

Answer to referee 3

The study performed by B. Torres et al. presents three years of solar and lunar AOD measurements aboard a research vessel in the area of the Indian Ocean, using a Cimel CE318T automatic sunphotometer, and following the standard procedure kept by the Aerosol Robotic Network (AERONET). The analysis also includes for the first time the measurements of sky radiance, performed in the almucantar and also using hybrid escenarios. The results show good performance, comparable to standard measurements taken at ground sites from AERONET. It is therefore considered kind of foundational paper for the future establishment of a network of instruments deployed at vessels. This is an important objective given the huge gap of data found in vast oceans. The text also points at future further developments in order to improve current limitations. The results are of scientific interest, well within the scope of the journal. The English usage is very good to my understanding, and it has been written and composed with care. However, I would recommend some major changes (on the structure mainly) before its acceptance.

We thank Referee 3 for their positive assessment of our work and for the constructive comments, which have helped us improve the structure and clarity of the manuscript. Below we address each point in turn:

General comments

The introduction is interesting and informative. However, I think many paragraphs should be moved to section 2. In fact, some of the information is redundant in section 2. Please, keep the introduction shorter, and integrate the removed paragraphs in section 2. I do not recoment elimination of information, but integration in the next section.

We agree with the reviewer that some paragraphs initially placed in the Introduction overlapped with content in Section 2. Following all reviewer's suggestion, we have revised and streamlined the Introduction by transferring history and technical details to Section 2, where they are more appropriately discussed. At the same time, we have slightly shortened some parts to avoid repetition.

I also think that section 5 (discussion) should be integrated in section 4 (results). In fact, the initial paragraphs in section 5 are redundant again. By moving section 5 to 4 you can eliminate them.

We acknowledge the reviewer's comment regarding redundancy. The opening paragraphs of Section 5 have been substantially revised to remove repetition with earlier sections. While we have not fully merged Section 5 into Section 4, we have significantly condensed the discussion. We chose to retain a dedicated Discussion section to allow for a more interpretative and contextual analysis of the results without interrupting the flow of the main findings.

It would be ilustrative to include an image of the new system and the platform in section 2.

A detailed schematic of the system and its modular components is already included in the current version (see Figure 2). We believe this provides sufficient visual context regarding the system design

and installation. Additional photographs of the platform and its integration aboard the R.V. Marion Dufresne are available in the appendix Tulet et al. 2024, which is cited in the manuscript.

Similar ship version developments of Prede POM instruments were tested in Japanese R.V. Shirase. It would be interesting to cite as an example in the introduction. See for example Kobayashi et al. (DOI: 10.1117/12.2195691).

We thank the reviewer for this useful reference. We have now included a citation to Kobayashi et al. (DOI: 10.1117/12.2195691) in the Introduction as an example of prior ship-based aerosol photometry with Prede POM instruments. This addition enriches the context and acknowledges other important efforts in this direction.

Specific comments and corrections:

- Line 10: Ångström exponent is written differently in the text. Please correct them accordingly (for example, it appears incorrectly at line 10, 100, table 1 and 2)

We thank the reviewer for pointing this out. The spelling of “Ångström exponent” has now been corrected and standardized throughout the manuscript. Starting from Section 2.2.1, we have adopted the symbol α to refer to the Ångström exponent as defined in that section, and this notation is consistently used throughout the rest of the text.

- Line 54: I would say that "preindustrial" conditions is not the best term to use, as the earth is already affected by anthropogenic emissions, even in remote areas. Maybe using remote oceanic conditions, or natural background conditions would suit better?

We thank the reviewer for this suggestion. While we understand the concern regarding the pervasiveness of anthropogenic emissions, we have retained the term “preindustrial” following the usage in Hamilton et al. (2014), which provides a quantitative definition of “preindustrial-like” regions based on aerosol properties and model simulations. As described in their study, a significant portion of the Southern Hemisphere oceans—particularly the tropical and mid-latitude areas—still exhibit aerosol conditions that closely resemble the preindustrial atmosphere, both in magnitude and behavior.

In this context, our use of “preindustrial conditions” refers to these rare, low-aerosol regions identified as baselines for quantifying anthropogenic forcing, and we believe it remains appropriate given the location of our measurements in the Southern Indian Ocean. Nonetheless, if the editor prefers a more neutral term such as “natural background conditions,” we would be happy to adjust accordingly.

- Line 101: Does AERONET use least-squares method over 440-870 nm wavelength range? Can you confirm? I thought the Ångström exponent was calculated by using ratios of channels 440 and 870 nm.

We thank the reviewer for raising this point. In AERONET, the Ångström exponent is indeed calculated using a least-squares linear regression in log–log space of aerosol optical depth (AOD) versus

wavelength. This calculation is typically performed over specific spectral ranges, the most commonly used being 440–870 nm. The regression uses all available AOD measurements within the selected range, depending on data availability and quality at each processing level (e.g., Level 1.0, 1.5, or 2.0).

We have clarified this in Section 2.1.2 of the manuscript, which describes the data processing procedures. In addition, we have updated the description of the MAN dataset in the Introduction to explicitly state that the Ångström exponent there is also derived using a least-squares linear regression in log–log space.

- Line 155: attempts

The paragraph has been edited, corrected and moved to the next section.

- Lines 164-167: there a series of typos and words sticked together that look caused by editor software problems: andber, imprimproved, greatlypared, shoshowing, squaredferences, all alls...

We thank the reviewer for pointing out these issues. These errors appear to be artifacts introduced during PDF rendering or typesetting, as they are not present in the source manuscript.

- Line 182-183: revise the sentence please.

The paragraph has been edited, corrected and moved to the next section.

- Line 194: Why not using a different name for the version of Cimel CE318-T?

We thank the reviewer for the suggestion. At this stage, the shipborne photometer remains a prototype based on the standard CE318-T core, with adaptations specifically designed for autonomous marine operation. Since the system is still under development and not yet industrialized as a separate commercial product, we have opted to retain the original designation. However, we agree that a distinct name may be appropriate in the future.

- Line 398: characteristic for the whole indian ocean or only SW?

We thank the reviewer for the observation. The sentence has been clarified to specify that these conditions are characteristic of the southwestern Indian Ocean, which corresponds to the primary operational region of the R.V. Marion Dufresne. The manuscript has been updated accordingly.

- Figure 3: why not merging together the two plots? Is there a problem in readability?

We thank the reviewer for the suggestion. We initially considered merging the two plots in Figure 3, but given the three-year timeline and the density of daily data points, combining both plots significantly reduced readability. Splitting the figure into two panels allowed for a clearer visual representation of the time series.

- Line 484: Please add a reference for last sentence.

We thank the reviewer for this observation. As also noted by another reviewer, a reference has now been added to support this statement. Specifically, we cite Holben et al. (1998), which reports that the total uncertainty in AOD from a newly calibrated field instrument is typically below 0.01 for wavelengths above 440 nm and below 0.02 for shorter wavelengths under cloud-free conditions. These uncertainty levels are based in part on root-mean-square differences observed during intercalibrations with AERONET reference instruments and are consistent with the AOD biases observed in our own intercomparison. Please note also that several authors of this study are directly involved in the calibration of a large number of AERONET instruments worldwide, and in this context, we confirm that these thresholds with respect to the master instrument are routinely applied as acceptance criteria for new valid calibrations.

- Line 494-499: this paragraph is redundant.

We thank the reviewer for the observation. The content originally flagged as potentially redundant has now been restructured and incorporated into Section 3.2.2, which is dedicated to the comparison with the AERONET Saint-Denis site. Within this new subsection, the paragraph serves to introduce and contextualize the comparison in a more concise and relevant manner. We believe this improves the organization of the manuscript.

- Line 503: state kilometers as km, as done in other appearances.

Thanks, corrected.

- Line 529: It is a pity not to include a period in which the instrument was installed at ground in the port to estimate the differences with Saint-Denis, so effect of the vessel could be removed.

We agree with the reviewer that having a reference period with the instrument installed at ground level near the port—prior to embarkation—would have allowed a more direct assessment of the vessel's influence on AOD measurements. Unfortunately, such a comparison was not feasible during this deployment, as no measurements were taken under these conditions. However, this is a valuable point that will be addressed in future studies. For instance, the R.V. Gaia Blu regularly operates from the Port of Naples, and its dock is located only 2 km from the AERONET site Napoli_CeSMA. This setup offers an excellent opportunity for land–sea cross-validation in upcoming studies.

- Figure 6: The black cross symbol is difficult to find...

We thank the reviewer for this suggestion. The black cross was chosen to ensure sufficient contrast against the red/orange background of the NASA Worldview AOD data. However, we understand that its visibility may vary depending on the viewing conditions or resolution. We will review this point during the final figure editing process and make adjustments if necessary, in coordination with the graphical editor, to improve clarity.

- Figure 7: The two M.D.Alm colors used for left figure are somewhat difficult to distinguish, mainly in printed material.

We thank the referee for this observation. Following the graphical editor's recommendation regarding Figure 8 and its accessibility for color vision deficiencies, we revised the color palette used in both Figures 7 and 8. The updated palette has been carefully selected to improve visual contrast and accessibility, ensuring distinguishability across all curves—even in printed versions or for readers with color vision deficiencies. We believe the figures are now significantly clearer and more informative.

- Line 666-668: please review the sentence.

We thank the reviewer for pointing this out. The sentence has been revised for clarity and correctness.

- Line 696-697: Repeated sentence

Thanks, the repetition has been erased.

- Line 716: SSA already defined in 625

Thanks, corrected.

- Line 760: extra dot

Thanks, corrected.

- Footnote 9: It would be interesting to add the corresponding histograms for comparison.

We thank the reviewer for the suggestion. While we agree that including the histograms could provide additional context, we believe the current figure and discussion already offer a sufficient level of detail for the intended comparison. Given the length of the discussion and the focus of the manuscript, we prefer to keep the analysis concise at this stage. However, we acknowledge that this could be an interesting addition in future studies or supplementary material.

- Line 835-836: repeated

We thank the reviewer for the remark. Upon careful review, we believe the current paragraph does not contain any actual repetition. Rather, it presents two alternative approaches (real-time orientation correction and mechanical stabilization) using a parallel structure to clearly contrast their respective advantages and limitations. We hope this clarifies the intent and are happy to revise further if the editor finds it necessary.