Biomass burning layers measured during the Deep Convective Clouds and Chemistry experiment (DC3) with an airborne Single Particle Soot Photometer (SP2)

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The Deep Convective Clouds and Chemistry (DC3) experiment was conducted in the central and eastern U.S. in the summer of 2012, investigating the role of thunderstorms in physical and chemical processes and their influence on the upper troposphere. Both ground-based and airborne measurements were performed, with radar, lightning and meteorological observations on the ground and three research aircraft, the NCAR GV, the NASA DC8 and the DLR (German Aerospace Center) Falcon. This presentation shows measurements made with a Single Particle Soot Photometer (SP2) mainly focusing on the instrument mounted on the DLR Falcon, data from the SP2 instrument on the DC8 are included for comparison.

The Falcon instrumentation comprised various instruments for in-situ measurements of trace gases and aerosols. Measured trace gas species were NO, CO, O_3, CO_2, CH_4, SO_2, and volatile organic compounds. The range of aerosol in-situ instruments included optical particle counters for size distributions in different size ranges (UHSAS-A, FSSP-300, FSSP-100, PCASP-100X and Sky-OPC 1.129), a multi-channel CPC system for total and non-volatile particle concentrations and, for absorbing particles, a three-wavelength PSAP and a Single Particle Soot Photometer (SP2), measuring the refractory black carbon (rBC) mass. Being a strongly absorbing product of combustion processes, rBC influences the global radiation budget depending on its highly variable concentration.

The DLR Falcon made measurements during 13 local flights based at the Salina/KS airport and during the transfer from Germany to the U.S. and back. Aside from thunderstorm measurements, biomass burning layers were detected almost during every flight, as the summer of 2012 was one of the worst wildfire seasons on record in the continental U.S. A biomass burning layer was also sampled during a wing-by-wing intercomparison flight between the DLR-Falcon and the NASA-DC8, providing a good opportunity to compare the two different SP2 instruments in a biomass burning plume.

In the middle troposphere, where the biomass burning layers with highest rBC mass concentrations were found, the rBC mass concentrations spanned four orders of magnitude (Figure 1). Most biomass burning layers measured during the local flights were observed between 3 and 8 km, although some layers were observed at 11 km during the transfer flights over North America and Greenland (not shown in this figure). The most prominent layers, originating from New Mexico wildfires, were found at 7 km, on June 11th 2012 (Little Bear wildfire), and between 3 and 6 km on May 29th and 30th of 2012 (Whitewater-Baldy wildfire).

rBC mass concentrations as high as 2 µg/m³ were detected in some plumes. All biomass burning plumes showed higher fractions of rBC cores with thick coatings than found in the boundary layer. However, a plume found at 11 km over Newfoundland during back transfer showed also a high fraction of thinly coated particles, while the median diameter of rBC particles in this plume was lower than found in other biomass burning plumes or the boundary layer.

This presentation will give an overview of the different biomass burning layers measured at various altitudes and distances from the wildfire. To address sources and characteristics of the various plumes, back trajectories and microphysical properties of the particles in the plumes will be presented.

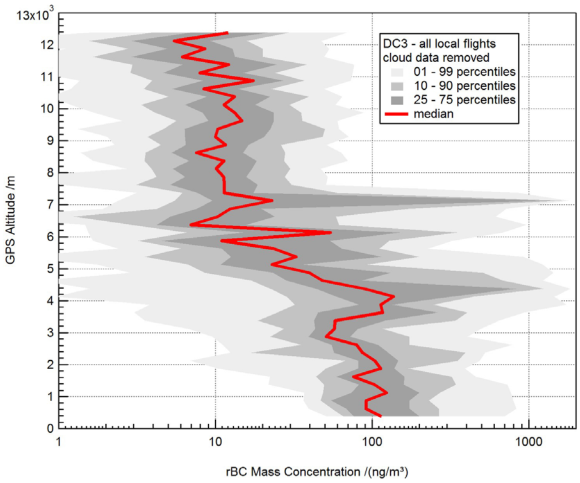

Figure 1: Median profile and percentiles of all rBC measurements outside clouds during DC3 local Falcon flights

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