Aerosol – Ocean Interaction: Oceanic Import of Dust

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Surface Ocean Processes in the Anthropocene

TROPOS Leibniz Institute for Tropospheric Research

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Long term measurements of aerosols at the CVAO

Physico-chemical Characterisation and Variability of Aerosols

Aims and Approach

The CVAO (Fig. 1) is an ideal place to investigate interactions between sea salt, Saharan dust, naturally and anthropogenically produced particles. The deposition of Saharan dust into the ocean is measured for the first time at a permanent sampling site in the tropical North Atlantic Ocean. The size selective collection of the particles was carried out in campaigns using a five-stage BERNER impactor. Size distribution measurements and the determination of dust deposition rates are important results of the measurements at the CVAO

What can we learn from the size distribution?

- The submicron fractions contain mainly secondary ionic compounds from natural and anthropogenic sources as well as elemental and organic carbon species.
- The supermicron fractions consist of sea salt, Saharan dust, nss-sulfate, and nitrate which are exchanging carbonate in dust and chloride in sea salt.
- The solubility of transition metals is decreasing with PM diameter.
- Nano-particles were dominated by organic matter. In the second fraction (d_P=140-420 nm) the nss-sulfate is the most prominent species.
- Dust and sea salt were found in the size classes 3 to 5 (d_P=420 nm-10 µm) and dominate the supermicron fractions.

What can we learn from the continuous measurements?

- Seasonality of Saharan dust
- Influences from continental emissions from Africa, Europe, and North America
- Marine contributions to the aerosol
- Physico-chemical aging properties of particles

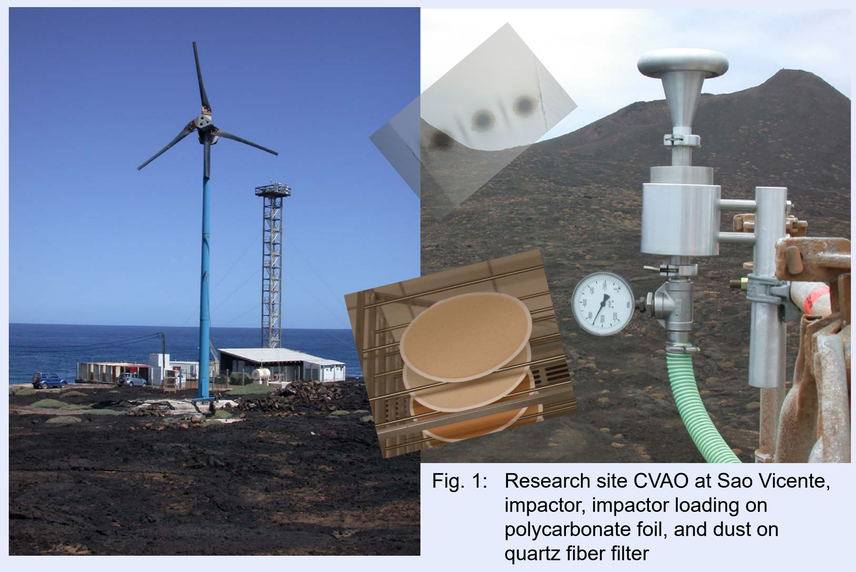

Fig. 1: Research site CVAO at Sao Vicente, impactor, impactor loading on polycarbonate foil, and dust on quartz fiber filter

MEASUREMENTS AND RESULTS

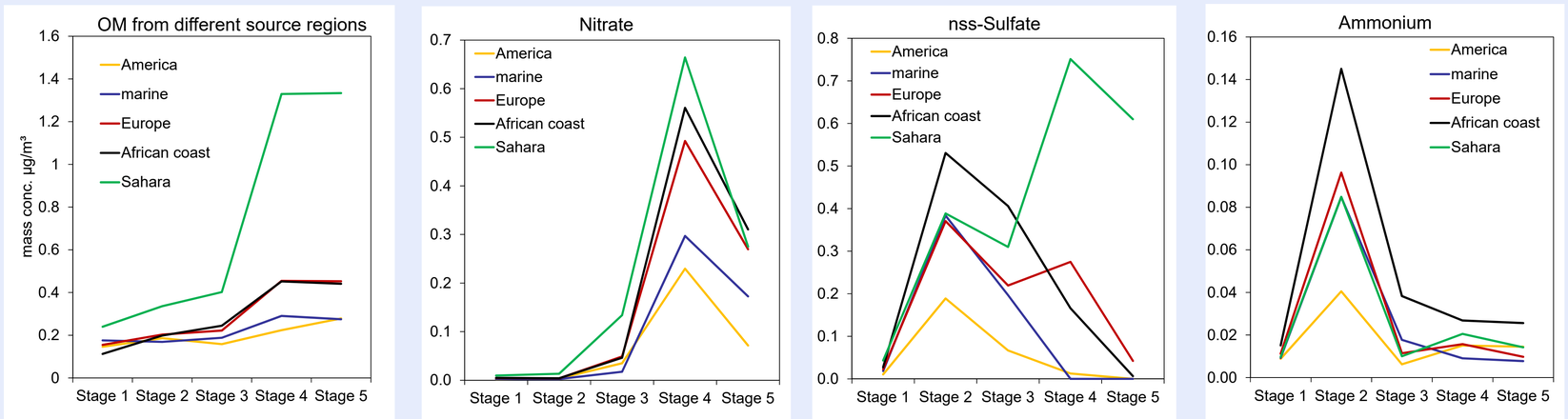

Fig. 2: Size distribution (lower cut-off: St. 1 - 0.05µm, St. 2 - 0.14 µm, St. 3 - 0.42 µm, St. 4 - 1.2 µm, St. 5 - 3.5 µm) of selected aerosol constituents

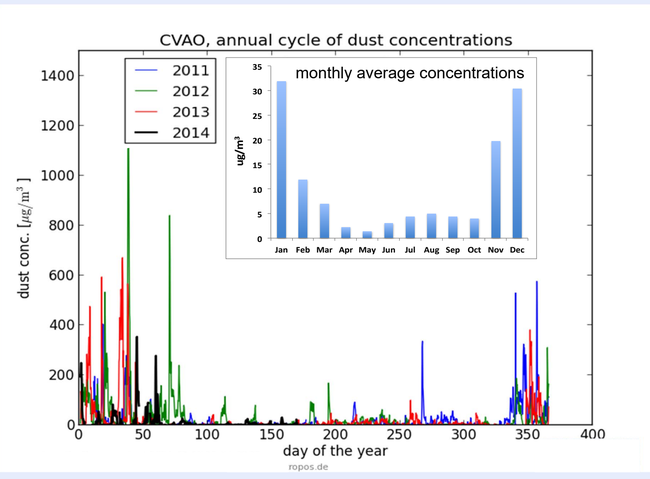

Fig. 3: Annual variability of dust concentration measured by SMPS/APS at the CVAO

Size segregated aerosols showed different chemical composition in the fractions (Fig. 2 & 4)

- Mineral dust was found in Saharan aerosol, and in European, and African coast aerosol as well.
- The size distribution of OM differs between the continental and mainly marine aerosols.
- Maximum concentrations of all species were transported with Saharan dust to the CVAO.
- Pure marine and America influenced aerosols have comparable chemical compostion except for the metals.
- Sea salt chloride in the coarse mode particles was substitued by nitrate and sulfate.
- Additionally, during dust events nitrate and sulfate substituted carbonate in dust particle.

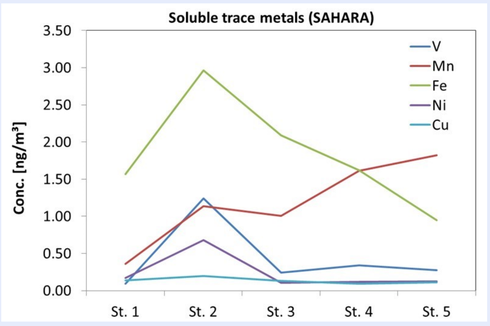

Fig. 4: Size distribution of soluble transition metals (mean of winter campaign 2012)

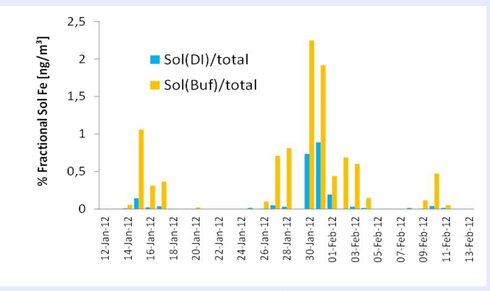

Fig. 6: Temporal variation of soluble iron in DI water and acetate buffer (pH 4.8)

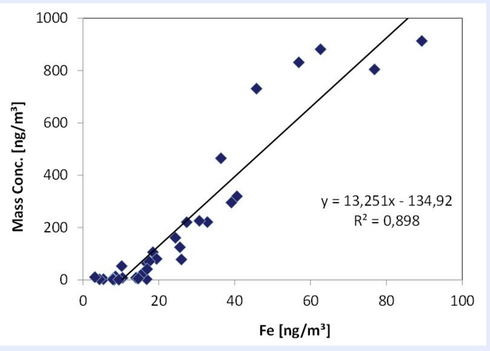

Fig. 7: Total iron in PM_{10} aerosol during winter 2009 campaign

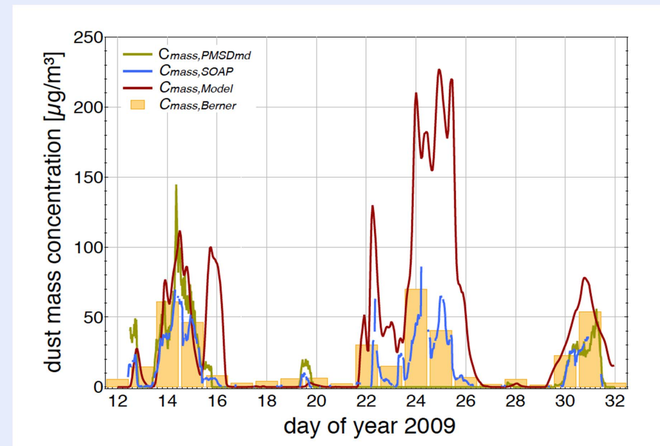

Fig.5: Dust mass concentration variation during winter campaign 2009, measured and modelled

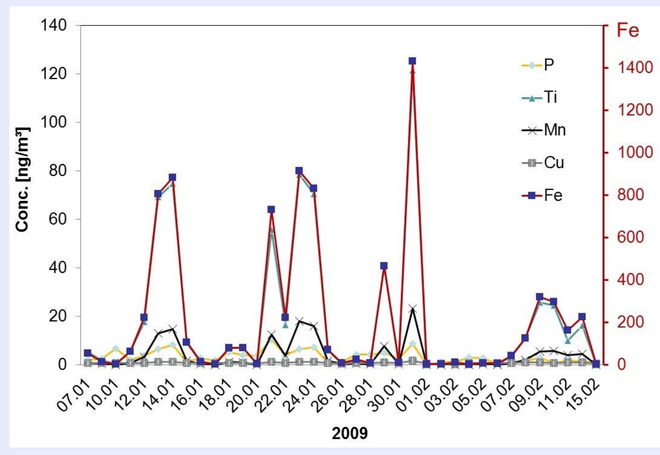

Fig. 8: Concentration variation of selected trace elements during winter campaign 2009

Summary and Outlook

- The collection of aerosols at the CVAO over eight years has shown a strong seasonal variabilty for the import of Saharan dust with a maximum during the Harmattan season (End of November till beginning of March) and a distinct interannual variation.
- Different methods of dust mass concentration measurements agree but the model sometimes overestimates the dust (Fig. 3 & 5).
- The size distribution of species in the aerosol differs in wide ranges:
  - Organic matter dominates the nano-particles but highest concentration was found in coarse mode PM.
  - Ammonium was found mainly in accumulation mode (d_p=140-420 nm).
  - Nss-sulfate was found often with a bimodal distribution.
  - Nitrate was found only in coarse mode particles (substitutes chloride).
  - Solubility of iron showed no direct dependence on total iron content but varied with particle size and air mass origin (Fig. 4 & 6).

To Do List:

- Input of data in PANGAEA
- Publication of results of the size segregated characterization of PM
- Joint publication of the observations around the dust event in February 2012
- Joint publication about the effects of dust deposition on the oceanic primary production of biomass

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Recent Publications

Fomba, K.W., Müller, K., van Pinxteren, D., Herrmann, H., Aerosol size-resolved trace metal composition in remote northern tropical Atlantic marine environment: case study Cape Verde islands, Atmos. Chem. Phys., 13, 4801-4814, 2013, DOI 10.5194/acp-13-4801-2013

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