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Modeling pseudo-turbulence in compressible particle-laden flows[1]

GREGORY SHALLCROSS, University of Michigan, RODNEY FOX, Iowa State University, JESSE CAPECELATRO, University of Michigan — When a shock passes through a dense suspension of solid particles, velocity fluctuations are generated in particle interstitial sites. While this is captured in fully resolved simulations of shock-particle interactions, it remains a challenge to reproduce using coarse-grained models, such as Eulerian-Eulerian and Eulerian-Lagrangian methods. Recent work has revealed that pseudo-turbulent kinetic energy (PTKE) can contribute significantly to the overall kinetic energy during shock-particle interactions. We demonstrate this term acts to systematically increase the local Mach number, and needs to be accounted for to properly capture particle dispersion. A transport equation for PTKE is presented, and closure for the dissipation rate is proposed. The equations are implementing in a high-order Eulerian-Lagrangian framework and compared against direct numerical simulations of shock-particle interactions. We demonstrate the model is capable of predicting the pseudo-turbulent Reynolds stresses with correct levels of anisotropy, independent of the drag law employed. Finally, a stochastic model informed by the PTKE is proposed to improve the prediction of particle dispersion.

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