グリーンランド北西部における氷河氷帽の質量損失

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Mass loss of glaciers and ice caps in northwestern Greenland

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Greenland Ice Sheet is currently losing mass at a rate increasing since the beginning of 21st century (e.g. Shepherd and others, 2013). The mass loss of the ice sheet is attributed to increasing surface melt and accelerated ice discharge from outlet glaciers. Rising temperature is the key driver of the melt increase, but accurate evaluation of surface mass balance over Greenalnd is still difficult because field data is lacking and not uniformly distributed. Recent observations have shown many glaciers are speeding up and discharging more ice than before (e.g. Moon and others, 2012). However, the mechanism of the speed up is not well constrained. To quantify the current ice mass loss in Greenland and better predict its future, we have established a research project in northwestern Greenland as a part of GRENE Arctic Climate Change Research Project. Field and satellite observations are performed to evaluate the ice mass loss of the ice sheet, outlet glaciers and ice caps. We also study details of the mass balance and dynamic processes to understand the mechanism of the mass loss. Our goal is to provide accurate figures of current and future ice mass change in Greenland based on observational data and numerical modeling. In this contribution, we present the overview of the project with a focus on the 2013 summer field campaign on Bowdoin Gletscher and Qaanaaq Ice Cap (Figure 1).

Initial field measurements on Bowdoin Gletscher were performed in July 2013. We established a camp beside the glacier to measure ice speed, melt rate, and glacier surface and bed elevations. Ice speed was processed with an hourly resolution to investigate its short-term variations. Surface elevation was compared with DEMs derived for previous years by satellite data. We also made several boat trips from Qaanaaq to the fjord of Bowdoin Gletscher for ocean measurements. We used a sonar to measure the ocean bed geometry and carried out preliminary measurements on ocean current and temperature. Ice speed showed short-term variations under the influence of tide, surface meltwater, and rain events. The glacier surface has been lowering since 2007 at a mean rate of -1.5 m a^{-1}. Glacier and ocean bed elevations show 200–700 deep trough incised along the fjord (Figure 2). Another field activity on Bowdoin Gletscher is scheduled in the summer 2014, including hot water drilling for subglacial observations.

Field measurements on Qaanaaq Ice Cap was performed from June to August 2013. This was the second field season in this ice cap after the measurements in summer 2012. Along a 8-km long route from the ice cap summit to the terminus of an outlet glacier, seven stakes were resurveyed by GPS positioning for ice flow speed and mass balance (Figure 3). Surface elevation was measured along the route to compare them with the data in the previous year. Surface elevation change showed mass loss of the ice cap at a rate increasing towards the lower elevation. Near the glacier terminus, surface lowered by about 4 m from 2012 to 2013. Summer ice speed in 2012 was significantly greater than the annual mean value in the middle part of the glacier, suggesting enhanced basal motion due to meltwater penetration to the bed. We plan to repeat these measurements on Qaanaaq Ice Cap to monitor the response of the ice cap to the warming climate in northwestern Greenland.

References

Shepherd A. and others, A reconciled estimate of ice-sheet mass balance, Science 338, 1183–1189, 2013.
Moon T., I. Joughin, B. Smith and I. Howat, 21st-century evolution of Greenland outlet glacier velocities, Science 336, 576–578, 2012.

Figure 1. Satellite image of the study site.

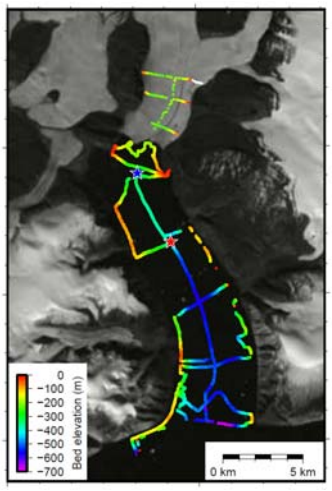

Figure 2. Glacier and ocean bed elevation measured in the field.

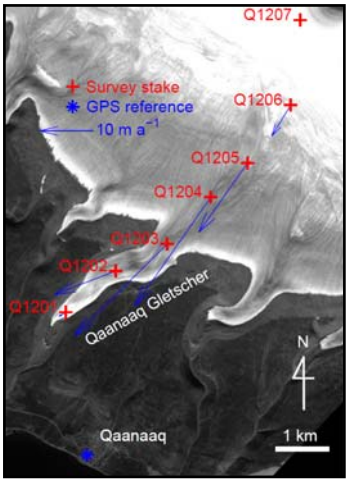

Figure 3. Locations of the survey stakes on Qaanaaq Ice Cap. Ice flow speeds are indicated by the arrows.