Chemical composition of Saharan dust and sea salt aerosol on Cape Verde Islands 2007

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Surface Ocean Processes in the Anthropocene

Introduction

The eastern part of the central North Atlantic is a major sink of Saharan dust (~20-100 g $m^{-2}a^{-1}$, Fig. 3 left). Desert dust carries many nutrients important for oceanic biota, it's availability controlled by the content and solubility of iron. The solubility of iron is influenced amongst others by chemical reactions on the particle surface.
As part of the German project SOPRAN (Surface Ocean PRocesses in the ANthropocene), aerosol samples were taken for chemical analysis on an atmospheric observatory on the island of São Vicente (Fig. 1, 2). For weekly measurements throughout the year a DIGITEL high volume filter sampler is used. Due to variations in the dust depositions throughout the year (Fig. 3 right), 3 intensive campaigns in summer and winter months took place. During these campaigns a 5-stages BERNER impactor is used for size segregated particle collection.
For chemical characterization determination of mass, inorganic ions (Ion chromatography), monosaccharide (Ion chromatography), OC/EC (Thermography) and first analysis of trace metals (Total X-Ray Reflectory Fluorescence Spectroscopy) was carried out up to now.

Fig. 2: Atmospheric observatory with 30 m-tower for chemical measurements, ~100 m onshore

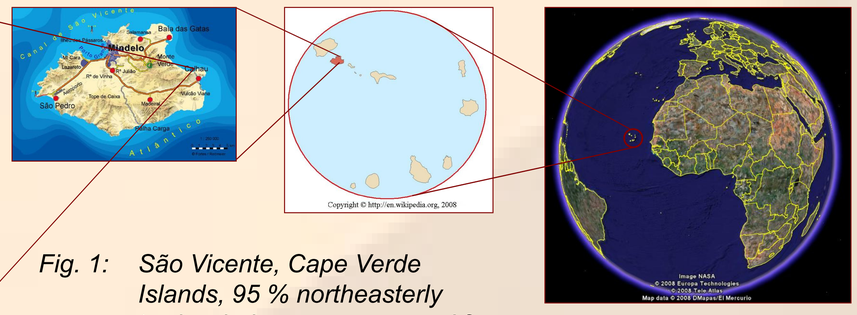
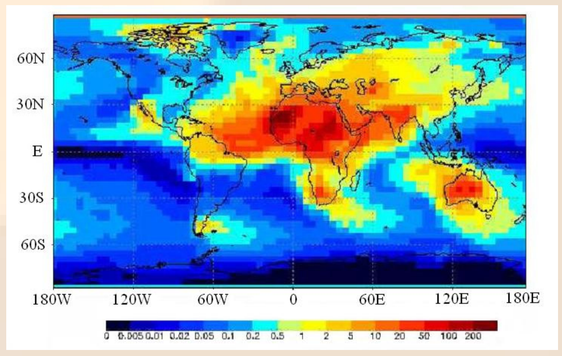


Fig. 1: São Vicente, Cape Verde Islands, 95 % northeasterly trade winds, average annual for temperature: 25 °C, precipitation: 50 mm



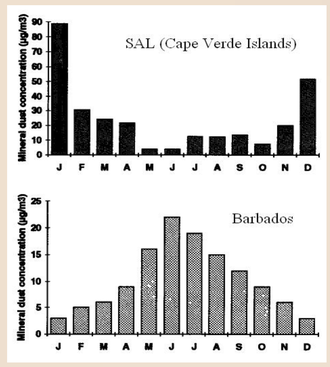


Fig. 3: Dust transport over the Atlantic Ocean: left – dust deposition [g m^{-2} a^{-1}] after Mahowald et al. (1999); right – dust concentration [µg m^{-3}] after Chiapello et al. (1995)

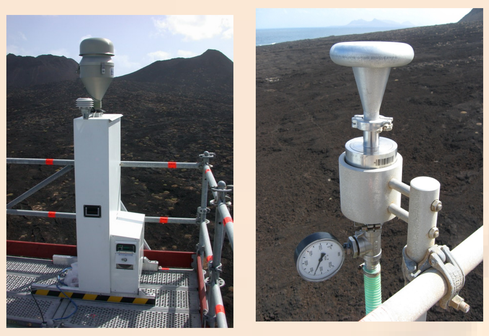


Fig. 4: DIGITEL high volume sampler (left) with PM_{10}-inlet, 500 l min^{-1}, 150 mm quartz fibre filters (Munktell MK 360); BERNER 5 - stages impactor (right), 75 l min^{-1}, collecting on aluminium and Nuclepore® foil, stages lower cut-offs: 0.05 - 0.14 - 0.42 - 1.2 - 3.5 µm,

Results

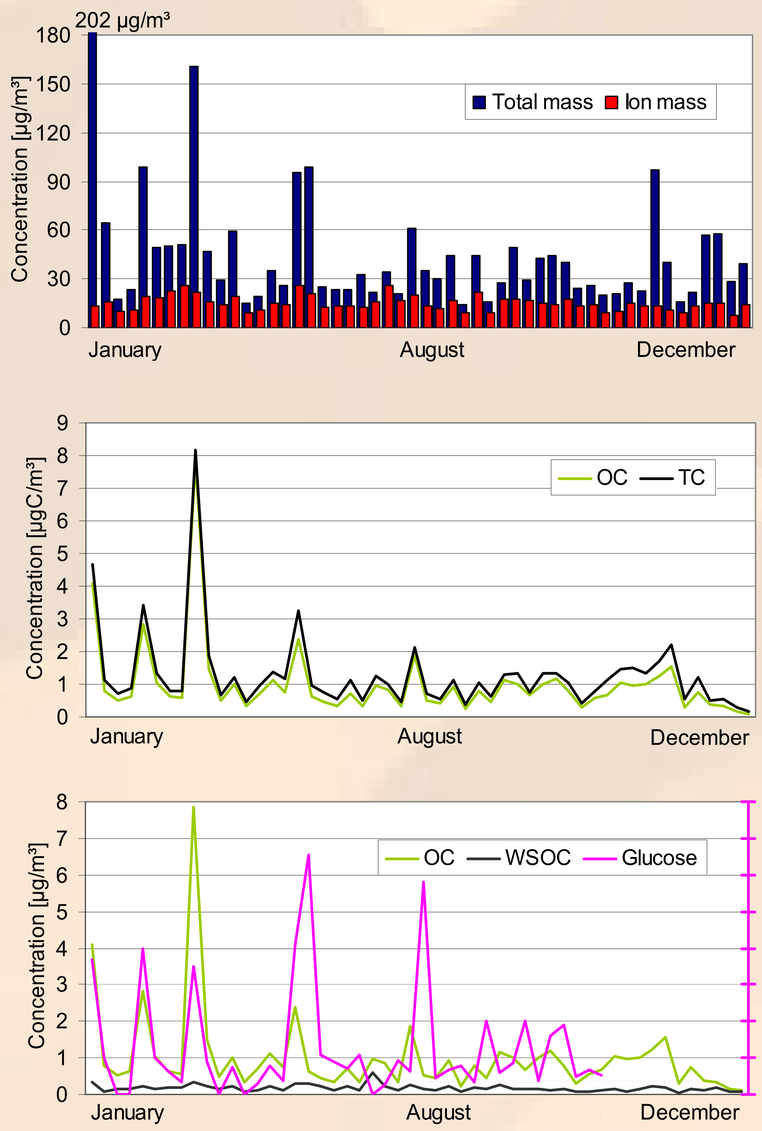


Fig. 5: Weekly averages of total and ion mass, organic (OC) and total carbon (TC), water soluble carbon (WSOC), Glucose from DIGITEL samples

Results

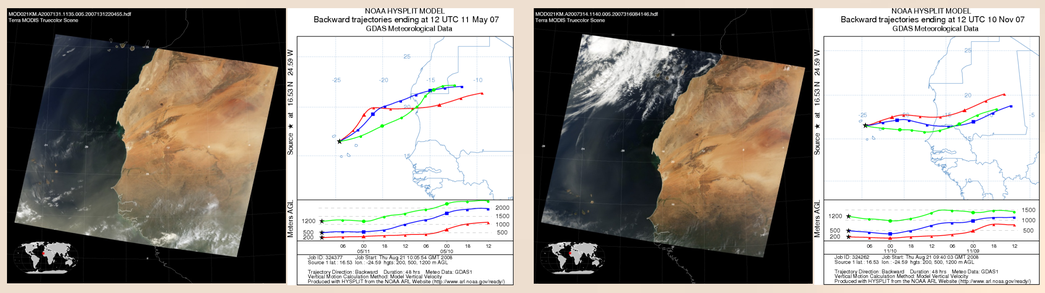


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Fig. 6: Satellite images (MODIS) and backward trajectories (Hysplit) for two dust events

Tab. 1: Total mass concentration as average amounts of 5 samples for dust events and 5 for low dust events from BERNER impactor

Total mass concentration		**Dust events [µg/m3]**	**Low dust events [µg/m3]**
Stage 1	0,05 - 0,14 µm	0.431	0.115
Stage 2	0,14 - 0,42 µm	2.344	1.047
Stage 3	0,42 - 1,2 µm	10.208	0.976
Stage 4	1,2 - 3,5 µm	45.217	3.669
Stage 5	3,5 - 10 µm	31.482	3.412
Sum		89.682	9.219

Tab. 2: Trace-metals of DIGITEL sample 05/10-05/11 (dust event)

Element	**Element conc. [µg/m³]**	**Ratio element to particle mass [%]**
Ca	7.427	2.24
Mn	0.077	0.02
Fe	3.676	1.11
Zn	0.077	0.02

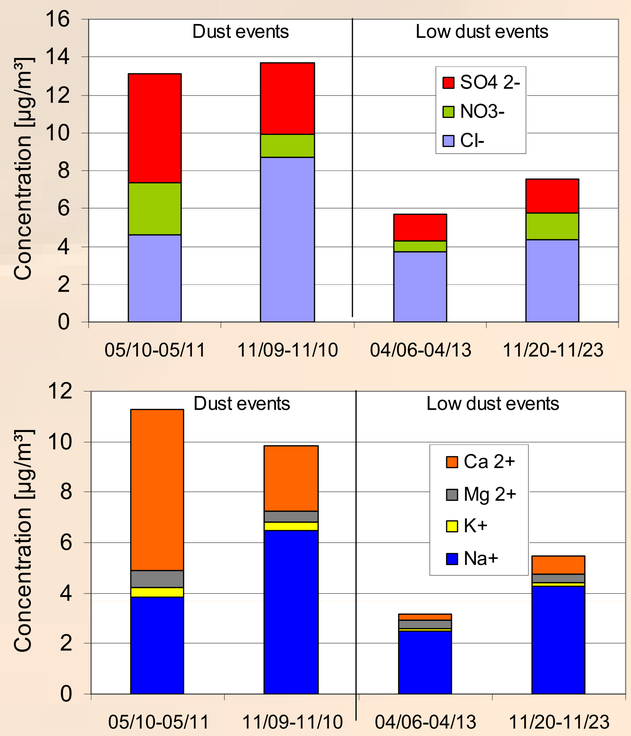

Fig. 7: Anorganic ions of DIGITEL filter samples during dust and low dust events

Summary

The results of the particle analysis show a distinction between dust and low dust events. Dust events are indicated by high loading of total mass compared to ion mass, accompanied by increased amounts of organic carbon and glucose (Fig. 5), supported by satellite and trajectory images (Fig. 6). The higher concentrations of SO_4^{2-} and NO_3^- indicate long range transport, the high Ca^{2+} is probably of mineral origin (Fig. 7). The difference between high and low dust can also be seen in the total mass concentration in the 3 upper stages of the BERNER impactor (Tab. 1).

Acknowledgement

This work was supported by the BMBF within the SOPRAN project under contract FKZ 03F0462J

References

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N. Mahowald, K. Kohfeld, M. Hansson, Y. Balkanski, S. P. Harrison, I. C. Prentice, M. Schulz, and H. Rohde, *J. Geophys. Res.*, 1999, 104, 15.895