Application for NRI Research License: Impacts of Melting Tidewater Glaciers on Marine Biogeochemical Cycles (NPC File No: 149049; NIRB File No: 19YN020)

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Project Location: Qikiqtani Region (Devon Ice Cap, Devon Island and Jones Sound, Nunavut)
Closest Community: Hamlet of Grise Fiord

Project Plans 2019

Field Team 2019: Maya Bhatia (Assistant Professor, University of Alberta); Erin Bertrand (Assistant Professor, Dalhousie University); David Burgess (Research Scientist, Natural Resources Canada); Jimmie Qaapik (Grise Fiord resident and ranger in the Grise Fiord Ranger Patrol Group)

Timeframe: July 2019 - August 2019 (~1 month in field)

Long-term Objective: Understand how melting glaciers are exporting sediment and dissolved chemical species to the ocean and the impact of this material on downstream regional marine primary production and biogeochemistry.

Short-term Objectives (2019):

(1) ***On-ice activities:*** To download and retrieve time-lapse cameras and pressure transducers deployed around Sverdrup and Belcher glaciers on Devon Island Ice Cap. Equipment will be deployed at the glacier terminus, and in/around ice-marginal ponds and streams, recording (i) changes in glacier hydrology as the melt season progresses and (ii) changes in plume development at the glacier terminus. We expect seasonal changes in the glacier hydrology to correspond to the timing and magnitude of discharge events at the glacier terminus. We also expect that the type of chemical species exported from the glacier will be related to the on-ice seasonal development. We will collect glacier ice and meltwater samples and process them for chemistry and microbial analyses and experiments.

(2) ***Marine-based activities:*** To conduct oceanic transects from the termini of Sydkap, Jakeman, Sverdrup, and Belcher glaciers across Jones Sound measuring changes in seawater conductivity, temperature, and pressure to map the extent of glacial plume discharge in the summer and its potential impact. This work will be conducted from small boats, consisting of a private sailboat and/or boats provided by the Grise Fiord Ranger Patrol group. We will also collect seawater samples in Jones Sound along these transects to measure chemical properties and biological properties. We expect that collectively this marine based work will elucidate the role of glacial meltwater runoff in regional primary production at the base of the marine food web and broader scale marine carbon cycling.

Scientific Rationale: Climate change has significantly increased glacial melt and runoff, and glacial fluxes are predicted to grow, as is the export of freshwater and glacially-derived,

biogeochemically reactive species to downstream marine environments. The Canadian Arctic Archipelago (CAA) is a key hotspot for such changes: from 2004-2009, CAA glaciers were the third largest contributor of glacier meltwater to the global ocean (Gardner et al., 2011). When glacial runoff enters the marine environment, it may stimulate biological productivity by supplying carbon, iron, and other essential micro- and macro-nutrients (Bhatia et al., 2010, 2013). Since peak glacial meltwater inputs occur during summer when primary production is nutrient-limited (Tremblay et al., 2015) this stimulation may be particularly significant for the functioning of affected marine ecosystems. To date, no single study has characterized the chemical and biological nature of glacially-derived submarine discharge, the effectiveness of its transport within the marine environment, or its seasonal impact on downstream marine ecosystems. Here, we propose to characterize the biogeochemical impact of glacial runoff and meltwater plumes on a regionally productive marine ecosystem that is central to the health of indigenous communities. In conclusion, the goals of the research project to monitor the glacier dynamics and hydrology of several tidewater glaciers in Jones Sound (Nunavut) over the course of a multi-year study to determine the quantity, timing and routing of meltwater delivery to the ocean, characterize the chemistry and microbiology of these meltwaters, and evaluate their impact on the downstream marine environment. In doing so, we'll also gain broader understanding of ice cap and tidewater glacier hydrological connections.

Progress To Date: This project is beginning this year, and thus, 2019 represents our first field season where we hope to collect scientific data during a field campaign, and also meet and make connections with the Hamlet of Grise Fiord.

Access: By twin otter from the Polar Continental Shelf Project (PCSP), Resolute Bay to Grise Fiord; Board a private sailboat and/or Grise Fiord Ranger Patrol Group boats in Grise Fiord. Travel to Truelove Inlet via boat. Travel on ice cap (Party of 2) by helicopter/foot.

Any structures that will be erected (permanent / temporary): A minimalist, temporary camp (party of 2 and the helicopter pilot) will be established at TrueLove Inlet for a few days, where we will meet the helicopter in preparation for our helicopter and on-ice sampling work. This temporary camp will be dismantled at the conclusion of our on-ice work. All fuel drums cached at TrueLove Inlet to support the helicopter work will be removed by PCSP at the end of the field season.

Restoration / abandonment plans: Equipment not needed for subsequent field seasons will be removed after the 2019 season. Some equipment and fuel needed for 2020 may be cached on the northern margin of the ice cap. All equipment and cached materials will be removed at the end of the project. There should be no need for restoration as camp sites on land will be minimally used, avoid any plant development by being situated on bedrock, and all equipment on the ice/bedrock can be easily removed.

Methodology: Collection Protocol and Mechanisms

(i) ***Time-lapse cameras***: Each time-lapse unit will consist of a tripod bolted into bedrock, a Nikon DSLR camera, a battery and solar panel. These systems operate year-round collecting images every hour until light becomes insufficient. We will service them and download data each spring and summer of the project.

(ii) ***Ice sampling:*** Small ice samples (~1 kg each) will be collected using a chisel and hammer.

(iii) ***Marine measurements:*** Measurements of ocean conductivity, temperature, pressure will be undertaken using an RBR multi-channel logger which will be profiled from the surface to ~500 m.

(iv) ***Glacial meltwater and marine sampling:*** Meltwater and ocean samples will be collected in bottles and filtered on-site aboard the sailboat, with only the filter paper or small liquid volumes (<500 mL) sent back to the laboratory for analysis.

Indicate why specific communities or individuals were selected for your research:
The Hamlet of Grise Fiord is surrounded by melting tidewater glaciers. Local indigenous knowledge indicates that waters near the termini of these glaciers are biologically productive. The community has expressed interest in understanding the impacts that climate change and enhanced glacial melting are having on the regional marine ecosystem. This project is being undertaken in collaboration with the Hamlet and the Geological Survey of Canada, who have been long-term partners to monitor the acceleration of glacier melt in this region and the broader scale impact of this melt.

Data Management: Will be used in student theses, research publications, public talks, and climate change assessment reports (e.g. IPCC, AMAP). Data will also be made available to the Hamlet of Grise Fiord. Ultimately, data will be deposited in a public data repository.

Research Outputs: Study results will be communicated through annual reports to the Nunavut Research Institute and Nunavut Climate Change Center, and summaries of research results to Grise Fiord and Resolute Bay communities in Inuktitut and English. NRI will receive copies of published articles.