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Liquid-bubble Interaction under Surf Zone Breaking Waves

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Abstract Text:

Liquid-bubble interaction, especially in complex two-phase bubbly flow under breaking waves, is still poorly understood. Derakhti and Kirby (2014a,b) have recently studied bubble entrainment and turbulence modulation by dispersed bubbles under isolated unsteady breaking waves along with extensive model verifications and convergence tests. In this presentation, we continue this examination with attention turned to the simulation of periodic surf zone breaking waves. In addition, the relative importance of preferential accumulation of dispersed bubbles in coherent vortex cores is investigated. Heavier-than-liquid particles, i.e. sediment, tend to accumulate in regions of high strain rate and avoid regions of intense vorticity. In contrast, lighter-than-liquid particles such as bubbles tend to congregate in vortical regions. We perform a three dimensional (3D) large-eddy simulation (LES) using a Navier-Stokes solver extended to incorporate entrained bubble populations, using an Eulerian-Eulerian formulation for the polydisperse bubble phase. The volume of fluid (VOF) method is used for free surface tracking. The model accounts for momentum exchange between dispersed bubbles and liquid phase as well as bubble-induced dissipation. We investigate the formation and evolution of breaking-induced turbulent coherent structures (BTCS) under both plunging and spilling periodic breaking waves as well as BTCS's role on the intermittent 3D distributions of bubble void fraction in the surf zone. We particularly examine the correlation between bubble void fractions and Q-criterion values to quantify this interaction. Also, the vertical transport of dispersed bubbles by downburst type coherent structures in the transition region is compared to that by obliquely descending eddies. All the results are summarized at different zones from outer to inner surf zone.

Session Selection: Nearshore Processes

Title: Liquid-bubble Interaction under Surf Zone Breaking Waves
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Preferred Presentation Format: Assigned by Program Committee (Oral or Poster)

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