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Whitecap coverage measurements in laboratory modeling of wind-wave interaction

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Whitecap coverage were retrieved from high-speed video recordings of the water surface obtained on the unique laboratory faculty Heidelberg Small-Scale Air-Sea Interaction Facility, the Aeolotron (annular wind-wave facility, 60 cm width, 2.4 m height, circumference of 27.3 m at the inner wall; water depth during experiments 1.0 m, water volume 18.0 m^3, air space volume 24 m^3; wind was generated by two axial fans mounted into the ceiling).

Records were made in the vertical direction (from top to bottom) in a shadowgraph configuration with backlight located under the channel. On the annular channel, regimes with an abrupt start of wind under an unperturbed surface condition were implemented, including the case of butanol presence in water simulating salinity. At the same time, the wave parameters varying depending on the time elapsed after the wind was turned on, made it possible to study the characteristics of the generation of spray at various effective fetches.
As a result of semi-automatic processing of image sequences using specially developed software that allows marking the moment and position of the bag-breakup formation on the videos, the dependences of the frequency of occurrence of these phenomena per unit surface area versus time after turning on the wind were obtained. From the same images, using the developed software for automatic detection of areas of wave breaking, the values of the whitecap coverage area were obtained. In this case, automatic image processing was performed using morphological analysis in combination with manual processing of part of the frames for tweaking the algorithm parameters: for each mode (water characteristics and wind speed), manual processing of several frames was performed, based on the results of which automatic algorithm parameters were selected to ensure that the resulting whitecap coverage corresponded. Since the same high-speed surface images were used to study the statistics of occurrence of events leading to the spray generation and the dependences of the whitecap coverage on time after turning on the wind for each regime were obtained, we were able to estimate the average number of fragmentation events per unit area of the collapse area.

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