Geophysical Research Abstracts
Vol. 17, EGU2015-10833, 2015
EGU General Assembly 2015

Characterization of residuals from ice particles and droplets sampled in mid-latitude natural and aviation-influenced cirrus and in tropical deep convective cloud systems during ML-CIRRUS and ACRIDICON

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Airborne sampling of cloud particles inside different cirrus cloud types and inside deep convective clouds was conducted during the HALO missions ML-CIRRUS over Europe in March/April 2014 and ACRIDICON over Amazonia in September 2014. ML-CIRRUS aims at the investigation of the for-mation, evolution, microphysical state and radiative effects of different natural and aviation-induced cirrus clouds in the mid-latitudes. The main objectives of ACRIDICON are the microphysical vertical profiling, vertical aerosol transport and the cloud processing of aerosol particles (compari-son in- and outflow) of tropical deep convective cloud systems in clean and polluted air masses and over forested and deforested regions.

The hydrometeors (drops and ice particles) are sampled by a counterflow virtual impactor (CVI) which has to be installed in the front part of the upper fuselage of the HALO aircraft. Such an intake position implies a size dependent abundance of cloud particles with respect to ambient conditions that was studied by particle trajectory simulations (Katrin Witte, HALO Technical Note 2008-003-A). On the other hand, this sampling location avoids that large ice crystals which could potentially bias the cloud particle sampling by shattering and break-up at the inlet shroud and tip enter the inlet. Both aspects as well as the flight conditions of HALO were taken into account for an optimized CVI design for HALO (HALO-CVI). Interstitial particles are pre-segregated and the condensed phase is evaporated/sublimated by the 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 like to report on the following measurements of certain aerosol properties. Particle number concentra-tion 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 mass concentration is derived from the particle soot absorption photometer (PSAP). In the lower warm parts of the probed convective clouds during the ACRIDICON mission the mean charge of droplets was inferred by means of electrometer measurements. For the determination of the chemical properties of CDR and IPR, the Aircraft-based Laser Ablation Aerosol Mass Spec-trometer (ALABAMA) and a Compact-Time-of-Flight-Aerosol-Mass-Spectrometer (C-ToF-AMS) was operated during ML-CIRRUS and ACRIDICON, respectively, to obtain the mixing state and chemical composition of the cloud particle residues.

During ML-CIRRUS, differences in IPR concentration, size distribution, and chemical composition between natural and aviation influenced cirrus clouds could be observed as well as between dif-ferent natural cirrus types and between young and aged contrail cirrus.

During ACRIDICON, CDR concentration, size distribution, and chemical composition are found to be different for convective cloud systems evolving from more clean air masses compared to systems evolving from more polluted air masses. Droplet charges change from negative to positive values with height in all vertical cloud profiles. The measured IPR concentration strongly vary in the anvil outflow regions.