Polarimetric Ku-Band Scatterometer for High Accuracy, Large Swath Global Wind Vector Measurements

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In the past, wind measurements from space using fan-beam antennas, such as Seasat Scatterometer (SASS-1), ERS-1 &2, and NASA scatterometer (NSCAT), required up to six large stick-like antennas and suffered a nadir gap of up to 400 km. In the near future, a spinning pencil-beam scatterometer system is to be used for the SeaWinds scatterometer on QuikSCAT (QSCAT) and on ADEOS-2 (SeaWinds). This scatterometer, though offering wind measurements in the nadir region, still suffers from degraded performance in the nadir and outer swath.

The purpose of this paper is to present an advanced polarimetric spinning pencil-beam scatterometer system, which can significantly improve the wind performance across the entire swath. The polarimetric scatterometer simultaneously measure co-polarized backscatter and the polarimetric correlation of co- and cross-polarized radar returns from the ocean surface. The advantage over the conventional scatterometer system is that, while the co-polarization radar returns are even function of the wind direction, the polarimetric correlation is an odd function of wind direction due to the reflection symmetry of the wind roughened surface. Therefore, this polarimetric scatterometer system can provide additional, equivalent measurements at azimuth angle 45° away from the corresponding co-polarization measurements. The combined co-polarization and correlation measurements enable good wind performance across the whole swath to be obtained.

In this paper, we will first present the theoretical formulation of all of the key components required for designing a polarimetric scatterometer. Then, we show that good wind performance can be achieved by a slight improvement in the signal-to-noise ratio of the current QSCAT/SeaWinds design. We then present the predicated wind performance using computer simulation based on a model function for the co-polarized backscatter obtained from actual spaceborne scatterometer data and an estimated model function for the polarimetric correlation based on the asymmetry observed in backscatter data. Finally, we will show that, aside from ocean applications, this polarimetric scatterometer can also be used for ice and land applications.