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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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General comments

First of all, we are grateful to the anonymous referee #1 for his/her comments/suggestions. We want to explain the purpose of this article before replying to comments. We bought a sunphotometer (SPM) from Cimel Company and installed it on the autumn 2006. After that time, we started to learning about aerosols, their parameters and retrieval of them from SPM. We initially used sun-mode data of the SPM and retrieved aerosol formal parameters such as aerosol optical depth (AOD)

and Angstrom exponent (α). We reviewed papers and saw some old techniques about retrieval of aerosol size distribution (ASD) from AOD and used these techniques for retrieval of ASD. We wrote this paper for state of conclusions of two year (2006-2008) sun-mode data analysis and send them to ISTP 2009 seminar that has been held at Delft University on October 2009. Finally seminar organizers decided to publish papers of this seminar in special issue of the AMT journal and requested us for submitting papers. We affirm that this paper doesn't state new technique for determining ASD and it is only an old technique that applied for our region data. We agree with you about that this paper maybe doesn't provide the aims of this journal completely. But we emphasize that we are only team in the extensive and important region ($\sim$ 1800 $\times$ 3000 km^2) of the world that study aerosols. We are at the beginning of the way. Our site now is a member of AERONET and we are now studying about retrieval of the aerosol parameters from sky-mode data. In this paper, we used sun-transmitted light at different wavelengths for determining ASD. It is now used sun-scattered light that received at different scattering angles for ASD determining. The new methods such as AERONET inversion method are more accurate than our used method because of more (>22) scattering angles instead of our method that used 4 AODs. Our method only gives semi-quantitative ASD that conforms somewhat to results of new methods.

Comments

1) *The authors state that they can only retrieve n(r) for four size bins, since there are only AOT measurements at four wavelengths. This would be true if the least squares method would be used for the inversion. The constrained linear inversion technique on the other hand is dedicated to "solve" ill-posed or underdetermined problems. For the latter method a finer radius grid would be more suitable, because then the method would retrieve those signatures of the size distribution about which information is contained in the measurement (indicated by the averaging kernel of the retrieval). So, the authors should make a clear choice between using the least-squares method with*

4 radius bins (which should be carefully selected and the choice should be motivated), or using a constrained inversion technique with a finer radius grid. Another option would be to use a Truncated Singular Value Decomposition (TSVD) method.

Our technique is the same method that has been presented in the Ref. (King et al., 1978). This method is named as a "Constrained Linear Inversion" at the Ref. (Liou, 2002) and difference of this method with "Least square Method" has been explained in the paper by Equations (10) and (11). On the other hand, we don't know any about the TSVD method.

2) *For the inversion a fixed value of the refractive index of 1.45 (no imaginary part?) has been used. In reality the real part of the refractive index may vary roughly between 1.33 and 1.6, and the imaginary part between virtually zero and $\sim$ 0.3 for strongly absorbing aerosols. These variations in refractive index may severely hamper the accuracy of the retrieved size distribution.*

We used the method of Ref. (King et al., 1978) that supposed aerosols as spheres with refractive index ($m' = 1.45 - 0i$). We now agree with you about using a precise aerosol refractive index and apply it. The detailed report is presented in here. Aerosols of our region are divided to urban-industrial and dust aerosols. First type is fine and we can suppose that as aerosols with radii smaller than 1 micron (submicron). The refractive index of them at 4 wavelengths 440, 670, 870 and 1020 nm are almost the same and are:

$m' = 1.40 - 0.02i.$

Dust aerosols commonly have radii $>$ 1 micron and refractive index of them is supposed as:

$m'(\lambda = 440nm) = 1.60 - 0.0030i; m'(\lambda = 670nm) = 1.60 - 0.0015i;$

$m'(\lambda = 870nm) = 1.60 - 0.0010i; m'(\lambda = 1020nm) = 1.60 - 0.0010i;$

We use now both previous and new assumptions of refractive index in our method. We retrieve ASD from both them and compare them with AERONET method conclusions for some days of this year for our station (IASBS station). For example, we exhibit 3 days results in here.

1. 7 Jan 2010. A day with minimum amount of AOD (τ_a (440nm) = 0.054) and large amount of Angstrom exponent (α = 1.77). The Fig. 1 and Fig. 2 are presented here.
The only basic difference between old and new refractive indices is seen at very coarse aerosols that increase for new amount of refractive index. Dust aerosols radii often are bigger than 1.9 micron (Ref: Dubovik et al., Journal of the atmospheric sciences, 59, 590-608, 2002) and results of method with new refractive indices confirm it. Also the supermicron aerosols volume concentration is increased slightly from 21% to 22% and other results of our method are almost unchanged.

2. 24 June 2010. A very dusty day with large amount of AOD (τ_a (440nm) = 1.451) and minimum amount of Angstrom exponent (α = 0.04). The Fig. 3 and Fig. 4 are presented here.
We see that for our method with new refractive index, amount of coarse aerosols is decreased, but amount of very coarse ones is increased instead. Also the supermicron aerosols volume concentration is increased slightly from 95% to 97% and other results of our method are almost unchanged.

3. 16 April 2010. A day with AOD (τ_a (440nm) = 0.113) and Angstrom exponent (α = 0.75). The Fig. 5 and Fig. 6 are presented here.
The only basic difference between old and new refractive indices is seen at very coarse aerosols that increase for new amount of refractive index. Also the supermicron aerosols volume concentration is increased slightly from 67% to 69% and other results of our method are almost unchanged.

Finally, we see that general behavior of ASD at our method is similar to AERONET method results especially for fine and coarse aerosols. But our method results are semi-quantitative and its accuracy is less than new methods. On the other hand, applying accurate refractive index in our method doesn't have considerable changes in results and only move boundary of fine and coarse modes from $\alpha \sim 1.2$ to $\alpha \sim 1.3$. We will add a section to revised paper and discuss effect of change of aerosol refractive index in it.

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

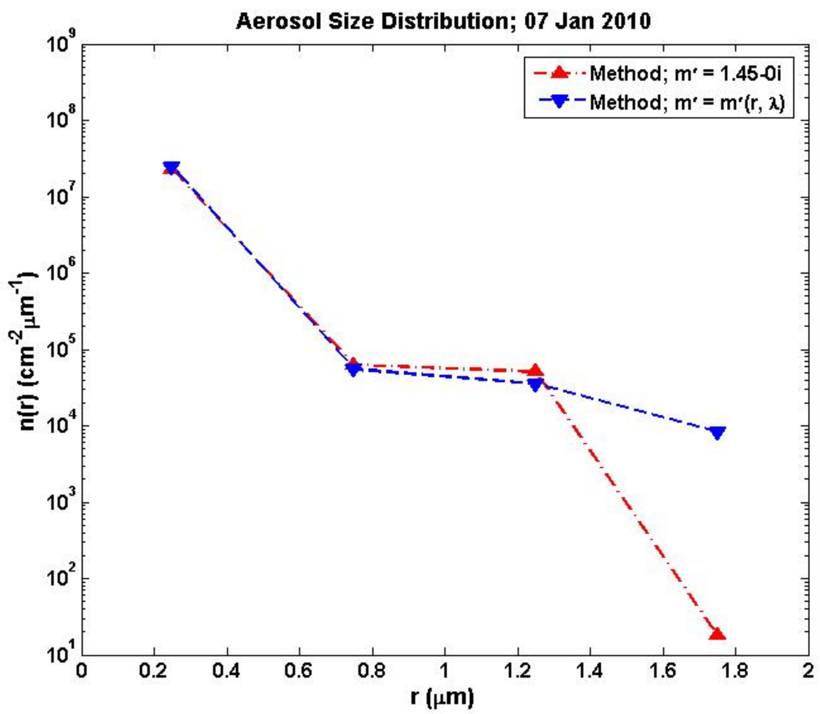

Fig. 1. Daily-averaged aerosol size distribution (1/ cm2 micron1) for 7 January 2010 for Zanjan, Iran. Our method is employed with old and new refractive indices respectively.

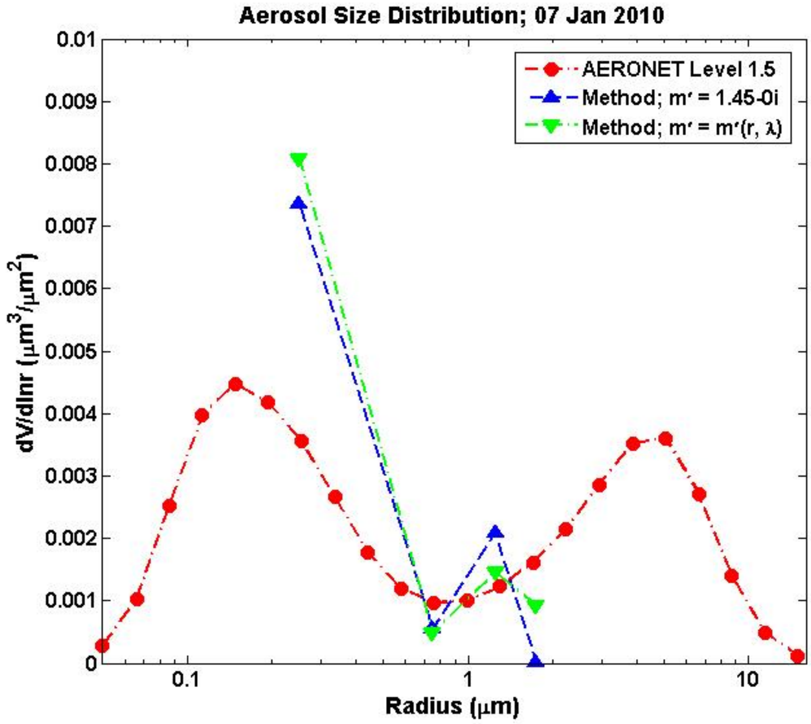

Fig. 2. Daily-averaged aerosol size distribution (micron3 /micron2) for 7 January 2010 for Zanjan, Iran. AERONET and our method with old and new refractive indices are employed respectively.

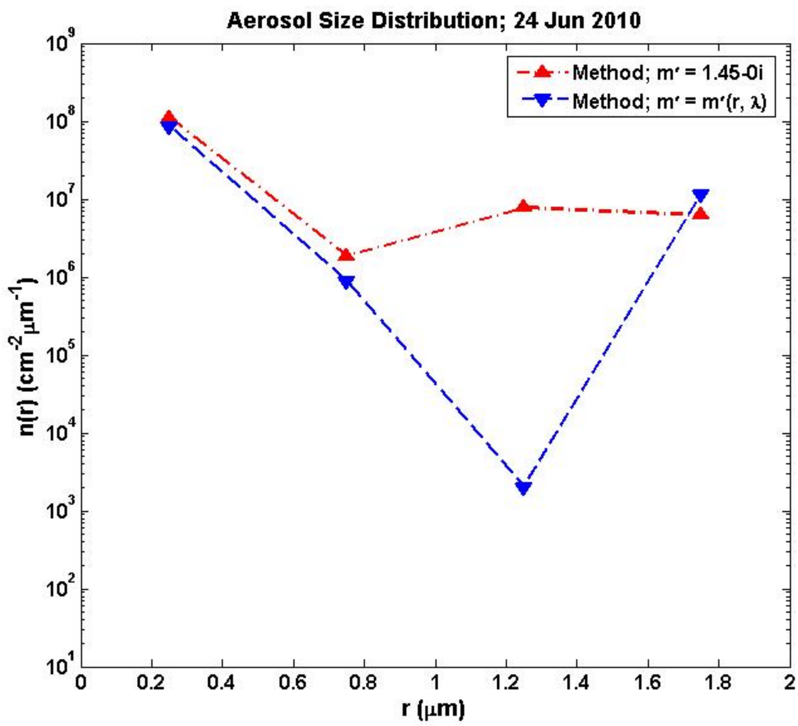

Fig. 3. Daily-averaged aerosol size distribution (1/ cm2 micron1) for 24 June 2010 for Zanjan, Iran. Our method is employed with old and new refractive indices respectively.

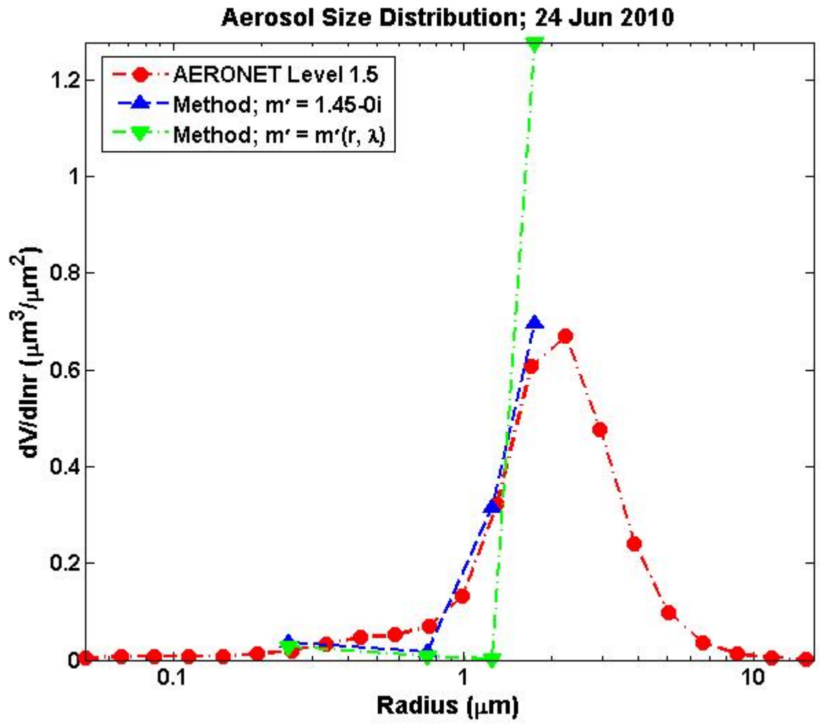

Fig. 4. Daily-averaged aerosol size distribution (micron3 /micron2) for 24 June 2010 for Zanjan, Iran. AERONET and our method with old and new refractive indices are employed respectively.

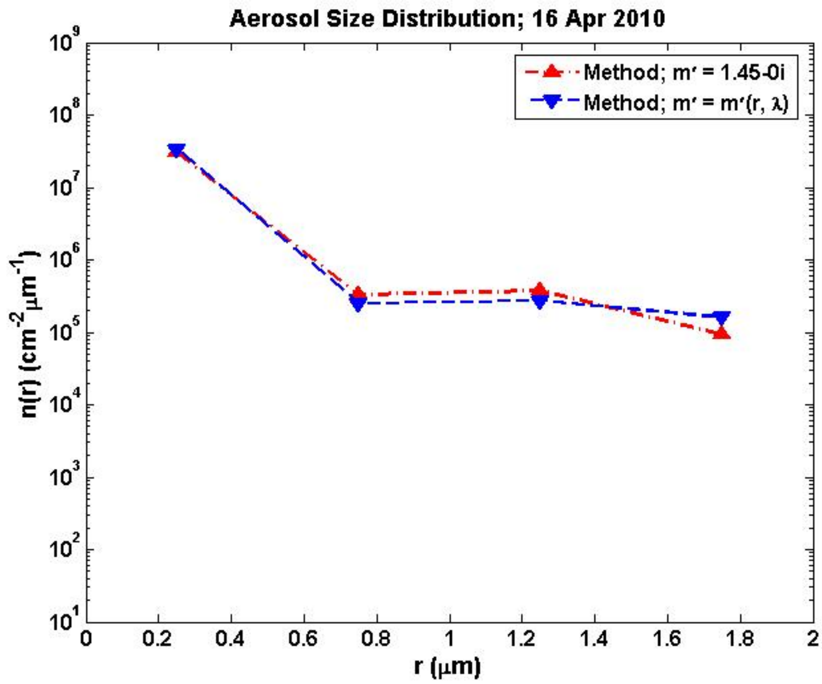

Fig. 5. Daily-averaged aerosol size distribution (1/ cm2 micron1) for 16 April 2010 for Zanjan, Iran. Our method is employed with old and new refractive indices respectively.

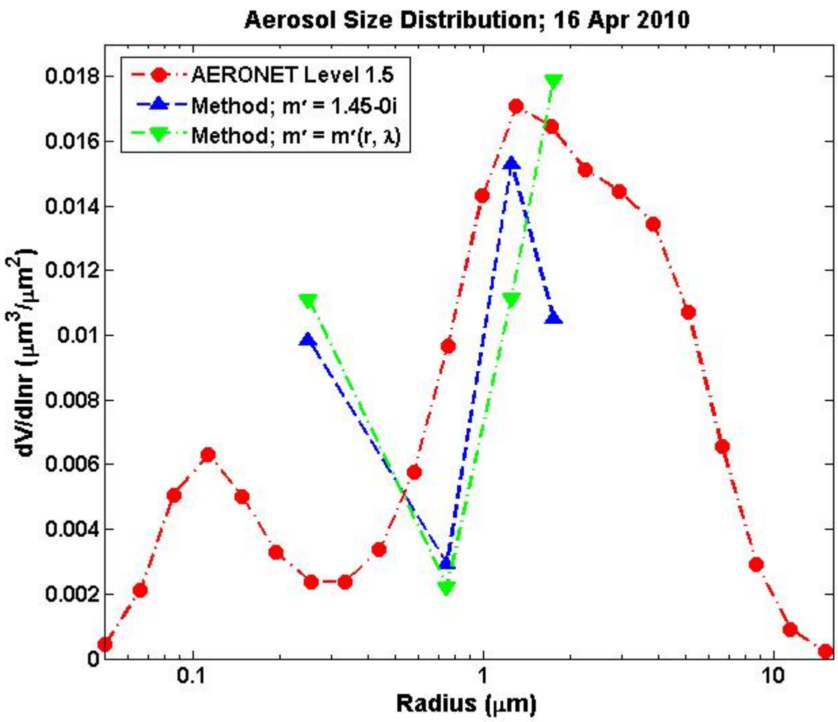

Fig. 6. Daily-averaged aerosol size distribution (micron3 /micron2) for 16 April 2010 for Zanjan, Iran. AERONET and our method with old and new refractive indices are employed respectively.