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Estimation of ice thickness on large lakes from passive microwave and radar altimeter data

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Lake ice grows steadily between the end of freeze-up period and the onset of break-up period as a result of the thermodynamics of freezing water as well as dynamic ice motion on the surface. In thermodynamic thickening, the conductive heat flow controls the ice growth rate and the ice thickness, and the ice thickens downward as a result of heat loss at the top of the ice cover. There has been some demonstration of the potential of brightness temperature from passive microwave airborne radiometers to estimate ice thickness. The value of passive microwave and radar altimeter data from current satellite missions merits to be examined in this respect.

The major objective of this study was estimate ice thickness from brightness temperature (TB) at 10.65 and 18.70 GHz from AMSR-E channels and the 19.35 GHz frequency channel from SSM/I on large lakes of the Northern Hemisphere (e.g. Great Bear Lake, Great Slave Lake, Lake Baikal). The evolution of horizontally and vertically polarized TB derived from AMSR-E level 2A raw brightness temperature and EASE Grid Level-3 SSM/I products was compared with ice thicknesses obtained with a previously validated thermodynamic lake ice model and in situ observations over the course of seven winter seasons (2002 and 2009), as well as with recent estimates from the Jason-2 Ku-band radar altimeter data (since 2008). Results show that both passive microwave and radar altimeter data acquired in the 10-19 GHz frequency range offer a promising means for estimating ice thickness from large northern lakes.