Paper # amt-2014-252

Improving satellite retrieved aerosol microphysical properties using GOCART data

Response to Comments

Reviewer #1:

General Comments:
The article aims to improve MISR aerosol optical properties by incorporating information from model-simulated (GOCART) aerosol properties, as MISR's ability to retrieve aerosol properties is weakened at low AOD levels. The authors propose a post-processing technique to improve MISR aerosol retrievals by constraining MISR mixtures' ANG and absorbing AOD (AAOD) using the GOCART aerosol simulations. Specific aerosol mixtures are selected when the differences of ANG and AAOD between MISR and GOCART are below a certain threshold.

This topic is important and such a study is valuable, but some more works need to be done before its publication (see specific comments). Overall, this paper is hard to read. The abstract is too long.

Response*: We have updated the descriptions for those parts of the text that were difficult to read, and shortened the abstract.*

Specific Comments:
P8954, eq.(4): α is the ANG, right ? explain it in the context.

Response*: The ANG (α) is explained in the revised abstract.*

P8954, L22: do you use three wavelengths? Rewrite this sentence to make it clear.

Response*: We have rewritten this sentence in the revised manuscript:*
"where ε_{ANG}% and ε_{AAOD}% *represent the corresponding thresholds for both ANG and AAOD differences at 558 nm."*

P8955, L8-9: Hard to understand. Please rewrite this sentence to make it clear.

Response*: We have rewritten this sentence in the revised manuscript:*

"We adopt this approach to help primarily in situations where the MISR radiances lack aerosol type information, and many mixtures pass."

Figure 1: hard to understand. Please put component fractional optical depth in a separate panel.

Response*: In the revised manuscript, we calculated the component-specific AOD percentages of MISR mixtures and show them in a separate panel together with the ANG and SSA in Figure 1.*

Figure 3 and other figures: It is better to give the bias and RMS error instead of "Diff".

Response*: We have moved the SD, p value, and the errors for slope and intercept from Figure 3 to Table 1.*

P8956, L29: AOD > 0.2, the MISR retrieved AOD, right ? why not show the corresponding points in the top panels, as in the lower two panels of Figure 3? Why the points in the bottom panels are much less than the middle panels ? you need to explain it in the caption of Figure 3.

Response*: In the revised manuscript, we have updated the caption of Figure 3, explained why there are fewer AAOD points in bottom panels, and discussed why we did not show the corresponding points for MISR AOD and GOCART.*

Bottom panel: AERONET AAOD is only retrieved when the AOD at 440nm is greater than 0.4 and the solar zenith angle is larger than 50˚. We found only 107 matched MISR-AERONET AAOD data records, which are far fewer than the number of direct-sun AOD measurements.

In Figure 3, we did not plot MISR AOD>0.2 dots because the X and Y axes can easily distinguish the distribution. In addition, we did not break up the GOCART points by AOD value because this paper mainly focuses on MISR performance and improving MISR's aerosol microphysical properties, not evaluating and refining GOCART.

Unfortunately, the GOCART simulations barely catch the variation of AOD, ANG and AAOD from the right panels of Figure 3, i.e. the observations from AERONET show a much large variation than GOCART. So, I doubt the performance of this algorithm by incorporating GOCART data to constraint the selection of mixtures in MISR products. Try to limit the AOD < 0.2 and plot these points in red colors in the right panels, recalculate the correlations between GOCART and AERONET. Guess only using the GOCART data with AOD < 0.2 may help to improve this MISR product, where the MISR product is poor as described in this paper, and this criteria should be add in the algorithm. Similarly, since ANG > 2 can not be simulated by GOCART, is it helpful to add it as one criteria in the algorithm?

Response*: The reviewer's understanding is correct and the suggestion will be important for future work. Indeed, the GOCART model (like all models) has deficiencies that limit our ability to improve MIRS's aerosol microphysical properties. For example, most models tend to show smaller dynamic ranges for AOD and aerosol properties than observations. Yet, empirically, the model does improve MISR aerosol-type retrievals at low AOD, as expected – aerosol type in the model depends heavily on the aerosol source inventories used, and is therefore far less sensitive to AOD than the satellite aerosol-type retrievals.*

To improve our refined MISR product further, given current limitations, we have stratified our analyses by season and geographical regions in the revised manuscript. Our ANG in spring is better than those for the whole year because GOCART captured springtime dust emissions well. Further evaluation of GOCART model performance is beyond the scope of our article, but we would expect the new version of GOCART, and perhaps other models in the future, to offer more skill at refining the MISR aerosol product. Here we have demonstrated the value of the

approach.

Figure 4: hard to understand. More description about how this figure is generated using simulation data should be added.

Response*: We have further elaborated the description for Figure 4 in the caption and text accordingly.*

In Figure 4's caption: "The axes specify the percent of mixtures passing the MISR retrieval acceptance criteria coming closest to the GOCART model value that is retained by our method (Equations 4 and 5), so a smaller number means the model is used to provide a tighter constraint. The resulting agreement is then assessed based on MISR-AERONET coincident observations. The color from blue to red represents the correlation coefficients (for AOD of Figure 4.a and ANG of Figure 4.b) or the mean ratio (for AAOD of Figure 4.c) from low to high, so for each panel, colors toward "red" indicate better MISR-AERONET agreement when the GOCART-MISR agreement criteria specified by the axes are applied.
"

Table 1 is too complicated and it is better to show it in a Figure, or make it simpler.

Response: *In the revised manuscript, we have reorganized this material as Table 2. The new table shows our results that were derived from the appropriate thresholds as in Figure 4, and compares them (e.g. correlation coefficients for AOD and ANG, and the mean ratio for AAOD) with the corresponding MISR retrievals.*