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Effects of preferential concentration on direct radiation transmission in a turbulent duct flow[1] LAURA VILLAFANE, ANDREW BANKO, JI HOON KIM, CHRIS ELKINS, JOHN EATON, Stanford University — Inertial particles in turbulent flows preferentially concentrate, giving rise to spatial and temporal fluctuations of particle number density that affect radiation transmission through the medium. Positive particle correlations enhance direct transmission when compared to the exponential attenuation predicted by the Beer's Law for randomly distributed particles. In the context of a particle based solar receiver, this work studies the effects of preferential concentration and optical depth on direct transmission through a particle laden turbulent duct flow. Time resolved measurements of transmission through the mixture were performed for various particle loadings and Reynolds numbers, thus varying particle correlation lengths, optical depth and concentration fluctuations. These measurements were made using a photodiode to record the transmission of a collimated laser beam along the wall bisector of the duct. A synchronized high-speed camera provided particle positions along most of the beam path. Average and fluctuating radiation transmission results are compared to predictions derived from the imaged number density fields and to simplified analytical models. Simplified models are able to capture the correct trends with varying loading and preferential concentration.

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