Abstract Submitted
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Stochastic Modeling of Direct Radiation Transmission in Particle-Laden Turbulent Flows[1] ANDREW BANKO, LAURA VILLAFANE, JI HOON KIM, MAHDI ESMAILY MOGHADAM, JOHN K. EATON, Stanford University — Direct radiation transmission in turbulent flows laden with heavy particles plays a fundamental role in systems such as clouds, spray combustors, and particle-solar-receivers. Owing to their inertia, the particles preferentially concentrate and the resulting voids and clusters lead to deviations in mean transmission from the classical Beer-Lambert law for exponential extinction. Additionally, the transmission fluctuations can exceed those of Poissonian media by an order of magnitude, which implies a gross misprediction in transmission statistics if the correlations in particle positions are neglected. On the other hand, tracking millions of particles in a turbulence simulation can be prohibitively expensive. This work presents stochastic processes as computationally cheap reduced order models for the instantaneous particle number density field and radiation transmission therein. Results from the stochastic processes are compared to Monte Carlo Ray Tracing (MCRT) simulations using the particle positions obtained from the point-particle DNS of isotropic turbulence at a Taylor Reynolds number of 150. Accurate transmission statistics are predicted with respect to MCRT by matching the mean, variance, and correlation length of DNS number density fields.

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