Raindrops and Turbulence in a Cloud

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Abstract: A cloud is in turbulent motion. It contains water vapour, aerosol particles and liquid water droplets. Depending on local levels of supersaturation, condensation takes place onto the aerosol particles and tiny droplets are formed. Our studies are aimed at understanding how these droplets grow in a short time, thought to be of the order of ten minutes, from about a micron in size into raindrops, which are of the order of millimeters. An important part of the process is collisions between droplets, some of which results in coalescence. Caustics from a single vortex are shown to be important for enhancing collisions between droplets [1]. We then ask how this process affects cloud turbulence [2], and show that significant amounts of small scale vorticity is produced in cloud turbulence as compared to standard turbulence where there is no phase change. We then discuss [3] how collisions between droplest happen in highly strained regions of the flow which are often not regions of highest droplet clustering due to turbulence. In the first part of the study [1-3] we assume that droplets may be described by the simplest form of the Maxey-Riley equation, including just Stokes drag. We next [4] show that the Basset history force, which is often neglected, can change the dynamics significantly. We show how to compute this force exactly for various time-independent flows, and how to compute it accurately with low memory requirement for a general flow.

References

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