ON EVALUATING THE ACCURACY OF SAR SEA-ICE CLASSIFICATION USING MULTIFREQUENCY POLARIMETRIC AIRSAIL DATA

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We investigate how multifrequency and polarimetric synthetic aperture aperture radar (SAR) imagery enhances present capability to discriminate different ice conditions in single-frequency, single-polarization satellite SAR data. Frequencies considered are C-($\lambda = 5.6cm$), L-($\lambda = 24cm$) and P-($\lambda = 68cm$) band. Radar backscatter characteristics of six radiometrically and polarimetrically distinct ice types are selected from a cluster analysis of the multifrequency polarimetric SAR data and used to classify SAIL images. Validation of these ice conditions is based on information provided by aerial photos, weather and ice surface measurements acquired at an ice camp, together with airborne passive microwave imagery, and visual analysis of the SAR data. The six identified sea-ice types are: 1) multiyear sea-ice; 2) compressed first year ice; 3) first year rubble and ridges; 4) first year rough ice; 5) first year smooth ice; and 6) thin ice. Open water is absent in all analyzed data. Classification of the SAR imagery into those six ice types is performed using a Bayesian Maximum A Posteriori classifier. Two complete scenes acquired at different dates in different locations are classified. The scenes were chosen such that they are representative of typical ice conditions in the Beaufort sea in March 1988 and because ancillary information is available for validating the segmentation of various ice surface conditions.

Maximum ice discrimination is achieved with combined C- and L-band fully polarimetric data. P-band is not used because it reduces the segmentation quality for thin ice of low backscatter. Overall classification accuracy is estimated to be greater than 90% in the two scenes analyzed. C-band VV-polarization alone achieves only 67% classification accuracy relative to the classification obtained at L- and C-band fully polarimetric because it confuses multiyear sea ice and rough, compressed, thick first-year ice surrounding the multiyear ice floes. Relative classification accuracy is increased by 7% with one other polarization and is 76% with C-band full polarimetry. Single frequency, L-band relative classification accuracy is 75% using HH-polarization and 84% using HH- and VV-polarizations combined. The full polarimetry yields a 1% drop in accuracy because HV-polarization increases confusion between multiyear and rough first-year ice. P-band accuracy is 70% using HH- and VV-polarizations combined, and 58% with the full polarimetry as many ice types have similar HV backscatter. Combinations of two frequencies at a single polarization show the greatest improvement over a single channel. With a relative accuracy of 90%, L-band HH-polarization and C-band VV-polarization together are nearly equivalent to L- and C-band fully polarimetric data, thus illustrating a combination of ERS-1 and J-ERS-1 SAR imagery.

The classification results are used to predict the level of performance of ERS-1, J-NILS-I, and RadarSat for mapping ice types during similar weather and ice conditions. ERS-1 is shown to overestimate the multiyear ice fraction although it may provide reliable estimates of the thick and of the thin ice fractions. Finally, the results stress the importance of accounting for the fraction of deformed first-year ice with greater precision in order to gain confidence in the sea ice concentration derived from SAR data and perform finer multisensory comparisons.