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Numerical Study of Interactions between Surface Waves and Turbulence Underneath Using Phase-Resolved Simulations ANQING XUAN, LIAN SHEN, Univ of Minnesota - Twin Cities — It has been known that waves can substantially modify the turbulent flow underneath, for example, leading to Langmuir turbulence. To elucidate the effects of surface waves on turbulence, we perform direct numerical and large-eddy simulations using a dynamically-evolving wave-surface-fitted grid with fully nonlinear kinematic and dynamic free-surface boundary conditions. Our simulations have the capability of explicitly resolving the distortion of turbulence by instantaneous phase-resolved wave motions, in addition to the averaged Stokes drift effects. The numerical results show that the effects of waves on turbulence have been successfully captured in our simulations. In the cases of wind-driven shear turbulence interacting with waves, the transition from shear turbulence to Langmuir turbulence occurs in our simulations as the turbulent Langmuir number $La_t = (u_*/u_s)^{1/2}$, the ratio of the friction velocity to the surface Stokes drift velocity, is decreased. Counter-rotating vortices and enhancement of the mixing due to Langmuir circulations have been observed. Our simulations also reveal detailed information on the underlying mechanisms of the interactions between turbulence and surface waves.

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