Monitoring Lake Ice Thickness Changes using Interferometric SAR

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ABSTRACT

Freshwater lake ice thickness is an important observable, both broadly relevant to human activities and a key driver of physical, chemical, and ecological processes in cold regions. In northern regions, where lakes contribute up to 40% of surface area, lake ice data is an especially important input into climatological and meteorological models. The remote nature and sheer number of Canadian lakes – over 900,000 greater than 10 hectares – makes satellite-based observation the only practical comprehensive monitoring method for many systems. Active microwave-band instruments are particularly appealing due to their ability to selectively penetrate cloud and snow cover by modulating the wavelength used; Differential Interferometric Synthetic Aperture Radar (DInSAR) has been proposed as a tool for monitoring ice thickness for some time, but research has been stymied by difficulty in acquiring quality image pairs and temporal coherence loss between pairs.

RADARSAT Constellation Mission (RCM) offers substantially improved revisit times (4-day); we evaluate its potential to overcome these limitations and extract lake ice thickness interferometrically. Interferograms are derived from a set of 5-m resolution compact-polarization images of Kluane Lake and Aishihik Lake, Canada. Topographic phase contributions are simulated using ArcticDEM and removed: resulting ice thickness growth measurements are then compared to thermodynamically simulated values (CLIMo using ERA5 reanalysis as input) and *in situ* measurements from the Kluane Lake Research Station where possible. Mean DInSAR-derived thickness growth shows generally good agreement with these datasets. Phase unwrapping can be complicated by the formation of long, thin zones of low coherence associated with ridging or cracking. These results support the potential use of DInSAR as a tool for high-resolution lake ice thickness monitoring.

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