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Effect of sea drops on surface drag and atmospheric boundary layer

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This study is focused on investigation of the effect of sea drops on the atmospheric boundary layer dynamics and the sea surface drag. Sea drops are mainly produced by two mechanisms: bursting of the air bubbles at the surface (bubble drops), and by wind tearing of wave crests (spume drops). Both these mechanisms are related to the wave breaking process. We show that the overall production of the spume drops is defined by the total length of wave breaking crests. To define the typical radius of the spume drops, we follow the Kolmogorov's (1949) idea that the surface tension prevents bubbles/drops disruption by inertial forces linked to the TKE dissipation.

We suggest that the spume drops, being torn off from breaking crests and sprayed inside the turbulent airflow, affect its dynamics through (i) buoyancy forces in the TKE balance equation (thus drops as heavy particles affect turbulent mixing), and (ii) increases of the effective density of the airflow (the air-water mixture) and modification of its momentum balance. Results of model simulations are presented. We show that high wind conditions (at wind above 25m/s) intensive production of spume drops significantly affects the airflow dynamics resulting in acceleration of the airflow, and suppression of the turbulence and the surface drag. At highest wind speeds (geostrophic wind speeds 50–80 m/s) the model actually predicts an effect of the "slippery surface" when the drag coefficient is reduced in about 10 times. A comparison with available observations is given.