

Clustering of inertial cloud droplets in isotropic turbulence

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Inertial particles (i.e., particles with densities greater than that of the carrier fluid) are centrifuged out of vortex cores in a turbulent flow and accumulate in low vorticity regions. Such accumulation, referred to as "clustering" or "preferential concentration," has been linked to the acceleration of precipitation in cumulus clouds by increasing the collision frequency and the coalescence rate of the cloud droplets. The videos show inertial droplets clustering in a direct numerical simulation of a turbulent flow performed on over 8 billion grid points, using 16,384 processors on the Yellowstone supercomputer at NCAR. The cloud droplets are visualized in white, and high vorticity regions of the flow are shown in yellow. The left image shows intermediate-sized droplets (75 microns with a Kolmogorov-scale Stokes number of 1) and the right image shows rain-size drops (400 microns with a Stokes number of 30). The former are very responsive to the underlying flow and form small, dense clusters, whereas the latter have a damped response to the flow and form larger, much less dense clusters. The radial distribution function (RDF) is a statistical measure of clustering. As you can see from the RDF plots included in the video, the degree of clustering for the smaller droplets is much higher than for the larger droplets. Indeed, clustering peaks near a Stokes number of unity.

URL: https://www.vapor.ucar.edu/sites/default/files/movies/Ireland_2.mp4