Geophysical Research Abstracts, Vol. 9, 08172, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-08172

Numerical investigation of entrainment and mixing near the stratocumulus top

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The evolution of a Stratocumulus (Sc) topped planetary boundary layer is investigated using the EULAG model in the large-eddy simulation experiment. Numerical setup is based on the data collected during DYCOMS II experiment and verified by comparison to other simulations described by Stevens et al., 2005. In the course of a simulation two passive scalars are injected: one into the free troposphere above the capping inversion, and the second one into the boundary layer below the cloud top. Transport of these scalars allow investigating relevant aspects of the entrainment processes. Radiative cooling at Sc top and evaporative cooling due to entrainment and mixing produce negative buoyancy, affecting vertical motions near the cloud top. As expected, downward flow of a scalar quantity originating from the free troposphere is correlated with the vertical velocity field near the cloud top. The latter has a structure of narrow and relatively strong downdraughts located between broad areas of slowly ascending air. Such a distribution of vertical motion results in non-homogeneous spatial distribution of that scalar inside the boundary layer. The penetration depth varies from several tens to a few hundred meters from place to place. When evolution of horizontally averaged concentration profile is considered, a given concentration threshold of the passive scalar descends with almost constant velocity. Detrainment of boundary-layer scalar into the inversion layer is due to overshooting cloud tops and results in stretched plumes associated with the mean shear near the boundary layer top. In a subsequent analysis, we consider dynamics of three surfaces which can be used to define Sc top, following ideas of Moeng et al. 2005. Their evolution differs, showing significant deviations from mean heights but relative positions remain unchanged. The uppermost is the surface defined by the jump of enstrophy, followed by the surface defined by the maximum temperature gradient. The lowermost is the surface defined by the jump

of the total water content. These results will be discussed in the context of recent observations and modelling of Sc dynamics.