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Entrainment rates at the tops of laboratory analogs of cumulus and stratocumulus clouds

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We investigate entrainment at tops of laboratory analogs of convective clouds: cumulus and stratocumulus. Cloudy saturated moist air ($T \sim$22 °C) containing droplets of diameters of $\sim$3–10 μm, is introduced into a laboratory cloud chamber of dimensions of $1.0\times1.0\times1.8$ through an opening in the bottom wall. Initialy cloudy air fills $\sim$60 cm thick layer at the bottom. Mixing between the cloud and unsaturated air above ($T \sim$22 °C, $RH \sim$35 %) results in evaporative cooling triggering convection which, in turn, leads to formation of a well mixed layer capperd with a temperature inversion. The temperature jump is about 2 °C within $\sim$30 cm deep layer. Then updrafts are forced through a 30cm high tube extending from the bottom of the chamber. „Strong" updrafts which penetrate the whole inversion layer mimic overshooting cumulus clouds while „weak" updrafts diverging under the inversion simulate stratocumulus clouds. We use a laser sheet technique to image two-dimensional cross sections through the clouds. A specially developed mutiscale Particle Image Velicimetry (PIV) algorithm allows to retrieve 2D velocity fields. Suitable image processing allows to determine cloud–clear air interface in the images. Extracting velocities of cloudy ($\mathbf{u}_i$) and environmental ($\mathbf{u}_a$) air on both sides of the interface allows us calculate entrainment / detrainment rates:

$E = -\rho_a(\mathbf{u}_a - \mathbf{u}_i)$ – entrainment rate

$D = \rho_a(\mathbf{u}_a - \mathbf{u}_i)$ – detrainment rate.

On the poster we will present fine structures of entraimnet/dertaiment process and discuss similarities and differences in both investigated types of clouds.