Geophysical Research Abstracts
Vol. 17, EGU2015-6430-1, 2015
EGU General Assembly 2015

Characterization of Saharan dust at different distances from the source based on lidar and photometer data from SAMUM and SALTRACE

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Properties of Saharan dust aerosol at different distances from the source regions were measured during the SAMUM and SALTRACE field experiments using a variety of in-situ and remote sensing techniques. In this contribution we characterize the dust based on lidar data supplemented with photometer data. The lidar data includes vertically-resolved multi-wavelength particulate extinction coefficients, backscatter coefficients, and linear depolarization ratios. Extensive quantities, like the extinction and backscatter coefficient, provide information on the vertical distribution of the aerosol amount. Intensive quantities, like the linear depolarization ratio, the lidar ratio (i.e. extinction-to-backscatter ratio), or the wavelength-dependence of extinction or backscatter coefficient, can be useful e.g. for aerosol type identification or for a microphysical characterization (particle size, shape, composition).

The SAMUM-2 lidar data from Capo Verde (East Atlantic) in January/February 2008 revealed a three-layer aerosol structure: the boundary layer up to heights of a few hundred meters contained mixtures of dust and marine aerosols, followed by dust-dominated layers up to heights of about 1 km, and mixtures of dust and biomass burning aerosols up to about 3-5 km. By contrast, the vertical structure during dust episodes at Barbados (West Atlantic) measured within the SALTRACE experiment in June/July 2013 in general showed marine-aerosol-dominated layers from the surface to about 2 km height, followed by dust-dominated layers up to about 4 km height. The extinction coefficients of the dust-dominated layers on average decrease from East to West, for which dilution of the Saharan dust plumes during their transport over the Atlantic is a plausible reason. The linear depolarization ratio in the dust-dominated layers show slight but significant changes between both campaigns, i.e. the linear depolarization ratio was 0.28 - 0.29 at 355 nm and 532 nm wavelengths during SALTRACE, whereas it was lower (0.24 - 0.27) at 355 nm and higher (0.30 - 0.31) at 532 nm during SAMUM-2. The lidar ratio at these wavelengths is slightly higher during SALTRACE (60 - 70 sr) compared to SAMUM-2 (50 - 60 sr).

One reason for the changes of intensive properties of the dust-dominated aerosol layers might be gravitational settling of the largest particles during the transport over the Atlantic. Knowledge on changes of the microphysical properties between SAMUM and SALTRACE is of particular interest to verify this hypothesis. Microphysical retrievals using the lidar data can, in principle, be used to quantify these changes. However, due to the limited information content of the lidar data, the retrieval uncertainties are larger than the changes of the microphysics with the consequence that no definite conclusions are possible if only lidar data is used. To overcome this limitation, we take additional input data from collocated sky radiance measurements of the photometers into account. We will present first results from this combined lidar-photometer retrieval to test the hypothesis on the removal of the largest dust particles during the transport. In addition, independent dust size distribution data from airborne in-situ measurements are available for comparisons.