

On the Uncertainties of Typhoon Surface Wind Speed Retrieved from Simulated GNSS-R Delay-Doppler Maps

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Abstract

Global Navigation Satellite System-Reflectometry (GNSS-R) is an innovative Earth observation technique that exploits signal from satellite constellations after reflection on the Earth surface. The GNSS-R techniques is also known to have the potential of mapping the surface wind speed up to 70 m/s, and thus provide a promising solution. Abundant real-time data of the typhoon surface wind speed will play the crucial role on the improvement of typhoon intensification forecasting.

The aim of present study is to investigate the influences of high wind speed and the corresponding giant waves during typhoon to the GNSS-R wind speed retrieval algorithms. The Mean Square Slope that altered by the complex wave directionality is discussed. Finally, the uncertainties of wind speed retrieval with respect to the influences of wave directionality is assessed.

The level 1 product from the GNSS-R receiver is a map of GPS signal power scattered from the sea surface, as a 2D function of delay and Doppler frequency, which is known as a Delay-Doppler Map, or DDM. Based on Zavorotny-Voronovich model, the DDMs are simulated from the Directional Mean Square Slope (DMSS) that obtained from the combination of capillary wave spectra and gravity wave spectra. The gravity wave spectra were calculated using a 3rd generation numerical wave model that driven by the Dujuan typhoon (2015) wind fields with super-fine resolution. The complexity of directional wave spectrum, such as extreme spatial heterogeneity, bimodal spectra and varying directional spreading alter the DMSS and DDM. Various observables, e.g. – DDM Average (DDMA), and Leading Edge Slope (LES) are then applied to the simulated DDM. Regression-based wind retrievals are developed for each individual observable using empirical geophysical model functions. The wind speed retrieval in case of Dujuan typhoon are compared with the target data uncertainty assessment.

Key word: GNSS-R, DDM, Typhoon, Sea Surface Wind speed, Z-V Model, Wave Directional Spectrum