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Atmospheric Measurement Techniques Discussions

Interactive comment on "Aerosol Optical Depth comparison between GAW-PFR and AERONET-Cimel radiometers from long term (2005–2015) 1-minute synchronous measurements" *by* Emilio Cuevas et al.

Anonymous Referee #4

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Review of Aerosol Optical Depth comparison between GAW-PFR and AERONET-Cimel radiometers from long term (2005-2015) 1-minute synchronous measurements

General Comments: The manuscript provides a comparison of AERONET-Cimel and GAW-PFR at IZO. The work is scientifically relevant given the analyzed data volume compared to previous studies. The manuscript identifies issues in the comparison of the AOD from the two different radiometers that are independently calibrated and processed in different networks. One major issue is the comparison of AERONET-Cimel to potentially suspect GAW-PFR field instrument (not reference) data (e.g., 2005-2010).

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Discussion paper

The authors present results in the abstract and conclusion with percentage agreement of 92.7% to 98.0% spectrally; however, these values are not from the apparently more optimal data set comparison for GAW-PFR (2010-2015), which show 1% to 2% improvement. Further, description of the causes of anomalies (i.e., not meeting the WMO standards) tend to be difficult to follow (e.g. reasoning for calibration and FOV) and it is not clear any corrections are actually applied to a final GAW-PFR data set. Also, the time matching criteria of 30 seconds is quite large for an instrument that performs measurements every minute and the AOD could change up to 0.01 per minute or potentially higher for dust. Some comparison results appear to be repeated in the tables. For example, the same "traceability" results (i.e., 92.7%, 95.6%, 95.8%, and 98.0%) appear to be repeated in three different tables (Tables 3, 4, and 8). Another major issue is that the study focuses more on the long-term and does not present any specific cases in pristine and dust events to specifically show examples of the differences in each instrument AOD measurements with subsequent analysis. A further issue is that the AERONET version 3 data are not included in the analysis. While these data are referenced as being available, the new product has some significant changes in regards to cloud screening and corrections made to the data that may impact agreement between the AERONET-Cimel and GAW-PFR instruments. Utilizing these AERONET V3 data would provide an added element of importance in AERONET/GAW-PFR comparisons. Last, the presentation of the document was difficult to follow at times. For example, the study objective statement is first encountered in the summary and conclusions section and this is not easy to follow. The "traceability" criteria tend to indicate that AERONET-Cimel is compared to the GAW-PFR but, in this case, GAW-PFR is not a reference instrument but a field instrument, which has higher uncertainty. Also, description in the text of the Figures and Tables needs further elaboration. Some specific comments are provided below on organization and other issues. The authors should take care to correct and address the issues here and below before resubmission.

Specific Comments: Abstract, Page 1, Line 6-9: "Traceability" as described only relates the precision of these two instruments. The result of the measurement may not

be accurate and but both measurements may be precise. What do you mean by “WMO standard?” In the abstract, the authors need to state that GAW-PFR is considered a ground-based WMO standard for AOD measurements and the field GAW-PFR and AERONET Cimel tend to have strong agreement. The use of “traceable” is an ambiguous term in defining more specifically the “agreement” between the two instruments. For example, the field PFR has a “traceable” calibration to the PFR triad. Please consider changing instances of “traceable” and “traceability” through the document. Page 2, Lines 28-29: How did you determine these totals? The AERONET web site provides partitioning of sites by equivalent data year and not the actual years (which can be greater). >10 years (data equivalent) is 84 sites (https://aeronet.gsfc.nasa.gov: last accessed 1/8/2019) >5 years (data equivalent) is 242 sites (https://aeronet.gsfc.nasa.gov last accessed 1/8/2019).

Page 3: Line 9: Please define “Triad” for PFR; perhaps the mean of three master PFR instruments?

Page 3, Line 13: What is a portable transfer standard radiometer? Is it a “reference” PFR?

Page 3, Lines 26-29: Additional reference is needed (e.g., Holben 1998, Eck 1999, Toledano 2018)

Page 4, Line 6: Change “thanks” to “has to be”

Page 4, Line 18: Need to spell-out “IZO” since it starts the sentence.

Page 5, Lines 10-11: Briefly discuss the differences between the two Cimels that affect the optical characteristics (i.e., why is this important?).

Page 5: Line 32: What type of filters?

Page 5: Line 33: Need citation and further explanation.

Page 6, Line 1: Place period after “position”

Page 6, Lines 26-27: How is the time matching performed between the AERONET-Cimel and the PFR? Is the closest PFR value used or an average of the two PFR values?

Page 7, Table 1: What is a GAW-PFR "field instrument?" What other can there be if it is the "world standard?" Also, AERONET-Cimel temperature control is different between AERONET Version 2 and Version 3.

Page 7, Lines 9-10: The results of the present study should be using AERONET Version 3, which has been available since early 2018 as discussed in Giles et al 2018.

Page 8, Line 1-4: Most instruments should be collecting data every 3 minutes. Why was the Cimel instrument at IZO collecting every 15 minutes? Why is 30 second difference used for time matching (the farthest away the PFR can be from the Cimel measurement? Should not the PFR be within say 10 seconds of the Cimel measurement to be matched?

Page 8, Line 19: AERONET data provides wavelength pairs and also computation of 440-870nm using all of the wavelengths in the range.

Page 9, Lines 1-31: The paragraphs are fragmented and they should be reorganization. Please revise and condense.

Page 9, Lines 10-12: As a result, it seems the PFR data from 2005-2010 should not be used in the study?

Page 10, Figure 1 Caption, Line 3: Please discuss here and in the text providing at least one specific case to analyze what is causing the large outliers.

Page 10, Table 3: The "Original GAW-PFR channel (%)" column is not correct if since you are expecting the AERONET values at different wavelengths to meet the AOD at PFR wavelengths. This column should be removed unless you interpolate AERONET AOD to PFR wavelengths.

Page 11, Table 4: What are the number of measurements for each cell used to compute the “traceability?”

Page 11, Line 15: Data-pairs should be 468 for AOD500nm as stated in Kazadzis et al (2014) plots.

Page 11, Line 16: Which instrument had poor calibration in the 500nm channel during the 9-day analysis period? Were both instruments field PFR and field Cimel instrument and not reference instruments or triad? It is important to draw this distinction in relation to the present study.

Page 11, Line 21: Change “among” to “between”

Page 12, Lines 3-5: It should be made clear that “non-traceability” is referring to PFR instrument and not the AERONET Cimel reference.

Page 12, Lines 9-13: More analysis and interpretation of Table 5 is needed with respect to the statistics presented in Table 5.

Page 12, Line 20: Better to use “reference” instead of “Master” throughout manuscript.

Page 13, Lines 8-33: The paragraphs are fragmented and they should be reorganized. Please revise and condense paragraphs.

Page 13, Lines 8-11: AERONET reference instrument should obtain Langley calibration coefficients every 3 to 8 months. (e.g., Giles et al., 2019). Please check with AERONET calibration center on the calibration interval.

Page 13, Lines 24-27; Page 14, Figure 2 Caption: Is the PFR AOD500nm used for the limitation “AOD-500nm <= 0.03” shown in Figure 2? The outliers in Figure 2 appear to be independent of air mass. Are these due to the PFR or Cimel?

Page 13, Lines 30-31: Uncertainty of field PFR (0.01) and uncertainty of reference AERONET-Cimel (0.005) at 380nm are maximum at low optical air mass and therefore the agreement between the two instruments will be inherently lower.

Page 14, Figure 2: Please change in the y-axis ticks to show zero. What is the optical air mass limitation for PFR measurements? The AERONET Version 3 processing is available up to optical air mass of up to 7 and AERONET Version 2 is up to 5.

Page 14, Table 6: What are the number of matched measurements in each optical air mass interval?

Page 15: Line 12: Also, include reference to Eck et al. 1999.

Page 15: Lines 29-32: AERONET-Cimel reference Langley is performed more frequently than once a year?

Page 16, Figure 3: It is difficult to quantify the relative significant difference between the Cimel and PFR in the logarithmic scale? Can you show a plot of the relative difference between the two instruments? Some significant variability in the differences exist and it could be due to differences in cloud screening, for example.

Page 16, Lines 3-12; Page 17 Lines 20-22: Authors should also utilize AERONET Version 3 with improved cloud screening techniques (Giles et al., 2019). It is not clear why the authors do not investigate AERONET Version 3 for this study since these data are available.

Page 17, Lines 10-22: The "traceability" here is difficult to interpret since the instruments do not use the same cloud screening which is evidenced by the lower "T(%)" numbers in the Table 7. More importantly, perhaps, are the percentage numbers in the column with FCS ranges in Table 7; however, although the solar radiation data may indicate a cloud, the sun photometers have the ability to find gaps in the clouds to perform measurements.

Page 17, Lines 29-35: A discussion of the COT effect on apparent optical depth due to different instrument FOV should be discussed (Kinne et al., 1997).

Page 18: Table 7: Define "FCS" in the caption. What are the number of measurements in each interval?

Page 19, Lines 22-25: Is this the PFR instrument with erroneous pressure reading in late 2014 at shown in Figure 4? Are the values in Table 4 computed without the malfunctioned barometer?

Page 20, Figure 4: What do you mean by 1-minute pressure data for AERONET-Cimel? Did Cimel have a pressure sensor in 2005? Please clarify.

Page 21, Lines 7-8: However, OMI O3 data are problematic due to sampling issues (McPeters et al, 2015).

Page 21, Lines 14-17: Are the discrepancies when using the OMI O3 for PFR?

Page 22, Figure 5: Need to state GAW-PFR uses OMI O3 and AERONET-Cimel uses climatological monthly average of TOMS O3.

Page 23, Figure 6: What is NO2 “annual course” in caption?

Page 24, Table 8: What do these data represent? What is the date period? Please provide the total number of match measurements for each wavelength.

Page 24, Lines 8-11: Where is it shown that 25% of the data outside U95 are from P, O3, and NO2?

Page 24, Lines 11-13: What corrections were applied and to which instrument?

Page 24, Lines 19-21: The AOD 870nm is only affected by Rayleigh component and therefore has the highest agreement as well as the lowest midday uncertainty of the four wavelengths analyzed.

Page 25, Figure 7: Are these data now all PFR (or AERONET-Cimel) corrected values to remove anomlies due to Rayleigh (due to pressure sensor issues) and trace gas corrections? I notice now that 2010-2015 is only presented. What are the total number of measurements in these plots? The limit of AOD>0.1 seems arbitrary as a threshold to use a fit of the non-traceable values. Note that many points appear to be very close to the “traceability” boundary limit. Also, black “traceable” points have larger difference

than red “untraceable” points with a smaller difference (somewhat counterintuitive). The reason (e.g., air mass dependence impact on the traceability criterion) for this affect should be stated in the caption for clarity.

Page 25, Table 9: Provide the number of measurements for each wavelength and AOD range.

Page 26, Line 12-13: Do you vary the surface albedo spectrally?

Page 26, Lines 20-24: AERONET-Cimel and PFR are simulated? Please state.

Page 27, Figure 8: What are the outliers between 1% and 2% PFR Circumsolar/Direct radiation in (a) and (b)? I cannot see the blue dots very well on panels (c) and (d); perhaps you can include on another plot? Please state that these results are simulated from the radiometers.

Page 28, Lines 17-22: Include the analyzed wavelength range for AE in the text, Figure 9, and Figure 9 caption.

Page 29, Table 10: Provide additional context on how these values were determined in the text.

Page 29, Lines 21-25: Please provide more background on how these values were determined. For example, it is not clear why AE is provided differently to AE PFR and AE Cimel in the number list.

Page 30, Figure 9: Please correct formatting problem with x-axis label of panel (a). Legend state “500-data intervals and standard deviations”; what does this mean? How do the plots change with “relative” difference since all differences are taken as absolute value in this plot? Does the relative difference show any trend in AE for Cimel lower than PFR or vice versa?

Page 31, Lines 3-4: This comment needs to be substantiated.

Page 31, Line 26: “traceability” is a confusing term and should be changed to agree-

ment or something similar.

Page 31, Lines 17-18: What is the “concern?”

Page 31, Lines 21-26: What are these “limits?”

Page 31, Line 30: Fragmented sentence.

Page 32, Lines 8-10: The fact that 380nm channel is more divergent is not a new finding since it is known to have higher uncertainty than other channels. Please state relevant citations.

Page 32, Lines 18-20: Also, optically thin cirrus clouds can also produce a difference in the measured values (Chew et al. 2011, Huang et al., 2011).

Page 32, Lines 23-28: Which instrument? PFR or Cimel?

Page 32, Lines 30-33: What causes large change in O3 concentration at Izana high altitude site?

Page 33, Line 14: Change “shouted” to “should be”

Page 33, Lines 15-18: Please elaborate.

Page 34, Line 15: Change “paid” to “made”

References:

Kinne et al., 1997: https://doi.org/10.1175/1520-0469(1997)054<2320:CCRAMP>2.0.CO;2

Eck et al., 1999: https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/1999JD900923

Giles et al., 2019: https://www.atmos-meas-tech.net/12/169/2019/

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2018-438, 2018.