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Interactive comment on "Improving satellite retrieved aerosol microphysical properties using GOCART data" *by* S. Li et al.

Anonymous Referee #2

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The article aims to improve MISR aerosol optical properties by incorporating information from model-simulated (GOCART) aerosol properties. When AOD is below 0.15 or 0.2, the sensitivity of the V22 MISR retrieval algorithm to aerosol component information is low. The authors propose a post-processing technique whereby inclusion of additional constraints from the GOCART CTM is used to constrain MISR's aerosol mixture selections. Specific aerosol mixtures are selected as the final retrieval only when the differences of ANG and AAOD between MISR and GOCART are below a certain threshold. These thresholds are not fixed a priori but dynamically adopted. It is not clear though: (a) how these dynamic thresholds should vary by season and/or region, (b) how much of an improvement does this post-processing technique buy, and (c) how relevant these results are beyond the MISR community. These points are of

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concern, and the following comments/question revolve around those issues and few other assumptions/choices that have been made.

(1). Section 3.2 and Figure 3 – This is really the crux of the manuscript. Unfortunately, the results that are currently in the manuscript (either in the Table or in the Figures) are not adequate to justify the authors' claim that their work improves the aerosol properties when AOD < 0.2. There are a variety of results that are presented, sometimes with all AOD, AOD > 0.2, or AOD > 0.5. And it is really difficult to distill the main message – whether or not the proposed methodology improves the aerosol optical properties for AOD < 0.15 or AOD < 0.2. A few comments to highlight this issue:

(i) The authors should include a column (d) in Figure 3, which shows visually the validation of the AOD, ANG and AAOD obtained from their work against the AERONET observations. Only the summary statistics are presented in Table 1 but these summary statistics are not presented for MISR and GOCART. Hence it is difficult to assess how much of an improvement in the aerosol properties is obtained.

(ii) Both rows (1) and (2) in the revised Figure 3 should show a set of red dots indicating AOD <= 0.2. For row (3), that is AAOD, this can be revised to AOD <= 0.5. Currently, row (2) shows a set of red dots for AOD > 0.2 and the expected improvement in the fit of MISR to AERONET observations. But the main point of the proposed algorithm is to improve the estimates when AOD <= 0.2. Indeed if the proposed technique is serving its purpose, the results (Table 1 and 2, Figure 3) should highlight: for AOD and ANG - (a) all AOD, and (b) AOD <= 0.2; and for AAOD – (a) all AOD, and (b) AOD <= 0.5.

(iii) Line 25, Page 8960 – The authors claim that "...Better correlation is seen in the East (0.87), summer (0.78) and fall (0.88)". But "better" relative to what? The authors haven't presented the corresponding values for MISR (or GOCART), so it's not clear how much of an improvement takes place.

(iv) In the caption, the authors should add a line clarifying the red dots in rows 2 and 3.

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(v) It is highly disappointing that in reporting the parameter estimates, the authors make no attempt to include a standard error on that estimate or report the statistical significance of that parameter (associated p value, for example). It is hard to interpret the differences, especially the slope and intercept values (for example, Figures 3.3a and 3.3b) without knowing whether the differences are significant or not.

(2). Line 26, Page 8954 – What do the authors mean by 'model-satellite discrepancies'? Is it simply differences in resolution or more general differences in how the aerosol-related information is derived in MISR and GOCART?

(3). Even though the authors have broken up their analyses by both season and geographical regions (Tables 1 and 2), the dynamic thresholds (for Equations 4 and 5) are assumed to be constant over the entire contiguous US (Lines 7-10, Page 8961). The authors need to clarify the impact of this assumption. Also in Line 9-10, Page 8961 – what do the authors mean by 'other parameters'? To demonstrate the full value of this methodology, additional sensitivity tests need to be presented by re-generating Figure 4 for different seasons and regions considered in the study.

(4). What are the assumptions made by GOCART that may affect the final results presented here? In Lines 1-9, Page 8956 the authors highlight a number of factors that may contribute to the poor performance of GOCART relative to AERONET. Are these factors specific to GOCART or any other CTM. How will switching to a different CTM (for e.g. GEOS-Chem as mentioned in Section 4) help? Later in Section 4, the authors state that GEOS-Chem may help (Line 12-14, Pg 8966) – '...especially when the information is lacking in the MISR radiances themselves, such as at low AOD'. But isn't that the reason for using GOCART in the first place. Why do the authors expect that GEOS-Chem will produce additional benefits relative to GOCART?

(5) Table 2 – The values reported in the AAOD section, especially for the row 'our work', do not match the stated values in the text in Section 3.3 (Pages 8963-8964). The differences are almost of an order of magnitude. Kindly check.

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(6) Also, the authors present only the mean values in Table 2. Calculating a direct 'mean' value may not be a statistically accurate metric for a log-normal distribution such as AOD (see O'Neill et al. [2000] and several other published work since then including Liu et al. [2004] that has been cited). Could the authors state if they took the logarithm of the AOD values, and then reported the mean? A simple goodness-of-fit test will reveal if the data are lognormal or not. Finally, the caption of Table 2 states – 'Statistics of the ....". The word statistics should not be used here since the authors present only one value and not the standard deviation or errors associated with that value.

References: [1] O'Neill, N. T., Ignatov, A., Holben, B. N., and Eck, T. F.: The lognormal distribution as a reference for reporting aerosol optical depth statistics; empirical tests using multi-year, multi-site AERONET Sunphotometer data, Geophys. Res. Lett., 27(20), 3333–3336, 2000

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