Characterization of residuals from ice particles and droplets sampled in tropical deep convective cloud systems during ACRIDICON-CHUVA

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Airborne sampling of hydrometeors (drops and ice particles) inside deep convective clouds was conducted during ACRIDICON-CHUVA by the HALO counterflow virtual impactor (HALO-CVI). Interstitial particles are pre-segregated and the condensed phase is evaporated/sublimated by the HALO-CVI, such that the residuals from cloud droplets and ice particles (CDR and IPR) can be microphysically and chemically analyzed by respective aerosol sensors located in the cabin.

Although an even more comprehensive characterization of CDR and IPR was carried out, we will focus here only on selected residual particle measurements. Number concentration and size distribution are measured by a condensation particle counter (CPC) and an ultra-high sensitivity aerosol spectrometer (UHSAS). The absorption coefficient and thus a measure for the black carbon (BC) mass concentration is derived from the particle soot absorption photometer (PSAP), whereby BC number concentration was obtained by means of a single particle soot photometer (SP-2). Further chemical residue components were determined by a compact-time-of-flight-aerosol-mass-spectrometer (C-ToF-AMS). In the lower liquid parts of the convective clouds the mean charge of droplets was inferred by means of CDR electrometer measurements.

The HALO-CVI sampling behavior, which is mainly influenced by its position at the front part of the upper fuselage of the HALO aircraft, is evaluated by the comparison with droplet and ice particle concentration measured by different cloud probes from close to cloud base up to the anvil and outflow region of the convective cloud systems.

The vertical profiles of the measured quantities and deduced parameters are analyzed to study the vertical transport and cloud processing of lower tropospheric aerosol particles in dependence of convective cloud systems evolving from more clean air masses compared to systems evolving from more polluted air masses. As an example, Fig.1 shows residual particle number and BC mass concentration along the flight track of HALO for mission flight AC09.

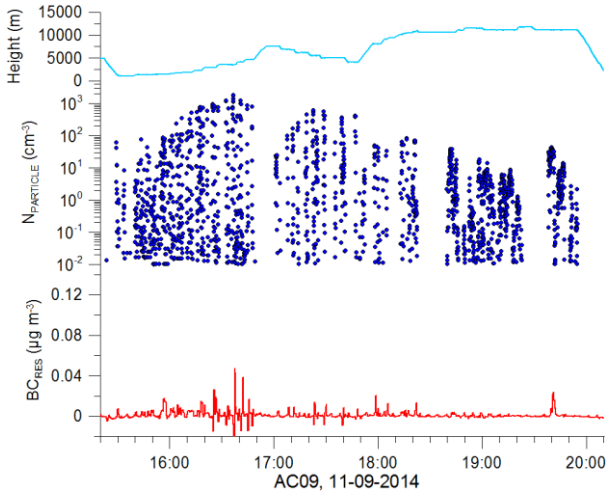

Fig.1: Time series of flight altitude, residual particle concentration and residual black carbon mass concentration for mission flight AC09.

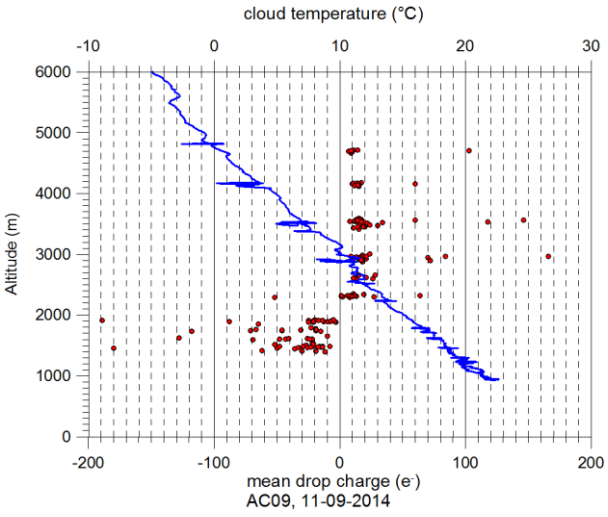

Fig.2: Vertical profile of cloud temperature (blue line) and measured cloud drop charges (red dots) for mission flight AC09.

Droplet charge polarity is found to change from negative to positive values with height mostly between 2000 and 4000 m at positive cloud temperatures in a range from -100 to +50 elementary charges (Fig.2, example from mission flight AC09).