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Atmospheric Measurement Techniques Discussions

Interactive comment on "Columnar aerosol size distribution function obtained by inversion of spectral optical depth measurements for the Zanjan, Iran" *by* A. Masoumi et al.

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The authors would like to express their gratitude to the referee for the valuable comments and questions. We have tried to answer all the questions and apply all the comments into the manuscript.

In this new version we made some general changes that are listed in the following. All the changes have been addressed by the page number, P, the column (C1 for left and C2 for right), and the line number, L. We also worked on the English writing of the manuscript.

General scientific revisions in the current version

1. We applied the Langley plot calibration method in the most appropriate possible conditions and used the cloud screening algorithm that suggested by AERONET. Also the ozone optical depths are subtracted from the measured optical depths to retrieve more exact AODs. Therefore, the AOD and Angstrom exponent values are changed slightly without basic effects on the conclusions of the manuscript.

2. As it appeared in P2C1L4-7, the separation point of the fine and coarse mode aerosols is shifted from r = 1 μm in the previous version to r = 0.75 μm in the current version, in agreement with the Version 2 AERONET inversion products that supposed a variable boundary between $\sim$ 0.5 μm to 1.0 μm for this parameter (http://aeronet.gsfc.nasa.gov/new_web/Documents/Inversion_products_V2.pdf).

3. We changed Eq. 8 in a manner that equal coarse radius intervals (Δr) are substituted by equal coarse logarithmic radius intervals (Δlogr) (P2C2L32). Also we supposed aerosols are spheres with radii between $\sim$0.15 μm and 3 μm (King et. al, 1978) (P2C2L4). Therefore, the radii of 0.25, 0.5, 1, and 2 μm are the midpoints of four coarse logarithm radius intervals in the revised manuscript (P3C1L39).

4. We applied the complex refractive index values suggested by Dubovik et al., 2002 for dust and urban-industrial aerosols at four different wavelength channels for the coarse and fine mode aerosols, respectively. These changes are appeared in Table 1.

Applying all above changes, Figures 1, 2, 3, 4, 6, 7, and 9 and Table 2 have been changed respect to the previous version but the main conclusions of the work concerning the observation of the aerosols in different seasons of the year are almost remained unchanged.

Answer to the questions and comments:

This study examines the aerosol size distribution over the arid environment of Zanjan in northwestern Iran. More specifically the authors used an inversion scheme for the retrieval of the aerosol size distribution from sun photometer measurements. In this field there are already some widely used algorithms, like King's inversion method, the algorithm by Dubovik and King used also in AERONET and the algorithm of Nakajima applied for measurements of the PRIDE sun photometer. These widely used algorithms are not discussed in the manuscript and the authors do not emphasize on the usefulness of their proposed methodology. Moreover, the results obtained are not compared at all with those of the aforementioned algorithms, which is a critical point for the justification of the method used. Since the results are somewhat interesting and the new method proposed may be also applied in other regions throughout the world I believe that more sensitivity analysis and comparison with other algorithms must be done in order the manuscript to warrants publication in AMT.

We affirm that this paper doesn't state new technique for calculation of columnar aerosol size distributions and we exactly used the King et al., 1978, technique and we mentioned this in P2C1L1 and Eq. 3-12 just presenting this technique. Different aerosol size distribution monitoring techniques are mentioned in P1C2L27-34 in this version. We have to add that just for the first time we are reporting the results of this types of calculations for an area in Iran but we did not use a new technique on doing this.

It is really unexpected that the authors used a refractive index without imaginary part (purely scattering aerosols) since it is well known that the dust, especially in UV, has a significant absorption. The refractive index is an important parameter for retrieving the aerosol size distribution. The inclusion of an imaginary part how much would differentiate the results? This is a critical point of the article and the overall analysis.

Thank you very much for this comment. We applied complex refractive indices. Please refer to comment No. 4 of the general revisions and the ending statements of that section. Just we have to add that none of the wavelengths of our sunphotometer are in the UV-region (P2C1L21-22). The considered values for aerosol refractive indices in Table 1 also are in agreement with reported AERONET values for our station during

2010 but we do not believe this should be referred in the current manuscript when all the measurements have been done during 2006-2008.

Over an arid environment as Iran is, I would expect a larger coarse mode fraction in the aerosol size distribution. However, in the discussion of the figure 1 the authors state "As it appeared in Fig. 1, even though always the number of very fine aerosols is more than other aerosol sizes, but for 82% of the days, number of coarse aerosols is more than fine ones and for these days alpha <1.2. For rest of the days, number of fine aerosols is more than coarse aerosols and alpha >1.2." This sentence is really confused and it has no good sense. I cannot understand if the number of coarse or fine aerosols is larger than that of the coarse-mode ones and in which case. Also, this is very hard to use as criterion for the discrimination between coarse and fine aerosols the alpha value 1.2. Some more clarification and discussion is needed here.

We apologize for the bad writing that made this confusion. First of all we would like to draw your attention to the general revisions No. 2, 3, and 4. After considering these changes in this new version it can be seen that for 57% of the days, coarse mode aerosols (r > 0.75 μm) are dominant and for rest of the days, fine mode aerosols mostly are observed. These have been discussed in P3C1L41-45 and P3C2L1-8 in the current version. As it is mentioned in P3C2L1-L8, when the volume concentration for the aerosols of r > 0.75 μm is larger than 50% of total aerosol volume concentration; coarse mode aerosols are considered as dominant ones. For these days we found that α < 0.8 and vice versa.

Regarding the Fig. 2, it seems somewhat unexpected that all the 3 days to present aerosol size distribution with the same mode radii. I doubt if somebody can fix initially in the methodology-algorithm the radii values for individual aerosol sizes. The radii as well as the logarithmic stdev are usually retrieved by the algorithms (e.g. King's algorithm, Dubovik's algorithm, Nakajima's algorithm).

We saw that the Angstrom exponent almost determines relative population of the aerosols at four mentioned aerosol size classes. For example the following figure shows n(r) for Oct 08, 2006, and Nov 23, 2006, when α = 1.01 for both days and AOD-440 nm = 0.15, 31 respectively. But we can't include all these figures into the manuscript and we do not believe that it is necessary.

It is expected that the most of the cases would correspond to coarse-mode aerosol dominance over this arid environment. However, despite the fact that desert dust is the dominant aerosol type over the study location any discussion about desert dust, exposure, transport, etc is missing.

In Sec 4.2 we discussed how dust sources like Tigris and Euphrates basin affect the atmosphere of Zanjan. The HYSPLIT back-trajectories model and Deep Blue AOD of Aqua/MODIS in Figures 7, 8 show such dust transportations over the region.

Interactive comment on Atmos. Meas. Tech. Discuss., 3, 2367, 2010.

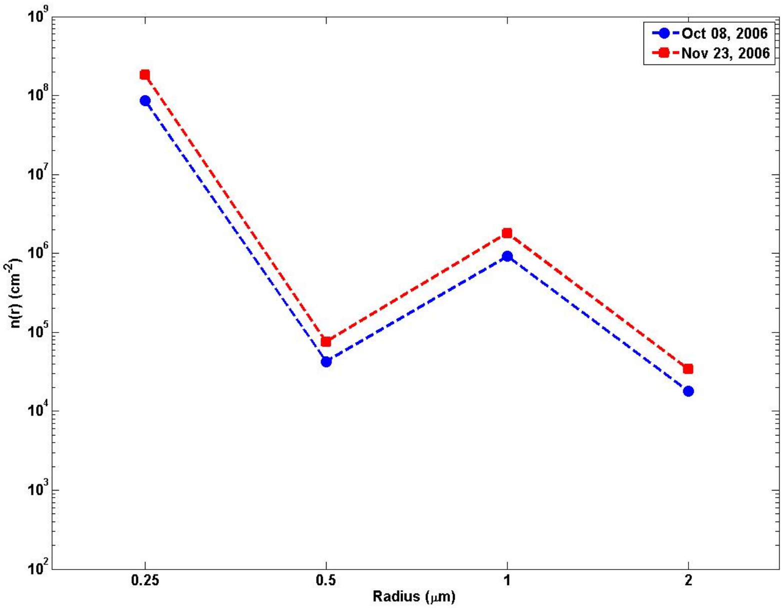

Fig. 1. Aerosol size distribution for Oct 8, 2006 and Nov 23, 2006 with alpha = 1.01, AOD-440 nm = 0.15 and 0.31, respectively.