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Dynamics and Change of the Devon Ice Cap, Nunavut

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Dates in the field: 5 May – 25 May, 2013.

This research program aims to measure changes in how much ice is stored in Canada's Arctic ice caps, and to determine what is causing the observed changes and how they affect global sea level. The program relies on measurements from satellites and aircraft to detect changes, but uses fieldwork to check the reliability of these measurements and to determine how and why the changes are taking place. Fieldwork, carried out on the Devon Ice Cap, has two main components. In the first, we are trying to determine the accuracy of measurements of the height of the ice cap surface made with the radar altimeter on the satellite CryoSat2. Repeated measurements of surface height allow us to track changes in the thickness, volume, and mass of Arctic ice caps. In the second, we are studying the Belcher Glacier, which terminates in the ocean, to determine what controls how much mass it loses to the ocean by iceberg calving and how it responds to climate change.

Recent Progress

Changes in the mass balance of Canada's Arctic ice caps in the 21st century are bigger than any seen previously in the 55-year period of observations. These recent changes are mainly due to warming of the summer climate and increased surface melting. The decade of the 2000s had the warmest summer temperatures in the last 60 years, and 2005-2009 was the warmest 5-year period on record. Across the Queen Elizabeth Islands, glacier lost mass about 3.8 times faster after 2005 than over the previous 50 years. Both modeling and satellite measurements show that, from 2007-2009, ice caps in the Canadian Arctic contributed more mass to global sea level rise than any other source apart from the ice sheets in Greenland and Antarctica. Our surveys of the Devon Ice Cap show that there has been a huge change since 2005 in how quickly snow is turned into glacier ice. Even at the highest elevations on the ice cap where, until the 2000s, surface melt occurred only once or twice a decade, surface meltwater is penetrating deep into snow and firn near the glacier surface and refreezing to form ice. The last time this happened was around 4200 years ago. This is reducing the amount of water that can be stored in the ice cap, and increasing the fraction of each year's melt that runs off to the ocean.

2013 Field Season:

As only two graduate students were involved in fieldwork in 2013, our work was limited in scope. It focused on the upper 20 km of the CryoSat Line (which runs from the ice cap

summit to its southern margin, and on the Belcher Glacier. A new survey of the CryoSat line with ground penetrating radar and GPS extended our annual record of surface elevation change begun in 2004 and provided new information about the amount of ice in the firn and how that had changed as a result of melt in summer 2012. We also recovered data from all our climate stations on the line and removed broken equipment. We re-measured 5 thermistor strings installed in shallow boreholes in 2012 to track changes in the temperature of the firn that result from climate warming and the release of latent heat that occurs when meltwater refreezes in the firn.

On Belcher Glacier, we made a GPS survey of a 15 km long section of the centerline transect that we have surveyed annually since 2007 to monitor surface height changes along the glacier. Five GPS stations that measure how fast the glacier is flowing were visited, downloaded and serviced and, in one case, removed. Time lapse cameras set up to record iceberg calving from the glacier terminus were also revisited and downloaded. As none had recorded for the full year, we removed them. We also removed the audio and seismic recording instruments that we had set up to monitor iceberg calving events.