RADAR REMOTE SENSING OF GREAT LAKES ICE COVER

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This paper presents remote sensing of Great Lakes ice cover using various classes of radars including scatterometer, polarimetric Synthetic Aperture Radar (SAR), and interferometric SAR. Applications of radar mapping of Great Lakes ice cover includes marine resource management, lake fisheries and ecosystem study, natural hazards such as ice jam 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 resolution of satellite SAR data with low temporal resolution. The approach is to use in-situ and ground truth measurements 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 determine scatterometer backscatter signatures of lake ice. The backscatter signatures are used as a library to develop the an ice mapping algorithm using first the NSCAT data acquired during GLAWEX 1997 and then SeaWinds data (currently operational on the QuikSCAT satellite). 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 under the jurisdiction of the Ninth Coast Guard District. 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, polarimetric radar backscatter measurements from a USCG icebreaker acquired during GLAWEX 1997 reveal that multi-polarization backscatter data 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. During our 2002 winter experiment (GLAWEX 2002) NASA AIRSAR C-band and L-band polarimetric and interferometric measurements are collected over Lake Superior, northern Lake Michigan, and Lake Erie together with in-situ field observations. Polarimetric C-band SAR data obtained form GLAWEX 1997 (shipborne radar) and GLAWEX 2002 (airborne SAR) are used to develop multi-polarization algorithms in view of ENVISAT and RADARSAT-2 multi-polarization SAR applications to lake ice mapping. Furthermore, interferometric SAR data acquired during GLAWEX 2002 are used to evaluate the utility of interferometric SAR data for three-dimensional mapping for lake ice including areal coverage and thickness. Note that lake ice does not contain salinity, unlike sea ice, allowing microwave to propagate into lake ice unless the surface is wet due to melting. GLAWEX 2002 is a large-scale experiment including in-situ observations by webcam with all azimuth coverage, in-situ measurements from ship, air reconnaissance from helicopter, polarimetric and interferometric SAR from NASA DC-8 aircraft, satellite QuikSCAT/SeaWinds scatterometer, and satellite RADARSAT SAR and ENVISAT SAR (pending on ENVISAT launch).