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Scale-dependent structures of particle clusters in cluster-induced turbulence JEONGLAE KIM, HOUSSEM KASBAOUI, Arizona State University — Recent studies have shown that settling inertial particles dispersed at a sufficiently high mass loading spontaneously cluster and generate turbulent motions in the carrier phase, known as cluster-induced turbulence (CIT). Variance of local volume fraction enhances the fluid-phase production in the Reynolds-averaged context, implying that spatially-local dynamics involving particle–particle and particle–fluid interactions contribute to CIT. This study employs DNS and wavelet multiresolution analysis (WMRA) to characterize and understand the structures of particle clusters at various scales in CIT driven by gravity. Euler–Lagrange simulations of CIT are conducted in two-way coupling at the mass loading 0.5 and particle Reynolds number $\mathrm{Re_p} = \tau_\mathrm{p} \mathrm{g} \mathrm{d_p}/\nu = 0.3$. The initially uniformly-distributed particles evolve into a statistically-stationary state of sustained clustering. WMRA is used to extract the clusters of inertial particles in a way similar to the coherent vorticity extraction technique. Following Bassenne et al. (Phys. Rev. Fluids 2017), coherent and incoherent components of volume fraction are obtained per scale, location and direction. Their correlations with particle and turbulence statistics are examined to study the structural characteristics of CIT.

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