POLARIMETRIC RADIOMETRY AND OCEAN SURFACE WIND VECTOR:

FROM WINDSAT TO CMIS

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ABSTRACT

The concept of polarimetric radiometry has been advanced over the last two decades as a means of observing the ocean surface wind vector. The concept hinges on the fact that the first and second Stokes parameters are even functions of wind direction (centered on the upwind direction) while the third and fourth Stokes parameters are odd functions of wind direction. Taken together then, these measurements showed potential for unambiguous wind vector retrieval. The challenge was to determine if the polarimetric signal is large enough to measure from space and robust in the presence of weather. Airborne xperiments carried out by several collaborating groups produced a data set that, while limited, provided observations over a reasonable range of surface and atmospheric conditions. This collection of data indicated that the signal strength reached 3K peak-to-peak and provided the basis for development of early experimental surface models and retrieval algorithms. These models provided the basis for developing requirements for a space borne polarimetric radiometer. This paper will provide an overview of the polarimetric radiometry concept as it relates to ocean surface wind vector.

In January of 2003 the Coriolis spacecraft was launched carrying WindSat, the first spaceborne radiometer to be fully polarimetric at 18.7, 23.8, and 37 GHz. The WindSat instrument was built by the US Naval Research Laboratory, supported by the US Navy, the US National Polar-orbiting Operational Environmental Satellite System (NPOESS), and the US Air Force Space Test Program. The WindSat mission goal is to provide a space borne demonstration of the passive polarimetric technique for measuring ocean surface wind vector, and to determine if these measurements can meet operational defense and civilian meteorological requirements. The Coriolis/WindSat mission also serves as a pathfinder for the operational Conical Microwave Imager and Sounder (CMIS), a key instrument in the operational NPOESS sensor suite.

The WindSat Calibration/Validation team has demonstrated the capability of WindSat to measure an ocean surface polarimetric signal of sufficient strength to retrieve wind vector, globally, under a broad range of weather conditions. In addition to surface wind vector, the WindSat system also provides retrievals of atmospheric water vapor, cloud liquid water, and sea surface temperature. Investigations into the polarimetric signal from land, snow and ice are ongoing to determine if improvements to heritage algorithms may be achieved over these scenes as well. This paper will present the latest models of the surface polarimetric signal, wind vector retrieval performance and ambiguity selection skill achieved by the WindSat system.

The CMIS sensor is currently in development for launch on the first operational NPOESS platform. The CMIS system combines the surface sensing capability of WindSat with conical atmospheric sounding capability. This paper will present the lessons learned from WindSat and the flow of these lessons into the CMIS sensor and algorithm development. These lessons include the surface wind signal strength, the performance and characterization requirements for antenna polarization and receiver cross-talk, calibration target concerns, and observations of Radio Frequency Interference (RFI) in the lower frequency channels over the US, Europe and India.