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Mineral dust chemistry, mineralogy, shape, mixing state and complex refractive index determined by electron microscopy and by X-ray diffraction at Praia, Cape Verde, in winter 2008

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A large field experiment of the Saharan Mineral Dust Experiment (SAMUM) was performed in Praia, Cape Verde, in January and February 2008. This work reports on the chemical composition, shape and mixing state as well as derived refractive indices of individual particles determined by electron microscopy. In addition, aerosol mass concentrations and bulk mineralogical composition are addressed.
Three dust periods were recorded during the measurements, divided by transitional periods and embedded in maritime-influenced situations. Determined by filter gravimetry, the total suspended particle mass/PM10/PM2.5 in average was 250/180/74μg/m^3, respectively, for the first dust period (17 to 21 January) and 250/230/83μg/m^3 for the second (24 to 26 January). The third period (28 January to 2 February) was the most intensive with 410/340/130μg/m^3.
Approximately 48,000 individual particles collected by cascade impactors were analyzed by automated scanning electron microscopy for their shape, chemical composition and mixing state. The aerosol at Praia is a superposition of mineral dust, sea-salt, sulfates, and soot aerosol. Particles smaller than 500nm are mainly sulfates, mineral dust, mineral dust-sulfate-mixtures, and soot-sulfate-mixtures. Particles larger then 2.5μm consist of mineral dust, sea-salt, and few mineral dust-sulfate-mixtures. A transition range exists in between. The major internal mixtures are mineral dust-sulfate (sub- and super-micron) and soot-sulfate (sub-micron only). Mineral dust-sea-salt mixtures occur occasionally, mineral dust-soot mixtures were not observed. The aspect ratio was 1.3-1.4 for dry particles smaller than 500nm and 1.6-1.7 for larger ones. The complex refractive index was derived from the measured chemical composition for each individual particle, using a mineralogy mixing model (Kandler et al., 2011). While the real part of the refractive index showed low variation (1.55-1.58 at 532nm), a multi-modal imaginary part was detected as function of particle size, reflecting the complex aerosol composition. Soot mainly influences the light absorption for wavelengths longer than the hematite absorption edge (500 to 550 nm), while for shorter wavelengths the iron oxide in the mineral dust is dominating. The refractive index distribution of the aerosol is depending on the source region of the mineral dust and on the presence/absence of a marine component.
By X-ray diffraction of filter samples it was determined that the total suspended dust (bulk) consisted of kaolinite, K-feldspar, quartz, plagioclase, illite, gypsum, halite, and calcite. Kaolinite dominated the clay minerals, and K-feldspar was the most abundant feldspar component. Even during maritime periods, mineral dust contributed significantly to the aerosol mass at Cape Verde, usually dominating over the sea-salt.

Kandler, K., Lieke, K., Benker, N., Emmel, C., Küpper, M., Müller-Ebert, D., Ebert, M., Scheuvens, D., Schladitz, A., Schütz, L., Weinbruch, S. (2011) Electron microscopy of particles collected at Praia, Cape Verde, during the Saharan Mineral dust experiment: particle chemistry, shape, mixing state and complex refractive index. Tellus 63B, submitted.