# Aerosol radiative forcing during African desert dust events (2005-2010) over south-eastern Spain.

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## **Answers to Reviewer #4 comments:**

**The authors greatly acknowledge the anonymous reviewer for carefully reading the manuscript and providing constructive comments that have led to an improved paper. Following referee's suggestions we have made these changes in the manuscript, and here we incorporate in bold the responses to reviewer comments.**

General comments

1. My major concern is the quality assurance of both measurements and retrieved aerosol parameters. On line 25 (Introduction) authors write that aerosol retrievals by AERONET from PP are not publicly available as compared to almucantar (ALM) retrievals. There is a good reason for this: the quality assurance for PP observations is much harder than for ALM. For ALM, the symmetry check along with the averaging of left and right parts of ALM sky radiances ensures that uncertainties due to the cloud contamination, aerosol in-homogeneity, and angular pointing bias are minimized. The PP measurements do not have the symmetry so the above criteria cannot be applied. It is not clear from the text how quality assurance of sky radiances was done. For example, what criteria, if any, were used to reduce effect of cloud contamination? I believe authors should describe in details how the quality assessment of PP sky radiances was performed, maybe even in a separate paragraph.

**One of the major difficulties of the retrieval of the sky radiance in principal plane and almucantar configurations is the cloud screening procedure. This quality assurance is more difficult, and possibly may have more errors, than for almucantar configuration, where symmetry analysis of the left and right parts of the sky radiance measurements can be used. However, the symmetry criteria cannot be applied on the principal plane data. In this study, to eliminate cloud contaminated aerosol optical depths, and the corresponding principal plane sky radiance measurements, first we applied the triplet stability criteria (Smirnov et al., 2000) to the spectral extinction data measured at the beginning of the principal plane scan. In addition, to consider the possible influence of thin clouds and spatially inhomogeneous clouds, which are difficult to completely eliminate and could contribute to the sky radiance errors, we have smoothed the principal plane sky radiances by a moving average smoothing algorithm with slide window of five-point width. If the number of scattering angles in the measured sky radiance**

**distributions is less than 20, the measurements record is eliminated. Also, we only consider as out parameters of the inversion code the aerosol properties retrieved with fitting accuracy (relative differences between the measured and computed principal plane sky radiances) less than 10%, and also RMSE –root mean square error- less than 5% for aerosol optical depth. Finally, to eliminate cloud contaminated principal plane sky radiance observations that passed the previous filters we used a manual inspection of an All-Sky Imager (e.g. Cazorla et al., 2008). In this sense, the methodology is not completely automatic.**

2. Quality assurance of aerosol retrievals also should be discussed. In particular, uncertainties of retrieved aerosol parameters should be assessed. For single scattering albedo, for example, these uncertainties are the function of AOD and solar zenith angle (SZA) and therefore are subjected to temporal and seasonal variability.

**We have described in our response to the Editor's the details of the retrieval scheme/algorithm as well as quality assurance of aerosol retrievals used in this work. In particular, a wide explanation about accuracy assessment of individual retrievals has been added in this response. Please, see information about this question in the response to the Editor.**

3. It is unclear what values of aerosol complex refractive index were used outside of CIMEL spectral range. Were they extrapolated? Or some other sources were used?

**Instead of aerosol complex refractive index the SBDART code use as input parameter the spectral single scattering albedo. The single scattering albedo at 440, 670 , 870, 1020 nm used as input in SBDART code have been extrapolated for wavelengths outside the spectral range 440-1020 nm. We have clarified this issue in the new version of the manuscript.**

4. Surface reflectance. It is unclear whether any spectral dependence of surface albedo was included in calculation or it was assumed to be spectral independent. In addition, what is the uncertainty due to not accounting for surface reflectance directionality (BRDF)?

**In the old version of the manuscript, we assumed a fixed surface albedo in the simulations. However, according to the suggestion of the referee we have re-calculated all simulated values of the aerosol radiative forcing, taking into account the spectral dependence of the surface albedo at the study site. For that, we used as input in the SBDART code the surface spectral albedo provided by the AERONET algorithm which is based on a dynamic spectral and spatial model estimation at four wavelengths: 0.05 at 440, 0.16 at 675, 0.31 at 870 and 0.32 at 1020 nm. This algorithm adopted the Lie-Ross model for land surface covers (Lucht and Roujean, 2000), considering the bidirectional reflectance distributions taken from MODIS (Moody et al., 2005). All this new information has been added to the revised version of the manuscript.**

## REFERENCES

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