition. Beyond this life extension, the vessel itself might need to be replaced, and different options are considered. Building a new ice breaker dedicated to science is an ambitious and exciting, yet challenging project, that also depends on several political decisions, and discussions with the Government of Canada are undergoing.

Finally, the scientific program for the coming years was briefly discussed. The current CFI funding is arriving to an end, and the Amundsen team will be applying for an extension for the period 2023-2029. Alexandre Forest, executive director of Amundsen Science, reminded us that any project could be discussed and planned for the coming years: it’s time for new ideas! So far, upcoming projects include a study of the fragile ecosystem of the deep ocean using the new Comanche ROV, a study of the permafrost Carbon on the Beaufort Shelf, the Dark Edge program, and the Sentinelle Nord International PhD School in 2022. The Amundsen team is further devising a wintering in the Baffin Bay and a trade in ship time with France Flotte (program named Oceanographic Fleet Exchange).

The Amundsen, a success story

Reaching beyond its core scientific mission, with education and youth involvement programs such as Schools on Board, visits to Inuit communities, and opportunities for graduate students, the success of the CCGS Amundsen in the last twenty years is undeniable. It accumulates over 2 200 research days at sea, 250 000 nautical miles (11.5 times around the Earth), 116 teams in 20 major programs, 98 international organizations, and 26 Canadian universities. It definitely played and keeps on playing a major role in training a new generation of Arctic scientists.

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Le NGCC Amundsen: une réussite en océanographie arctique

WRITTEN BY CMOS BULLETIN SCMO ON APRIL 21, 2021. POSTED IN NOUVELLES ET ÉVÉNEMENTS, OCÉANS, QUOI DE NEUF.

– Par Charles Brunette, Alice Le Guern-Lepage, Oreste Marquis, Noémie Planat, Antoine Savard and Sandrine Trotechaud (Université McGill, Department of Atmospheric and Oceanic Sciences) –

En tant que chercheur.euse.s en début de carrière, nous sommes toujours à l'affût d'en apprendre davantage sur le milieu scientifique dans lequel nous évoluons. Nous sommes six étudiant.e.s à la maîtrise et au doctorat du groupe des glaces de mer de l'Université McGill, et nos recherches portent sur l'océan Arctique. Nous étions naturellement intéressé.e.s par l'atelier d'information organisé par Amundsen Science le 23 mars, curieux.ses d'en connaître plus sur les futures expéditions et les possibilités de recherche à bord du navire de la Garde côtière canadienne (NGCC) Amundsen. Nous souhaitions également approfondir nos connaissances sur l'histoire, l'appareil de recherche et la logistique des expéditions de ce navire renommé. Organisé dans le contexte plus large de la réunion de planification scientifique de l'Amundsen, l'atelier d'information visait à établir un contact avec le public et avec différents groupes d'utilisateurs potentiels (comme nous !), et à sensibiliser le public à l'importance du NGCC Amundsen pour la recherche dans l'Arctique canadien. Dans les lignes qui suivent, nous résumons le contenu de l'atelier et partageons quelques points à retenir.

Histoire de l'Amundsen

Dans les années 1990, l'absence de navires canadiens dédiés à la recherche polaire a poussé les scientifiques à déployer des camps directement sur la banquise afin d'effectuer leurs études. Bien qu'il s'agissait certainement d'une expérience unique, l'entretien des camps exigeait un travail physique considérable, et le nombre d'océanographes pouvant se rendre sur la mer gelée était limité. De par leur conception, ces camps ne permettaient pas de récolter de données sur les polynies, des zones d'eau libre entourées de glace de mer, qui revêtent une importance particulière pour la recherche écologique et océanographique. Quelques navires avaient commencé à être utilisés à des fins scientifiques à cette époque, notamment pour étudier la polynie des eaux du Nord, et le succès de ces premières missions a incité les scientifiques à vouloir explorer la partie occidentale de l'Arctique.

C’est ici que commence l’histoire de l’Amundsen. Un groupe de 54 chercheurs de 12 universités, dirigé par l’infatigable Louis Fortier (1953-2020), soumet au CRSNG le projet d’un brise-glace canadien. En mars 2001, la Fondation canadienne pour l’innovation (FCI) a été autorisée à financer le projet de navire des chercheurs et, dans les cales sèches de Les Méchins (Québec), le NGCC Amundsen a émergé de la coque désaffectée du navire anciennement connu sous le nom de NGCC Sir John Franklin. En septembre 2003, le navire, maintenant équipé d’un matériel scientifique de pointe, était prêt à entreprendre son voyage inaugural d’un an, avec Martin Fortier comme scientifique en chef. Depuis ce temps, l’Amundsen a participé à plus de dix-sept expéditions importantes: le Canadian Arctic Shelf Exchange Study (CASES-2003), plusieurs Nunavik Inuit Health Survey (2004, 2007-2008 et 2017), le Circumpolar Flaw Lead (CFL), et plusieurs autres..

Dès le début, une collaboration productive s’est développée entre l’Amundsen et ArcticNet, cette dernière étant la principale utilisatrice du navire. Une autre collaboration importante a été établie avec l’industrie pétrolière et gazière. Ce partenariat avait pour objectif d’explorer la mer de Beaufort, bien que l’inquiétude du public concernant les déversements de pétrole ait soulevé des questions éthiques. Durant le partenariat avec les industries pétrolières et gazières, qui a pris fin en 2015, l’équipe de l’Amundsen a saisi l’occasion d’apprendre à balancer les intérêts de recherche de différents acteurs, en élaborant des expéditions qui répondent aux besoins du secteur académique, du secteur gouvernemental, des communautés et des partenaires industriels occasionnels. Les nombreux collaborateurs scientifiques ayant rejoint l’aventure Amundsen au cours des dernières années auront permis de diversifier les échanges à bord.

Comment c’est fait

Depuis 2002, le brise-glace Amundsen de la flotte de la Garde côtière canadienne se consacre à la science. Au fil des ans, le partenariat étroit entre Amundsen Science et la Garde côtière canadienne a fait de ce navire une force de premier plan dans la recherche arctique canadienne. Amundsen Science est l'organisme sans but lucratif qui gère le mandat scientifique du navire. Amundsen Science est également l'une des 17 installations de recherche nationales soutenues par le Fonds des initiatives scientifiques majeures de la Fondation canadienne pour l'innovation (FCI). La FCI contribue à 60% du financement, tandis que les 40% restants dépendent de contributions externes. Le personnel terrestre et maritime dévoué de la Garde côtière canadienne joue un rôle clé dans les coulisses des expéditions scientifiques à bord du NGCC Amundsen en gérant la logistique et en assurant l'entretien du navire. Le lien étroit avec la communauté des utilisateurs (principalement des chercheurs gouvernementaux et universitaires, mais aussi des communautés locales ou des partenaires externes) est également important pour les réalisations de l'Amundsen. En effet, l'équipe scientifique de l'Amundsen est animée par la volonté de comprendre et de répondre aux besoins de la communauté des utilisateurs par le biais de plusieurs projets tels que le programme Schools on Board (écoles à bord) consacré à la participation des jeunes, l'atelier annuel de planification des expéditions, ou encore l'enquête sur la santé des Inuits (Qanuilirpitaa) au Nunavik.

Impacts de l'Amundsen dans le monde scientifique

D’autres présentations ont abordé le rôle déterminant du NGCC Amundsen et d’Amundsen Science dans le soutien de la recherche arctique au Canada et à l’international. Au niveau national, le brise-glace de recherche favorise un leadership nordique, en servant de « première plateforme de réseautage au Canada », selon David Barber de l’Université du Manitoba, qui a poursuivi en décrivant le projet Amundsen comme un incubateur scientifique qui nous aide à comprendre l’Arctique et son fonctionnement. En tant que laboratoire mobile, le brise-glace peut relier différentes communautés et constitue un élément stratégique dans la planification des projets d’infrastructure de recherche dans l’Arctique canadien, comme le futur observatoire marin de Churchill. Le rôle central du NGCC Amundsen dans la recherche au niveau national lui vaut une place bien méritée sur notre billet de 50 $! L’Amundsen favorise également les partenariats internationaux, par exemple en faisant partie de l’Arctic Research Icebreaker Consortium (ARICE), aux côtés d’autres navires phares comme le R/V Polarstern. Marcel Babin (U. Laval) a donné en exemple deux collaborations internationales ayant connu du succès, à savoir le projet Malina (Canada-France-États-Unis) portant sur les exportations de carbone terrestre dans l’Arctique, et le projet Green Edge (Canada-France) portant sur l’efflorescence des écosystèmes marins au printemps. Ces projets de recherche synergiques à grande échelle ont été décrits comme étant les plus productifs sur le plan scientifique, et utilisent l’Amundsen à pleine capacité. Ces quelques exemples illustrent l’importance de maintenir de solides capacités de recherche polaire en mer pour soutenir des réseaux de recherche nationaux et internationaux productifs. L’Amundsen n’est pas seulement présent dans la communauté scientifique, mais aussi auprès du public. Grâce à des projets tels que Artist on Board et des concours médiatiques, la mission du navire est partagée à travers le monde. Ce dernier concours a permis à une quinzaine de journalistes de douze pays différents d’embarquer sur l’Amundsen pour un voyage dans l’Arctique.

Quel futur pour l’Amundsen ?

La dernière partie de l’atelier a abordé les futurs évolutions de l’Amundsen. Le bateau a maintenant 42 ans, et sera complètement rééquipé et rénové en prévision des 10 prochaines années. Cette réparation a commencé en mai 2020 et finira en juillet 2022, avec une interruption pour l’été 2021. À cette occasion, le bateau sera équipé avec de nouveaux instruments qui servirons à l’exploration scientifique ou à la mission de gardecôtes du navire. Au delà de ces 10 années supplémentaires, il faudra sûrement considérer changer entièrement le brise-glace, et plusieurs options sont actuellement envisagées. Construire un nouveau navire entièrement dédié à la science est un projet ambitieux, avec des perspectives scientifiques très intéressantes, mais reste complexe à implémenter du point de vue des décisions politiques et économiques; des discussions sont en cours avec le Gouvernement du Canada.

Enfin, le programme scientifique des prochaines années a été brièvement discuté. Le financement actuel à travers le CFI se termine l'an prochain, et l'équipe d'Amundsen science appliquera à nouveau afin de bénéficier de ce financement pour la période 2023-2029. Dans cette optique, c'est le bon moment pour discuter et planifier de nouvelles idées et de nouveaux projets, nous rappelle Alexandre Forest (directeur exécutif d'Amundsen sicence). Les prochaines années permettront d'étudier l'écosystème fragile de l'océan profond avec un nouveau véhicule sous-marin téléguidé, une analyse du permafrost sur le plateau continental de Beaufort, le programme Dark Edge et l'école d'été Sentinelle Nord qui devraient avoir lieu à l'été 2022. Un hivernage dans la Baie de Baffin est aussi en discussion, ainsi que des échanges de temps de navire avec la Flotte océanographique française (programme appelé Oceanographic Fleet Exchange).

La réussite de l'Amundsen

Allant au-delà de sa mission scientifique fondamentale, avec des programmes d'éducation et de participation des jeunes tels que des écoles flottantes, des visites aux communautés inuites et des opportunités pour les étudiants diplômés, le succès du NGCC Amundsen au cours des vingt dernières années est indéniable. Il cumule plus de 2 200 jours de recherche en mer, 250 000 miles nautiques (11,5 fois le tour de la Terre), 116 équipes dans 20 programmes majeurs, 98 organisations internationales et 26 universités canadiennes. Il a définitivement joué et continue de jouer un rôle majeur dans la formation d'une nouvelle génération de scientifiques de l'Arctique.

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Climate Science for the People

WRITTEN BY CMOS BULLETIN SCMO ON APRIL 29, 2021. POSTED IN OTHER, WHAT'S CURRENT.

– By Haley Alcock from an interview with Dr. Jennifer Gobby –

Last September, as the Day for Climate Action was approaching, the Climate Scenarios, Impacts and Modelling Lab at Concordia University asked themselves what they as a group could do to contribute to this globally recognized day. The lab, lead by Damon Mathews, was traditionally a climate modelling research group but in recent years has been welcoming social scientists as experts in the social dimensions of climate change. One of these social scientists is postdoctoral fellow Dr. Jen Gobby, who came in with the suggestion that for the Global Day of Climate Action, the lab open up their weekly Zoom lab meeting and invite climate activists from across the country to attend and ask any questions they have about the science of climate change.

Dr. Gobby is an activist-scholar who has worked closely with climate activists, Indigenous land defenders and academics to “figure out ways that we can use research to support transformative change towards climate justice in Canada”. Throughout this work, Dr. Gobby has found that some of the most transformative change happens when different communities come together to build relationships and solidarity with each other. Opening the lab meeting to climate activists came from the idea that it could help facilitate this type of connection. As climate scientists, we are often isolated and siloed within academia, government, and research. While most care about creating change, climate scientists are not always the best at communicating motivation or galvanizing action. Welcoming climate activists into the (zoom) room—in particular, youth activists who in recent years have been extremely effective in the climate movement—allowed the activists to ask the questions that they need answered to better back up their arguments and communicate their messages. They called the event “Climate Science for the People” and two separate events were hosted in each English and French.

The poster used for advertising the event on social media

In Dr. Gobby's work, she has found that for transformative change through relationship-building to be effective, there must be an equalizing or "flipping" of power. Whereas typically science knowledge mobilization is based on what the scientist wants to talk about and then figuring out who might be interested in that, the Climate Science for the People event differed in that the conversation was shaped around what the activists wanted to talk about.

Flipping the knowledge mobilization model brought out some unanticipated topics. Dr. Gobby explained that prior to the event, she had been expecting technical scientific questions to be asked around emissions measurements or the science of how the planet warms. Instead, many of the questions had deep philosophical or strategic components, in addition to being scientific questions. In both the English and the French events questions came up again and again such as, "Do you feel like there's hope?", "Is geoengineering a good idea?", "How much can natural solutions like re-forestation or regenerative agriculture actually help?", and "What the best thing we can do?". From this unique event format, the scientists who participated had the chance to evaluate how the knowledge that they have relates to what these activists are interested in and how to best support them.

Both the English and French events brought in nearly thirty people. Dr. Gobby said that she would like to run the event annually with a continued focus on climate activists, but also for other audiences such as policymakers, urban planners or other folks who are making decisions around how we will act on climate change. She reiterated the importance of increasing communications between all these different groups that are working on the climate crisis.

To truly do science that contributes to transformation change towards climate justice, Dr. Gobby explained, this equalizing (or even reversal) of power that she facilitated in the Climate Science for the People event must start much before knowledge mobilization and go right down to the defining of the research questions. Grassroots communities everywhere—whether they be activists, frontline land defenders, community groups, Indigenous groups, local policymakers, etc— want to implement climate solutions that reflect the needs of their community. If these communities were able to link up with researchers who are ready to have the communities defining the research questions and leading the projects for the community's own benefit, this could be a path towards really scaling up the capacity for climate justice solutions to be implemented across Canada.

Dr. Gobby's advice for scientists who want to do this kind of work: relationship building. Researchers need to be clear from the start that they will share decision making power with the communities they are working with, and that they're committed to doing research that actively benefits the community based on the community's own measures of what will benefit them. Research groups (whether that be departments or individual labs) that want to increase their impact need to do more collaborative strategic planning that includes bringing community members, activists and social scientists to those conversations and asking questions like, "What do we want to accomplish in the next 5 years?", "What do we want to be focusing on?", "Who do we want to be working with?", and "How can we mobilize our knowledge in meaningful and accessible ways that contribute to creating change?".

There are lots of ways that climate scientists can become more engaged with climate action and flip the script on how and why we do science. The Climate Science for the People series is a great example of what that can look like!

Haley Alcock *is the editor of the CMOS Bulletin. She holds a masters of science in micrometeorology from McGill University. Haley splits their time between doing climate science, communicating science, organic farming and working towards climate justice.*

Dr. Jennifer Gobby *is an activist-scholar based in rural Quebec. She is founder of the MudGirls Natural Building Collective, and organizes with Climate Justice Montreal. She completed her Ph.D at McGill in 2019 as part of the Economics for the Anthropocene partnership and is now a post doctoral fellow at Concordia University in the Department of Geography, Planning and Environment. She has spent the last 5 years thinking collaboratively with land defenders and environmental justice activists about how we can more powerfully push for large scale social change. Her current research focuses on documenting and leveraging the learnings going on in movements and communities about how we can seize the Covid-19 crisis to push for transformative change in social, economic and political systems. She is also working on a project with Indigenous Climate Action to develop Indigenous-led climate policy. She is on the steering committee of Concordia's SHIFT Centre for Social Transformation.*

La science climatique pour le peuple

WRITTEN BY CMOS BULLETIN SCMO ON APRIL 29, 2021. POSTED IN AUTRES, QUOI DE NEUF.

– Par Haley Alcock (à la suite d'une entrevue avec Mme Jennifer Gobby) –

Dans le cadre de la Journée mondiale d'action pour le climat à l'automne 2020, Mme Jennifer Gobby a organisé deux événements intitulés La science climatique pour le peuple en français et en anglais. Dans le cadre de ces événements, des activistes luttant contre les changements climatiques ont été invités à poser des questions à des spécialistes du climat concernant la science des changements climatiques. Tandis que la mobilisation du savoir scientifique est généralement fondée sur les sujets que les scientifiques veulent aborder avant de s'enquérir de ceux qui pourraient s'y intéresser, l'événement La science climatique pour le peuple donnait la parole aux activistes. À partir de ce format d'événement unique, les scientifiques qui ont participé ont eu la chance de déterminer comment les connaissances qu'ils possèdent ont trait aux champs d'intérêt de ces activistes et la meilleure façon de les soutenir.

Mme Gobby est une savante engagée qui a travaillé en étroite collaboration avec des activistes luttant contre les changements climatiques, des défenseurs des territoires autochtones et des universitaires afin de « trouver des façons dont nous pouvons exploiter la recherche pour appuyer un changement transformateur menant vers une justice climatique au Canada ». Elle a découvert que l'exercice de la science d'une façon qui contribue au changement transformateur menant à une justice climatique exige d'établir des relations avec les communautés en leur donnant du pouvoir. Les communautés locales de tout genre — qu'il s'agisse d'activistes, de défenseurs de territoires, de groupes communautaires, de groupes autochtones, de décideurs politiques locaux, etc. — veulent mettre en œuvre des solutions climatiques qui tiennent compte de leurs besoins. Si ces communautés pouvaient s'associer à des chercheurs qui sont prêts à ce que les communautés définissent les questions de recherche et dirigent les projets au profit de la communauté, il pourrait être possible de renforcer réellement la capacité des solutions de justice climatique à mettre en œuvre partout au Canada.

La série La science climatique pour le peuple est un excellent exemple de la façon dont les scientifiques climatiques peuvent s'investir davantage dans l'action climatique et renverser la vapeur sur la manière d'exercer la science et les raisons de le faire.

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A Message from the CMOS President, Spring 2021

WRITTEN BY CMOS BULLETIN SCMO ON MAY 7, 2021. POSTED IN MEMBERS, OTHER, WHAT'S CURRENT.

– By Marek Stastna –

As I sit down to write my comments, it seems that the Southern Ontario spring has finally sprung. Outside of my bedroom/office windows, the grass is green, the odd tree has buds and bird song can be heard from very early in the morning. It is true that yesterday I could have looked out at wet snow, but this was short-lived, and every walk I take with my loyal spaniel seems to be a stop and go challenge of the 1000 smells of an awakening world. The dog is, after 12 solid months of having all his humans at home, thoroughly spoiled; a happy exception in a list of pandemic problems for which the adjective "happy" is rarely accurate.

This April also marks my third term of teaching online. What started out as an interesting challenge in late March of 2020 has become a slog of multi-tasking: I create content, I schedule meet times for students strewn across a half dozen time zones, I listen when students need to talk, and increasingly I struggle for evaluation options. I am lucky to teach a sizeable class divided between upper-year physics and mathematics students. Many of these students are struggling with the "what do I do after undergraduate studies" question, and for many, the corner of the research universe I inhabit is terra incognita. This year, I was able to leverage the online nature of the CMOS Speaker Tour for a small reaction piece assignment. I asked these students to react to any aspect of Prof. Fennel's talk and develop their reaction into a half-page mini-essay. Quite a few of the students hit upon the same science themes, and if you missed the Speaker Tour yourself, the YouTube recording is the best source for developing your own opinions. But it was the commonality of theme in the students' reactions that I want to expand on here. Put quite simply, the challenges of under-sampling of the ocean were completely new to the students. In fact, not only was the topic new, the students as a group were shocked that under-sampling isn't being actively fixed. At first, I was quite shocked myself since there isn't a week during which the vagaries of cobbling together a research program on limited funding don't occupy at least some of my time. However, on subsequent reflection, it makes good sense that a younger generation who have essentially grown up with the upward spiralling urgency of climate change would expect better.

What stops us from doing better? Much of this younger generation has the energy to fix these challenges and are passionate about finding solutions to climate change but in hierarchies such as those that distribute research funding young people are frozen out of the decision making structures entirely. Moreover, there is a strange perversion in that the urgency of climate change often works against the funding of basic science related to climate. Put simply, Canada's funding agencies have a far clearer track record in demanding social science involvement in very large grants (in itself, quite a good thing) than they do in ensuring that our basic data gathering ability grows at a rate commensurate to our GDP. There is the secondary issue of making sure that when data is gathered, it is openly available to the community. On this front, there is recent progress, but here again, we trail well behind our major international collaborators and competitors.

I believe quite strongly that we can have both climate impacts research and an increase in the gathering of vital data from atmosphere, ocean, land and cryosphere. I also believe relatively simple technologies exist for sharing this data in an open, and equitable way. To round this corner, however, we need clear, two-way communication with our funding agencies, something that is shockingly absent at the moment. The COVID-pandemic will create a significant disruption in many data sets, and this is the right time for a national conversation on how we ensure that the core strength of the sciences within the CMOS mandate is enhanced going forward. I hope in a few years when I again ask for a thought paper from students on the topic of data sampling, I will be surprised at how much better our data volume and data access got after 2021.

***Marek Stastna** is presently serving as the President of CMOS. Marek studies internal waves in the coastal ocean using a combination simulations and mathematical modelling. He has a broad set of interests in software development and the applications of modern computational mathematics in oceanography and climate science. He is a professor in the Department of Applied Mathematics at the University of Waterloo.*

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Message du président de la SCMO, printemps 2021

WRITTEN BY CMOS BULLETIN SCMO ON MAY 7, 2021. POSTED IN QUOI DE NEUF.

– Par Marek Stastna –

Le printemps est arrivé dans le Sud de l'Ontario et le mois d'avril marquera mon troisième mandat d'enseignement en ligne. Ce qui a d'abord pris la forme d'un défi intéressant à la fin mars 2020 s'est transformé en une multiplicité de tâches à accomplir. J'ai la chance de donner un cours à un groupe assez nombreux d'étudiants de dernier cycle en physique et en mathématiques. Cette année, j'ai pu tirer parti de la tournée de conférenciers itinérants de la SCMO en ligne afin de solliciter les commentaires de mes étudiants. Je leur ai demandé de réagir à tout aspect de la conférence du professeur Fennel en rédigeant un mini-essai d'une demi-page. Les problèmes de sous-échantillonnage de l'océan ont été l'une des principales réactions des étudiants. En fait, il s'agissait non seulement d'un nouveau sujet pour eux, mais en tant que groupe, les étudiants ont été consternés d'apprendre que le sous-échantillonnage n'est pas corrigé. Il est logique qu'une génération plus jeune ayant essentiellement grandi dans la spirale croissante de l'urgence des changements climatiques s'attende à mieux.

Qu'est-ce qui nous empêche de faire mieux? Une grande partie de cette génération plus jeune a l'énergie nécessaire pour régler ces problèmes et la volonté de trouver des solutions aux changements climatiques, mais dans les hiérarchies en place comme celles qui distribuent des fonds pour la recherche, les jeunes sont totalement écartés des structures décisionnelles. De surcroît, l'urgence des changements climatiques va souvent à l'encontre du financement de la science fondamentale liée au climat. Il y a aussi la question secondaire de faire en sorte que lorsque les données sont recueillies, elles soient accessibles à la communauté. À ce chapitre, des progrès récents ont été réalisés, mais nous tirons vraiment de l'arrière par rapport à nos principaux collaborateurs et concurrents internationaux.

Je suis d'avis que nous pouvons à la fois mener des recherches sur les impacts climatiques et accroître la collecte de données essentielles relatives à l'atmosphère, à l'océan, à la terre et à la cryosphère. Je crois également que des technologies relativement simples existent pour partager ces données de façon ouverte et équitable. Nous avons besoin de communications bidirectionnelles claires avec nos organismes de financement, un aspect qui est lamentablement absent à l'heure actuelle. La pandémie de COVID-19 perturbera considérablement de nombreux ensembles de données, et l'heure est arrivée d'avoir une conversation nationale sur la façon de nous assurer que la principale force des sciences au sein du mandat de la SCMO est améliorée à l'avenir. J'espère que d'ici quelques années, lorsque je demanderai encore *une fois un document de réflexion à mes étudiants sur la question de l'échantillonnage de données, je serai agréablement surpris de l'amélioration notable de notre volume de données et de leur accès après 2021.*

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Outgoing President’s Message from Marek Stastna

WRITTEN BY CMOS BULLETIN SCMO ON JUNE 14, 2021. POSTED IN MEMBERS, WHAT'S CURRENT.

– By Marek Stastna –

In any other year, this article would probably start with something along the lines of “looking back at my year as President, I am not sure where the time went”. Given the enforced repetition of working from home, and especially of working from home during stay-at-home orders, the year didn’t exactly scamper by me. Nevertheless, there is an undeniable temporal slippage associated with large organizations, spread over larger geographic areas. So as we head into a very busy Congress, the annual meeting of various committees, and of course the AGM that will formally end my Presidency here is a quick look back.

Let me begin by noting that one year ago we weren’t really sure if electronic conferences were going to work. The 54th CMOS Congress, organized on the fly by extremely dedicated, Ottawa-based volunteers, proved more popular than anyone expected. With a year of online conferencing under our collective belts, the expectation is that the 55th CMOS Congress will prove even more popular. Put simply, online conferences fit more busy schedules, satisfy more budget constraints, and keep the better half of internet-based anonymity (you can watch talks in your PJs) while controlling the more negative aspects (moderators ensure civility). Online conferences cannot replace physical meetings but can provide a carbon footprint reducing alternative that CMOS has agreed to adopt going forward in alternate years.

Of course, CMOS has never been based on physical meetings. Thus, it is perhaps no surprise that the Executive, Council, Center Chairs, and the Schools and Public Education Committee all had a smooth, highly productive year. Indeed, perhaps due to the limited set of distractions, the consultations conducted as part of the Strategic Planning exercise proved quite popular with a broad range of voices providing feedback. The result is CMOS’ first full Strategic Plan-Implementation Plan combination. The first of these provides a partial accounting of the Society’s priorities over the next three years, with more than enough flexibility to take advantage of opportunities that develop and address challenges that arise. The second provides a more detailed set of actions for the upcoming year (a new Implementation Plan will be developed each year going forward), something that is important as the Executive officially moves to Halifax and multiple individuals transition into new roles.

This is also the year that the Society’s efforts to re-engage the civil service have begun to bear fruit. The “bulk” rate for ECCC staff will allow a much larger number of government scientists to participate in the 55th CMOS Congress. Securing a similar arrangement for DFO staff and staff of other federal and provincial departments is high on the priority list for next year. Expanding participation within all these groups as full CMOS members remains a longer-term work in progress. The United Nations Decade of Ocean Science for Sustainable Development presents further opportunities for CMOS to expand its activities in the marine sciences, and for CMOS members to play strong roles in national and international projects.

Finally, the generous support for non-profits provided by the federal government has allowed CMOS to work on modernizing our business practices. For many members, the inner workings of the CMOS Council and Executive must seem quite removed from their daily experience. I sympathize with this view, and note that the strong, local Center Chairs are an essential part of CMOS going forward precisely because they better represent the diversity of individual member experiences. Nevertheless, governance is the motor oil of any organization's engine. It was thus a real pleasure to interact with the Institute on Governance, which provided a formal review of CMOS governance, making a number of clear and cogent suggestions that we, as an organization, have begun to implement. Their final report is available online, and its footprint is evident throughout the Strategic and Implementation plan.

CMOS is not an organization without its challenges. Certainly, as Canada comes out of the pandemic the fiscal situation of non-profits like CMOS will need careful monitoring. I do note that this year's budget is far healthier than I anticipated a year ago. However, our biggest challenge as a Society is to be truly inclusive. Here I certainly mean inclusive of members with different personal backgrounds, but also inclusive in terms of scientific disciplines. I believe disciplinary boundaries mean less to our younger members than they once did, and while CMOS is not the only home for environmental and climate-related science in Canada we should strive to be known as the most welcoming; whether through sessions at our Congresses, joint ventures with related societies, or a generous and welcoming spirit toward new types of members with new types of interests.

I began my time as President by noting that my guiding principle for my Presidential year comes from Mr. Spock: "The needs of the many outweigh the needs of the few or the one." Over my year as President, I have had multiple occasions to remind me of the difficulty of successfully applying this principle, but overall, I believe our Society has managed to stick to it. Moreover, I believe Jim Abraham, the next CMOS President, and the incoming Halifax cohort will ably guide CMOS forward, through what I hope is a year of reopening and rediscovery. I thus sign off, returning to being a proud resident of CMOS' techie, mathematics heavy corner and say to the Society and its scientific smorgasbord of members "Live long, and prosper".

***Marek Stastna** is presently serving as the President of CMOS. Marek studies internal waves in the coastal ocean using a combination simulations and mathematical modelling. He has a broad set of interests in software development and the applications of modern computational mathematics in oceanography and climate science. He is a professor in the Department of Applied Mathematics at the University of Waterloo.*

Message du président sortant par Marek Stastna

WRITTEN BY CMOS BULLETIN SCMO ON JUNE 14, 2021. POSTED IN QUOI DE NEUF.

– Par Marek Stastna –

N'importe quelle autre année, cet article commencerait probablement par quelque chose du genre « lorsque je pense à mon année de présidence, je me demande où est passé le temps ». Étant donné la répétition forcée du travail à la maison, et surtout du travail à domicile pendant les décrets ordonnant de rester chez soi, disons que l'année n'a pas exactement passé à la vitesse supérieure pour moi. Néanmoins, il existe un glissement temporel indéniable associé aux grandes organisations, réparties sur de plus grandes zones géographiques. À l'aube d'un congrès très chargé, de la réunion annuelle des différents comités et, bien entendu, de l'assemblée générale annuelle qui mettra officiellement fin à ma présidence, voici un bref retour en arrière.

Cette année, nous avons été en mesure de planifier et de réaliser avec succès deux congrès en ligne. Nous avons établi la première combinaison complète Plan stratégique-Plan de mise en œuvre de la SCMO qui nous guidera pour les trois prochaines années. Nous avons obtenu l'espace nécessaire pour permettre à beaucoup plus de membres du personnel d'ECCC d'assister au congrès et nous continuons à travailler à un engagement encore plus large des fonctionnaires dans la société, notamment les spécialistes des sciences de la mer. Enfin, nous avons procédé à un examen de la gouvernance afin d'actualiser nos pratiques commerciales, qui est désormais accessible sur le site Web.

La SCMO connaît son lot de défis. Il est certain qu'à mesure que le Canada se rétablit de la pandémie, la situation financière des organismes sans but lucratif comme la SCMO devra être surveillée de près. Cependant, notre plus grand défi en tant que société est d'être réellement inclusifs. J'entends par là l'inclusion de membres ayant des antécédents personnels différents, mais aussi l'inclusion en termes de disciplines scientifiques. Je crois que les frontières disciplinaires ont moins d'importance pour nos jeunes membres qu'auparavant, et bien que la SCMO ne soit pas le seul foyer pour la science environnementale et climatique au Canada, nous devons nous efforcer d'être reconnus comme étant les plus accueillants, que ce soit par le biais de séances lors de nos congrès, de projets conjoints avec des sociétés apparentées ou d'un esprit généreux et accueillant envers de nouveaux types de membres ayant de nouveaux types d'intérêts.

J'ai entamé mon mandat de président en notant que mon principe directeur pour mon année présidentielle vient de M. Spock : « Les besoins du plus grand nombre l'emportent sur les besoins d'un petit nombre ou d'un seul. » Au cours de mon année de *présidence, j'ai eu de multiples occasions de me rappeler la difficulté d'appliquer ce principe avec succès, mais dans l'ensemble, je crois que notre Société a réussi à s'y tenir. De plus, je crois que Jim Abraham, le prochain président de la SCMO, et la nouvelle cohorte d'Halifax guideront habilement la SCMO vers l'avant, au cours de ce que j'espère être une année de réouverture et de redécouverte. Je me retire donc, redevenant un fier résident du coin technologique et mathématique de la SCMO, et souhaitant une vie longue et prospère à la Société et à son assortiment scientifique de membres.*

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Fog over Sable Island

WRITTEN BY CMOS BULLETIN SCMO ON JUNE 21, 2021. POSTED IN OCEANS, UNCATEGORIZED, WEATHER, WHAT'S CURRENT.

– By Li Cheng, Zheqi Chen, Peter Taylor, Yongsheng Chen and George Isaac –

Introduction

Marine fog occurs frequently offshore from Atlantic Canada. It can cause problems for helicopter flights to offshore worker from Newfoundland and any flights to the National Park on Sable Island, Nova Scotia as well as in many coastal communities along the East Coast. Fog is formally defined as visibility or Meteorological Optical Range (MOR) less than 1 km and mist is specified when 1 km < MOR < 5 km. Summer statistics (1971-2000 Climate Normals note 1981-2010 not available) from Sable Island show fog reported in 200 (out of 720 or 744) hours in June and July, although individual Sable Island A weather reports often indicate fog with visibility > 1 km. Isaac et al (2020) report fog from a platform on the Grand Banks occurring approximately 40% of the time in June and July from 20 years of METAR reports. Aborted flights to the Grand Banks or to Sable Island because fog prevents landing are inconvenient and accurately forecasting visibility conditions is a continuing challenge.

Fig 1. Two photos of fog on Sable Island, including the MSC Operations Building.

The initiation, development and decay of fog can involve many physical processes. The marine fog that is our focus arises as warm moist air, typically from over the Gulf stream, is advected over colder water, influenced by the Labrador current. The moist air cools as turbulent diffusion mixes heat down towards the water surface. Water vapour can diffuse up or down depending on the mixing ratio profile. When the relative humidity gets to 100% fog droplets will form. Radiation can play an important role. Once fog has formed, longwave radiation loss from the fog top can cool the upper fog layers, enhance mixing within the fog and create a stably stratified layer above.

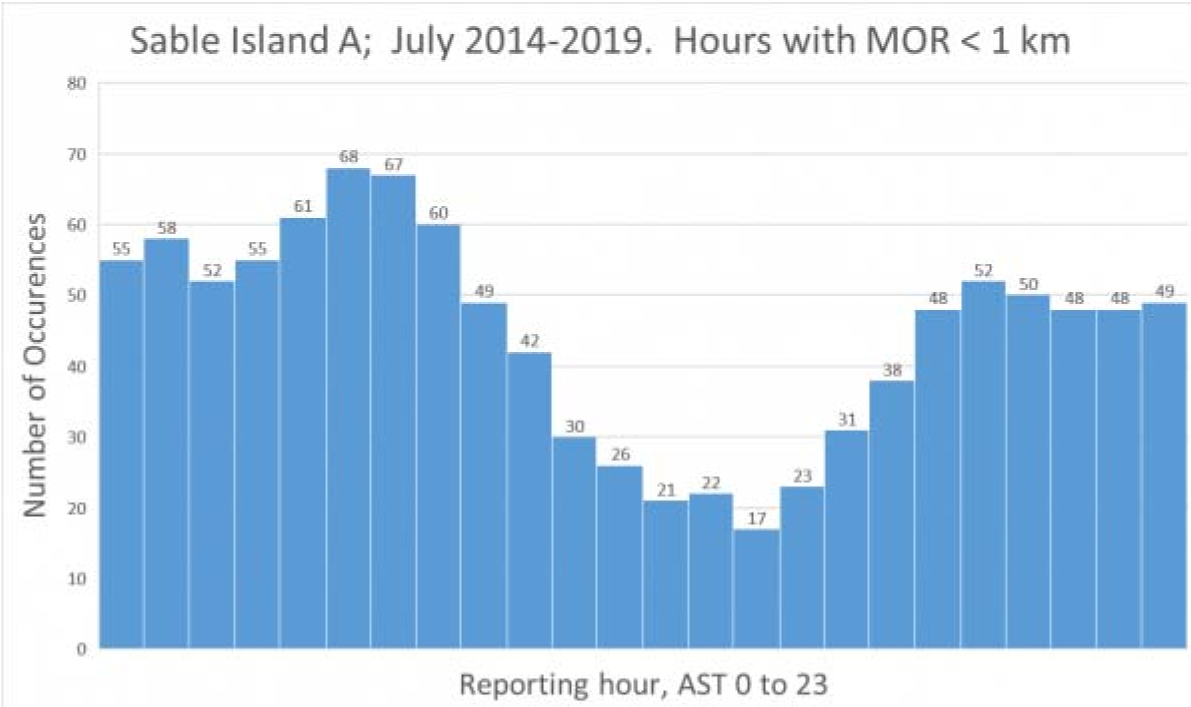
Over the past year Wood Environmental and NSERC have supported research at York University using, and modifying the Advanced Research (ARW) version of the Weather Research and Forecasting (WRF) model developed at NCAR and widely used throughout the world. One test for our modelling work is how well our modelling matches the winds, temperatures and visibilities reported from the Sable Island A weather station. We found that the statement at the beginning of ECCC marine weather reports stating “Please note that these observations might not always be representative of weather conditions over their associated marine area” needs to be taken seriously as far as Sable Island fog is concerned.

Fog on Sable Island

On land, even on the narrow (~ 1 km) strip of sand that is Sable Island, heating of the ground by solar radiation and cooling at night via longwave radiation lead to diurnal changes in land surface and near-surface air temperatures which are greater than they are over water, where mixing in the upper water column reduces water surface temperature variations. At an inland site like Halifax Airport, the diurnal temperature cycle in July often spans 10 °C or more while on Sable Island it is more often 5 °C or less. Even so, with saturated or near-saturated air drifting in from the sea, and radiative cooling of the land surface at night, more water vapour can condense and a low-level radiation fog can occur or intensify, especially in light wind conditions. With strong winds and marine fog over the water being advected over Sable Island, even a small afternoon warming of the near-surface air in its 400 m path over the sand and bushes between the water and the YSA weather station could cause some evaporation of fog droplets and modify the visibility reported by the automatic weather station instrument relative to that over the surrounding ocean.

On one of the days shown in the two photos above (Sept 26, 2020), and from a study of weather reports for that day, it appears that winds were relatively light, fog formed at the weather station overnight but skies cleared by noon. In the distance, there would still appear to be fog or mist over the ocean in the distance. The fog did return later that day. Looking through historical weather data for Sable Island A we find many other days with similar time sequences. On other occasions, such as May 31, 2021, (shown above) fog or mist persists all day in Sable Island A reports although with increasing temperatures during the day; visibility there may be better than over the surrounding ocean.

We can also use the Hourly Data Reports to investigate whether there is a diurnal cycle in the frequency of fog occurrence. Figure 2 below shows the numbers of hours with visibility < 1 km and < 5 km for 6 years of July data (visibility data are not available in July 2020).



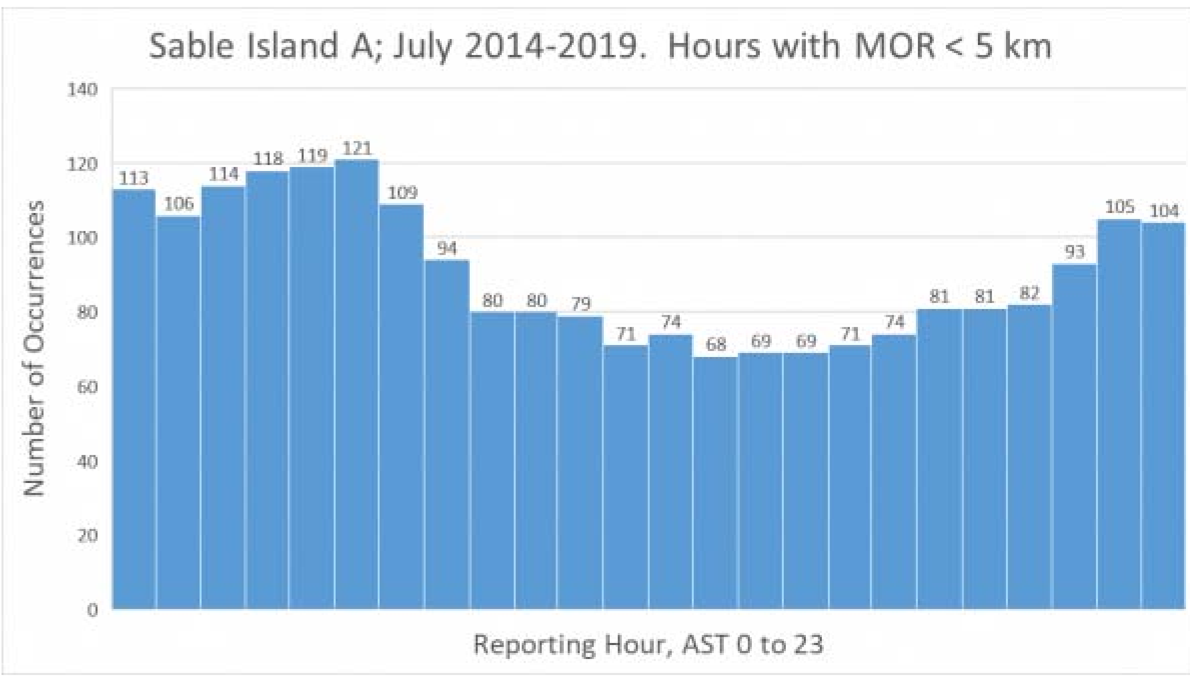


Fig 2. Frequencies of fog and mist in Sable Island A weather reports for July 2014-2019. Over 6 years the maximum for each hour would be 186, Note the different scales in the two plots. Reporting times are in Atlantic Standard Time, AST = UTC-4 h running, left to right from 0 to 23.

Using the strict < 1km definition of fog we see a pronounced diurnal cycle on Sable Island with a maximum occurrence near 37% around dawn and a minimum of 9% in the early afternoon. For visibility < 5 km, there is a less pronounced diurnal variation with

65% occurrence at 5 am (EST) reports and a minimum of 37% in the early afternoon. These reflect temperature variations at the land site in comparison with the open ocean situation where there is minimal diurnal variation in visibility, air or sea surface temperature. Isaac et al (2020), report on fog measurements (< 1 km) made over the Grand Banks on "Installation 1" over a 20-year period. There is virtually no diurnal variation in fog occurrence there.

The land surface clearly modifies temperatures and visibility at the Sable Island A site, about 400 m inland from the S shoreline, relative to open ocean conditions. Even at the shoreline, steepening and breaking waves could be an enhanced sink for fog droplets and a source of spray droplets affecting near-surface measurements of liquid water content and droplet size distributions.

WRF Modelling

WRF comes with many options to represent boundary layer mixing, cloud physics and radiation processes and it is important to select the best options. The modules used for the results presented below used MYNN boundary-layer treatment, Thompson microphysics and a modified fogdes scheme.

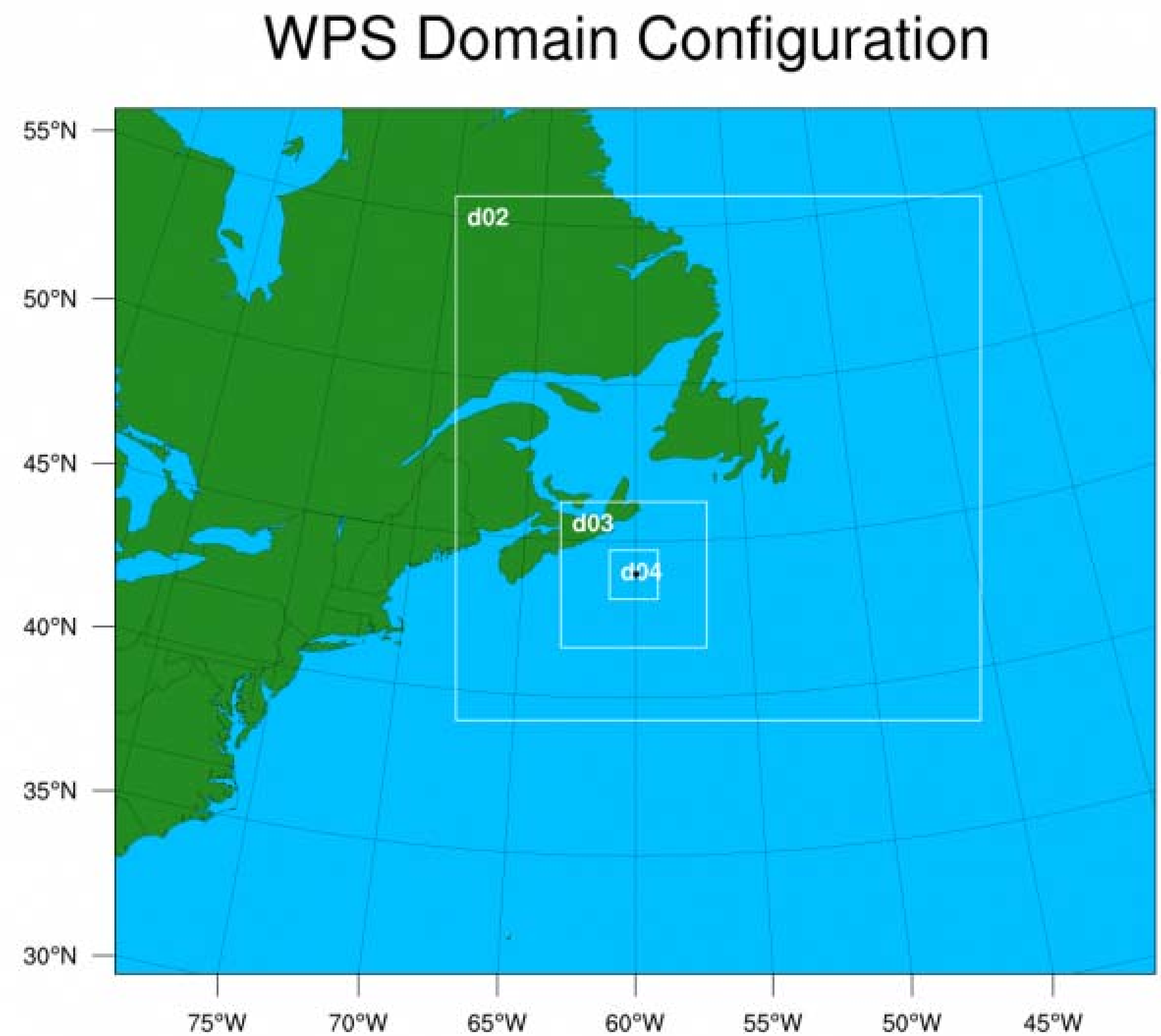


Fig 3. WRF domains used for Sable Island study. Grid resolutions (30 km, 10 km, 3.3 km, 1.1 km)

Once cloud droplets, typically in the size range 1-50 µm (see Isaac et al, 2020 for examples) have formed they will be subject to gravitational settling (typical velocities in the cm s-1 range) and this is represented within WRF. What is not generally included for marine fog is the added deposition to the surface associated with turbulent impaction, collision and coalescence of water droplets with the surface. Several weather forecast models combine fog liquid water and water vapour as total water, but we would argue that deposition and transfer processes of the two states (liquid or vapour) at water surfaces need separate treatment. We have added an optional process in our modified treatment of the boundary layer and surface interactions through a roughness length (z0c) concept in the turbulent mixing of fog liquid water and deposition to the surface. One consequence of this is that the underlying water surface then becomes a stronger sink for fog droplets and the liquid water concentration, and visibility can then vary significantly with height. In the results presented here we take z0c = 0.01 m.

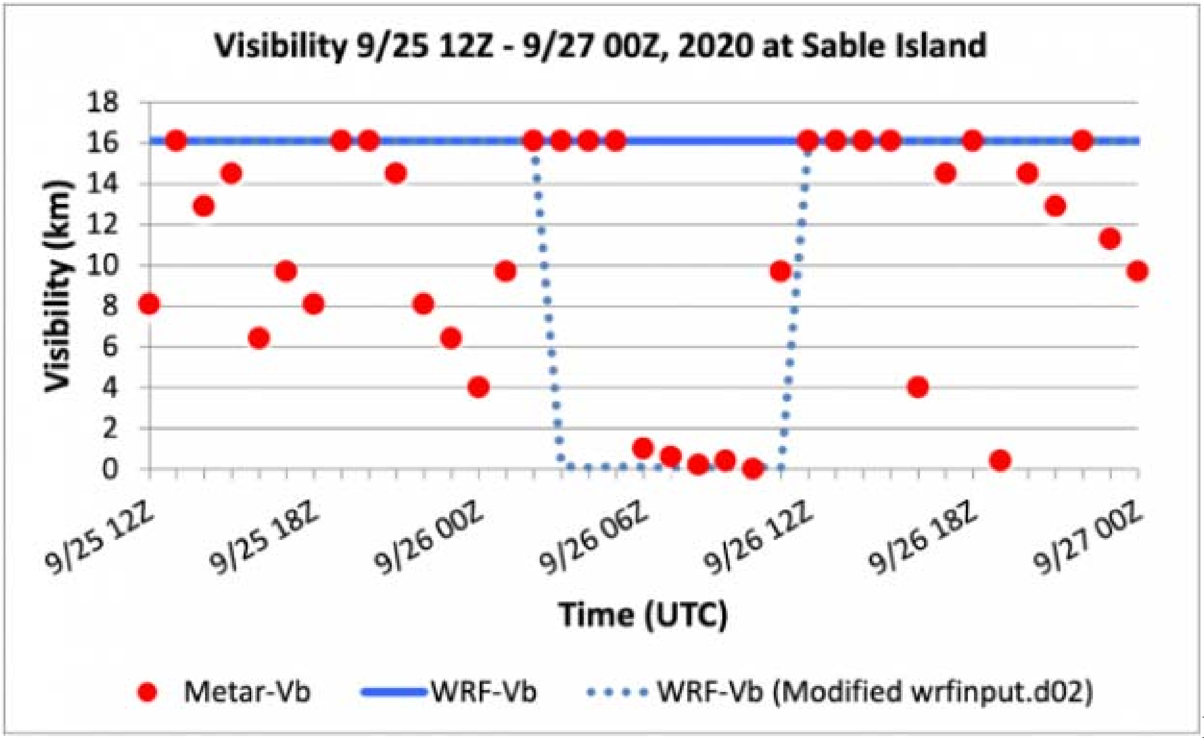


Fig 4. WRF 10 km grid visibility (at 2 m) simulations with (·······) and without (———) a land point representing Sable Island. We used ERA5 reanalysis data to drive the simulations for Sept. 26, 2020.

WRF was run with nested grids starting at 30 km. Figure 3 shows the domains used. For much of our work, and for practical computer resource considerations, we often only use domains 1 (the full figure) and 2, with a 10 km grid. In this case, Sable Island does not exist. We can however set one grid point as land to represent a 10km x 10 km island in the same location.

To illustrate the performance of the model Figures 4 – 6 show WRF temperature, fog water (Qc) and visibility results (hindcasts) for times around those shown in Figure 1; Sept 26, 2020, and May 31, 2021.

Sept 26, 2020

Visibility results shown in Fig 4 used nesting only to domain 2 and had one (10 km x 10 km) land point representing Sable Island. Even with that simple representation, WRF shows a reasonable match with the observations on Sable Island for 26 Sept 2020. According to our model Qc contours and vertical profiles, the fog is shallow, ~40 m and the surrounding grid points do not have fog. The model results support the idea that it is radiation fog. We have also made a high-resolution simulation (4 nested domains and 101 vertical levels). They take more computer time!

May 31, 2021 with High Resolution

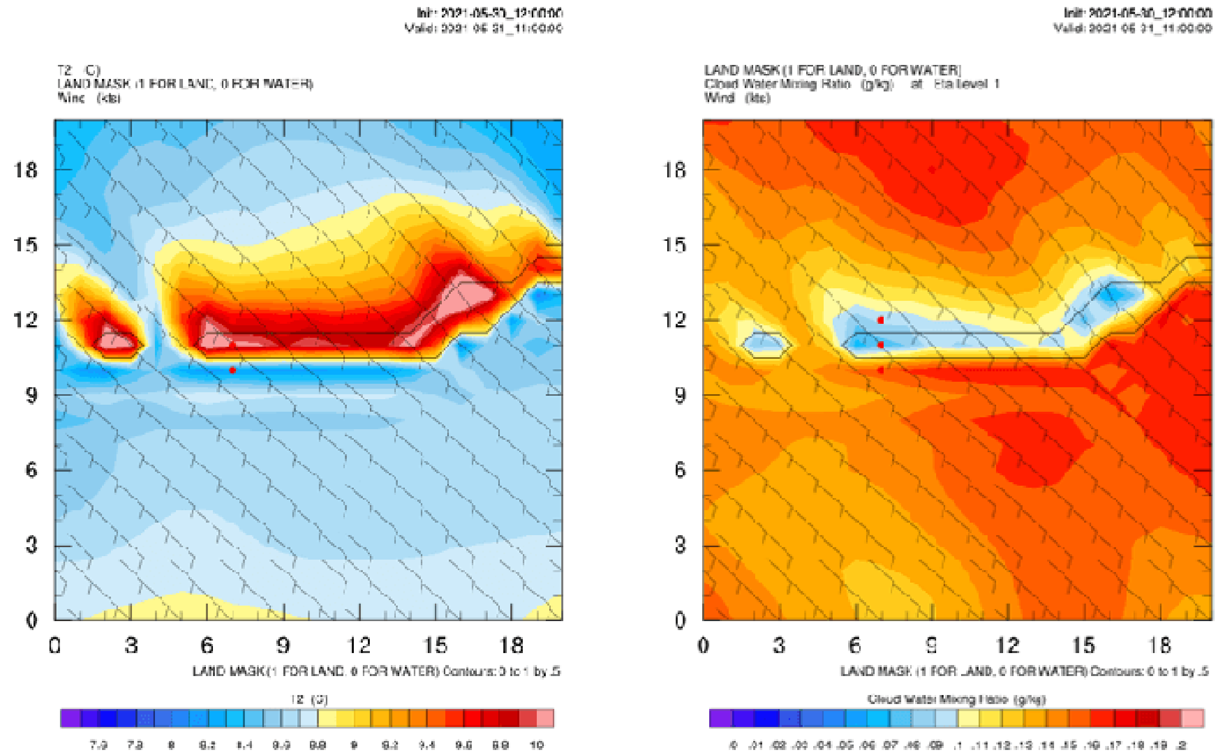


Fig 5. Temperature and Qc (g/kg) at 2 m height, at 11Z, (08:00 ADT) on 31 May 2021. Red dots are points used for time series.

The contour plots shown in Figure 5 show winds from the SE, advecting cool temperatures and thick fog (LWC ~ 0.17 g/kg) on to Sable island at around 8 am ADT, about an hour after the photograph in Fig 1 and with visibility ~ 1.2 km (Fig. 6). The temperature at 2 m on the island is modelled as about 10 °C by WRF compared to about 8.5 °C upwind over the water. Weather station measured temperatures have risen from around 8 °C overnight to 10 °C by 8 am ADT. The air remains saturated as it is advected onto the island but Qc drops from about 0.16 to 0.08 g/kg.

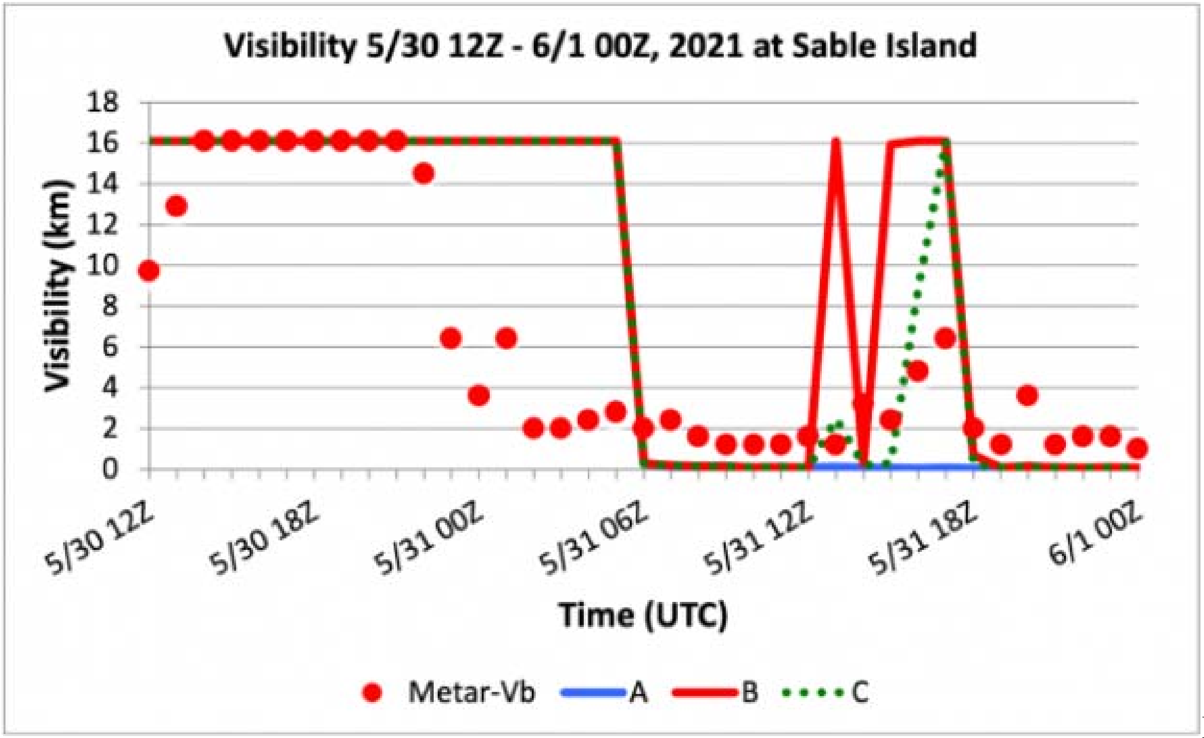


Fig 6. Visibility (2 m, MOR) simulations upwind, on and downwind of Sable Island during advection of marine fog from the SE on May 30,31, 2021. A is in the water S of the island, B on Sable Island, close to YSA and C is in water 1 grid point (1.1 km) North of B. All three model output lines overlay each other until 5/31 12Z and after 5/31 19Z.

These are recent, preliminary, results but clearly illustrate that WRF has the capacity to simulate interesting details of fog at relatively high spatial resolution. For the 1 km wide Sable Island case even higher spatial resolution is desirable but with a 1.1 km grid, and a very simple representation of uniform-sized fog droplets we can get interesting results. Accurate determination of visibility reduction and timing is more challenging but Fig 6 shows the WRF simulation and weather station reports over our 36-hour simulation (which followed a 12-hour initial spin-up). The model run seems to miss fog 00Z-06Z on 31 May in Easterly winds, but tracks visibility (MOR) increases on the island (point B) and downwind (point C) between 12Z – 18Z in SE winds.

Fatima 2022

A research group led by Professor Harindra (Joe) Fernando from Notre Dame University have a major fog research program just getting underway. Fatima (Fog and turbulence interactions in the marine atmosphere) is a multi-year program funded by the US Office of Naval Research, Multidisciplinary University Research Initiative (MURI) program (ONR Grant: N00014-21-1-2296). Some initial details are at available here.

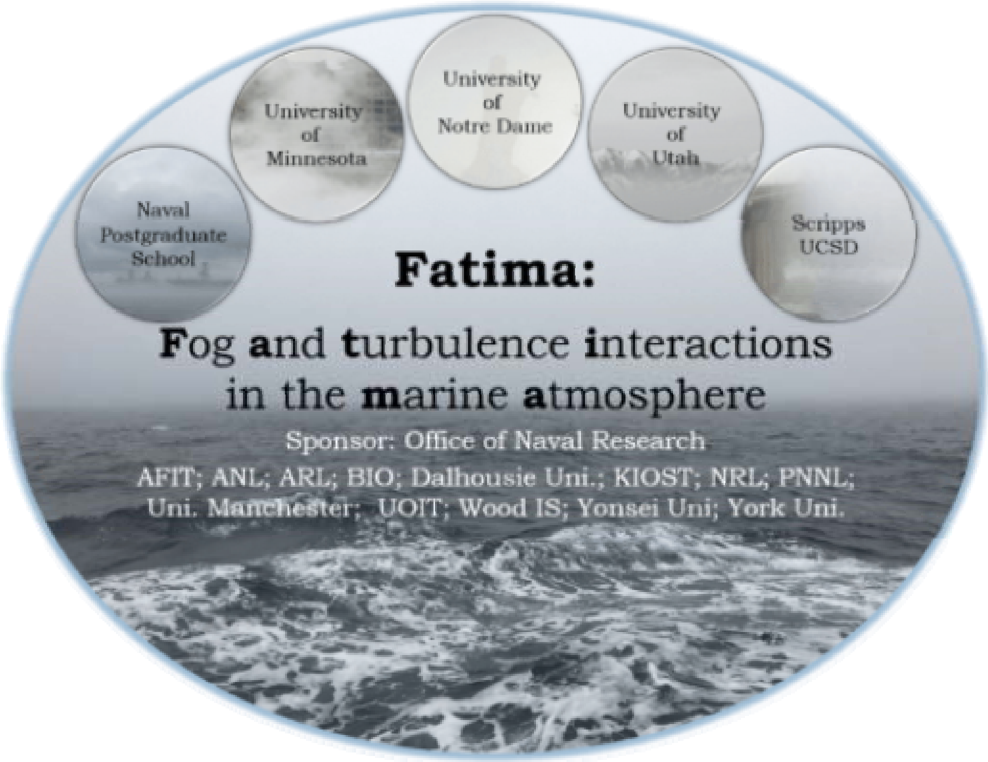


Fig 7. The Fatima logo

In addition to the core, MURI funded, participants, a number of Canadian groups are collaborating in the program, including a group of us from York and others from Dalhousie, UOIT, Wood Environmental and BIO. One component of a Fatima field program planned for summer 2022 is a series of measurements on Sable Island, subject to Parks Canada approvals. We are hoping to secure Canadian funding to be a significant part of this international effort.

Acknowledgements

This work has been supported through an NSERC Collaborative Research and Development grant (CRDPJ: 543476-19), with Wood Environmental and Infrastructure Solutions as the industry partner. We are very grateful for the involvement by Terry Bullock and his team at Wood. We also appreciate informative discussions about fog on Sable Island with Zoe Lucas (Sable Island Institute), Jason Surette (Parks Canada) and Gerry Forbes (ECCC), all of whom are very familiar with the island!

***Li Cheng** obtained her PhD in Physics at McGill University in 2005. She is now a Research Associate at York University. Her research area is on numerical modelling of marine weather including sea fogs and high wind conditions.*

Zheqi Chen *is a graduate student at York University, supervised by Peter Taylor and Yongsheng Chen. He has a background in atmospheric science from his undergraduate study at the University of Alberta. In York, he has been studying marine fog over Sable Island. In 2021 Zheqi received his master's degree, but he carries on the research as a PhD student.*

Peter Taylor*has been a Professor of Atmospheric Science at York University since 1988 when he moved there from the Boundary-Layer Research division of Environment Canada. Most of his research has involved atmospheric boundary-layer flows in complex terrain but his current research has broadened to include fog and other issues. Peter was on Sable Island conducting research as part of the Canadian Atlantic Storms Program (CASP I) in winter 1986.*

Yongsheng Chen *is an Associate Professor of Atmospheric Science at York University. He has extensive experience in numerical modelling and data assimilation for mesoscale weather prediction. He was one of the main developers of WRF/DART and WRFDA data assimilation systems. His recent research has been extended to atmospheric chemistry modelling using WRF-Chem and upper atmosphere modelling using WACCM-X.*

George A. Isaac *retired in 2013 as a Senior Scientist from ECCC after 40+ years of service. He formed a small company Weather Impacts Consulting and has continued doing research. He is also active as an Adjunct Professor at York University and Dalhousie University with their Atmospheric Science groups. Current projects include studying winter weather, aircraft in-flight icing, better methods for using weather radar data, and improving forecasts of high impact weather offshore Newfoundland and Labrador.*

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Brouillard sur l'île de Sable et l'océan environnant

WRITTEN BY CMOS BULLETIN SCMO ON JUNE 21, 2021. POSTED IN MÉTÉO, OCÉANS, QUOI DE NEUF, UNCATEGORIZED.

– Par Li Cheng, Zheqi Chen, Peter Taylor, Yongsheng Chen and George Isaac –

L'île de Sable est un endroit très intéressant qui est maintenant géré par Parcs Canada et désigné comme réserve de parc national. L'accès est difficile et le brouillard peut poser problème. Dans le cadre d'un projet de recherche sur le brouillard marin, appuyé par le CRSNG et Wood Environmental, un groupe d'entre nous a travaillé avec le modèle WRF-ARW afin d'améliorer ses résultats en matière de brouillard et de visibilité. L'île de Sable, dotée d'une station météorologique standard et fiable, est l'un de nos cas d'essai. On s'attend à ce que ce premier article présentant des exemples de résultats soit suivi d'articles scientifiques plus détaillés. À l'heure actuelle, le WRF considère la teneur totale en eau liquide sans distribution de taille spécifiée et toutes les gouttelettes ont la même taille. Notre étape de dépôt d'eau liquide améliorée est un début d'élaboration d'un modèle de prédiction de brouillard plus détaillé. Une représentation plus détaillée de la taille des gouttelettes de brouillard serait une prochaine étape utile.

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Advice for Aspiring Meteorologists

WRITTEN BY CMOS BULLETIN SCMO ON JUNE 28, 2021. POSTED IN WEATHER, WHAT'S CURRENT.

– By Christopher Poitras –

I was fortunate enough to organize and moderate an amazing webinar that enabled students with a meteorology interest and early-career meteorologists to learn and chat with some of the best professionals in the field!

Students and early-career meteorologists were able to understand the meteorological operations of Environment and Climate Change Canada, as well as The Weather Network, all while hearing from Meteorologists Jim Abraham, Chris Scott, Doug Gillham, and Mark Robinson on what it is like to become and work as a Meteorologist. All of the meteorologists that spoke were delighted with their experience as a meteorologist and encouraged students to follow their passion. While there were similarities in both the experience as an ECCC and Weather Network meteorologist, the experts explained that the main working differences between the organizations is that ECCC uses more raw data, and then translates it into weather maps, whereas The Weather Network has access to already computer-processed raw weather data that can be placed into forecast maps. In both cases, the path to meteorology is pretty similar: a general degree the meteorology or a related field. However, a main theme that all of the meteorologists emphasized was that it is good to know coding and programming even if it’s not included in your program and to be ready for shift work that includes overnight shifts.

Furthermore, participants were able to ask UBC professor Douw Steyn, all of their educational questions, including whether or not a PhD program would be right for them. His advice was that if you have a strong desire to pursue your PhD in a topic you are really interested in and have a passion for teaching in this topic in the future, then you are strongly encouraged to apply and complete your PhD. However, if you are on the fence about it, then it is best to not pursue this degree, at least until you are sure.

I would say the most imperative part of the seminar was the ability for the audience to get a real understanding of whether they are on track to become a Meteorologist, or if they need to go back and take certain courses. The experts agreed that if you are pursuing a Bachelor’s of Science in meteorology or a related field, and are trying to get some internship or volunteer experience, you’re on the right track! But whether or not you should pursue a government job, graduate studies or private weather forecasting depends on you and your personal career goals. Additionally, the questions that students and early-career meteorologists asked, were vital to giving them the motivation and satisfaction that they are on the right path to their career goals.

In closing, I would like to mention that the recording of this session is available on the CMOS YouTube channel, or through this link here.

*My name is **Christopher Poitras**, and I am from Calgary, Alberta, Canada. I am a first-year student at Mississippi State University, completing a Master's of Science in Environmental Geoscience. I am also a recent graduate of a Bachelor's of Science in Geography, Weather Broadcasting, and Meteorology, as well as the Penn State Weather Forecasting certificate program.*

Since I can remember, having been born and raised in Calgary, the constantly fluctuating and volatile climate has further sparked an already budding interest in weather. As I was growing up, all weather fascinated me, especially how every person relies on a great forecast in one way or another. However being a prairies kid, thunderstorms have always fascinated me the most. As a result, after experiencing a few severe thunderstorms in my own backyard (and even having to hide in the basement on a couple of occasions, due to an imminent tornado threat), I knew exactly what career path was meant for me! My strong interest in Meteorology led me to start as a weather forecaster with Wx Centre in May of 2018.

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Conseils pour les aspirants-météorologues

WRITTEN BY CMOS BULLETIN SCMO ON JUNE 28, 2021. POSTED IN MÉTÉO, QUOI DE NEUF.

– Par Christopher Poitras –

J'ai eu la chance d'organiser et de modérer un webinaire formidable qui a permis aux étudiants intéressés par la météorologie et aux météorologues en début de carrière d'apprendre et de discuter avec certains des meilleurs professionnels du domaine!

Les étudiants et les météorologues en début de carrière ont été capables de comprendre les opérations météorologiques d'Environnement et Changement climatique Canada, ainsi que de MétéoMédia, tout en écoutant les météorologues Jim Abraham, Chris Scott, Doug Gillham et Mark Robinson parler de leur formation et de leur travail de météorologue. De surcroît, les participants ont pu poser toutes leurs questions relatives à l'éducation à Douw Steyn, professeur à UBC, y compris la pertinence pour eux d'effectuer des études doctorales.

Je dirais que la partie la plus fondamentale du séminaire serait la capacité des auditeurs de vraiment comprendre s'ils sont en bonne voie pour devenir des météorologues ou s'ils doivent suivre certains cours. En outre, les questions qu'ont posées les étudiants et/ou les météorologues en début de carrière étaient essentielles pour les motiver et les convaincre qu'ils sont en passe d'atteindre leurs objectifs de carrière.

En terminant, j'aimerais mentionner que l'enregistrement de cette séance est accessible sur la chaîne YouTube de la SCMO ou en cliquant sur ce lien ici.

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