The Baffin Bay Observing System (BBOS)
Integrating data, information and knowledge to understand change and variability in the Arctic

Introduction

The Arctic is a key topic in international relations due to climate change and growing global economic interests in the possibilities for establishing new, shorter shipping routes, for expanding resource development including the offshore extraction of oil and gas and adjacent fisheries. As the geopolitics shift, the Arctic is transforming into an important area with new and sometimes contested economic, legal, and governance perspectives on maritime activities. For Canada these changes imply enormous possibilities that come with challenges and obligations. For the local communities there are potential economic benefits but also unknown risks to the environment, subsistence, cultural, social, community and individual well-being.

The Lincoln Sea - Baffin Bay - Davis Strait - Labrador Sea corridor (hereinafter Baffin Bay) is a central ecological hub shared between Greenland and Canada. Massive southward flows of freshwater, sea ice and glacial ice converge along both the Greenland and Canada coasts affecting natural and anthropogenic processes operating in the Bay and along its coasts. The North Open Water Polynya (NOW) located at the northern limit of Baffin Bay is one of the most productive marine systems in the northern hemisphere, having an indigenous presence for thousands of years. The Greenland Ice Sheet to the east and multiple terrestrial glaciers to the west, and the Arctic Ocean to the north, dominate the contrasting climate of Baffin Bay. In addition, oil and gas development, marine shipping, increased tourism, cruise ship expeditions and extraction of nonrenewable (e.g, minerals) and renewable (e.g. fisheries) resources are experiencing rapid growth in the area due to a changing Arctic climate and increased global demand for resources.

There is an urgent need to determine the role of freshwater fluxes (liquid and solid) on marine processes in Baffin Bay and how the system responds to the warming global climate. By modulating the fluxes and configuration of ice and freshwater in the bay, the changing Arctic climate will affect ecosystem services regionally, in the western north Atlantic and globally. In addition, the volume of Arctic glaciers and sea ice has radically declined in recent decades. River discharge has increased while icebergs calving and accelerated melting of the Greenland Ice Sheet are having an increasing impact on global sea level rise. Baffin Bay also provides critical water mass exchange with the North Atlantic. This interconnectivity underlies the support of the Galway Statement for broad international cooperation on Arctic and Atlantic Ocean studies.

Research Objectives

The research objective of the BBOS is to increase understanding on how global climate change affects the Atlantic sector of the Arctic, and in turn how changes in the Arctic affect the North Atlantic.

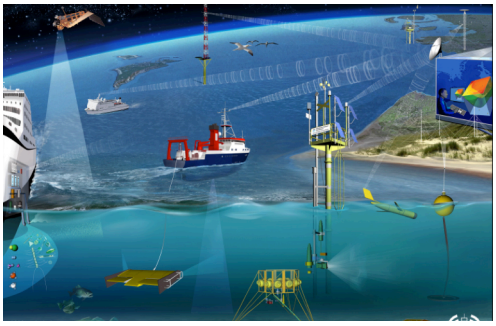
There are several themes related to **the polar climate system** that need further attention. These include identification and quantification of key processes regulating atmosphere-ice-ocean interactions; key physical and chemical processes in the ocean and how to improve forecasting and projections of future polar and global climate.

In **the cryosphere** specific research tasks include key processes controlling polar glaciers and ice sheets and how they affect future global sea level; how floating ice (sea ice and icebergs)

interact with the physical and chemical exchanges within the polar climate system; how to model and predict climate change and extreme weather and how they will affect the probability distributions of glacial and sea ice hazards.

Research tasks in **Polar ecosystems and sustainable management of resources** will focus on how polar ecosystems adapt to future climate changes; if and how long-term changes in polar food webs will occur; how vulnerable polar ecosystems are to combined human and natural influences; how we manage polar marine living resources in a sustainable way; and how extractive industrial activities affect the Baffin Bay system.

There is a need for development and **new technologies and innovation** to improve understanding, enhance observational data, and reduce logistical costs and environmental impacts in sensitive Polar Regions. Baffin Bay will be the first Bay-wide observatory of its kind in the Arctic. We will develop and miniaturise sensors, systems, observatories, methods and models to observe and predict the climate and its changes at different scales, to monitor and assess the status of Bay-wide and marine environment with direct connections to existing observing systems in the north Atlantic and the Labrador Sea.



Inuit **Traditional Knowledge** and western science will be used in tandem to rapidly advance understanding of marine biodiversity, biological productivity and ecosystem function with respect to the present and future yield, and geographical distribution of harvestable resources (traditional and commercial). It will lead to major scientific developments, and improved cooperation and collaboration with Inuit knowledge holders and other Arctic stakeholders. This improved understanding will be valuable for advancing Arctic Council's, Canada's, and Inuit objectives around sustainable development, food security, ocean management, search and rescue, technological development, community engagement and co-management of resources.

Infrastructure Required

The Baffin Bay Observing System will be a global first for the Arctic, enabling the long-term, real-time study of climate-ocean interactions in the Arctic at the scale of an entire basin. Offshore and deep water sensors will monitor ocean circulation, chemistry and biological activity while near-shore observatories in coastal communities will provide data on water quality, biology, ice thickness, sea state and vessel traffic. All underwater instrument platforms will be equipped with hydrophones to support the study of marine mammal activities and their relationship to environmental variables (tidal cycles, marine productivity and anthropogenic noise (shipping, seismic activity, port construction, etc.)). Weather/climate drivers affect oceanographic processes in Baffin Bay through sea ice dynamics (formation, growth, breakup, drifting pack ice and bergs) and freshwater input from melting of the Greenland ice sheet. We envision a series of marine field sites where process studies will be conducted in a coordinated way between Greenland and Canada, coastal marine research using research vessels owned by Canada, Greenland, Denmark, and Norway and deep-water marine work in central Baffin Bay using the Canadian Research Icebreaker CCGS Amundsen. Data collected by mobile platforms (powered vehicles & gliders), autonomous oceanographic moorings and satellites will complement observations from fixed cabled observatories on the seabed. Shore-based climate stations will provide meteorological data to support studies of ice formation and melt. Residents of local communities will use portable field equipment and mobile computing technologies to collect data on snow and ice thickness, seawater properties, marine species activities and other coastal zone environmental variables includ-

ing those prioritized by Inuit as part of an integrated Community Based Monitoring (CBM) system. Data from all marine and coastal sensors will be hosted and served by Ocean Network Canada (ONC) Oceans 2.0 ocean data infrastructure system.

The Baffin Bay Observing System will be designed and built for an expected lifetime of 30 years. If the proposal is successful, we anticipate CFI funds to become available in late 2017, permitting installation to begin in summer 2018, and project completion in summer 2022. Each BBOS network partnered university will be responsible for the operation and maintenance of its contributed components and will in turn collaborate with other universities in all other components of the network. The UVic component will become part of Ocean Networks Canada's ocean observatory infrastructure. Funds for the operation and maintenance of the Baffin Bay facilities will be applied for during the 2021-2025 funding cycle of the CFI Major Science Initiatives (MSI) program.

Canada's marine technology sector will provide many of the underwater and shore-based components for the Baffin Bay Observatory. These technologies will include seafloor nodes, sensor platforms, sensors, shore-based control equipment and software for generating specialized data products. Canadian companies participating in the Baffin Bay Observing System will be able to showcase their ocean technologies in an Arctic setting, where ocean monitoring represents a future market. ONC's Smart Oceans program is currently demonstrating how ocean-observing technologies can contribute to the marine safety, security and sustainability needs of government agencies, communities and industries in coastal British Columbia. The BBOS will extend this demonstration to the challenging Arctic coast where remote monitoring is often the only option for situational awareness and long-term environmental management.

Engagement

National and international scientists and students will be central users of the facility. The engagement of stakeholders in the scientific achievements of BBOS is expected to foster an environment in which knowledge mobilization and knowledge translation can be used in decision making. Inuit Circumpolar Council (ICC), local policymakers and Self-governments will form a consultative team, bringing both traditional knowledge and co-management of resources to bear on science-to-policy integration in both Canada and Greenland/Denmark. Local, regional and national bodies with co-management responsibilities will be partners in the program from the outset to ensure that the design meets expected information requirements and policy outputs, and that outputs are delivered to pertinent users responsible for resource management and development in this region of rapid environment change and globalization. Finally, BBOS will play an important role in educating the new generation of multi-disciplinary researchers who will be prepared to continue the dialogue and development of cross-disciplinary, cross-cultural, and cross-institutional decision support.

Management

University of Manitoba will lead the BBOS network and partner with 5 other Canadian universities (Memorial, Dalhousie, Laval, Calgary, and Victoria) forming the first ever national University network focused around a single collaborative world-class Marine Observatory. Partners will contribute separate components to the observatory infrastructure, based on their institutional

strengths. ONC-UVic would contribute data management infrastructure, a VENUS-scale cabled ocean observatory and a network of up to 6 near-shore observatories similar to ONC's system in Cambridge Bay, Nunavut and the network currently being installed at 5 locations in coastal British Columbia. A shore station would be hosted at 'Qik base', a research station to be built by the Université Laval, as their contribution to this project. Near-shore observatories (see map) would be established at locations on Baffin Island (Pond Inlet), Ellesmere Island (Cape Herschel) and on the eastern shore of Baffin Bay in Greenland (Thule, Greenland Arctic Research Station, Greenland Institute of Natural Resources) led by Manitoba and Calgary. Autonomous sensors will be developed and deployed by Memorial and Dalhousie, who will also be responsible for moorings connecting Baffin Bay to the North Atlantic/Labrador Sea. The total integrated budget for the BBOS is still in development but is on the order of $123M; distributed amongst the BBOS network as follows:

1) Memorial University - Autonomous vehicles ($19M).
2) Dalhousie University - Autonomous instrument moorings ($14M).
3) Université Laval - Qik base, climate stations, acoustic data telemetry ($25M).
4) University of Manitoba - Herschel base, marine radars, climate stations ($23M).
5) University of Calgary - Community based monitoring infrastructure and CBM data management ($12M).
6) UVic - VENUS-scale observatory, mini-observatories, data management ($30M).

The Arctic Science Partnership will catalyze collaboration between Canada and Greenland/Denmark and add all existing infrastructure on the Greenland side of Baffin Bay into this collaboration. In addition, we are currently negotiating with private foundations to expand our infrastructure on this side as well. Long-term monitoring programs will also be expanded.

For further information contact: Søren Rysgaard at University of Manitoba (Rysgaard@umanitoba.ca)