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Understanding and Predicting the Climate Change for our Planet (1)

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DEEP LEARNING-BASED SUPRAGLACIAL LAKE DEPTH DETECTION ON THE GREENLAND ICE SHEET BY COMBINING ICESAT-2 AND SENTINEL-2 DATA

Abstract

Supraglacial lake volume is an important parameter with respect to understanding the hydrology of the Greenland ice sheet. Previous studies have focussed on mapping the outline of supraglacial lakes using both optical and radar satellites like Sentinel-2 (S2) and Sentinel-1, respectively. The depth of the lakes is known to have high variance, and volume estimates can't be accurately made solely based on the lake extent. Lake depth can be measured using the ICESat-2 (IS2) LiDAR altimeter instrument which captures along track 2D profiles and has a monthly repeating sub-cycle. The IS2 dataset captures only a sparse spatial and temporal record of lake depth. Since supraglacial lakes occur seasonally and change in depth and size rapidly, a dense record both spatially and temporally is desirable. S2 could potentially be exploited to retrieve such a dense record of lake depth. The spectral signature of the lake changes subtly with lake depth. Previously S2 has been used to map supraglacial lake depth through a radiative transfer modeling approach. This approach is limited as it typically only takes single pixel input, not taking into account contextual information about for example: neighboring pixels, terrain, atmospheric conditions, floating ice, shading etc. By taking into account such contextual information, a deep learning approach has the potential of yielding improved results. To the best of our knowledge deep learning has not yet been exploited to model supraglacial lake depth from S2. The proposed method would cover the entire extent of the lakes, unlike the IceSat tracks, and aims to exploit contextual information.

We present a deep learning approach to estimate lake extent and depth based on Sentinel-2 imagery and partial training labels are derived from IS2. The presented results are preliminary. The project, which is part of the ESA Greenland Ice Sheet Climate Change Initiative (ESA GIS CCI+), ends in 2024.