Universität Bremen

CENTER OF APPLIED SPACE TECHNOLOGY AND MICROGRAVITY

ZARM

Fluid Dynamics Seminar

Date: Wednesday, June 14, 2017 at 13:00
Location: ZARM, Room 1730

On the relevance of small-scale turbulence in planetary boundary layers

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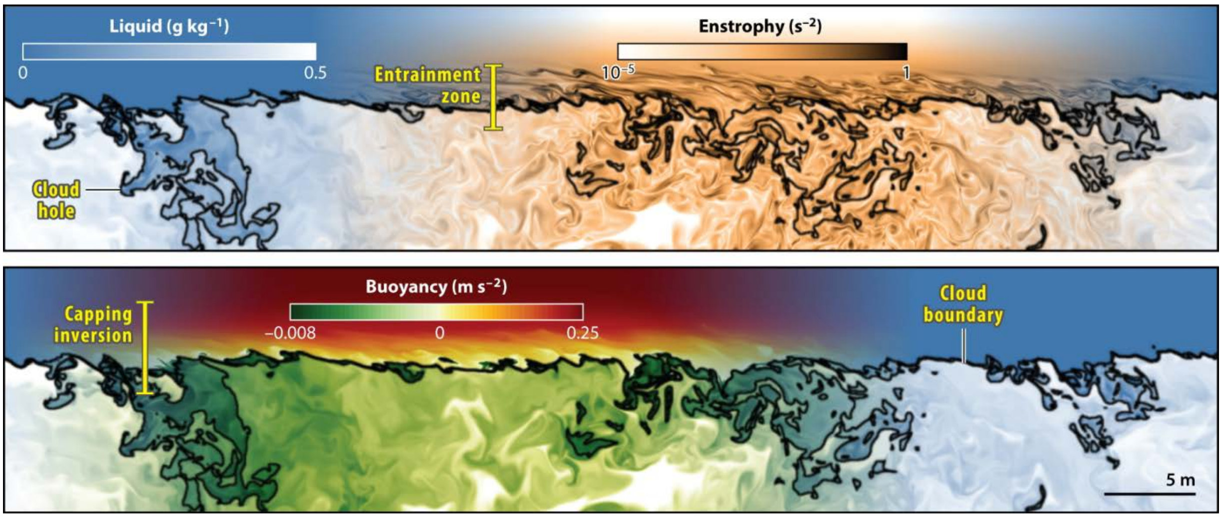

Vertical cross-sections illustrating the meter- and submeter-scale structure of the cloud-top region. Different properties define different interfacial layers: enstrophy defines the entrainment zone, buoyancy defines the capping inversion, and liquid defines the cloud boundary. (From Mellado, Annu. Rev. Fluid Mech., 2017.)

Planetary boundary layers are important in a wide variety of contexts: in climatology, since they modulate the fluxes between atmosphere, land and ocean; in meteorology, since they influence weather conditions; in fluid mechanics, since they constitute a paradigm of multi-scale, complex systems. Despite their relevance, our understanding of how turbulence interacts with other phenomena in planetary boundary layers, such as density stratification, radiation or clouds, remains limited in crucial ways, particularly at meter and submeter scales. During the last decades, direct numerical simulations have provided further insight into these interactions. In this talk, I will use two examples to illustrate some of these recent developments. The first example considers the stable boundary layer in the strongly stratified regime. We will see that turbulence collapse in the stable boundary layer can occur intermittently in space without the need of external triggers, such as surface heterogeneity. It suffices that intrinsic large-scale flow structures have space and time to develop. This finding reconciles previous results and explains the difficulty to reproduce this intermittent behavior in simulations, where domains are often too small or grid resolutions too coarse. The second example is cloud-top entrainment in stratocumulus. We will see that centimeter scales are important to faithfully represent the effects of evaporative cooling and gravitational settling on radiative cooling. This finding helps to explain the observed variability across large-scale models when droplet evaporation strongly affects the cloud dynamics, like for buoyancy-reversal conditions.