

***Interactive comment on “Comparison of aerosol optical depth from satellite (MODIS), Sun photometer and pyrhelimeter ground-based measurements in Cuba” by Juan Carlos Antuña-Marrero et al.***

**Anonymous Referee #1**

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Review of the manuscript by Antuña-Marrero et al. submitted to ACPD.

Antuña-Marrero et al. have compared aerosol optical depth (AOD) retrievals from the spaceborne MODIS instruments to ground-based observations done in Cuba. The ground-based observations include sun photometer (AERONET) and pyrhelimeter measurements from several sites. The authors conclude that both MODIS instruments produce AOD data with corresponding accuracy, the Dark target retrievals are in better agreement with the ground-based observations than the Deep blue retrievals, and the pyrhelimeter measurements could be used to construct reliable time-series of broad-

C1

band AOD at sites which do not have sunphotometer measurements.

The manuscript has the potential to be an interesting paper but it requires some work. First of all, the manuscript is hard to follow due to complicated sentences and other language issues. The English language has to be improved throughout the manuscript to make it easier to understand.

Secondly, I do not see the value of doing the comparison between the MODIS and AERONET observations using single observations. Single observation pairs may not represent the same air mass thus, they might have different values for the right reasons. In addition, the uncertainty/noise in single observations is larger than in spatially or temporally averaged values. As the comparisons using single observations and the so-called “daily means” produced comparable statistics I do not see any reason to use single observations in the analysis. Therefore, I suggest that the authors leave out the discussion/results regarding single observations.

Thirdly, not all the methods are described accurately enough. For example, the calculation of broadband AOD (BAOD) or monthly averages are not described at all.

Fourthly, the manuscript lacks discussion on the results. What do the results mean and how do they compare with are studies done in this region?

Lastly, the comparison of AERONET and MODIS AODs is a routine task thus, the results may not be that interesting to a wider audience. The most interesting part of the paper is the broadband AOD thus, the authors should discuss it in more detail. For example, it would be interesting to see the time series of BAOD from the four sites: how they compare with each other and with AERONET and MODIS. And if there are clear differences during some periods, it would be interesting to read what is causing the differences.

Consequently, the manuscript should be thoroughly revised to clarify the content and to make it more interesting to the readers.

C2

My specific comments are given below:

P2, Abstract: The reported results should be given with more details and numerical values.

P2, I48: Results improve in comparison to what?

P2, I51: I understand what you mean with “extending backward in time AOD estimates” but it sounds grammatically confusing.

P3, I57: You mention that aerosols have a small mass but compared to what? Gases have even smaller masses and they have even larger effects on the climate.

P3, I59: “chemical Earth’s processes” → chemical processes in the atmosphere

P3, I70: comes → goes

P3, I78: Antuña → Antuña-Marrero

P4, I104: accumulate → have accumulated

P4, I108: Regions visually → Regions which appear visually

P5, I112: improving the signal → improving the information content

P5, I134: What is considered as moderate or high AOD? Please provide a numerical value.

P5, I137: Please explain in more detail how the AE is calculated in the traditional version.

P6, I140-143: I don’t think this information is needed in the manuscript.

P6, I144: What do you mean with replacement? Do you mean the annual calibration of the instruments or was the cimel replaced with another one? Please clarify.

P6, I155: Is the selected wavelength range closest to the wavelength range used in the DB retrievals?

C3

P6, I158: Please clarify what you mean with an observation here. Is it an observation at a specific time at all possible wavelengths or are all the wavelengths calculated separately?

P6, I159: You are using the Ångström power law so please reference it accordingly.

P6, I166: What do you mean with “cloudiness equal or less than one”? Usually cloudiness is given with values ranging from 0 to 1, 0 being cloud-free and 1 being completely cloudy.

P7, I167: “That-free”. What does it mean? Please explain here in detail how the AOD is calculated from the pyrheliometer observations.

P7, I180: Why is the monthly mean PW calculated differently for Camagüe than for the other sites? How large difference in the BAOD could this change cause? It would be clearer and more robust to use the same method for each site.

P7, I185: “enough amount of satellite” → enough satellite

P7, I186: Why is Cuba different from the other regions? Are there more clouds or something else?

P7, I187: To my knowledge, L2 data is typically used when comparing with AERONET observations. L3 is used in model comparisons and climatological analysis.

P7, I188: Which methodology are you referring to?

P8, I215: As I mentioned in the general comments, the exclusion of the analysis regarding individual measurements would make the manuscript easier to follow.

P9, I243: As you mention in the text, “daily mean” is not the best term for the calculated values. Maybe collocated mean values or something like that would be better.

P9, I247: Is there a minimum number requirement for the MODIS and AERONET observations? Sayer et al. (2014) required only single observations from both instru-

C4

ments but other studies have used lower limits ranging from 2 to 5 (e.g. Petrenko et al. (2012)). I would prefer the usage of some lower limit (e.g. at least 3 observations from MODIS and 2 from AERONET). Of course the selection of these limits affects the number of overpasses available for analysis so you have to select in a way that you do not throw away too much data but at the same time, you only compare representative observations.

P9, I248: Did you limit the AE comparison to cases with moderate or high AOD? I think you should because the MODIS AE's are only usable in those cases.

P10, I262: This is a confusing sentence. You should explain here that EE\_DT is defined relative to AERONET AOD and is therefore independent of the MODIS retrievals.

P11, I278-279: I wasn't able to follow this sentence

P11, I284: Can you really say that the monthly values will also be good because the daily values are good? In addition to the accuracy of the daily means, the quality of the monthly means depends on the temporal sampling within the months. For example, if you have 5 accurate daily means from a month but all 5 values are from the first week of the month, will the monthly mean be representative? When you calculate monthly averages you should also consider the distribution of the daily means within the months. If the temporal coverage is poor, the monthly mean will not be that reliable. Consequently, the authors should explain in text in detail how they calculated the monthly means and they should use some kind of a lower limit for the daily means before monthly means are calculated.

P11, I290: This section could be omitted.

P12, I305: What does the work "single" refer to in the title?

P12, I319: You should check if sampling could explain the peak. In any case, some explanation for the feature would be welcome.

P12, I330: What could explain this feature? Is it related to the number of points in each

C5

month?

P12, I331: This is surprising result as the correlation coefficients are the lowest during the months with the highest fractions. What could explain this contradiction?

P13, I337: well → better

P13, I351: I think this analysis should also be done using daily means instead of individual observations.

P13, I355: 1S → S2

P14, I365: As you have DNI measurements only once an hour, you could modify the coincidence criteria to average a couple of measurements even though both of them are not within the one-hour time window. That might provide you with more comparable observations.

P14, I368: The combination of the sites works only if all the sites have similar aerosol populations. Otherwise the combination might mask some site specific features and, in the worst case, lead to erroneous conclusions. Are the aerosols the same at each site?

P14, I370: Why did you leave out the days with high AOD? Are they cloud contaminated?

P14, I376: Why the DB retrievals match better with BAOD than DT retrievals. It was the opposite with the AERONET data. What about monthly comparisons between MODIS and BAOD?

P14, I381: I would suggest to change the places of the sections 3.3 and 3.4. It would be clearer if the BAODs would be compared first with ground-based and then with spaceborne measurements.

P15, I392: 2S → S2

C6

P15, l401: There isn't much discussion regarding the results. How do these findings compare with other studies done in this region/with similar methods? I would also like to see the long BAOD time-series from these sites and how they compare with the AERONET and MODIS time-series. Those results would make the manuscript more interesting to a wider audience.

P15, l402: Please include numerical values in the conclusions to make it more robust and clear.

P26, Fig 3: Please include the error envelopes in the plots. Density plots would make it easier to see where most of the observations are (see for example Fig. 5 in Petrenko et al. (2012)) and you should limit the axis range to 0.0-0.6 to remove unnecessary empty space.

P28, Fig 5: Shouldn't these values be collocated? Now the AERONET data seems to have over two times more points. Collocated values would enable a more meaningful comparison.

#### References:

Petrenko et al. (2012). Multi-sensor Aerosol Products Sampling System (MAPSS), <https://www.atmos-meas-tech.net/5/913/2012/amt-5-913-2012.pdf>

Sayer et al. (2014). MODIS Collection 6 aerosol products: Comparison between Aqua's e-Deep Blue, Dark Target, and "merged" data sets, and usage recommendations, <http://onlinelibrary.wiley.com/doi/10.1002/2014JD022453/full>

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