

Closing the Gap: An Algorithmic Approach to Reconciling In-Situ and Remotely Sensed Aerosol Particle Properties

I would like to thank the authors for addressing some of my previous comments. For the new manuscript, there are enough typos that I would advise the authors to proofread more carefully next time (e.g., L980). In terms of content, despite the authors providing more explanation, I still find the manuscript unclear at times. Below are my questions and comments that suggests this manuscript needs at least MINOR revisions (I think it really sits right between MINOR and MAJOR revisions), but I think the authors can address the following relatively quickly.

General comment:

I am not clear in the way the authors set up the synthetic consistency analysis. Specifically, in response to Reviewer 3's comment on expanding the variety of synthetic size distributions, the authors gave Figure 5 as an example of a bimodal size distribution that appears unimodal to me. Are there other examples of size distributions that the authors could offer for different layers of the sampled atmosphere?

Figure 15 shows a clear high bias in remote-sensing retrieved values (e.g., C_{ext}) compared to the ISARA values that the authors did not explain well. Besides the reported statistics, the authors seem convinced that the bias is from under-sampling of coarse-mode particles. Given the high uncertainty in retrieved κ and refractive index values, I would be more convinced in the bias coming from one of these retrieved values.

I am still unclear on the uncertainty associated with the gamma parameterization. Is there a reported uncertainty somewhere on the manuscript that I may have missed?

Specific comments/questions:

L204: The ACTIVATE "mission" or "field campaign". The authors' response of to a similar comment made by Reviewer 3 was not satisfactory. On L110 in the Introduction section, the authors already used the term "ACTIVATE field campaign" as well as "ACTIVATE mission" on L138, so there should be no issue to use something similar on L204. "The ACTIVATE featured..." sentence reads awkwardly, otherwise.

L212: Did you mean S_I (theta) is the angular light intensity and not S_1 (theta)?

L369: "... 1 um aerodynamic cutoff for scattering coefficient measurements only." Then delete the next sentence. As the sentence is currently, it reads a little odd.

L432: change "an relative accuracy" to "a relative accuracy"

L446-447: The following sentence seems vague to me: "As such, the external consistency analysis is most useful from vertical profiles where the in-situ platform samples the column of air above an arbitrary ground location." Instead of "above an arbitrary ground location," it would sound better to say "to an approximate altitude of > 230 m" (based on reported spiral altitudes in Table 3).

L456-457: The first sentence ("As discussed above, ... for ACTIVATE 2021-2022.") summarized the same info from L365-380, so it is redundant and should be removed.

L490: Replace "measurement" with "value". You did not technically measure gamma but calculate it from the measured scattering coefficients.

Figure 4 caption: for (a) IRI...

L525: Specify that "...properties are presented in Sect. A **at the end of the main manuscript.**" Otherwise, it is hard to tell whether this Sect. A is in the SI document or somewhere else. I also think the authors can just remove the list of statistical metrics here since you already put it in Sect. A. You just need to write out the terms before using the acronym in the text.

L553: Remove "if" from "..., if the CAS data are used." Or it would be best if the authors remove the sentences on L553-554. The authors are repeating what coarse mode aerosol data to use as stated previously on L428-429.

L585: Remove "With the ground truth size distributions generated,"

Figure 5: The example size distribution is unimodal, so wouldn't it better to show an example of bimodal size distribution?

L605: "is" adjusted

Table 4: Is HSRL-2 AOD from the reported HSRL-2 data that accounts for the entire sampled column from ~9 km downward looking to the ground? The reported in-situ AODs are from Falcon's vertical profiles that mostly got up to 1-2 km based on Table 3. This is not an apple-to-apple comparison which Table 4 seems to imply. This goes back to the previous comment #6 from Reviewer 3 for the R2 version of this manuscript. I would suggest the authors to add a footnote or be explicitly clear in the text for Table 4 that there is a difference between the 2 AOD columns. Otherwise, the authors could add a "HSRL-2 equivalent AOD with in-situ profile" (or something to that effect) that only accounts for the sampled altitude performed by the Falcon (e.g., up to 1.47 km for case #9).

L684: Similar to Sect. A, specify that "...B6 and B7 in Sect. B at the end of the main manuscript."

L710: Extra space between "non-zero" and "measurements"

L731: ...there "are" still some cases

L780-793: Mention Fig. 10 somewhere in these 2 paragraphs when you describe Case 7

L792: change "scene" to "scenario"

Figure 10: Explain what the red and blue lines represent either in the caption or in the legend

Figure 13: Panels (i, k, l) need units for the x-axis

L816-817: "There also appears to be two noticeable nonspherical coarse aerosol layers within the column as evident from the spikes in LDR between 3 and 5 km" – does this refer to the vertical profile of LDR in Fig. 13c? I do not see any spike in LDR values in specified altitude range.

L819-820: "The lower layer of coarse aerosol have $LR \approx 35$ sr. The upper layer of coarse aerosol has $LR \approx 45$ sr, is less depolarizing, and appears to be more absorbing than the lower layer."

+ Change "have" to "has"

+ Fig. 12 panels (g) and (h) both show LR but at 2 different wavelengths, so please clarify which wavelength these sentences refer to.

L867-899: “The latter of the two findings is evident from both the profile’s limited vertical extent of 1.02 km and in Table 4, which shows that the ISARA-derived AOD is only 20% of the RSP- and HSRL-2-derived AOD for this profile.” – since the Falcon completed a limited spiral up to 1.02 km only, why not cut off HSRL-2 AOD value from altitude above maximum-sampled altitude by the Falcon? This way the only difference between HSRL-2 AOD and in-situ AOD would be the missing sampled altitude from the ground level to the bottom of the spiral.

L957-958: “The consistency statistics between HSRL-2- and ISARA-derived ambient LR and LDR are generally worse, relative to C_ext and C_ext,...” – did you mean C_ext and C_bsc?

L981: “These ranges are the highest if any of the comparisons within this data set” – this sentence does not make sense.

L 986: “Overall, the N comparisons are considered to be closed relatively successfully when...” – do the authors mean “...comparisons are considered to be relatively successful when...”?

Figure 15: Since the presented statistics in Table 7 and the discussion of plotted data in Figure 15 focus on the blue points (data from vertical profiles with 3+ points), I highly suggest the authors to plot the red points on Fig. 15 as greyed out points (gray points with alpha value < 0.5 if plotted with Python). Otherwise, the existing Fig. 15 panels are too busy on the eyes. The authors could also show a version of Fig. 15 with ALL red data points highlighted and the blue points grayed out in the SI document for clarity and to pair with Table S3.

+ For the blue data points, do the outliers (e.g., elevated HSRL-2 532-nm C_bsc values in panel (e)) correspond to low/high altitude bins? I.e., is there any clear bias in sampling/retrieval when you look at ALL the blue points vs. just Case 7/9 earlier? Expanding on your explanation for the relative difference between HSRL-2 and ISARA values would add value to the manuscript. As it stands, the generalized study section reads more like a list of statistical values.

L1003: Remove “the” before “ISARA”

L1049: extra word “the”