C-Band Polarimetric Backscatter Observations of Great Lakes Ice

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For applications to radar remote sensing of the Great Lakes ice cover, we conducted two experiments during the 1997 winter season across the Straits of Mackinac and Lake Superior. The particular objective of these experiments is to measure radar backscatter signatures of various ice types and open water together with ground truth data to establish a backscatter library that can be used to translate Synthetic Aperture Radar (SAR) data into ice maps. The experimental campaign was coordinated into two expeditions on two different United States Coast Guard (USCG) Ice Breaker vessels, the Biscayne Bay in February and the Mackinaw (an Arctic-class ice breaker) in March.

In these experiments, the Jet Propulsion Laboratory C-band polarimetric scatterometer was used to obtain radar data at the same frequency band, incident angles, and polarizations of operating satellite SARs such as RADARSAT and ERS or future multi-polarization SARs such as ENVISAT. During the experiments, ice truth data for different ice types were obtained and accurate radar calibration measurements were conducted. We acquired backscatter signatures of various ice types with different physical conditions, feature scale, thickness, snow cover, and concentration. Measured backscatter data of typical snow covered lake ice indicate that the horizontal backscatter is larger than the vertical backscatter especially at larger incident angles. Radar data of the typical lake ice type taken in March along the ship track show that C-band waves can propagate more than 1 m in the ice. For deformed ice in a rubble field, the backscatter is very strong across the range of incident angles (20-60 degrees). Backscatter of pancake ice has a steep slope as a function of incident angle and the complex copolarized polarimetric correlation coefficient has a small magnitude at large incident angles. Black ice with a thin snow cover has low backscatter with a strong decreasing gradient in incident angle. The polarimetric scatterometer data set is useful for the development of the Great Lakes ice mapping algorithm. Furthermore, this data set can be used to determine which ice type can be observed for a given set of operating parameters of a satellite SAR, such as the system noise floor, polarizations, and incident angles.