Geophysical Research Abstracts, Vol. 9, 07825, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-07825

Optical Properties of Desert Dust: Airborne vertical Profile Observations of Dust Properties and Closure with Ground and Satellite Observations during the Saharan Mineral Dust Experiment SAMUM 2006

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The Saharan Mineral Dust Experiment (SAMUM) is an initiative of several German institutes. Its goal is the characterisation of optical, physical, chemical, and radiative properties of Saharan dust at the source region. SAMUM data will also serve as ground truth data to validate satellite products and atmospheric transport models, and to support the CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation) mission. The SAMUM closure concept combines ground, aircraft, and satellite based observations. The first SAMUM intensive field phase was conducted in May and June 2006 in Southern Morocco. Ground sites were Ouarzazate (30.93°N, 6.9°W), Zagora (30.15°N, 5.37°W), and Evora (38.53°N, 7.90°E) in Portugal for long-range transport studies. Research aircraft were operating from Ouarzazate (Partenavia, local flights, boundary layer) and Casablanca (DLR Falcon, tropospheric column) at the Moroccan west coast.

The DLR Falcon was equipped with an extensive set of aerosol physico-chemical instruments for measuring particle size distribution (0.005 $< D_p <$ 30 μm), volatility, and spectral absorption coefficients, as well as for particle impactor sampling for chemical analyses, and with a nadir-looking high spectral resolution lidar (HSRL) for measuring aerosol extinction at 532 nm, and aerosol backscatter and depolarisation at 532 nm and 1064 nm. The field sites were equipped with similar instruments for aerosol sampling and measuring particle size distribution, volatility, and hygroscopicity, as well as for ground based remote sensing by sunphotometer and multi-wavelength lidar.

During the SAMUM core phase, three large-scale dust events were probed close to the source region. Vertical (0 - 10 km) dust plume structures, aerosol optical depth as well as particle microphysical and optical properties were studied multiple times for all cases, resulting in 3 complete closure datasets with information from ground, aircraft, and satellite sensors. The upper boundary of the dust layers was found at altitudes between 4 and 6 km above sea level. The internal structure of the dust layers varied from well mixed to stratified.

First results will be presented on the dust particle size distribution, particle size dependent volatility, and particle optical properties as a function of altitude during the dust event. As expected, the dust optical properties are dominated by particles in the coarse mode size fraction larger than 1 μm particle diameter. The particle volatility shows a marked dependence on particle size with an obvious volatile coating on particles smaller than the coarse mode size range. The spectral dependence of the particle absorption coefficient is indicative of absorbing iron compounds in the dust particles. It will be demonstrated how simultaneous and collocated measurements of particle size distribution, main chemical components, and spectral absorption can constrain the content and type of certain absorbing particle components and the solar spectral particle refractive index. This information is used to calculate the particle extinction and optical depth for comparison and (successful!) closure with HSRL, sunphotometer, and satellite measurements. Also, the effect of particle asphericity will be discussed.

This work is supported by the Deutsche Forschungsgemeinschaft DFG, the European Space Agency ESA and the European Fleet for Airborne research EUFAR.