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Comment

Interactive comment on “Global evaluation of the Collection 5 MODIS dark-target aerosol products over land” by R. C. Levy et al.

Anonymous Referee #2

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The authors assess the performance of the MODIS (Terra and Aqua) Collection 5 aerosol products over dark-land targets based on comparison with collocated AERONET Sun-Photometer-derived AOD at 555nm as ground truth. Based on the huge amount of collocated data used and the good comparison between the data sets, i.e. the fraction of data within expected error is more than 1 standard deviation, they consider the AOD at 555 nm validated. Quality flags for MODIS data, i.e. the confidence in the MODIS retrieval, is taken into account. The MODIS products include several other parameters than AOD such as aerosol model weighing factor and size information reflected by the Ångström exponent and the fine mode fraction. However the use of these products over land is not recommended and the MODIS team considers to remove the latter two products from future products lists. The authors also validate the Collection 5 MODIS products for local conditions and discuss systematic errors.

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They recommend the users of the MODIS products to take their findings into account.

This is a very valuable paper with a critical assessment of the MODIS products by the providers of these products. Based on long-term experience with the use of the MODIS data and interaction with user groups the authors express their confidence in part of the data products and warn the users for over-confidence in other products such as size information. I fully support their advise to use only those data in which the scientific community has confidence (AOD with quality flag 3), and the authors mention at several instances that size and model weighing factor retrieved from MODIS over land should not be used. However, it is not clear from the manuscript why: probably a few sentences to clarify would provide better understanding. Adding to Section 2 a few words on the retrieval method might help in this respect: as described in Section 2 (pp 19 and 20) and section 3 (24, 13) AOD at 555nm and ETA are the primary fitting parameters: why if 555 nm is not used in the retrieval? How are the MODIS wavelengths (470 and 650 nm) used in the retrieval? How can the model weighing factor ETA, based on the comparison of the spectral AOD from MODIS and the forward model (using LUTs), be determined for 555 nm? Should that include the two mentioned wavelengths, in which case also the AOD at these wavelengths (spectral AOD) would be primary? I presume that the ETA is not a physical parameter because “effective” aerosol models are used, i.e. models that describe a quantity that would provide a fit over the column, rather than the actual models which would change with air mass at different heights and varying relative humidity throughout the column? Is there such large uncertainty in ETA and in AE, because they are no real physical parameters but related to an effective column? And why is there higher confidence in AOD? Why is spectral AOD determined from AOD at 555 nm and ETA and not directly if used in matching the spectral dependence and aerosol models (see above); if there is little confidence in ETA, how can there be such high confidence in AOD at 555 nm? Likely all these questions have been answered in earlier papers on the method, but it may help the reader if this is briefly explained here as well (with proper reference to more extensive explanation).

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Minor comments (page nr indicated by last 2 digits, line nr)

17, 10: spectral resolution: the number of bands does not indicate the resolution of these bands; of these 36 bands only 3 seem to be used for the retrieval over land (20, 12))

18, 16: the C004 products were not accurate enough for use in global model assimilation: what are the criteria that aerosol products can be used for global model assimilation and are the C005 products good enough?

18, 29: I would not consider Ångström exponent and fine AOD to be aerosol size parameters: at best the AE is an indication of the shape of the size distribution (i.e. relative concentration of coarse and fine particles, where for concentration the presentation of the size distribution needs to be specified) whereas fAOD would be the contribution of smaller particles to the total AOD.

20, 1: is the fitting error an error on ETA?

20, 5: why does ETA not represent a physical aerosol quantity if it describes the ratio of aerosol models to match the observed spectral dependence (see also general comments)? Are 2 aerosol models used to determine ETA or more?

20, 16-20: four models are defined for the retrieval (27, 5), here I get the impression that only 2 models are used in the actual retrieval, please clarify; what are common definitions of fine mode AOD? Provide reference and explain what the difference is between fAOD in this paper and for MODIS over ocean.

20, 26: indicate that QAC runs between 0 and 3 (this is done later may be should be done here)

22, 15: are $\text{ssa} > 0.95$ not used? Ssa equal to or smaller than 0.95 seems quite absorbing, is there a climatology known from ground based measurements? Are the seasonal gridded maps based on climatology?

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22, 25: transparent assumptions and non-transparent dust: apparently transparent has different meanings here

24, 13: ETA would be independent of wavelength, isn't it? Hence the (0.55 μm) should be after AOD. See also my general question about the retrieval algorithm.

24, 19: see my general comment on the retrieval algorithm: why are AOD and fAOD at 470 and 650 additional parameters while 555 nm isn't even used in the algorithm?

24, 25: Levy et al. (2009b) : there is only one Levy et al. 2009 in the references

25, 1: "fill": apparently missing AOD are filled? How?

25, 5: why is fAOD reported and not ETA while ETA is the primary parameter from which fAOD is computed?

25, 22-25: similar to above: explain the difference between AERONET fine mode fraction and the MODIS fAOD? Why would correlations be checked if these are difference parameters? Would a good correlation suggest that they do indicate similar quantities?

27, 5: bi-lognormal fine and coarse: in what representation (number, volume, radius, diameter, ...) ?

27, 5-17: the concept of weighing: why does this provide a physical parameter over ocean and also from AERONET and not from the MODIS dark-target algorithm? This is quite crucial for understanding the products and why ETA should not be used, could you explain?

27, 25: why is the algorithm choosing the dust model? To understand this, more info is needed on how the algorithm works (see general comment). I presume that since only the two visible wavelengths are used, there would be more sensitivity to fine particles than for coarse particles? How can total AOD be well-retrieved in such cases (see 28, 8); what would be the QAC when ETA is wrong?

28, 15: why is ETA retained? If ETA is a weak parameter, as described just above,

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would this not result in a low QAC and hence confidence?

30, 14-16: has indeed been demonstrated that the algorithm makes the correct assumptions to surface and aerosol characteristics? Where, did I overlook it? I think that only has been demonstrated that AOD (555) is validated while other aerosol parameters retrieved are weak.

31, 11: why was Venice included: on p. 26 was mentioned that over water sites would not be included.

31, 21-24: when surface properties are not much different, does that imply that aerosol models should match well too, or were the aerosol models for Japan and Korea well chosen?

34, 7-11: how does that fit in with the above comment on Japan and Korea? What is the difference, if surface is not too bright in both cases?

33, 5: does that imply that MODID uses only the climatologically assigned models?

38, 20: This means that even though AOD cannot, or not well, be validated in the vicinity of clouds, but physically one expects that AOD would be higher near clouds.

42, 15 and 25: Sometimes “Figure” is used, at other times “Fig.”. Please change to consistent notation

46, 28: “assumed assigned aerosol properties”, are they assumed or assigned?

47, 5 and 11: the basis for the assumption is the AERONET climatology (Levy et al., 2007)? Are these the maps referred to in line 11?

47, 15: MODIS AE is not reliable as discussed in the paper; for clarity, should be mentioned here that this conclusion is based on AERONET AE?

Table 1, line 3: wavelength instead of wave

Figures: “both” in Figure headings seems to indicate both AQUA and TERRA, this

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should be indicated when first used.

In several figures, such as Figure 7, 9, 12 and 13, two plots are given but it's not clear from the caption or the legend which case is displayed. Although this is mentioned in the text, it should also be mentioned in the caption. In figure 15 is referred to left and right whereas the figures are plotted above each other. Suggest to use a and b.

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