Drone survey on Qaanaaq Glacier, northwestern Greenland, for studying surface elevation change and supraglacial stream development

Soratakato Yamada[1,2] Shin Sugiyama[1] , Shinta Ukai[1,2,]
[1]*Institute of Low Temperature Science, Hokkaido University*
[2]*Graduate School of Environmental Science, Hokkaido University*

Glaciers and Ice Caps along the coast of Greenland are rapidly losing mass (e.g. Khan et al., 2022). In order to gain a deeper understanding of the processes driving the glacier changes in Greenland, we have been conducting field investigations on Qaanaaq Ice Cap in northwestern Greenland since 2012 (Sugiyama et al., 2014). In 2022, we performed a drone survey for our first time on Qaanaaq Glacier to study surface elevation change and supraglacial streams. Drone survey has the potential to analyze glacier surface with high-resolution images at a relatively low cost. In this presentation, we report a drone survey carried out on Qaanaaq Glacier in the summer of 2023.

Drone surveys in 2023 took place six days between 17th July and 8th August. We used a drone (DJI Phantom4Pro V2.0) equipped with a camera with an 8.8 mm lens. The drone was operated at an altitude of 120 m above the glacier surface, capturing images with a ground resolution of 33mm/pixel. To improve the precision of the survey, we placed painted wooden boards on the glacier and its surroundings as ground control points (GCPs). The GCPs were separated by a distance of about 400 m and surveyed with the kinematic GNSS (Global Navigation Satellite System) positioning technique. Four surveys were carried out in the middle reaches of the ablation area, covering an area of 1.6 km² with elevations ranging from 600 to 800 a.s.l. (Fig. 1). Approximately 1300 images were taken during each survey. Two other surveys covered the downglacier extending to the glacier front as well. The total area and the approximate number of images taken during each of the surveys were 3.3 km² and about 3200.

The acquired images were processed for digital elevation models (DEMs), using Structure-from-Motion (SfM) technology with Agisoft's Metashape software. Orthoimages were generated using the DEMs. The DEMs are compared with surface elevation data obtained by previous GNSS surveys, as well as with those obtained by satellite remote sensing to quantify surface elevation change over the past few decades. We also compare DEMs obtained in 2022 and 2023 for more details of the elevation change. We will present the preliminary results of the surveys and analyses of the data obtained in 2022 and 2023.

Reference

- Khan, S. A., Colgan, W., Neumann, T. A., van den Broeke, M. R., Brunt, K. M., Noël, B., et al. (2022).Accelerating Ice Loss From Peripheral Glaciers in North Greenland. *Geophysical Research Letters,* **49**(12).
- Sugiyama, S., Sakakibara, D., Matsuno, S., Yamaguchi, S., Matoba, S., & Aoki, T. (2014). Initial field observations on Qaanaaq ice cap, northwestern Greenland. *Annals of Glaciology*, **55**(66), 25–33.

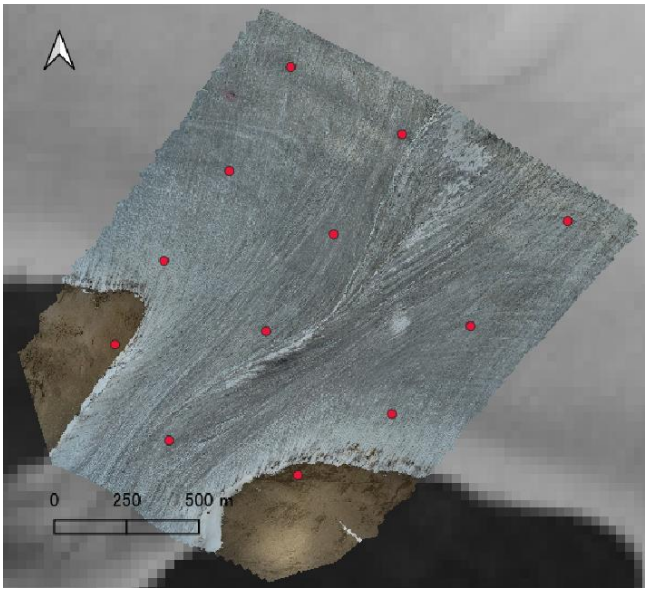

Figure 1.
Orthorectified mosaic image of Qaanaaq Glacier obtained by the drone survey. Red dots indicate the locations of the GCPs used for the analysis.
The background is a Landsat satellite image acquired on 27 August, 2022.