EGU21-7866
https://doi.org/10.5194/egusphere-egu21-7866
EGU General Assembly 2021

Automated mapping of supraglacial hydrology using Machine Learning

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Mass loss from Greenlandic and Antarctic ice sheets are predicted to be the dominant contribution to global sea level rise in coming years. Supraglacial lakes and channels are thought to play a significant role in ice sheet mass balance by causing the speed-up of grounded ice and weakening, floating ice shelves to the point of collapse. Identifying the location, distribution and life cycle of these hydrological features on both the Greenland and Antarctic ice sheets is therefore important in understanding their present and future contribution to global sea level rise. Supraglacial hydrological features can be easily identified by eye in optical satellite imagery. However, given that there are many thousands of these features, and they appear in many hundreds of satellite images, automated approaches to mapping these features in such images are urgently needed.

Current automated approaches in mapping supraglacial hydrology tend to have high false positive and false negative rates, which are often followed by manual corrections and quality control processes. Given the scale of the data however, methods such as those that require manual post-processing are not feasible for repeat monitoring of surface hydrology at continental scale. Here, we present initial results from our work conducted as part of the 4D Greenland and 4D Antarctica projects, which increases the accuracy of supraglacial lake and channel delineation using Sentinel-2 and Landsat-7/8 imagery, while reducing the need for manual intervention. We use Machine Learning approaches including a Random Forest algorithm trained to recognise water, ice, cloud, rock, shadow, blue-ice and crevassed regions. Both labelled optical imagery and auxiliary data (e.g. digital elevation models) are used in our approach. Our methods are trained and validated using data covering a range of glaciological and climatological conditions, including images of both ice sheets and those acquired at different points during the melt-season. The workflow, developed under Google Cloud Platform, which hosts the entire archive of Sentinel-2 and Landsat-8 data, allows for large-scale application over Greenlandic and Antarctic ice sheets, and is intended for repeated use throughout future melt-seasons.