

Report on 2021 Research Activities

Team Members:

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Research Title: “Weather, Ice, Ocean, and Freshwater Measurements to Understand Greenhouse Gas Cycles and Aquatic Ecosystems”

Project Overview and Objectives: This project tries to understand how greenhouse gases move through the Arctic environment. Greenhouse gases are the cause of climate change, and most people know that humans make them when we do things like drive cars, or heat our homes. But, greenhouse gases are also a natural part of ecosystems. One important place to find natural greenhouse gases like methane (CH₄) and carbon dioxide (CO₂) is in freshwater and seawater, where they exist as dissolved gases. CO₂ and CH₄ are important parts of these ecosystems, because some organisms that live in the water make these gases, while others use them. For example, algae and other plants take CO₂ out of the water to make oxygen, while certain types of bacteria use up oxygen and make CH₄. We want to study how gases like CO₂ and CH₄ work in these systems, and how those gases might eventually get into the atmosphere. It is challenging to do a good job of this in the Arctic, because we need to make these measurements all year-round.

A second objective of this project is to find way to make our science useful to northern communities. We have been able to do this in the past. For example, we measure greenhouse gases at weather stations, and so we have worked with the HTO to set up weather stations at important locations. Data from those weather stations can be accessed online, and used when traveling. We think our measurements of dissolved gases in freshwater and seawater might also be interesting to the community, because there may be important links to wildlife. For example, spots that have high dissolved methane also usually have low dissolved oxygen, and these are places that fish like Arctic Char will avoid. Also, human impacts like sewage disposal in Cambridge Bay may affect greenhouse gases in the ocean. We are committed to working with the HTO and other stakeholders to make our research relevant.

2021 Activities

Sample Collection Dates: May 04 – Oct. 06, 2021

Locations: Cambridge Bay and Surrounding Areas.

Weather Station Operations: May 15 – Dec. 31, 2021

Locations: Halokvik River (30 Mile), Melbourne Island, Finlayson Islands

Normally, we have three weather stations working near Cambridge Bay (see photos and map below). The big weather station was damaged by ice in spring 2019, and we were finally able to repair it this year. The two small community weather stations were also repaired this year. The community weather stations measure air temperature, wind speed, wind direction, relative humidity, and pressure. They report every hour, and the data can be viewed at https://people.ucalgary.ca/~belse/Brent_Else/WX.html and at <http://siku.org>. At the Qikirtaajuk Island station, we also measure incoming energy (from the sun and atmosphere), and carbon dioxide in the atmosphere.

In most years we collect seawater, freshwater, and sea ice samples, to help us understand how the atmosphere interacts with water or ice surfaces. They are also used to study how water moves through the landscape and into the ocean. Water and ice samples are preserved and shipped back to our laboratory at the University of Calgary, where we analyze them for salinity, pH, CO₂, CH₄, and isotopic composition. At each of our water collection locations, we typically measure ice thickness, snow depth (in the winter), water temperature, salinity, dissolved oxygen, and chlorophyll-*a* content. The locations where we collect seawater are shown in the attached map. When we are working onboard the R/V *Martin Bergmann*, we also use an “underway system”, which measures pH, CO₂, salinity, and water temperature while the ship is travelling. During the *Bergmann* cruise, we also collaborate with researchers from Environment and Climate Change Canada (Project leader: Jane Kirk) who collects seawater samples to monitor mercury and persistent organic pollutants as part of their Northern Contaminants Program project: “Community based seawater monitoring for organic contaminants and mercury in the Canadian Arctic”

In 2021, our activities were limited by the COVID-19 pandemic. We decided to send only three researchers from UCalgary, while also hiring three Cambridge Bay residents to help with sampling. The researchers who visited from the south were in town from May 04 – Jun. 21, 2021. Their travel was approved by the Cambridge Bay Town Council and Nunavut’s Chief Public Health Officer. They attended a Government of Nunavut quarantine facility for 2 weeks in Edmonton, and followed a comprehensive safety plan to limit the risk of COVID-19. The research team repaired the weather stations, and collected water samples in several lakes and rivers surrounding Cambridge Bay. The location of the lake and river samples is shown in the map below, along with several photographs. We did not do the cruise on the R/V *Bergmann* this year. No sea ice or seawater samples were collected.

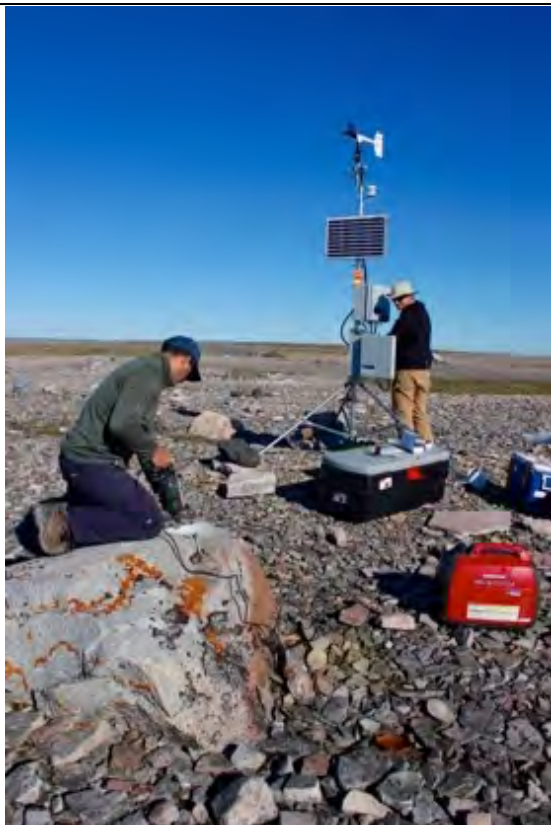
Photos and Maps Illustrating 2021 Activities:



Map of locations where we collected lake samples. The lakes were visited mainly by snowmobile during the month of May.



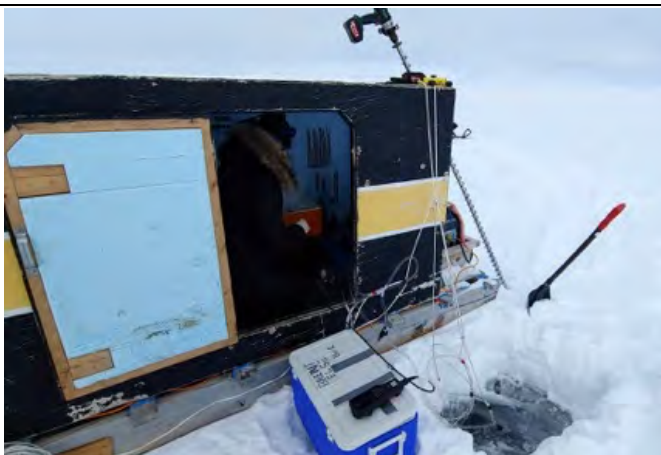
Map of locations where we collected river samples. The rivers were visited mainly by helicopter in the month of June.



The weather station at 30 Mile. A similar weather station is located at Melbourne Island.



The weather station at Qikirtaariuk Island after being repaired.



This is what our lake sampling usually looks like. We drill a small hole, then pump water up to our instruments.



This is what our river sampling usually looks like. This photo is from a past year, when we collected samples with Francis Emingak at Freshwater Creek.

Planned Activities for 2022-2023

Team Members:

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Megan Leung (Graduate Student, University of Calgary)
Christina Braybrook (Graduate Student, University of Calgary)
Nicole Johnson (Undergraduate Student, University of Calgary)
Elise Imbeau (Research Assistant, Cambridge Bay)
Brendan Langan (Research Assistant, Cambridge Bay)

Planned Activities for 2022: We hope to be able to do more research near Cambridge Bay this spring. Specifically, we have two projects with researchers from outside of Canada that were originally planned for 2019, but have not been completed due to COVID. However, we understand how important it is to keep COVID-19 out of Nunavut communities, and we share that priority with Nunavummiut. We will abide by all public health orders regarding travel to Nunavut, and observe any COVID-19 restrictions or guidelines while in Nunavut. The University of Calgary requires all personnel to be fully vaccinated, and requires a detailed safety plan for fieldwork.

If we are permitted entry to Nunavut, we will try to do the research activities that were approved for our 2019 and 2020 license. Most activities are similar to what we have done in the past.

1. Weather Stations

In the coming year, we will visit the three weather stations near Cambridge Bay for repairs. We will hire at least one more Cambridge Bay resident to help with the weather stations throughout the year. The pandemic made it difficult for us to discuss the future of this weather station project with the community, and to advertise the project. We have an outreach video (<https://vimeo.com/362146773>) that we will circulate on social media. We have one new weather station to be set up in the Cambridge Bay region. A while ago it was suggested to put it at Halfway Cabin, but we did not get a final decision from the HTO. As part of our visit to Cambridge Bay this spring, the project leader will meet with the HTO to finalize a location. We will likely need to hire HTO guides to help install this station.

2. Sea Ice Sampling

In 2022, our focus will be on sea ice and seawater sampling near the weather station at the Finlayson Islands. Starting in May, we will travel by snowmobile to collect samples at two locations (see map). Most of the sea ice samples will be melted and returned to our labs in the south for analysis of CO₂, salinity, dissolved oxygen, and nutrients. We will also deploy instruments and collect samples to study ice algae primary production. On sea ice, our disturbances will be small, only leaving auger holes (maximum 10"). We

will not be carrying much chemicals, so the risk of a spill is low. We will take care with snowmobiles, and generators to minimize the risk of fuel or oil spills.

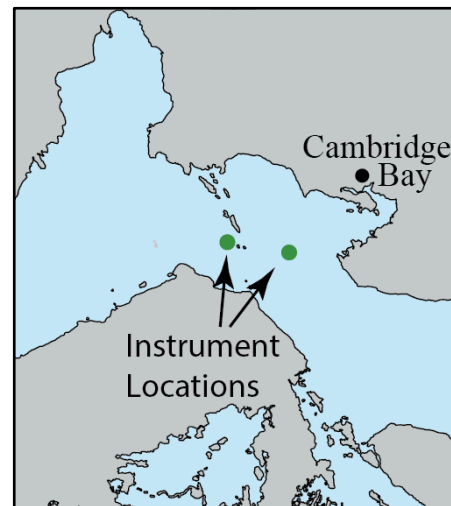
This sea ice project involves collaborators from other countries. It is challenging to predict the exact composition of the team due to COVID travel restrictions. The current plan for international researchers associated with this team is:

Country/Institution	Number of Participants
Belgium (Université Liège)	3
Japan (Hokkaido University)	4
Norway (The Arctic University of Norway)	3

These visiting scientists will stay at the Canadian High Arctic Research Station (CHARS). To ensure that this team is safe while we are traveling to the sea ice sites, we plan to hire one local field technician, and employ guides from the HTO.



Photo of one of the instrument deployments from a previous year. They will be installed in early May, so the hole will freeze over.



Map of the sea ice sampling locations, and where the instruments will be located.

3. Water Sensors Beneath the Sea Ice

At the sea ice sampling locations, we will install underwater sensors (see photo above). We previously installed instruments like this in 2019. To set up these sensors, we would travel to the sites, make a large hole (probably about 4 auger holes connected together), and then hang the instruments just below the bottom of the ice. The hole would be allowed to freeze over. On the top of the ice would be a box with a battery and a solar panel.

These will not be located right beside Cambridge Bay, they will be located in Dease Strait and near the Finlayson Islands. We will put them away from the snowmobile trail to the mainland so they do not bother anyone. We will put reflectors up all around them so they are visible. These instruments do not make any sound underwater, so they should

not disturb wildlife. They just measure CO₂, oxygen, temperature, salinity, pH, and ocean currents. We will retrieve them before the sea ice breaks up.

4. Camp at Finlayson Islands

We will end the sea ice sampling project based out of CHARS in late May when melt ponds are forming. To continue collecting samples near the weather station in June and July, we plan to set up a camp at the Finlayson Islands. The camp will consist of one or two cooking tents, and several sleeping tents. We will continue sampling on the sea ice as long as the ice is thick enough, and then switch our sampling activities to a small boat.

The team for this camp will be small, consisting of only 2-3 scientists. We will hire people from Cambridge Bay to help with the camp, probably one research assistant and one guide. People and supplies will be moved back and forth from the island every two weeks by helicopter. When operating the helicopter we will fly high enough to avoid startling wildlife and disturbing campers. When planning our route from Cambridge Bay to Finlayson Islands we will avoid flying over any sensitive areas.

5. Freshwater Sampling

In summer, we will collect water samples from the banks of lakes/rivers, or from small boats. Our collaborators at the U of C (Dr. Stadnyk) will be involved in water collection. For lakes and rivers, we will collect water by driving up to the shore, and then pumping water using a small pump. Like our ocean sampling, lake and river sampling will have minimal impacts. We will continue to be careful to avoid spills. In addition to working in the Greiner Lake watershed, we also would like to collect samples from the Fergusun Lake watershed, and the Kitikga Lake watershed.

6. Summer Ocean Sampling

It is currently uncertain whether the R/V *Martin Bergmann* will be able to sail out of Cambridge Bay this summer. If it is possible, we will use that ship to collect samples for CH₄, CO₂, oxygen, temperature, and salinity. We will also use our “underway system” to measure pH, CO₂, salinity, and water temperature while the ship is travelling. We will visit our usual sampling locations, which are shown in a map below. We usually hire one community member to help with the sampling.

7. JetYak (remote controlled research boat)

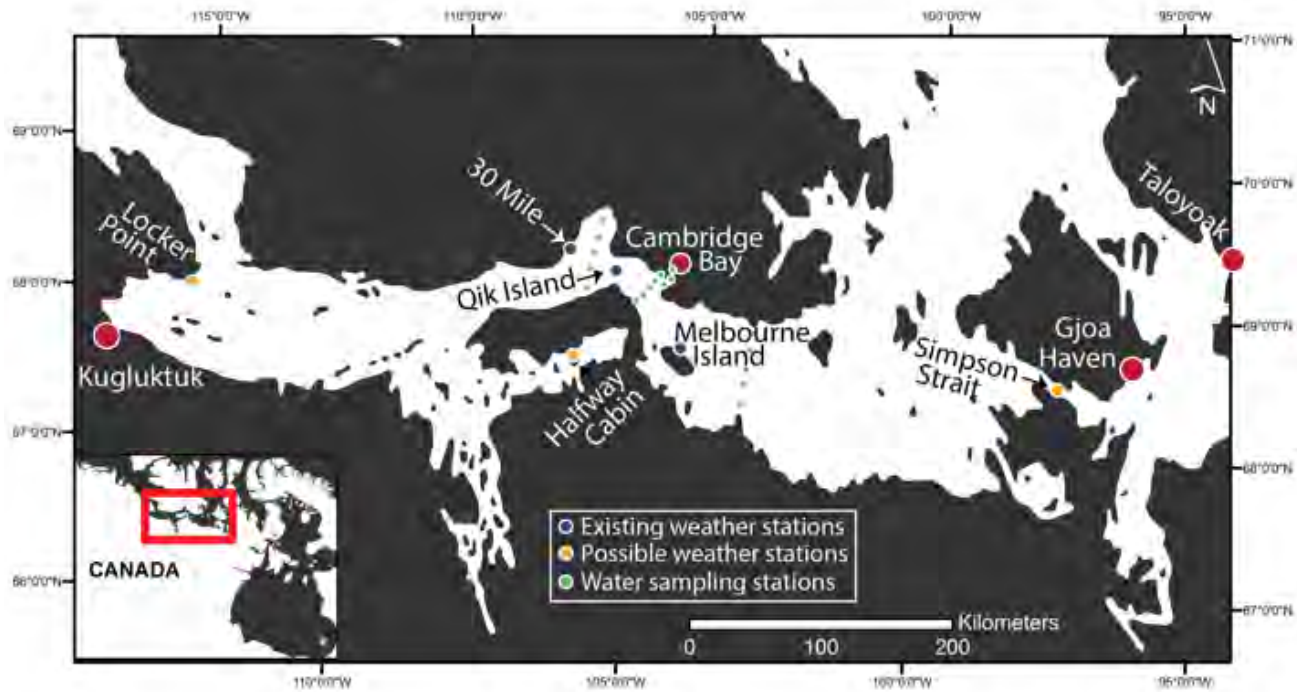
In 2018, we worked with some researchers from the United States (Dr. Anna Michel, Woods Hole Oceanographic Institution) who operated a remotely controlled kayak near Cambridge Bay. The kayak makes measurements of CO₂, CH₄, temperature, and salinity as it drives around. These researchers would like to use the JetYak again during the ice breakup time next spring. The JetYak is powered by a gasoline engine, so we will be careful to make sure no fuel spills occur. Otherwise, this is unlikely to have any impacts on the environment. The JetYak will be used in the river plume area that opens up near Freshwater Creek when it first starts running in June. We are also interested in using it in Freshwater Creek and Greiner Lake. We may fly a small drone to collect images over Freshwater Creek and Greiner Lake. The current plan for international researchers associated with this team is:

Country/Institution	Number of Participants
USA (Woods Hole Oceanographic)	3

8. Outreach Activity/Knowledge Co-Generation Session

We plan to host a knowledge sharing session where members of our research team and a group of community members look at scientific data collected in Greiner Lake, Freshwater Creek, and the coastal ocean in Cambridge Bay and work together to make interpretations based on the results. Research results will be presented using maps and images and the session will allow discussion and annotation of the maps and images to make changes, improvements, or additions based on local knowledge and views. The session may also be used to propose new study sites or research activities based on community priorities. The outcomes will be included in a PhD thesis and related academic publications and the participants in the session will be co-authors (if they wish) on the publications/products that arise from the session. We received ethics approval for this knowledge co-generation activity in the spring of 2020 (REB19-2110) and will work with the University ethics board to implement additional COVID risk mitigations and modifications.

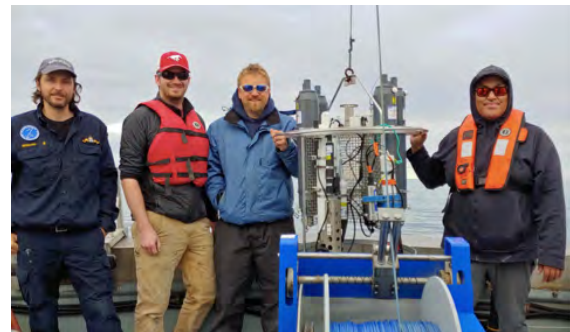
Photos and Maps Illustrating 2022 Activities:



Map of existing weather stations, possible new weather stations, and water sampling stations. Sea ice sampling will take place near the Qik Island (Finlayson Islands) weather station site.



Example of what sea ice sampling looks like. We will collect many sea ice cores like this.



Example of seawater sampling on the Bergmann. Community members are usually involved in this work.



This is what the JetYak looked like in 2018 when it was in Cambridge Bay.