

Comment on amt-2021-204

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Referee comment on "Retrieval of aerosol properties using relative radiance measurements from an all-sky camera" by Roberto Román et al., Atmos. Meas. Tech. Discuss., <https://doi.org/10.5194/amt-2021-204-RC1>, 2021

The manuscript investigates aerosol retrievals performed on normalized sky radiances obtained from an upward looking all-sky camera. Retrievals are first simulated using synthetic data corresponding to a variety of aerosol types to estimate uncertainties under known conditions. The retrieval is then applied to real data obtained from a sky camera located in Valladolid, Spain and the resulting retrieved parameters are compared with their counterparts from AERONET inversions. It is found that the method has good sensitivity to AOD in scenes with low to moderate aerosol loading and it can characterize some aspects of the particle size distribution, especially in the fine mode.

The study demonstrates that upward looking cameras have the potential to retrieve useful aerosol information even without an absolute calibration. This approach has the potential to provide a low cost means of significantly expanding ground-based remote sensing coverage and the topic is certainly relevant for AMT. There are a few points that I feel need further clarification though, particularly some details regarding the preparation of the measurements used as input to the retrieval. Additionally, I would recommend another round of proof reading for English language usage.

Detailed Comments

1) LN 60: Since the comparisons are with retrieved values the term "retrievals" is probably more appropriate than "real measurements".

2) LN 91: "geometries" should be "scan" since each of the two scans contains observations at multiple geometries.

3) LN 104: It would be helpful to specify the field of view of this fisheye lens.

4) LN 106: Given that stock Bayer filters are typically quite broad, will there still be significant spectral crosstalk (i.e., band overlap) between the three channels? It would be good to provide some description of the magnitude of this effect as well as a definition of exactly how the "effective wavelengths" are calculated. I would also be interested to hear the authors thoughts on how this could potentially impact the retrievals (perhaps at a later point in the manuscript).

5) LN 122: I believe the measurements made here cover to most of the sky. Presumably using observations at so many viewing angles would place a high computational burden on the retrieval but what was the motivation for subsampling these observations to the AERONET hybrid scan viewing geometry in particular?

6) LN 126: This is a little ambiguous in my view. Is the spectral dependence accurately captured here as well, or just the angular dependence? It would be good to include an equation and/or make the description of the normalization procedure more precise.

7) LN 128: I am struggling to track the remainder of this paragraph. Which uncertainties are used for the 5% screening criteria? If all observations with uncertainties greater than 5% are removed in QA, how is the uncertainty of the remaining quality screened 605nm data still above 5%?

8) LN145: Were any corrections applied to account for gas absorption or was it assumed negligible?

9) LN 150: How is the aerosol's vertical distribution modeled by GRASP in this study?

10) LN 152: Could other points in the FOV be used to provide more measurements if <6 data points are available within the hybrid scan geometry?

11) LN 156: A more precise explanation of "residual higher than the uncertainty" should be provided. The exact expression used to calculate the residual and the corresponding threshold value would be helpful.

12) LN 165: Is it possible to provide some metric conveying the strength of these temporal smoothness constraints? (e.g., typical level of autocorrelation)

13) LN 179: I'm not following what is meant by "using the Valladolid coordinates as a reference" and how the analysis went from seven to nine aerosol scenarios. Were two additional scenarios added corresponding to Valladolid aerosols? If so, how were these two scenarios derived?

14) Figure 4/6: These figures might be a bit easier to follow if all panels on each row had the same y-axis scaling.

15) LN 240: It is shown that the normalized sky radiances do not change significantly with AOD at high aerosol loads. Said another way, there are many possible aerosol concentrations that produce the observed normalized radiances so, while the retrieval lacks sensitivity to AOD in these cases, it still should be able to fit the measurements relatively well. Thus, I am wondering why the number of converged cases (N) decreases to near zero at the higher AODs?

16) Figure 6: The authors might consider including a plot of normalized (instead of absolute) size distributions so that the retrieval errors are not dominated by uncertainties in the total concentration, especially at high AODs.

17) LN 265: How exactly is the lognormal's σ defined here? I generally take σ to be a unitless quantity.

18) LN 295: It is a little surprising to me that more real retrievals pass the convergence test (>80%) than simulated retrievals (<65%, even for the lowest AODs). Do the authors have any thoughts as to why this might be?

19) LN 302: My understanding is that GRASP radiative transfer assumes plane-parallel geometry. Are errors in GRASP's forward modeling a significant concern at such high SZAs?

20) LN 368: Since the sentence is referring to the bias (not the spread) of the points "Most of the differences" should probably be replaced with a term that means the center of the distribution (i.e., "mode").

21) LN 451: I found the first few sentences of this paragraph to be very confusing. I recommend rewording.

22) LN 518: Why is AERONET able to retrieve absorption with hybrid geometry but GRASP-

CAM has no sensitivity? Is it due the lack of absolute calibration in the GRASP-CAM data? If the authors have an intuitive explanation of this phenomenon, it would be helpful to include it.

Technical Comments

LN 25: "makes" should be "means"

LN 32: "using all" should read "all using"

LN 34: It would be clearer to say "...capable of measuring..."

LN 74: While the acronym is common, "m.a.s.l" should be defined within the text.

LN 144: "AWRONET" needs correcting.

LN 389: I think this should reference Figure 13, not 12.

LN 413: Should say "...than the ones obtained..."