Response to Dr. Kahn - Reviewer's comments are *italicized*; response are not.

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.

We thank Dr. Kahn for his constructive comments and suggestions.

Comment 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."*

Answer: Done. We have deleted "For the first time" in the text as suggested.

Comment 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.*

Answer: Done. The conditions under which high biases tend to occur are identified in the abstract. "However, biases much larger than this mean value are found in individual retrievals, especially in retrievals that are near cloud edges."

Comment 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.*

Answer: Done. We have mentioned in the text that "Note that the operational MISR cloud screening method does not fully exploit the MISR data for aerosol related applications. For example, Pierce et al. [2010] shows with their research algorithm that MISR can retrieve thin cirrus for optical depth below ~0.3 under favorable conditions."

Comment 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).*

Answer: We have changed the number to 0.025-0.04 and added Kahn et al., [2010] as a reference.

Comment 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 editorializing – the decrease in mid-visible AOD might rather be stated explicitly as ~0.04 when ~85% of the data is removed.*

Answer: Done. We have changed the text to "A recent study by Witek et al. [2013] has extended the cloud screening effort by requiring 60% clear pixels for every MISR AOD retrieval using a 1.1 km resolution clear flag that is included in the MISR aerosol products. Using the Witek et al. [2013] method, MISR AODs are reduced by 0.04 with an 85% data loss rate, and the averaged MISR AODs are in line with the Navy MODIS data assimilation grade product."

Comment 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.).*

Answer: Done. We have updated the references as suggested.

Comment 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.*

Answer: Done. We have changed the sentence to "The Retrieval Applicability Mask flag (=0) is used to identify pixels free of cloud, glint, and other factors."

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

Answer: Done.

Comment 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.*

Answer: The reference has been added.

Comment 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.*

Answer: Done. We have added the reference.

Comment 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.*

Answer: Done. We added "Ackerman et al. [2008] showed that cloud/clear areas from the MODIS cloud mask products agree with lidar data about 85% of the time with a cloud optical depth sensitivity of ~0.4. Uncertainties in the MODIS cloud mask products as well as the complicated nature of near cloud aerosols contribute to the complexity of the cloud-clearing issue. For example, particle hydration [Tackett and Di Girolamo, 2009] and/or cloud particle detrainment might occur near clouds, which make it ambiguous in discriminating clouds and aerosols."

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

Answer: Done. We changed the text to "Figure 1d shows the MODIS brightness temperature (BT) at a 5 km resolution."

Comment 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.*

Answer: We have added the following discussions. "Still readers should be aware that there are uncertainties in cloud masking itself, such issues are discussed later in the discussion and conclusion sections."

Comment 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.*

Answer: Done. Both mean and median values are plotted in Figure 2. Also, to avoid confusion, we have modified the Fig. 2 caption as the following and replaced Fig. 2 with a new figure that includes the median values.

"Figure 2. MISR AOD as functions of the percentage of occurrences of the cloud flags from the MODIS cloud mask products: (a, e) confident clear fraction (Fcc), (b, f) probably clear fraction (Fpc), (c, g) uncertainty clear fraction (Fuc) and (d, h) cloudy fraction (Fcd). Fig. 2a to d are for the over-water data and Fig. 2e to h are for the over-land data. The color contour shows the fractional data density. The red and black dots represent the mean and median MISR AOD values within a 10% cloud fraction bin, respectively."

Also, 1% of the $0.1 < F_{cc} < 0.2$ case represents ~1478 data points over ocean and ~217 data points over land.

Comment 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.*

Answer: We agree with Dr. Kahn on this. As suggested from Reviewer 2, the new collection 6 MODIS aerosol products contain a parameter called "Average Cloud Distance Land Ocean" that can be used in this research. However, I believe this is a study of itself. We leave this for a future study. Still, we have added discussions in Section 4 as suggested from Dr. Kahn. "A closer look over the distance between the aerosol retrievals and cloud edge (Levy et al., 2013) may help users to choose the thresholds of the F_{cc} cloud filter for their applications. For example, MODIS Collection 6 Dark Target aerosol products include a parameter called "Average Cloud Distance Land Ocean" that is helpful to solve this problem. It may also facilitate further investigation over the cloud contaminations due to cloud 3-D effects, aerosol hydration over the high humidity environment, and the twilight zone issue."

Comment 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.

Answer: Thank you for the comments. It is hard to distinguish cases between AERONET might retrieve through clear gaps and there is thin cirrus cloud contamination in the AERONET data. We thus didn't add new discussions. Still, as suggested, we have added the number of cases (collocated with AERONET) in Tables 1 and 2.

Comment 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.*

Answer: It is also possible that the difference in the study periods, as well as spatial and temporal collocating methods used for pairing up AERONET and MISR data, contributed to the difference. We are unsure which case is true, so we didn't add new discussions.

Comment 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.*

Answer: Done. We added the following sentence to the text. "Note that AERONET data may also be impacted by the thin cirrus contamination [Chew et al., 2011]."

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

Answer: Reviewer 3 suggested that the reduction in MISR AOD over the high latitude northern oceans could be associated with the broad storm track. We have modified the text based on the suggestion: "Similar suppression in AOD is also found in high latitude northern oceans, which could be partially related to the broad regions of winter storm tracks."

Comment 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.*

Answer: The large reduction in AOD over oceans may be partially due to the misidentification of thick aerosol plumes as clouds by the MODIS cloud mask schemes. We have discussed this issue in the conclusion section of the paper.

Comment 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).*

Answer: Agreed. We changed the sentence to "This study suggests that additional cloud screening methods may be needed for using MISR aerosol products for future studies."

Comment 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.*

Answer: Done. We added discussions on uncertainties in the MODIS cloud mask data in Section 2.4. See answer to comment 11.