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Atmospheric Chemistry and Physics Discussions

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

Anonymous Referee #1

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General comments

In the present paper, authors perform an overall assessment of the MODIS Collection 005 aerosol products (aerosol optical depth, AOD, and size parameters, mainly Angstrom exponent, AE, and fine AOD) over dark land surface relative to AERONET, and try to identify and quantify systematic biases that are functions of Angstrom exponent (AE), cloud fraction, surface scene conditions, and time. They find that the observed AOD biases may be positive or negative, and could be large in either absolute or relative senses. Despite these systematic biases, nearly 80% of the retrievals are found to fall into a parameter range where AOD errors are less than 0.01.

The major conclusions of the paper can be summarized as it follows: (i) the MODIS-C005 AOD product can be considered to be successfully validated, since it matches

the required expected error (EE) criterion, and it is recommended for quantitative use (ii) use of QAC (Quality Assurance Confidence) along with is recommended and useful; use of AOD with QAC=3 should be preferred for quantitative AOD studies, (iii) avoiding use of aerosol size products (AE and fine AOD) is strongly recommended for quantitative studies. There are also minor conclusions drawn from the study, which refer to the role of various factors/parameters, as error sources for retrieved MODIS-C005 aerosol products, such as surface reflectance/aerosol properties (e.g. single scattering albedo, SSA) characteristics/assumptions, AE, cloud fraction, scattering angle, Moreover, there are examined differences in retrieval biases between Terra and Aqua.

The paper addresses relevant scientific questions within the scope of ACP. MODIS aerosol products are extremely valuable to the scientific community nowadays, since the climate and aerosol communities are strongly relying on them for various research and other applications, constituting thus a key tool. Therefore any assessment of their quality is crucial for our research community. In the past, some attempts were performed to assess the quality of MODIS-C005 aerosol products, but the present study is really the first integrated attempt to assess their quality. It is based on the use of extended high-quality ground truth data (from 300 AERONET sites) and on a very large test bed of 85000 matched MODIS-AERONET points. The validation is thorough and detailed using accurate mathematical/statistical tools and techniques. The paper is very well structured and written. Its large extent (including 15 Figures) is reasonable since it provides a massive amount of information to the readers/users. The reached conclusions are of extreme importance to the scientific community and are expected to crucially determine the future use of MODIS-C005 aerosol products over dark-land while providing a solid base for adjusting the MODIS retrieval algorithm when preparing future MODIS products.

Therefore, I recommend the publication of this paper in ACP with minor corrections. My minor concerns are the following ones:

(i) authors have to explain/state more explicitly what do they mean by “quantitative”

ACPD

10, C6707–C6712, 2010

information and use with respect to AE and fine AOD (but also AOD). This is very important for the future use of MODIS-C005 aerosol size products

(ii) authors have considered separately the cases of τaer smaller than 0.15 (light loading) and τaer larger than 0.45 (heavy loading) to assign surface reflectance and aerosol properties as source of errors in the retrieval of AOD. Although how the separation of these two sources of errors has been explained, however, there is probably still some contribution of each one of the two parameters to the class of AOD loading (light/heavy) for which the other parameter dominates

(iii) in page 14828 (end of sub-section 3.3) it is stated that "there will be no additional discussion of the aerosol size parameters in this paper", but later on, in the discussion of Figures 6 and 7, AE is used

Further minor detailed comments are found below.

Detailed Comments

1. Abstract, page 14816, line 11: replace ". . . global AOD to be validated" by ". . .global AOD to be successfully validated"

2. Introduction, page 14816, line 24: global aerosol distribution is not a component of the Earth's global climate system, only aerosols are so.

3. Page 14817, line 29: replace "using 0.47 and 0.65μm. . . ." by "using AOD values at 0.47 and 0.65μm. . . ."

4. Page 14818, line 9: although the expected error (EE) is defined later on, it is useful to give a short definition here since it is its first occurrence in the paper.

5. Page 14818, line 22, ". . . and regionally (e.g. Mi et al., 2007) . . .": why only China is reported here? Validation of MODIS C005 products have been also performed for other world regions such as India or Mediterranean.

6. Page 14820, lines 5-6, "ETA does not represent . . .": a better explanation is required

ACPD

10, C6707–C6712, 2010

to clarify why ETA, which represents the fraction of the total AOD contributed by fine-sized aerosols, is not a physical aerosol quantity, as would be expected.

7. Page 14825, lines 22-24, "Again, note that ... for respective correlation": please, explain why in a few words.

8. Page 14825, line 26: replace "of 5 by 5 MODIS aerosol ..." by "of 5-deg by 5-deg MODIS aerosol ..."

9. Page 14826, lines 15-16: has the altitude (>300m) been changed to examine the sensitivity of the evaluation to that elevation criterion?

10. Page 14828, lines 15-17 "Due to their ... parameters in this paper": however, AE is used in the discussion of Figures 6 and 7. How consistent is using AE for further analysis?

11. Page 14829, sub-section 3.5: apart from technical/mathematical assessments based on Fig. 3, can any physical one be made as well? For example, is there any dependence of the statistics/comparison MODIS-AERONET on the AERONET AOD magnitude?

12. Page 14830, line 22: although it is answered at the end of the section, it should be noted here why only summer months have been selected and not others.

13. Page 14831, lines 8-10, "An exception is New York City ... (Oo et al., 2010).": isn't that problem (of poor representation of urban surface in MODIS surface reflectance parameterization) encountered in other sites than those of NYC all over the globe?

14. Page 14831, lines 16-17, "... and a high single scattering albedo.": what about absorbing aerosols (e.g. carbonaceous)?

15. Page 14831, line 27, "... in a small pocket of vegetation.": how small? Comparable to MODIS 10km retrieval?

16. Page 14832: there are reported a lot of names of AERONET sites that cannot how-

ACPD

10, C6707–C6712, 2010

ever be easily traced onto the map of Figure 4. It would be helpful to add coordinates (latitude-longitude) on the map.

17. Page 14833, lines 21-25, "Collocations where ... model assumptions": the attribution of surface and aerosol assumptions as main source of errors for light (AOD<0.15) and heavy (AOD>0.4) aerosol loading conditions needs to be further supported and clarified. Both sources can be potentially contributing to errors.

18. Page 14834, line 24, "... confined to the low AOD conditions,": for AOD>0.4 there are sites around the Sahara desert (having high surface reflectance) where MODIS underestimates AOD.

19. Page 14834, line 29, "... and not due to surface assumptions": further support is required for this statement.

20. Page 14836, line 22, "... AERONET observed-AOD is lower, ...": please, specify in Figure 6 that diamonds correspond to AOD.

21. Page 14841, line 20: replace "... indicating that the EE an accurate..." by "... indicating that the EE is an accurate..."

22. Page 14842, line 4: replace "... overestimates" by "... overestimate"

23. Page 14843, line 14: see comment on Table 4.

24. Page 14845, line 5, "... Sensitivity tests show that ...": please, specify which sensitivity tests.

25. Page 14845: the results of Figure 15a imply that MODIS-Terra suggests some decreasing trend in AOD while AERONET data do not. This finding, which is claimed here to be probably due to calibration issues, is valid as shown for the entire testbed of AOD data. However, regional studies (e.g. Papadimas et al., 2008; 2009) have shown some MODIS-based decreasing AOD tendencies which are in agreement with AERONET data. Therefore, probably the general statement made here is not valid all

ACPD

10, C6707–C6712, 2010

over the globe. Performing similar comparisons to those of Figure 15 separately for specific world regions would be valuable to clarify this.

Table 1: why R and RMS improve with decreasing wavelength while % in EE decreases?

Table 4: presumably, in this Table are shown the results of the comparison including all available data for Terra and Aqua; if so, this can raise sampling issues regarding the conclusions derived from the statistics. To remove such issues the comparison should be performed using only data for the common period of Terra and Aqua.

Figure 2: The plotted quantities (AE and fine AOD) should be clearly indicated in the two graphs labels.

Figure 4: In the caption, replace "... comparisons of total AOD over land ..." by "... comparisons of total AOD at 0.55microns over land ..."

Figure 6: Specify in the caption that the right y-axis is the scale for AERONET AOD (diamonds).

Figure 15: The y-axes labels (ExpErr Ratio), correspond to expected error ratio or to error ratio (ER) as defined in Eq. 3?

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 14815, 2010.