Geophysical Research Abstracts
Vol. 21, EGU2019-5798, 2019
EGU General Assembly 2019

Aerosol properties and processing in the upper troposphere in aged biomass burning outflow: First results from the HALO mission CAFE-Africa in 2018

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Biomass burning emissions in Africa are important sources for trace gases and aerosol particles. The African monsoon systems can lift these emissions into the middle and upper troposphere, where they are transported over long distances over the Atlantic Ocean, even as far as the Caribbean and the South American continent. The HALO mission CAFE-Africa (Chemistry of the Atmosphere – Field Experiment in Africa) was conducted in August 2018 out of Cape Verde. The objectives included studying the temporal evolution of aerosol and trace gas properties during transport to and in the upper troposphere.
Here we report on measurements of the composition and processing of aerosol particles using two concurrently operating aerosol mass spectrometers: a bipolar single-particle ablation instrument (ALABAMA) and an Aerodyne-AMS type (C-ToF-AMS) instrument. Auxiliary data include particle number concentration and size distribution.
The data show that the background aerosol in the upper troposphere is mainly composed of organics and sulfate. The single particle mass spectra resemble those from secondary organic aerosol (SOA) laboratory experiments. In contrast, the particle composition in aged biomass burning plumes is dominated by organic matter. The single particle data show clear signs of biological material (nitrogen compounds, potassium). These particles are also abundant in the background free troposphere, but in a much smaller percentage. This finding shows that aged biomass burning plumes mix into the background free troposphere where they have a long-lasting influence on the particle composition.
Photochemical processing of biomass burning particles is expected to increase their hygroscopicity. Mass spectral markers can be used to study the degree of oxidation as a function of atmospheric residence time. These results will be presented along with the chemical composition data from selected research flights of the CAFE-Africa mission.