Spatial Variability of Lake Ice Thickness and Phenology on Sub-Arctic Lakes in Yellowknife, Northwest Territories

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ABSTRACT

Lake ice is a valuable resource to northern communities such as those within the Northwest Territories (NT). Ice roads are constructed on lake ice (e.g., the ice longest road in Yellowknife, NT, spreading over 80 lakes) during winter to haul goods to and from industrial establishments (e.g., mines) and for travel within communities. A major detriment to the ongoing use of ice roads are the changes in duration and thickness of lake ice due to climate warming. Studies show that a one-degree increase or decrease in air temperature leads to a 6-day almost linear change in ice cover duration making it an essential climate variable to monitor. Crucial knowledge on lake ice and temperature is however limited especially in sub-artic lakes due to logistical difficulties in collecting direct measurements. Methods adopted such as one-dimensional lake ice models rely on weather stations/*in situ* data as inputs which are sparse in the NT hence overlook several lakes. To address this limitation, this study uses remote sensing coupled with a thermodynamic lake ice model to monitor the spatial distribution, duration, and thickness of lake ice.

Over 500 small to medium lakes are monitored in this study. To effectively simulate lake ice thickness, an algorithm-based surface temperature for each lake was derived from the thermal bands of Landsat which showed good agreement with *in situ* data (1.88 °C > RMSE > 1.54 °C). Lake surface temperatures generated in addition to variables (wind speed (m s^{-1}), relative humidity (%), snowfall (m), and cloud cover (0-1)) and reanalysis (ERA5) data served as major inputs in the spatially-distributed thermodynamic model applied. Field work was conducted to collect ice thickness measurements across 10 lake sites in Yellowknife to evaluate model output. Output derived from model simulations not only demonstrate changes in lake ice thickness, but also highlights the spatial variability within lakes.

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