Polarimetric C-band SAR Observations of Sea Ice in the Greenland Sea

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Synthetic Aperture Radar (SAR) has been used to map sea ice for operational applications and climatic studies. Current and future satellite SARs such as ERS, RADARSAT, and ENVISAT operate at different polarisations. Hence, the SAR data cannot be directly compared without understanding the effect of polarisational dependence. Also different meteorological conditions can have a significant impact on measured backscatter levels of sea ice and open water that often cause ambiguity in identifying the correct ice type. Polarimetric SAR can improve ice analyses due to the increased amount of independent information. Since polarimetric SAR is able to synthesize any polarisation, studies of polarimetric signatures are important for development of future applications of multichannel SAR systems. The Danish airborne system EMISAR has, as the only system so far, acquired C-band polarimetric SAR data of sea ice in the Greenland Sea. The observations obtained with EMISAR have much higher spatial (2 meter) and radiometric resolution (0.1 dB relative) and a lower noise equivalent backscatter (-38 dB) compared to previous airborne systems. The high resolution allows small areas of ice to be analyzed and limits the mixing of different ice types.

We present observations from March 1995 of the marginal ice zone in the Greenland Sea. We have analysed the co-polarisation (HH and VV) and the cross-polarisation (HV) backscatter levels, HH/VV backscatter ratios, and complex correlation between HH and VV channels in terms of correlation coefficient and phase difference. A unique map of the polarimetric delta parameter, defined on the basis of symmetry, is analysed in order to evalute preferred structural alignments of surface or volume. The delta parameter is a function of the absolute correlation coefficient and the cross polarisation backscatter ratio. The observations are compared to modelled polarimetric signatures of ice types found in the region. We compare this data with contemporaneous ERS and AVHRR observations. The polarimetric SAR study shows that (1) co-polarisation phase difference can be used for seperating water and different ranges of thin ice, and (2) different types of symmetries in the scattering mechanisms can be detected and used to seperate in particular frazil and congelation ice in newly formed leads and open water. We also find that (3) co-polarisation ratio is useful for separating multiyear ice from rough thin ice and open water. We relate the observed phase difference of thin ice to its anisotropic behaviour. Furthermore, different values of delta result from different symmetrical properties related to the columnar growth structure of ice or the directional structure of water waves. These properties help to eliminate some of the ambiguities in SAR data analyses of sea ice.