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Laboratory modeling of depolarized radar return at strong and hurricane winds

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The accuracy of modeling and operational forecasting of storm events strongly depends on quality of data. The prevailing methods of monitoring wind speeds and directions over sea surface, which is vital for storm forecasting, employ satellite based scatterometers (satellites MetOp and, before 2009, QuikSCAT). The principal difficulty of the existing algorithms of retrieving wind based on dependence of microwave backscattering cross-section on wind speed (Geophysical Model Function GMF) is due to its saturation at winds exceeding 25 m/s. Then the accuracy of wind speed retrieval cease for very strong winds. Recently analysis of dual- and quad-polarization observations by satellite Radarsat-1 carried out with co-located concomitant direct measurements of wind from oceanographic buoys NDBC [1], suggested that the cross-polarization GMF does not saturate for higher winds. However it is not straightforward to build a new wind retrieving algorithm upon this very promising observation. Co-located simultaneous observations from satellites and buoys are very rare, and at present there are no reported observations for wind speeds exceeding 26 m/s. Then, a promising approach is related to the laboratory modeling of microwave scattering sea surface in a strong wind.
This paper presents preliminary data of laboratory experiments on a high-speed wind-wave flume of Institute of Applied Physics, which are devoted to the investigation of the X-band co-polarized and depolarized (de-pol) radar return in a wide range of high speeds (from 8 to 40 m/s).
Experiments have shown that the de-pol return at an equivalent 10 m-wind speed less than 30 m/s grows proportionally to the third degree of wind speed, as well as in field conditions [1]. At wind speeds exceeding 30 m / s, the de-pol radar return growth slows down and becomes linear with the wind speed. In this case, in the same time the co-pol radar return decreases slowly with increasing wind speed.
Doppler spectra of radar returns at co- and cross- polarizations were investigated. Analysis of the Doppler spectra shows, that at wind speeds exceeding 14 m/s, peaks corresponding to the Bragg resonant surface waves are not observed in the spectra of radar return. Smooth peaks of the wide Doppler spectra of radar returns corresponds to the equivalent velocity of the effective Doppler scatters essentially exceeding the phase velocity of the dominant wave in the wind wave spectra, that seems to be evidence of contribution of scattering by sprays. Based on laboratory experiments proposed the Geophysical Model Function, applicable in a wide range of speeds (up to 40 m/s) is suggested.

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References

1. Zhang, Biao, William Perrie, 2012: Cross-Polarized Synthetic Aperture Radar: A New Potential Measurement Technique for Hurricanes. Bull. Amer. Meteor. Soc., 93, 531–541.