

Referee comment on “Intercomparison of AOD retrievals from GAW-PFR and SKYNET sun photometer networks and the effect of calibration” by Karanikolas et al.

Anonymous Referee

This paper describes the intercomparison analysis between the AOD retrieved from the three different photometer models currently used in the most important aerosol monitoring networks. This is a quite interesting topic which has not been addressed in this level of detail so far in the literature. Therefore, the results presented here can be considered the reference publication to understand the reasons behind the different performance of these instruments. This topic is not only challenging but crucial when it comes to using these different datasets for global climate studies.

This referee believes that the manuscript aligns perfectly with the scope of AMT, and the presented results are indeed relevant for publication in this journal. However, there are some general comments that this referee would like to see addressed before final publication, in addition to some technical-minor remarks.

General comments:

The use of English is poor. I strongly encourage the authors to have the paper checked by a native English speaker. There are grammar problems which make the paper quite difficult to read and understand in some parts.

In general, the paper includes many aspects impacting the accuracy of the POM AOD product. The inclusion of all these factors (very challenging task) is a strong point of this study, resulting in a comprehensive review of the factors affecting this product. However, the way in which this large amount of information is presented is truly complicated, and if not expressed correctly, it can result in a study that is not properly understood and does not adequately link the different sections. For this reason, I encourage the authors to try to better organize or somewhat synthesize the results presented here.

Minor/Technical comments:

References: Please check the reference format. Many references in the text do not follow the journal's requirements.

Decimal places: Please standardize the decimal places used in the current work according to the journal's requirements.

Numbering: Please ensure that all numbering used in the current work follows the journal's requirements.

Capital letters: Please standardize the capitalization of terms such as Sun photometer, sun photometer, Sun-sky photometer, etc.

Abstract, Line 15: Correct use of commas: "... Improved Langley calibration method, (ILP), used by SKYNET, and..."

Line 17: Please correct this sentence: One is a mountainous rural area (Davos, Switzerland) and the other is urban (Rome, Italy).

Abstract, Line 18: Is "where" the proper wording in this case?

Abstract, Line 21: Is "In Rome at 500 nm..." a proper wording?

Abstract, Line 33: In "input parameters needed for it" please define what "it" is. Additionally, please correct: "... we report on **the** results **of** the AOD retrievals".

Line 44: I'm wondering if the authors can include the latest version (AR6) of the IPCC (2023).

Line 67: Do the authors consider Doppler et al. (2023) to be the only reference for intercomparison campaigns between photometers?

Lines 94 and 95: The authors refer to Table 1 in this part of the paper, which is located in a different section.

Line 97: Why emphasize at this point that it is a discussion paper? By the time the paper is published, it might no longer be in the discussion stage, making this paper outdated...

Line 100-101: Please rephrase; the extra comma and the final part make the sentence unclear to the reader.

Line 104: "The data used" is referred to this work/paper? Sometimes I feel there is a lack of information to understand the sentences. The entire sentence is not clear to me.

Line 109-110: Something is missing in this sentence.

Line 110: a co-located Cimel?

Line 111: I don't understand what "initial" means in this sentence. Please rephrase.

Table 1: The mention to the ability to perform lunar measurements is only mentioned in this table. Why not mention this in Sect. 2.1.2?

Line 145: FWHM is different for 1640 nm spectral band. Please correct.

Line 149: Please delete "The" before AERONET AOD data.

Line 155: Please correct the typo in “Langley”.

Lines 171-172: Is there a typo at the end of the sentence? I’m not able to understand it.

Line 181: Please correct “**to** increase” and “**their** status”.

Line 182: I consider it is more useful to include that it is usable at every type of station.

Line 184: Please delete the extra point.

Lines 185-185: Some commas could improve the readability of this sentence.

Line 199: **To** retrieve...

Line 201: It is strange using “also” in a new paragraph...

Line 204: What is the “case” you are referring?

Lines 204-206: Please rephrase.

Line 211: Add “the” before POM.

Lines 211-212: Please rephrase: “The calibration constants and raw signals are in the units measured by each instrument and are corrected ...”

Line 214: **A** diurnal variation seems to be the reason for restricting ratios. Is it something that happens every day? If so, “**A**” is not necessary.

Line 215: Time interval?

Line 216: Rest of data? This sentence seems unfinished...

Line 216: 2 std of the points? Please correct.

Lines 216-217: I don’t understand this sentence...

Lines 217-218: Is the same criterion than the stated in line 215?

Line 218: Is this rejection regarding calibration error a visual analysis or it is based on a certain threshold?

Lines 223-224: I’m not sure I've understood correctly this sentence. Between 2 months the authors use a linear interpolation between two values, with a constant value during the whole month. But what happens in the case of the first month of measurements?

Line 225: I suggest to remove this sentence: “The actual wavelength of each instrument may vary”.

Line 238: The authors are talking about two different datasets: original ESR and calculated from calibration transference. In this sentence, the authors are stating that the second dataset (own calibration) does not include NO₂ correction but SKYNET (first dataset) includes it? Please explain why.

Line 243: Please add reference for the AERONET algorithm.

Line 244: Are the authors using a double screening? AERONET & PFR cloud screenings.

Line 252: I understand what the authors are pointing here, but don't you think that anticipating the reader with results which will be published later in the paper is not recommendable? Maybe the authors can reference a published paper (Campanelli, 2023) or move this section to the results section?

Line 257: Is the first time that tau_sc is written as sc-AOD? I think it is better to standardize the terms to prevent the reader from getting lost when reading the paper.

Line 261: This is a general comment. Don't you think that the sentence "There are three parameters included in this section" has perfect meaning without the words "which be"? In my view, the use of these extra words leads to a wordy reading.

Line 264: Its variability? Variability of what variable?

Line 267: Is there an estimation on the different uncertainty of levels 1.5 and 2.0 or this sentence is relating large uncertainty and the lack of QA/QC of AERONET level 1.5 data?

Line 268: change **in**? (Repeated twice in this sentence).

From line 268 onwards: From this point onward, this referee will no longer correct grammar-related aspects as it is not the object of the review and I am not a native English speaker. I would like to recommend that the authors undertake a thorough correction of the writing and the English used in this manuscript. It is difficult to understand some reasoning presented in this work.

Line 277: Are these abbreviations already included before in the text? If so, please make use of abbreviations.

Line 288: Since the restriction to QUATRAM-II campaign is presented in this specific paragraph, focus on SVA, this referee understand that these input files are only referred to SVA and not to the rest of parameters (P, SA, etc). Can the authors confirm?

Line 289: Since the authors will follow the same structure in section 3.2.2 I would recommend separate these sub-studies more clearly in this section, according to the sub-sub-sections defined in section 3.2.2.

Line 299: Do the authors mean: in the case of SA? I don't understand what the authors are referring here.

Line 324: The method uses $\log(\text{DSI})$ **plus Rayleigh and gas absorption terms** versus $m \cdot \text{AOD}_{\text{sc}}$, right?

Line 346: The methods presented in this paper related to POM retrievals seem to be more accurate at high AOD conditions but then, cloud screening impose AOD to be below 0.4. I understand that this assumption is out of the scope of this paper, but I'm wondering if the authors could explain shortly in plain words if you see any inconsistency between these criteria or if you expect to change them in the future.

Line 369: Yes, it is quite noticeable the differences observed during this campaign, especially at 500 nm. Are these results already published or the authors have any explanation for these high discrepancies?

Line 384: I don't understand "random differences within the retrieved uncertainty". Can the authors elaborate what this partial conclusion means?

Figure 1: What are the two red lines at ± 0.01 ? It will be useful here include "(POM_IL-PFR)", as it is stated in the legend. The same for "POM_TR" and "Cimel-PFR".

Table 2: I suggest to define the instruments as POM-XXX or POM/XXX to make clear the two words (instrument + location). I know that you have also the difference in calibration method (POM_XX) that can cause confusion...

Lines 407-409: Please rephrase this sentence. The part in parenthesis is a sentence itself and it is very difficult to read as it is.

Line 413: Is it expected the uncertainties of ILP to be purely random?

Line 413: Is the estimation "evident"?

Line 424: What are the fluctuations expressed here? Are authors referring to the amplitude of the uncertainties previously reported? I'm not able to understand this paragraph...

Line 449: Can you please help the reader with a reference to the corresponding figure, table or number?

Figure 2: AOD in the figure caption is referred to PFR, right? Can you clarify?

Line 466: Can you please help the reader with a reference to the corresponding figure, table or number? The same for the rest of partial conclusions.

Line 471: Is 2.4.1. a reference to a Section?

Figure 3: Is the SSA extracted from AERONET? Please clarify.

Line 481 and Figure 4: Is the AE retrieved from PFR? Please clarify.

Line 496: Is this analysis restricted to QUATRAM_II campaign as stated in line 289?

Line 502: As commented in line 287, the name of these sub-studies should be similar and clearly related to the description in line 287.

Line 514: Are the acronyms already defined? If so, use the acronym.

Line 518: Is not all this section referred to QUATRAM-II?

Line 530: What type of modifications the authors expect in the v4.2?

Figure 5: Do the authors think that the title of the graphs are needed? The same for the rest of figures. I suggest to include panels (a) and (b) rather than "left side" and "right side" in the caption. The same for the rest of figures.

Table 4: The first sentence in the caption case seem unfinished. What "selected case" means?

Figure 8: Again, comment on title and legend meaning.

Line 615: I recall reading in the first part of the paper about the difference between Skyrad and MRI and the importance of including the second method. However, unfortunately, after so much information, at this point, the reader no longer remembers that information. This comment is not aimed at repeating the information in this section but simply to inform the authors that reading this paper, as it is presented, is quite challenging.

Table 6: As in the case of the figures and previous tables, in the caption should appear the information as written in the table. In this case, I believe that (P5th, P95th) should be mentioned.

Table 7: The same for Delta V0.

Line 662: Maybe it is interesting to provide here some numbers about the systematically lower AOD?

Line 681 onwards: Please, focus only on the most important information...

Line 693: Is it necessary to repeat again the acronyms?

Line 745: Can the authors provided here some numbers when they talk about the underestimation?