Long-term Chemical Characterization of Aerosol at the CVAO (Cape Verde)

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GOALS AND METHODS

Introduction

Cape Verde islands are the best place to investigate aerosols over the tropical NE Atlantic. At the CVAO the PM collection started in 2007, with one important goal being the input of nutrients into the Atlantic Ocean by Saharan dust.

Experimental approach

A PM_{10} HV sampler (DHA-80, Digitel) and a five-stage low pressure impactor (LPI80/0.05, Hauke) were applied to collect PM for chemical analyses. The impactors were used only during intensive campaigns.

In this study the PM samples and cloud water samples were investigated for water soluble ions, H_2O_2, formaldehyde, OC and EC by ion chromatography (ICS3000, Dionex) and a thermographic method (Cmat5500, Ströhlein).

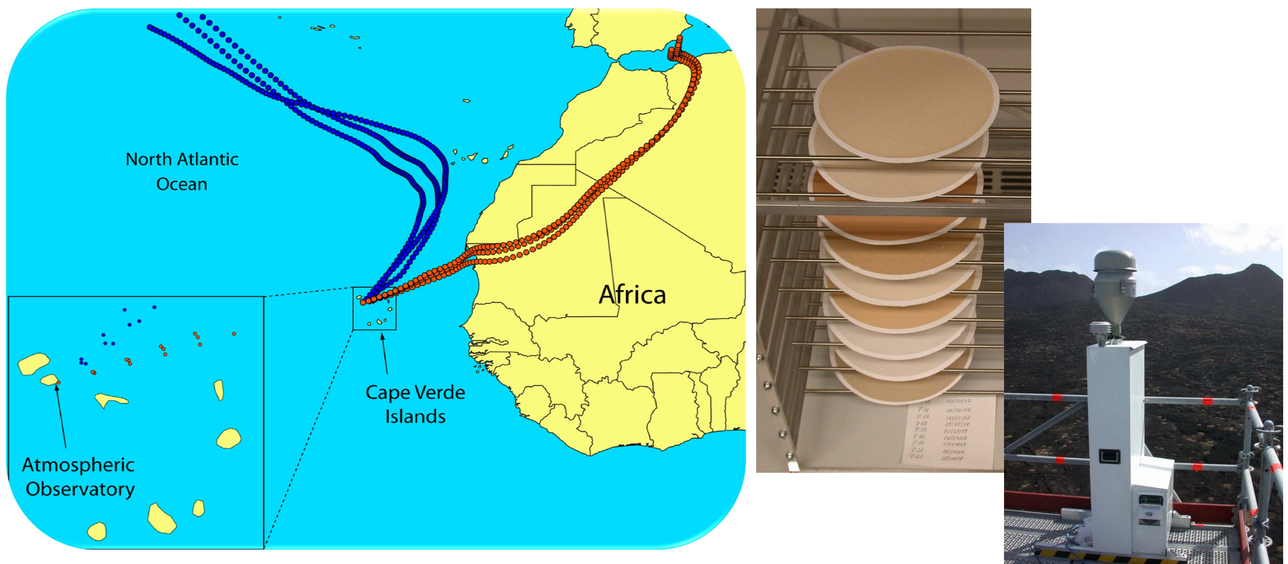


Fig. 1. Typical back trajectories during a winterly (red) Saharan dust event and for a day with clean marine air. Filter samples during conditioning and sampler on the tower.

RESULTS

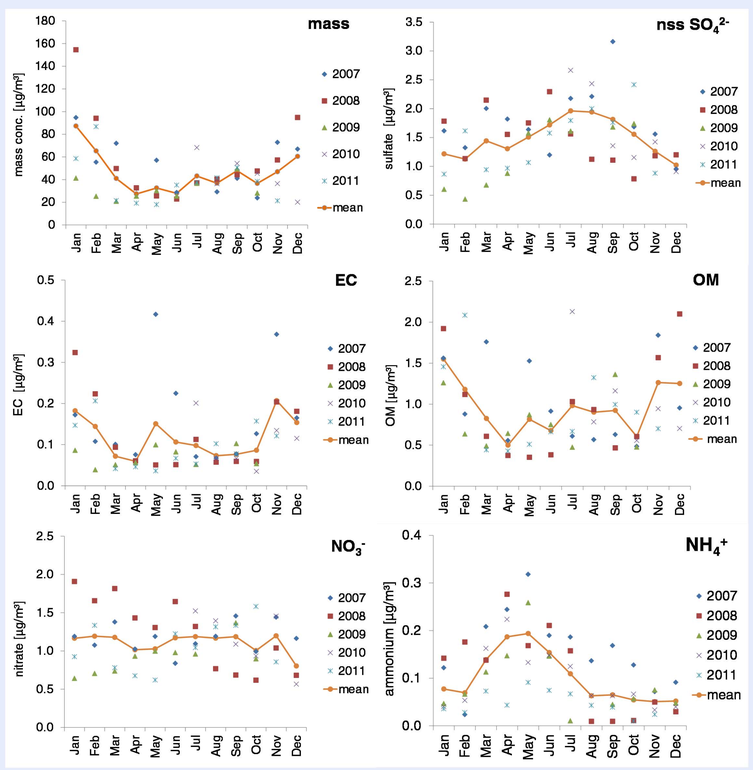


Fig. 2 Annual variability and monthly mean of PM10 mass concentration, non-sea-salt sulfate, EC, OM, nitrate and ammonium from all samples collected on top of the tower

Table 2: Chloride depletion [in % ± standard deviation] in the five size fraction collected by Berner impactor characterized by the air mass origin

Size class Dp [µm]	Sahara	Marine - summer	Marine - winter	Europe	Mean of all
0.05 – 0.14	56±22	n.d.	n.d.	100±	81±13
0.14 – 0.42	50±32	89±11	62±14	100±	78±14
0.42 – 1.2	21±4	84±11	36.2±7	58±12	41±11
1.2 – 3.5	3.6±2.6	27.8±5.3	25.6±5.2	29.9±7.2	26±8
3.5 - 10	6.4±3.7	27.4±7.2	10.2±4.1	28.2±5.1	24±8

Table 1: Seasonality of PM_{10} particle mass concentration collected with DHA-80 HV-filter sampler between January 2007 and November 2011 on top of the tower*.

Mass concentration [µg/m³]	Mar - May	Jun – Aug	Sep – Nov	Dec - Feb	Total
Number of samples	118	124	121	176	539
>200	2	0	1	15	18
90-200	7	4	10	22	43
50-90	9	15	22	30	76
20-50	53	83	69	68	273
<20	47	22	19	41	129

*Samples collected between 23 October 2009 and 09 July 2010 were not included here because of the lower sampling height on the container roof.

Fig. 3 Size-segregated measurements of total iron in aerosols during a winter campaign 2007/2008.

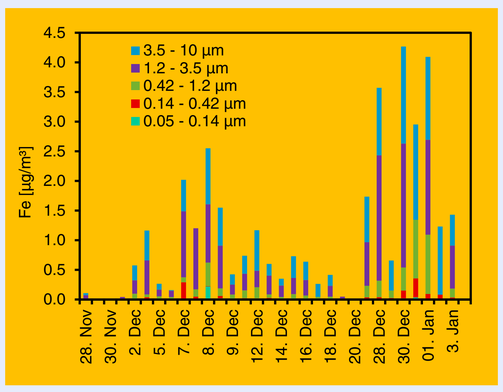
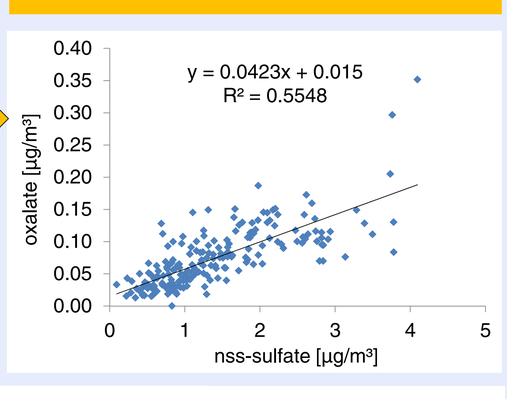


Fig. 4 Correlation of nss-sulfate and oxalate during all measurements between July 2010 and November 2011.



Major observations during HV sampling over five years

- Saharan dust season is from end of November to beginning of March (Tab. 1).
- In the yearly mean Saharan dust was found to 25 µg/m³ before sea salt with 20 µg/m³ and secondary ions with 2.7 µg/m³.
- Iron (Fig. 3) was found during dust events in concentrations up to 5µg/m³.
- Elevated EC is coupled to higher OC values (mainly in winters with air mass origin in Westafrica) but for OC during summer higher concentrations were observed from marine production.
- Ammonium, nss-sulfate, EC and OM were found in ultrafine and fine particles preferentially (Fig. 5).
- Ammonium was found with a spring maximum coupled to chlorophyll A.
- In clean marine air masses nss-sulfate is correlated to oxalate (R^2 >0.9) in all other samples a lower correlation (Fig. 4) was found.
- Nitrate is found during summers to 97% in coarse mode and to 88% in winters.
- Chloride depletion (Tab. 2) was found in nearly all samples (depending on air mass):

  Europe > marine summer > marine winter > Sahara

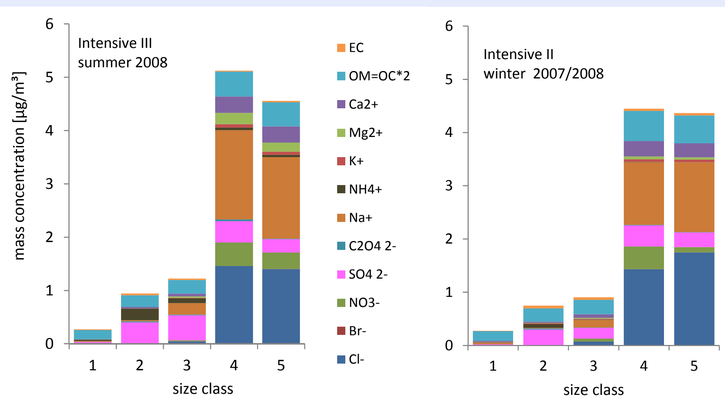


Fig. 5 Mean constitution of PM (without dust) during a summer and a winter campaign.

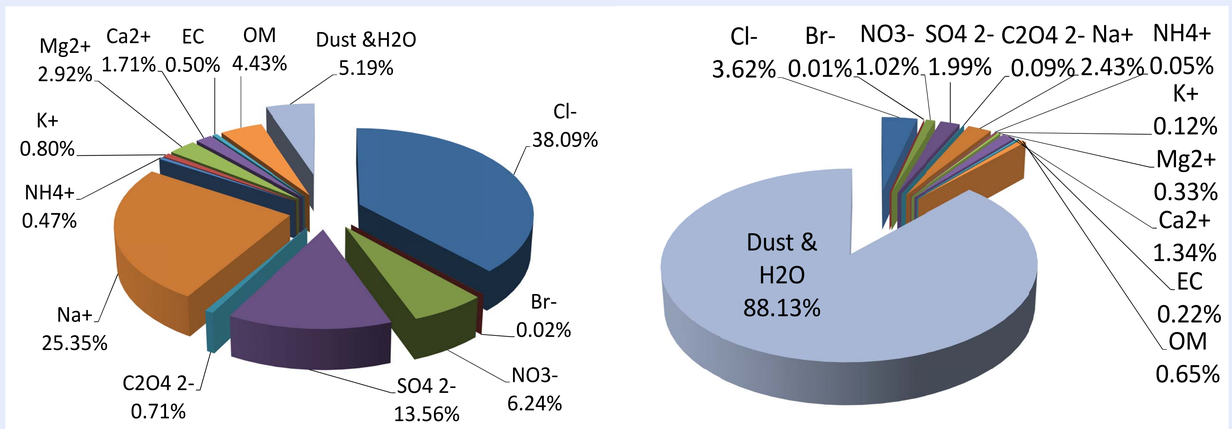


Fig. 6 Mean PM_{10} constitution of 183 marine samples (left) and 49 mineral dust dominated samples (right).

SUMMARY AND OUTLOOK

The CVAO is an excellent place to investigate Saharan dust and marine aerosols.

Saharan dust and sea salt are the dominating aerosol constituents.

Non sea salt components were found from long range transports from Africa and Europe or were formed from marine precursors.

Interannual variability and seasonality were observed for all components.

In close cooperation with oceanic research the effects of PM deposition and the feeding by mineral dust and accompanied secondary species will be investigated.

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