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Combining data from different measurement techniques: Optical modeling studies for mineral dust during SAMUM and SALTRACE

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The microphysical properties of mineral dust aerosols are quite complex: aside from the variability of particle sizes, a mineral dust ensemble is characterized by a strong variability of irregular particle shapes and is composed of a variety of minerals. As a consequence, a precise microphysical description of a mineral dust ensemble requires in principle a very complex aerosol model with a large number of parameters. The amount of information that is available from measurements, however, is limited and assumptions are required in dust models.

In our study we investigate the sensitivity of multi-wavelength Raman-/depolarization lidar and sunphotometer (forward scattering) measurements to changes of the ensemble microphysics. Benefits from combining complementary data from both remote sensing techniques are investigated and the modeling results are compared to Saharan dust data available from the two SAMUM campaigns which were conducted in Morocco and the Cape Verde Islands. Our aerosol model considers irregular particle shapes as well as external mixing of different minerals.

The sensitivity study revealed that lidar backscattering is strongly sensitive to the mineralogical composition including the external mixing. Furthermore, if a realistic wavelength dependence of the refractive index of desert dust is considered, it is indispensable to consider also external mixing in the model to achieve agreement with the wavelength dependence of measured lidar data. Moreover, it is found that forward scattering provides valuable information about the particle size distribution because the former is nearly insensitive to particle shape and refractive index. The simulations showed that lidar and photometer measurements are sensitive to the particle microphysics in different manner. Therefore strong benefits, including the requirement of fewer model assumptions, can be expected from combining both remote sensing techniques in dust retrievals.

As a next step, we will apply our study to SALTRACE measurements that were performed in the Caribbean, investigating the changes of Saharan dust during the transport over the Atlantic ocean. Furthermore, it is planned to consider large scattering angles from sunphotometers (almucantar and principal plane) and sky polarization measurements during SALTRACE.