

***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 #2

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This manuscript focuses on the comparison of aerosol optical depth (AOD) retrieved using satellite (MODIS) and ground-based instruments (sun photometer and pyrhelimeter) in Cuba. This study draws conclusions about the different MODIS aerosol algorithms (Dark target and Deep Blue) for deriving aerosols on oceans and land, as well as, the distinct retrievals between the different sensors onboard Terra and Aqua platforms.

An interesting aspect of this paper is the potential to use pyrhelimeter measurements as a reliable source for aerosol characterization in the absence of sun photometer data,

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allowing for the reconstruction of AOD time series under such circumstances. It is a notable contribution to extend the existing AOD series in the Caribbean region, a key zone for studying dust transport.

However, the paper needs major modifications before being published.

GENERAL COMMENTS:

- The use of English is poor. I would strongly encourage the authors to have the paper checked by a native English speaker. There quite a lot of grammar problems, mistakes with figure numbers and general imprecisions which make the paper quite difficult to read and understand.
- From the information given in the introduction, I understand there are no previous studies in scientific journals about the AOD series extracted from the Camagüey sun photometer, and in Cuba in general. If so, the AOD series presented in Figure 4 (a) is the first AOD series derived from sun photometry published in Cuba, and not enough discussion has been carried out on this important result. On the contrary, notable efforts have been devoted to the superficial and less interesting discussion on the AOD extracted from MODIS. Under this circumstance, a non-existing AOD time series can hardly be extended backwards in time, as is stated in both the Abstract and in the Introduction alike. I strongly recommend the authors reconsider the objective of this publication, placing emphasis on the AOD retrieval by the sun photometer and the Broadband AOD (BAOD) from the pyrhelimeter (both at Camagüey). MODIS comparison should be used once the complete AOD series in Cuba has been published and evaluated.
- The systematic lack of high-impact references in the manuscript is very concerning. Despite the fact there are published few papers in the literature aimed at the aerosol characterization in Cuba, there are many examples at other sites around the world to enrich the methodology and the discussion section as well. A reader

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could have the impression that this type of analysis has been only performed in Cuba.

- Despite being the most relevant contribution to the paper, the pyrhelimeter description is missing. Therefore, please include at least some information about pyrhelimeters spectral response, field of view (FOV) and calibration.
- Apparently, four pyrhelimeters have been used in this study. However, only one of them (the one at Camagüey) has been used in the discussion. Please clarify the source of these discrepancies. If these three instruments don't provide reliable results, please do not include any mention of them in the paper.
- Is the inclusion of single measurements in the discussion section really important? Personally, I am quite confused with the results section. Reducing the amount of approaches will improve the readability of the paper considerably.
- As I mentioned previously, the FOV of the pyrhelimeter used in the present study is missing in the text but it is expected to be significantly different to the FOV of the sun photometer. Please include discussion on how to reconcile the two different pieces of information and the possible impact of the scattering radiation effect on pyrhelimeter measurements as a result of the wider FOV.
- The BAOD retrieval method is not described adequately. Equations and information about how the different terms have been calculated need to be included. García et al. (2015) is not an appropriate reference in this context.
- Regarding the BAOD uncertainty estimation, if we look at the methodology presented in Gueymard et al. (1998), the total uncertainty in BAOD can conceptually be evaluated taking into account three sources of error (modelling, atmospheric inputs and experimental errors). I strongly suggest the authors perform a more rigorous estimation of the BAOD uncertainty.

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SPECIFIC COMMENTS:

P2, Abstract: Please quantify the main results including some numbers in the Abstract.

P3, I.57: Is the small mass of aerosols an important issue related to the role of atmospheric constituents in weather and climate?

P3, I. 78: Antuña-Marrero et al. (2016) does not seem an adequate reference.

P5, I.117-123: I think this MODIS calculus chain is not relevant in this manuscript.

P5, I.129-131: This information is missing in the Introduction and would be better in the introductory part.

P6, I.140-147: It does not seem relevant to me for this study.

P6, I.148-155: Information about sun photometer nominal wavelengths is required.

P6, I. 159: Please refer to Angstrom Law and reference this law accordingly.

P6. L. 159: Please, include in this section the information required about PWV calculation using the sun photometer.

P6. I. 161: Please, clarify the method and include equations as well.

P7. I. 167: What does “That-free” mean? Is it a typo?

P7, I.179-183: This is not the place to describe the PWV retrieval using sun photometry. In addition, García et al. (2015) does not seem an adequate reference for this methodology.

P7, I. 182: Is Barja et al. (2015) the only reference for this type of analysis?

P7, I. 182-183: Gueymard et al. (1998) pointed to instrumental errors and PWV estimation as the main limiting factors of this method. So, the uncertainty of this type of methodology is linked to the uncertainty on these factors. Please include details on these sources of error.

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P7, l. 185-187: It sounds better in the Introduction. Take into account that many references in the literature using the MODIS Level 2 in these types of comparisons exist. Please remove this sentence.

P8, l. 208: Why these two periods?

P12, l. 315-319: What about the maximum in summer?

P12, l. 315-323: Figure 3 > Figure 4? Please revise figure numbers and table captions.

P. 17, l. 461: This is not a reference but an URL.

Figures 3 and 6: Please add diagonal lines. I also suggest including some statistics in the figures. Mixing tables and figures could help to improve comprehension.

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