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Laboratory investigation of separate bag-breakup event during sea-spray production at hurricane winds

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Sea sprays are typical element of the marine atmospheric boundary layer of important environmental effect. There are still significant uncertainties in estimations of these effects due to insufficient knowledge on the sea spray generation function. The reason for that are difficulties of direct measurements and insufficient knowledge about the mechanisms of the spume droplet's formation. This study is concerned with the laboratory experiments for identification of mechanisms due to which a strong wind tears off water from the crest of the waves made at the high-speed wind-wave flume of IAP RAS. Statistical analysis of number of these phenomena at different winds showed that the "bag-breakup" is the major mechanism of spume droplets generation at strong and hurricane winds [1]. Bag breakup is a mechanism that begins with increase of small-scale elevation of the surface, transforming to small "sails" then inflated to a water film bordered by a thicker rim and at last blows up, so the droplets are produced from rupture of the water film and fragmentation of the rim (the first report on the observation of a new mechanism of spume droplets', similar to bag-breakup regime was made in [2]).
In this work a separate bag-breakup event was investigated in a dried high-speed wind-wave flume with a small reservoir put at a distance of 7.5 m from the beginning. The flume was closed from the bottom with rigid plates at the water level. Initial disturbance from which the bag breakup develops was artificially created at the desired position using the underwater jet from a submerged nozzle. The water surface around the area was covered with a dampening material. Simultaneous multiperspective high-speed shooting was used. The main shadowgraph recording was carried out in horizontal direction with the NAC Memrecam HX-3 camera at 3990 frames per second. Additional shooting was done from above on the camera Optronis CamRecord CR3000x2. Special software was developed to process the images from side view to obtain detailed data on the dynamics of the resulting structures: the shape of the structure before and during the rupture, the speed and size of the droplets formed. The top view was used to control the shape of the structure in the transverse direction. Records were performed for 10 to 17 m/s centerline wind speeds
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