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.

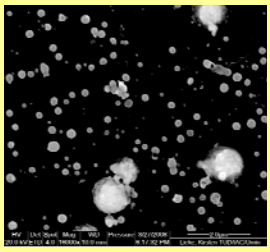


Fig. 5: Ammonium sulfate and aged sea salt

Fig. 6: Admixture of aluminosilicates with sulfate

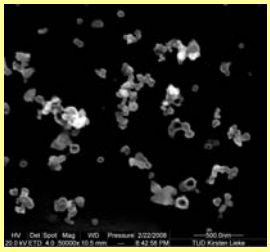
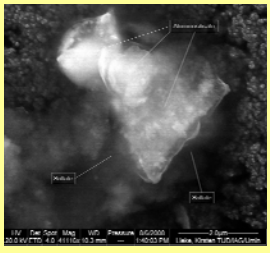


Fig. 7: Soot and soot agglomerates



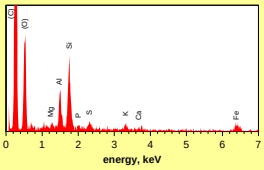


Fig. 8: Aluminosilicate particle mixed with sulfate and its X-ray fluorescence spectrum

Results

As shown in Fig. 1 to 4, the size-resolved chemical composition shows a high dominance of aluminiosilicate particles, most of them iron-containing (see Fig. 6 and 8). Another important particle group are the sulfate silicate mixtures. Regarding the vicinity of the sampling site to the sea, the amount of sea salt and aged sea salt is remarkably low for the ground-based samples. Quartz is present as a minor component. Calcium-dominated minerals are found in traces.
A high variability in composition exists for the particles smaller than 0.25 µm. Most of the measured ground-based samples show a dominance of ammonium sulfate for particles smaller than 0.5 µm (more than 90%, see Fig. 1 and 5). In contrast, ammonium sulfate is a minor component only for the airborne samples.
Samples from biomass burning aerosol (upper layers) contain a high number of soot particles and soot agglomerates (Fig. 3). An ensemble of these particles is shown in Fig. 7. As sulfur is detected within these particles and they are modifying under electron bombardment, it can be concluded that they consist of aged soot. To a minor extent, potassium chloride particles are present.
First preliminary calculations indicate the presence of sulfate as a coating on most particle groups. In addition, potassium is found on many particles, but its distribution inside the particle could not yet be determined, though hints exist that it may also be present as a coating on a fraction of the particles.

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, accepted.

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.

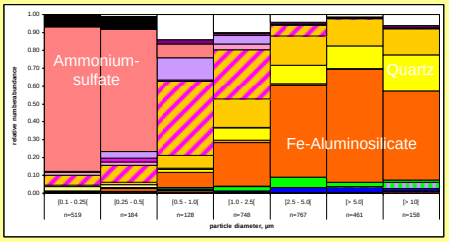


Fig. 1: Size-resolved relative number abundance of the different particle groups averaged for all ground-based samples of Jan. 25th. 2008 at Praia. n is the number of particles analyzed.

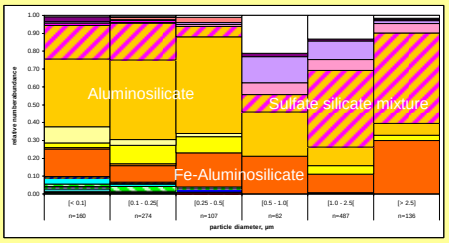


Fig. 2: Size-resolved relative number abundance of the different particle groups averaged for airborne urban and dust samples at 900 m asl. on Jan. 29th, 2008 over the City of Dakar. n is the number of particles analyzed.

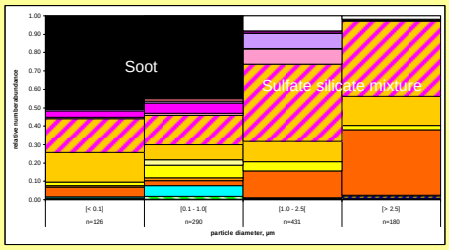


Fig. 3: Size-resolved relative number abundance of the different particle groups averaged for biomass and dust samples at 900 m asl. on Feb. 4th, 2008 south of Cape Verde Islands. n is the number of particles analyzed.

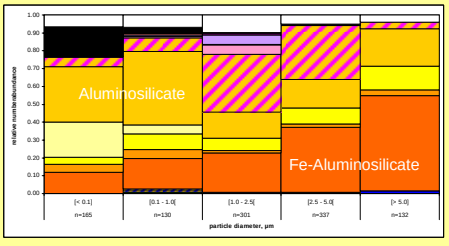
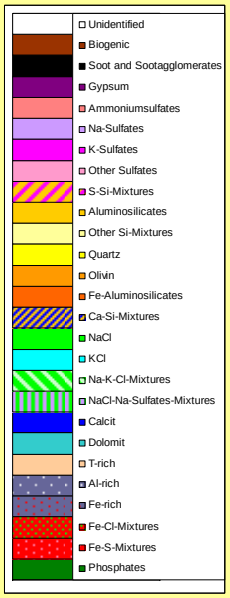


Fig. 4: Size-resolved relative number abundance of the different particle groups averaged for dust samples at 940 m asl. on Jan. 29th, 2008 over Senegal. n is the number of particles analyzed.



Color key for the particle groups

Outlook

Further investigations on soot particles and their agglomerates have to provide more information on the state of aging.
Coatings are to be investigated in more detail by calculations and additional transmission electron microscope analyses.
More samples have to be analyzed to create a more consistent link between their source, age and composition.

Acknowledgments

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