Submicron aerosol composition measurements during ACRIDICON-CHUVA: Indications for secondary organic aerosol formation in the upper tropical troposphere

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During the ACRIDICON-CHUVA campaign we operated a Compact Time-of-Flight Aerosol Mass Spectrometer (C-ToF-AMS, Drewnick et al., 2005) to investigate aerosol and cloud residual composition in and around deep convective systems. The C-ToF-AMS was connected to two different inlets: The HALO Aerosol Submicrometer Inlet (HASI) samples aerosol particles, whereas the HALO Counterflow Virtual Impactor (HALO-CVI) samples cloud droplets and ice particles during in-cloud measurements, such that cloud residual particles can be analyzed (Ogren et al., 1985).

As an example, one flight (AC 11, September 16, 2014) is presented here in more detail.

The aerosol mass concentration was dominated by organics (max. mean of 5 μ g/m³) during the whole flight. The highest sulfate mass concentrations (max. mean of 0.8 μ g/m³) were observed below 3000 km. Above 8 km, the nitrate and organic mass concentrations were noticeably increasing (Figure 1) while sulfate remained low. This indicates vertical redistribution of boundary layer particles and gases by convection and subsequent processes like cloud processing (removal of sulfate particles) and condensation of HNO₃ and organic precursor gases on pre-existing particles, or even new particle formation by nucleation.

To investigate the organic mass spectra more closely, the statistical tool SoFi (Source Finder, Canonaco et al., 2013) was used. Organic mass spectra can be apportioned to source- or process-related components by using Positive Matrix Factorization (PMF). First results show factors for oxidized (OOA) and hydrocarbon-like organic aerosol (HOA). Besides that, there are indications for a factor representing isoprene epoxydiols secondary organic aerosol (IEPOX-SOA): aerosol that is formed by oxidation of isoprene emitted by vegetation (Surratt et al., 2009). Especially at high altitudes and also in an outflow region of a cloud IEPOX-SOA was observed, indicating secondary organic aerosol formation at high altitudes.

Cloud residual particles measured during incloud sampling through the CVI contained mainly organic material and, to a lesser extent, nitrate. Up to now no indications for the presence of IEPOX-SOA in the cloud residual particles were found.



Fig. 1: Mean vertical profiles of organic, nitrate and sulfate aerosol mass concentration during AC 11.

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