Saharan Mineral Dust Experiment 2008: Airborne observations of dust and biomass burning layers over Cape Verde

B. Weinzierl[1], A. Petzold[1], M. Esselborn[1], K. Rasp[1], A. Minikin[1], A. Dörnbrack[1], M. Wirth[1], P. Mahnke[1] and M. Fiebig[2]

[1] Deutsches Zentrum für Luft- und Raumfahrt, Institut für Physik der Atmosphäre, Oberpfaffenhofen, 82234 Wessling, Germany
[2] Department for Atmospheric and Climate Research, Norwegian Institute or Air Research, Kjeller, Norway

The Saharan Mineral Dust Experiment (SAMUM) aims to characterise the optical, physical, chemical, and radiative properties of Saharan dust close to the source region and during transport. A first field experiment, SAMUM-1, focussing on pure dust close to the Sahara, was conducted in May/June 2006 in Southern Morocco. A second field experiment, SAMUM-2, focussing on the transformation of dust properties during transport and mixing with biomass burning aerosol, took place in January/February 2008.

During SAMUM-2, the DLR Falcon research aircraft operated from Praia/Cape Verde. The DLR Falcon was equipped with an extensive set of aerosol physico-chemical instruments for size, volatility, and absorption measurements, impactor sampling for chemical analyses and with a nadir-looking high spectral resolution lidar (HSRL).

In total, ten mission flights were conducted from Cape Verde providing data of dust and biomass burning plumes. In all cases with both aerosol types, the biomass burning layers were observed above the dust layer. On average, the Saharan dust plumes were situated below 2 km altitude above sea level (a.s.l.). The biomass burning layers which were advected from central Africa covered the altitude range between 2 and 4-5 km.

Figure 1 shows averaged vertical profiles of total aerosol number concentration (N_{10}, top left panel), the non-volatile fraction of the total aerosol ($f_{\text{non-vol 10}}$, top right panel), accumulation mode concentration (N_{ACC}, bottom left panel) and coarse mode number concentrations (N_{COARSE}, bottom right panel) measured during SAMUM-2. In the averaged vertical profiles of the total aerosol number concentration, the desert dust and biomass burning layers are not obvious. However, the vertical profile of $f_{\text{non-vol 10}}$ clearly indicates the presence of dust and biomass burning plumes: above the aerosol layers (> 4.5 km), only 30% of the particles are non-volatile, while within the aerosol layers 70-90% of the particles are non-volatile. The accumulation mode concentration is enhanced in both, dust and biomass burning layers. However, the accumulation mode particle concentration is a factor of 2-3 higher in the biomass burning plumes. It is striking that the biomass burning layers contain a fraction of large particles (D_p > 3 µm), although the concentration of these large particles is near the detection limit of the FSSP-300 instrument. Note the sharp upper boundary of the aerosol layers.

Figure 2 shows an example for a dust size distribution measured at 570 m a.s.l. over Cape Verde on 25 January 2008. The black lines show the envelope of all dust size distributions measured during SAMUM-1 close to the Sahara. It is obvious that the size distribution larger 0.1 µm is within the range of size distributions measured during SAMUM-1.

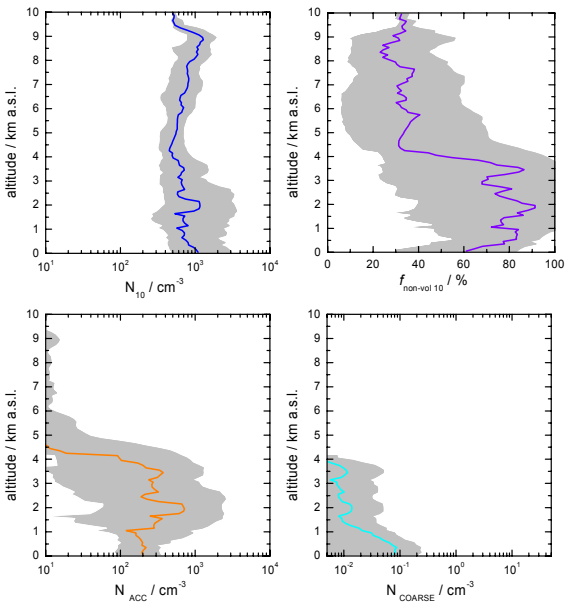

Figure 1. Mean vertical profiles of total aerosol number concentration (N_{10}, top left panel), the non-volatile fraction of the total aerosol ($f_{non\text{-}vol\ 10}$, top right panel), accumulation mode concentration (N_{ACC}, bottom left panel) and coarse mode number concentrations (N_{COARSE}, bottom right panel). The shaded area represents the range within 10- and 90-percentile values. Particle concentrations are given for standard conditions (273.15 K, 1013.25 hPa).

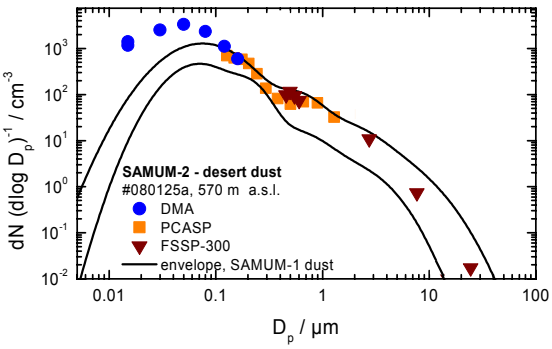

Figure 2. Composite size distribution of desert dust from Differential Mobility Analyser (DMA), and optical particle counters PCASP-100X and FSSP-300 found on 25 January 2008 over Cape Verde. The black lines show the envelope of the dust size distributions found during SAMUM-1 close to the Sahara.

Presented results will cover profiles of dust size distributions and dust optical properties. The microphysical properties of the dust size distributions measured during SAMUM-2 will be compared with those measured during SAMUM-1. Furthermore, similarities and differences in the size distribution observed over Cape Verde compared to Morocco will be discussed.

This work was supported by the Deutsche Forschungsgemeinschaft DFG.