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Numerical study of interaction of turbulence with free surface and wave XIN GUO, LIAN SHEN, Johns Hopkins University — Direct numerical simulation is performed for free-surface turbulent flows. The Navier-Stokes equations subject to fully nonlinear dynamic and kinematic free-surface boundary conditions are integrated in time using a fractional-step method. The kinematic boundary condition is advanced in time with a Runge-Kutta scheme to obtain the evolution of surface elevation. Pseudo-spectral and finite-difference methods are used respectively in the horizontal and vertical directions for spatial discretization. Computational grid is clustered towards the free surface to ensure that flow details near the free surface are captured adequately. Various Froude and Weber numbers are considered. Surface signatures, e.g. propagating waves and surface roughness, are illustrated. The effect of free surface and surface waves is found to be important to the underlying turbulence. The variations of turbulence statistics and characteristic vortical structures near the free surface are elucidated. The budgets of turbulence kinetic energy and enstrophy are also quantified and their dependence on the free-surface conditions is analyzed.

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