PROGRAM

CHURCHILL BARBER SYMPOSIUM 2024

Looking into the Future: Opportunities and Challenges

AUGUST 28TH
DISCUSSION PANEL: 7:00PM - 8:30 PM

AUGUST 29TH
SUBMITTED TALKS: 9:00AM - 2:45PM

LOCATION: CHURCHILL COMPLEX THEATRE

The Town of Churchill

churchillnorthernstudiescentre

University of Manitoba

POLAR BEARS INTERNATIONAL

JOIN VIRTUALLY Via Zoom

Meeting ID: 861 7461 1482
Passcode: 292061

Breaks supported with coffee and snacks

Contact us for further information about the symposium: CNSC@churchillscience.ca

Churchill Barber Symposium 2024

The Churchill Barber Symposium 2024 will host a knowledge exchange forum on **28 (evening) and 29 (day) August 2024** in Churchill, MB. On 28 August there will be an evening discussion panel of invited experts to discuss topics related to the conference focus of *Looking into the Future: Opportunities and Challenges*. On 29 August, a collection of submitted talks will present on active and past research that examine Churchill, Hudson Bay and its coast. *All aspects of the symposium will be open to the public, both in person and via zoom (https://us02web.zoom.us/j/86174611482?pwd=ekeFp8qTGbXHL2eXPuz8xtZTeUE1cD.1) .*

In October 2022, the first Churchill Barber Symposium (supported by Polar Bears International, Town of Churchill, and academic and government scientists) gathered a group of experts to discuss questions regarding the ecological future of Hudson Bay with a focus on sea ice change and its impact on the regional ecosystem near Churchill, Manitoba. The symposium was named in honour of Dr. David Barber whose legacy of love for the Arctic, thirst for knowledge, and passion for working with Churchill and northern communities continues to inspire new research and help us prepare for the changes already affecting the Arctic, its peoples, and ecosystems.

Discussion Panel, August 28, 7:00 – 8:30 pm

Topic: *Looking into the Future: Opportunities and Challenges*

6:30 – 7:00 pm	Welcome Refreshments
Discussion Leaders	Clive Tesar and C.J. Mundy
Panel Members	
Dr. Feiyue Wang (University of Manitoba)	*Future research plans associated with the Churchill Marine Observatory*
Dr. Julienne Stroeve (University of Manitoba)	*Ice-free period too long for Southern and Western Hudson Bay polar bear populations if global warming exceeds 1.6 to 2.6 °C*
Hope Hill (Mushkegowuk Council)	*Mushkegowuk Council Cree Geomatics - Data Management, Visualization, and Analyses for the Nations*

Program of Submitted Talks, August 29, 9:00 am-2:45 pm

8:30 – 8:50 am	Welcome Refreshments	
8:50 – 9:00 am	Opening Remarks, C.J. Mundy	
	Talk Title	**Speaker**
9:00 – 9:15 am	1. Transport infrastructure and community development in Churchill: Findings from future scenario workshops	Philipp Budka, University of Vienna
9:15 – 9:30 am	2. Using Airships and CubeSats to enhance climate resilience in northern communities	Mitesh Patel, University of Manitoba
9:30 – 9:45 am	3. Churchill and Hudson Bay's memory of two kilometers of ice	Dorthe Dahl-Jensen, University of Manitoba
9:45 – 10:00 am	4. Emerging land: A study on the nature and impact of the emerging coastal landscape of the Hudson Bay Lowlands	Kaushik Gupta, University of Manitoba

10:00 – 10:15 am	5. Carbon loss studies in rivers of the Hudson Bay Lowlands	Tim Papakyriakou, University of Manitoba
10:15 – 10:45 am	Break with refreshments	
10:45 – 11:00 am	6. High resolution NEMO modelling for the Hudson Bay Complex	Paul Myers, University of Alberta
11:00 – 11:15 am	7. A window into current biogeochemical modelling of the Hudson Bay Complex	Inge Deschepper, Université Laval
11:15 – 11:30 am	8. Surface-based KuKa Radar measurements of snow depth on sea ice and lake ice in Churchill, Manitoba	Monojit Saha, NASA Goddard Space Flight Center & University of Maryland College Park
11:30 – 11:45 am	9. Inaugural remote sensing tests of sea ice forming using surface-based L-, C-, And Ku-band radars at Churchill Marine Observatory	Mehran Dadjoo, University of Manitoba
11:45 am – Noon	10. GENICE II: Experimental testing of monitored natural attenuation (MNA) using large scale genomics	Eric Collins, University of Manitoba
Noon – 1:30 pm	Lunch on your own	
1:30 – 1:45 pm	11. Biodegradation potential of Arctic microbes in connection with crude oil concentration in sea ice	Durell Desmond, University of Manitoba
1:45 – 2:00 pm	12. Primary production hotspot identified in the coastal waters of Southampton Island, Nunavut in summer 2019	C.J. Mundy, University of Manitoba
2:00 – 2:15 pm	13. Structure and functioning of the Southampton Island food web	Rémi Amiraux, IRL Takuvik (CNRS - Université Laval)
2:15 – 2:30 pm	14. Spatiotemporal dynamics of predator and prey hotspots on the sea ice near the Western Hudson Bay coast	Chloé Warret-Rodrigues, University of Manitoba, Polar Bear International
2:30 – 2:45 pm	15. Polar bear-human interaction risk is governed by sea ice loss but independent of bear body condition	Danielle Rivet, University of Saskatchewan
End of Symposium		

List of Abstracts

1. *Transport infrastructure and community development in Churchill: Findings from future scenario workshops*

   Authors: Budka, P. and Grill, C.

   Abstract:

   The Town of Churchill, a community of 870 people on the Hudson Bay in northern Manitoba, is unique in terms of transport infrastructure. It is inaccessible by road but it is home to the only deep-water port on the Arctic Ocean that is directly linked to the North American rail system. The communityís relatively large airport, which was constructed due to the former military presence, has become a key component of the growing tourism industry in the ìPolar Bear Capital of the Worldî. The townís history is closely intertwined with these infrastructures, and they have played a significant role in its growth and development. But what does the future hold for Churchill? What are the implications of the transfer of ownership and operation of the Hudson Bay Railway and the

Port of Churchill to a consortium of local communities for the town and the region? How might climate change and environmental crises impact the community, its economy and infrastructure? What could a sustainable Churchill look like? To address such questions and related future scenarios, the European Research Council (ERC) project InfraNorth, with the support of the Town of Churchill, organized two future scenario workshops in August 2023. These events brought together locals as well as transport professionals to discuss, evaluate, and outline a variety of infrastructure scenarios. In this presentation, we will discuss aspects of the planning and organization of the workshops, as well as selected results.

2. *Using Airships and CubeSats to enhance climate resilience in northern communities*
   Authors: Patel, M. and Ferguson, P.
   Abstract:
   Canada's northern regions have seen rapid climate-induced changes over the past decade and have warmed at a pace that has surprised climate scientists. Many northern communities rely on sea ice for transportation and livelihood, but warmer winters are causing hazardous sea ice conditions for northern communities, who lack accessible, real-time data on sea ice conditions. Available technology has inherent delays and limits access to important data, which limits response strategies during rescue missions. By developing an airship with remote sensing sensors and communication equipment onboard, communities will have access to real-time sea ice conditions and reliable high speed internet when traveling on sea ice, which could aid in better rescue responses and medical aid. Further, information about the quantity and quality of the ice can also be accessed using space. CubeSats provide unprecedented access to space in ways that were not possible with traditional space missions. A CubeSat in a polar orbit, outfitted with passive snow and ice sensors would empower northern communities with critical environmental data to help them monitor their surroundings and mitigate the risks associated with climate change. Using airships and CubeSats empowers the communities with tools to cope with a rapidly changing climate and make informed decisions regarding sea ice safety.

3. *Churchill and Hudson Bay's memory of two kilometers of ice*
   Authors: Dahl-Jensen, D.
   Abstract:
   During the last Glacial Period the Laurentide ice sheet covered North America and Hudson Bay. The top of the ice sheet, the Keewatin Dome west of Churchill was believed to be covered with 3000 m of ice. During the glacial time several surges of ice streamed out of the Hudson Strait bringing detrial carbonates from the Hudson Bay out into the Atlantic Ocean. The ice sheet melted away after the glacial period and around 5-7 ka only the remains of the Northern Innuitian ice sheet is found in the Barnes ice cap. The area around Churchill is however still lifting with a rate of 10 mm each year as a consequence of the removal of the Laurentide ice sheet and mantle convection. Even with a global sea level increase of 3-4 mm each year, thermal expansion of the water and the changes of river in flow a decrease of the water level in the Churchill deep harbor has been observed. The elevation changes in Manitoba varies from the strong uplift of 10 mm each year in Churchill to a slight depression in Winnipeg resulting in a tilt of the elevations. On the long term this will result in changing hydrologic pathways and watersheds in Manitoba.

4. *Emerging land: A study on the nature and impact of the emerging coastal landscape of the Hudson Bay Lowlands*
   Authors: Gupta, K., Bruneau, J., Guzzi, A., St.Germain-Silva, S., Ehn, J., Kuzyk, Z., and Papakyriakou, T.

Abstract:

The Hudson Bay Lowlands is situated along the south-western Hudson Bay and James Bay covering a staggering 325,000 km^2 area and stretches over a length of 1400 km and 540 km in width. This area is characterized by unconfined, cold climate peatlands, second only to the worldís largest peatland i.e., West Siberian Plain (540,000 km^2). The entire area has emerged out of the Tyrell Sea because of marine regression brought about by post glacial isostacy. The peatlands have then accumulated over the last ten thousand years, with the majority of the landscape being dominant peat bog, and salt marshes near the coastal region. Apart from being a habitat to several arctic species like snow geese, polar bears and arctic foxes, this landscape draws global interest for its rich carbon reserves. To understand the true impact and utilization of this landscape it is important to understand its geological evolution and geomorphological processes that operate within the region. This study aims to investigate the evolution of this coastal landscape and its impact across various spectrums of the coastal environment. The study involves use of remote sensing techniques applied over southern Hudson Bay coastal margins; as well as fine scale in-situ based studies which was based out of Wapusk National Park, Manitoba.

5. *Carbon loss studies in rivers of the Hudson Bay Lowlands*
Authors: Papakyriakou, T., Litvinov, A., Kuzyk, Z.A., Ledger, K., Decker, N., Soloway, A., Gedig, D., Guzzi, A., Ahrenholtz, H., Gupta, K., Regehr, A., St. Germain-Silva, S., Ehn, J., Mundy, C.J.
Abstract:

A large proportion of carbon (C) taken up through primary production by terrestrial ecosystems is introduced to the land-to-ocean aquatic continuum (LOAC) for C. Within this continuum, a proportion of C is evaded to the atmosphere and buried within inland or coastal environments, leaving a largely unquantified proportion reaching the marine system. Once in the marine system, river inflow can have ecosystem wide impacts that includes a reduction in the seawater's buffering capacity, making the ocean more vulnerable to ocean acidification (OA), while large inputs of river borne terrestrial C will impact both the ocean's CO_2 source or sink status, as well as OA through a complex interplay of abiotic and biotic processes.

There are few places globally where the understanding of LOAC processes is more important than the Hudson Bay Lowlands (HBL). A large proportion of North American river inflow to the Arctic Ocean is through southern Hudson Bay and James Bay, locally draining the massive permafrost laden peatlands of the HBL. The HBL provides critical ecosystem services, is homeland to a number of First Nations, and is estimated to hold a significant proportion of the world's terrestrial permafrost C. Increased emissions of C from HBL with regional warming, or in response to other disturbances (e.g., hydroelectric development, mining, etc.), either through direct evasion to the atmosphere, and/or by relocation of the C to the ocean by rivers, followed by degradation to CO_2 or CH_4 could trigger a strong positive climate feedback.

This presentation reports on results from on-going research whose objectives are to better understand variability in LOAC processes within lower HBL watersheds of rivers entering the coastal zone of southern Hudson Bay and James Bay. The focus of this presentation will be the characterization of C and nutrient delivery from select watersheds draining different parts of the HBL, and thus with different catchment characteristics and experiencing different development pressures. Results will be placed in context of river delivery from other parts of the Arctic. A component of research results from a community partnered research and monitoring program.

6. *High resolution NEMO modelling for the Hudson Bay Complex*
Authors: Myers, P.G., Louis, H.H., Weiss-Gibbons, T., Pennelly, C., and Deschepper, I.
Abstract:

The numerical modelling framework of the Nucleus for the European Modelling of the Ocean (NEMO) is now widely used throughout Canada. Here we use several configurations, run at resolutions from 1/4 to 1/60 degree to explore questions of ocean circulation and hydrography in the Hudson Bay Complex. We consider the role of river runoff, including heat input from rivers. We examine specific questions including marine heat waves and changes in the length of the ice free season.

7. *A window into current biogeochemical modelling of the Hudson Bay Complex*
   Authors: Deschepper, I., Papakyriakou, T., Lavoie, D., Myers, P., Maps, F.
   Abstract:
   The Hudson Bay Complex (HBC) is home to many communities and apex predators reliant on lower trophic levels. The physical and chemical environment that drives the base of the food web, on which higher trophic levels are reliant, can change the health and abundance of the food sources that the total system is reliant on. It is essential to understand the physical and biogeochemical drivers of the base of the food web to predict possible changes to the system in the future due to climate change. Biogeochemical models (BGCMs) can be a helpful tool that provides information about the base of the food web of the HBC on a larger, bay-wide, and long-term scale. Recent efforts into improving and developing BGCMs in the HBC by coupling a BGCM to a physical modelling system have shown the importance of sea-ice dynamics and river runoff on the variability of nutrient concentration in the water and the ice-associated primary producers. This study reports on results from a modelling study whose objective are to unravel the environmental controls on biogeochemical productivity of the Hudson Bayh Complex. The river runoff and sea-ice production influence 8-20 % and 5-13% of the nitrogen within the primary producers in HBC, respectively.

8. *Surface-based KuKa Radar measurements of snow depth on sea ice and lake ice in Churchill, Manitoba*
   Authors: Saha, M., Willatt, R., Nandan, V., Mallett, R., Newman, T., Stroeve, J., Yackel, J., and Isleifson, D.
   Abstract:
   This study addresses the critical task of measuring snow depth on both landfast sea ice and lake ice in Churchill, Manitoba—a region where accurate snow depth data is vital for the well-being of local flora, fauna, and communities. By investigating the challenges of radar signal penetration through snow, the research focuses on data from a surface-based radar system operating at Ku- and Ka-bands, collected during the 2021 freeze-up period. Through comparison of snow depths on different ice types under similar conditions, the study aims to enhance the accuracy of snow depth measurements from satellite altimetry missions like ESA's CRISTAL. The findings will contribute to improving global monitoring of snow and ice, addressing critical gaps in our understanding of radar interactions with snow-covered ice surfaces—knowledge that is crucial for the environment and inhabitants of Churchill.

9. *Inaugural remote sensing tests of sea ice forming using surface-based L-, C-, And Ku-band radars at Churchill Marine Observatory*
   Authors: Dadjoo, M., Mayvan, M.Z., and Isleifson, D.
   Abstract:
   Sea ice is vital for regulating Earth's climate, especially in the Arctic, by reflecting solar radiation and helping to control global temperatures. However, climate change has significantly reduced the extent and thickness of Arctic sea ice in recent decades, raising concerns about its impacts. To

monitor polar sea ice, scientists use satellite observations, field measurements, and computer models to track changes in sea ice extent, thickness, and composition. Surface-based microwave remote sensing data complement satellite data by providing detailed local conditions.

In December 2023, inaugural remote sensing tests were conducted at the Churchill Marine Observatory (CMO) in Churchill, Manitoba. This facility is a controlled environment designed to simulate the conditions of the ocean and sea ice in a laboratory setting. The tests aimed to obtain polarimetric backscattering measurements from freezing seawater in a mesocosm. Using three polarimetric radars (L-, C-, and Ku-band) in various polarizations (VV, VH, HV, and HH), data on the Normalized Radar Cross Section (NRCS) were collected. Physical sampling and meteorological observations were also performed to characterize the freeze-up.

Results indicated that it is feasible to track sea ice signatures using surface-based radars. In calm weather, sea ice backscattering is stronger than that of open seawater, resulting in higher NRCS values. This is due to the higher conductivity of saline ice surfaces, frost flowers, and the rougher surface of sea ice compared to calm open water. Future analysis aims to predict sea ice thickness using deep learning models, linking physical/environmental parameters and radar backscattering to improve predictability.

10. *GENICE II: Experimental testing of monitored natural attenuation (MNA) using large scale genomics*
Authors: Collins, E.
Abstract:

Sea ice is a living ecosystem that hosts unique populations of algae, fungi, bacteria, and protists. Sea ice microbial communities are foundational to the marine food web in the Arctic, and thus to the culture and livelihood of Inuit people. Shipping accidents threaten the health of sea ice microbial communities and thus threaten the health of the people that rely on them, so the MNA approach must take into account the fact that sea ice is common in the region for the majority of the year. The presence of sea ice during an oil spill poses unique challenges to oil spill detection, monitoring and remediation. GENICE II is developing a set of data-driven protocols for successful MNA of oil spilled in ice-laden waters including best practices, computer code, and visualization tools. We will use advanced petroleomics techniques to quantify the concentrations of petroleum compounds and their attenuation rates in mesocosm experiments at Churchill Marine Observatory and use advanced -omics techniques to compare the microbial community structure and functions in oiled and unoiled mesocosm experiments to identify key biological determinants of oil biodegradation rates. We will identify microbial genes, taxa, and community structures to be used as genomic biomarkers for MNA and Community Based Monitoring activities.

11. *Biodegradation potential of Arctic microbes in connection with crude oil concentration in sea ice*
Authors: Saltymakova, D., Desmond, D.S., Smith, A.F., Bautista, M.A., Polcwiartek, K., Snyder, N., Wolfe, T., Hubert, C., Collins, E., Isleifson, D., and Stern, G.
Abstract:

Petroleum-derived contamination is a growing hazard for the Arctic and Subarctic Ocean. In Northern settings where the accessibility to oil spills can be limited, natural attenuation is the most promising remediation process. The goal of the presented research is to evaluate the impact of biodegradation on crude oil inside sea ice. To this end, a bioremediation experiment was conducted at the Sea-ice Environmental Research Facility located at the University of Manitoba. The experiment utilized two mesocosm tanks (augmented and native) filled with nutrient enriched artificial seawater (i.e., biostimulation). The water in the augmented tank also contained oil exposed bacteria cultured from Arctic surface seawater from Cambridge Bay, Canada (i.e., bioaugmentation). The Native tank was not inoculated but contained the bacteria present from the

local source groundwater used in the fabrication of the artificial seawater. Light crude oil (supplied by Tundra Oil & Gas Partnership) was added under the naturally formed ice cover of each tank, creating areas that contained different oil concentrations. The samples drawn from the augmented tank contained sixteen distinct microbial genera. The abundance of distinct microbial genera was maximal in the water column as well as in the least contaminated ice core samples (< 0.21 g/L). In these ice cores, biodegradation affected the concentration of low-molecular-weight aliphatic compounds (<C18) and Naphthalenes (<C5). Biodegradation was not detected in the chemical composition of higher contaminated samples for both augmented and native tanks. Similar experiments using diesel fuel will take place at the Churchill Marine Observatory in the near future.

12. *Primary production hotspot identified in the coastal waters of Southampton Island, Nunavut in summer 2019*
    Authors: Kitching, E., Michel, C., Matthes, L.C., Castro De La Guardia, L., Kuzyk, Z., Limoges, A., Ehn, J.K., Papakyriakou, T.N., and Mundy, C.J.
    Abstract:
    The marine region surrounding Southampton Island (northwestern Hudson Bay, Nunavut, Canada) supports relatively large populations of marine mammals, provides ecosystem services to local communities, and is being considered for the establishment of a Marine Protected Area. However, little information exists on estimates of production at the base of the food web. Here we investigate the role of physical and biological forcings on phytoplankton primary production around Southampton Island during 2019. Differences in physical characteristics around the island, including ice conditions and mixing processes, resulted in differences in phytoplankton bloom stage during the study period. Tidal and wind-mixing along the constricted waterways of Frozen Strait and Roes Welcome Sound were found to support a productive phytoplankton bloom north of the island, which was greater than estimates for Hudson Bay and Foxe Basin and more comparable to that of Hudson Strait. The greater phytoplankton production to the north of the island can help explain the existence of greater marine mammal presence in this region assuming a bottom-up driven food web. The research highlights the critical role of local and coastal observations relative to offshore regional primary production estimates, and the important role of climate-sensitive processes in driving spatial variability in summertime primary production and bloom phenology in Arctic areas.

13. *Structure and functioning of the Southampton Island food web*
    Authors: Amiraux, R., Mundy, C.J., Pierrejean, M., Massicotte, P., and Yurkowski, D.
    Abstract:
    The structure and functioning of the Arctic marine food web are shaped by the origin (sympagic or pelagic), quantity, and quality of primary production, all influenced by environmental factors such as sea ice cover, temperature, salinity, irradiance, and nutrients. While many studies have examined large-scale spatial or temporal variations in the Arctic food web, this study focuses on small-scale north-south variability around Southampton Island. We analyzed bulk stable carbon and nitrogen isotopes, as well as highly branched isoprenoids, in samples from 149 taxa, including invertebrates, fishes, and marine mammals. Our findings reveal significant differences between the northern and southern zones. The northern region, characterized by greater depth (mean 155.8 m) and low ice algae production, had a benthic sub-web spanning four trophic levels, mainly relying on phytoplankton. This was evidenced by a narrow ?13C range and a low percentage of sympagic carbon (mean 13.5 ± 10.7%). In contrast, the southern region, with shallower waters (mean 78.3 m) and higher ice algae production, exhibited a benthic sub-web with three trophic levels, relying on both phytoplankton and ice algae. This was indicated by a broader ?13C range and a higher

percentage of sympagic carbon (mean 35.1 ± 19.7%), and a prevalence of deposit feeders. We hypothesize that the reduced trophic levels in the south may result from shallow bathymetry, allowing walrus and seabirds to exert significant top-down control, thereby disrupting benthic top-down regulation.

14. *Spatiotemporal dynamics of predator and prey hotspots on the sea ice near the Western Hudson Bay coast*
    Authors: Warret Rodrigues, C., Roth, J.D., Pilfold, N.W., McGeachy, D., and Derocher, A.E.
    Abstract:
    Wildlife often exhibits patchy distributions as a result of spatial or seasonal variation in resource availability or competitive interactions. Individuals from diverse species may therefore aggregate in areas of high biological significance, creating biological hotspots that may play key roles in population persistence and ecosystem functioning. Flaw leads and recurring polynyas, (i.e. areas of open water surrounded by sea ice), promote high biological abundance and diversity. The western Hudson Bay flaw lead extends along the western coast of the Hudson Bay down to the Churchill area, and its form varies daily and seasonally. Using a 4-year data set compiling direct and indirect observations of seals, polar bears and Arctic foxes collected during the hyperphagic period of bears (April-May) near the shores of the Churchill area, we aim to determine the distribution and persistence of hotspots of these species and assess the possible drivers of their distribution and abundance. In light of the highly variable nature of the western Hudson Bay flaw lead, we hypothesize that hotspots of the three species overlap, but show high spatial variability between years. We further hypothesize that intra-specific avoidance promotes differential distribution of bears according to sex and age. Given the key role of top predators in regulating biodiversity and stabilizing ecosystems, predicting the location of predator hotspots has key implications for planning and managing conservation areas.

15. *Polar bear-human interaction risk is governed by sea ice loss but independent of bear body condition*
    Authors: Rivet, D. R., Brook, R. K., Crawford, A., Kramer, C. J., Laforge, M. P., Stroeve, J., and Clark, D. A.
    Abstract:
    Polar bear-human conflicts are increasing across the Arctic as climate change reduces available sea ice habitat. The mechanisms behind these conflicts, however, remain unclear. Between the years of 2011-2021, we used remote cameras to capture observations of 580 polar bear visits to three intermittently occupied field camps in Wapusk National Park, and a year-round research station (the Churchill Northern Studies Centre), all located along the Hudson Bay coast. We analyzed the impact of sea ice break-up in the summer, polar bear body condition, and human activity on the frequency of polar bear visits to these four sites. Our findings indicate that the time since ice break-up is the primary driver of polar bear visits, while poor bear body conditionóa known risk factor for polar bear attacks on humansóand human activity do not significantly influence visitation frequency. Thus, the likelihood of polar bear-human interactions is driven by sea ice conditions, independently of nutritional stress. Therefore, below-average body condition of polar bears may only influence the escalation of interactions into conflicts, rather than causing the interactions themselves. These insights help reconcile discrepancies in previous studies and between scientific and Indigenous explanations for polar bear-human conflicts.