On the edge of a cloud

Detailed studies on cloud-environment interaction

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In my talk, I will focus on the interaction between individual cumulus clouds and their environment. We attack this problem with a combination of detailed large-eddy simulations (LES) and air-plane observations.

The main topic of the presentation is a statistical life-cycle analysis of cumulus clouds. Although trained observers have no problem in distinguishing the different lifestages of a cloud, this process proves difficult to be automate, since cloud-splitting and cloud-merging events complicate the distinction between a single system divided in several cloudy parts and two independent systems that collided. Because the human perception is well-equipped to capture and to make sense of these time-dependent three-dimensional features, a combination of automated constraints and human inspection in a 3D virtual reality environment is used to select clouds that are exemplary in their behavior throughout their entire lifespan. The considerable number of selected clouds warrants reliable statistics of cloud properties conditioned on the phase in their life cycle. The most dominant feature in this statistical life-cycle analysis is the pulsating growth that is present throughout the entire life time of the cloud. The pulses are a self-sustained phenomenon, driven by a balance between buoyancy and horizontal convergence of dry air. The convective inhibition just above cloud base plays a crucial role as a barrier for the cloud to overcome in its infancy stage, and as a buffer region later on, ensuring a steady supply of buoyancy into the cloud.

Along the way, other points of entrainment and detrainment will be discussed, such as the occurrence of downdrafts in and around the cloud, including the subsiding shell around cumulus clouds that can be held responsible for a considerable amount of the compensating downward mass flux, even though a high resolution LES is barely enough to resolve the minimum in the vertical velocity.