Geophysical Research Abstracts, Vol. 7, 05973, 2005
SRef-ID: 1607-7962/gra/EGU05-A-05973

Entrainment and mixing in convective clouds

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Entrainment-mixing processes in convective clouds

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Convective clouds are made of droplets that form by condensation of the water vapour in excess to the saturation mixing ratio. The liquid water mixing ratio in an adiabatic cell can simply be derived from the temperature and pressure at cloud base, following a wet adiabatic ascent. The actual liquid water mixing ratio is in fact lower than its adiabatic value because of turbulent mixing between the ascending cell and its drier environment. It is not clear however if the reduction of liquid water mixing ratio is accounted for by the volume dilution of the existing droplets and further evaporation, the same process as during condensational growth, also referred to as homogeneous mixing process, or if some droplets are totally evaporated until the mixture reaches saturation, while the remaining droplets keep their initial sizes (heterogeneous mixing process). In situ microphysical measurements made in cumulus and stratocumulus clouds reveal that the observed features are closer to the heterogeneous model predictions. Various physical hypothesis will be discussed that could explain the observations. It appears however that the methodology itself that consists in counting droplets along the aircraft path and averaging over scales of a few meters is responsible for the observed features. Because the droplet spatial distribution in mixing regions is highly heterogeneous the measured mean volume diameter (an intensive parameter) is strongly biased toward its value in the least diluted cloud volumes, while the measured concentration (an extensive parameter) is significantly reduced by the large proportion

of highly diluted volumes.