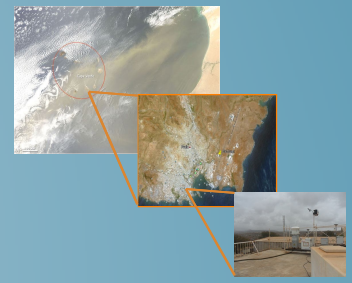
CV-Dust: Atmospheric aerosol in the Cape Verde region: carbon and soluble fractions of PM_{10}

D. Custódio (1), C. Pio (1), T. Nunes (1), J. Cardoso (1,2), A. Caseiro (1), M. Cerqueira (1), D. Patoilo (1), S. M. Almeida (3), and M. C. Freitas (3)
(1) CESAM & Department of Environment, University of Aveiro, 3810-193 Aveiro, Portugal, (2) University of Cape Verde, 279 CPraia, Santiago, Cabo Verde, (3) ITN/MCTES - 2686-953 Sacavém, Portugal
danilocustodio@ua.pt

INTRODUCTION

Every year, billions of tons of eroded mineral soils from the Saharan Desert and the Sahel region, the largest dust source in the world, cross Mediterranean towards Europe, W. Asia and the tropical N. At. Ocean as far as the Caribbean and S. America. Many aspects of the direct and indirect effects of dust on climate are not well understood and the bulk and surface chemistry of the mineral dust particles determines interactions with gaseous and other particle species. The quantification of the magnitude of warming or cooling remains open because of the strong variability of the atmospheric dust burden and the lack of representative data for the spatial and temporal distribution of the dust composition.



EXPERIMENTAL

Particulate matter was sampled simultaneously with a Hi-Volume sampler (Tisch) and a low-volume sampler (Partisol), both with standard PM_{10} inlet heads, between January 2011 and January 2012. 115 parallel samples were collected. Teflon filters with 0.45 µm pore size and quartz filters were used with low and high volume samplers, respectively. Teflon filter samples were used to quantify inorganic water soluble species by ion chromatography; quartz filter samples were used to quantify carbonaceous species. PM_{10} total mass concentrations were quantified by gravimetric method. Carbonate fraction was determined by sample acidification with phosphoric acid and the CO_2 evolved measured with a NDIR gas analyzer. Organic and elemental carbon were determined by using a thermal-optical transmission technique after removing carbonates, by exposing the filters to HCl vapours (Castro et al., 1999).

RESULTS AND DISCUSSION

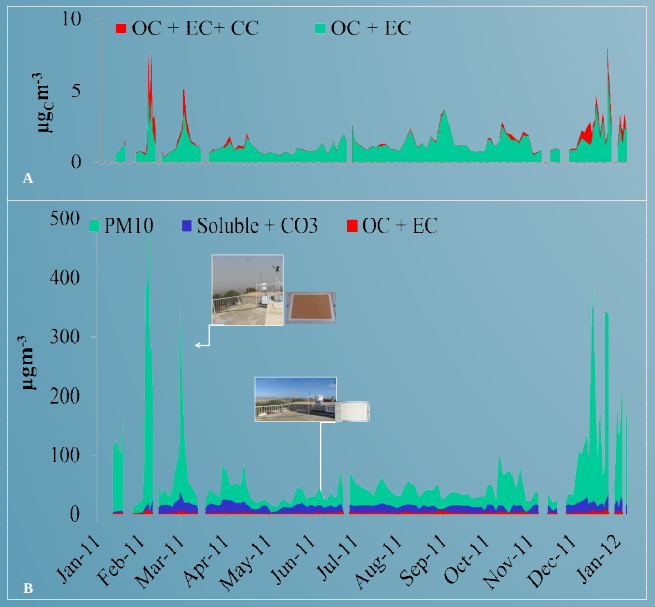


Figure 1: A) Total Carbon (OC = Organic Carbon; EC= Elemental Carbon; CC= Carbonated Carbon); B) PM_{10}, Soluble ions + CO_3^{-2} and non-Carbonated Carbon (OC + EC).

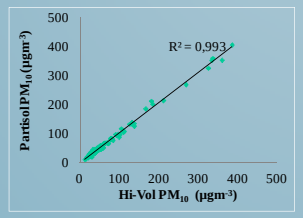


Figure 2: Comparison of Hi – Vol. and Partisol samplers PM_{10} total mass concentration levels.

Table 1: Average PM_{10} concentrations and % of WSII, carbonate and non-carbonated carbon (OC + EC) during dust season (Oct – Apr) and non dust season (May – Sept.).

Periods	%			µgm-3
	WSII	CO_3^{-2}	OC + EC	PM_{10}
Dust	20.9	1.32	2.35	68.2
non Dust	32.3	0.49	4.19	39.8

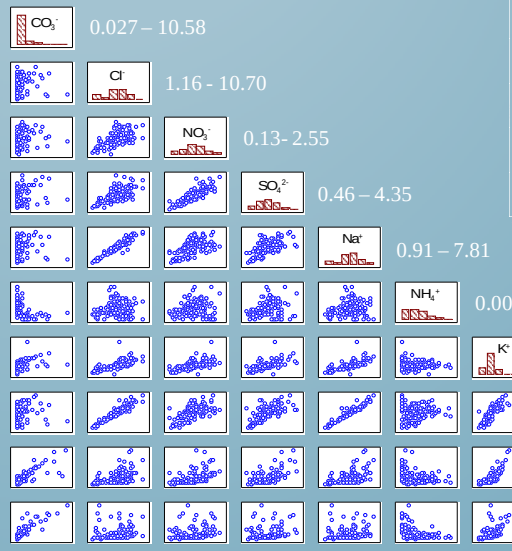


Figure 3: PM10 mass and Ions relations and histogram distributions (six classes) in Cape Verde Aerosol. Range concentration of each ion (µgm^{-3}) is showed in brackets.

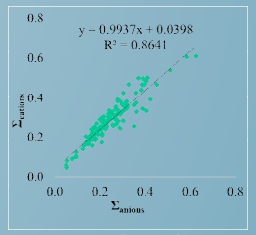


Figure 4: Correlation between total anions (WSII+CO_3^{-2}) and total cations (WSII) analyzed in Cape Verde samples

Figure 3 displays the relations between soluble inorganic ions and PM_{10}. High correlation between chloride and sodium is observed (r^2= 0.88). The same for chloride/magnesium (r^2 = 0.84), and for sodium/magnesium (r^2 = 0.91). The results reveal similarity with sea water ions ratios, which denote the importance of sea salt contribution to respective ions in the samples. High correlations were also observed between carbonate and calcium (r^2 = 0.80), same as between calcium and potassium (r^2 = 0.69), which may indicate the influence of Saharan dust transport. The ionic balance without carbonate contribution displays a strong deficit in negative ions. The addition of carbonates neutralize this deficit (figure 4); during high dust events not all carbonate is water soluble.

PM_{10} concentrations at Cape Verde Island show a high variation, ranging between <15µg m^{-3} up to 500 µg m^{-3}. (sampling time range 8 h – 48h)

During dust events the contribution of water soluble inorganic ions (WSII) to PM_{10} mass concentration decreased significantly to values lower than 10% . During non-dust period WSII could represent more than 60% of PM_{10}. Ca^{2+} + Carbonates contribute with 2.79 ±1.43 % of PM_{10} mass, however carbonate during some dust events could be the main carbon species present in PM_{10}. Organic and Elemental carbon account in average to 2.0 ± 1.4% of PM_{10}. During dust events, PM_{10} mass concentration at Cape Verde is dominated by insoluble mineral species.

CONCLUSIONS

Organic component represents a low percentage of Cape Verde aerosol
Sea salt source and Saharan dust events affect strongly the local atmospheric aerosol. In non dust condition aerosol is dominated by soluble fraction. Characterization of insoluble fraction is in course by mineralogical analysis and will be presented in the future.

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