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Spatio-Temporal Measurements of Short Wind Water Waves

Roland Rocholz (1) and Bernd Jähne (1,2)

(1) Institute of Environmental Physics, University of Heidelberg, Germany (roland.rocholz@IUP.uni-heidelberg.de), (2) Heidelberg Collaboratory of Image Processing (HCI) at the Interdisciplinary Center for Scientific Computing, Speyerer Straße 6, University of Heidelberg, Germany (bernd.jaehne@iwr.uni-heidelberg.de)

Spatio-temporal measurements of wind-driven short-gravity capillary waves are reported for a wide range of experimental conditions, including wind, rain and surface slicks. The experiments were conducted in the Hamburg linear wind/wave flume in cooperation with the Institute of Oceanography at the University of Hamburg, Germany. Both components of the slope field were measured optically at a fetch of 14.4 m using a color imaging slope gauge (CISG) with a footprint of 223 x 104 mm and a resolution of 0.7 mm. The instrument was improved versus earlier versions (Jähne and Riemer (1990), Klinke (1992)) to achieve a sampling rate of 312.5 Hz, which now allows for the computation of 3D wavenumber-frequency spectra (see Rocholz (2008)). This made it possible to distinguish waves traveling in and against wind direction, which proved useful to distinguish wind waves from ring waves caused by rain drop impacts. Using a new calibration method it was possible to correct for the intrinsic nonlinearities of the instrument in the slope range up to ± 1. In addition, the Modulation Transfer Function (MTF) was measured and employed for the restoration of the spectral amplitudes for wavenumbers in the range from 60 to 2300 rad/m.

The spectra for pure wind conditions are generally consistent with previous measurements. But, the shape of the saturation spectra in the vicinity of k$\sim$1000 rad/m (i.e. pure capillary waves) stands in contradiction to former investigations where a sharp spectral cutoff (k^(−2) or k^(−3)) is commonly reported (e.g. Jähne and Riemer (1990)). This cutoff is reproduced by almost all semi-empirical models of the energy flux in the capillary range (e.g. Kudryavtsev et al. (1999), Apel (1994)). However, the new MTF corrected spectra show only a gentle decrease (between k^(−0.5) and k^(-1)) for k > 1000 rad/m. Therefore the question for the relative importance of different dissipation mechanisms might need a new assessment.

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