Variations of whitecap properties with meteorological and wave-field conditions

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Whitecaps play an important role in gas transfer processes across the air-sea interface because of the entrainment of bubbles and the breaking of the interface. Whitecap coverage becomes an effective parameter for estimating the gas transfer velocity and the drag coefficient on the sea surface. The purpose of this study is to investigate how whitecap properties such as whitecap coverage and bubbly layer depth vary depending on meteorological and wave-field conditions on the basis of field observations. The observations were conducted from 11 November to 9 December 2003 and from 13 February to 5 March 2004, at the storm surge observation tower of the Shirahama oceanographic observatory of Kyoto University, which is located in the west region of Tanabe Bay, Wakayama, Japan and 2 km off the nearest coast.

Images of whitecaps were taken every 7 hours in the daytime using a 3CCD digital video camera fixed at 14 m elevation, and they were stored automatically in a hard disk video recorder at a time interval of 1 s. Wind speeds at 23 m were measured using an ultrasonic anemometer at a sampling rate of 10 Hz. An acoustic Doppler current profiler (WAVEADCP) was set on the sea bed at a distance 20 m apart from the tower. Statistical wave characteristics such as the significant wave height, spectral peak period of waves and directional wave spectrum were obtained from the WAVEADCP data. The determination of whitecap coverage was made by means of a digital image processing. The depth of bubbly layer generated by whitecaps was estimated from vertical distributions of echo intensities measured by WAVEADCP.

The present results show that the 1/3 power of whitecap coverage increases linearly with increasing the friction velocity and it is influenced by the near-water air stability. On the basis of the deflection angle between propagating directions of wind waves and swell, wave-field conditions are classified into four cases [Donelan et al., 1997]. Whitecaps are produced most activity under the condition of pure windsea and they tend to be suppressed by the presence of swell. It is difficult to find a certain relation between whitecap coverage and the deflection angle. Explanations about the relationship between the depth of bubbly layer and wave characteristics will be given at the colloquium.

REFERENCES