Area change of supraglacial lakes on Tracy and Heilprin Glaciers, northwestern Greenland

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1.Background

Supraglacial lakes form in the ablation and lower accumulation areas on the Greenland ice sheet. Many of the lakes appear in the early to mid-melt season and drain later in the year. The lakes contribute to the increase in ice sheet mass loss by two ways. First, surface melt increases because of the albedo lower than surrounding bare ice. Additionally, rapid drainage events allow plenty of surface meltwater reaches the bed of the ice, which elevates basal water pressures and hence surface ice velocities. Therefore, knowing the supraglacial lake evolution may shed new light on understanding the effect of meltwater on Greenlandic glaciers. Nevertheless, manual mapping of lakes on a satellite image is too laborious to process a number of images over a large area. Here, we used a machine learning technique to measure areal change of supraglacial lakes on Tracy and Heilprin Glaciers in northwestern Greenland (Fig. 1) during the melt season in 2019.

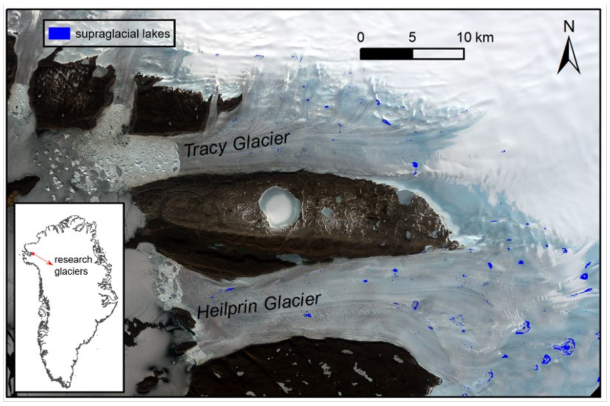

Fig. 1. Map of the study glaciers and the detected supraglacial lakes

2.Data and method

We used Google Earth Engine (GEE) to compile imagery from Landsat 8 top-of-atmosphere reflectance dataset. We selected 32 optical images covering the two glaciers with sun elevation angles greater than 20°. The data covers a period from 1st May to 21st August in 2019. Glacier masks were generated in this study to eliminate sea and land areas from the analysis.

On ten images selected from the list, polygons were generated in GEE for two classes, namely "water" and "non-water". By using the pixels within the polygons as training samples, a classifier to distinguish water on the glacier was established using the random forest algorithm. The classifier was applied to the rest of the imagery to map supraglacial lakes from 1st May to 21st August in 2019. The water body smaller than 5 pixels and narrower than 2 pixels were removed by assuming they are slush or streams rather than lakes).

3. Results and discussion

Area of supraglacial lakes show a similar temporal pattern on Tracy and Heilprin Glaciers (Fig. 2). The lakes appeared in the middle of May and lake area increased sharply in the end of June. After reaching a maximum in early July, the area decreased in August. Despite the similarity in the temporal pattern, the lake area on Heilprin Glacier is obviously higher than Tracy Glacier during the whole research period. This difference may be attributed to the faster ice velocity of Tray Glacier) since supraglacial lakes tend to grow larger and deeper on slower-moving ice[3]). Because of the thick cloud, lake evolution was unavailable in the middle of June, which may be a key period for lake developing. Also, some sharp decreases in Fig.2 are artifacts due to cloud cover (e.g. 1st August).

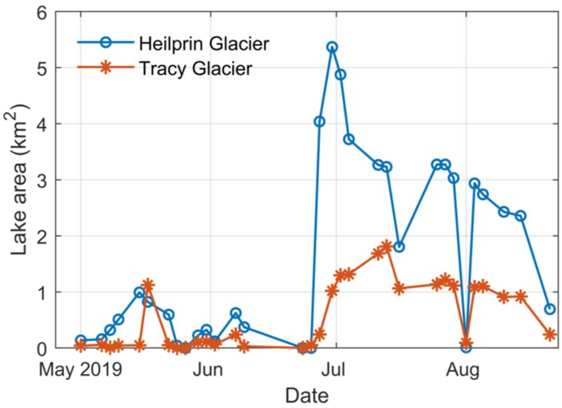

Fig. 2. Evolution of lake area for Heilprin and Tracy Glaciers during the 2019 melt season

4.Outlook

We are going to apply the lake mapping algorithm to images in other years to assess its performance. Analysis of Sentinel-2 image is also planned to increase the temporal resolution. Study results will help us to better understand the effect of lake fill/drainage event on glaciers.

References

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