Remote Sensing and Cloud Computing: Determining Lake Ice Phenology using Google Earth Engine and Sentinel-1 SAR Imagery

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ABSTRACT

Monitoring lake ice phenology is crucial for climate modelling and managing the logistics of daily life in remote northern communities. Determining lake ice phenology using *in situ* measurements is costly and time-consuming, and standard remote sensing techniques have substantial processing and storage requirements. This project blends remote sensing and cloud computing to make large-scale lake ice phenology monitoring fast and accessible with minor hardware requirements.

The project runs a dynamic threshold variability method (DVTM) algorithm on the Google Earth Engine (GEE) processing environment. The DVTM requires a single shapefile of up to 10,000 lakes as input, then collects all Sentinel-1 C-band synthetic aperture radar (SAR) acquisitions covering the lakes a given winter season. It then creates a range of thresholds based on how much the backscatter values within the lakes change between Sentinel-1 acquisitions. Whenever the range of thresholds is crossed, the algorithm flags that date as melt or freeze onset for that specific lake.

Algorithm validation has been conducted on three study areas with 400 lakes each and has been focused on the melt onset portion of the algorithm. All three study areas are within the Alaska North Slope. Based on results from the Canadian Lake Ice Model (CLIMo), temperature records from weather stations, ERA5 reanalysis data, and qualitative analysis of Sentinel-1 SAR imagery, the algorithm can accurately determine the melt onset date of 80% of lakes.

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