Water droplets simulation in a warm cloud-like ambient

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Simulations of lukewarm clouds usually assume static and homogeneous conditions on average. However, we are here interested in the unsteady dynamics of the transport through the interface between cloud and the clear air surrounding it. Clouds in fact are fugitive in nature. If one looks for a few seconds, they seem to keep the same form. When looking again, after a minute, one finds that are somewhat changed. Hardly then extended cloud formations can live for more than 2-3 days. Their spatial structure is in-homogenous with continuous changes associated with a large set of coexisting timescales.

In our numerical simulation, the cloud interface is modeled through two interacting regions at different turbulent intensity [1, 2]. Different initial conditions reproduce possible local stable or unstable stratification in density and temperature. Currently, our droplet model includes evaporation, condensation, collision and coalescence. The typical water content, associated to an initial condition where drops are 30 microns in diameter, leads to an initial number of drops of $10^{1}1$ in a cloud volume of about 500 cubic meters. A computational grid up to 2048x1024x1024 points is used leads to a Taylor's microscale Reynolds number of 250. The governing equations are NS equations in Boussinesqs approximation coupled to equations describing the evolution of water drops seen as inertia particles, transported by background turbulence and gravity.

One aim is the determination of the clustering feature of water droplets inside the shearles turbulent mixing at the clear air – cloud interface. We compute the distrution of the droplet size and compare the distribution shape with those obtained in a laboratory chamber where turbulent cloud formation is enabled via moist convection [3]. This to deduce information on the possible aerosol/nucleation inputs leading to the local cloud state produced in the simulation.

References

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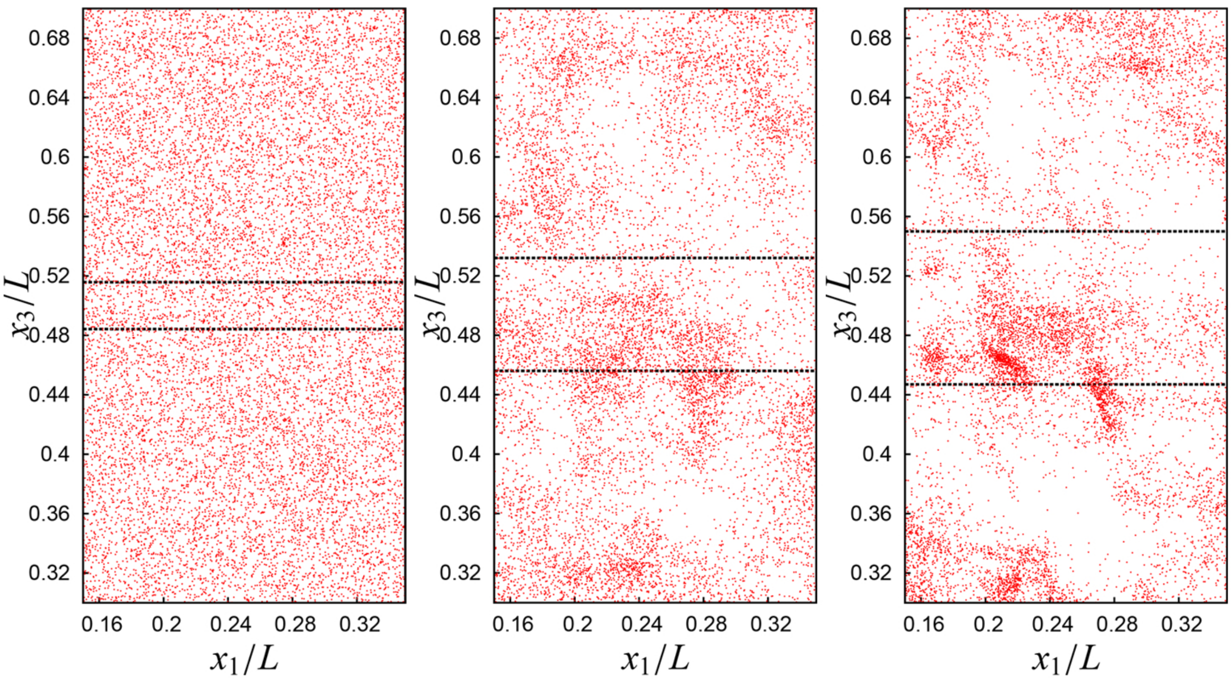

Figure 1: DNS of the transient clustering of water droplets across a shearless turbulent mixing. $Re_\lambda \sim 100$, x_3 cross mixing direction, L linear scale of the cloud portion under study.