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On the accuracy of the two-fluid formulation in DNS of bubble-laden turbulent boundary layers A. FERRANTE, S. ELGHOBASHI, University of California, Irvine — The objective of the present paper is to examine the accuracy of the two-fluid (TF) formulation in DNS of a microbubble-laden spatially developing turbulent boundary layer (SDTBL) over a flat plate by comparing the results with those of the Eulerian-Lagrangian (EL) formulation (Ferrante & Elghobashi, J. Fluid Mech. 2004 & 2005). Our results show that DNS with TF (TFDNS) does not reproduce the physical mechanisms responsible for drag reduction observed in the EL results. The reason is that TFDNS does not produce accurate instantaneous local bubble concentration $C(\boldsymbol{x},t)$ gradients which are responsible for the generation of a positive $\langle \nabla \cdot \boldsymbol{U} \rangle$ that is essential for the drag reduction mechanism. The inaccuracy of the TFDNS in computing $C(\boldsymbol{x},t)$ is due to the invalidity of the bubble-phase continuity equation in regions where the continuum assumption for the bubble-phase breaks down. It is recommended that if the real (experimental or DNS) instantaneous spatial distribution of bubble (or particle) concentration is discontinuous, and if this concentration discontinuity is crucial for the realization of the physical phenomenon of interest, then DNS should use the EL formulation. We propose a *Knudsen number* criterion for the validity of the two-fluid formulation in DNS of dispersed two-phase flows with strong unsteady preferential concentration.

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