DEFENDED ePOSTER

High variability of dust composition in the Saharan Air Layer

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Every year, 1500-2000 Tg of dust are emitted from soil to the atmosphere. The resulting aerosol dust particles have a size ranging from sub-1 µm to tens of microns, and a lifetime from hours to two weeks. Aerosol dust impacts on climate and on biogeochemical cycles, and is involved in the Earth System.

About 50 to 70% of global dust emissions occur in North Africa. Most of dust exports to the Atlantic occur in the so-called Saharan Air Layer, a warm, dry and dusty high-altitude air stream that reaches the Americas. At the Izaña Observatory, 2400 m.a.s.l. in Tenerife (Spain), we studied

(i) the variability of dust composition in the Saharan Air Layer,

(ii) the North African sources and (iii) the large-scale meteorology prompting the variability observed.

For this purpose, we performed

(i) one-hour resolution sampling of aerosols, followed by

(ii) PIXE (Particle bombing Induced X Ray Emission) analysis, and

(iii) further data interpretation with meteorological tools and satellite observations.

During one-week dust events, we found that the ratios of some elements (e.g. Ca, Mg or K, among others) to Al (soil tracer) changed by a factor of about 2 in a few (5-7) hours. This high variability in dust points to a concatenation of the sources contributing to dust over the North Atlantic.

By back-trajectory analysis, Median Ratios At Receptor plots and MODIS and MSG – SEVIRI satellite observations, we observed that the sources activated during the study period were located in topographical lows located in three main regions:

NE Algeria – Tunisia (dust rich in Ca, Sr, Mg and K),

W Algeria-E Morocco (Na and Cl) and

N Mali-S Algeria (rich in Si and Fe).

In a six-day period, there were seven concatenated impacts from the sources identified, which were traced by the variability in the ratios of the different elements to Al.

These results provide a new and more complex view of the dust exported to the Atlantic, compared to the simplistic approach based on bulk-dust measurements and modelling.

These results have implications of the impact and influence of dust on climate.

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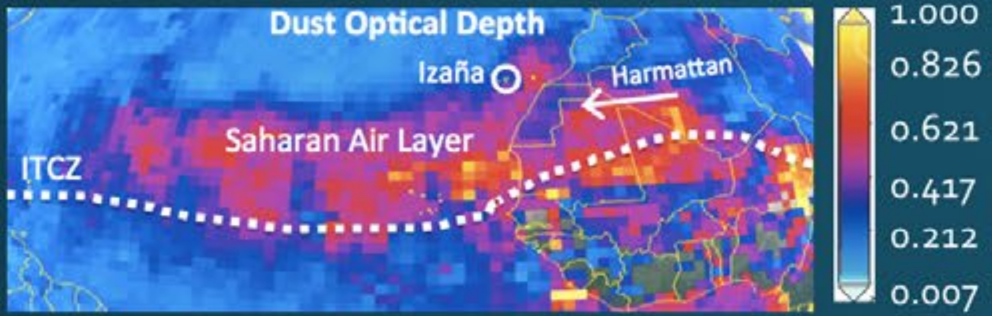


Fig. 1. Saharan Air Layer, detected as Dust Optical Depth by MODIS satellite sensor.

Introduction

Every year ≈2000 Tg of dust are emitted to the atmosphere. North Africa accounts for 50-70% of global emissions. Dust is mostly exported to the Atlantic in a dusty airstream so-called Saharan Air Layer (SAL, Fig .1).

Dust influences on climate by (i) scattering and absorbing sunlight, (ii) catalysing the ice clouds (cirrus) formation and (iii) providing bioavailable iron to the ocean and thus influencing the CO_2 exchanges between the ocean and the atmosphere. Dust impacts depend on dust microphysical properties, which are influenced by its mineralogy and mixing with pollutants. Based on measurements performed in Izaña Observatory (2400 m.a.s.l.) Tenerife, **we studied** the variability of dust composition, dust sources and the origin of some pollutants observed with dust in the SAL. Method used are described by Rodríguez et al. (2012, 2015).

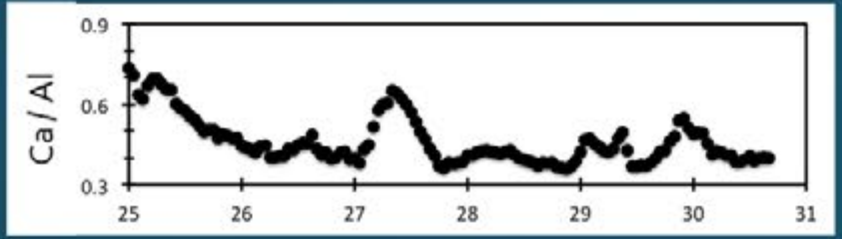


Fig. 2. ratio Ca/Al in the SAL during Aug.

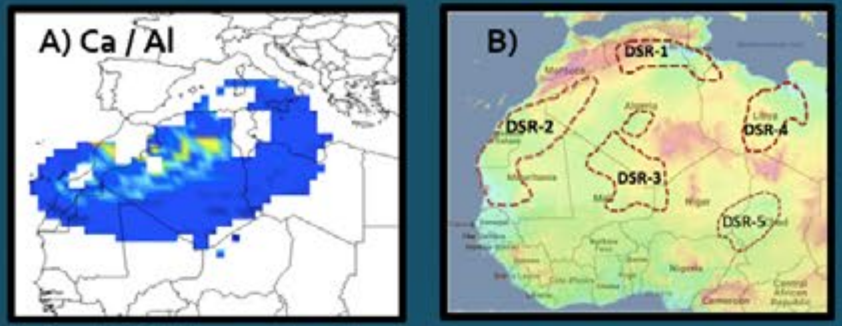
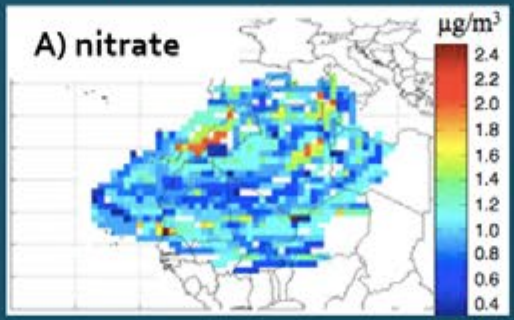
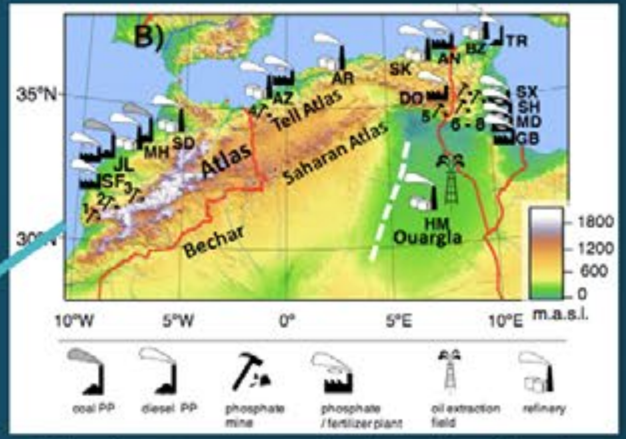


Fig.3. A) ratio Ca/Al and B) Dust Sources Regions (DSR) by Schuevens et al. (2013)

Highlights of key results

- Dust composition experiences rapid changes in the SAL, the ratios of some elements (to Al) change in a factor 2 in short periods ≈5 h (Fig. 2, example ratio Ca / Al).
- Dust Source Regions (DSR) 1 to 3 influence on dust composition (Fig 3): DSR 1 enriched in Ca, Mg, Sr and S, DSR 3 enriched in Si, Fe and Mn.
- High concentrations of ammonium sulphate and nitrate pollutants were found when the air masses had previously passed over the industrialized regions of Morocco, Algeria and Tunisia, where power-plants, phosphate rock and fertilizer industry is located (Fig.4).





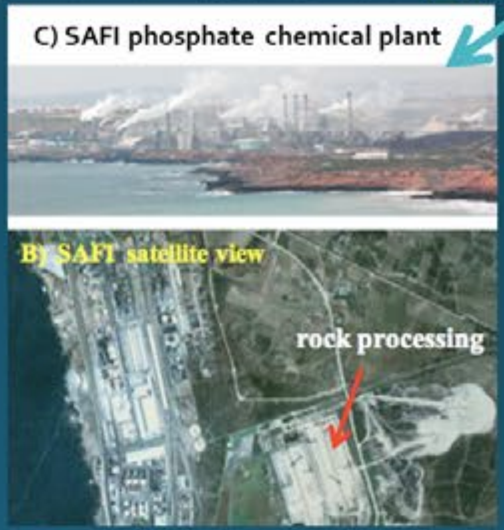


Fig.4. A) nitrate recorded at Izaña depending on air mass origin, B) industrial areas, C) SAFI fertiliser industry (Rodríguez et al., 2011).

Conclusions

- The SAL acts as conveyor belt exporting both dust and pollutants from North Africa, with large scale impacts.
- Dust composition changes much faster than expected and this has implications on the resolution of dust models.
- A better understanding on dust aging processes is needed to assess implications in environment and climate.

References

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