Eastern Snow Conference: 2017 Student Award Recipient

Presentation title: Tracking changes in iceberg calving events and characteristics from Trinity and Wykeham Glaciers, SE Ellesmere Island, Canada

Authors: Abigail Dalton (MSc Student) & Dr. Luke Copland, Department of Geography, Environment and Geomatics, University of Ottawa

Abstract: The Canadian Ice Service (CIS) produces charts to identify iceberg presence in Canadian waters for navigational purposes, but there is uncertainty surrounding the origin of these features. Previous work has been conducted on the location of the main tidewater glaciers in Canada and the volumes of ice that they discharge to the ocean, but little research has been done on the processes controlling iceberg production and drift patterns in Canadian Arctic waters. Recent and rapid changes have been observed in the ice discharge patterns of glaciers in this region. For example, Trinity and Wykeham glaciers contributed ~62% of total iceberg discharge from the Canadian Arctic Archipelago in 2016, compared to ~22% in 2000. Given these changes, an important question is whether there is a relationship between changing sea ice conditions (e.g., thickness, extent, freeze up dates, break up dates) and iceberg production from these glaciers. Using SAR and optical imagery to identify iceberg calving events between 1997 and 2015, iceberg calving events are classified in two ways: through the identification of iceberg plumes, and through the measurement of glacier terminus changes. Often when a calving event occurs a plume of glacial ice debris is also produced at the terminus and is clearly visible in SAR imagery. In some cases, such as when a large event composed of a single iceberg rather than many small pieces of ice, a plume is not always produced making it difficult to detect in SAR imagery. Glacier area loss detected in optical imagery data is compared to the plume event data from SAR imagery between 1997 and 2015 to determine whether a relationship exists between glacier area loss and plume size. To understand where these icebergs drift to, how they deteriorate and the time scale of these processes, a series of satellite tracking beacons were deployed in summer 2016. These were helicopter-deployed from aboard the CCGS Amundsen, and provide near real-time (hourly) information concerning the movement of 13 icebergs and ice islands within Baffin Bay. Initial results show that, to date, the most active iceberg has drifted over 3200km south through Baffin Bay. Some of the icebergs have also exhibited a spiraling pattern as they drift west across Baffin Bay and are influenced by ocean currents and tides. Results from this work provide information about patterns of iceberg movement, including common areas where icebergs become grounded in relation to bathymetry.

Glaciers, Icebergs and Ice Islands

**Principal Investigators:** Luke Copland (luke.copland@uottawa.ca), **Cruise participants:** Luke Copland and Abby Dalton

[1]University of Ottawa, Department of Geography, Laboratory for Cryospheric Research, 043 Simard Building, 60 University Pvt., Ottawa, ON, K1N8Z4

**Introduction and Objectives:** Tidewater glaciers drain glaciers, ice caps and ice sheets and terminate into the ocean where they discharge through the calving of icebergs and ice islands (large tabular icebergs). The Canadian Ice Service (CIS) produces charts to identify the presence of icebergs but has little knowledge about the sources and sinks of icebergs in Canadian waters. It is important to understand where these icebergs and ice islands originate, where they drift, how they deteriorate and the time scale of these processes. Trinity and Wykeham Glaciers on SE Ellesmere Island have increased iceberg production from 22% of total discharge from the CAA (Canadian Arctic Archipelago) in 2000 to 62% in 2016. They are the only two glaciers in the Queen Elizabeth Islands (QEI) to have shown consistent acceleration between 1999 and 2015 making it an area of significance for the study of ice discharge into Canadian Waters (Van Wychen et al., 2016). Operations during this leg will address the following gaps in knowledge surrounding the production and movement of icebergs and ice islands in Canadian waters:

- Which tidewater glaciers are the sources of icebergs and ice islands in Canadian waters and where do they drift?
- Are there changes in the size, shape or timing of iceberg production in the recent past and is this linked to glacier dynamics?
- Do sea ice conditions impact the production of icebergs at the termini of tidewater glaciers?
- How is the velocity of Trinity Glacier changing over time?

Iceberg Beacon Deployment

Between July 31, 2016 and August 14, 2016 a total of 13 beacons were deployed on icebergs and ice islands in Baffin Bay. Through a contract with Environment and Climate Change Canada (ECCC) six CALIB beacons were deployed onto icebergs and ice islands within Baffin Bay and Nares Strait (Table 1). Two beacons were deployed onto targets chosen by CIS and the remaining four targets were chosen based on size, location and whether they were likely to drift (Figure 2). Five of six beacons have since successfully transmitted data remotely. One of the beacons deployed (ID#: 300234011758690) is suspected to have had issues with the battery and has not transmitted any data since being deployed.

Table 1: CIS beacon deployment summary.

| Asset Name | Deployment Date | Deployment Time (UTC) | Latitude (start position) | Longitude (start position) | Deployment Location | Notes |
|---|---|---|---|---|---|---|
| ICALIB (4701652-8690) | 02-Aug-16 | 11:30 AM | 72.06178 | -73.31847 | Baffin Bay | Buchan Gulf Iceberg. **Faulty Device - Not working** |
| ICALIB (4701653-3030) | 02-Aug-16 | 12:20 PM | 71.88914 | -72.25875 | Baffin Bay | Unk_S1 Ice Island |
| ICALIB (4701654-5450) | 09-Aug-16 | 11:35 UTC | 76.30836 | -74.81636 | Baffin Bay | S Nares Strait Ice Island |
| ICALIB (4701655-1040) | 09-Aug-16 | 12:45 UTC | 76.84956 | -75.88631 | Baffin Bay | East of Manson Icefield Ice Island |
| ICALIB (4701657-3450) | 14-Aug-16 | 11:31 AM | 79.74294 | -64.96186 | Baffin Bay | Humboldt Glacier Ice Island |
| ICALIB (4701656-8060) | 14-Aug-16 | 11:49 AM | 79.83578 | -67.35725 | Baffin Bay | Kane Basin Ice Island |

Figure 1: Example of placement of CIS beacon. Deployed on iceberg near Buchan Gulf (72.06178, -73.31847), August 2, 2016. Photo courtesy of Luke Copland.

Seven additional beacons were deployed containing iridium GPS receivers (RockStar), batteries and solar panels (Figure 3). Three of these beacons were deployed onto icebergs/ice islands within Baffin Bay and four were deployed within Trinity Fiord to track movement of icebergs produced by Trinity Glacier within and out of the fiord (Table 2). Positions of these seven beacons will be viewed on

www.core.rock7.com to monitor movement and identify drift patterns of icebergs around Baffin Bay.

Figure 2: Example of placement of beacon on ice island. Deployed SE of Sam Ford Fiord, July 31, 2016. Photo courtesy of Abby Dalton.

Table 2: RockStar beacon deployment summary

| Unit # | Deployment Date | Deployment Time (UTC) | Latitude (start position) | Longitude (start position) | Deployment Location |
|---|---|---|---|---|---|
| 3655 | 31-Jul-16 | 18:37 | 70º45'46.76" | 67º51'26.50" | SE of Sam Ford Fiord |
| 3534 | 06-Aug-16 | 18:34 | 76º11'02.29" | 69º55'31.80" | SW of Thule |
| 3651 | 06-Aug-16 | 18:58 | 76º35'15.51" | 71º35'00.91" | W of Thule |
| 20781 | 10-Aug-16 | 17:54 | 77º57'01.57" | 78º31'25.99" | Trinity Terminus |
| 3635 | 10-Aug-16 | 17:59 | 77º56'07.96" | 78º08'41.42" | Trinity Island |
| 20785 | 10-Aug-16 | 10:22 | 77º56'30.47" | 77º55'50.91" | Trinity Mid Fiord |
| 20784 | 10-Aug-16 | 10:28 | 77º54'17.19" | 77º29'8.83" | Trinity Outer Fiord |

Figure 3: Iceberg tracking beacons built by Abby Dalton and Luke Copland. Three of these beacons were deployed onto icebergs in Baffin Bay and four were deployed onto icebergs within Trinity Fiord to monitor their movement. GPS trackers transmit their position using the Irisium satellite network and can be programmed remotely to modify transmission frequency according to activity (e.g. less frequent transmissions during winter when they are frozen in sea ice and have minimal movement). Photo: Luke Copland.

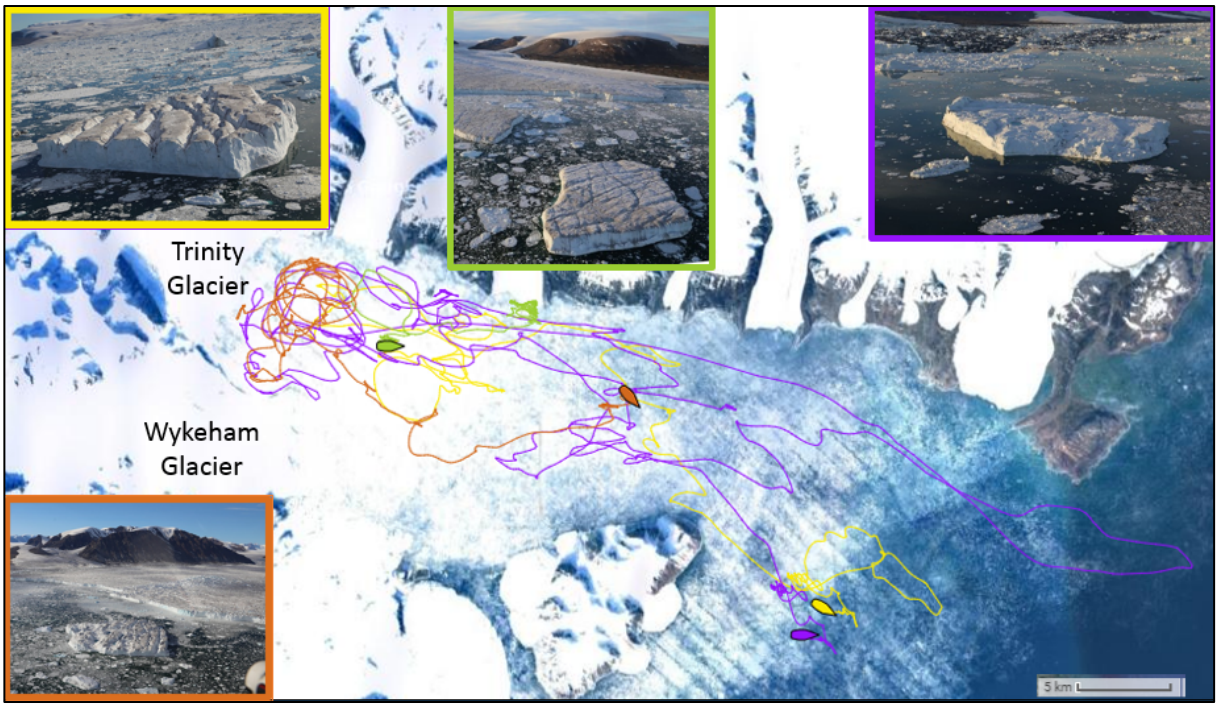


Figure 4: Drift tracks of icebergs tagged with beacons between August and December 2016. One of the icebergs (purple track) travelled approximately 25km in one day on September 13, 2016.