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Direct Numerical Simulation of Turbulence over Wavy Surfaces
DI YANG, LIAN SHEN, Department of Civil Engineering, Johns Hopkins University — In order to study the mechanism of wind-wave growth, we perform direct numerical simulation for turbulent flows over surface waves. The simulation is realized through a hybrid pseudo-spectral and finite-difference method on boundary fitted grid. We consider wavy surfaces with various conditions of wave age, wave slope, wave nonlinearity, and wind drift. Instantaneous and statistical flow features have been investigated. It is found that the distributions of wave-correlated pressure, momentum flux, and TKE budget are sensitive to surface orbital velocity and wave age. Near the wavy surface, semi-streamwise vortices are found to be prominent, the generation of which is associated with the Gortler instability. Evolution and transport of coherent vortex structures can be strongly affected by the value of wave age. Based on the extensive simulation data obtained, we quantify statistics of wave-coherent pressure, which is useful for modeling wind input for water waves.

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