# African and local wind-blown dust contributions at three rural sites in SE Spain: the aerosol size distribution

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## ABSTRACT

The entrainment of particulate material into the atmosphere by wind action on surface soils both disturbed and natural, as well as directly due to human activities like agricultural practices, mineral industry operations, construction works and traffic, is a significant contribution to the aerosol load in Mediterranean semi-arid areas. A further crustal contribution in the region comes from the frequent arrival of African mineral dust plumes.

We summarize some of the results obtained after 4-6 -month campaigns at three rural sites in SE Spain where the aerosol number size distribution (31 size bins between 0.25 and 32 μm) was continuously measured. The influence of both local wind speed and the arrival of air masses loaded with African dust on the airborne particulate distribution is assessed. Similarities and differences between the three locations give information that allows a better understanding of the influence of both local wind speed and African dust outbreaks (ADO), while highlight what is mostly related to local features.

**Palabras clave**: aeolian erosion, wind-blown dust, African dust outbreak

## INTRODUCTION

Most aeolian erosion studies have been focused on major dust entrainment events, like those associated to wind storms in desert or agricultural areas with highly erodible soils. However, studies under typical moderate winds are scarce. The main local and regional contributors to suspended crustal particulates in Mediterranean semi-arid areas are wind and human activity. A number of factors point out its relevance in the study area, especially in summer: the low moisture content of the topsoil and the sparse vegetation cover; the atmospheric convective dynamics induced by intense insolation; and the reduced particulate scavenging potential associated to low rainfall. In addition, the area has been subjected to land-use changes and abandonment of marginal inland areas leading to land degradation. The transport of Afican dust under the appropriate meteorological conditions is an additional crustal contribution in the region.

The aim of our work is to assess, from inmission (ambient air) measurements, the net contributions of wind action and ADO to the airborne crustal material in SE Spain. Continous measurement of the aerosol size distribution and meteorological variables at three rural locations should identify the relevant particle size ranges linked to both processes and discriminate local features.

## METHODS

Meteorological parameters and aerosol number size distribution (31 size bins, from >0.25 μm to >32 μm in diameter, measured with a GRIMM 190 aerosol spectrometer) were continuously recordered at three distinct rural locations:

- From July to October 2006, on the SE slope of the Crevillente Mountain Range, that rises to over 835 m from the coastal plain. The site is located in **Los Molinos** Centre for Environmental Education (38.26N, 0.83W, 231 m asl, 21.8 km inland), in an area of perennial tussock grasslands with sparse vegetation dominated by *Stipa tenacissima* L. and loam soil texture. Categorized as a rural background site (**RB**).

- From June to December 2007, in **Agost**, an open rural area where brick manufacturing and grape cultivation are the main activities. The monitoring site (38.42N, 0.65W, 288 m asl, 17.4 km inland) is surrounded by abandoned agricultural plots where vegetation includes mainly *Avena* sp. and *Inula viscosa*, and soil texture is classified as silt-loam. There exists a small paved road 30 m to the East with some heavy-duty traffic. Categorized as a rural site with high crustal particulate load (**R1**).

- From February to June 2008, in **La Matanza** (38.11N, 1.02W), an agricultural plot (**R2**), 380m x 110m, with its long side from NNW to SSE, that previously was cleared and then lightly leveled and compacted for future lemon-tree cultivation. Soil texture is silt-loam. The boundaries of the field are a four-lane highway on the N, running from W to E, and lemon tree fields along the western and eastern margins. The southern one is on a foothill.

Meteorological synoptic conditions leading to the arrival of air masses on days with ADO were also studied by means of back-trajectory analysis using the HYSPLIT v.4.8 model. Predictions from the SKIRON, NAAPS and BSC-DREAM dust transport models as well as satellite imagery from the SeaWiFS project were also used.

## RESULTS AND DISCUSSION

There is a net increase in coarse particle concentrations (particles >2 μm at RB, see Fig. 1, and R2 sites, and >6.5 μm at R1) with increasing wind speed, while the concentrations decrease for smaller particles due to ventilation. Such difference in the R1 location with respect to the other two sites is probably associated to the mineral industry activity in the area, that maintains a loaded atmosphere at light winds while dilution becomes higher than resuspension in the 2–6 μm interval with stronger winds.

Particulate resuspension is found to occur at all wind speeds, although wind threshold values, $v_{th}$, can be considered by identifying a sharp increase in particle concentrations for a range of particle sizes:

$v_{th}$ = 3 m/s for particles larger than 3–3.5 μm at the Rural Background site
$v_{th}$ = 2 m/s for particles larger than 10–12.5 μm at the Rural 1 site
$v_{th}$ = 5 m/s for particles larger than 8–10 μm at the Rural 2 site

Such thresholds depend both on the soil properties and the nature of the human activities in the study area.

A detailed analysis shows that light winds entrain large particles while stronger winds additionally entrain particles of smaller size (down to 2.5 μm). The size of the smallest particles for which concentration increases with increasing wind speed varies from 10 to 5 μm when winds increase from 1 to 9 m/s at the R1 location. At the RB site, however, size is reduced from 2.5 to 1.6 μm with winds increasing from 1 to 7 m/s.

The arrival of air masses loaded with African dust was registered on one-third of the days in the study period, although not always influenced particulate concentrations at the ground level. The particle number size range influenced by ADO in all the study locations is 0.7–3.5 μm, and the ratio ADO/nADO presents maxima at 1.6–2 μm and 3–3.5 μm (Fig. 2). Differences for lower and higher particle sizes between the study locations can be associated to local factors and different monitoring time periods.

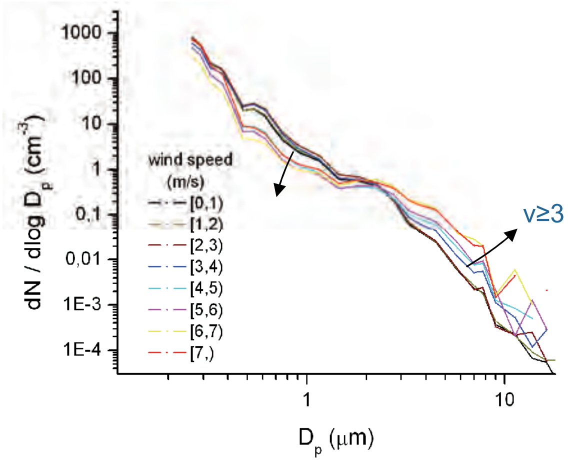


Figure 1. Aerosol size distributions for the rural background location (RB), segregated by wind speed.

The ratios of the aerosol size distributions averaged over *(a)* wind speeds smaller/greater than $v_{th}$; *(b)* weekdays/weekends; and *(c)* ADO/nADO, (see Fig. 3), evidence the relevance of each contribution. ADO, human activities and wind speed, in this order, are the main contributors for increasing particle size at R1 and R2 sites. The anthropic contribution at the RB location is secondary as compared to the wind-suspended component.

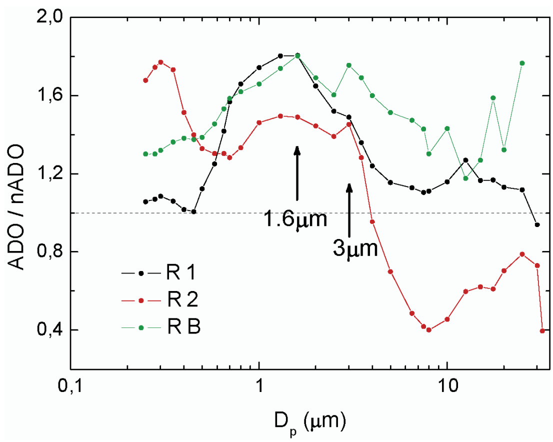


Figure 2. Ratio of the number size distributions averaged over ADO and non-ADO days for the three study locations.

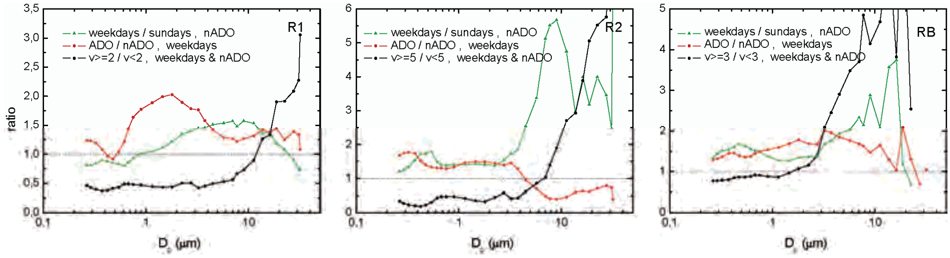


Figure 3. Ratio of the number size distributions averaged over weekdays and weekends, ADO and non-ADO days, and on winds higher and lower than the threshold value for the three locations.

## CONCLUSIONS

Wind speed is the major contributor for suspended particulates larger than 12.5 μm at the R1 and R2 sites. Human activity in such locations leads to higher concentration increase for particles in the range 2-3 (depending on the particular features of the site) to 10 μm. At the RB site wind speed is the major contributor for particles larger than 3 μm, anthropogenic contributions being secondary.

Wind speed thresholds for each location are identified. Some increase in such thresholds with decreasing particle size can be appreciated.

ADO increase concentration of smaller particles. A contribution of particles in the ranges 1.6–2 μm and 3–3.5 μm is found at the three locations associated to the arrival of air masses loaded with African dust.

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