Algorithm Development for Satellite Synthetic Aperture Radar (SAR) Classification and Mapping of Great Lakes Ice Cover

G. A. LESHKEVICH[1], S. V. NGHIEM[2], and R. KWOK[2]

[1]Great Lakes Environmental Research Laboratory
National Oceanic and Atmospheric Administration
2205 Commonwealth Blvd., Ann Arbor, Michigan 48105, U.S.A.
Tel: 734-741-2265, Fax: 734-741-2055, E-mail:leshkevich@glerl.noaa.gov

[2]Jet Propulsion Laboratory, California Institute of Technology, MS 300-235
4800 Oak Grove Drive, Pasadena, California 91109, U.S.A.
Tel: 818-354-2982, Fax: 818-393-3077, E-mail: nghiem@solar.jpl.nasa.gov

The Laurentian Great Lakes, having the world's largest freshwater surface covering an area of 245,000 km^2, contributes significantly to the economic and social activities of North America. Ice cover on the Great Lakes, the most obvious seasonal transformation in the physical characteristics of the lakes, has a major impact on the regional climate, ecology, commerce, and public safety. Many practical applications such as winter navigation, shore structure protection, hydropower generation, lake ecology, and potential flooding caused by ice jams necessitate monitoring and mapping the ice cover from space.

Owing to the size and extent of the Great Lakes and the variety of ice types and features found there, the timely and objective qualities inherent in computer processing of satellite data make it well suited for such purpose. However, during winter months cloud cover over the Great Lakes impairs the use of satellite imagery from passive sensors operating in the visible, near infrared, and thermal infrared regions and passive microwave data lacks the spatial resolution required for ice cover monitoring and analysis. The all-weather, day/night viewing capability of satellite Synthetic Aperture Radar (SAR) makes it a unique and valuable tool for Great Lakes ice identification and mapping providing that data analysis techniques and capability for using SAR data in an operational setting can be developed. The European Remote-Sensing Satellite (ERS-1) launched in 1991 and more recently RADARSAT, an operational satellite carrying a SAR operating at 5.3 GHz (C-Band) with a horizontal polarization launched in 1995, provide an opportunity for this development. This study explores algorithms for Great Lakes ice cover classification and mapping using satellite SAR data.

Preliminary computer analysis of a ERS-1 and RADARSAT ScanSAR narrow images of the Great Lakes using a supervised (level slicing) classification technique indicates that different ice types in the ice cover can be identified and mapped and that wind speed and direction can have a strong influence on the backscatter from open water. During the 1997 winter season, shipborne polarimetric backscatter data using the Jet Propulsion Laboratory (JPL) C-band scatterometer, together with surface-based ice physical characterization measurements and environmental parameters were acquired concurrently with RADARSAT and ERS-2 overpass. This data set was processed to radar cross-section and will establish a library of signatures (look-up table) for different ice types to be used in the machine classification of calibrated satellite SAR data.