Monitoring Great Lakes Ice Cover With Spaceborne Radars

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This paper presents results of algorithm development for the detection and classification of Great Lakes (fresh water) ice cover using spaceborne radars. Applications of radar mapping of Great Lakes ice cover includes marine resource management, lake fisheries and ecosystem studies, natural hazards such as ice jams and flooding, shipping and hydropower industries, and Great Lakes climatology. Satellite wide-swath scatterometers provide large areal coverage with high temporal resolution data to map Great Lakes ice cover. They compliment the high spatial but lower temporal resolution of satellite synthetic aperture radar (SAR) data. The approach is to use polarimetric C-band radar backscatter measurements and in situ data from our 1997 Great Lakes winter experiments (GLAWEX 1997) in conjunction with concurrent satellite SAR data from ERS-2 and RADARSAT-1 and scatterometer data from NSCAT to develop lake ice classification and mapping algorithms. When applied to the calibrated ERS-2 and RADARSAT-1 scenes of the same area, the library of backscatter signatures produced similar classification results. Based on the SAR classification, an ice mapping algorithm is developed using first the NSCAT data acquired during GLAWEX 1997 and then SeaWinds data currently operational on the QuikSCAT satellite. Examples using data over Great Bear Lake in Canada and Lake Superior in the Great Lakes are used to define periods of open water, freeze-up, and break-up. Verification of the ice mapping results are carried out with in-situ observations from US Coast Guard (USCG) icebreaker vessels operating on the Great Lakes. In addition, we installed a web camera to monitor ice cover over an area in Lake Superior to verify time-series scatterometer results obtained from QuikSCAT data. Moreover, the polarimetric radar backscatter measurements acquired during GLAWEX 1997 reveal that multi-polarization backscatter data (such as that from ENVISAT at large incidence angles) for the typical snow-covered snow ice on lake ice in the Great Lakes can be used to map ice and open water without the ambiguity encountered in single polarization data due to variations in wind speed over water.