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Atmospheric Measurement Techniques Discussions

Interactive comment on "Role of coarse and fine mode aerosols in MODIS AOD retrieval: a case study" *by* M. N. Sai Suman et al.

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Manuscript title: Role of Coarse and Fine Mode Aerosols in MODIS AOD Retrieval: A Case Study

Authors: Sai Suman et al.

General comments to the Editor/Associate Editor:

In this paper, author compares the MODIS collection 005 aerosol optical depth (AOD) and size-resolved fine and coarse mode AOD retrieval with those measured by the ground-based sky radiometer over a tropical remote station, Gadanki, located in the

southern peninsular India region. The MODIS Level-3 1 deg AOD data has been used in the present validation analysis. While author finds a reasonable agreement (R2=0.7) between the space-ground retrieval of total AOD, a large systematic discrepancy exists between the fine mode AOD and fine mode fraction. MODIS tends to retrieve consistently lower fine mode AOD/fraction throughout the three years (2008 to 2011) over the study region. Based on these observations, author argues that the selection of the aerosol model in the MODIS retrieval seems to be inappropriate over this region. Author suggests that instead of using 'moderately absorbing' model, a 'more absorbing' model would be better suited for the fine mode aerosol retrieval and 'sea salt' model should be used instead of 'dust' model for the coarse mode retrieval.

The present paper is basically a validation exercise of the MODIS dark target aerosol retrieval (MOD04) over a tropical site in India. I expect author should have used MODIS Level-2 10 km retrieval instead of L3 1 deg data. However, use of L3 1 deg may be OK for the present analysis because the spatially-averaged MODIS L2 retrieval within a small region (for instance, 0.5 deg box averaging) around the study location is expected to provide similar retrievals if aerosol loading is homogeneous in the region. On the basis of my own analysis on the MODIS aerosol retrieval over the Indian subcontinent region (Jethva et al. 2010), I found essentially the same results that have been presented in this paper that the total AODs from MODIS are in good agreement with ground-truth but the size-resolved properties (Fine/Coarse AOD, fraction) are not, particularly the fine mode properties. Author anticipates that the observed discrepancy can be attributed to the inappropriate selection of the aerosol model over the study region which could be partly true. However, authors are completely missing an important and critical component of the MODIS algorithm, which is the surface characterization. This is the major deficiency of the present analysis. On contrary to the author's argument, I concluded in my JGR 2010 paper that the change in the surface reflectance has significant impact on the size-resolved properties retrieval, whereas role of the aerosol model was found to be secondary.

Though an inappropriate selection of the aerosol model could be one reason for the under-estimation in AOT/Fine AOT, one cannot reach to this conclusion without having knowledge of the true aerosol model/properties, particularly the single-scattering albedo over the study region. It is mentioned in the manuscript that the sky-radiometer installed at the study location also retrieves column integrated refractive indices and size distribution. If these retrievals are reliable then it is extremely useful to bring the refractive index/single-scattering albedo analysis in this paper. Differences between the ground-observed aerosol properties and that assumed in the MODIS algorithm then can act as a basis for the argument put forward by the author.

To my knowledge, the present study is only second to our first Jethva et al. (2010) paper that attempted to validate the MODIS-retrieved total as well as size-resolved aerosol properties over the Indian region. This is an important exercise and is quite relevant to the MODIS aerosol team to revisit their algorithm and look for the possible improvements in the aerosol retrieval, particularly the size-resolved properties which are critical in attributing the human-made/natural contribution in the total aerosol loading.

The language and representation of the manuscript can be improved further. I am attaching my comments and concerns with this review. Contingent upon the supportive analysis and satisfactory improvement in the paper, it may be published in the Atmos. Meas. Tech. Also, I am forwarding selected slides of my PhD colloquium (year 2008) for authors to pay attention that essentially highlights the sensitivity of the MODIS aerosol retrieval (total and size-resolved) to the aerosol model and surface reflectance over the Indian region, particularly southern India which is most relevant to the present study.

Thanks for choosing me as a reviewer of the above manuscript.

Sincerely,

Hiren Jethva USRA/NASA GSFC Greenbelt, MD, USA

Specific comments:

Abstract: Not just correlation but also mentioned RMS difference.

Abstract: Use ‘southern India’ terminology instead of ‘South India’

Introduction, Page 9111, line 14: there is a paper by O’Neill et al. which directly retrieves fine and coarse mode fractions from the direct spectral AOT measurements.

Introduction, Page 9111, line 26: over land as well as ocean

Introduction, Page 9112, line15-20: A sensitivity study conducted by Jethva et al. (2010) shows that the retrieval of FMF is strongly impacted by the assumed surface reflectance in the visible channels.

Introduction, Page 9113, first paragraph: Jethva et al. (2010) validated MODIS C005 multi-year AOD and FMF retrievals AERONET data at Kanpur. Also, they compared the different set of MODIS retrievals with the in situ size-resolved properties measured during ISRO-GBP Feb 2004 campaign over southern India. Based on these results, the paper concluded that the retrievals of fine/coarse mode AODs and FMF are strongly sensitive to the assumption of the surface albedo at visible wavelengths. The selection of aerosol model played a secondary role in the whole exercise.

Introduction, Page 9113, line 7: to diagnose deficiencies in the algorithm.

Introduction, Page 9113, line 14-17: define the study region here. Along with size-resolved properties, present study also compares the MODIS total AOD against ground measurements.

Section 2.2, MODIS data, Page 9115, line 3: Does MODIS L3 1 deg data are of the best quality (Quality Flag=3?)?

Section 2.2, MODIS data, Page 9115, line 24-28: Without performing a sensitivity anal-

ysis and/or showing the large discrepancies between the observations and algorithm assumptions, it is merely an empty speculation to make a statement about the appropriateness of the aerosol model.

Author should have supported his statement about lower SSA by providing information on the ground-measured columnar SSA over the study location.

Section 3: Results and discussion, Page 9116, line 15: A similar time-series plot of Angstrom Exponent will show the seasonal difference in the dominant aerosol type. I suggest to add this plot along with the present AOD plot.

Section 3: Results and discussion, Page 9117, 1st paragraph: This is an important piece of information retrieved from the sky-radiometer observations. The particle size distribution is reported in the manuscript. However, no data pertaining to the refractive index (real and imaginary) are being presented and discussed anywhere in the paper. This appears to be a severe weakness of the present work.

Author put forward the argument based on the MODIS/ground instrument comparison that the aerosol model selection in the MODIS algorithm is inappropriate. This conclusion should be based on a one-to-one comparison between the aerosol model used by the satellite algorithm and one retrieved from the ground instrument. An analysis on the comparison of the PSD and SSA between MODIS algorithm and ground-based measurements is badly needed to support the argument made by the authors.

Section 4: Page 9119, Conclusion: Emphasize here that this was the first MODIS validation study over Gadanki, southern India. It is valuable because most validation studies compared MODIS retrieval with that observed by the AERONET sunphometers, which Gandaki doesn't have. However, it has its own sky-radiometer measurements of the spectral AOT and inversions which in my opinion is a valuable database for the satellite validation and aerosol climatology over that region.

Section 4: Page 9119, line 15: Seasonality is captured by MODIS but with significant

differences in retrieval of size-resolved properties.

Section 4: Page 9119, line 20: the selection of aerosol type used in the MODIS retrieval may not be a source of observed discrepancies, particularly the size-separated fine and coarse mode AODs.

Section 4: Page 9119, line 23: "a more absorbing type aerosol is better suited for fine mode aerosols". Author cannot make such statement without presenting supportive measurements of the aerosol single-scattering albedo over that station.

Section 4: Page 9119, line 24-25: "use of coarse mode sea-salt model". This could be true. However, MODIS doesn't employ sea-salt model over land. Its over-ocean algorithm should have such models.

References: Page 9121, line 20: Jethva et al. (2010) listed in the references but not cited/discussed anywhere in the text!

Table 1. 'Total AOD' in place of 'Unseparated AOD'

Table 1. Correlations are not enough. Add RMS and slope of linear regression. Figure 2 and Figure 7 have these numbers which should be also listed in this table.

Figure 2. Provide the uncertainty equation in caption (0.05+0.15*AOD). Figure 3. A similar time-series plot of Angstrom Exponent would highlight the seasonality of aerosol type, i.e., smoke vs. dust

Please also note the supplement to this comment:
http://www.atmos-meas-tech-discuss.net/6/C3406/2013/amtd-6-C3406-2013-supplement.pdf

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