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Simulation of turbulence interacting with free surface and wave
XIN GUO, LIAN SHEN, Johns Hopkins University — Direct numerical simulation is performed for homogeneous turbulence interacting with deformable free surfaces and progressive waves, respectively. For the free surface case, various Froude and Weber numbers are considered. Surface manifestations of the underlying turbulence in the forms of propagating waves and surface roughness are elucidated. Effects of splats and anti-splats on turbulence kinetic energy budget are quantified. For the progressive wave case, effects of wave strain field and Stokes drift are examined. It is found that turbulent Reynolds stress is strongly dependent on the wave phase. Wave normal production, pressure-strain correlation, and pressure transport are essential in the Reynolds stress budget. Vortices are turned, stretched, and compressed periodically by the wave strain field, leading to their wave-phase dependent distribution. Lagriangian average shows that both the Stokes drift and the high correlation between wave strain field and turbulence contribute to the turning of vertical vorticity into streamwise direction.

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