EMS Annual Meeting Abstracts
Vol. 10, EMS2013-366, 2013
13th EMS / 11th ECAM

Small-scale atmosphere-ocean coupling in gale-force winds: models, experiments, remote sensing.

Yu. Troitskaya (1,2), D. Sergeev (1,2), A. Ermoshkin (1,2), A. Kandaurov (1,2), E. Ezhova (1,2)

(1) Institute of Applied Physics, Nonlinear Oscillations and waves, Nizhny Novgorod, Russian Federation (yuliya@hydro.appl.sci-nnov.ru), (2) N.I. Lobachevski State University of Nizhniy Novgorod, Russia

One of the most important factors determining the dynamics of polar and tropical storms over the sea, is the coupling of atmospheric and oceanic boundary layers. Quantitative characteristic of this interaction is the drag coefficient of the sea surface. On the basis of recent measurements of wind speed and turbulence when flying through tropical cyclones at low altitudes, as well as with falling GPS-probe discovered the phenomenon of decline (or saturation), the drag coefficient with gale-force wind (the effect of the crisis resistance).

Possible mechanisms of reduction (saturation), the drag coefficient of the sea surface are summarized. We discuss the details of new laboratory experiments to study the drag surface of the water in a strong wind, which found a tendency to saturation coefficient of resistance in hurricane wind speed. The quantitative explanation of the effect of saturation drag in the quasi-linear model of a turbulent boundary layer over the rough surface of the water, taking into account the contribution of the high-frequency part of the spectrum of excitement in the aerodynamic resistance of the surface water is suggested.

The effect of the spray on the momentum exchange in the atmospheric boundary layer over the sea is discussed within a stochastic model of the "life cycle" of a droplet torn off from the crest of a steep surface wave and then falling into the water, based on the use of a Markovian chain used for description of the interaction of water droplets in the atmospheric boundary layer with turbulent fluctuations. The preliminary data on laboratory experiments at the high-speed wind- wave flume to investigate the mechanisms of injection of water droplets in the wind flow based on the conduct of high-speed video are presented.

The possibilities of active microwave remote diagnostics of wind speed in the storm and hurricane are discussed. 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 30m/s, the de-pol radar return growth slows down and becomes linear with the wind speed. Based on laboratory experiments the de-pol GMF, applicable in a wide range of speeds (up to 40 m / s) is suggested.

This work was supported by a grant from the Government of the Russian Federation under Contract no. 11.G34.31.0048; the European Research Council Advanced Grant, FP7-IDEAS, 227915; RFBF grant 13-05-00865-, 13-05-12093-ofi-m, 12-05-01064, 12-05-31435 mol_a, 12-05-12-05-33070 mol_a_ved, Federal Target Program “Research and scientific-pedagogical cadres of Innovative Russia” for 2009–2013 GK 14.132.21.1384, GK № 16.740.11.0673.