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Single particle chemical composition, state of mixing and shape of fresh and aged Saharan dust in Morocco and at Cape Verde Islands during SAMUM I and II

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The Saharan Mineral Dust Experiment (SAMUM) is focussed to the understanding of the radiative effects of mineral dust. During the SAMUM 2006 field campaign at Tinfou, southern Morocco, chemical and mineralogical properties of fresh desert aerosol was measured. The winter campaign of Saharan Mineral Dust Experiment II in 2008 was based in Praia, Island of Santiago, Cape Verde. This second field campaign was dedicated to the investigation of transported Saharan Mineral Dust. Ground-based and airborne measurements were performed in the winter season, where mineral dust from the Western Sahara and biomass burning aerosol from the Sahel region occurred.

Samples were collected with a miniature impactor system, a sedimentation trap, a free-wing impactor, and a filter sampler. Beryllium discs as well as carbon coated nickel discs, carbon foils, and nuclepore and fiber filters were used as sampling substrates. The size-resolved particle aspect ratio and the chemical composition are determined by scanning electron microscopy and energy-dispersive X-ray microanalysis of single particles. Mineralogical bulk composition is determined by X-ray diffraction analysis.

In Morocco, three size regimes are identified in the aerosol: Smaller than 500 nm in diameter, the aerosol consists of sulfates and mineral dust. Larger than 500 nm up to 50 μm, mineral dust dominates, consisting mainly of silicates, and – to a lesser extent – carbonates and quartz. Larger than 50 μm, approximately half of the particles consist of quartz. Time series of the elemental composition show a moderate temporal variability of the major compounds. Calcium-dominated particles are enhanced during advection from a prominent dust source in Northern Africa (Chott El Djerid and surroundings). More detailed results are found in Kandler et al. (2009)

At Praia, Cape Verde, the boundary layer aerosol consists of a superposition of mineral dust, marine aerosol and ammonium sulfate, soot, and other sulfates as well as mixtures of these components. During low-dust periods, the aerosol is dominated by sea salt. During dust events, mineral dust dominates the particle mass (more than 90 %). Particles smaller 500 nm in diameter always show a significant abundance of ammonium sulfate.

Comparing a high dust period at Cape Verde with the total data from Morocco, it is found that the atomic ratio distributions of Al/Si, K/Si and Fe/Si for the single particles are very similar for the dust component. This indicates that the dominating silicate minerals are the same. In contrast, the content of calcium rich minerals at Cape Verde is significantly lower than in Morocco which is in agreement with the source regions for the Cape Verde dust (E Mali and W Niger) derived from trajectory analysis.

The sulfur content of super-micron aerosol particles at Cape Verde scales with the particle surface, indicating the presence of sulfate coatings. For the submicron particles, the sulfur content scales with particle volume, which can be attributed to the large amount of particles identified as ammonium sulfate. In contrast to findings in Japan (Zhang et al., 2006), no internal mixtures between pristine seasalt and mineral dust are present during this dust period at Cape Verde. However, for a significant number of particles a small amount of sodium and chlorine is associated with internal mixtures of dust and sulfate, what may indicate that these particles started as internal mixture of dust with a sea water droplet before taking up more sulfur from the gas phase.

In general, the shape of the particles in Morocco and Cape Verde is rather similar: The distributions of the two-dimensional aspect ratio of an ellipse fitted to each particle's shape for the total aerosol show no significant differences. A median value of 1.6 is found for both locations.

References
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