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Numerical Investigation of the New Observation-Based Wind-Wave Source Function

Alexander Babanin (1), Kakha Tsagareli (2), Ian Young (1), and David Walker (2)

(1) Swinburne University of Technology, Melbourne, Australia (ababanin@swin.edu.au), (2) The University of Adelaide, South Australia

Numerical simulations of the wind-wave spectrum evolution are conducted by means of new observation-based wind-input and wave-dissipation functions obtained in the Lake George field experiment. This experiment allowed simultaneous measurements of the source functions in a broad range of conditions, including extreme wind-wave circumstances. Results of the experiment revealed new physical mechanisms in the processes of spectral input/dissipation of wave energy, which are presently not accounted for in wave forecast models. These features had been parameterised as source terms in a form suitable for spectral wave models, and in the presented study were tested, calibrated and validated on the basis of such a model. In the case of the input term, which is the main subject of this paper, these are its nonlinear behaviour and its relative reduction at conditions of strong winds/steep waves. For the dissipation function, the main new features are the wave-breaking threshold and the cumulative term.

Physical constraints were imposed on the source functions in terms of the known experimental dependences for the total wind-wave momentum flux and for the ratio between the total input and total dissipation. Enforcing the constraints in the course of wave-spectrum evolution allowed calibration of the free experimental parameters of the new input and dissipation functions. The approach thus allows separate calibration of the source functions, before they are employed in the evolution tests. The evolution simulations were conducted by means of the one-dimensional research WAVETIME model with an exact solution for the nonlinear term. The resulting time-limited evolution of integral, spectral and directional wave properties, based on implementation of the new physically-justified source/sink terms and constraints, is then analysed. Good agreement of the simulated evolution with known experimental dependences is demonstrated.