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Cloud-In-Cell modeling of shocked particle-laden flows at a "SPARSE" cost[1] SOREN TAVERNIERS, GUSTAAF JACOBS, San Diego State University, OISHIK SEN, H. S. UDAYKUMAR, University of Iowa — A common tool for enabling process-scale simulations of shocked particle-laden flows is Eulerian-Lagrangian Particle-Source-In-Cell (PSIC) modeling where each particle is traced in its Lagrangian frame and treated as a mathematical point. Its dynamics are governed by Stokes drag corrected for high Reynolds and Mach numbers. The computational burden is often reduced further through a "Cloud-In-Cell" (CIC) approach which amalgamates groups of physical particles into computational "macro-particles". CIC does not account for subgrid particle fluctuations, leading to erroneous predictions of cloud dynamics. A Subgrid Particle-Averaged Reynolds-Stress Equivalent (SPARSE) model is proposed that incorporates subgrid interphase velocity and temperature perturbations. A bivariate Gaussian source distribution, whose covariance captures the cloud's deformation to first order, accounts for the particles' momentum and energy influence on the carrier gas. SPARSE is validated by conducting tests on the interaction of a particle cloud with the accelerated flow behind a shock. The cloud's average dynamics and its deformation over time predicted with SPARSE converge to their counterparts computed with reference PSIC models as the number of Gaussians is increased from 1 to 16.

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