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A Numerical Study of Wind-Wave Interaction DI YANG, XIN GUO, LIAN SHEN, Department of Civil Engineering, Johns Hopkins University — The problem of wind interacting with water waves is important to many air-sea interaction applications. In this study, we perform direct simulation of turbulent flows over water waves for a mechanistic study of this problem. For motions of the air, the unsteady, three-dimensional momentum equations in the primitive form are simulated with a hybrid pseudo-spectral and finite-difference method on a boundary-fitted grid that fits the surface wave profile. The evolution of the water wave can be either prescribed based on wave theory, or simulated dynamically and coupled with wind motions. Through systematic simulations with a wide range of wave conditions, we investigate the flow structure in detail. It is found that the mean flow, turbulence intensity, Reynolds stress, and vortical structures in the air are strongly dependent on the wave motion, mainly in terms of wave phase, wave age, and wave nonlinearity. The wind input to waves is also quantified based on the simulation results, which compares well with our direct simulation of wind-wave growth.

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