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Cloud droplet collisions under different turbulent intensities

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Turbulence has long been postulated to have a large contribution in accelerating cloud droplet growth through the collision-coalescence process. Previous studies have shown that turbulence can enhance the collision kernel and may speed up the warm rain processes and even increase the precipitation. We use the Direct Numerical Simulation (DNS) model from Franklin et al. (2005) to simulate the motion of cloud droplets and their collisions under the effects of turbulence. In order to expand the range of investigated Reynolds number, we parallelize the code using MPI technique, so that larger and more energetic scales in the flow can be resolved.

Previous DNS studies either span a narrow range of Reynolds number or just a few dissipation rates. This work will be based on a wide range of Reynolds number (R_λ is from 63 to 589) and eddy dissipation rates (from 50 to 1500 cm^2 s^{-3}). The purpose is to quantify the influence of Reynolds number (box size) and turbulence intensity (i.e. eddy dissipation rate) on the collision statistics (for example, the relative radial velocity, the radial distribution function, and the collision kernel) to shed light on future microphysics parameterizations for collision statistics under different turbulent conditions.

The droplet radii range from 5 to 25 μm because these sizes are crucial to the formation of larger droplets important for effective gravitational collisional growth. The collision statistics between pairs of those sizes are studied. The results show no dependency of collision statics on Reynolds number, in contrast to the conclusions of some previous studies. On the other hand the collision kernel increases monotonically with dissipation rate in a close-to-linear manner.