

## ***Interactive comment on “Science impact of MODIS C5 calibration degradation and C6+ improvements” by A. Lyapustin et al.***

### **Anonymous Referee #3**

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Lyapustin et al. start out by showing examples of trends observed in MODIS C5 Terra aerosol, cloud and land surface products that are thought to be false. They attribute these trends to changes in MODIS Terra calibration, which they describe in some detail along with changes applied in the MODIS C6 calibration procedure. Then they show that although most of the false trends are gone or reduced in the C6 products, Terra could still benefit from a correction for polarization sensitivity. Finally, using “stable” desert sites they show that some residual trend still remains in the C6 products; and then present a method for de-trending the C6 products using correction factors determined with the application of the MAIAC algorithm.

Main comments:

C3108

1. The paper could be useful to inform the general users of MODIS products about the implications of sensor degradation and shortcomings in calibration of MODIS, and to document these implications.
2. Together with the cited references the explanation of the MODIS C5 and C6 calibration approach should be adequate for the majority of the readers of the paper and for the users of MODIS products. The “overview of the long-term calibration trends in aerosol, cloud, and surface reflectance C5 products from MODIS Terra and Aqua”, however, could use some more in-depth analysis. For example, giving an estimate of trends is almost mandatory in trend analysis, yet there are no levels of uncertainties provided in this paper. (Although Table 1 lists the standard deviations they are not discussed.) If they are not needed for this work, it must be stated so and justified.
3. The work, as the authors state, is triggered by the different trends observed in the MODIS Terra and Aqua C5 products. But they never actually say that these two products should have the same (or at least much less different) trend in reality. Now, this is of course obvious for many researchers in the field, but may not be so for the “broad MODIS user community”.
4. The soundness of de-trending, of course, hinges on the stability of the desert sites chosen. How confident one could be that this is indeed the case, given what the authors also state as the “accuracy of this vicarious calibration approach is not as high as the one based on the direct Moon view”. Also, does the fact that a particular algorithm (MAIAC) is used to determine the cross-calibration factors limit its applicability? In other words, would the same corrections to TOA reflectance apply when a different aerosol, cloud and atmospheric correction algorithms are used? How uncertainties in the MAIAC retrievals affect the de-trending and cross-calibration factors?
5. Will the method (PC correction) that leads to C6+ be applied to the MODIS data distributed to the public? In other words, are all MODIS L1B data and L2/L3 products going to be reprocessed? If not, is the recommendation of the authors to users to apply

C3109

the cross-calibration coefficients presented in Table 2?

Other comments:

1. While reviewing the paper it was not always clear to me if the trend plots are from the quoted published papers or from the current work.
2. Since the C6 products are already out consider changing the reference to them from "will be available".
3. Page 7284, line 16: Instead of just saying that the signal in ocean color is small, it would be useful to quote a reference value relative to those for aerosol and surface reflectance.
4. Page 7285, line 2: List the reference, if exists, to the trend in cloud optical thickness.
5. Page 7287, line 25: Please specify the period of analysis in Fig 3b. From this figure it appears to start July 2002 and end May 2013. If this is the case then the period is not 11.5 years, right?
6. Page 7288, line 14: Moon AOI: Would it be more appropriate to call this as space view since this should be available during every rotation of the scan mirror just like the SD view? I can't imagine MODIS "sees" the Moon during every scan.
7. Page 7291, line 10 and Figure 6: I assume correction for calibration drift is applied in both columns (left and right) of Fig. 6, and the only difference is that the right column also has polarization correction, while the left one does not. Is my assumption correct?
8. Page 7291, lines 16-18: Could a deficiency of Rayleigh scattering correction, that is residual Rayleigh contamination, also produce a blue reflectance that is larger than the green and red reflectances?
9. Page 7291, lines 20-26: How well does the polarization sensitivity estimated from a monthly average reflectance represent the instantaneous sensitivity? This might be useful to know.

C3110

10. Page 7291, line 27 and Figure 7a: Is full correction applied in the "corrected" component?
11. Page 7292, lines 7-9: Is there an explanation for the observed difference in polarization sensitivity of MS1 and MS2?
12. Page 7293, lines 1-4: Could you please clarify? Does this mean that PC is not significant for AOT? That is, the MCST C6 L1B already removes the spurious trend and Terra C6 trend now agrees with C6 Aqua trend. However, at least according to MAIAC, without PC correction Terra C6 BRF still has a positive trend that is not seen in Aqua C6 BRF. (Is the polarization sensitivity of Aqua negligible?)
13. Page 7293, line 13: How many of the CEOS-recommended desert calibration sites have been used?
14. Page 7294, line 19, and Figure 10: Please make text and figure consistent (there is no blue color in the figure).
15. Page 7294, lines 20-21: I do not see how sampling biases are avoided by using "daily" values. Terra and Aqua observe the same area at two different times of the day, and atmospheric/surface conditions can be different.
16. Page 7296, line 18: Contrary to what is said in the paper, the C6 to C6+ change in NDVI does not appear to be small; in the early period it is almost as large as that for C5 to C6.
17. Figure 1: Is the unit for  $\beta_R$  indeed % per decade, like the caption says? If yes, then according to the figure the trend is -0.267% decade<sup>-1</sup> for Terra C5 AOD over land. However, the text on page 7286, line 5, says the trend is about -27%.
18. Figure 1: It would also help to explicitly define  $\beta_R$ . For example, it is the change divided by the mean value for the period considered.
19. Figure 1: Is there an inconsistency in the notation regarding  $\beta_R$  and  $\beta_B$ ? For

C3111

example, if  $\beta_R$  and  $\beta_B$  are the absolute change per decade and fractional change per decade, respectively, then should not " $\beta_R = -0.049$  per dec (abs)" for Terra AOD over land be  $\beta_B$ ?

20. Figure 3b: As one of the objectives is to show the absence of drift in the Terra C6 data, would it be more convincing to show Terra C6 NDVI instead of, or in addition to, Aqua C6 in Fig. 3b?

21. Figure 7a: Consider changing the caption to explicitly say that the TOA reflectance is displayed.

22. The papers Levy et al., 2007a,b, Levy et al., 2009, and Remer et al., 2008 are quoted in the paper but they are missing from the reference list.

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Interactive comment on Atmos. Meas. Tech. Discuss., 7, 7281, 2014.