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Direct Numerical Simulation of turbulent flows over superhydrophobic surfaces: capillary waves on gas-liquid interface[1] JONGMIN SEO, Stanford University, RICARDO GARCÍA-MAYORAL , University of Cambridge, ALI MANI, Stanford University — Superhydrophobic surfaces under liquid flow can produce significant slip, and thus drag reduction, when they entrap gas bubbles within their roughness elements. Our work aims to explore the onset mechanism to the failure of drag reduction by superhydrophobic surfaces when they are exposed to turbulent boundary layers. We focus on the effect of finite surface tension to the dynamic response of deformable interfaces between overlying water flow and the gas pockets. To this end, we conduct direct numerical simulations of turbulent flows over superhydrophobic surfaces allowing deformable gas-liquid interface. DNS results show that spanwise-coherent, upstream-traveling waves develop on the gas-liquid interface as a result of its interactions with turbulence. We study the nature and scaling of the upstream-traveling waves through semi-analytical modeling. We will show that the traveling waves are well described by a Weber number based on the slip velocity at the interface. In higher Weber number, the stability of gas pocket decreases as the amplitude of interface deformation and the magnitude of pressure fluctuations are augmented.

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