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Analysis of WindSat Measured Polarimetric Microwave Brightness Temperatures over Sea Ice

Parag S. Narvekar (1), Georg Heygster (1), Rasmus Tonboe (2), Thomas J. Jackson (3) and Rajat Bindlish (3)

(1) Institute of Environmental Physics, Bremen University, Germany (narvekar@iup.physik.uni-bremen.de / narvekar@hydrolab.arsusda.gov / Phone: +49 421-218-4274), (2) Danish Meteorological Institute, Denmark, (3) Hydrology and Remote Sensing Lab., USDA, Maryland, USA

WindSat is the first radiometer that acquires fully polarimetric microwave measurements of the Earth's surface from space. It was developed primarily for ocean surface wind vector retrievals, however it also provides measurements over land, snow and sea ice. This has created an opportunity to investigate the polarimetric signature over different land types, snow/ice and sea ice covers. WindSat data is provided at 6.8 and 23.8 GHz with vertical and horizontal polarizations (the first two components of the Stokes vector) and at 10.7, 18.7, and 37 GHz with all four components of the Stokes vector. The 3^{rd} and 4^{th} Stokes components are the correlations between the first two components. Passive microwave polarimetry has been well exploited and theoretically well developed for the sea surface wind vector retrievals. However, other types of target such as land surfaces, snow and sea ice have not been rigorously investigated due to the lack of polarimetric observations. Some recent studies have investigated WindSat data over different land surface types and snow covered regions of Antarctica. These studies have shown a clear azimuthally anisotropic response in the 3^{rd} and 4^{th} Stokes component, which can be related to the orientation of slopes and surface structures at various scales. To extend these studies to sea ice and to investigate the new information present in polarimetric channels, areas with different sea ice types in the Arctic were selected. Previous theoretical studies predict that the cause of a non-zero 3^{rd} and 4^{th} Stokes component can be due to the orientation of the c-axis of the sea ice crystals. It has been discussed that the c-axis can align over a large area and the direction of the alignment and is expected to correlate with the mean direction

of the current flow. Also the percentage of alignment may change from one layer to another. However, the exact dimensions of the area over which these alignments may take place has not been described. In the present work, uniform ice coverage areas of size 1ž latitude and 5ž longitude ($\sim$ 100 km x 100 km) were chosen. Azimuthal and time series analysis of the 3^{rd} and 4^{th} Stokes components were performed to investigate their response to spatial and seasonal variability of snow and sea ice. The horizontal and vertical channels are used as references. The paper presents analyses based on previously developed theory for the polarimetric emission from sea ice.