

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

### **Anonymous Referee #2**

Received and published: 29 November 2013

The present study compares the MODIS AODs with those obtained from SKYRAD sky-radiometer at a remote rural location in South India (Gadanki). The comparisons between the two parameters further emphasize on the fine and coarse mode AODs, as calculated via the MODIS FM fraction and the columnar size distribution derived from SKYRAD observations. The results show a very poor correlation between MODIS and SKYRAD fine-mode AODs, with a systematic MODIS underestimation, while the comparisons between the coarse-mode AODs are significantly better. Some reasons are discussed for these discrepancies mainly due to inappropriate absorption components in aerosol types used by the MODIS retrieval algorithm over land. The results are clear and well presented, but the whole manuscript lacks of detailed discussion and comparison with other studies over Indian region. Further comparison with Jethva et al. (2010)

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paper will enhance the analysis and provide a better knowledge of the MODIS size-resolved retrievals over India. However, the main drawback of the paper is the lack of analysis about the surface reflectance and variations on this, which is an important factor in MODIS retrievals algorithm and can strongly affect the size-resolved parameters even more than the effects of the assumption of different aerosol models. Overall, the study theme is quite interesting, since the satellite algorithms are subject of continuous development and the current results are in this direction. The whole manuscript needs a final editing, improving the language and syntax in some parts before considered for publication in the journal. According to my opinion, the current work can be published in AMT after major revisions summarized below.

The current work focused over south India and this has to be mentioned in the title. The objective, highlights, importance and scientific contribution of the present work have to be better discussed at the last paragraph of the Introduction section. The current discussion seems to be rather poor and the authors have to highlight the significance of the present work also communicating it with a similar one performed over India (Jethva et al., 2010, JGR). The concluding remark of the study, that a more absorbing aerosol type must be selected from MODIS for fine-mode AOD retrievals over the area, is not so much supported from the current analysis, since there are no comparisons of single scattering albedo values between MODIS and sky radiometer. The most part of the Introduction seems more like discussion of previous results and the MODIS retrieval algorithms. So, it can be used as discussion material along with the current results at the last end of the study and not in the Introduction. In Introduction somewhat more general can be used, like the importance of the fine-mode retrievals, previous studies using FM fraction for aerosol studies and be more specific with the results of Lee and Chung (2013). This is my thought about it, but I leave it to authors to decide. The description of the study site needs more information in the view of the aerosol field, dominance of fine or coarse aerosols, seasonal variations, etc... The NCEP/NCAR maps, although informative for the whole region, do not provide details for the study location. Also, for the winter air masses, the influence of the IGP region has to be

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underlined (see a recent paper by Das and Jayaraman for aerosols in the Indian east coast). Also, the air masses from the Bay of Bengal are not so anthropogenic-polluted in cases that they do not transfer biomass-burning aerosols from southeast Asia. About the instrumentation part, the error of about 6% for AOD seems to be high compared to AERONET CIMEL and microtops-II instruments. Is this error wavelength dependent? Has the same instrument been used before over the study location and what about the retrievals? Has ever been any validation with other instrument over the measuring site? Furthermore, it is not so clear why the authors did use the sky radiance data for the AOD retrievals. Usually, the sun photometers use the direct-beam irradiance measurements for AOD calculations. Which are the absolute radiation measurements and how the AOD retrievals from the direct-beam irradiance cannot be used for long-term studies? Do the AOD retrievals from sky radiance measurements have the same or similar range of uncertainty with those obtained via direct-beam measurements? Why do the authors use L3 and not L2 MODIS data, which are most useful for comparison studies above a unique location? Of course, L3 is the spatially averaged at 1x1 degree of the L2, but this can be considered as absolutely valid for areas mostly characterized by aerosol homogeneity. Thus, could the L3 MODIS dataset be assumed representative for the measuring site? Previous studies over Indian subcontinent, e.g. Kharol et al. (2011, Atmos. Environ.) over Hyderabad, Gupta et al. (2013, Atmos. Pollution Res.) over Lahore, have shown large differences between L2 and L3 MODIS retrievals around urban centers as well as significant spatial heterogeneity in the AOD values and in the availability of pixels as well. This should be taken into account and discussed in the manuscript in case that no L2 dataset is utilized. MODIS vs SKYRANET AODs are not well coincide in Fig. 2. Note that there are several data points out of the regression error lines and far away from the linear regression. Also, the regressions are seasonally dependent and the authors may provide some reasons for that. Maybe, a more homogeneous atmosphere during winter plays a role as well as the cloud contamination and the larger errors in the retrievals during the rainy monsoon season. Furthermore, the comparison between SKYRAD and MODIS retrievals is rather poorly described and

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fairly discussed. There is no info about absolute or even percentage differences, range between the differences, etc. On the other hand, in Fig. 2a, b the regression line must lie within the two error lines, not outside as in the current case; something wrong is here. Authors also have to provide the 1-1 line in the graph in order to show the over-estimation or underestimation of MODIS AOD. However, one cannot reach to a safe conclusion that the observed AOD underestimation is due to underestimation of the aerosol absorption, extra analysis is needed before this statement. Comparison with results obtained over other environments in India, like IGP, urban locations, etc, may be useful for the discussion of the present results. At final, the dust aerosols are not so absorbing in the vis band, they are absorbing only in the UV, so this must be taken into account and corrected in the text Why do the authors use the median and not the mean values of the AOD in Fig. 3? The differences between AODs at shorter and longer wavelengths are also characteristic for the Angstrom exponent and aerosol type that is not referred. It would be in advance to provide the columnar size distributions in all seasons and discuss more the modifications on them due to different aerosol dominance. The large vertical bars especially for coarse mode during summer suggest large heterogeneity in the aerosol field. Is the aerosol field significantly influenced by dust plumes on that season? The differing air masses controlling the FM values are not shown, so that, the statement cannot be justified from the present analysis and without any references. Since this is the main objective of the work much more discussion is needed on this part. Moreover, the seasonal variability of fine and coarse mode AODs must be discussed in more detail comparing it with other studies over peninsular India. The last paragraph of the results section needs to be discussed in view of references for MODIS algorithms, aerosol types used and look-up tables for the size-resolved parameters. In this view, the changes in surface reflectance must be taken seriously into account, since surface reflectance is a significant parameter in aerosol retrievals via MODIS algorithms. The whole analysis clearly reveals a MODIS incapability of reproducing the fine-mode AOD over south India due to possible inaccuracy in the input aerosol models in the retrieval algorithms, but further from this point, we may see what

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else may contribute in this inconsistency and to improve the algorithms. These discussions may also be separated for summer and winter, since the results were very contrasting. The conclusion section has to be re-written since in most parts is similar to abstract.

Minor Comments The study period has to be referred in the abstract. Page 9112, line 26. Please check the R2 value between MODIS and AERONET. It seems too low.

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Interactive comment on Atmos. Meas. Tech. Discuss., 6, 9109, 2013.

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