Ocean Surface Wind Vector Measurements from High-Altitude Aircraft Using GPS Delay-Doppler Maps

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Reflectometry of opportunity signals such as Global Positioning Satellites System, known as GNSS-R, has been developed in the last years as a technique with a great potential for ocean scatterometry, among other applications. Different approaches have been proposed to use GNSS-R for remote sensing of the ocean surface roughness. One of them is based on deriving some descriptor/metric from the measured delay-Doppler map (DDM) and directly relating it to a geophysical property of the scattering surface. For instance, different descriptors have been proposed in the literature to measure the DDM spreading caused by increase in ocean surface mean square slopes due to surface winds.

In this work a new descriptor based on the DDM is proposed for wind direction retrieval. The inspection of DDM data obtained during the NOAA aircraft experiment revealed a DDM asymmetry that appeared to be related to two directional parameters of the problem, namely wind direction and receiver's direction. This descriptor, named as skew angle (φ_{skew}), measures the asymmetry in the DDM power distribution along the Doppler frequency axis, and it was modeled as a function of wind direction by means of a simulation study. Then, that model was validated using real GNSS-R data from an airborne experiment. After validation, the DDM skewness model was successfully used for wind direction retrieval with a resulting *RMS* error of the order of 20º.

The main limitation of the proposed technique appears to be an insufficiently high SNR of the measurements with a low-gain down-looking antenna. Since the DDM skewness caused by wind direction is observed in the lower power region of the DDM (from -4 dB to -8 dB w.r.t. the DDM peak), wind direction retrievals are more sensitive to noise than wind speed retrievals which are based on the higher power region of the DDM.