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Atmospheric Measurement Techniques Discussions

Interactive comment on "Application of spectral analysis techniques to the intercomparison of aerosol data – Part 4: Combined maximum covariance analysis to bridge the gap between multi-sensor satellite retrievals and ground-based measurements" *by* J. Li et al.

Anonymous Referee #2

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General comments: This paper demonstrates an effective way of analyzing the combined data sets of AOD data field from multi satellite sensors (i.e., MODIS, MISR, SeaWiFS, and OMI) and AERONET ground observations simultaneously for studying spatio-temporal variations. This is well written and seems to be a first attempt (to my best knowledge) to look at multiple AOD data sets using PCA and SVD techniques, which addresses a relevant topic for the journal of AMT. However, this manuscript

needs further clarifications and explanations to be a separate 4th paper discernable from the previous three papers which also analyzed the same topics with similar techniques (i.e, PCA, MCA, and CPCA). A fundamental question is why we need this technique (Combined Maximum Covariance Analysis: CMCA) to analyze the spatio-temporal variations of AOD, if we can achieve nearly same results from other previous techniques. Another comment is that the authors tend to overemphasize the advantages of these techniques and not mention limits of those at all. Pros and cons of methods should be well balanced and documented for user community for future applications.

Specific comments:

Page 3503, Title: reconsider the change of title and be shortened. I disagree that the content of this paper is enough to support that the CMCA technique is able to bridge (and explain) the gap between satellites and AERONETobservations.

Page 3504, lines 1-14: these descriptions might be better fit in introduction than in abstract. Overall, this abstract is lack of specific results and conclusions.

Page 3505, line 21: put the acronym (OMI), same as those for other instruments.

Page 3507, line14: clarify the Angstrom relationship. Did you use the Angstrom exponent parameter from MODIS, MISR, and SeaWiFS to obtain the 500 AOD or use a linear interpolation as described in Page 3509, lines 16 and 28?

Page 3511, line 9: list wavelengths (two UV and five visible channels).

Page 3512, lines 13-19, Verify this technique by omitting two or three month data from a few selected sites having a full data record and reconstructing a full time series for comparison. These results should be shown in Figure 3.

Page 3513, line 5 and section 3.2: need more literature review and add more references on these techniques, not only the author's two papers listed here but also other references for other applications because these techniques are commonly used

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in many fields to deal with multivariate data sets. And also discuss thoroughly advantages and disadvantages (or limits) of these techniques.

Page 3513, lines 14-15: might be helpful to put actual numbers of dimensions (e.g., n = 6 years x 12 months = 72, m = 360 x180 grid cells = 64800 for each satellite; m = 58 AERONET locations).

Page 3514, lines 4-7: the assumption of "equal weight" for each AOD data set mapped to the same spatial resolution (1 x 1 degree) for this analysis may not be adequate, (though mathematically enough), especially for monthly AERONET gridded data. Does it have representativeness in space and time to be comparable to those from satellites? We have been observing some discrepancies between satellite and AERONET point measurements over some locations even with daily matchups. As the spatial and temporal window of AERONET increases, the importance of AERONET as a ground truth will become lesser in the comparison with satellites. Different sampling issues among satellites should be also discussed how they can affect the covariance and results.

Page 3514, line 10 and 13: equation (3) and (4), also useful put actual numbers of dimensions.

Page 3516, lines 7-9: Remove ("we choose not to dive into ..."), not necessary for results. Page 3516, lines 15-17: provide a summary of the previous studies and highlight conclusions; discuss clearly advantages/disadvantages of the previous techniques compared to CMCA. Justify the need of CMCA with results.

Page 3518, line 16: typo ("anomly").

Page 3519, lines 2-4: rewording; I believe that direct comparisons (satellites vs ground observations) are the most reliable approach to understand the sources and types of aerosols in space and time with prior knowledge and information on those.

Page 3520, lines 5 – 10: these are true for OMI and relevant to mention here. These two factors (i.e, crude cloud screening scheme due to a large footprint at nadir of13 x

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24 km2 and row anomaly issue) are associated with instrumental design and issues and cannot be much improved by upgrading the OMI algorithm. Therefore, it is not necessary to state and emphasize this in the caption of Figure 12.

Page 3520, line 23: typo (‘Gengetic”).

Page 3521, lines 1-8: difficult to discern the colors (blue or green?) and magnitudes of two dots in the mode 1over this region; same for the mode 2. Reconsider a way of presenting these to support discussions by adding a separate table or line plot.

Page 3521, line 7 and 15: rewording, (“problematic” and “problems” in satellite sensors); “difference” found in this analysis does not necessarily mean a sensor is wrong or problematic. Differences can be found for many reasons.

Page 3522, line 23: the techniques (i.e., PCA and SVD) in this study are widely used in many applications and it’s difficult to say it is a “new” technique.

Page 3523, lines 1-3: explain specifically what useful insights into the underlying physics of the problem can be obtained from this analysis. I disagree that this kind of data analysis technique (i.e., eigen analysis with the covariance) can provide it.

Page 3524, line 8: typo (“in accurate”), should be one word (inaccurate).

Page 3533, Figure 1: add NDVI time series to confirm the seasonality of each plot. Why are there gaps for the plot of Bratt_Lake site?

Page 3535, Figure 3: add more plots before and after interpolation over some sites as suggested in Page 3512, lines 13-19.

Page 3539, Figure 7: Why did you put the triangle marks (AERONET sites) on the plot? If not necessary in this Figure, remove them.

Page 3543, 3544, Figure 11 & 12: those intense wildfires of unusually large scale in Russia cannot be missed by any satellite instruments. In Fig 11 &12, weak signals from SeaWiFS and OMI should be most likely due to cloud screening schemes in the

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process of AOD retrievals. In fact, OMI aerosol index maps clearly show those events in August, 2010 even though some missing data observed due to the row anomaly (refer to: Witte, J. C et al.,: NASA A-Train and Terra observations of the 2010 Russian wildfires, Atmos. Chem. Phys., 11, 9287–9301 doi:10.5194/acp-11-9287-2011, 2011). In particular, OMI with a large footprint can be quickly contaminated by cloudy scenes of thick smoke plumes and difficult to retrieve reliable AOD under those conditions. The authors do not have to describe all the details on the captions of Figure 11 and 12. However, it is not necessary to point out that SeaWiFS and OMI do not capture this event well in the captions, neither.

Page 3547, Figure 15: these are the most critical results to confirm/support discussions on Figure 13 and 14. Should include comparisons for all four stations (or at least two stations over the Gangetic region). I also would like to look at similar time series plots but using the grand mean of the five instruments as a proxy of the truth (x-axis) instead of the monthly mean of AERONET. The reason is that SeaWiFS shows some missing data during the summer months and OMI has significantly reduced samples due to the row anomaly issue since 2008, and MISR has lesser samples than those of OMI and MODIS due to a narrower swath, and AERONET monthly AOD at such a coarse resolution of 1 x 1 degree grid cell may not be representative for comparison with those of satellites. Under those tricky conditions, the grand mean of all instruments might be more reliable as a “reference” than that of any other single instrument.

In addition, it’s also interesting to look at other regions such as the Sahel demonstrating a large uncertainty in the spread maps with at least 3-4 AERONET stations (Figures 7 & 10). Why are the authors asking readers to look into other interesting regions with these techniques (Page 3523, lines 26-28) without showing results you can do easily here?

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