We plan to retrieve an ice core from Müller Ice Cap on Axel Heiberg Island. Recovering this small core of ice will not change the overall flow or melting of the ice cap, but will provide us important information about past climate change. The core will be approximately 10 cm in diameter and 600 m long, and contain a record of air temperature, sea-ice cover, and ice properties in the Northern Canadian Arctic over the past 4–20 millennia. To retrieve this core, we plan to go to the ice cap during spring/summer 2023 and 2024. In 2023, a small team will use radar to determine the best location to drill. In 2024, a group of about twelve will spend 2–3 months recovering the core itself. Analyzing this ice will greatly increase our understanding of past climate in Arctic Canada.

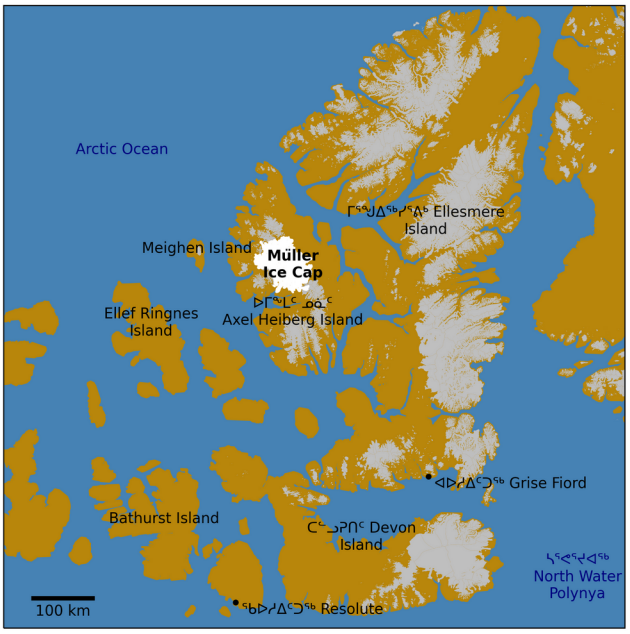

Figure 1: Location of Müller Ice Cap.

The Arctic Ocean is undergoing dramatic changes as sea ice thins and retreats further north throughout the year. During summer 2018, the ocean even opened north of Greenland, with thousands of square kilometers of open water where thick, perennial sea ice used to be. This sea-ice retreat changes the climate of the land surrounding the Arctic Ocean. Ice caps on these islands are thus retreating as they are exposed to warmer conditions and more melt. By studying cores from these ice caps, it is possible to retrieve proxy records of past Arctic sea-ice and climate conditions. Furthermore, stratigraphic analysis and dating of the ice cores provide a window into the age and past ice flow dynamics of the small ice caps, thus indicating their response to climate change.

The Müller Ice Cap core will help answer:
- How did sea ice conditions change in the Arctic Ocean during past millennia?
- What climatic conditions did the Arctic ice caps experience during past millennia, and what is the relationship between sea ice change and climate change?
- How sensitive are the Arctic ice caps to changes in sea ice and climatic conditions?
- How old is Müller Ice Cap?

This project is timely, since an ice core is only a useful climate record while the stratigraphy is still preserved. Cores from other ice caps suffer from surface melt, which starts to refreeze deeper in the ice, thus mixing the annual layers. While its elevation and latitude mean that the top of Müller Ice Cap is almost melt-free at present (Figure 2), it too may experience melt as the Arctic warms. It is thus imperative that an ice core is retrieved before the warming in the Arctic degrades or completely erases the layering.

Due to the importance of preserving ice cores for future generations, much of the ice core will be stored as an archive in freezers.

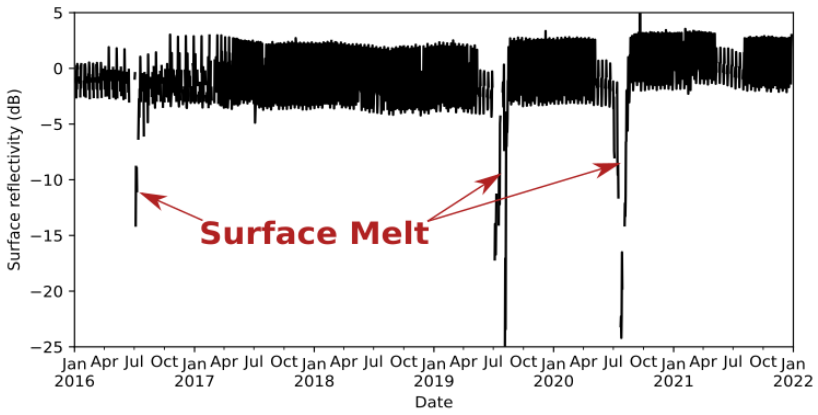

Figure 2: Reflectivity of ice-cap summit from Sentinel-1 satellites. Only days with very low reflectivity (below -5 dB) have melt.

In general, our knowledge about the many ice caps in the vicinity of the Arctic Ocean is limited. This holds especially true for the northernmost Canadian ice caps, where deep ice cores have never been drilled. Müller Ice Cap is well located to provide new information on the last 10,000 years of air-temperature history in the western part of the Canadian Arctic Archipelago and on fluctuations in sea ice cover within the channels of the archipelago and in the Arctic Ocean to the north of it. The ability to infer past sea-ice conditions from ice cores has only recently been developed, so the record from this core will give new insight into ice conditions in this part of the Arctic thousands of years ago. Moreover, the only other ice core from the area is a short, low-elevation core retrieved from Meighen Ice Cap in the 1960s. That core contains disturbances resulting from intense surface melting during past warm periods. The high elevation (over 1800 m) of the summit area of Müller Ice Cap should limit surface melting and percolation of surface melt water that could potentially smooth and degrade the isotopic and chemical records. We thus expect this new ice core to have a better climate record than any previous core from the northern Canadian Arctic.

The age of Müller Ice Cap is a major open question. Is it like other ice caps in the Canadian Arctic, such as Agassiz Ice Cap, which contain ice from the last glacial (17,000 years ago)? Or is it like Hans Tausen Ice Cap in Greenland (at a similar latitude), which melted away during the Holocene climatic optimum (4,000 years ago)? Determining the age of the ice will be key to our understanding of the sensitivity of other ice caps on Axel Heiberg and Ellesmere islands in a warming climate.

While Müller Ice Cap is far from any town in Nunavut, the ice core will provide information relevant for northern towns. The record of sea-ice conditions from the core will tell us about a much larger area than just the fjords around Axel Heiberg Island. Similarly, the connections between climate at this remote location and that in Grise Fiord and Resolute is strong, and isotopes in the ice core tell us about the climate of the whole region. Thus, the ice core might help give context to where modern climate change is leading for these communities, for example by providing a record of sea ice and air temperature in the whole region during the Holocene Climatic Optimum (~4000-8000 years ago), an extended period that was about as warm as today.