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Interactive comment on “A decadal regional and global trend analysis of the aerosol optical depth using a data-assimilation grade over-water MODIS and Level 2 MISR aerosol products” by J. Zhang and J. S. Reid

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This paper makes a thorough analysis of the AOD trend in the MODIS and MISR products using the 10-year data record of these sensors. The authors do not take their initial results at face value but make a complete investigation of why there is an apparent trend in both MODIS sensors, but not in MISR. As part of this investigation they question the radiometric calibration of the MODIS sensors. However, there is a bit of confusion given that both Terra and Aqua show very similar trends, but are separate instruments, each calibrated separately. In the end, after a series of tests, the authors

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conclude that the apparent trend in the MODIS product must be radiometric calibration drift despite the Terra/Aqua similarity.

In fact, the authors are correct in this conclusion. The clue is the “jump” in the time series in 2006. This corresponds to the onset of Collection 5 processing. Aqua began forward processing Collection 5 on 1 April 2006, and followed later that month with a reprocessing of the past data from 2002 to April 2006. Terra began its forward and reprocessing in July 2006. During a reprocessing both the aerosol algorithm and the calibration coefficients change. The MODIS Characterization Support Team (MCST) uses the opportunity of a reprocessing to update and refine each instrument’s calibration coefficients. While on-board calibration devices and monthly lunar views help a great deal to adjust calibration on a monthly basis and reduce drift, these “real-time” calibration adjustments are no substitute for analysis and adjustment to the time series as a whole. Prior to 2006, Collection 5 benefits from analysis of the calibration data as a whole. After early 2006, Collection 5 radiances are being produced on a month-by-month basis. Drift can enter the picture. The next reprocessing to Collection 6 is scheduled for 2011, when we hope that an eleven-year Terra time series can be produced free of artificial trends.

The paper does not end with a conclusion about radiometric calibration drift in the MODIS global AOD time series, but produces interesting scientific results concerning regional aerosol trends, and an attempt to isolate anthropogenic from natural aerosol.

This is a strong paper, well-written, conservative in approach and a contribution to the community. I recommend making changes to some nomenclature and several statements in the paper, but overall I feel the paper is worthy of publication.

Comments: 1. DA versus QA'd. I strongly object to the use of the term “QA'd data assimilation quality” and the label “QAed” in the legends of several of the figures. The “natural MODIS” product is a “QAed” product, meaning a quality has been assigned to each retrieval. Furthermore there are two MODIS Level 3 products: (a) Mean (b)

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QA_Mean. The QA_Mean product is a “QA-weighted” aggregation of the Level 2 product. Seeing QA'd and QAed all over this paper brings to mind the “natural MODIS” QA_Mean product. The first time I read the paper I did not realize until well beyond Figure 5 that comparisons were being made of “natural” and “DA” products, not the two “natural” products of “Mean” and “QA_Mean”.

This is especially confusing since the paper starts off by referring to the Data Assimilation quality product as ‘DA’, (Figure 1), then switches nomenclature. I strongly recommend changing ‘QAed’ to ‘DA’ throughout, not changing ‘DA’ to ‘QAed’ for consistency yet confusion.

I’m not sure whether “natural” is the right word for the “operational” product. I might have used MODIS_G (for Goddard) and MODIS_N (for Navy), or something similar. I can accept “natural” if necessary, but “QAed” is too confusing for the standard MODIS aerosol user community.

Don’t use ‘DA’ in the first sentence of the abstract without defining it.

2. At the end of Section 4.3, there is a confusing statement with no support. How can the global trend of AODa be significantly negative when the picture of Figure 10a is entirely positive? This has to be explained. Keep in mind that Eq. 4 may create its own trends. Think about what might happen as MODIS calibration issues create an artificial trend in fine fraction. This has not been explored in the paper, but most certainly must be happening. Aerosol size parameters are extremely sensitive to calibration issues. I would be hesitant about using Eq. 4 and drawing physical conclusions without understanding the role of an artificially changing fine fraction, especially when faced with results that appear to be contradictory. (Global trend of AODa is negative when Figure 10a is entirely positive.)

3. In Section 1, in the list of papers considering temporal consistency in radiometric calibration, I would add Levy et al. (ACPD, 10, 14815–14873, 2010). 4. In Section 2, the paragraph that begins with “To minimize the effects of cloud contamination...” The

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statement about ‘buddy checks’ is unnecessary and needs explanation if kept. Just take it out. 5. In Section 2, next paragraph down. Here standard Level 3 products are mentioned, but not whether this is Mean or QA_Mean. Please clarify in the text and the caption. 6. Section 4.2, the discussion of the MODIS onboard and external calibration methods. There has been an issue with Terra’s Solar Diffuser, starting in 2003. The door is stuck ‘OPEN’. This means that space dust is collecting on this white plate over time. This degradation of the SD over time has to be corrected. From what I understand, solar diffuser data from Terra is almost totally disregarded in calibration because of this issue. 7. Figure 8 and the paragraph in Section 4.3 that begins with “For the first question, we compared AOD spectrum from years 2000-2002...” To me, AOD spectrum refers to AOD as a function of wavelength, not these histograms of Figure 8. I strongly recommend changing the nomenclature here from “spectrum” to “histograms”.

Also, what is with this 6-hour average? Overpass is once per day. At higher latitudes you might see the same spot more than once per day, but to talk about a 6 hour average, as though there was an average from a Geostationary satellite, is misleading.

Finally, 2000-2002 is a dangerous period with Terra. That is when there was the flipping between Side A and Side B electronics, which even with several reprocessings was never completely smoothed over. It would have been safer to use a period 2002-2004 as the beginning period.

8. Section 4.3, the final statement in the paragraph with Equation (4) “... can be considered a proxy for the fine mode AOD”. AODa is not the same as fine mode AOD. I’m not sure what is meant by “proxy” here. It has been a struggle ever since Yoram published that paper to wean people off the concept that fine mode AOD is the same as AODa. Please don’t contribute to that misconception. You don’t need that sentence. Please remove it. Also, at the end of Section 4.3, it says “... are induced by fine mode or anthropogenic aerosols.” Again there is the implication that these are the same things, when they are not.

Also, you might mention for the confused audience that AODa is a “combustion” optical depth, and some smoke is natural and some dust might be anthropogenic.

9. I would stand by the final conclusion point in the last section. Calibration drift is extremely difficult to (a) notice and then (b) quantify, for any sensor.

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