Monitoring Freshwater Lake Ice Thickness and Ice Bottom Roughness in Central Ontario

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ABSTRACT

Lake ice thickness is an important parameter for understanding hydrological changes and implications in the Northern Hemisphere, yet there is a stark lack of ground-based lake ice data across Canada. Remote sensing techniques are increasingly used to address this void. Satellite-based ice thickness retrievals are becoming more reliable and widely used for Arctic sea ice, however, these methods are not yet viable for most freshwater lakes. Currently, satellite-based lake ice thickness can only be retrieved for very large lakes or small lakes where the ice freezes to the lakebed. Current approaches of lake ice thickness retrieval on other lakes, including those in the mid-latitudes, focus on RADAR backscatter analysis and are working towards accounting for the distortion of the backscatter signal at the ice-water interface, caused by roughness on the underside of the ice layer. To date, there is no field-based method to quantify the roughness of the ice bottom surface in deeper freshwater lakes. Using *in situ* measurements of lake ice thickness, and by measuring roughness from physical imprints of the ice bottom surface, this project aims to identify a correlation between these two characteristics that will better inform how ice bottom roughness impacts total ice thickness on mid-latitude freshwater lakes. Preliminary results from measurements of early-season roughness indicate ice bottom features ranging from 0.010 mm to 2.071 mm in height protruding from the ice bottom surface. Measurements of the total imprint depth per unit area of the ice bottom surface range from 0.198 mm cm^{-2} to 1.323 mm cm^{-2}. Further sampling of ice bottom roughness characteristics is planned to better relate observed roughness characteristics with airborne ice thickness retrievals using Ku-band and L-band RADAR backscatter analysis, towards developing space-based ice thickness retrievals in the future.

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