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Effects of clustering on heat transfer in particle-laden turbulence[1]

HADI POURANSARI, ALI MANI, Stanford University — Particle-laden flows are ubiquitous in variety of natural and industrial phenomena. Rain droplets in clouds, protoplanetary disks, and combustion chambers are examples in which particles are interacting with a background turbulence. It is well known that interaction of particles and turbulent flow results in preferential concentration. The extent of preferential concentration depends on ratio of particle relaxation time and turbulent eddies time scale.this work, we consider particle-laden turbulent flows, in which particles are heated. This is the case for example in the particle-based solar receivers where particles absorb external radiation and heat the background gas. We use three-dimensional variable density direct numerical simulations for the turbulent flow and Lagrangian point-particle tracking to study the implication of particle clustering in particle-to-gas heat transfer. We investigate variety of non-dimensional numbers including particle Stokes number, Reynolds number, and mass loading ratio. Using our statistical analyses we introduce a model to correct the particle-to-gas heat transfer to account for particle clustering. This can be employed in Reynolds average Navier Stokes (RANS) computations.

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