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Response of ice cover on shallow Arctic lakes to contemporary climate conditions: Numerical modeling and remote sensing data analysis

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Lake ice cover has been shown to be a robust indicator of climate variability and change. Recent studies have demonstrated that break-up dates, in particular, have been occurring earlier in many parts of the Northern Hemisphere over the last 50 years in response to warmer climatic conditions in the winter and spring seasons. The impacts of trends in air temperature and winter precipitation over the last five decades and those projected by global climate models will affect the timing and duration of ice cover (and ice thickness) on Arctic lakes. This will likely, in turn, have an important feedback effect on energy, water, and biogeochemical cycling in various regions of the Arctic. In the case of shallow tundra lakes, many of which are less than 3-m deep, warmer climate conditions could result in a smaller fraction of lakes that freeze to their bed in winter since thinner ice covers are expected to develop. Shallow lakes of the coastal plain of northern Alaska, and other similar regions of the Arctic, have likely been experiencing changes in seasonal ice thickness (and phenology) over the last few decades but these have not yet been documented.

This paper presents results from a numerical lake ice modeling experiment and the analysis of ERS-1/2 synthetic aperture radar (SAR) data to elucidate the response of ice cover (thickness, freezing to bed, and phenology) on shallow lakes of the North Slope of Alaska (NSA)to climate conditions over the last three decades. New downscaled data specific for the Arctic domain (at a resolution of 0.44 degrees using ERA Interim Reanalysis as boundary condition) produced by the Rossby Centre regional atmospheric model (RCA4) was used to force the Canadian Lake Ice Model (CLIMo) for the period 1979-2010. Output from CLIMo included freeze-up and break-up dates as well as ice thickness on a daily basis. ERS-1/2 data was used to map areas of shallow lakes that freeze to bed and when this happens (timing) in winter for the period 1991-2010. Preliminary results from a sub-region of the NSA show that the interannual variability in ice thickness simulated with CLIMo match well that of the fraction of lakes that freeze to their bed in winter as determined from the analysis of SAR data.