Aerosol properties over the western Mediterranean basin: temporal and spatial variability

By Lyamani et al.,

Answers to reviewer #1

We would like to express our sincere gratitude to the reviewer for his helpful comments that will contribute to improve the quality of the manuscript. We have answered to each specific comment in detail and updated the manuscript according to his suggestions. Comments are in black and our responses are in blue, and the changes inserted in the manuscript are noted here in Red.

The effort of the authors to improve the quality of the paper, satisfying the reviewer's requests, has been greatly appreciated: the results are now much more clear and defined and the further clarification of the following two points will make the paper, in my opinion, worth publishing.

Authors suppose that the high fine particles load from 30 September to 4 October is due to the presence of anthropogenic particles carried from Central Europe to Alboran Island. They support this hypothesis with the HYSPLIT back-trajectories shown in figure 4c saying:

" ***Indeed, the back trajectory analysis revealed that this event was associated with air masses coming from central Europe and passing over the Mediterranean Sea and Spanish costal urban areas before reaching Alborán Island (Fig. 4c). Therefore, these air masses might pick up fine anthropogenic particles in their way to Alborán Island, which may explain the high values of both δα(500 nm) and α(440-870) parameters observed during this event.*** **" The figure they refer to (reported below) shows something different**

The trajectories shown cross regions that, even if they host some industrial area, cannot be considered as if they were in Po valley. Moreover, the trajectory with ending point 3000, moves very high above the ground level, in such a way it can be considered out of the Boundary Layer. For this reason and considering only this figure, it can be hypothized that marine aerosol are the main particles family carried over the measurement site, thus not explaining the experimental results. In the figures reported below, the NAAPS maps for the days preceding 4 October are shown. It is interesting to note that the trajectory ending at 1500 m, before its arrival over Alboran, crosses an area with a great contribution of sulphates to the aerosol loading

at the surface. This could better support the hypothesis of an anthropic particles loading over the measurement site.

Other kind of measurements, i. e. single scattering albedo data, could explain experimental data, as authors did in a paper just published on JGR: A.Valenzuela, F.J. Olmo, H. Lyamani, M.J. Granados-Muñoz, M. Antón, J.L. Guerrero-Rascado, A. Quirantes, C. Toledano, D. Perez-Ramírez and L. Alados-Arboledas, Title "AEROSOL TRANSPORT OVER THE WESTERN MEDITERRANEAN BASIN: EVIDENCE OF THE CONTRIBUTION OF FINE PARTICLES TO DESERT DUST PLUMES OVER ALBORÁN ISLAND."

We agree with the reviewer that the NAAPS maps can support the hypothesis of anthropic particles loading on 4 October. Thus, we think that adding NAAPs information is sufficient to explain the cause of this event without the need of other kinds of measurements. In this sense, in page 10, line 18, we made the following change: "*Indeed, on this day the air mass ending at 1500 m a.g.l (Fig. 4c) came from central Europe and traveled at low altitude on the last 3 days before its arrival at Alborán Island, over an area with a great sulfate surface concentration according to NAAPS model (Fig.4d). Therefore, these air masses might pick up fine anthropogenic particles in their way to Alborán Island, which may explain the high values of both* δ_a*(500 nm) and* α*(440-870) parameters observed during this event.*

The following figure is added in the manuscript

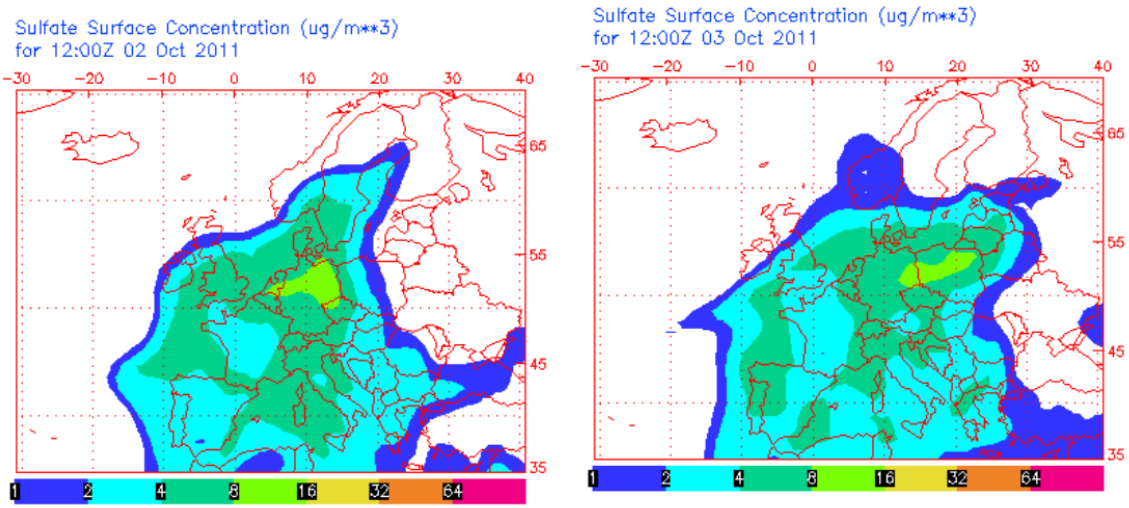

Fig.4d: NAAPS maps for sulfate surface concentrations for 2 and 3 October 2011 at 12:00 UTC

The paragraph 3.5 has been improved too. However, table 4 says that the number of coincident measurements for the Black sea segment of the ship cruise is 26, whereas for the Eastern Mediterranean it is 28, a little more than 1 measurement per day. By the light of this, one can ask if it is meaningful to compare an average AOD value in Alboran and an "average" value over the Black Sea or in the Eastern Mediterranean.

We agree with the reviewer that the comparison of a short number of dada cannot give an insight on the average conditions over different Mediterranean regions. In fact, the comparison we did was more focused on the comparison of the different regions during the coincident periods. To avoid confusion we suppress this comparison and do the appropriate changes in the text.

Aerosol properties over the western Mediterranean basin: temporal and spatial variability

By Lyamani et al.,

Answers to reviewer 2

We would like to express our sincere gratitude to the reviewer for his revision of the manuscript. In the next paragraphs we will answer his criticism.

The paper presents 7 months of some aerosol parameters (AOT, Å, and FMF) retrieved from sun/sky photometer measurements performed at the Alboran Island. Additional aerosol data from three nearest AERONET stations and from the MAN have also been provided. The analyzed data do not provide a substantial scientific contribution to the related subject as the abstract main issues clearly reveal. Further investigation using additional data and observations over a longer time scale is needed to meet the ACP publishing criteria.

Aerosol data over open Ocean and Sea or from Island sites are of great scientific interest. However, these types of data are very scarce due to the technical and logistic difficulties. In fact, in the case of Alborán Island the sun-photometer measurements were interrupted on February 2011 due to the logistical problem and no measurements could be obtained from this time until now. On the other hand, the data obtained at Alborán Island presented in this paper are unique in the westernmost part of the Mediterranean Sea and even though the measurement period is relatively short (7 months), it covers the summer, autumn and winter seasons. In addition, the data measured over Alborán were complemented by data from other 3 AERONET stations in the westernmost Mediterranean region and shipborne MAN data from a cruise across the Mediterranean, Black Sea and northeastern Atlantic. Thus, we think that the combined analysis of all these data and the use of ancillary information from NAAPs model, MSG satellite and Hysplit back trajectories make the paper very sound.

From the data analysis presented here very interesting results were already obtained. In this sense, we don't agree with the referee that the analyzed data don't provide a substantial scientific contribution. In fact, one of the main findings of this paper is the homogeneous spatial distribution of fine particle loads over the four AERONET sites in the westernmost Mediterranean basin, in spite of the large differences in local sources, which may be of great interest for satellite retrievals and aerosol models. Furthermore, the analysis of the data revealed North Africa and urban –industrial European areas as potential aerosol sources for this region. Taking into the account the interesting findings obtained by this relatively short database, we hope to have in the future a larger database for completing this study.

The abstract sentence " The aerosol load over Alborán was significantly larger than that reported for open oceanic areas in the absence of long- range transport influences." does not represent a significant paper issue. Indeed, it is quite obvious considering the Alboran Island location.

Ok. We removed this sentence.

In addition, the last abstract sentence "Alborán was less influenced by anthropogenic particles than the Black Sea and eastern Mediterranean region during the cruise period." also does not represent a significant paper issue. An inter comparison analysis based on few days cannot be used to draw comments of scientific interest for the aerosol characterization over the eastern and western Mediterranean.

We agree with the referee that the database used in the comparison is relatively small, which again reflects the scarcity of data over the Mediterranean Sea. However this result is in good agreement with those obtained in other studies using AERONET data (e.g. Mallet et al. 2013: Absorption properties of Mediterranean aerosols. Atmos. Chem. Phys., 13, 9195–9210, 2013). In any case, although with this sentence we focus on the comparison during the analyzed period we suppress this statement in order to avoid any misinterpretation as a climatological result.

To this end, I wish to mention that the paper title "Aerosol properties over the western Mediterranean basin: temporal and spatial variability" is too ambitious.

We think that the title reflects the analysis presented in this paper. In fact, we have presented an analysis of temporal and spatial variation of aerosol parameters at four AERONET sites in the westernmost Mediterranean basin in addition to MAN data.

Size distributions should also be provided to better characterize polluted days from dust-affected and clean maritime days, in addition to AOT and Å values.

The size distributions give similar results as Å values and fine mode fraction. Thus, we think that including size distribution analysis do not add any interesting information to the paper.

A cluster analysis of backtrajectories should also be provided to properly characterize aerosol properties under different advection patterns. Note that the advection patterns leading to Fig. 5c have not been properly characterized.

The classification of aerosol properties over Alborán by cluster analysis of backtrajectories was recently published in Journal of Geophysical Research:

A.Valenzuela, F.J. Olmo, H. Lyamani, M.J. Granados-Muñoz, M. Antón, J.L. Guerrero-Rascado, A. Quirantes, C. Toledano, D. Perez-Ramírez and L. Alados-Arboledas, Title

“AEROSOL TRANSPORT OVER THE WESTERN MEDITERRANEAN BASIN: EVIDENCE OF THE CONTRIBUTION OF FINE PARTICLES TO DESERT DUST PLUMES OVER ALBORÁN ISLAND.”

In addition, we changed our explanation of figure 5 by adding NAAPS maps in order to give more support to our hypothesis (see our response to referee 1).