Monitoring Iceberg Drift Patterns in Canadian Waters

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Background

Tidewater glaciers drain a significant proportion of the Greenland Ice Sheet, and the ice caps of the Queen Elizabeth Islands, Nunavut, and provide the primary source of icebergs and ice islands in Canadian waters. The Canadian Ice Service produces charts which identify the presence of icebergs, but currently has little knowledge about the sources and sinks of icebergs in Canadian waters.

Since 2000, Trinity and Wykeham glaciers in Talbot Inlet on SE Ellesmere Island (Figure 4; inset) have consistently accelerated and, as of 2016, contributed ~66% of total ice discharge from the Canadian Arctic Archipelago, compared to ~22% in 2000 (Van Wychen et al., 2015, J. Glac.). In this project, helicopter-deployed satellite tracking beacons are used to demonstrate the ability to observe the movement of icebergs and ice islands out of Talbot Inlet and through Canadian waters.

Methods: Tracking Beacon Deployment

Between 2016 and 2018, a total of 39 tracking beacons were deployed by helicopter on icebergs and ice islands in Baffin Bay from the CCGS Amundsen icebreaker (Figure 1a).

On behalf of Environment and Climate Change Canada (ECCC) 10 CALIB beacons (Figure 1b) were deployed onto icebergs and ice islands within Baffin Bay and Nares Strait. Twenty-nine additional beacons were deployed containing Iridium GPS receivers (RockStar and Solara), batteries and solar panels (Figure 1c & d). Thirty tracking beacons were deployed onto icebergs/ice islands within Baffin Bay and 9 were deployed within Talbot Inlet to track movement of icebergs produced by Trinity and Wykeham Glaciers within and out of the fiord.

Figure 1: (a) CCGS Amundsen used for deployment, (b) ECCC CALIB tracking beacon, (c) uOttawa Rockstar tracking beacon, (d) beacon deployment.

Methods: Ice Island Thickness

A 10MHz ground penetrating radar (GPR) system was used to measure the thickness of several ice islands in Baffin Bay.

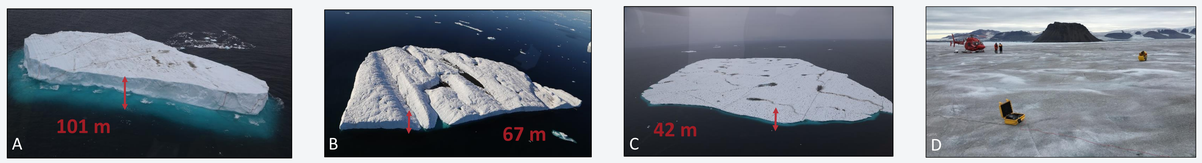


Figure 2: (a-c) Examples of ice islands in Baffin Bay where thickness measurements were taken using GPR (see Figure 3 for location) (d) GPR measurement setup.

Results

One uOttawa iceberg tracking beacon and three ECCC beacons are currently transmitting their positions. The remaining beacons are no longer transmitting their positions, likely due to either battery issues or as a result of the iceberg flipping or breaking apart. The nine beacons within Trinity Fiord clearly show how active the icebergs have been within the fiord (inset map). One of the icebergs (pink track) travelled approximately 25km in one day on September 13, 2016. Only one iceberg (orange track) has left Talbot Inlet and travelled south, drifting about 3300 km in ~9 months before losing contact near Makkovik, Labrador.

Thickness measurements of several ice islands showed that thicknesses ranged from ~40-100 m (Figure 2). Several icebergs have travelled west from Greenland across Baffin Bay before beginning to move south along Baffin Island. Many icebergs also follow a semi-diurnal looping pattern (Figure 3) for segments of their tracks as they were influenced by both ocean currents and tides, however it is not consistent (e.g. navy blue track).

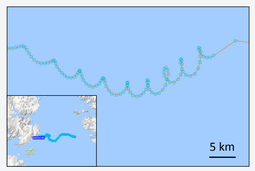
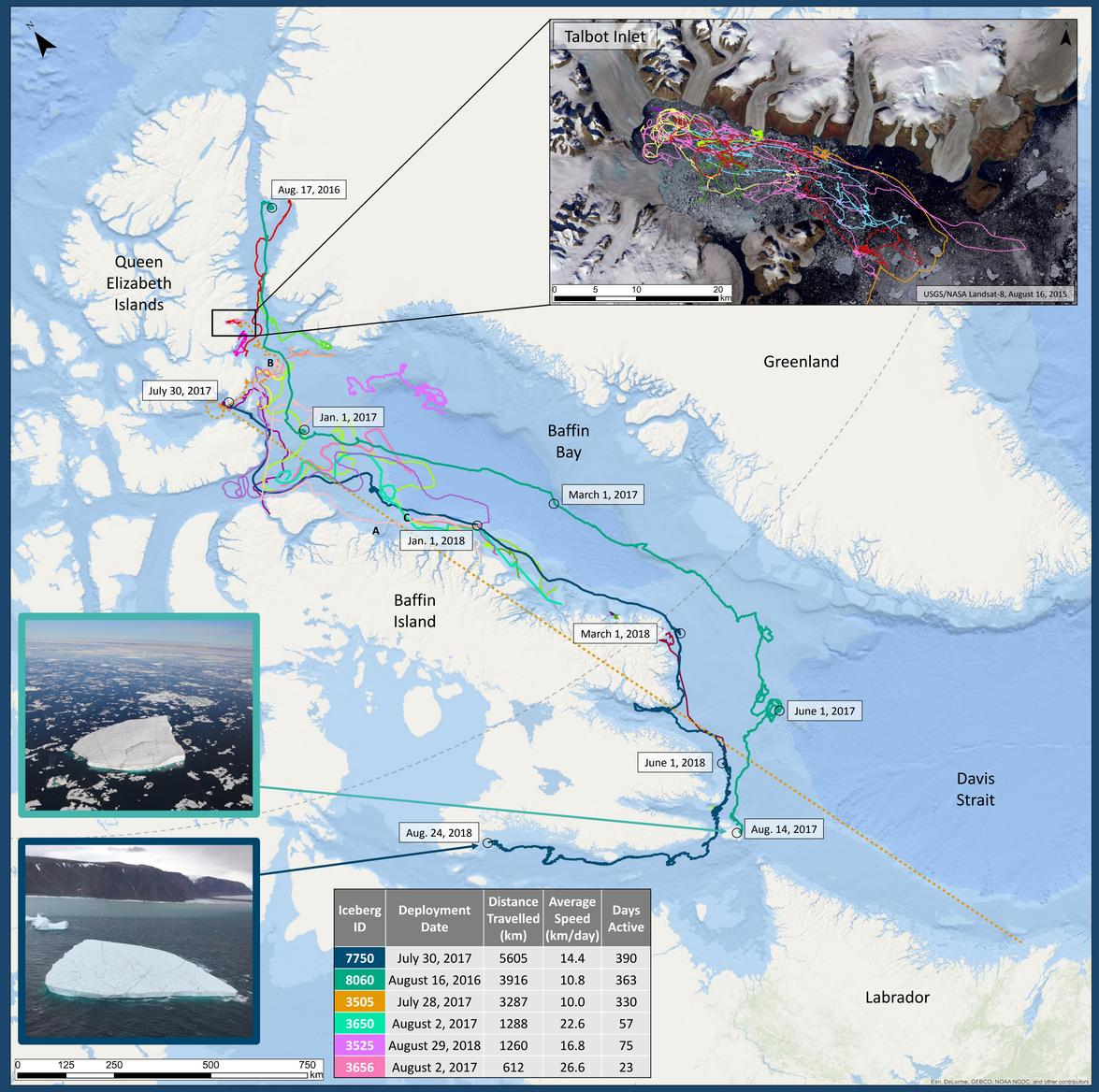


Figure 3: Example of iceberg following looping pattern between August 8, 2016 and August 12, 2016 as it moves west across Baffin Bay.



Iceberg ID	Deployment Date	Distance Travelled (km)	Average Speed (km/day)	Days Active
7750	July 30, 2017	5605	14.4	390
8060	August 16, 2016	3916	10.8	363
3505	July 28, 2017	3287	10.0	330
3650	August 2, 2017	1288	22.6	57
3525	August 29, 2018	1260	16.8	75
3656	August 2, 2017	612	26.6	23

Figure 4: Map of iceberg drift tracks from 40 satellite tracking beacons. Inset map shows iceberg drift tracks within Talbot Inlet on SE Ellesmere Island.

Conclusions

Deploying beacons onto icebergs has proven to be an effective method of tracking iceberg movement. Initial results show a combination of tides and currents moving the icebergs south/west, with bathymetry influencing the iceberg drift pattern. Results from the last ~3 years show the most active iceberg moved at a rate of about 26.6 km/day. The most distance that was observed for an iceberg in this study was >5 600km over a 390 day period.

Results from this work characterize patterns of iceberg movement, including common areas where icebergs become grounded due to bathymetry. They can also be used to determine the interactions between iceberg drift patterns and primary shipping routes and offshore oil exploration areas along the east coast of Canada. This enables improved risk assessment for ice hazards, and improved accuracy of operational iceberg charts issued by the Canadian Ice Service.

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