# Chemical and mineralogical composition and morphology of aged Saharan dust, marine, urban and biomass burning aerosol at Cape Verde

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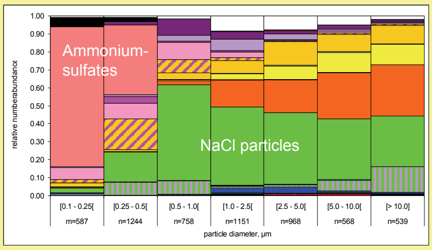
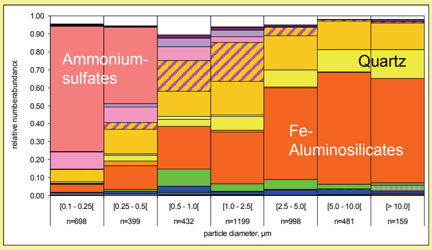
## Introduction

The Saharan Mineral Dust Experiment (SAMUM) is dedicated to the understanding of the radiative effects of mineral dust. A joint field campaign focused on the investigation of aged Saharan dust and admixtures of biomass burning, urban and marine aerosols was carried out at the airport of Praia, island of Santiago, Cape Verde. 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 occur. In addition, flights over the city of Dakar were performed.

## Results

In the investigated samples, aluminosilicate particles - most of them iron-containing - and sulfate silicate mixtures are found in high number concentrations. Quartz is present as a minor component. Calcium-dominated minerals are found to a minor extent. Particles smaller than 0.5 µm are dominated by ammoniumsulfates or soot. NaCl is a major component in the background aerosol at Praia airport. For this sampling site, one can distinguish between days with high dust load and a background situation (see Fig. 1 and 2). However, the composition of the mineral dust it self is very similar for the considered days.




*Color key for the particle groups*

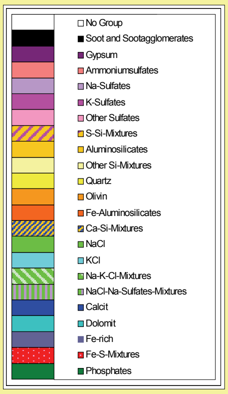
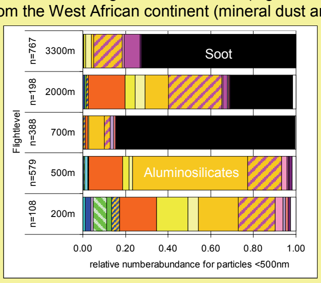



*Fig 1/2: Average size-resolved relative number abundance of the particle groups: Praia background (upper figure) and Praia dust (lower figure)*

For the airborne samples a great variability among the fine and ultra-fine mode particles can be seen. Figures 3 and 4 show the size-resolved relative number abundance of the different particle groups for different flightlevels above Praia on Jan. 25th, 2008. Biomass burning aerosol can be easily recognized at 3300m, 2000m and 700m by the high amount of soot particles in the fine and ultra-fine mode.
The Dakar overflight measurements (Fig. 5, below) show a high influence of background Aerosol from the West African continent (mineral dust and secondary sulfates).



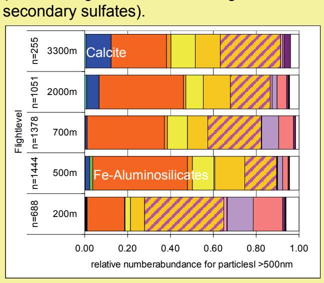




*Fig. 3 and 4: Size-resolved relative number abundance of the different particle groups for different flight levels above Praia for particles of < 500nm (left) and > 500nm (right)*

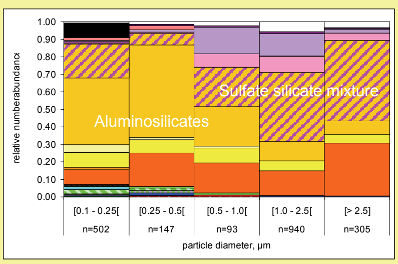



*Fig 5: Average size-resolved relative number abundance of the different particle groups for flight level 900m above the City of Dakar*

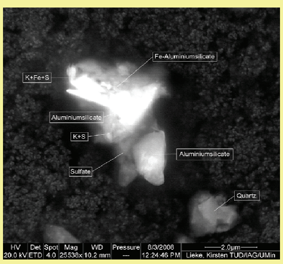



*Fig. 6: Admixture of aluminosilicates with sulfate*

## Methods

The samples were collected with a miniature impactor system, an airborne body impactor, a free-wing impactor, and a sedimentation trap. Carbon-coated nickel discs and polyvinylformal foil with carbon coating on nickel grids were used as substrates. The ground-based sampling equipment was installed 4 m above ground (109 m asl.). The airborne sampling equipment was mounted on the DLR Falcon D-CMET.
The size-resolved particle aspect ratio and the chemical composition is derived by means of electron-microscopical single particle analysis and energy-dispersive X-ray analysis with an Environmental Scanning Electron Microscope FEI, Quanta 200 FEG and a Transmission Electron Microscope Phillips CM-20 ($LaB_6$).

As ammonium sulfates are a dominant particle group among the fine and ultra-fine particles and occur mixed with other particles, their residuals are of great interest. Therefore, the behavior of ammonium sulfate particles under electron bombardment is investigated by means of transmission electron microscopy. First preliminary results show that there are only few or even none particulate residuals. After some seconds under the electron beam there is an annular frame left, following the primal shape of the particle, as shown in Fig. 8. The components of this residual have not been identified yet.

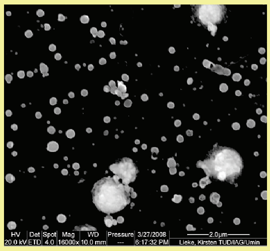


*Fig. 7: Ammonium sulfate and aged sea salt*

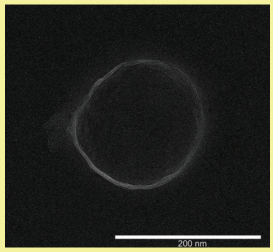
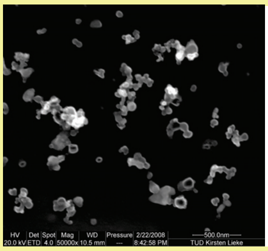
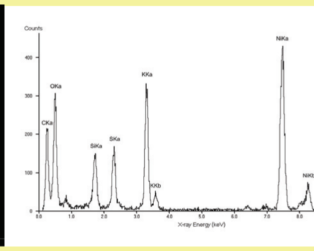



*Fig. 8: TEM image of Ammonium sulfate residuum*

First preliminary calculations indicate the presence of sulfate as a coating on most particle groups.

Samples from biomass burning aerosol (upper layers) contain a high number of soot particles and soot agglomerates. As sulfur is detected within these particles and they are modifying under electron bombardment, it can be concluded that they consist of aged soot. Potassium is also detected in those particles (see Fig. 10). First preliminary calculations lead to the assumption, that it may be present as a coating as well.





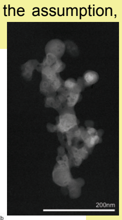




*Fig. 9: Soot and soot agglomerates*

*Fig. 10: X-ray spectra of a potassium- and sulfur-containing soot agglomerate*

*Fig. 11: TEM image of a soot agglomerate*

## Conclusions

- **Particles in coarse mode consist mainly of aluminosilicate agglomerates and mixed particles.**
- **Sulfur is present as coating and inside the particles**
- **Particles may contain different coatings**
- **Potassium is found in many particles, probably as a coating on some of them**
- **Soot from biomass burning layers may be internally mixed with sulfate**
- **High variability in fine and ultra-fine mode**
- **Mixtures at Cape Verde Islands are usually more complex than over the African continent** (earlier measurements: Kandler et al. 2009)

## Reference

Kandler et al. 2009: Size distribution, mass concentration, chemical and mineralogical composition, and derived optical parameters of the boundary layer aerosol at Tinfou, Morocco, during SAMUM 2006. Tellus 61B, in press.

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