Ku-band Polarization Difference Model From SCAT Measurements

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Résumé

The CFOSAT mission provides a unique data set of collocated nadir, near-nadir, and moderate angle dual-polarization Ku-band radar measurements. These resulting collocated data sets for wind and wave observations, and this original multi-incidence and azimuthal radar configuration, provide unique opportunities to investigate the sea state impacts on the satellite radar wind estimates. In this work, we propose a theoretical framework to help refine the analysis of sea surface backscatter properties and to extend the wind vector inversion algorithm.
Usually, Geophysical Model Functions (GMFs) are derived to describe relationships between Normalized Radar Backscattering Cross-Section (NRSC) mean and spectral properties with ocean sea surface statistical and forcing properties. For wind scatterometry, the robust derivation of the GMF is the key element for the wind vector inversion algorithm, describing the sensitivity of the averaged NRSC properties, at each incidence and observation azimuth, with wind speed and/or direction changes. As a common practice, for each new instrument, a GMF is derived from massive collocations of radar measurements with global wind model outputs and offshore buoy network data. For Ku-band instrument, a reference GMF is the NSCAT-4 GMF which directly relates NRSC with wind speed and direction [Wentz and. Smith 1999]. Very efficient, however, this empirical approach can still suffer to cover all environmental conditions, e.g. non-stationary sea state, sea surface current, sea surface temperature, presence of biological films, etc.

The present work describes an alternative GMF approach, based on the differing polarization sensitivity of backscatter Ku-band signals. This approach is indeed anticipated to quantitatively separate the measured roughness variations between changes associated with denser breaking patches and purely resonant short-scale scatter modulations [Kudryavtsev et al. 2014]. Polarization sensitivity, i.e. the difference between vertically (VV) and horizontally (HH) polarized radar signals, is indeed characteristic of a resonant scattering mechanism mostly governed by small surface scales. This strategy can then build on the use of semi-empirical short wind spectra, e.g. [Kudryavtsev et al. 2003, Yurovskaya et al. 2013, Kudryavtsev et al. 2014] .
Based on CFOSAT measurements, the polarization-difference GMF reproduces the main properties of standard empirical radar GMFs. However, it is more directly related to a theoretical short wave spectral model. This approach naturally enables the inclusion of additional sea state variables. Results of this work are intended to be implemented in wind retrieval processors to complement existing methods.

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