Baffin Bay Observing System (BBOS)

A long history – Søren Rysgaard has worked hard on this initiative

News – U. of Manitoba is applying for a CFI (Infrastructure Grant) for a program focussed on the Northern Baffin Bay – especially the Pikialasorsuaq area

Notice of Intent is submitted

Budget: 20 mill CAD

Full proposal due January 6th 2020

We have suggested many of you as partners – you will hear from me soon – very interested in input and comments

Baffin Bay Observing System (BBOS)

The overarching vision for the Baffin Bay Observing System (BBOS) is to develop an integrated Baffin Bay environmental observation system that will enable sustained year-round, near real-time observation of the atmosphere, ice, coast and ocean of northern Baffin Bay, with a special focus on freshwater-marine coupling in a changing climate. This observatory is the first-of-a-kind observing system for the circumpolar Arctic and will be a unique platform for advancing our understanding of how global climate change affects the Atlantic sector of the Arctic system, and in turn how changes in the Arctic system affect the North Atlantic and beyond. With a warming climate and an increased release of freshwater to the Arctic Ocean through enhanced land ice and sea ice melt and increased river input, climate and ecosystem conditions are rapidly changing. These changes are already impacting the livelihoods of northern communities, presenting unprecedented opportunities as well as new challenges.

Baffin Bay Observing System (BBOS)-Objectives

Developing and maintaining a novel observing system specifically designed to understand the impacts of climate change on freshwater-marine coupling in the Arctic;

Developing knowledge that can lead to mitigation of environmental impacts from these changes on a full range of physical, geochemical, and biological impacts;

Building research capacity to understand the past, present and future evolution of freshwater- marine coupling in the Arctic;

Expanding the state-of-the-art observational equipment with innovative autonomous observations;

Including and integrating Early Career researchers and Indigenous students and researchers in the program;

Building and extending national and international collaborations and establishing global leadership in observations in Baffin Bay with connections to the High Arctic and North Atlantic.

Training of a large number of highly qualified personnel (HQP), including those from the Indigenous communities, who will have the expertise and capacity to manage and support Arctic sustainable development.

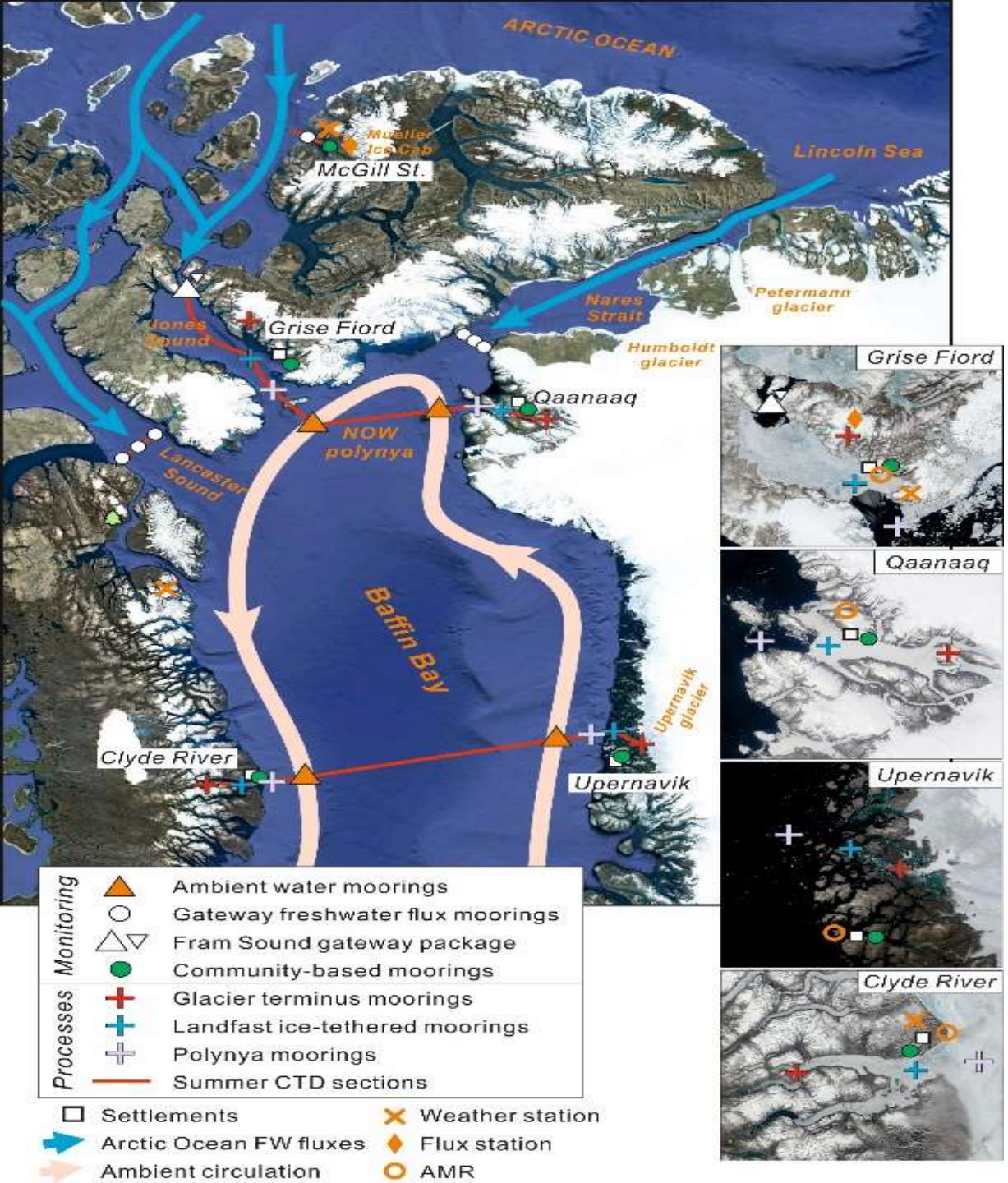
Baffin Bay Observing System (BBOS) – Key Questions

What will the increase of freshwater be?
Changes in freshwater within the northern Baffin Bay is a balance between increasing melt and discharge of land ice, decreasing amount of sea ice, changes in precipitation and changing flows of ocean water in and out of the basins. All these sources need to be measured and processes clarified to understand how freshwater and associated constituents in this region are changing and how they will evolve in the future.

How will this impact the climate system?
The increasing amount of freshwater is speculated to influence the strength of the Atlantic Meridional Overturning Circulation (AMOC). This is known to have happened during the last glacial period and caused very abrupt climate changes, influencing atmospheric circulation and sea level rise, with impacts on the ecosystems at regional to global scales.

How will living conditions change?
Changing sea ice conditions, ocean and land temperatures and freshwater input and distribution will all have an immense impact on living conditions in the North. Fisheries will be influenced by changing ocean temperatures, salinity and stratification. Constituents carried by freshwater affect marine ecosystem systems. Reductions in sea ice are opening shipping routes and offer new opportunities for ocean oil and gas exploration, leading to the need for new ports and increased risks of pollution.

Baffin Bay Observing System



Four supersites :

Clyde River (Kanngiqtugaapik)

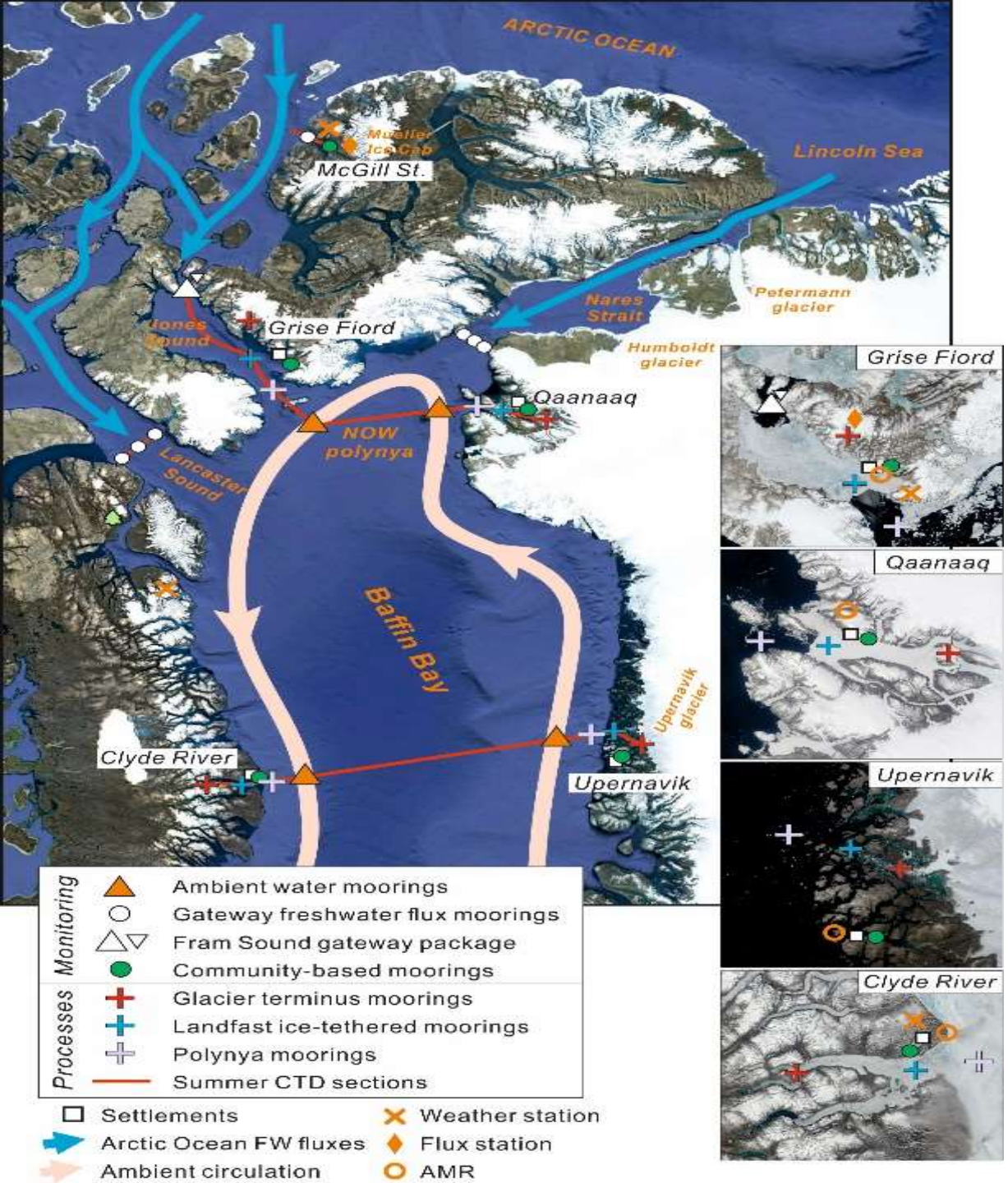
Grise Fjord (Aujuittuq)

Qaannaq

Upernavik

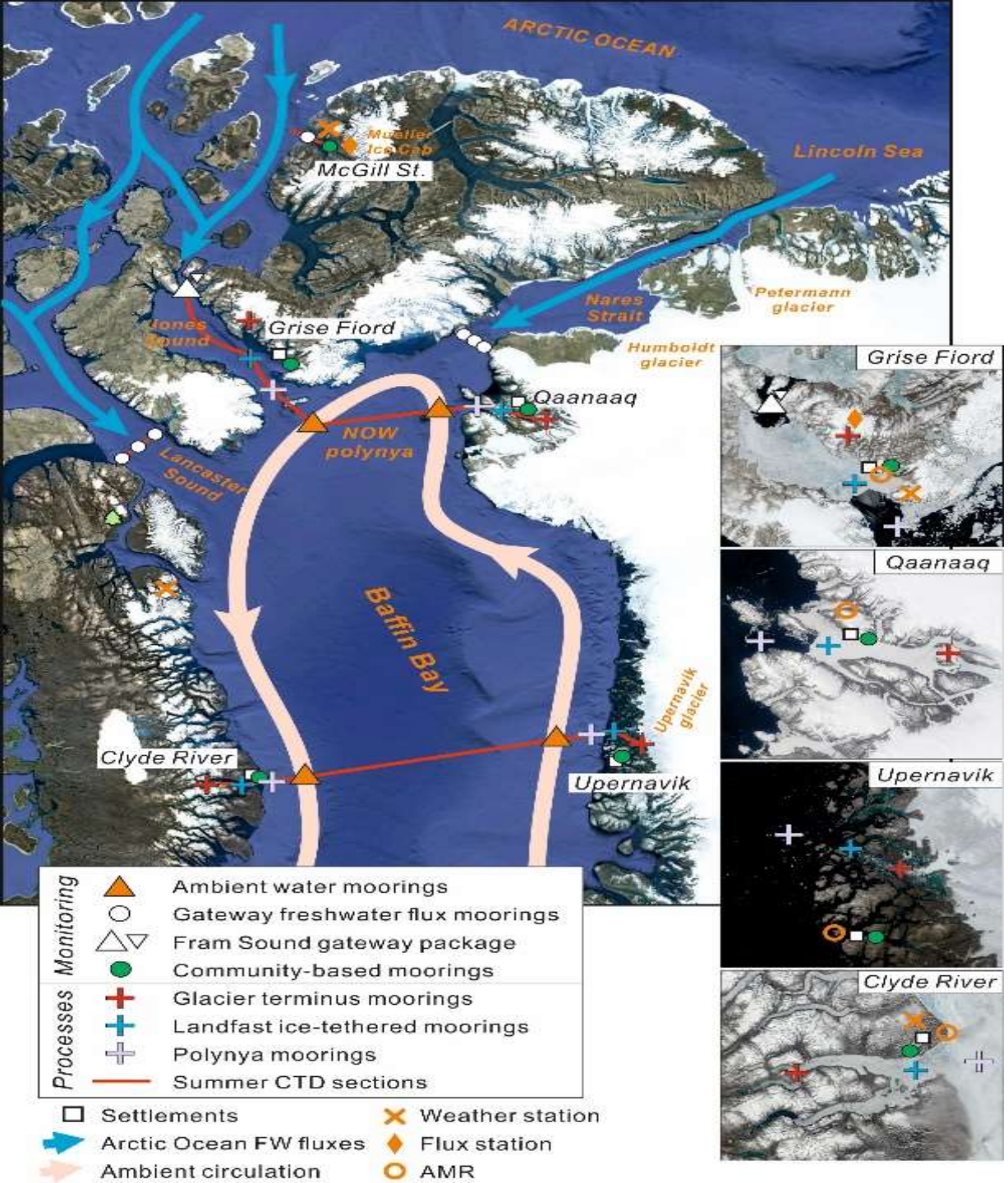
A fifth strategic supersite at the Müller Ice Cap is selected to look into the transport not captured through the switch gate.

Baffin Bay Observing System



Baffin Bay is one of the most productive marine systems in the Northern Hemisphere and represents an important connection between the Arctic Ocean and the North Atlantic. Baffin Bay is also an Inuit homeland and an important site for cultural resources and coastal interactions. Pikialasorsuaq (refers to the North Water Polynya region in the Greenlandic language)[6] in the northern Baffin Bay has just been acknowledged as a co-management area and is the focus of the BBOS program.

Baffin Bay Observing System



Seven highly integrated **themes**

i) Inuit Knowledge

ii) Climate

iii) Ice Sheets and Glaciers

iv) Sea Ice

v) Oceans and Fjords

vi) Marine Ecosystems

vi) Biogeochemistry.

Baffin Bay Observing System (BBOS) T1-Inuit Knowledge

Objectives:

Build relationships with communities and engage in developing community driven research and leadership
Ensure that the project reflects Inuit research priorities.
Obtain funding for involvement and education of young community members.
Invest in broadband access and regional capacity to engage in Inuit Nunangat research.
Ensure transparency, coordination, and accountability in the resourcing of Inuit Nunangat research.
Develop a database and ensure ownership of Inuit data by Inuit-appointed entities.
Invest in Inuit-led data and information technology and infrastructure.
Develop Inuit-specific guidelines on data accessibility, ownership, and control.

Baffin Bay Observing System (BBOS) T2-Climate

Objectives:
How will past, present and future atmospheric states influence freshwater discharge to the ocean with linkages to the marine ecosystem?

How is the exchange of momentum, energy and mass (vertical and horizontal) impacting freshwater – marine coupling regionally, and conversely, how do changes in the underlying system impact surface climate and regional budgets of GHGs?

What is the role of the atmosphere across temporal scales on the evolution of the glacier and ice sheet – marine coupling and the terrestrial- marine coupling of the study domains?

How do extreme events (e.g., storms, temperature and precipitation extremes) influence the freshwater balance, ecosystem processes and societal use of land and water?

Weatherstations **Heat and Gas Flux Stations** **Atmospheric Microwave Radiometers**

Baffin Bay Observing System (BBOS) T3-Glaciers

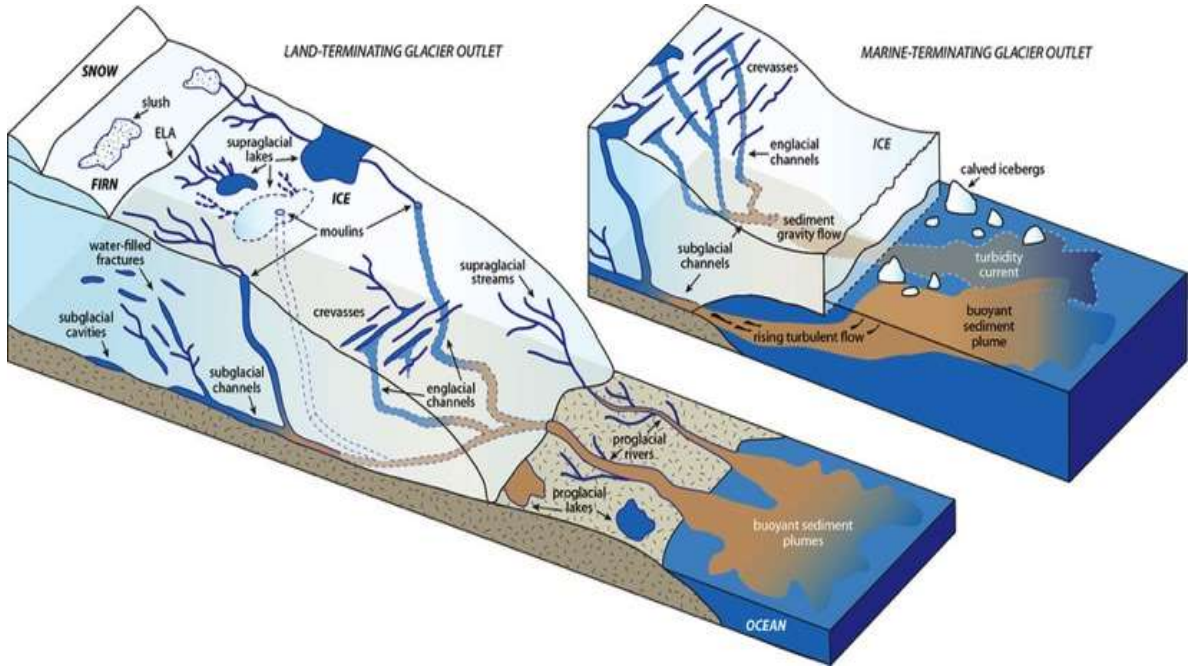
Objectives:
What controls the velocity, annual and inter-annual flow of land ice to the marine system, and how does this vary depending on the land ice and ocean characteristics?

Do oceans and sea ice contribute to the exchange of mass and heat between the ocean and the glaciers/ice sheet?

How will climate change affect the mass balance of ice caps, ice sheet and glaciers?

Can we predict future melt and run-off on the land ice surfaces and can we predict subsurface discharge as a function of surface melt? and,

What is the past extent and evolution of the ice sheets in the North?



Land and ocean terminating glaciers showing the key processes controlling the transfer of solid and liquid phase water to the marine system.

Time lapse cameras Ocean measurements in front of glaciers Mass Balance buoys Ice camp for Mûllers
Drones (MicroSAR Lidar Photogrammetry) Water Level Temperature Strings Passive Microwave

Baffin Bay Observing System (BBOS) T4-Sea Ice

Objectives: To achieve the aforementioned vision, the objectives of the Sea Ice Theme are to address the following questions:

What are the primary oceanic and atmospheric forcing mechanisms that control the sea ice thermodynamic state and how does this forcing manifest itself in the coastal Arctic where significant freshwater is now available?

How is increasing freshwater inflow affecting the momentum exchange across the OSA interface, and how does this feed back to both dynamic and thermodynamic sea ice processes?

What are the processes controlling landfast sea ice formation and do fast ice thermodynamic processes differ because of large scale differences in climate forcing (i.e., latitudinal temperature gradients, and are there feedbacks that exist with coincident changes in land-ice cover?

How does sea ice affect land ice thermal processes (and *vice versa)*, via the planetary boundary layer, and how does this coupling evolve in both space and time?

On-ice stations Ice-tethered Moorings CTD Multiprobes Niskin Bottles Trace-Metal Seawater Sampling System Trace-Metal Seawater Sampling System

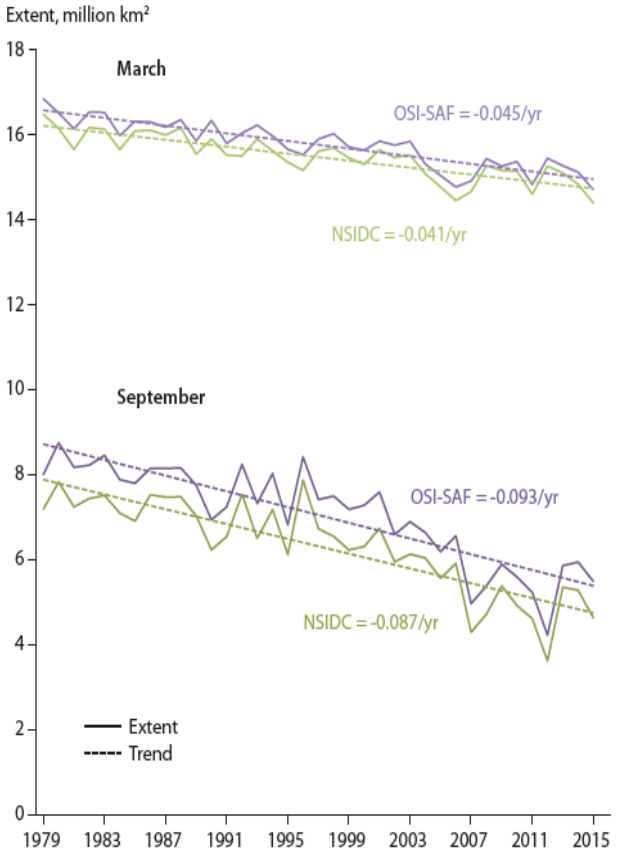


Figure 5: Maximum sea ice extent (March) and minimum extent (Sept.) in the Arctic Ocean over the passive microwave instrumental record (adapted from Barber et al. 2017[2]).

Baffin Bay Observing System (BBOS) T5-Oceans and Fjords

Objectives: The key scientific questions of the Oceans and Fjords Theme are: What are the volume and freshwater fluxes into Baffin Bay, and how do they change over seasonal and interannual time-scales?

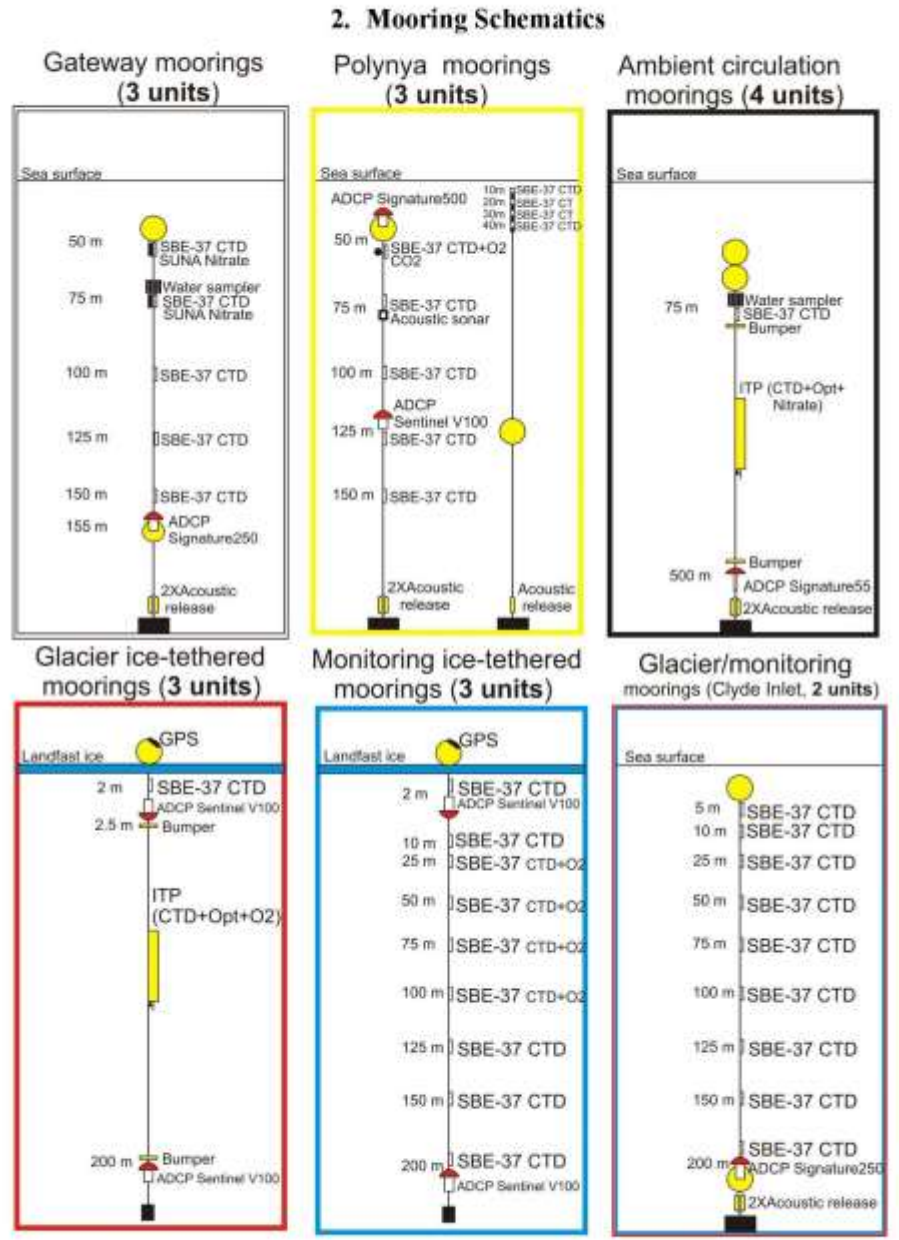
What are the inventories and residence times of freshwater in the Baffin Bay, and how do they change over seasonal and interannual time-scales?

What are the pathways for Pacific and Atlantic waters (bringing freshwater and heat) to enter the study area and what impacts do they have on circulation and thermodynamics?

How do fjords modulate the exchange of heat and freshwater between the ambient waters on the continental shelf and the glaciated inner fjords, and what role does the type and thermal condition of glacier termini play on these processes?

How are seawater properties in the coastal domain near the communities coupled to changes occurring in the broader marine environment?

Bottom mounted moorings Optical instruments Wave gliders Ice-tethered moorings Hydrophones



Baffin Bay Observing System (BBOS) T6-Marine Ecosystems

Objectives: To achieve the aforementioned vision, the objectives of the Marine Ecosystems Theme are to address the following questions:

What is the effect of timing of sea ice melt and freeze-up on the ecosystem as related to shifts in the location of primary production, and subsequent changes in vertical export of organic matter?

What is the role of increased freshwater on surface stratification and nutrient supply to primary producers?

Are surface nutrients enhanced by glacial melt in northern Baffin Bay ?

What is the spatial extent of glacial melt impacts on the ecosystem ?

How do impacts of freshwater-marine coupling at lower trophic levels cascade to higher trophic levels and how can Inuit knowledge be integrated with western science to understand these impacts.

Nutrient autoanalyzer **Precision salinometer**

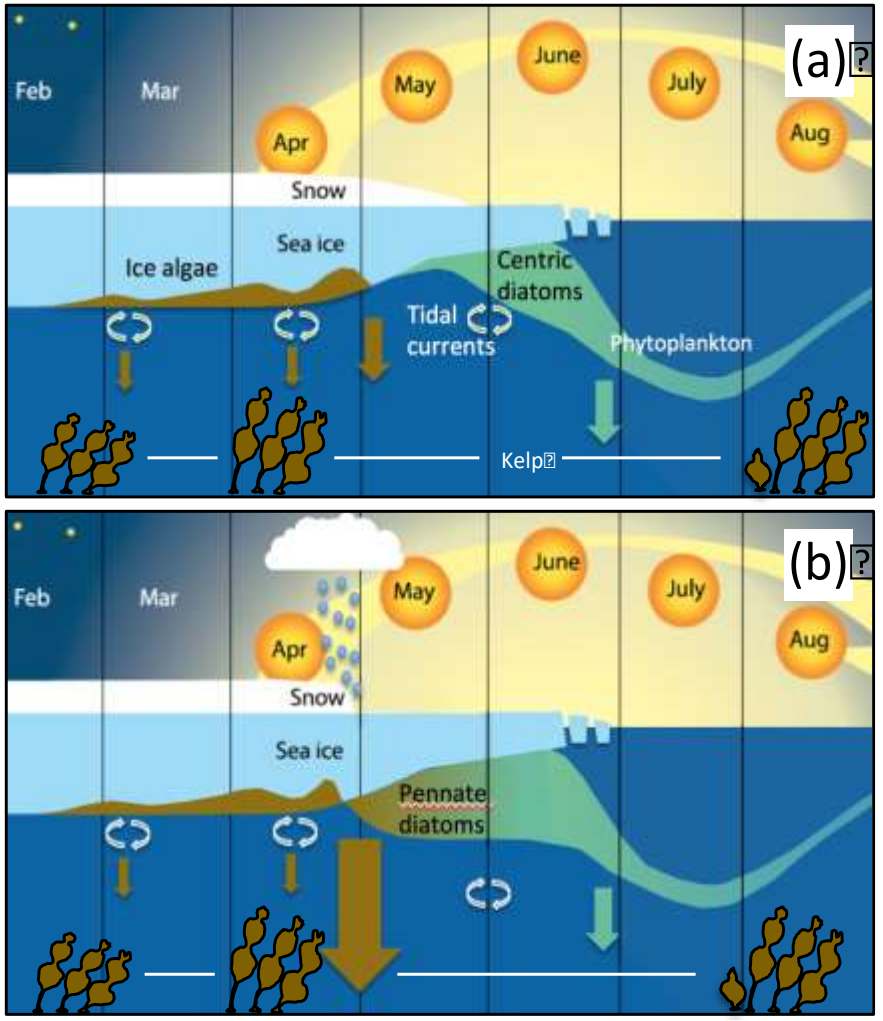


Figure 7: Hypothesized processes of algal bloom timing, location (sea ice, pelagic, or benthic), magnitude, and fate (downward arrows) for (a) a normal melt progression and (b) an early rain event as an example of how timing can impact ice-pelagic-benthic.

Baffin Bay Observing System (BBOS) T7- Biogeochemistry.

Objectives

How do we differentiate various sources of freshwater in the Arctic?

Can we use the bromine concentration in glacier ice cores to reconstruct the FYI coverage in the Arctic in the past?

How do processes that moderate carbon and contaminant cycling in Arctic waters respond to various land-water and glacier-water coastal settings and through what mechanisms?

How will ocean acidification progress in the eastern Canadian Arctic and what are the likely impacts?

What are the relative contributions of natural, anthropogenic, and legacy sources of mercury to the eastern Canadian Arctic, and how will climate change affect the mercury in country food to our Inuit partners.

MC-ICP-MS **Continuous Flow Analysis** **Fluorescence analysis system** **Absorption Analysis System**

Baffin Bay Observing System (BBOS)

The CFI will provide instrumentation to study the BBOS

No ship time is included

Logistic help is included

Collaboration is crucial

Vision is that the observing system will be community lead after some years