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Investigation of turbulence modulation in particle-laden flows using the lattice Boltzmann method. CHENG PENG, NICHOLAS GENEVA, HAODA MIN, LIAN-PING WANG, University of Delaware — Turbulent modulation by finite-size solid particles has been studied experimentally and numerically in the past several decades. Previous studies have revealed that resolving the interfaces between particle surfaces and fluid is crucial to properly include finite-size effects on local fluid turbulence. Finite-size particles also produce pseudo-turbulence that may not decay locally, leading to a stronger nonlinear dependence of the level of turbulence modulation on the particle volume fraction. In this study we apply the lattice Boltzmann method (LBM) to perform interface-resolved simulations of turbulent particle-laden flow, focusing on local turbulence dynamics at the scale of particle size. We will discuss the accuracy of this mesoscopic approach when compared to other macroscopic methods. We consider both fully developed homogeneous isotropic (HI) turbulent flows and turbulent channel flows laden with finite-size particles. The particle volume fraction is around 10% and the particle-to-fluid density ratio is of the order of one. Conditional statistics as a function of distance from the moving particle surfaces are studied in detail, and are used to help interpret global turbulence modulation by particles. Grid convergence of these conditional statistics will be discussed.

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