Review of Shi et al., AMTD 2013. "Critical evaluation of cloud contamination in the MISR aerosol products…"

This paper makes some important points about how cloud contamination affects the MISR aerosol product, and it should be published in AMT. A recent paper by *Witek et al*. (2013) finds that by eliminating MISR over-ocean retrievals where the "cloud-free" fraction (CFF) of 1.1 km pixels in a retrieval region is low, the MISR AOD overestimation relative to the sun photometers is systematically reduced. To reduce the apparent AOD bias, *Witek et al*. suggest removing entire 17.6 km MISR retrieval regions when the CFF ≤ 0.6, resulting in about an 85% reduction in product coverage. (Actually, they seem to include in the CFF count pixels eliminated for reasons other than cloud, such as glint.) *Shi et al*. take an independent look at the situation using MODIS cloud screening that includes infrared channels unavailable from MISR, and carry their assessment through at 1 km resolution. The result is some good suggestions about how to improve cloud screening for the MISR aerosol product.

1. Abstract, sentence 1. Although it is the first time cloud contamination has been assessed in the MISR aerosol product using MODIS, it is not the first time cloud contamination has been assessed in the MISR aerosol product (e.g., the *Witek et al*., 2013 study you cite in the paper). So it would be fair either to eliminate "For the first time," or at least to remove the comma after "time."

2. Abstract, lines 11-12. You make the point that biases much higher than the mean value occur in some places. But if the mean value is correct, there must be compensating lower biases too, so it might be better to express this as something about variability. It would be yet more useful to identify the conditions under which high biases tend to occur. E.g., at least from the case study presented in Section 3, it seems high biases might occur preferentially at cloud edges; if this is generally true, it would be worth stating.

3. Abstract, lines 12-14. I agree that the longer MODIS wavelengths can help screen for clouds. However, the MISR the operational algorithm cloud screening does not fully exploit the MISR data for this purpose either. For example, *Pierce et al*. (2010) show with the research algorithm that MISR can retrieve thin cirrus for optical depth below ~0.3 under favorable conditions, and it is possible (though not yet tested) that this is as sensitive or even more sensitive to thin cirrus than the MODIS 1.38 micron channel in some circumstances. Perhaps this should be mentioned in the paper too.

4. Introduction, P10059, lines 6-7. Based on comparisons with AERONET and MAN, the MISR positive AOD bias over ocean is probably closer to 0.025 than 0.04 (e.g., *Kahn et al*., 2010. Figure 4). But there is a complication here. MISR-AERONET coincidences are found only when both algorithms identify cloud-free conditions, so the comparisons themselves are cloud-cleared by AERONET as well as MISR (see Point 17 below).

5. Introduction, P10059, lines 16-19. The MISR Standard algorithm uses the same 1.1 km resolution data as *Witek et al*. to perform cloud screening, so that is not the difference. The difference is that in the standard algorithm, retrieval on a 16 x 16

pixel region proceeds as long as there are at least 32 unscreened pixels (12.5%) remaining after all tests are performed (see *Kahn et al*., TGARS 2009), whereas *Witek et al*. suggest requiring 60% unscreened pixels. Also, I think "vastly lower" represents a bit of editoralizing – the decrease in mid-visible AOD might rather be stated explicitly as ~0.04 when ~85% of the data is removed.

6. Section 2.2, p10060, lines 20-23. A more complete description of the quality flags is given in *Kahn et al*. (TGARS 2009) and *Bull et al*. (MISR Data Products Specifications Document, JPL D-13963, Revision S, 2010). These might be referenced here for the benefit of other users. Also, the process is more accurately described as "quality assessment" rather than "quality assurance" (*ibid*.).

7. Section 2.2, p10060, line 25. "The Retrieval Applicability Mask (=0) is used to identify pixels free of cloud, glint, and other factors." I know you get to this later, but over ocean, glint actually removes more channels at 1.1 km than cloud factors in many places.

8. Section 2.2, p10061, line 3. "The Aerosol Retrieval Success flag (=7) is used to identify successful retrievals."

9. Section 2.3, p10062, line 4. The MISR cloud masking scheme over land and water is described in detail in this reference: Martonchik, J.V., R.A. Kahn, and D.J. Diner, 2009. Retrieval of Aerosol Properties over Land Using MISR Observations. In: Kokhanovsky, A.A. and G. de Leeuw, ed., Satellite Aerosol Remote Sensing Over Land. Springer, Berlin, pp.267-293.

10. Section 2.3, p10062, line 19. You might add the following reference here: *Martonchik et al*. (TGARS 2002). Note that the angular correlation mask is assessed at 275 m, not 1.1 km.

11. Section 2.4, P10063, line 10. It might be worth saying something here about cloud masking uncertainties, and specifically about ambiguity in the definition of cloud vs. aerosol, especially at cloud edges. For example, particle hydration and/or cloud particle detrainment might occur near clouds, possibly yielding an intermediate category. Using CALIPSO lidar data, *Tackett and Di Girolamo* (GRL, 2009) show that aerosol particles adjacent to clouds are preferentially larger than more distant particles, which seems to support the particle hydration idea.

12. Section 3, P10064, lines 15-17. At what spatial resolution is the MODIS BT assessed? This could matter, because cloud edges are tricky.

13. Section 3, P10064, lines 25-28, P10065 lines 1-4 and Figure 1f-i. I agree with the questions you raise here, but I think the answers might not be so clear-cut. See Point 11 above. Similarly for the conclusion on P10065 lines 15-18.

14. Section 3.1, Figure 2. The text indicates that the contours are in 10% increments, yet the first three contours are labeled 1%, 3%, and 6%. I'm unsure what these contours mean. For example, in Figure 2a, is this saying that for all the MISR over-ocean retrievals during 2007, where the MODIS Fcc=20%, 1% of the data has MISR

AOD ~0.34 and 2% of the data has AOD of ~0.26, whereas for Fcc=80%, 1% has AOD of ~0.26 and 2% has AOD of ~0.18? If I have this right, the bulk of the data falls within the white band, yet the mean value is at the top edge of the white band for the entire range. This, as well as the large area between the 1%, 2%, and 3% contours, suggests there could be very small percentages of outliers heavily influencing the appearance of these figures. In this case, perhaps the median would better represent the properties of the retrievals than the mean, and maybe the contouring approach chosen conveys undue importance to the behavior of a few percent of the data. Also, it might be worth knowing how many actual points are represented, e.g., by 1% of the Fcc=0.2 cases.

15. Section 3.1, P10066, lines 13-15. I agree that cloud contamination is likely in many or most cases identified here, but there is some uncertainty in the cloudiness indicators related to cloud edges that is not expressed with the current wording. Though this is probably too much work to include here, it would be especially useful to understand in more detail the behavior of the results based on the proximity of the retrieval region to a cloud edge.

16. Section 3.1, Table 1. I appreciate that AERONET might retrieve through clear gaps between clouds in some cases where MISR or MODIS could not. But if collocation with AERONET means there are both MISR and AERONET retrievals for the events tallied, then this table says that between about 30% and more than 50% of the time, AERONET reports retrievals when the MODIS mask indicates cloudy conditions, and 22% of the time AERONET fails to filter due to the presence of thin cirrus. If so, this might have implications for interpreting the AERONET data, and possibly the MODIS cloud mask as well. Again, it would be helpful to know how many cases are represented by these stratifications of the MISR data.

17. Section 3.1, Tables 1 and 2. Another observation. In both Tables 1 and 2, about 60% of the "Self-QAed" cases fall within expected error. In previous work (e.g., *Kahn et al.*, 2010), about 67% of retrievals fell within the MISR uncertainty envelope when MISR-AERONET collocations were used. One uncertainty reported with those determinations is that both MISR and AERONET had to find adequate retrieval conditions for an event to be included in the statistics. So the result here suggests that based on the MODIS cloud mask, about 7% of MISR cases falling outside the envelope were eliminated by the AERONET cloud mask in the earlier studies.

18. Section 3.1, P10067, lines 19-20. Given that 22% of the time AERONET appears to miss cirrus based on the MODIS cloud screen (Table 1 and Point 16 above), interpreting the 0.006 discrepancy between MISR and AERONET over global ocean in MODIS-identified cirrus cases might require some further caveats.

19. Section 3.1, P10068, lines 4-5. What is known about uncertainties in the MODIS cloud mask at these latitudes?

20. Section 3.2, P10069, lines 10-12. A reduction of the mean MISR AOD over ocean as large as 0.06 would bring MISR AOD significantly *below* AERONET values. This is interesting, but I'm not sure what it means, because uncertainties in the AERONET statistics, the MODIS cloud masking, and the MISR AOD might all contribute.

21. Section 4, P10070, lines 2-3. I think this is a bit overstated. Certainly the biases need to be reduced or eliminated to the extent possible. But many types of studies do not require AOD accuracy as high as 0.01, or even 0.02, and even the best available surface-based sun photometers only provide this level of accuracy (e.g., *Eck et al.*, 1999).

22. Section 4, P10070, lines 8-11. I agree with this point, but more might be said about the limitations of the MODIS cloud masking too. I see you begin to get to this in your next bullet – in Section 2.4 you might say more about the degree to which the MODIS cloud mask has been or should be validated.