Investigating subarctic lake ice formation and growth using a floating research raft

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Freshwater lake ice is a significant transportation asset for communities within the Northwest Territories (NWT), Canada. Lake ice is used by large and small vehicles across these communities on natural (frozen lakes and rivers) and engineered infrastructure (ice roads, crossings, and bridges). However, variability in climate and weather associated with future climate change is predicted to alter the formation, growth, and decay (i.e., evolution) of lake ice covers across the NWT, which could threaten the future viability of Canada's northern transportation. Unfortunately, there is currently limited understanding of how ice covers will respond to these changes, in part due to a scarcity of field measurements in freshwater ice. This is especially emphasized during freeze-up, and during break-up periods, when ice safety concerns are heightened due to inadequate load bearing capacities. To address this knowledge gap, a floating research raft was designed, built, and deployed with an automated ice sensor and auxiliary instrumentation in a small subarctic lake located ~12 km north of Yellowknife within the Baker Creek Research Watershed. The study was conducted between October-December 2022 and the results showed that ice formation and growth were uncharacteristically driven by snow ice production, in contrast to typical thermally driven congelation ice growth, in response to record snowfall in October and November 2022 in Yellowknife. Heavy snowfall led to frequent slushing events resulting in lower density and warm ice, suggesting a reduced load-bearing capacity in the early ice cover season and heightened creep rate dependence. With projected increasing autumnal precipitation in the region, the results of this study could shed insight into a new potential ice formation regime under a continually warming planet. The findings will be crucial in informing future lake ice models and in improving safety measures for transportation across the NWT.