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A study of turbulence modulation by particle clusters in dilute and moderately-dilute channel flows using mesoscale DNS JESSE CAPECELATRO, OLIVIER DESJARDINS, Cornell University, NATIONAL RENEWABLE ENERGY LABORATORY COLLABORATION — This work investigates fluid-particle interactions in turbulent channel flows using highly-resolved Euler-Lagrange simulations. In the dilute regime, particle dynamics are mostly controlled by vortical structures in the flow, and wakes past individual particles can modify the underlying fluid turbulence at the particle scale. At moderate concentrations and mass loadings, flow instabilities may lead to mesoscale structures (i.e., clusters) that control underlying fluid turbulence. A Re=13,500 channel flow is studied in both regimes. It is shown in this work that the fluid turbulence departs significantly from the initially fully-developed turbulent flow when subjected to mean particle volume fractions of 1%, where all unsteady features are generated by the cluster dynamics. To study the effect of gravity on clustering dynamics, simulations are conducted with gravity aligned in the mean flow direction, as well as gravity opposing the mean flow direction (i.e., a riser configuration). Velocity fluctuations and energy spectra are computed for each case, along with higher order Lagrangian statistics including collision frequency, radial distribution function, and particle number density.

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