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Atmospheric Measurement Techniques Discussions
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Interactive comment on "Combining low-cost, surface-based aerosol monitors with size-resolved satellite data for air quality applications" *by* Priyanka deSouza et al.

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We are grateful for the constructive reviews we received for our paper. We have modified the manuscript to address the reviewers' comments, and herein resubmit the updated paper and detailed responses to the reviewers.

Reviewer 1

General Comments: In this manuscript, the authors present a technique to combine particle counts from low-cost, ground-based sensors with the additional information provided by MISR's size resolved AOD retrieval to infer PM2.5. With some modifications, I would recommend this manuscript for publication: the technique is novel and will be of interest with scientists seeking to balance the strengths and weaknesses of low-cost sensors.

Thank you. We are grateful to the reviewer for recognizing the novelty of this technique.

That said, there are clear limitations to the current study that may limit broader application of their approach, although many of these shortcomings are already identified by the authors. Of particular concern, but as noted by the authors, is the inability to validate their results against reference-grade observations. Without such a comparison, it is difficult to determine the relative value of this combined approach compared to the uncertainties of its underlying assumptions. With this in mind, whether or not this work is published I would strongly encourage the authors to continue to develop this approach in a location that allows direct validation.

We agree with the reviewer. In the current paper, we describe a novel methodology and demonstrate it using data from Nairobi. We recognize that many conditions of that experiment were not ideal. Our demonstration of this technique using data from Nairobi helps us highlight these limitations, which are enumerated in the text and supplement, as the reviewer acknowledges. We aim to use the publication of the current paper, presenting the technique, along with what we have learned from this initial pilot, to support a proposal for a future deployment that will allow us to validate this methodology under more ideal conditions. The published paper giving the technique, along with the limitations of the Nairobi experiment, will be essential support for any proposal we might write requesting to perform an improved experiment.

Specific Comments:

Supplemental L192: I have some concerns that the GEOS-Chem simulation used to scale total column AOD to near-surface AOD is based on a simulation from 2012. The amount and relative influence of transported Saharan dust and biomass burning from the Congo on the vertical distribution of aerosol have significant annual variation and may impact the author's results. A plot comparing 2012 and 2016 monthly mean MAIAC AOD over Central and Northern Africa for October and December may provide some reassurance, or alternatively motivate the need for a more recent simulation (or perhaps such a simulation could be run).

This is a fair point. Unfortunately, more recent GEOS-Chem simulations are not available to us for Nairobi, nor the ability to re-run the model. Thus, the purpose of this paper is limited to methods development. In the future, we hope to validate this method in a more ideal location: one for which we will have CALIPSO or other space- and/or ground-based lidar data, a collocated reference monitor, along with a contemporaneous run of the GEOS-Chem or other model, to assess aerosol vertical distribution with greater confidence. We have discussed this in Section 4.2 of the paper

Supplemental L264: How well correlated are these results when taken against total column AOD instead of near-surface AOD? As given, the high rËĘ2 could be due to MISR AOD, even if the GEOS-Chem scaling was not working well. The change in correlation when using the total-column instead of near-surface AOD is more relevant to the quality of GEOS-Chem in this application.

When repeating this analysis with the total column AOD for the 10 measurements, we obtain an adjusted R squared of 0.89. This is comparable with the adjusted R squared obtained when using the near-surface AOD (0.88). This supports the assumption that the aerosol is concentrated near-surface. We have included a short sentence in the text in Section S2 in the SI about this.

Figure S5: Given the sampling shown in Table 1, it would be more useful to show the vertical structure of August and October.

Thank you. We have updated this Figure.

What is the cause of the flat sections in the OPC $PM_{2.5}$, shown in Figure S7?

The flat estimates are because a single OPC $PM_{2.5}$ value was used to constrain MA-

IAC AODs of the grid cells within a 1.6 km radius from each surface monitoring site. Thus, the same $PM_{2.5}$ value from an OPC is linked with multiple MAIAC-derived $PM_{2.5}$ concentrations.

We have added this information to the caption of Figure S7. Thank you. The updated caption is reproduced here:

"Figure S7: (Blue) $PM_{2.5}$ values (in μg/m^3) from the MAIAC Analysis 5 in Table 2 (Remember only 85 satellite observations with the total MAIAC AOD $\geq$ 0.15 are considered in this analysis). The corresponding daily-averaged $PM_{2.5}$ from the ground-based OPC in units of μg/m^3 are shown in red. The correlation between the two estimates of $PM_{2.5}$ is 0.47. Note that the flat estimates are because a single OPC $PM_{2.5}$ value was used to calibrate MAIAC AODs of the grid cells within a 1.6 km radius from each surface monitoring site. Thus, the same $PM_{2.5}$ value from an OPC is linked with multiple MAIAC-derived $PM_{2.5}$ concentrations."

At the author's discretion, it may be appropriate to mention the application of such a technique to the upcoming MAIA mission. I expect MAIA's multi-angular viewing will allow similar size-resolved information as MISR provides. If appropriate, this connection would help broaden the applicability of the author's work.

We are aware of MAIA, and now mention this possibility in the text. Note that to apply our method, we would also need to deploy OPCs at one or more locations that MAIA is sampling. Specifically, we include the following text in the Conclusion:

"We hope with the increasing focus on air quality (e.g., the expansion of the SPARTAN network, Weagle et al., 2018), broader application of low-cost monitoring can occur. Further, the planned MAIA instrument (expected launch year: 2022), like MISR, will be able to provide size-resolved information about aerosols from space for a subset of cities at higher temporal resolution (Diner et al., 2018). As such, it should better capture the variability in aerosol type, and the data can be incorporated into our methodology."

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