

Report on 2023 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 ways 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.

2023 Activities

Sample Collection Dates: May 7 – Jun. 3, 2023

Locations: Cambridge Bay and Surrounding Areas.

Weather Station Operations: Jan. 01 – Dec. 31, 2022

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

Weather Stations

Normally, we have three weather stations working near Cambridge Bay (see photos and map below). 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 <http://siku.org>. At the Qikirtaajuk Island station, we also measure incoming energy (from the sun and atmosphere), and carbon dioxide in the atmosphere.

Ice and Seawater Measurements

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.

In 2023 seawater and sea ice samples were collected at one station: just west of Cambridge Bay (see map below). Between May 7 – Jun. 3 we stayed at CHARS and traveled to the sites by snowmobile. This year, there were large cracks running from Long Point to the mainland, which made it difficult to travel to the island station. Our Japanese collaborators had planned to set up a small weather station at Finlayson Islands. Instead, they set up their weather station at the sea ice and water sampling site. Since our plans changed because of the cracks, we obtained approval from the HTO Board before setting up the small weather station at the site, which was much closer to Cambridge Bay. We hired guides from the HTO and several local field assistants to help with this work, and to keep everyone safe.

Estuary and River Measurements

In 2023, our collaborators from the USA measured greenhouse gases in Greiner Lake, Freshwater Creek, the Freshwater Creek estuary (Cambridge Bay) and 5 surrounding ponds over a three week period when the ice thawed and broke up using the JetYak and a suite of sensors. We are able to compare surface waters to waters up to 10 m deep. In addition to the JetYak sensors, gas samples were collected. These measurements are helping us to compare the greenhouse gas emissions from the different types of water bodies. A drone was used to image ice change. The team from USA did about 5 classroom visits and hosted a community event at CHARS to explain their research.

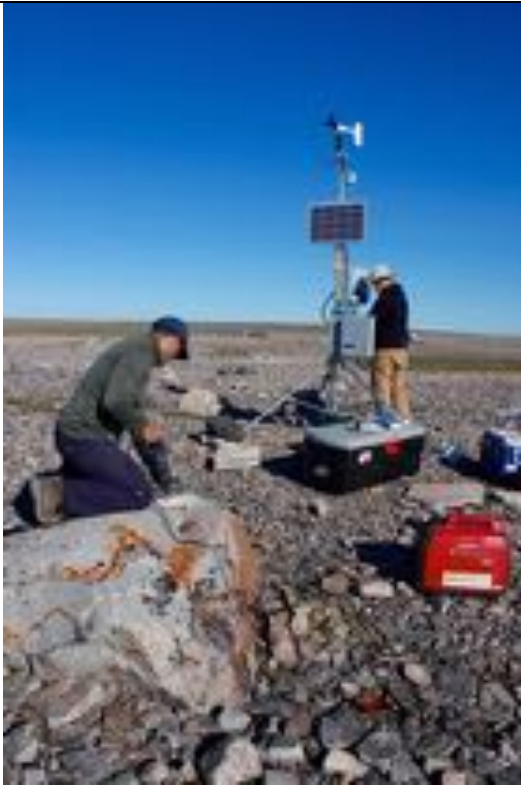
River and Lake Measurements

Water samples were collected at 35 locations in Greiner Lake, and 35 locations in Kitigak Lake (see map below). Between May 14 and 27 we traveled to these locations by snowmobile with a local field technician. An ice fishing auger was used to drill a 10" hole at each site. In each hole we lowered instruments to measure water temperature and dissolved oxygen, and then collected about 0.5L of water. The water samples are analyzed at our lab for dissolved CO₂ and dissolved CH₄. We then lowered a camera to the bottom, which we left for 30-60 minutes to record pictures of the bottom, and any fish that might swim by. An opportunistic water sample was also collected from the edge of Long Lake on August 15, 2023 to determine nutrients, dissolved organic carbon, water isotopes, and ion concentrations later in the season.

Photos and Maps Illustrating 2023 Activities:



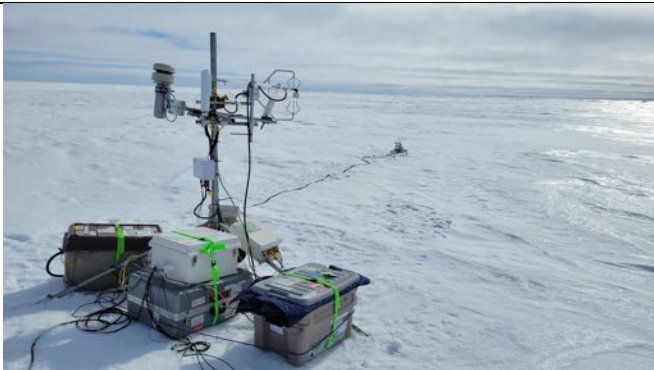
Map of weather station locations, and location of ice and sea water sampling stations.



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



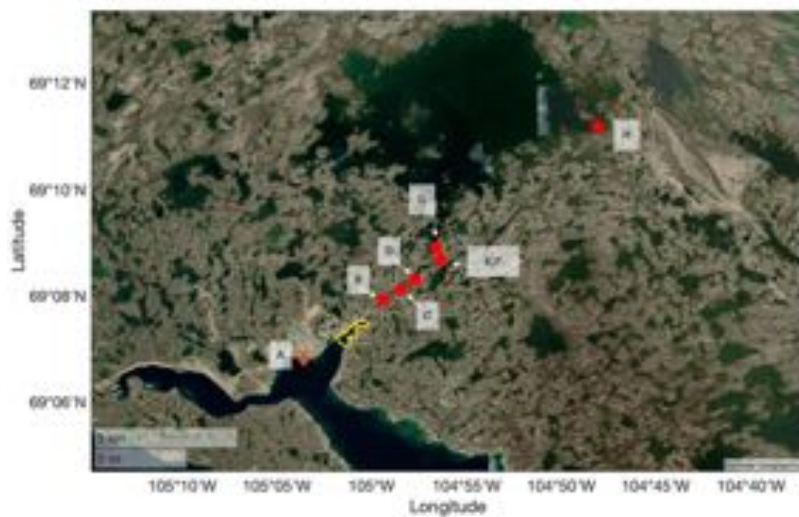
The weather station at Qikirtaarjuk Island after being repaired.



The small, temporary weather station near Cambridge Bay



Collecting sea ice samples.



A map of where samples were collected as part of the JetYak sampling program during spring break-up.



Photograph of the JetYak sampling program.

Planned Activities for 2023-2024

Team Members:

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Planned Activities for 2024: We hope to be able to do more research near Cambridge Bay this spring. 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.

2. Sea Water Sampling

In 2023, our focus will be on seawater sampling near the weather station at the Finlayson Islands. Starting in May, we will travel by snowmobile to collect samples. Most of the samples will be returned to our labs in the south for analysis of CO₂, salinity, dissolved oxygen, and nutrients. 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.

3. Summer Freshwater Sampling

In summer, we will collect water samples from the banks of lakes/ivers, or from small boats. Our collaborators at the U of M (Dr. Brown) 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 Ferguson Lake watershed, and the Kitigak Lake watershed. River water samples for geochemical measurements will also be collected from Freshwater Creek to compare to the sensors on a river mooring (NRI SRL #04 016 23R-M) placed in the river during the open water season (July-September). This system will measure temperature, conductivity, dissolved oxygen, and coloured dissolved organic material.

4. Pond Measurements

In 2024 researchers from the United States (Dr. Anna Michel, Woods Hole Oceanographic Institution) plan to make measurements of CO₂, CH₄, temperature, and

salinity in local ponds. The current plan for international researchers associated with this team is:

Country/Institution	Number of Participants
USA (Woods Hole Oceanographic)	2

5. Outreach Activity/Knowledge Co-Generation Session

We still wish 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. This workshop has been delayed as we wait for a PhD student to complete her preliminary studies of Freshwater Creek and Greiner Lake. We received ethics approval for this knowledge co-generation activity in the spring of 2020 (REB19-2110), and have maintained the active approval. It may be possible to complete this workshop in the fall or early winter of 2024.