

Interactive comment on “Multi-modal analysis of aerosol robotic network size distributions for remote sensing applications: dominant aerosol type cases” by M. Taylor et al.

M. Taylor et al.

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We would like to begin by thanking the reviewer for their view that the findings of our study are interesting and relevant and that the manuscript should be published in AMT. In reply to their general comments:

“In my opinion, the authors selected their four cases somewhat arbitrarily, assuming that the global model would well represent the aerosol conditions in each site in daily temporal resolution. The cases would have been more representative, if monthly averages were used”

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The reviewer makes an interesting point. We are aware that longer-term averaging would be more representative of aerosol conditions in the context of climatological averages. The daily-averaging we performed on GOCART 3-hourly measurements and AERONET Level 2.0 Version “all point” data could have been done at the monthly scale, but we were conscious of also not wanting to “wash-out” potentially interesting effects that exhibit themselves at the daily timescale. The daily timescale is particularly relevant to our use of GOCART chemical composition data to distinguish aerosol types and mixtures and to rank sites by the number of complete daily data records they contained. This systematic approach meant that we did not need to select sites in a random way.

“I glanced through Lanai for an extended period around 21 January 2002 and indeed the “double hump” is not very typical. Therefore, it would have been equally justified to include also other interesting and reported cases of interesting AERONET-retrieved size distributions. Now the challenging cases included bi-modality or “shoulder” in the coarse mode. Eck et al. 2012 [Eck, T. F., Holben, B. N., Reid, J. S., Giles, D. M., Rivas, M. A., Singh, R. P., ... & Goloub, P.: Fog- and cloud-induced aerosol modification observed by the Aerosol Robotic Network (AERONET). *Journal of Geophysical Research*, 117(D7), D07206, doi:10.1029/2011JD016839, 2012] reported interesting cases of bi-modality or “shoulders” in the accumulation mode. It would be likely interesting and relevant to see how those kind of reported cases were fitted by the new methods proposed by the authors”.

The reviewer is right that the “double hump” in the coarse mode region of the AVSD for Lanai is not the norm. However, it is prevalent especially on those days exhibiting the highest proportions of marine aerosol according to GOCART. Following the suggestion of Dr Andrew Sayer (please see our reply to his interactive comment below for more details), we used the GOCART ranking approach to construct an ensemble of 10 daily-averaged AVSDs for each dominant aerosol type. In the case of marine (sea salt) aerosol at Lanai, 6 out of the 10 AVSDs in the ensemble presented a “double hump”.

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In our reply to Dr Sayer (below), we have added a new paragraph to end of Sect. 4 on page 10592 line 7 and a new table (Table 4) to briefly reporting the results of our ensemble analysis.

With regard to the reviewer's suggestion that we study also the case of AVSDs exhibiting a double peak in the fine mode region, we are very grateful to them for kindly drawing our attention to the interesting case of fog-induced aerosol modification at Fresno on the 11th of February 2006 (as shown in Figure 1 of Eck et al, 2012). We have investigated this event in a little more detail. In particular, we extracted the AERONET Level 2.0 Version 2 inversion products (daily-averages) at the Fresno site for the first three weeks of February 2006 so as to take a closer look at the temporal evolution of the AVSD over a fairly broad temporal window encompassing the 11th of February. In Fig. 1 accompanying this reply, we show the overall progression of the AVSD during the 9 days of available AERONET data spanning the period (5th to 20th of February). The double-peak in the fine mode region observed by Eck et al (2012) on the 11th of February is clearly visible. A double-peak is also present on the 9th and 10th of February. We applied the OEV method and the GMM method developed in our manuscript to fit the size distribution on each of the 9 days above and found that the AVSD is best fit with 3 modes on all days (with the exception of the 9th of February where the best fit required 4 modes) as shown in Fig. 2 accompanying this reply.

AERONET reconstructed bi-lognormal fits (red lines) are only approximately applicable on the 14th and the 20th of February when the AVSD is more close to a bi-lognormal. The AERONET bi-lognormal is not able to trace the double-peak in the fine mode region as shown by low goodness of fit statistics on the 9th, 10th and 11th of February: $R^2=0.951$, 0.892 and 0.931 respectively, as compared with $R^2=0.999$, 0.997 and 0.998 when the GMM method is used to fit the AVSD with multiple ($n>2$) modes. A second observation is that somewhat surprisingly, two days where no double-peak is observable (the 5th and 16th of February) presented an even stronger challenge for the validity of the AERONET bi-lognormal fit: $R^2=0.800$ and $R^2=0.784$ respectively. The first of

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these two days presents a fine mode that is strongly skewed towards smaller radii (i.e. a short tail) while the second of these two days clearly reveals the presence of a third (intermediate) peak in the AVSD at $r \approx 1 \mu\text{m}$ not present in any of the other cases. The AVSD at Lanai (used to illustrate the methods developed in the manuscript) suggests that this additional mode is possibly connected with an influx of marine aerosol on this day. Application of the GMM method to the challenging AVSDs of the 5th and 16th of February produces excellent fits to the AERONET inversion data: $R^2=0.999$ and $R^2=0.994$ respectively.

We are grateful to the reviewer for kindly drawing our attention to this interesting case and we have decided to include a new figure (Figure 7) as an example of fitting the case of an AVSD having a double-hump in the fine mode region. While not strictly a "dominant aerosol" case in itself, it helps provide a broader context for our discussion of the problems associated with fitting AVSDs having clearly non-bi-lognormal signatures. In particular, in the manuscript we have added to page 10584 (line 27) the phrase:

"Recently, a double-peak confined to the fine mode region has also been observed (Eck et al., 2012)."

Then, at the end of the results section (page 10592, line 7) we have added the following 2 sentences:

"As mentioned in Sect. 3.3, a double-hump feature has also been observed in the fine mode region associated with fog and cloud aerosol modification at Fresno (Eck et al., 2012). As a further illustration of the applicability of the methods developed in Sect.3, in Fig. 7 we present the fits to the AVSD of this novel phenomenon. The goodness of fit of this atypical AVSD with the GMM method is $R^2 = 0.998$ as compared with values of $R^2 = 0.931$ and $R^2 = 0.939$ for the AERONET and OEV method bi-lognormal fits respectively."

Fig. 7 is shown in the attached Fig.3 accompanying this reply. The associated figure caption is as follows:

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"Fig.7 Comparison of the interpolated AVSD, the AERONET bi-lognormal fit, the OEV bi-lognormal fit and the GMM optimal fit for the daily-averaged AERONET AVSD at Fresno on the 11th of February, 2006 which displays a clear double-hump in the fine mode region. The grey band is the uncertainty on the AERONET AVSD."

Regarding specific editorial comments made by the reviewer:

"Block 10579, line 10, "of of" -> of"

Thank you, we have made this correction.

"In couple of occasions, you write "AOD extinction". Seems repetition, perhaps better and more precise nomenclature would be only AOD or only columnar extinction, or something like that".

Thank you, we have retained simply AOD throughout the text.

"Block, 10585, line 1, "statistically-significant exceptions"? You did not assess whether these cases are statistically-significant or not, right? But it would have been certainly very interesting (this is also related to my general point above). Perhaps this sentence could be clarified."

We agree with the reviewer and have changed the sentence in question from:

"Here, we wish to assess whether or not there are statistically-significant exceptions where additional modes should be included in the analysis."

to:

"Here, we wish to assess whether or not there are statistically-significant exceptions to the bi-lognormal case where additional modes should be included in the analysis."

"Block 10594, line 14, "In this work, it was found". This is also somewhat misleading statement. I think you could simply say that you used GOCART to select the cases, since there were no results showing how well the spatial and (daily) temporal resolution

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used really could capture the aerosol conditions in each site".

Thank you, we agree. We have changed the sentence from:

"In this work, it was found that the results of the GOCART model could be used to rank and filter AERONET sites by aerosol type and used to select sites and individual daily-averaged records of the AERONET retrieved AVSD for dominant types."

to:

"In this work, the results of the GOCART model were used to rank and filter AERONET sites by aerosol type and used to select sites and individual daily-averaged records of the AERONET retrieved AVSD."

"Text for the Table 1. Mention that these are from GOCART model data."

Thank you. We have changed the caption for Table 1 from:

"Dataset comprising the 4 dominant aerosol type cases studied in this work. Peak percentages are highlighted. Note that SS at Lanai is the least "dominant" aerosol type case with marine aerosol being mixed with other aerosols in the proportion \approx 60%: 40%."

to:

"Dataset derived from GOCART global chemical data comprising the 4 dominant aerosol type cases studied in this work. Note that SS at Lanai is the least "dominant" aerosol type case with marine aerosol being mixed with other aerosols in the proportion \approx 60% : 40%."

"Text for the Figure 1. "next paragraph". The reference cannot likely be this specific; the place of this figure in the final layout may not be the same as in the current manuscript."

Thank you for such careful attention to detail. We have changed: "described in the next paragraph" to: "described in the text". We are grateful to the reviewer for their

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constructive comments on the manuscript.

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 10571, 2013.

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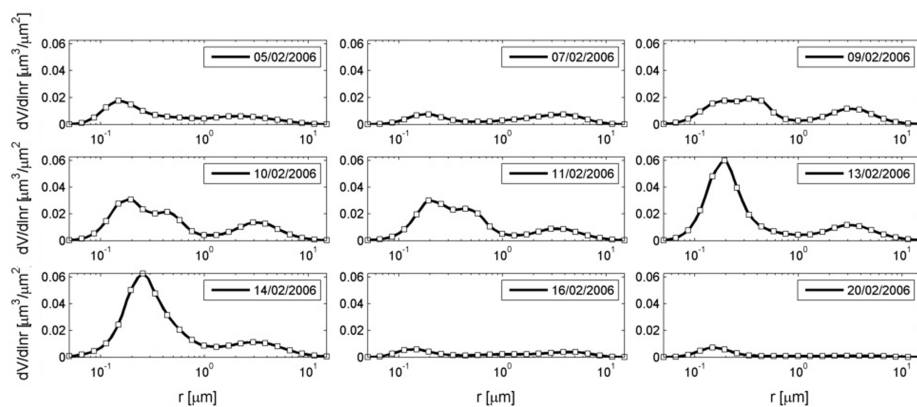


Fig. 1.

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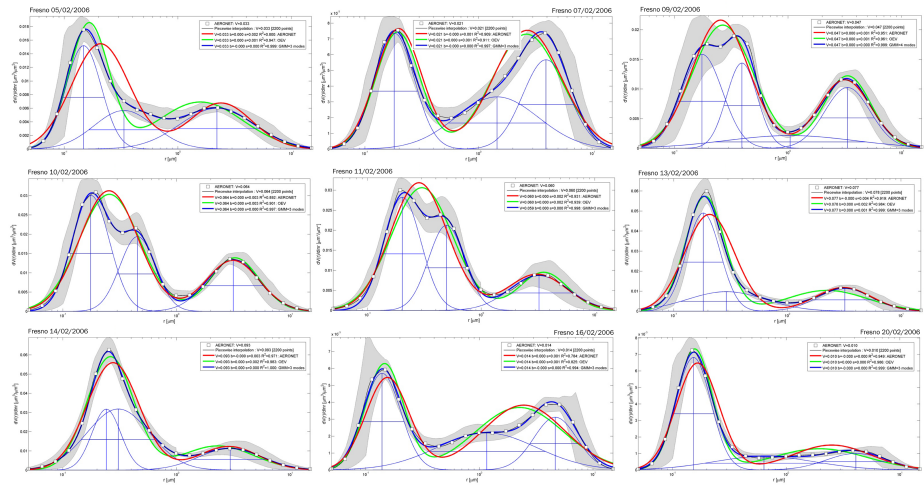


Fig. 2.

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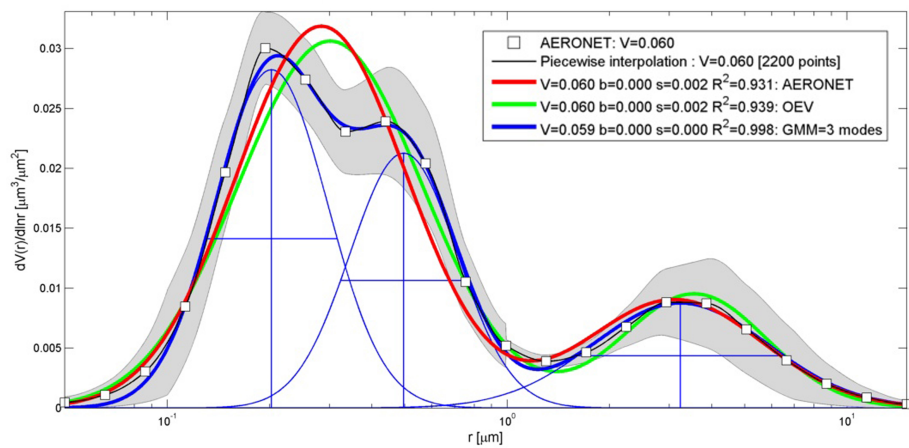


Fig. 3.

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