Aerosol trace metals and chemical composition of Saharan dust

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SOPRAN Surface Ocean Processes in the Anthropocene

TROPOS Leibniz Institute for Tropospheric Research

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Introduction

Fig. 1. Cape Verde Atmospheric Observatory (CVAO) with a 30 m-tower for aerosol particle sampling , ~100 m offshore.

Mineral dust deposition onto the oceans is a vital nutrient source to the ocean microbes and thereby influences the oceanic biogeochemical cycle and thus the oceanic emissions.

Chemical and trace metal composition of Saharan dust aerosol have been characterized during a 6 weeks intensive field studies in winter 2012 at the Cape Verde Atmospheric Observatory (CVAO, Fig 1).

Experiment and Sampling

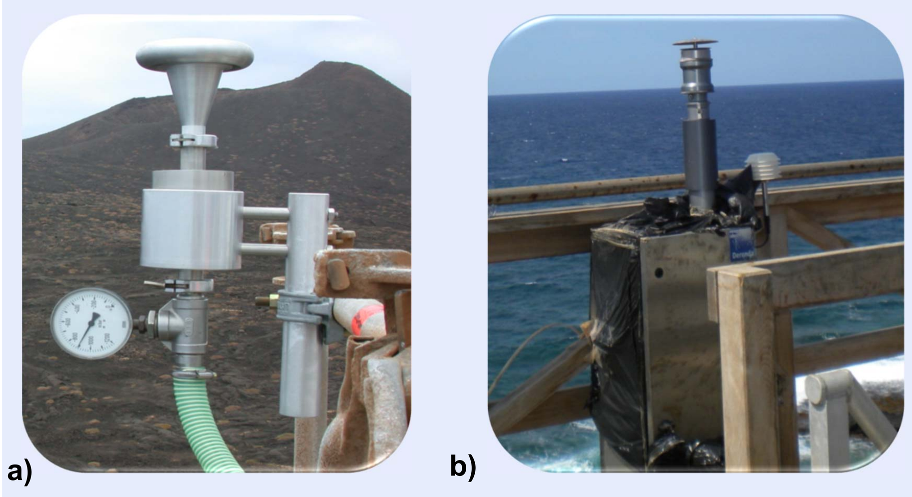

Fig. 2. a) 5-stage BERNER impactor with 75 l/min, sampling rate, stage cut-offs: 0.05 - 0.14 - 0.42 - 1.2 - 3.5 -10 µm. b) Derenda low volume sampler with PM_{10}-inlet, 4 m³/h sampling rate

Aerosol particles were collected at the top of a 30 m tower using a high volume DIGITEL DHA-80 for bulk PM_{10} particles and a five-stage BERNER impactor (Fig. 2a) with PM_{10} cutoff 0.05-10 µm for size resolved analysis.

A low volume (DERENDA) PM_{10} sampler (Fig. 2b) was operated for soluble trace metal analysis. The filters were leached in DI water (pH 5.5), acetate buffer (pH 4.5), via shaking for 2 hours and filtrate were analyzed for water soluble metals including Fe (III), Fe (II).

Trace metals

Element	Min [ng/m³]	Max [ng/m³]	Average [ng/m³]
Al	524	26,487	4,434
Si	189	47,689	7,291
Ca	129	21,450	3,089
Fe	57	31,861	3,794
Ti	3.7	2,517	311
Mn	0.3	472	60
Sr	2.9	302	47
Cr	0.7	64	9.6
Cu	0.3	26	3.9

Table 1. Trace metal concentrations of give metals with siginificant differences observed between high dust and low dust periods.

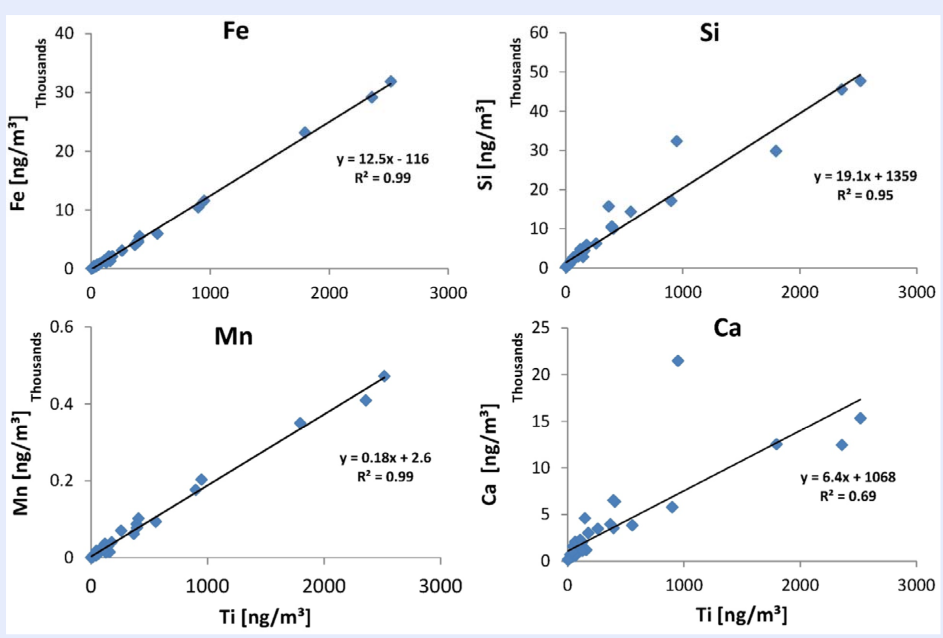

Fig. 7. Ti showed good correlation with other crustal metals making it a suitable tracer for dust

- Differences in 3 order of magnitude was observed for iron concentrations.
- Titanium showed good correlation with crustal metals and was consider as tracer for mineral dust
- A reciprocal relationship was found between soluble iron and total iron with higher soluble iron observed during periods of low dust and vise versa.
- Enrichment factor analysis with respect to titanium shows that , high soluble iron was often observed during periods of high anthropogenic air mass influence
- Vanadium enrichment showed good correlation with soluble iron implying anthropogenic sources of iron played an important role in iron solubility during this period.

Results

Strong variation in aerosol mass concentration with peak concentrations of about 880 µg/m³ observed with the aerosol mass concentrated in the coarse mode. Inorganic ions dominated ionic composition in fine and coarse mode. High organic matter observed during periods of high mass concentration with most of organic mass found in the coarse mode

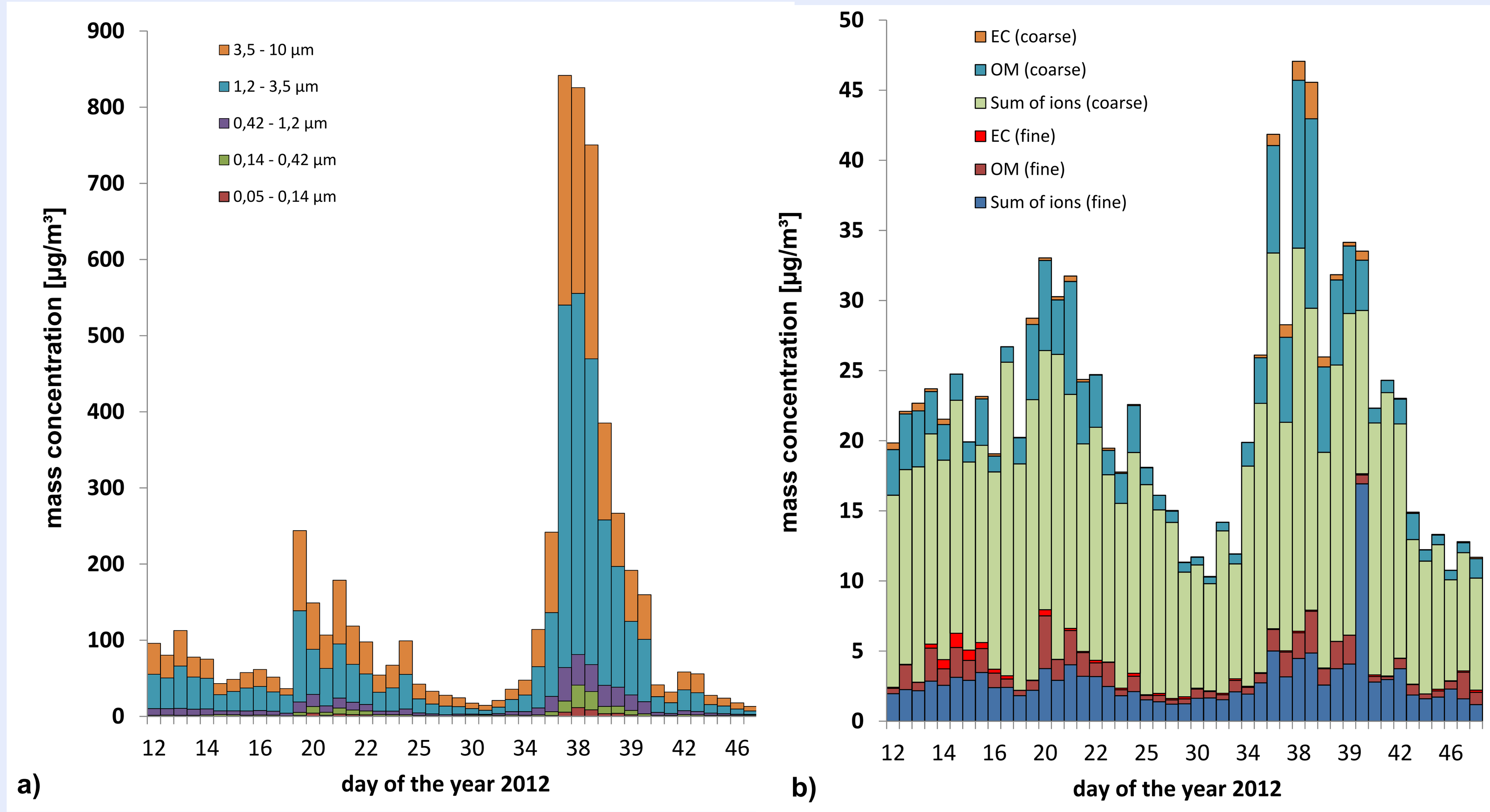

*Fig. 3. Size resolved aerosol **a)** mass concentration and **b)** chemical components during a six weeks intensive campaign in winter at CVAO.*

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Iron was concentrated in the coarse aerosol fraction and soluble iron was mainly present in its iron (III) state.

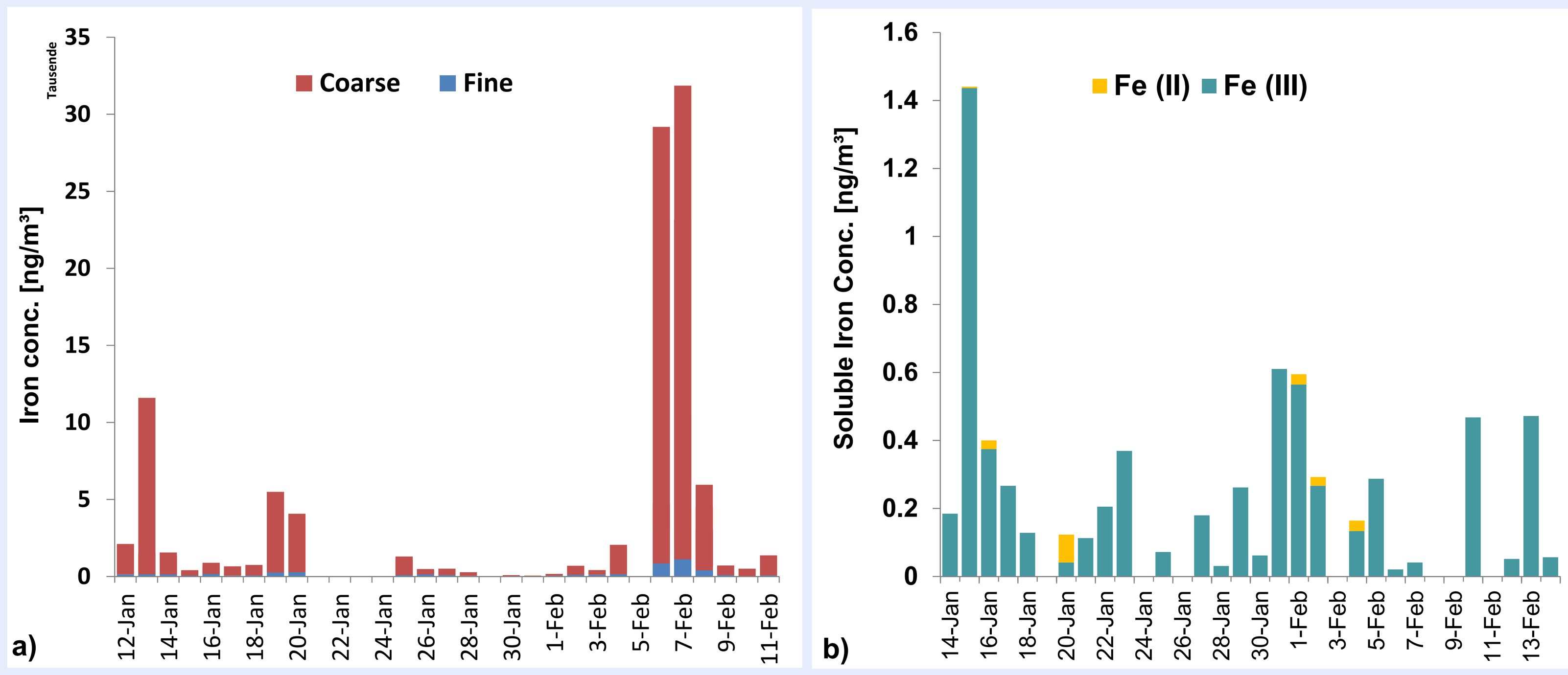

*Fig. 4). Temporal variation of **a)** size resolved iron and **b)** soluble iron (II) and iron (III) concentrations*

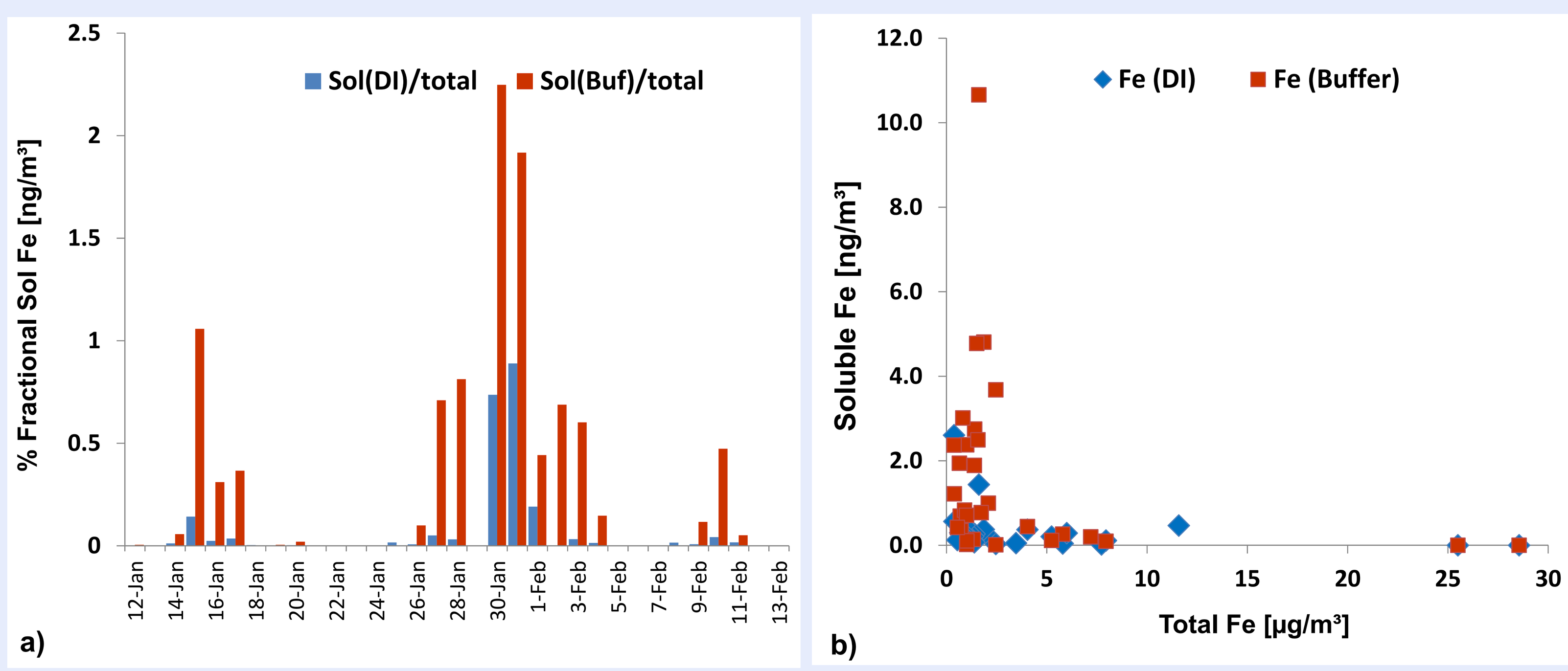

*Fig. 5: **a)** Variation in fractional soluble iron in deionized water (DI) and acetate buffer and **b)** scatter plot of soluble iron against total iron.*

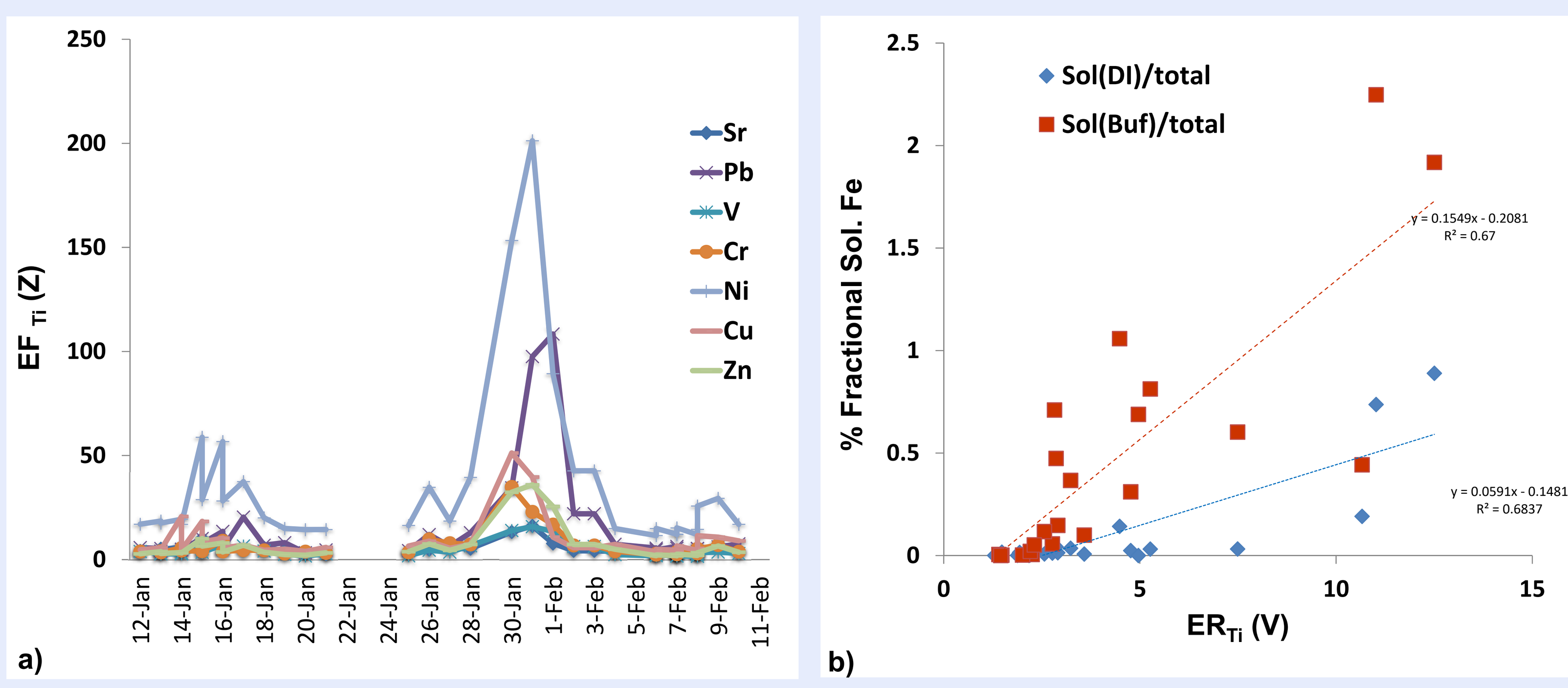

Fig. 6. Variation of enrichment factor (with respect to Titanium) of selected trace metals and b) good correlation between enrichment of vanadium and fractional soluble iron.

References

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