Reviewer's comments in plain text. **Our response in bold.**

As I mentioned in my earlier review of this paper, this is an opinion piece, and the reviewer need not agree with the authors, except on factual points. So, here again are a few thoughts from my perspective, for the authors to consider if they wish.

Now that the reviewer has revealed has identity, we would like to personally thank Dr. Kahn for his two excellent thought-stimulating reviews of our Opinion.

Abstract and Line 124: I'm wondering whether "hyperspectral" would always be the best choice if it comes at the expense of spatial resolution or coverage, or instrument cost. Similar thought regrading hyper-angle.

We believe the abstract is accurate in the way it is presently stated,

"We anticipate technology that will replace today's standard multi-wavelength radiometers with hyperspectral and/or polarimetry all viewing in multiple angles."

Look at PACE. There's a hyperspectral radiometer that tilts. Sure to avoid glint, but it is not a big step to make something like that into a two-angle radiometer like the AATSR family. Complementing the radiometer are two multi-angle polarimeters. The Abstract statement is and/or. We believe that is accurate.

Line 124. Yes. We see Dr. Kahn's point and have modified the wording to avoid a reader from visualizing a super instrument. New text,

"Future imaging polarimeters will improve upon the POLDER/PARASOL technology with better polarization accuracy, hyper spectral and hyper angle capabilities, decreases in pixel size, increase in the number of wavelengths with polarization and still allow for imaging. Super polarimeters with *all* of this technology in a single instrument are not necessary. Individual missions will tailor their instrument characteristics to meet particular mission needs, but these types of instrument advancement will be available for mission design. "

Abstract and Lines 508-509: I expect that applying algorithms to single sensors will probably still occur, in part because a lot can be retrieved from an instrument that combines the spectral range from the UV to the IR with multi-angle and polarization capabilities, and in part because the retrieval uncertainty will have to be estimated, and that will depend on each individual instrument's radiometric calibration uncertainty as well as the uncertainties in the assumptions that must be made to retrieve aerosol constraints, which will be different for instruments having different measurement capabilities. Further, the importance of error and uncertainty estimation, especially when multiple instruments having different capabilities contribute to a single retrieval, I think deserved more emphasis.

Dr. Kahn keeps jumping on all of our provocative statements!

We have changed the wording in the abstract and at line 508 to read "in decline" rather than "extinct".
And we agree about the difficulty in applying uncertainty estimates to multi-sensor inversions. We have added the sentence,

"The caveat with multi-sensor inversions is the difficulty of determining the propagation of error and uncertainty from sensors of various capability and calibration."

Abstract, and Lines 321-323, and it goes beyond what is stated in Lines 361-364: At least currently, "assimilation" has a specific meaning that you describe in Section 4, but it might not apply to every way in which measurements can be used to constrain models. Not all satellite datasets useful for constraining aerosol representation in models are well sampled spatially, are regularly sampled temporally, or have formal uncertainty estimates. For example, in addition to characterizing aerosol sources in models based on measurements, improving the parameterization of aerosol processes such as chemical evolution and aerosol-cloud interactions in models cannot be done via assimilation. (In case it is of interest, the issue of constraining aerosol modeling with measurements more generally is discussed, e.g., in Kahn et al., doi:10.1029/2022RG000796; also relevant for improving climate prediction and air quality forecasting (mentioned in Section 7).)

The cyborg idea is another provocative concept! Dr. Kahn is correct in that satellite aerosol products have many uses besides assimilation. We have chosen to emphasize the cyborg idea as a way to provoke a conversation with our readers. Because of that we prefer to keep the Abstract, as is, and increase the discussion of satellite product interaction with models in the text. We have added the following to the final paragraph of Section 4.

"Using satellite-derived data sets as separate, independent data can improve parameterization of aerosol processes within models. Such processes include chemical transformation and aerosol-cloud interactions. Such independent constraints on models have important implications for climate prediction and air quality applications (Kahn et al., 2022)."

Section 5. I know this goes beyond the scope of the current paper, but there are issues with space debris creating hazards for satellites (and space stations); at some point, actions might be taken to limit the number and type of material placed into orbit – hard to tell whether that would occur by 2043.

True. I do know that at least in Europe all small sats now require propulsion in the design to enforce an efficient burn up during re-entry. But, it is beyond scope.

Lines 528-529. As long as climate prediction matters, people will still be interested in aerosol radiative forcing. If the world is lucky enough not to have to worry about climate change by 2043, so much the better. However, at present that seems overly optimistic.

Ok. Ok. We will modify our language again.

"Those interested in aerosol radiative forcing, will find numbers in Wm^{-2} coming automatically out of some assimilation system."

And Lines 522-523. If researchers are doing careful work, and their results depend on some estimate of aerosol amount, they will still likely use AOD, at least to test aspects of their results. AOD has the advantage of being easier to retrieve with confidence than aerosol quantities that also depends on the particle SSA or mass-extinction efficiency.

Validation is a good point. We prefer to keep the leading sentence, as is, but have added validation as another use of AOD in the final sentence of the paragraph.

"The only interest in aerosol optical depth will be users working towards continuity with the old sensors for long-term trend analysis or as a critical first step in validating a retrieval."

A few detailed suggestions:

Line 54. The following reference supersedes Martonchik et al. (2002): Martonchik, J.V., et al., 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. ISBN 978-3-540-69396-3.

Thank you for the reference update. Implemented.

Line 56. A better reference than Kahn et al. (1998) here would be: Kahn, R.A., P. Banerjee, and D. McDonald, 2001. The Sensitivity of Multiangle Imaging to Natural Mixtures of Aerosols Over Ocean, J. Geophys. Res.106, 18219-18238, doi: 10.1029/2000JD900497.

Thank you again for the updated reference. Implemented.

Line 166. Might be: "…lidars flying now or expected in the near future…"

Implemented. Thank you.

Table 1. You might use an asterisk to distinguish those missions that have launched successfully from those yet to be deployed.

Lines 270-271. Cost-function minimization does not require replacing the LUT; we actually use LUTs and apply cost-function minimization in MISR retrievals.

The wording here was introduced after the last round of reviewer comments. It did not quite convey the meaning we intended. Yes, cost-function minimization can be applied to LUTs. We have made slight wording adjustments.

"Today, as information content increases and computer power grows to meet demand, LUTs are being supplemented by other methods to solve the radiative transfer equation. Techniques are being used to simultaneously retrieve multiple aerosol, gases, and surface parameters."

Lines 434-437. AERONET indices of refraction, SSA, and particle sphericity variables are remote-sensing retrieval results that require many more assumptions and entail much greater uncertainties than the spectral AOD. At best, these are column-effective values that do not capture the distinct particle properties in the atmospheric column under the frequent circumstance that multiple aerosol modes are present. These limitations are often ignored by users of the data. For example, we can *compare* MISR-retrieved SSA with AERONET values, but we cannot validate the MISR results with AERONET data; the AERONET results are often no better, and sometimes not as good, as those from MISR. (This leads to the need for systematic in situ measurements if we are to improve key aspects of climate simulation and prediction, and also to the desirability of incorporating modeling in the retrieval process, e.g., to help constrain aerosol type by identifying the likely aerosol sources.)

Dr. Kahn is correct. We knew this but didn't take manuscript space to write it. We have added text.

"The AERONET retrieval that produces reliable aerosol characterization in addition to AOD, including particle size distribution, single scattering albedo, complex refractive indices, and non-sphericity, will become a more important asset over time as aerosol satellite remote sensing advances in information content, requiring evaluation of satellite-retrieved products that include a wide range of aerosol parameters. However, we note that while the uncertainty in AERONET AOD is sufficiently small to offer true validation to a collocated satellite AOD product, the uncertainty of AERONET inversion products (particle size distribution, single scattering albedo etc.) is not. The AERONET inversion products are themselves subject to assumptions and caveats, and may have greater error than certain satellite parameters. Still, the inversion products provide a vital service in the evaluation of satellite products, providing a standardized framework of high quality, widely distributed aerosol characterization for nearly immediate comparisons with satellite products."

Line 469. Why only in developed countries?

We took those words out.