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Droplets condensation in turbulent warm clouds

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Microdroplets growth by condensation/evaporation is a question of paramount importance to understand warm clouds formation. We consider the problem of droplet growth by condensation in a turbulent flow of nearly saturated vapour both from a theoretical and numerical point of view. Water droplets form from the condensation of moist air onto small polydisperse aerosols. Tipically, starting from a narrow distribution of submicron aerosols, after few minutes a broad distribution of water droplet sizes is experimentally observed, with radii in the range $1-20$ micron. Once droplets have reached these dimensions, growth by collisions starts to take place. The presence of a large distribution of droplets sizes can significantly enhance the efficiency of collisions, and eventually lead to a fast initiation of precipitation.

We model water droplets as inertial particles, subject to Stokes drag and gravity, transported by a turbulent flow, and whose size depends on the available saturated vapour turbulent fluctuations. The feeedback of the droplets condensation/evaporation on the vapour field is also taken into account. By means of high resolution $3D$ direct numerical simulations, we show how the presence of an underlying turbulent velocity field can induce a correlation between droplet trajectories and supersaturation. This leads both to the enhancement of the droplet growth rate and to a fast spreading of the droplet size distribution. We conclude that the enlargement of droplet size spectrum seems to crucially depend on the turbulent fluctuations that droplets experience along their lagrangian motion.