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Eulerian and Lagrangian effects of surface wave on turbulence underneath XIN GUO, LIAN SHEN, Mechanical Engineering & St. Anthony Falls Laboratory, University of Minnesota, Twin Cities — Direct numerical simulation is performed to study the effects of surface wave on underlying turbulence. In the simulations, fully nonlinear kinematic and dynamic boundary conditions are applied at the free surface. The evolution of surface elevation is obtained by advancing the kinematic boundary condition with a Runge-Kutta scheme. In the vertical direction, grid is clustered towards the free surface to ensure the boundary layers of the free surface and surface wave are fully resolved. For spatial discretization, pseudo-spectral method is used in the horizontal directions, and second-order finite difference method is used in the vertical direction. The interaction of surface wave with underlying turbulence is carefully studied in both Eulerian and Lagrangian frames. In the Eulerian frame, turbulence statistics become wave-phase dependent due to the distortion of both the free surface and the periodic wave strain field. Budget of the Reynolds normal stresses is analyzed. In the Lagrangian frame, net effect of surface wave on turbulence is identified. It is found that the net wave effect is contributed by both the Stokes drift and the correlation between the wave field and the distorted turbulence field.

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