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Air entrainment due to shear-flow free surface turbulence XIANGMING YU, DICK K.P. YUE, KELLI HENDRICKSON, Massachusetts Institute of Technology, Cambridge, MA, 02139 — We perform direct numerical simulations to study air entrainment at the air-water interface in three dimensional sheared turbulent flows with two-phase coupled at the free surface, using a two-phase conservative Volume-Of-Fluid (cVOF) method. For a given Reynolds number the problem is governed by the Froude number (Fr), above a threshold value of which air entrainment (AE) is observed. We consider a range of Fr and study the dependence on Fr of the volume V of AE, and the underlying air entraining structures and mechanisms of the interface. We determine the scaling of V with Fr and identify two key mechanisms for AE characterized respectively by surface-parallel vorticity and wave breaking. The former is associated with rising lambda vortices and strong near-surface horizontal vorticity, while the latter can be quantified by the decrease in potential energy of the interface. We propose models parameterized on Fr and the local turbulent flow properties that predict the AE volume associated with each of these mechanisms.

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