Atmos. Chem. Phys. Discuss., 10, C8373–C8380, 2010
www.atmos-chem-phys-discuss.net/10/C8373/2010/

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.

R. C. Levy et al.

robert.c.levy@nasa.gov

Received and published: 7 October 2010

Responses to Reviews

We would like to the reviewer for their time in reading and reviewing this lengthy paper. We appreciate their comments and have endeavored to address each recommendation seriously. Only the comments that require revision/rebuttal are included here.

REVIEWER #1

. . .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"

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

We added this text to section 2.2 "The question is whether the MODIS products are quantitative. By quantitative, we refer to a product that A) we can validate, B) has statistically significant correlation with an observable physical quantity and C) we believe can be used in a scientific study or application relating to understanding of a geophysical quantity or process. By validation, we mean that we can assign well-characterized error bars to the product such that 2/3 of the values, globally, match with ground truth (e.g., AERONET) –observed properties."

We consider AOD to be quantitative because it meets all three criteria. ETA or AE are not because while we can assign error bars to these products, the correlation with well-characterized ground truth is insignificant and the spread of scatter within any defined error bar renders the information offered to geophysical applications to be so limited as to be useless. For example we cannot rely on ETA or AE to discern the seasonal shift from dust to pollution in India, because the MODIS product suggests that dust aerosol dominates all year long.

(ii) authors have considered separately the cases of τ aer smaller than 0.15 (light loading) and τ aer larger than 0.45 (heavy loading) to assign surface reïňĆectance and aerosol proper ties 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

Clarified in section 4.0. "By separating into cases with light aerosol loadings ($\tau < 0.15$) and heavy aerosol loadings ($\tau > 0.4$), we can distinguish between cases where the systematic errors result from poor surface assumptions and cases where systematic errors result from poor aerosol model assumptions. Although the separation can never be complete, surface assumptions tend to dominate the retrieval when there is little

aerosol, whereas the surface becomes less important as the aerosol load increases."

(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

What we meant to say was that "there will be no additional evaluation of the MODIS-retrieved aerosol size parameters in this paper. All subsequent references to AE refer to AERONET-measured values." Text changed accordingly in section 3.3.

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"

DONE

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

DONE

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

DONE

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

DONE

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

ADDED SOME REFERENCES (Jethva et al., 2007, Papadimas, et al., 2009)

6. Page 14820, lines 5-6, "ETA does not represent . . .": a better explanation is required to clarify why ETA, which represents the fraction of the total AOD contributed by ïňĄne-sized aerosols, is not a physical aerosol quantity, as would be expected.

DONE. See additions and revisions to Section 2.1

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

OK

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

NO, we want 5 x 5 box (of 10 km) which is approximately 50 x 50 km. Sentence added: "Since each MODIS aerosol pixel represents approximately a 10 km area, the subsetted 5 x 5 area is approximately 50 km by 50 km."

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

Not really, the 300m was chosen because 200m removed too much global data, and 500m seemed not stringent enough. We added a sentence.

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?

SEE comment iii above.

11. Page 14829, sub-section 3.5: apar t 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?

YES, absolute error can increase while relative error may not.

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.

OK. Sentence added near the top of the section, “Although the summer months are plotted here because there are more aerosol hotsptots (Northern Hemisphere pollution, Saharan dust, etc) during this season, similar maps have been examined for other seasons, but are not shown here.”

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 reïňĆectance parameterization) encountered in other sites than those of NYC all over the globe?

YES. But except for Kanpur and a few other sites, most AERONET sites are not in cities. NYC is such an extreme case it is mentioned here. Sentence added to text, “Similar urban surface problems are also encountered elsewhere (e.g. Jethva et al., 2007). “

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

The assumption is that on the U.S. east coast, even when the aerosol loading is high and carbonaceous, the SSA is still high. Note Novakov and Hegg (1997).

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

$\sim$1km. Added in the text.

16. Page 14832: there are repor ted a lot of names of AERONET sites that cannot however be easily traced onto the map of Figure 4. It would be helpful to add coordinates (latitude-longitude) on the map.

Good idea. Grids and lat/lon has been added to plots

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 fur ther suppor ted and clariïňĄed. Both sources can be potentially contributing to errors.

OF course, but the fact is that the surface dominates the signal for low AOD, whereas the aerosol dominates the signal for high AOD. See our response to (ii) above also. Think about a clean day. The reflectance received by the satellite is almost entirely direct reflection from the surface with only slight modification as it passes through the aerosol layer, whereas on a hazy day, much of the signal received at the satellite is path radiance that never interacts with the surface at all. These two situations are affected very differently by errors in surface assumptions and errors in assumptions of aerosol particle properties. With due respect, we believe the different sensitivities to aerosol loading are understood intuitively and require no modification of the text.

18. Page 14834, line 24, “. . . conïňĄned to the low AOD conditions,”: for AOD>0.4 there are sites around the Sahara deser t (having high surface reïňĆectance) where MODIS underestimates AOD.

YES. Text added. “The cases of $0.15 \leq \tau \leq 0.4$ likely are influenced by both surface and aerosol errors, so we will ignore these cases for this exercise. Of course, there are also regions, such as the borders of the Sahara, where there is heavy aerosol, and we also expect there to be problems with our dark surface assumptions..“

19. Page 14834, line 29, “. . . and not due to surface assumptions”: fur ther suppor t is required for this statement.

Done, clarified text

20. Page 14836, line 22, “. . . AERONET obser ved-AOD is lower, . . .”: please, specify in Figure 6 that diamonds correspond to AOD.

DONE

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

DONE

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

DONE

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

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

The sensitivity tests were not important. The sentence has been modified.

25. Page 14845: the results of Figure 15a imply that MODIS-Terra suggests some decreasing trend in AOD while AERONET data do not. This ïňĄnding, 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

This text revised in section 6.1: In recent years, there has been some effort to use satellite data to examine global and regional aerosol trends (e.g. Mishchenko et al., 2007, Karneili et al, 2009; Papadimas et al, 2008). In these studies, the magnitude of trends is on the order of 0.01-0.02 per decade. We can identify similar trends in the MODIS data record. For regional trends, it is plausible that we can compare with that reported by ground based or other satellites measurements (e.g., Karneili et al, 2009; Papadimas et al, 2008). However, we believe that global trends are much more difficult to quantify, due to complicated sampling patterns over different aerosol types and surface conditions. Even if global trends in the MODIS data record seem statistically significant, we must rule out the possibility that they are caused by artifacts, such as instrument calibration drift (e.g. Zhang and Reid, 2010).

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