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La Société canadienne de météorologie et d'océanographie

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Stories Inside: *Replacement of the Canadian Weather Radar Network* (p. 10) *Radar Events Initiative* (p. 17) and more.

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CMOS Bulletin SCMO
"at the service of its members / au service de ses membres"

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CMOS exists for the advancement of meteorology and oceanography in Canada.

Le but de la SCMO est de promouvoir l'avancement de la météorologie et l'océanographie au Canada.

Words from the President

Communication, Partnership and Change

At this time of year, as we enjoy the beautiful fall colours and brace for winter, thoughts of CMOS members also turn to spring as we plan ahead for our annual Congress. The 54th CMOS Congress will be held in Ottawa from May 24 to 28, 2020 with a focus on "Building Societal Resilience to Changing Weather, Climate, Oceans and Environment". The Local Arrangements Committee, chaired by Bruce Angle, and the Science Programme Committee, co-chaired by Leonard Barrie and Gordon McBean, are hard at work putting together an excellent programme that we expect will attract as many as 700 participants.

Proposals are now invited for scientific or technical sessions that relate to eight broad themes:

- Risks and Impacts of Climate Change on the Resilience of Major Sectors
- Tornadoes and Other Extreme Weather Events Impacting Canadians
- Oceans and Ice in a Changing Climate
- Floods and Water Crises in Canada and Globally
- Impacts of A Changing Climate in the Arctic
- Climate-Weather-Water and Food
- Pollution of the Air, Water and Ecosystems
- The Cryosphere – Impacts Locally to Globally

The call for sessions (due November 28) is posted at https://www.cmos.ca/site/sessions_submission and additional information about the Congress will be posted on http://congress.cmos.ca – please keep an eye on this website and plan to attend the Congress next May.

Climate change loomed large in the recent federal election. It is sure to be prominent in the 43rd Parliament and is an issue that is now with us for the long haul. Holding our Congress in Ottawa will give CMOS members an excellent opportunity to communicate their work to policy makers and to highlight how it can contribute to reducing risk and increasing resilience to extreme weather, climate change, and other environmental events.

Related to this, CMOS is a member of the Partnership Group for Science and Engineering (PAGSE), which is a cooperative association of national Science and Engineering organizations whose objective is to raise awareness of science, technology and innovation issues among federal decision-makers. We recently renewed our membership, which means that all CMOS members also have an affiliation with PAGSE. I encourage you to visit their website (www.pagse.org) to read about PAGSE activities, including the Bacon and Eggheads breakfasts with parliamentarians, the annual submission to the House of Commons Committee on Finance, and the SciEng Pages on topical issues. I welcome suggestions for a CMOS-related SciEng topic.

CMOS also has a number of other partners, which strengthen our Society and its wider impact. These include the Canadian Consortium for Research (CCR, https://ccr-ccr.ca/), which is the largest umbrella organization in Canada whose primary concerns are the funding of research in all sectors and support for post-secondary education. I would particularly like to remind you that as a CMOS member, you can join the American Meteorological Society (details of our recently renewed agreement are here) and the Australian Meteorological and Oceanographic Society (details here) as Affiliate Members, which entitles you to benefits associated with these societies. We are also in the process of establishing a similar partnership with the Royal Meteorological Society. Continuing this theme, October means that it is time to renew your CMOS membership. I encourage you to renew online at http://www.cmos.ca/ and to recruit a new member or two. You may find some inspiration in the Bulletin's engaging profile of Haowen Qin, our youngest member!

Finally, I am delighted to report that Environment and Climate Change Canada has accepted our invitation to be the CMOS Tour Speaker this year. Several ECCC scientists will be involved and all will be speaking about Canada's Changing Climate Report released earlier this year. Watch for an announcement from your local CMOS Centre.

As always, I invite you to contact me (president@cmos.ca) if you would like to get involved in any area of CMOS activities.

Kim

Kimberly Strong, CMOS President and Professor & Chair, Department of Physics, University of Toronto

Mot du présidente

Communication, Partenariat et Changement

En cette période de l’année, bien que nous profitions encore des belles couleurs de l’automne et que nous attendions l’hiver de pied ferme, les membres de la SCMO pensent aussi au printemps, tandis que nous planifions notre congrès annuel. Le 54e Congrès de la SCMO se tiendra à Ottawa du 24 au 28 mai 2020 et portera sur le thème « Bâtir une résilience sociétale face à l’évolution du temps, du climat, des océans et de l’environnement ». Le comité local d’organisation, que préside Bruce Angle, et le comité du programme scientifique, que coprésident Leonard Barrie et Gordon McBean, travaillent d’arrache-pied pour monter un excellent programme, qui devrait attirer jusqu’à 700 participants. Nous avons déjà lancé l’invitation à proposer des séances scientifiques ou techniques portant sur huit grands thèmes :

- Les risques et les impacts des changements climatiques relativement à la résilience des secteurs importants
- Les tornades et autres phénomènes météorologiques extrêmes et leur répercussion sur les Canadiens
- Les océans et les glaces dans un climat en évolution
- Les inondations et la crise de l’eau au Canada et dans le monde
- Les impacts des changements climatiques dans l’Arctique
- Le climat, le temps et l’eau relativement à l’alimentation
- La pollution de l’air, de l’eau et des écosystèmes
- La cryosphère : impacts locaux à mondiaux

L’invitation à proposer des séances (échéance le 28 novembre) est là https://www.cmos.ca/site/sessions_submission et d’autres renseignements sur le congrès paraîtront à l’adresse https://congress.cmos.ca/. Consultez régulièrement ce site Web et n’hésitez pas à vous inscrire au prochain congrès.

Les changements climatiques ont volé la vedette lors des dernières élections fédérales. Ils occuperont certainement une place importante au cours de la 43e législature, car ils constituent un enjeu qui nous préoccupera encore longtemps. La tenue de notre congrès à Ottawa permettra aux membres de la SCMO de transmettre directement les résultats de leurs travaux aux décideurs, et de souligner de quelle façon cette information contribue à réduire les risques et à renforcer la résilience face aux phénomènes météorologiques extrêmes, aux changements climatiques et aux autres événements environnementaux.

Dans le même ordre d’idées, je vous rappelle que la SCMO est membre du Partenariat en faveur des sciences et de la technologie (PFST), une association coopérative d’organismes nationaux en sciences et en génie, dont l’objectif est de sensibiliser les décideurs fédéraux aux enjeux relatifs aux sciences, à la technologie et à l’innovation. Nous avons récemment renouvelé notre adhésion au PFST, ainsi tous les membres de la SCMO y sont aussi affiliés. Je vous invite à consulter le site Web du Partenariat (www.pagse.org), qui vous renseignera sur ses activités, y compris : les « déjeuners avec des têtes à Papineau » avec des parlementaires, la présentation annuelle destinée au Comité des finances de la Chambre des communes, et le site Sciences et génie à la page, SciEng, qui porte sur des questions d’actualité. Je vous encourage à me faire part de vos sujets d’actualité liés à la SCMO, pour soumission à Sciences et génie à la page.

La SCMO collabore également avec certains autres partenaires qui renforcent notre organisation et son incidence générale. Entre autres, le Consortium canadien pour la recherche (CCR, https://ccr-ccr.ca), le plus important organisme-cadre au Canada dont les principales préoccupations sont le financement de tous les domaines de recherche et le soutien de l’enseignement postsecondaire. Je vous rappelle qu’en tant que membre de la SCMO, vous pouvez adhérer, à titre de membre affilié, à l’American Meteorological Society (détails de notre accord récemment renouvelé) et à l’Australian Meteorological and Oceanographic Society (voir détails), ce qui vous donne droit aux avantages associés à ces sociétés. Nous sommes également en train d’établir un partenariat similaire avec la Royal Meteorological Society. Parlant d’adhésion, le mois d’octobre nous rappelle qu’il est temps de renouveler votre inscription à la SCMO. Je vous encourage à adhérer en ligne à http://www.scmo.ca/ et à recruter un ou deux nouveaux membres. Vous vous sentirez peut-être inspiré par le profil captivant de Haowen Qin, notre membre le plus jeune!

Enfin, je suis ravie d’annoncer qu’Environnement et Changements climatiques Canada a accepté cette année notre invitation à participer à la tournée de conférences de la SCMO. Plusieurs scientifiques d’ECCC s’y impliqueront et tous discuteront du Rapport sur le climat changeant du Canada, publié cette année. Ne manquez pas l’annonce de votre centre local de la SCMO.

Comme toujours, vous n’avez qu’à communiquer avec moi (president@scmo.ca) si vous souhaitez apporter votre aide à n’importe quelle activité de la Société.

Kim

Kimberly Strong, Présidente de la SCMO et directrice du département de physique de l’Université de Toronto

Article: Wind Forecasts and Observations, Lake St. Charles

Comparison of wind forecasts and observations at Lake Saint-Charles, Quebec: Results from 2018 / Comparaison des prévisions et des observations de vent au lac-St-Charles, Québec. Résultats de 2018

By Richard Leduc, AirMet Science Inc.

*In a recent CMOS Bulletin (Vol 46, No 4), **the results of the comparison between the wind forecasts from the high resolution deterministic prediction system (SHRPD, 2.5 km, EAST sub-domain) which served as inputs to the CALMET diagnostic model and observations of the Lac St-Charles meteorological tower were presented for 273 days in 2017**. The main results for 331 days of 2018 are discussed in this short article. There are some differences between the two years but overall, the results of 2018 are similar to those of 2017. A similar comparison will be made in a different environment for a station along the St-Lawrence River (with coastal effect) in Gaspésie with the data acquired in 2019 for the Maritime sub- domain.*

INTRODUCTION

Dans un récent Bulletin de la SCMO (vol. 46, no. 4), **nous avons présenté les résultats de la comparaison entre les prévisions de vent issues du système à haute résolution de prévision déterministe (SHRPD, 2.5 km) qui ont servies d'intrants au modèle diagnostique CALMET et les observations de la tour météorologique du Lac St-Charles**. On trouvera Leduc et Chartrand (2018) les détails concernant la motivation à l'origine des mesures météorologiques, le domaine de calcul et autres informations sur le modèle. Les résultats étaient présentés pour 273 jours de 2017. L'objectif du texte actuel est de présenter les principaux résultats de la comparaison faite avec les données de 2018. Afin de faciliter la lecture, on reprend quelques informations de base à la section suivante puis les résultats sont à la section 3.

DONNÉES

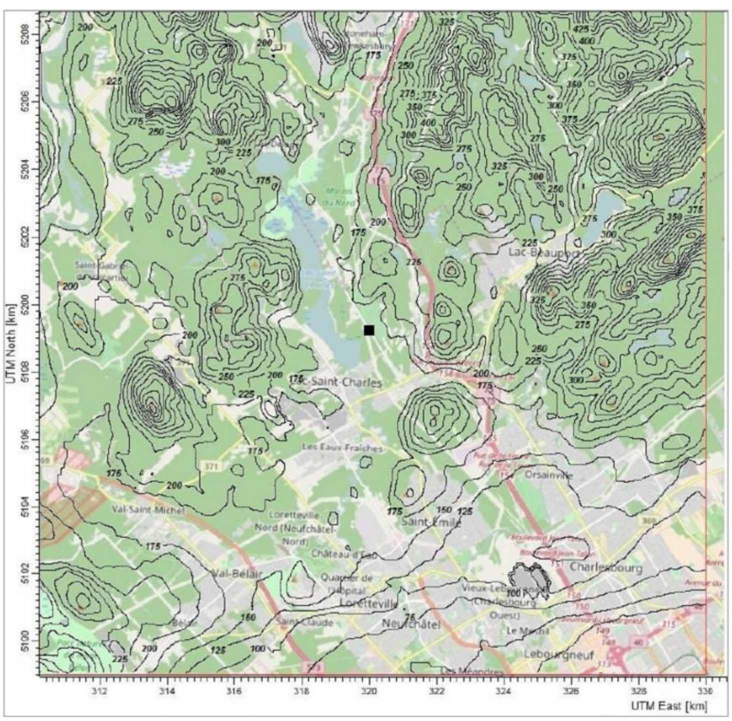


Figure 1. Localisation de la tour et topographie sur le domaine de calcul.

La Figure 1 esquisse la topographie locale et le relief de part et d'autre du lac qui fait environ 5 km par environ 700 m dans sa partie la plus large. La topographie montagneuse de cette région pourrait canaliser le vent dans le sens du lac et favoriser le transport de cyanobactéries vers le barrage situé dans la section la plus au sud.

La localisation de la tour météorologique (10 m) est illustrée par le carré noir de la Figure 1 aux coordonnées UTM 19T (319991 m, 5199212 m) et son élévation au-dessus de la mer est de 156 m.

Les prévisions du système à haute résolution de prévision déterministe (SHRPD) dont la résolution est de 2.5 km ont été acquises et les résultats sont disponibles pour 331 journées en 2018 (sous-domaine EST) basés sur la prévision issue à 06 TUC pour les prochaines 48 heures.

Afin d'effectuer un ajustement aux conditions locales autour du Lac St-Charles, on utilise le modèle météorologique diagnostique CALMET qui permet de simuler des effets locaux (écoulement catabatique, canalisation, effets côtiers, etc.). Pour l'usage de CALMET, on a défini un domaine de 20 km par 20 km centré sur le Lac St-Charles avec une résolution de 100 m par 100 m, ce qui permet d'avoir plusieurs points de calcul sur le lac et autour du lac. Les prévisions de 48 heures du SHRPD servent d'intrant au modèle CALMET et avec les valeurs calculée au point de grille (de CALMET) comprenant la tour météorologique, on peut comparer les prévisions et les observations pour les diverses échéances des prévisions (de 0 heures à 48 heures à compter de 06 TUC) . On s'intéresse à la vitesse et la direction du vent.

RÉSULTATS

Au Tableau 1 on présente les statistiques descriptives pour les 7715 heures communes (il y a des observations manquantes à la tour); les données prévues dans ce cas sont les prévisions des échéances 0 h à 23 h de chaque jour disponible. La vitesse du vent à la tour a une moyenne inférieure d'environ 37% par rapport à celle prévue (i.e. calculée par CALMET avec les prévisions), soit respectivement 1.71 m/s et 2.72 m/s comparativement à 1.67 m/s et 2.53 m/s respectivement en 2017. On constate qu'il n'y a pas de différence majeure entre les deux années.

Les histogrammes des vitesses (m/s) mesurées et prévues (Figure 2) montrent la différence entre les deux séries de données, les valeurs calculées par le modèle étant distribuées de manière plus continue et la fréquence des faibles vitesses observées étant davantage importante. La corrélation entre les valeurs mesurées et prévues est de 0.56 (0.54 en 2017).

2018 Variable (m/s)	Prévue	Mesurée à la tour
Moyenne	2.72	1.71
Nombre d'heures	7715	7715
Écart-type	1.50	1.44
Médiane	2.50	1.40
Maximum	10.2	7.80

Tableau 1. Statistiques descriptives des vitesses prévues et mesurées (2018)

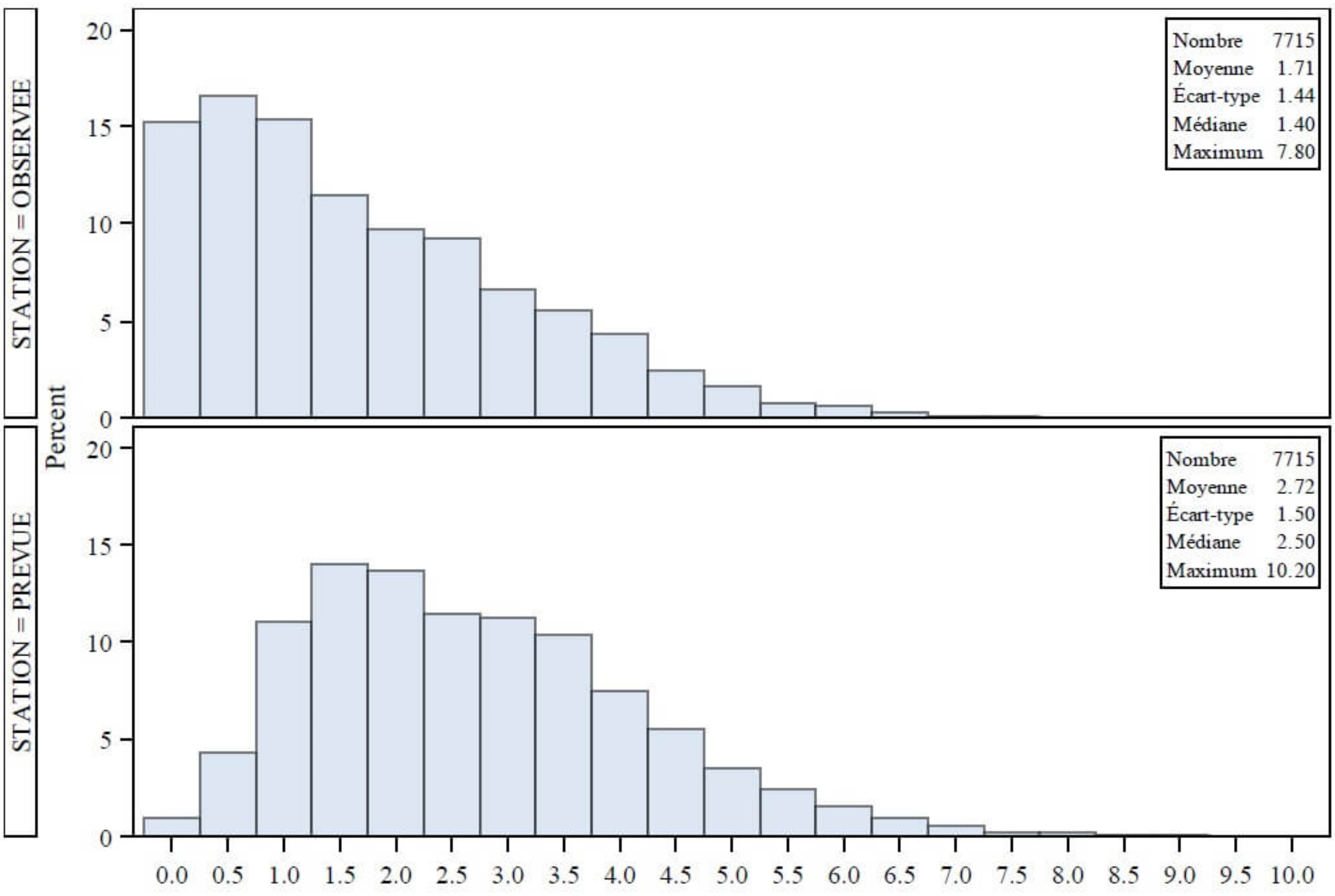


Figure 2. Histogramme des vitesses (m/s) prévues (bas) et observées (haut) pour 2018.

Deux roses des vents sont illustrées à la Figure 3, soit celle à la tour (à droite, à la position de la tour) et celle obtenue avec les prévisions aux échéances de 0 h à 23 h de chaque jour (à gauche, mais pas à la position de la tour). Des résultats semblables sont aussi disponibles pour diverses échéances des prévisions (par exemple prévision de 6 heures, de 12 heures, etc.).

La fréquence de CALME (< 0.4 m/s) est élevée à la tour à environ 15.3% comparativement à environ 1% pour celle prévue (ce qui ne diffère pas de 2017).

On constate une fréquence observée beaucoup plus élevée pour les directions NNE et NE que celles obtenues par CALMET. Il y a aussi des différences importantes du côté EST et OUEST. CALMET ajuste de manière significative les directions du dernier quadrant où la direction N, dans le sens du lac, devient prédominante.

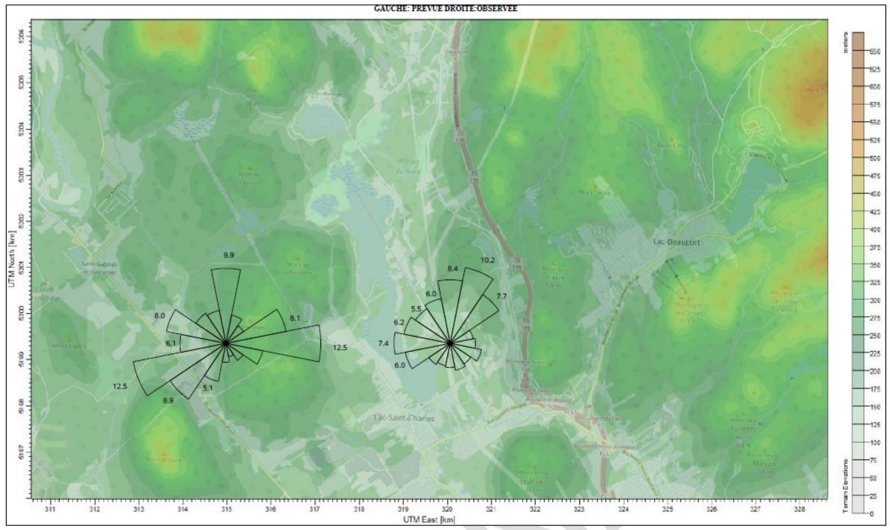


Figure 3. Rose des vents prévue (gauche) et observée (droite) pour 2018

La distribution des directions individuelles (observées vs prévues) ne diffère pas de manière significative de celle de 2017 (Figure 3 f dans Leduc et Chartrand, 2018). On note que les directions observées du NNE et du NE sont le plus fréquemment associées à une direction prévue du N. Les directions observées de l'ESE à S sont le plus souvent associées à la direction prévue de l'EST. À partir de la direction observée SSW, les directions prévues les plus fréquentes sont décalées et les prévues peuvent aussi couvrir quelques directions avoisinantes. À la direction CALME observée s'associe le plus fréquemment la direction N prévue.

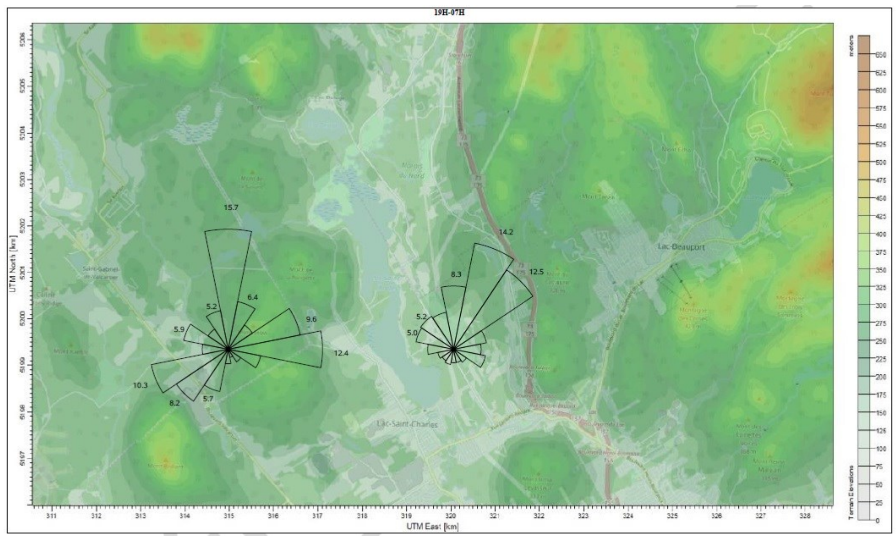


Figure 4. Rose des vents prévue (gauche) et observée (droite) de nuit pour 2018

On note par ailleurs que les vitesses mesurées sont faibles pour les directions NNE (1.55 m/s), NE (0.86 m/s) et ENE (1.17 m/s); les directions NNE (14.2%) et NE (12.5%) sont fréquentes la nuit entre 19 h et 7 h (Figure 4). La direction prévue la plus fréquente à ce moment est le N (15.7%) probablement associée à un écoulement (catabatique) en provenance des sommets au nord et nord-est et qui se canalise dans le sens du lac.

Lorsque le vent est de 2 m/s et plus, les directions observées et prévues se répartissent de manière plus uniforme autour des directions respectives (pairées) mais un bon nombre de directions observées du N et du NNE sont associées à des directions prévues dans les directions NW et NNW.

On présente au Tableau 2 les coefficients de corrélation pour diverses échéances de prévision entre les valeurs calculées par CALMET et les observations; on y donne aussi le coefficient de corrélation vectorielle (ρ2). Les faibles valeurs de la corrélation de Pearson ou vectorielle peuvent s'expliquer compte tenu des différences déjà exposées. Les valeurs changent quelque peu par rapport à 2017 mais il n'y a pas de différence majeure.

CONCLUSION

On a comparé pour l'année 2018 les observations de vent de la tour météorologique du Lac St-Charles et les résultats des calculs du modèle diagnostique CALMET (résolution de 100 m) dont les intrants proviennent des prévisions de 48 heures basées sur le système SHRPD (résolution de 2.5 km) pour 331 jours. On en arrive à des résultats semblables à ceux de 2017.

On constate aussi pour 2018 que le modèle CALMET ajuste des directions prévues par le SHRPD dans le sens du lac mais que les écoulements catabatiques (de nuit) des directions NNE et NE qui y sont importants ne sont pas bien reproduits.

Échéance	Corrélation Pearson vitesse	Corrélation vectorielle (ρ^2) vitesse-direction
00	0.61 (0.50)	0.96 (0.84)
06	0.58 (0.62)	1.06 (0.80)
12	0.56 (0.66)	1.24 (1.14)
18	0.54 (0.46)	0.92 (0.86)
24	0.49 (0.45)	0.82 (0.76)
36	0.52 (0.66)	1.17 (1.16)
42	0.50 (0.45)	0.85 (0.79)
00-23	0.56 (0.54)	1.05 (0.92)
	() pour 2017	

Tableau 2. Coefficients de corrélation

RÉFÉRENCES

Leduc, R., M. Chartrand, 2018: Comparaison des prévisions et des observations de vent au lac St-Charles, Québec. Bulletin de la SCMO, vol. 46, no. 4, 10-15.

REMERCIEMENTS

Nos remerciements s'adressent à nouveau à Philippe Barnéoud (ECC Canada) pour ses commentaires et suggestions de même qu'à Environnement et Changement climatique Canada (ECC Canada) qui rend ces données disponibles aux usagers. Nous remercions aussi la Ville de Québec et l'APEL qui ont rendus les données d'observations disponibles.

About the Author

Richard Leduc a débuté sa carrière en 1972 à Downsview. En 1979, il a rejoint Environnement-Québec où il a travaillé durant 28 ans en qualité de l'air (modélisation et applications des réseaux de mesures). Il est Professeur-associé (bénévole) à l'Université Laval. Depuis 12 ans, il travaille chez AirMet Science Inc.

Replacement of the Canadian Weather Radar Network

By Sylvain Laramée, Qian Li, Pat Wong, Sylvain Savard, Peter Leibiuk, Steven Brady, Rick Czepita, Hamid Nasr, Todd Benko, Michael Romaniuk, Mark Abt and Ingrid Wong
Canadian Weather Radar Replacement Program, Meteorological Service of Canada, Environment and Climate Change Canada

Meteorologists use many tools to forecast Canada's weather. Among which, radar is a primary tool that provides 3D observations of the atmosphere with high temporal and spatial resolution to assist in forecasting short-term severe weather events such as thunderstorms, tornadoes, hurricanes, ice storms and blizzards.

In 2016, the Meteorological Service of Canada (MSC) operated a network of 28 Doppler weather radars across Canada. In addition, there were 2 radars owned and operated by the Department of National Defence (DND), and a research radar owned and operated by McGill University which together comprised the 31 sites in the Canadian Weather Radar Network (CWRN). Most of the infrastructure and hardware in the network was beyond its 25-year life expectancy. The network had radars of several different generations, with some of them 30-40 years old which relied on obsolete technology that could no longer be procured, maintained or upgraded. Additionally, the McGill University radar was one of the oldest with unique technology and was the sole source of Canadian radar data for the Montreal area.

The 2008 Commissioner of the Environment and Sustainable Development (CESD) audit on ECCC's Severe Weather Warning Program concluded that MSC's existing monitoring networks were becoming obsolete and at increasing risk of failure, notably a large percentage of the networks were approaching or were beyond their planned operational lifespan. To revitalize Canada's weather services, the Government of Canada's Budget 2011 and Budget 2013 announced multi-year funding to further strengthen Canada's meteorological services through new federal infrastructure investments in radars. Funding from Budget 2013 was split into 2 gates, Gate 1 – Definition phase and Gate 2 – Implementation phase (Figure 1).

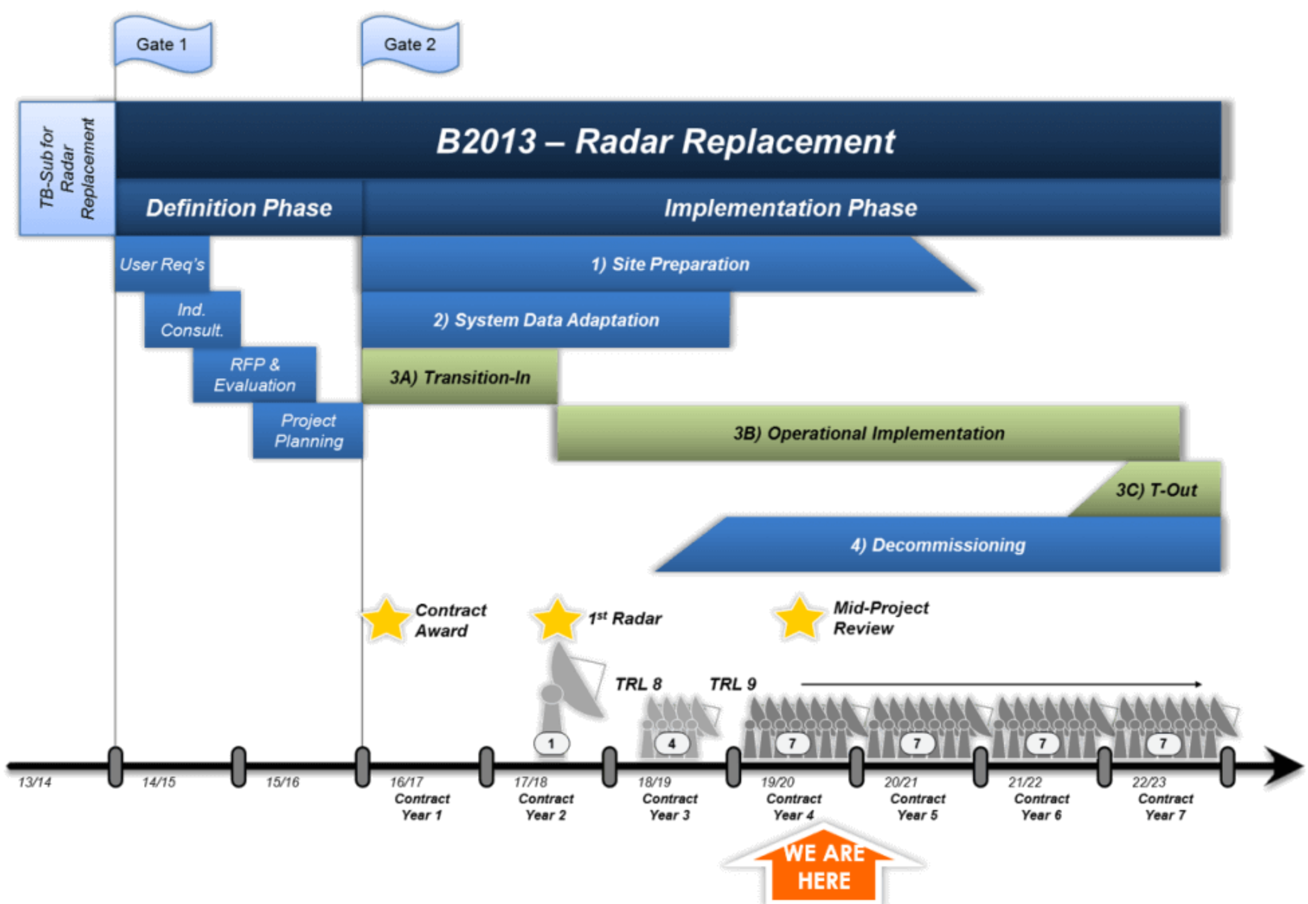


Figure 1. An Overview of Radar Replacement Project Timeline

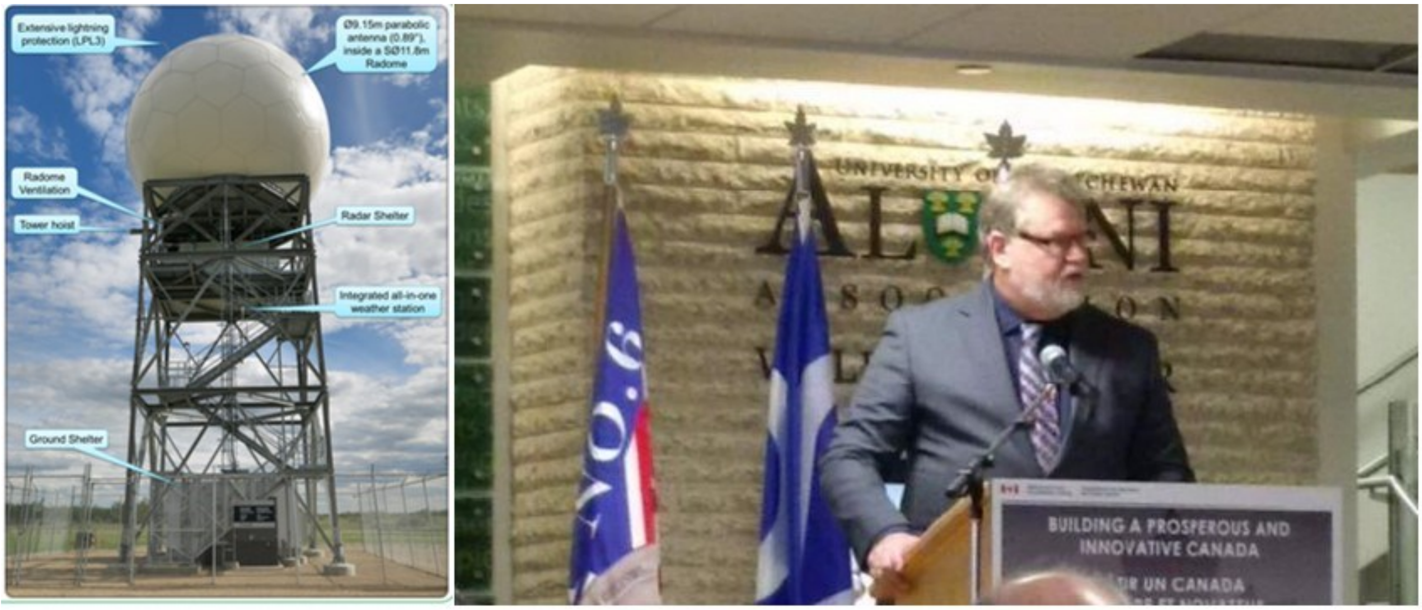


Figure 2. Mr. David Grimes, the ADM of MSC, ECCC announces the completion of the first new radar at Radisson, SK

During the Definition Phase (2014/15 – 15/16), ECCC was tasked with reviewing the approaches for accomplishing the project goals, defining user requirements, developing high-quality estimates for the radar replacement project, and developing a detailed project plan to replace the existing radars with modern technology.

On February 28th, 2017, Canada's Minister of the Environment and Climate Change Canada announced investments to modernize Canada's weather-forecasting infrastructure. As part of this initiative, an $83-million contract was awarded to Selex ES GmbH (now Leonardo) for 20 new weather radars to replace existing radars across the country by 2023. The contract on the modernization of the weather radars also contains options to replace all remaining radars in the Canadian weather-radar network by March 31, 2023. So far, 6 additional radars have been added by the Government, for a total of 26 new radars and an overall investment of $107 million.

Gate 2 also known as the implementation phase commenced in fiscal year 2016/2017, with the start-up of the Canadian Weather Radar Replacement Program (CWRRP). This phase is a seven-year infrastructure program that will replace the existing radar network with new modern Dual Polarized radar systems. This project will ensure that ECCC can continue to provide Canadians with the weather information they need to make informed decisions to protect their health, safety, and security. The outcome of this project will be a modern, affordable, and sustainable network of reliable weather radars covering a larger area of Canada – through extended range capabilities, and the addition of a new radar site in the Lower Athabasca region of Alberta.

The first radar was installed at Radisson SK and officially announced on November 15, 2017 by MSC's then Assistant Deputy Minister (ADM), David Grimes (Figure 2). The project remains on schedule and on budget with 4 additional radar installations completed in 2018 at Blainville QC, Foxwarren MB, Smooth Rock Falls ON, Spirit River AB. Replacement of 7 radars is underway for 2019. As this manuscript is drafted, construction of four of the 7 is complete with the remaining 3 well underway. As of early September the new radars at Exeter ON, Bethune SK, Marion Bridge NS and Chipman NB have been calibrated and are in their burn-in stage before the final site acceptance testing. Replacement of 7 radars per year is planned for the remainder of the project.

This paper provides an overview of the CWRRP project; the advantage and benefit of the new technology, and some data and products the new radars start to offer.

Advantage and Benefit of the New Radar Technology

Dual-Polarization: A Leading-edge Technology

The new and state-of-the-art radars will have fully integrated dual-polarization technology, which will enable forecasters to better distinguish between rain, snow, hail, and freezing rain as well as better discern the size, shape, and variety of precipitation particles. This technology will also enable better identification and removal of non-meteorological targets such as birds, bugs, and debris from the data. As a result, the meteorologists will be able to issue more precise and timely weather watches and warnings for significant weather events, giving Canadians more lead time to take appropriate actions to protect themselves, their family, and their property from the effects of severe weather.

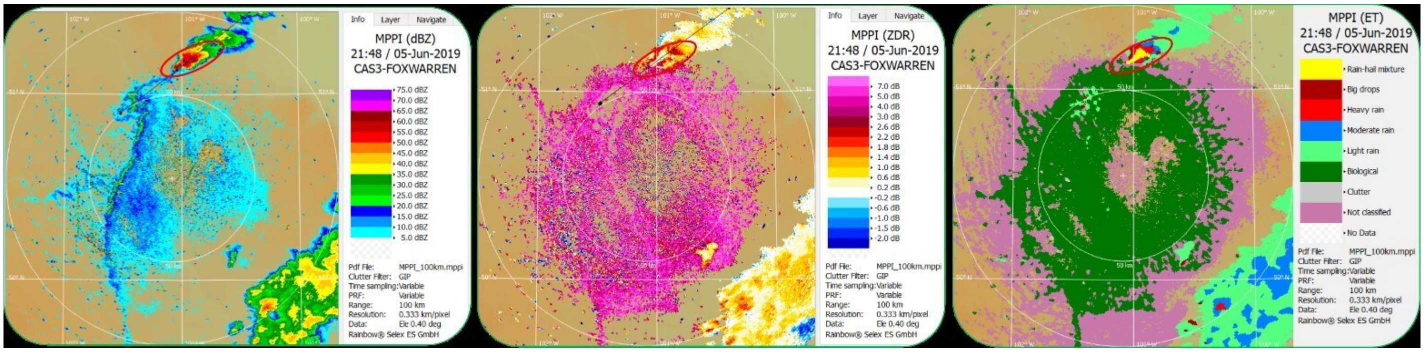


Figure 3. Examples showing the advantage of using Dual-Polarization data in hydro-meteor classification: a thunderstorm case with hail reports in the Prairies on June 5th 2019 (Foxwarren Radar). Left: reflectivity (dBZ); Middle: Differential Reflectivity (ZDR); Right: illustration of a hydrometeor classification product.

As demonstrated in Figure 3, a case showing a severe thunderstorm with hail reports in Manitoba on June 5th 2019 (Foxwarren Radar), the Dual Pol data are able to distinguish and detect different types of echoes, identify potential areas of hail in the classification products, and improve quantitative precipitation estimates (QPE).

New Radar Network – Extended Doppler Coverage

A key difference with the new radar network is the extension of the Doppler range from the old radar's 113 km to the new radar's 240 km. This will both increase the ability to detect severe weather and increase the overlap with neighboring radars in case of outages.

In 2016, the total area of Doppler coverage was 1,355,700km^2 (113km C-Band Doppler range) as shown in Figure 4a.

Figure 4b depicts a scenario when the network is completed. The Doppler coverage will increase to 4,047,800 km^2.The green circles in Figure 4b indicate the radars completed so far. The blue circles indicate radars to be replaced in the same location. The orange circles indicate new locations (this includes the new radar in the Lower Athabasca region, and planned relocations of 3 sites (two DND radars and the Vancouver Island radar).

Better Data Quality and Increased Data Frequency

The new S-Band radars have higher power and reduced attenuation compared to the old C-Band radars. This allows for

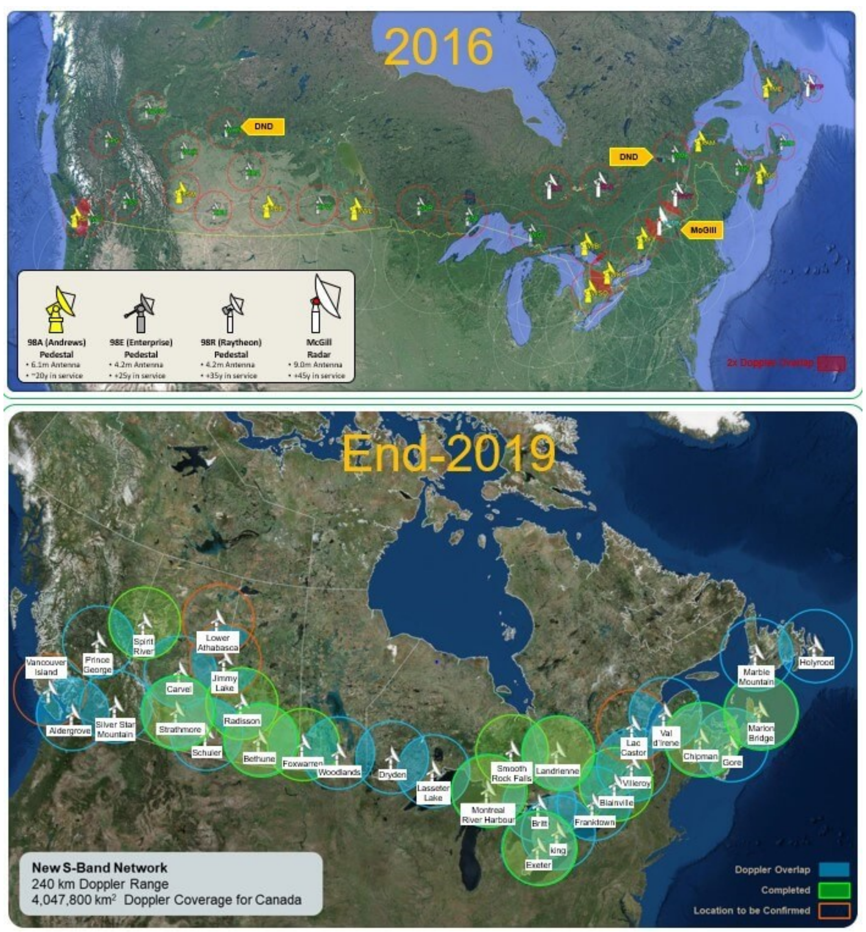
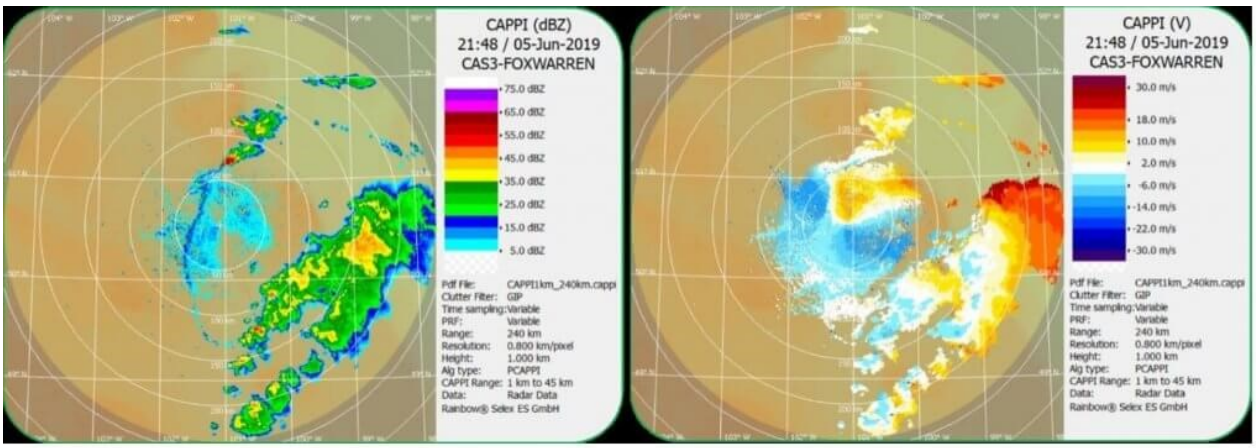


Figure 4. A comparison of the radar network for Doppler coverage in (a) 2016 and (b) 2019. Green: replacement completed; Blue: replacement in the same location; Orange: new or relocating sites.

much better “storm penetration” performance. The radar is able to pierce through or “see” deep into dense weather systems and even beyond to see severe weather developing behind a large storm cell. This is an important feature especially in detecting storms that present a high flooding risk.

In addition, the scan cycle of the new radars is shortened to 6 minutes from the 10 minutes of old C-Band radars. A more rapid scan is essential for issuing timely warnings as well as being very important for data assimilation for nowcasting.

The improved weather-data quality will also allow for more effective use of the information in other areas, such as water management, as radar images are used to understand the effects of precipitation on drainage basins, in particular in support of flood forecasting by provinces.



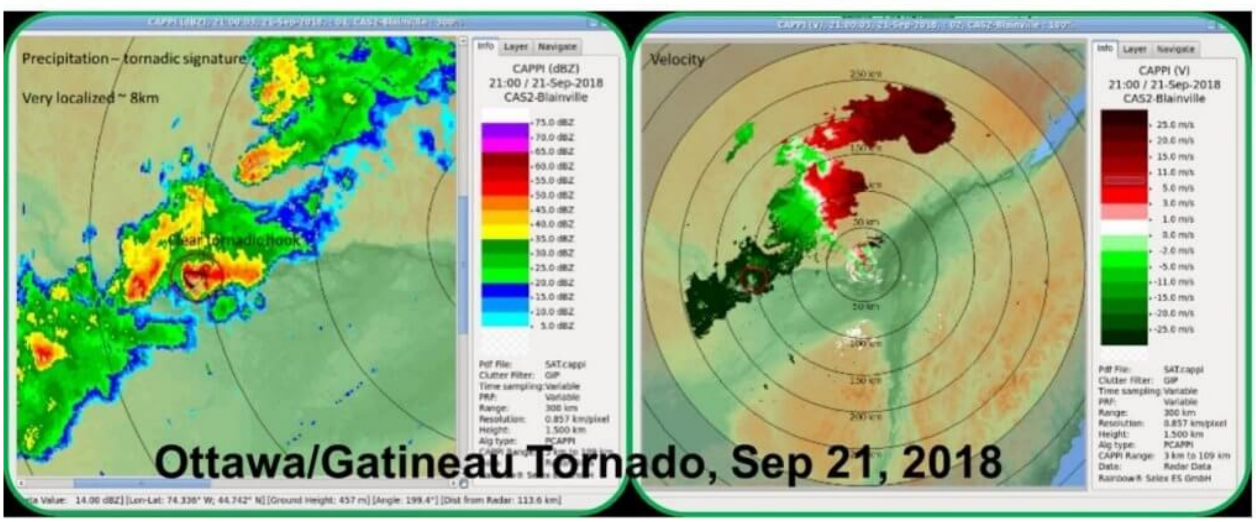


Figure 5 (top). Reflectivity and Doppler velocity products from the Foxwarren radar in Manitoba, with 240km coverage range.
Figure 6 (bottom). Tornado signature observed from the Montreal Area Radar (Blainville) about 150km away

Reduced Maintenance

One of the big features with the newer radars will be a significant reduction in maintenance costs as well as the time associated with maintenance. The old system requires the radars to be taken offline bimonthly for maintenance with a longer duration outage for the “annual” maintenance. New radars will require only 2 semi-annual maintenance visits. This will lead to greater availability of the radar data. Maintenance is provided by Selex (Leonardo) during the warranty period.

Radar Replacement Schedule

Stepwise Approach to Replacement Schedule

The contract with Leonardo provides for a commercial-of-the-shelf product with the contractor responsible for the complete construction from foundation to operational status. With the five radars operating in 2018, there were challenges associated with technical issues which led to several unexpected radar outages. Some of these issues were repeated at other radars. To address this, the contractor initially stabilized the technical issues with temporary measures while permanent solutions were developed. These permanent solutions have now been rolled out to all the new radars. Uptime for the new radars since the countermeasures were employed is near 100%.

Figure 7. Foxwarren MB: Example of new S-band radar alongside old C-band radar in 2018 (with temporary X-band radar on right hand side)

Starting in 2019, an ambitious plan of seven radar installations per year for the balance of the program is underway. The seven radars being replaced in 2019 are Bethune SK, Exeter ON, Marion Bridge NS, Chipman NB, Landrienne QC, Montreal River Harbour ON, and Strathmore AB. Selecting which radar is to be replaced in any given year by ECCC and the timing of the construction by the contractor is a balancing act between competing priorities. These include current operational status, climate and local severe weather frequency, location, access and the status of consultations and approvals. As the schedule is developed, it is updated on the project website at https://www.canada.ca/en/environment-climate-change/services/weather-general-tools-resources/radar-overview.html

Typical Radar Construction Timeline

In 2019, a radar construction timeline is 20 weeks at a minimum (Figure 8), including foundation work, tower construction, radar installation, establishment of power and telecommunication, new radar calibration and commissioning, burn-in and Site Acceptance Test (SAT). The 30-day burn-In phase allows for final work and tests to enable a smooth SAT. During the burn-in period, test data will be sent to a server within ECCC for data quality assessment and user evaluation. Data flows to the internal operational servers and to external sites and clients once SAT is complete.

Replacement of the seven radars in 2019 is underway. As the manuscript is drafted, Exeter ON, Bethune SK, Marion Bridge NS and Chipman NB had entered their burn-in stage before the final site acceptance tests.

Figure 8 (left). Typical Radar Construction Timeline in 2019.
Figure 9 (right). Collaboration with key enablers is essential to ensure a successful project delivery.

Collaboration with Key Enablers

Collaboration with key enablers is essential to ensuring a successful project delivery. These include contract monitoring; IT infrastructure; radar data and processing software adaptation; development of new Dual-Pol products; radar system and data quality control; as well as providing data and product services to internal and external clients (Figure 9).

Key project enablers and stakeholders include:

- Public Services and Procurement Canada (PSPC)
- Shared Services Canada (SSC)
- Environment and Climate Change Canada (ECCC)
    - Meteorological Service of Canada Branch (MSC)
    - Corporate Services and Finance Branch (CSFB)
    - Science and Technology Branch (STB)

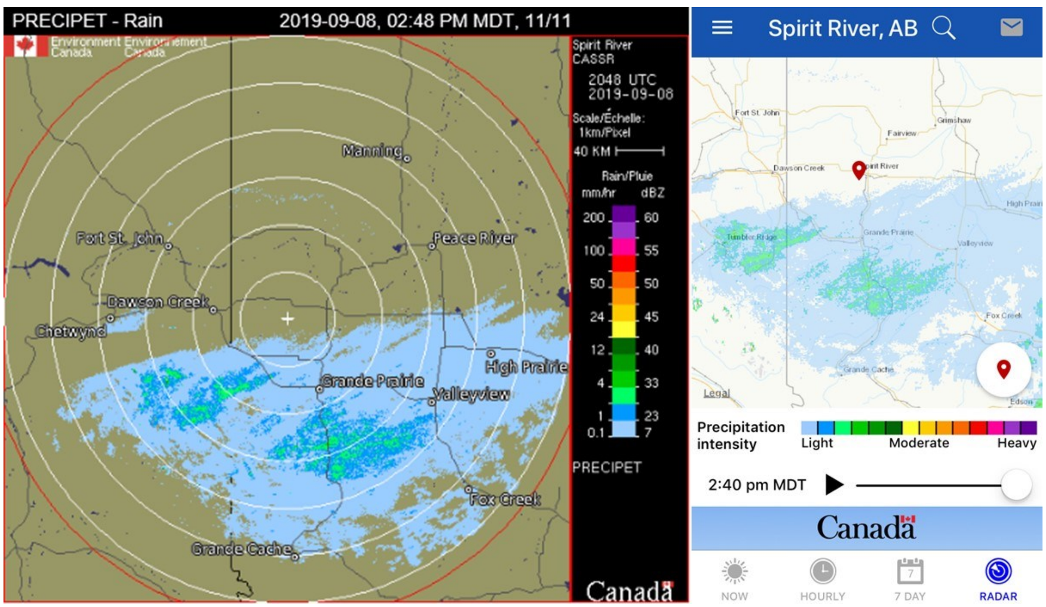


Figure 10. Examples of new radar products from the Spirit River Radar on www.weather.gc.ca (left) and ECCC's WeatherCan APP (right).

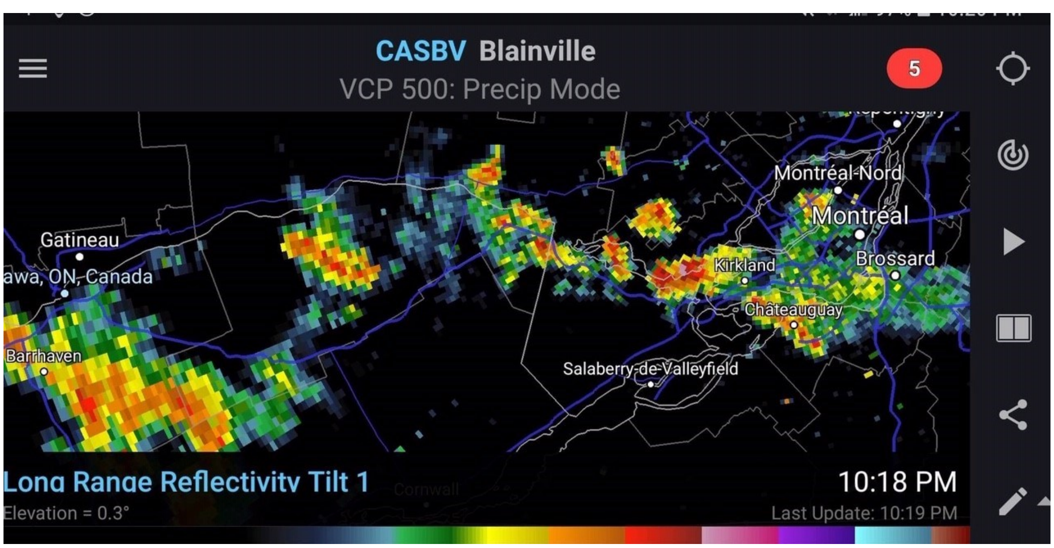


Figure 11. An Example of External Validation: "RadarScope" – a 3rd party app displaying ECCC's new radar data (June 27 thunderstorm events). Ottawa-Gatineau area: existing C-Band radar at Franktown: Montreal area: new S-Band radar at Blainville.

Understanding the new S-Band radar system and improving the quality of radar data and products is a priority for ECCC, both from a hardware and a software perspective. The new system needs to be tested in different weather situations and user feedback is critical to identify potential issues. Radar experts and scientists from the Science and Technology Branch (STB) of ECCC have been leading the data piece and working collaboratively with CWRRP, the manufacturer (Leonardo), academia, the data processing team and radar users to develop a better understanding of radar signal processing, to improve scan configuration, data quality, and to develop new products.

Where to See the New Radar Data and Products

Data from the new S-band radars is made available at the successful end of the Site Acceptance Testing. Products from the new radars can be found on ECCC's Weather.gc.ca website (Figure 10) and datamart (dd.weather.ec.gc.ca).

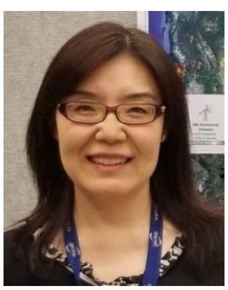
In addition, a higher resolution 1km composite radar animation is available on a zoomable map background within ECCC's "WeatherCAN" smartphone app and on GeoMet. More products will be rolled out as the project proceeds.

External data to radar clients are available in ODIM_H5 format and products from the new radars are now available on many 3rd party apps such as RadarScope (Figure 11).

About the Authors

Sylvain Laramée

Sylvain Laramée joined Environment and Climate Change Canada in 2003 and occupied several management positions in the Environmental Protection and Operations Division before joining the Meteorological Service of Canada in 2012. He worked as the Regional Manager, Atmospheric Monitoring for Quebec Region and as Senior Manager for Regional Operations also for Atmospheric Monitoring. Since 2017 he is the Director for Canadian Weather Radar Replacement Project. He holds a second degree diploma from the University of Sherbrooke in Environmental Management.



Qian Li

Qian Li joined CWRRP in 2017 before the commissioning of the first new radar at Radisson, Saskatchewan. Her role as Science Liaison Officer is to liaise with radar scientists from ECCC's Science and Technology Branch, as well as radar data integration team to ensure the successful delivery of the new radar data and products to downstream applications and users. She started her career within Environment Climate Change Canada in 2002 and holds a Bachelor of Science Degree in Geophysics from Peking University, and a Master of Science Degree in Atmospheric Physics from Chinese Academy of Meteorological Sciences.

Radar Events Initiative

By Phil Chadwick, Meteorologist and EcoArtist

Tenacity may be a good thing especially if it is well intentioned – the objective analysis of the weather services provided by Environment Canada. The following was written in 2004 to address some perceived deficiencies. The quality and quantity of radar were expanding and there were many imperative applications for that burgeoning information. The following were just a few of those and I had many more in the queue ready for implementation.

Now 15 years later I have not yet given up. A new generation of S-Band radars are being deployed across Canada offering much superior data that needs to be fully utilized as this 2004 research proposed. Acronyms and the organization of Environment Canada may have changed but the science of the natural world and the requirement to better understand weather and climate has become even more imperative.

Figure 1. Graphics Illustrating the Deployment and Distribution of NRP Radars.

The National Radar Project (NRP) has deployed conventional and Doppler radars across southern Canada. An enormous volume of data is being produced in support of operational meteorology. Algorithms are applied to this data to aid the severe weather meteorologist in the identification of severe weather conditions. In the case of convection, many algorithms are used to quantitatively analyse the three dimensional volume scanned radar data. These algorithms also keep track of temporal changes in the calculated quantities. When the algorithms produce quantities exceeding predetermined thresholds, the time and place of the exceedance in the volume scan is identified as a convective cell. The quantitative exceedance for several convective quantities as well as a summary quantity are also tracked. This information is summarized in the Severe Convection Index Table (SCIT). These convective cells are tracked in time and space and used by the severe weather meteorologist as an aid in the warning program. (Figure 2)

These algorithms have been used since the initial updated radars were installed beginning in 2000. Unfortunately the SCIT data has never been archived and the algorithms for cell identification have never been calibrated. The creation of a “Radar Event” definition and this initiative is the first, very important step in addressing these concerns. This is also an important initiative in the use of remote sensing (radar) data to estimate a more accurate time and space distribution of severe convection. The information can also be used in performance measurement of the severe weather program.

Radar Events are convective events identified by the operational radar network. Events that occur within roughly 220 km of radar are assessed using conventional radar information while events that occur within 100 km of radar can be identified in both conventional and Doppler mode. Radar events can be mapped in time and space to produce a radar-based Severe Weather Events climatology associated with severe convection in Canada. When reported severe events are vetted and coincide with radar events, the algorithms used to quantify the severity of the radar events can be calibrated. There is much more that can be done with this data but the preliminary step is to archive the data required to quantify radar events. This information can then be used in severe weather prediction, climatology, algorithm calibration, event investigation, meteorologist training and evaluation and finally performance measurement. Some of these applications will be illustrated.

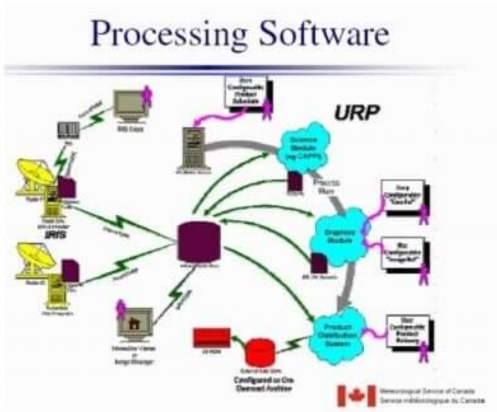


Figure 2a

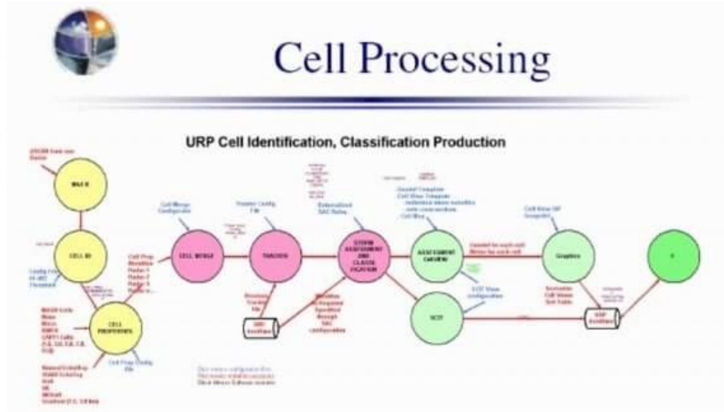


Figure 2b

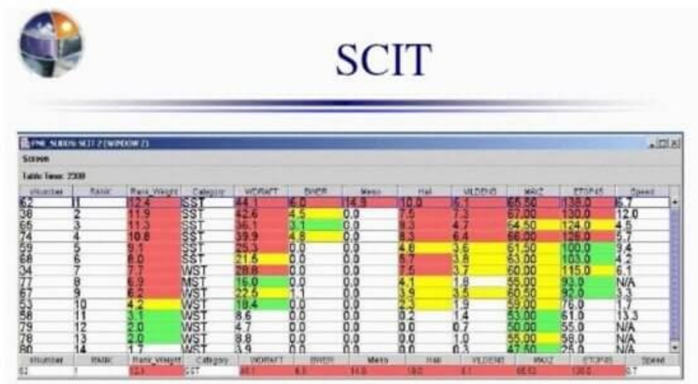


Figure 2c

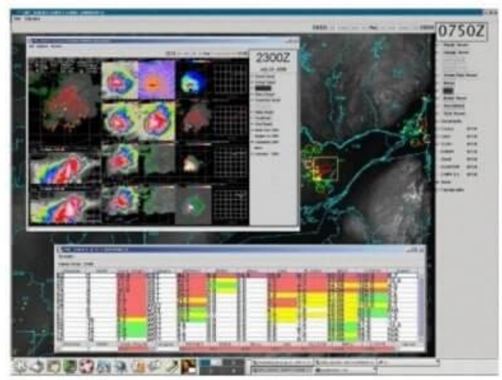


Figure 2d

Figure 2. Graphics Illustrating the Identification of Convective Cells and the Display of SCIT and NRP Radar Data.

Concerns with radar artefacts and the accepted difficulties with radar remote sensing of the atmosphere must be noted. These include but are not limited to:

- Anomalous propagation
- Beam blocking
- Partial Beam filling
- Dome wetting
- Attenuation
- Non meteorological targets (birds and insects)
- Multiple trip echoes

The factors that can influence the returned radar energy to the radar are many and varied. However application of the radar event initiative offers considerable information that promises to advance the science of remote sensing and severe weather meteorology. As a result it is suggested that the radar events initiative proceed is spite of the noted difficulties.

It is important to state some preliminary definitions that are used throughout this research paper.

Report – An observation of a meteorological event at a specific time and place is a report. The report can only describe the characteristics of the event at that specific time and place and not the overall characteristics of the event.

Event – An event is the result of the merging of all reports that occur within the climatological time and space scale of a meteorological event. The start of the event is the start of the first report that was merged into the event. The end of the event is the end of the last report that was merged into the event. An event is defined by the phenomena creating it.

Radar Event – a radar event is the merging of all of the convective cells identified by radar that occurred within 30 minutes and 30 kilometres of each other. The 30 minute and 30 kilometres climatological scale of a convective event used here is a definition that has been used in Ontario Region since the inception of the Severe Weather Program. This somewhat arbitrary definition of the climatological scale of convective events is a good place to start. The highest values of the algorithms (SCIT data) determined for any of the cells merged into the single radar event, are used to characterize the radar event.

Radar Events Initiative – Details

The “Radar Events Initiative” incorporates:

- **The Rank Weight and Component Severity Indices.** The Radar Event is comprised of an overall event severity quantity (Rank Weight) as well as the severity of each of the convective weather elements that can comprise a convective event. These convective weather elements include hail, wind, rain and tornado. Each of these has an estimated severity or quantitative value based on the report algorithm. None of these algorithms have been calibrated or investigated. Plotting the severity or quantitative value for each radar report is a start in the calibration process.

- **The Temporal and Spatial Distribution of Convective Events**. Mapping of the radar events in time and space provides a more accurate representation of the distribution of convective evens. The maps in figure 3 from August 2004 reveals the disparage between those 12 events detected by the official MSC observation network and those detected by radar. Certainly not all of the radar events are severe. However, it is also certain that many of the radar events did reach severe limits and produced damage in areas where that damage was not detected through the traditional MSC observation network.

- **Performance Measurement.** The use of radar events in performance measurement allows the estimate of the actual range in performance scores as well as the most likely performance values.

Meteorological Training. The use of radar events will aid in the training and evaluation of severe weather meteorologists. Briefly, meteorologists can learn meteorological patterns that later result in severe convection. They will be better prepared to issue messages for those patterns while not issuing for those that do not result in severe convection.

Radar Events Initiative Examples

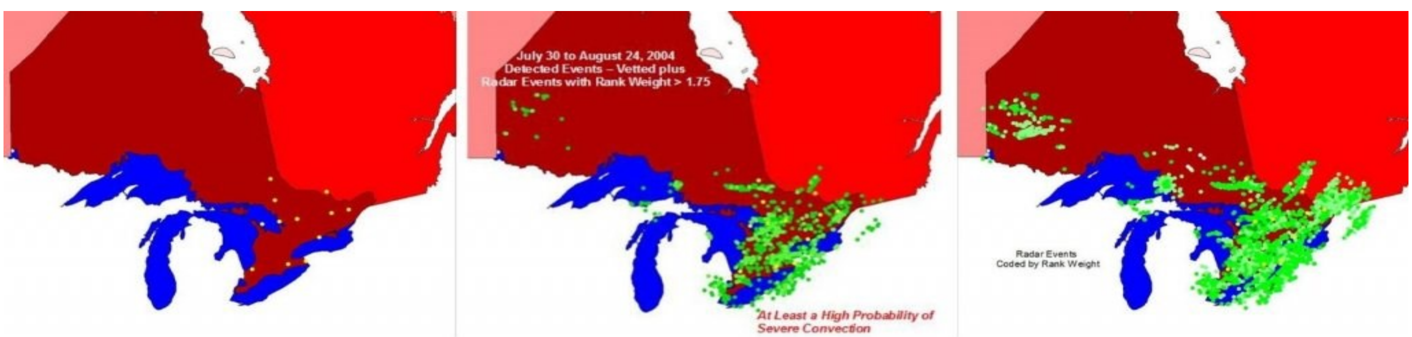


Figure 3. Maps from August of 2004 show that only twelve (12) severe weather events were detected (reported or observed) during the 30 day study period (far left). The radar network identified many more convective cells with potential severe signatures (far right).

The above examples are all for the same time period in August of 2004. Only twelve (12) severe weather events were detected (reported or observed) during the 30 day study period. The radar network identified many more convective cells with potential severe signatures. Certainly not all of the 3000 radar events identified from these convective cells produced damage at the surface but it is also certain that some of them did. The mapping of the radar events gives a more accurate distribution in time and space where possible severe weather may have had an impact on the Canadian society. These graphics are for the entire 30 day study period but can also be produced for any temporal and spatial subset of the study. Given the proper software applications, these events can be interactively queried for specific information including the Rank Weight and the severity of the individual weather elements.

By comparing the radar signatures with co-located detected (MSC observed) events, one can calibrate the radar algorithms and establish radar rank weights which are highly correlated with damage at the surface. The volume scan signatures for the specific weather element comprising the severe convection event can also be calibrated in addition to the rank weight. The calibration of the Rank Weight and the related algorithms is essential in order to increase their utility to the severe weather meteorologist.

The location of these radar events and severe weather element quantities can then be mapped in time and space.

Illustrations of Concepts

The following graphs and accompanying text illustrates just some of the concepts that can be applied using the Radar Events Initiative.

Figure 4 illustrates how the number of radar events identified by the NRP radars varies with Rank Weight. The radar events included in each of the five data sets is determined by the Rank Weight of the radar events. The first data set includes all of the 3000 radar events identified by radar. The second data set includes only those radar events with a Rank Weight greater than 1.25. Subsequent data sets are constructed using ever higher Rank Weight thresholds. The fifth and final data set includes only the 12 vetted events detected through the official MSC observation network.

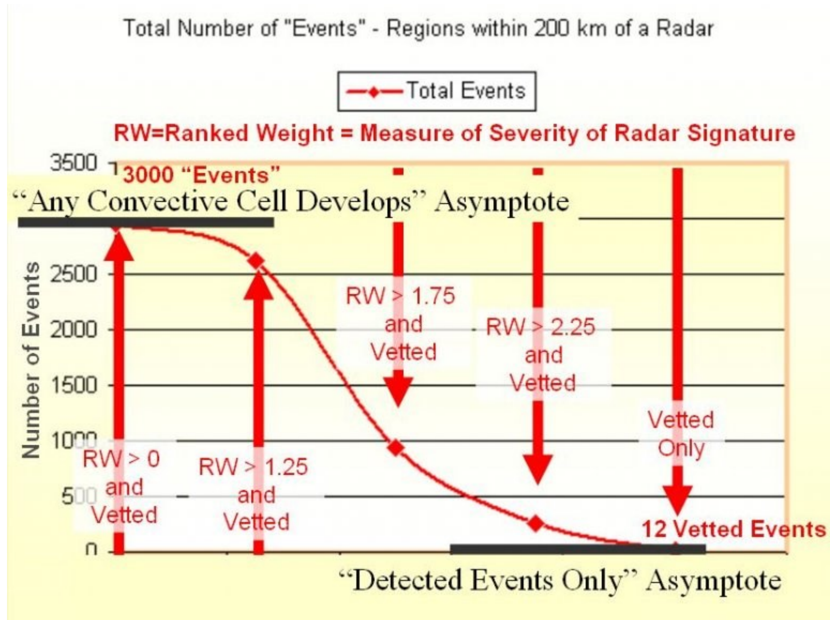


Figure 4. The graph illustrates how the number of radar events identified by the NRP radars varies with Rank Weight.

The relationship between Rank Weight and the severity of the convective events is unknown at this point and is a major motivation for this paper. As labelled in the graphic, it is presumed that the probability that a radar event reaches severe thresholds increases with the value of the Rank Weight. The convective cell severity is certainly qualitatively related to Rank Weight but a quantitative relationship is required in order to glean the maximum amount of information from the NRP radar network.

Figure 5 illustrates the five distinct data sets used in this study and the rank weights of the radar events that were included. The Probability of Detection (POD) is determined for each event data set. Note that the POD steadily increases as more radar information is included. The relative slope of the POD segments is very important. The absolute value of the slope of the POD segments is purely a function of the Rank Weight Thresholds selected. For maximum utility, the Rank Weight must be calibrated in terms of severity.

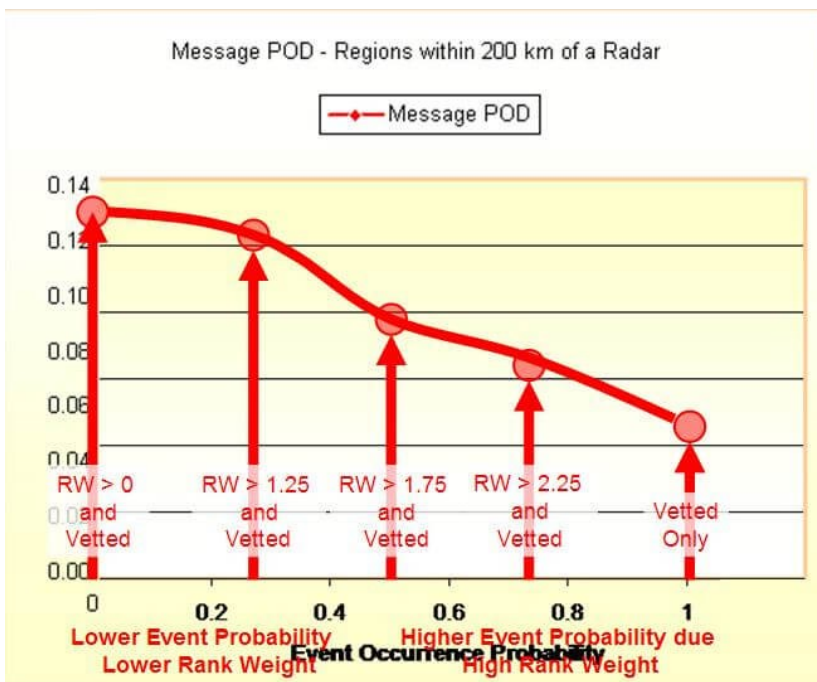


Figure 5. Graphic illustrating the five distinct data sets used in this study and the rank weights of the radar events that were included.

Some examples of how this information may be used, are described as follows using this 30 day data set to illustrate the concepts.

Figure 6 illustrates the relationship between the message based POD and the various event data sets that include radar events with specific Rank Weight thresholds. The use of this information can give much better estimates of the actual performance of the severe weather program. This graph clearly illustrates the upper and lower estimates of message based POD for the 30 days in August 2004.

It is proposed that the above information be displayed as a "whiskers plot" with the extreme high and low PODS being the extreme whiskers. Initially the central POD value plotted would be located at the point of inflection in the POD trace which is the point where the severe weather meteorologist believes that the transition from non-severe to severe convection occurs. The graphic illustrates this whiskers plot in "black".

After calibration of the Rank Weight, the most probable message based POD is found at the point where the Rank Weight of the convective events is most correlated with the transition from non-severe to severe convection. The graphic illustrates this whiskers plot in "gray".

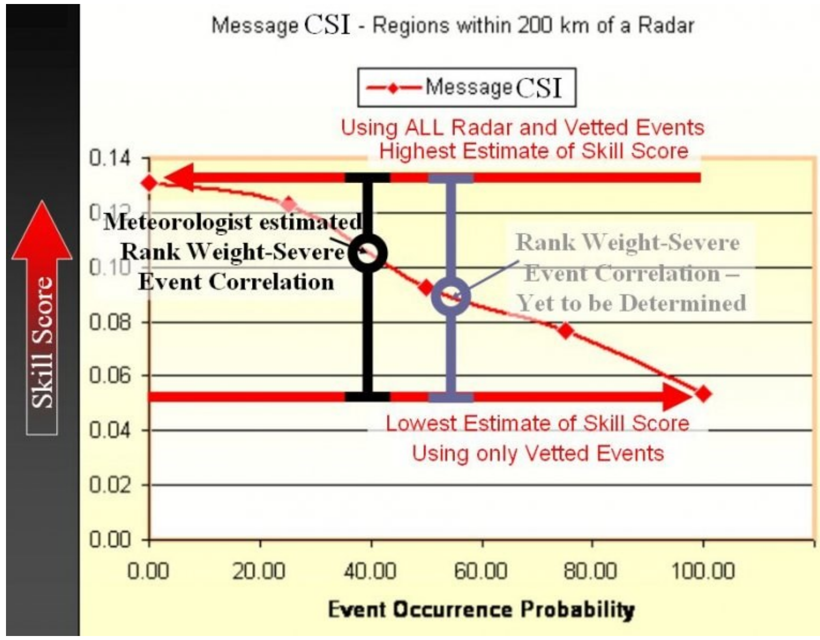


Figure 6. This graph illustrates the relationship between the message based POD and the various event data sets that include radar events with specific Rank Weight thresholds.

Conclusions

Radar events calculated from volume scan data can be used:

- to produce higher resolution temporal and spatial distributions that augment the climatology of severe events determined solely from detected (MSC observed) events;
- in performance measurement to estimate the actual range of skill achieved by the severe weather program;
- to calibrate the Rank Weight associated with severe weather in order to estimate the most probable performance measurement score;
- to aid the severe weather meteorologist in the consistent evaluation of severe weather patterns;
- to aid in the training and evaluation of severe weather meteorologists.

About the Author

Phil trained at Queen's University as a nuclear physicist, "Phil the Forecaster" has been a professional meteorologist since 1976. However, painting has always been his passion. Phil is an avid "plein air" painter when he's not doing severe weather prediction for Environment Canada or looking after nature on Singleton Lake.

Article: UQAM Atmospheric Science Program

Revitalization of UQAM Atmospheric Science undergraduate programme / Revitalisation du programme de baccalauréat en sciences de l'atmosphère de l'UQAM

René Laprise and Julie Mireille Thériault, Department of Earth and Atmospheric Sciences, Université du Québec à Montréal (UQAM), laprise.rene@uqam.ca, theriault.julie@uqam.ca

Le nombre d'inscriptions aux programmes de sciences de l'atmosphère s'avère plutôt faible dans les universités canadiennes. La situation à l'UQAM ne fait pas exception. La rentabilité insuffisante de ces programmes menace la viabilité à long terme de la formation de spécialistes dans les domaines liés à l'atmosphère (voir le rapport du groupe d'intérêt sur l'enseignement, la formation, la communication et la sensibilisation [ETCO] du groupe de travail sur la recherche reliée à l'atmosphère dans les universités canadiennes [ARRCU]). Néanmoins, les Canadiens dépendent de l'information météorologique, climatologique et de qualité de l'air pour planifier leurs activités quotidiennes, prendre des décisions financières et commerciales éclairées, et planifier des infrastructures efficaces. Nous avons besoin d'experts scientifiques spécialisés dans le domaine de l'atmosphère pour obtenir des informations de haute qualité sur les conditions météorologiques dangereuses, l'évolution prévue et les variations du climat, et sur leurs incidences connexes. Les programmes de sciences de l'atmosphère dans les universités canadiennes fournissent la formation nécessaire pour répondre aux besoins de notre société dans ces domaines, et ce, afin de renforcer notre résilience et de réduire notre vulnérabilité et les pertes que causent les dangers liés aux intempéries, particulièrement dans le contexte de l'évolution rapide du climat.

L'UQAM a récemment adopté certaines mesures qui visent à améliorer la situation en ce qui concerne le programme de premier cycle en sciences de l'atmosphère.

L'approche consiste à profiter d'une condition particulière à l'UQAM, l'absence d'un programme de baccalauréat en physique. Cette situation permet d'intégrer dans les cours de sciences de l'atmosphère les concepts de physique classique requis. Ainsi les bases des sciences de l'atmosphère sont abordées dès le début du baccalauréat, plutôt qu'à la fin. Par exemple, la météorologie synoptique s'enseigne au 3e trimestre, ce qui donne plus de temps pour intégrer, assimiler et appliquer les notions des sciences de l'atmosphère. La vision du nouveau programme de sciences de l'atmosphère permet à la discipline de rester distincte et autonome, plutôt que de passer pour une spécialisation de la physique.

Le nouveau programme

*Le nom du programme de baccalauréat est passé de « Météorologie » à **« Sciences de l'atmosphère : météo et climat »** afin de refléter l'importance et la complémentarité de la météorologie et du climat, et la diversification du marché du travail.*

Le nouveau programme de baccalauréat comprend 14 cours spécifiques aux sciences de l'atmosphère (sur un total de 30). Le reste des cours émane de programmes existants : programmation scientifique, système d'information géographique, communication des risques et statistiques, en plus de deux autres cours en mathématiques, en chimie atmosphérique, en océanographie, en hydrologie, et deux cours de projet ou des stages.

Cinq cours optionnels complètent le programme, selon la spécialisation choisie : axe Informatique et traitement de données, ou axe Environnement, eau et risques.

The enrollments in Atmospheric Science (AS) programmes are rather low in Canadian universities, and the situation at UQAM is no exception. The low profitability of AS programmes threatens the long-term perspectives for training specialists in atmospheric-related fields. (See the report by the interest group on Education, Training, Communication and Outreach (ETCO) of the **Atmospheric-Related Research in Canadian Universities (ARRCU)** working group.) Nevertheless, Canadians depend on weather, climate and air quality information to plan everyday activities, make informed financial and business decisions, and plan effective infrastructures. Atmosphere-related scientific experts are needed to provide high-quality information about weather hazards, climate variations and projected changes, and related impacts. AS programmes in Canadian universities provide the required education to fulfill the needs of our society in these areas, in order to increase its resilience and reduce its vulnerability and losses due to weather-related hazards, especially in this time of rapid climate change.

Some measures were recently taken at UQAM in an attempt to improve the situation of its AS undergraduate programme, as described below.

Article: UQAM Atmospheric Science Program

The historical situation at UQAM

Atmospheric Science (AS) programmes exist at UQAM since 1973. They were initiated through a contract from the Meteorological Service of Canada (MSC) to provide a weather forecasting training in the French language to satisfy the Official Language Act adopted in 1969. AS rapidly became the dominant specialization of the Physics Bachelor programme at UQAM. A Master program was added in 1976 and a Ph.D. in 2008.

The AS undergraduate programme underwent several modifications over the years. A major one occurred in 1995 following the closing of the Physics Department, and another one in 2008 with the creation of a joint Bachelor programme in Earth and Atmospheric Sciences (BSTA), with two concentrations: Geology and Meteorology. The joint BSTA entailed a large common trunk between the two concentrations to reduce its operating costs: 10 out of 30 courses (recall that in Québec, B.Sc. is 3 years, following 2-year CEGEP – College of General and Vocational Education). Registrations in the Meteorology concentration of that programme remained low however, and even fizzled over time, threatening the survival of the programme, despite the fact that it is the only one in Canada to offer French-language training in this specialization.

A thorough programme evaluation revealed several issues, some common to all Canadian AS programmes, others specific to the UQAM one.

1. AS programmes are generally designed and perceived as a specialization of Physics. This is problematic in the context of a general downward trend of interest for “hard” science (science, technology, engineering and mathematics – STEM). Viewed as a specialization of Physics, AS can only hope to get a fraction of the small number of students registering in Physics, which clearly limits the potential size of AS cohorts.

2. In a typical AS curriculum, Mathematics and Physics are taught in the first semesters, followed by AS courses in the latter part. This sequential approach makes difficult maintaining motivation of students interested primarily in AS and their applications.

3. The common trunk courses in the joint BSTA programme at UQAM had a strong Geology slant, creating additional challenges to maintain motivation of AS students.

4. The Meteorology concentration was strongly oriented towards theory, with little experimentation, applications or laboratories.

Beginning in summer 2018, a serious brainstorming was undertaken, involving professors, students and the Faculty management, to improve the AS programme and increase the number of students. After lots of discussions, debates and scenario considerations, a consensus was reached for building a new AS programme based on a radically new approach.

Photo of students attending the first class of the Atmospheric Physics course, September 3rd 2019. The group includes students from 1st and 2nd year.

Article: UQAM Atmospheric Science Program

The approach consists of taking advantage of a peculiar condition at UQAM: the absence of a Physics Bachelor programme. In universities where a Physics programme exists, the AS programme must take Physics courses from the Physics curriculum, which forces the aforementioned sequential approach. The distinct situation of UQAM allows integrating the required classical Physics concepts within the AS courses. The resulting effect is that students learn AS basics from the start of their Bachelor, rather than at the end. As a consequence, for example, synoptic meteorology is taught in the 3rd semester, allowing more time to integrate, assimilate and apply AS notions. The vision of the new AS programme is that of a distinct, autonomous discipline, rather than a specialization of Physics.

The New Atmospheric Sciences Programme at UQAM

The name of the AS Bachelor programme was changed from "Météorologie" to "Sciences de l'atmosphère : météo et climat", to reflect the dual importance and complementarity of meteorology and climate, and the diversification of the job market.

<u>The new Bachelor programme</u> contains 14 AS-specific courses (out of a total of 30):

- 9 courses cover AS theory,
- 2 courses cover AS-specific mathematics (Mathematical Physics, Numerical Methods),
- 3 laboratories (weather charts, instrumentation and measurements, numerical experimentation).

The programme is completed by courses taken from existing programmes:

- 6 courses provide useful tools (Scientific Programming, Geographic Information System, Risks Communication, Statistics and 2 other courses in Mathematics),
- 3 courses provide broadening to related fields (Atmospheric Chemistry, Oceanography, Hydrology),
- 2 courses for projects or internships.

The programme is completed with 5 elective courses depending on the choice of specialization:

- Computer science and data processing,
- Environment, water and risks.

A new one-year programme "Certificat en sciences de l'atmosphère" was also created as an introduction to AS with a minimum of mathematical formalism. Such one-year programmes are popular at UQAM. Students can obtain a Bachelor diploma through a combination of 3 certificates. An interesting sequence would be, for example: Certificat en sciences de l'atmosphère, Certificat en ressources énergétiques durables, and Certificat en sciences de l'environnement.

In addition, the weekly weather discussion, which had become rather sporadic after the loss of the late Prof. Peter Zwack, has been resumed and is greatly appreciated by students. Several measures were undertaken to promote the new AS programmes and give them more visibility. The web site was improved to describe all the AS programmes (**https://scta.uqam.ca/futurs-etudiants/les-sciences-de-latmosphere-luqam/**), and provide a list of professional opportunities, testimonies of past students, and a description of some of recent students' projects.

The outcome

In September 2019, 14 students registered in the AS Bachelor programme and 7 in the Certificat en sciences de l'atmosphère. This can be compared to previous Fall registrations of 6 in 2016, 5 in 2017, 7 in 2018. Although it is too early to claim victory, the statistics are encouraging. But continued efforts will be needed to consolidate the growth of the AS programmes at UQAM.

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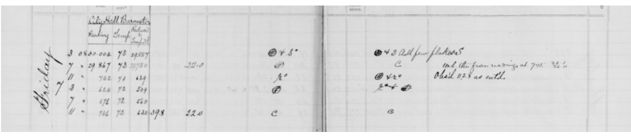
In case you missed it...

From CMOS Bulletin Volume 47, Number 4:

Updated CMOS Position on Climate Change / Énoncé de position de la SCMO sur les changements climatique

Haowen Qin, Budding Meteorologist and CMOS' Youngest Member
by Sarah Knight

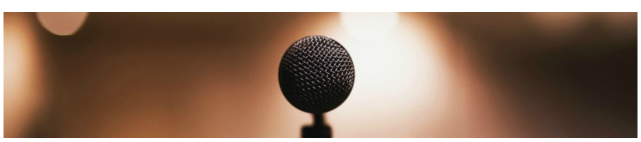


Historical Weather Data Rescue with McGill's DRAW (Data Rescues: Archives and Weather) in Canada and around the World
by Victoria Slonosky

Message from CMOS President, Kimberly Strong: Working For Our Members So They Can Work for Science

Book Review: Climate in the Age of Empire: Weather Observers in Colonial Canada
Book by Victoria Slonosky, Review by Richard Leduc

Book Review: Verner Suomi: The Life and Work of the Founder of Satellite Meteorology
Book by John Lewis, Review by Lewis Poulin



Members Updates
Meeting Notifications, Books for Review, and more

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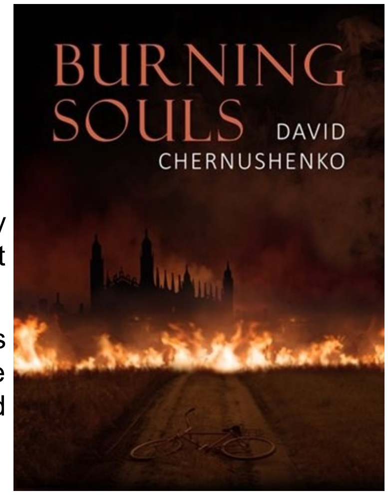
Book Review

[Burning Souls]

Review by Frank Johnson, President, Ottawa Intrumentation Inc.



By David Chernushenko
Published by Green & Gold Inc
Paperback, 670 pages
ISBN 978-1-9991138-0-3
$30.00 (CAD).

Into the burgeoning field of climate change novels we receive **Burning Souls**, by former Ottawa City Councillor David Chernushenko. This book is different. Do not pick it up unless you're prepared to stay up late finishing it.

Chernushenko has a notable pedigree as an educator, film-maker, and author. His service on the council of the City of Ottawa included being Chair of the Environment and Climate Protection Committee. That breadth of background knowledge shines through in this novel.

Crafted around the adventures of four optimistic Cambridge graduate students, *Burning Souls* is well-paced and compelling. The principal characters – Sagan, Jenny, Jiro, and Simone – develop interests and careers in climate science, business, and journalism. Each are well developed and their stories form an excellent narrative that underpins the novel.

Chernushenko manages to join all the dots between the symptoms and events of the growing crisis, tracing an arc from the 'Lost Decade' of the 1990s to a nail-biting finale in the mid-2020s. He brings a wealth of accurate information, garnered during his career interest in climate change and responsible life style. His insight into the Machiavellian intrigues within politics and commerce are frightening enough, but his predictions of the course of events in the world at large will take away what little sleep you might have hoped for.

Novels in this genre are necessarily didactic and portentous. Chernushenko however navigates this with panache, speaking through his characters with precision and depth. The multifaceted dark sides of our society are exposed to the searing light of consequence. Given the news each day ("Humans threaten one million species with extinction"; "Nature's emergency in five graphics"; "Five things we have learned from the nature crisis study", — just to look at the one news site in the past week!) together with the increasing number of declarations of "climate emergency" by governments and school children around the world, his illumination is timely and sobering.

An intriguing thread throughout the novel is the many references to an encyclical published by Pope Francis in 2015 – Laudato si: On Care for our Common Home. This oft-overlooked work is a lucid account of the harm inflicted on the earth by our irresponsible use and abuse of the goods with which God has endowed it. Whatever one's spiritual outlook, the theme merits careful attention – especially in light of the generations of exploitation justified by a misinterpretation of the injunction to "fill the earth and subdue it". Apocalyptic fatalism and its ties to Fundamentalism – as Atwood's Handmaid's Tale so aptly cautions – have long served as an excuse for capitalistic greed. It is a bankrupt philosophy that demands more vigorous confrontation (as indeed some apologists in addition to Pope Francis are attempting, such as David Bookless, Ontario native Katherine Hayhoe, Director of the Climate Science Center, or Wendel Berry).

Chernushenko explores the redemptive power of acting with courage and integrity and the value of close friends in the face of critics and opponents, but ultimately comes to the same position as many mythopoetic authors before him: a physical extermination of evil is the only remaining option. Will the travails of his characters compel us to the same position? Do we have the courage of Simone to take up those arms? The arc of history traced in this novel may portend only one conclusion.

About the Author

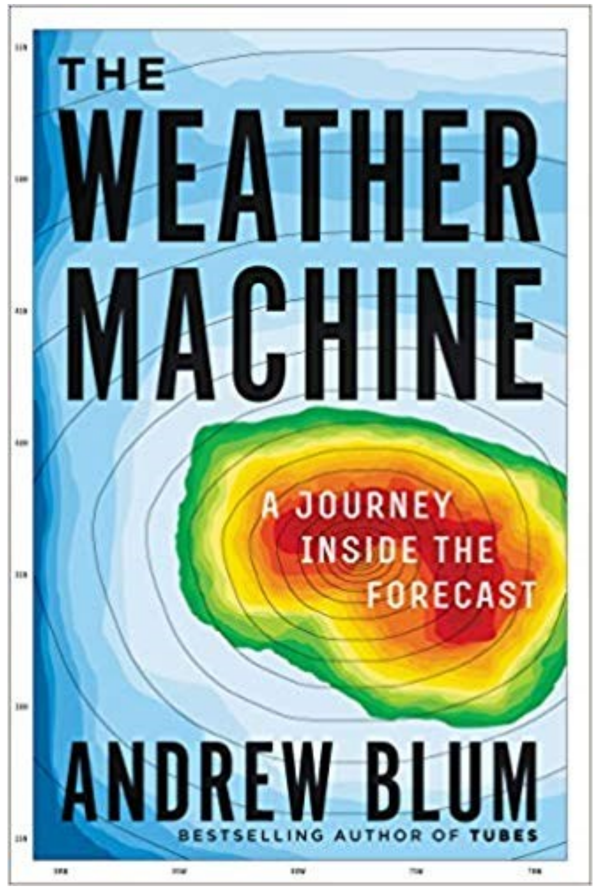
From 1998-2013, Frank Johnson managed his company RBR Ltd. RBR has been a long-time Corporate Member of CMOS and frequently exhibits at Congresses. He is now president of **Ottawa Instrumentation Ltd.**, and continues to be involved in development of sensors for oceanography and sleep apnoea recording. Frank is an active member of CMOS and spoke at the January 2019 Ottawa Centre lunch meeting on Citizen Scientific Tourism on an Unexpected Circumnavigation of Baffin Bay.

Book Review

The Weather Machine: A Journey Inside The Forecast

Review by Bob Jones, CMOS Archivist

By Andrew Blum
Published by HarperCollins Publishers Ltd
Hardcover, 224 pages
ISBN 978-1-4434-3859-9, $32.00 (CAD).



Quite by accident I stumbled upon this book in the express collection of the Ottawa Public Library. Seeing it was about weather forecasting, I could not resist it. After reading the short book, I am amazed it was not sent to the CMOS Office like so many other books offered for review in the Bulletin. **The Weather Machine** is at the core of what meteorologists past and present do, and should be a pre-requisite for any undergrad or grad course in meteorology.

Andrew Blum is no stranger to CMOS. At the beginning of this summer we linked an article on our social media, published in Time Magazine, called *Inside the Weather Wars That May Threaten the Daily Forecast You Depend On*. It should still be available at: **https://tinyurl.com/y34u2rob**

The Weather Machine was referenced there. Blum's book traces the history of meteorology, first with historic primitive observing all the way to producing a usable forecast. Later chapters cover the current state of the science which includes global model ensembles and the newest crop of orbital and stationary weather satellites. Canada and its met services are not ignored but the state of the art physics and world class numerical weather prediction we did under experts like Warren Godson and André Robert should have been mentioned. The end of the book references CMOS members Bruce Angle and David Grimes. The book concludes with an interview with David, retiring as Head of the World Meteorological Organization, who gives his insights on the way forward.

The Weather Machine is very heavily noted, referenced and indexed, displaying the amount of effort and research Blum made to accurately produce such a compact version of literally the history of meteorology.

In less than 200 pages, the book is a quick easy read and probably the most complicated part is Blum's explanation of how the regional and global models work. There is little oceanography, although sea surface temperature is included as an important model input. The focus is always on better understanding of the atmosphere and predicting the associated weather. A couple of his conclusions near the end are interesting. In the chapter called *The Euro*, Blum says that of all the models currently available to forecasters, the European (**The European Centre for Medium-Range Weather Forecasts – ECMWF**) model performs consistently better – but only by a small amount. This was due to excellent co-operation among the many European Meteorological Services which pooled resources and expertise to their advantage. More startlingly, he describes the outputs from all the models processed with super computers of *The Weather Company*, an offshoot of *Weather Underground* and *The Weather (cable) Channel* in the USA. This system now produces global point forecasts which are so good that human (read meteorologist) intervention in any stage or parameter has been proven to decrease the machine forecast accuracy. This foretells new roles for newly hired meteorologists at weather centres and offices, and their roles will start with a machine-produced forecast!

Blum makes other interesting conclusions which we will leave to those reading the entire book.

CMOS News

Call for CMOS Awards Nominations

February 15th is the deadline for nominations for the CMOS Prizes and Awards. It may seem far away, but it always seems to arrive faster than we thought. Please take a moment to visit **http://www.cmos.ca/site/awards** for a list of the eight awards, for instructions on how to make a nomination and then submit something on behalf of one of your colleagues or students. CMOS has a rich history recognizing deserving persons (members and non-members) through its awards programs. But regrettably, there are many deserving candidates who go unrewarded each year because we were too busy to work up a nomination. Don't wait – do it now!

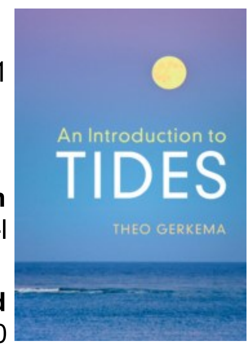
Note that any inquiries and all nominations are to be forwarded to the CMOS Awards Coordinator (Denis Bourque) at awards-coord@cmos.ca.

Appel pour les nominations : Prix de la SCMO

Le 15 février est la date limite pour la soumissions des mises en candidature pour les prix et honneurs de la Société. Cela semble peut-être loin, mais il semble toujours que la date arrive soudainement. Veuillez prendre quelques secondes pour visiter **http://www.cmos.ca/site/awards?language=fr_FR&** pour la liste des huit prix et pour lire les instructions, puis prendre le temps de soumettre la nomination d'un de vos collègues ou étudiants. La SCMO a une histoire qui souligne les personnes méritantes (membres et non-membres) par ses programmes de reconnaissance. Malheureusement, il y a beaucoup de personnes qui méritent d'être nommées qui ne le sont pas, parce qu'on est trop occupé. N'attendez pas : faites-le maintenant!

À noter que toutes enquêtes ainsi que toutes nominations doivent être soumises au Coordinateur des honneurs de la SCMO (Denis Bourque) au coord-honneurs@scmo.ca.

Books Available for Review



An Introduction to Tides, 2019. By Theo Gerkema, Cambridge University Press, ISBN 978-1-108-46405-5 (Paperback), 211 pages, $51.95 USD (2019-3)

Other recent titles still available for review by a CMOS member:

- **A Bright Future: How Some Countries Have Solved Climate Change and the Rest Can Follow**, 2019. By Joshua S. Goldstein and Staffan A. Qvist, Hachette Book Group, ISBNs 978-l-5417-241O-5 (hardcover), 978-1-5417-2409-9 (e-book), 288 pages, $34.00. (2018-9)
- **Trends and Changes in Hydroclimatic Variables: Links to Climate Variability and Change**, 2019. Edited by Ramesh Teegavarapu, Elsevier Inc., ISBN 978-0-12-810985-4, 400 pages, US$127 (2017-10)
- **Tropical Extremes: Natural Variabilities and Trends**, 2019. Edited by V. Venugopal, Jai Sukhatme, Raghu Murtugudde, Remy Roca, Elsevier Inc. ISBN 978-0-12.809248-4, 333 pages, US$110 (2018-11)
- **World Seas, An Environmental Evaluation. VOLUME III: Ecological Issues and Environmental Impacts**, Second Edition, 2019. Edited by Charles Sheppard, Elsevier Inc. ISBN 978-0-12-805052-1, 633 pages, US$250. (2018-12)
- **Synoptic Analysis and Forecasting, An Introductory Toolkit**, 2017. By Shawn Milrad, Elsevier, ISBN 9780128092477, 246 pages, US$125.00 (2018-1)
- **Ice Caves**, 2017. Edited by Aurel Persoiu, Elsevier, ISBN 9780128117392, 752 pages, $225.00 (2018-2)
- **Rainbows: Nature and Culture**, 2018. By Daniel MacCannell, The University of Chicago Press and Reaktion Books Ltd, ISBN 9781780239200, 208 pages, US$24.95 (2018-4)
- **The Deep Pull: A Major Advance in the Science of Ocean Tides**, 2018. By Walter Hayduk, FriesenPress, ISBN 9781525518706 (hardcover) $35.49, 9781525518713 (softcover) $27.49, 9781525517820 (eBook) $11.99, 251 pages. (2018-7)

Never reviewed a book before? No problem! Check out some of these past reviews for ideas: Ice: Nature and Culture; Weather in the Courtroom; Convenient Mistruths: A Novel of Intrigue, Danger and Global Warming; Weather, A Very Short Introduction; Nonlinear and Stochastic Climate Dynamics.

If you a review a book it is yours to keep! Contact the Editor to get involved.

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Thank you to Bob Jones for his continued editorial assistance and guidance.

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