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Vertical thermodynamic phase distribution in convective clouds derived from cloud side observations

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Clouds are a dominant modulator of the Earth's climate. Depending on the cloud properties they have either cooling or warming effects on the Earth's atmosphere. Different processes influence the coagulation (collision and coalescence) and freezing mechanisms inside clouds which determine the precipitation formation, the lifetime and vertical extent of the cloud. To investigate these complex interactions, vertical profile measurements of microphysical properties are essential. Deep convective clouds have been observed during the ACRIDICON experiment conducted in September 2014 over the Brazilian rain forest near Manaus. One of the ACRIDICON missions was focused on cloud profiling to document the vertical evolution (from cloud base to anvil) of the cloud microstructure during the different phases of the cloud life cycle under various thermodynamic conditions. In particular the aerosol effect on the cloud profile was investigated by measurements downwind Manaus (polluted plume) and upwind Manaus (pristine conditions).

Cloud penetrations by aircraft and so in situ measurements are limited due to the strong updraft and downdraft in these types of clouds. Therefore passive remote sensing methods by cloud side observations using imaging spectroradiometers (specMACS instrument) were used to complete the characterization of the cloud properties.

This presentation will give an overview of the vertical distribution of the thermodynamic phase for different cloud scenes subdivided in pristine and polluted aerosol conditions. The retrieval method for phase discrimination uses the spectral slope of the reflected radiances in the near-infrared spectral range and has been applied for ground based observations (Jäkel et al., 2013) before. A pre-selection of only illuminated, non-shadowed cloud portions is required, since only for these cases the spectral signature is determined by the downward solar radiation and its spectral extinction by the observed cloud element. In contrast, for shadowed clouds the spectral slope of the measured radiances is contaminated due to the significant fraction of diffuse radiation originated from unknown directions. The vertical allocation of the observed cloud element and the cloud distance is estimated from stereographic analysis of additional video camera data.