ESSD-2026-95 | Data description article

Dataset of aerosol, ozone, and meteorology observations at the surface coastal site of Henties Bay in Namibia

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Dear editor and dear Referees

We thank you for the positive and rapid evaluation and useful comments which certainly improve the precision and significance of the publication. Here below find our point by point responses in blue.

Referee 1

The manuscript by Formenti et al. presents a valuable and comprehensive dataset collected at the Henties Bay Aerosol Observatory (HBAO), Namibia, including aerosol optical properties, aerosol mass concentrations, equivalent black carbon (eBC), ozone, meteorological observations, and chemical composition measurements. This dataset is extremely useful for research on aerosol transport, marine boundary layer processes, atmospheric chemistry, and model evaluation since HBAO site fills a significant observational gap across the southeast Atlantic coastal region. Overall, the dataset was of significant scientific value and the manuscript was well-structured. The measurements, which span a number of years and integrate numerous complementary observational techniques, offer a resource that will be helpful to a wide range of people. However, I found that some parts of the Results section are difficult to follow because the connection between the text, the figures, and the corresponding interpretations is not always immediately clear. In addition, several figures rely heavily on the captions or the main text for their interpretation, making them less self-contained than they could be. The manuscript also occasionally assumes a level of familiarity with the dataset that external readers may not have. Improving the clarity of the figures and making some of the interpretative steps more explicit would substantially enhance the accessibility and long-term usability of this otherwise valuable dataset.

None of the comments below diminish the overall value of the dataset, which I believe will constitute an important resource for the atmospheric science community. My suggestions are primarily intended to improve the clarity and long-term usability of the manuscript and its associated data products. Overall, I believe that the manuscript would benefit from minor revisions before publication. My suggestions are reported in the supplement file.

Major comments

Throughout the manuscript, several interpretations presented in the text are not immediately supported by the accompanying figures. In general, I encourage the authors to improve the consistency between the discussion in the text and the graphical evidence provided in the figures.

Lines 318-320: The discussion linking the seasonal increase in AOD with the decrease in SSA and the increase in fine-mode aerosols is not straightforward when comparing Figures 3 and 4. While the interpretation provided by the authors may well be correct, this relationship is not immediately apparent from visual inspection of the monthly box-plots. In addition, the Henties Bay panel in Figure 3 and the panel showing SSA in Figure 4 look very similar and also by their visual appearance (box-plot style, color scheme, and overall layout), despite representing different physical quantities. This similarity may inadvertently suggest a stronger correspondence between the variables than intended and makes the comparison more difficult for the reader. A more distinctive graphical presentation and clearer annotation would improve the interpretation of these results.

Thank you for this comment which actually makes us realise that we made a mistake in Fig. 4 which reproduced the AOD and SSA and not the SSA and the fine/coarse volume fractions as stated in the legend. We corrected the legend accordingly. To clarify the message, we propose to move Fig. 3 in the supplementary material and keep only Fig 4 (now Fig 3) in the main text. The text now reads "*The AOD at Henties Bay is characterised by very low to moderate values (averages between 0.08 and 0.4) and a clear seasonal cycle with peak values from August to October. Fig. S1 compares the AOD values at Henties Bay with those of the sunphotometers of the regional AERONET/PHOTONS network (Fig. 1). The operating periods are reported in Table S1 in the supplementary material. The AOD values at Henties Bay are lower than at the sites closer to fire regions (Maun Tower, Lubango, Mongu, Windpoort) but similar to values at Ascension Island, Gobabeb and Upington, which all display a very similar seasonal cycle. Differences are evident compared to the coastal station of Simonstown, in South Africa, where AOD is of the order of 0.1 through the year. The AOD seasonality, and the fact that on the same period, the average AE at Henties Bay is above 1 which is indicative of the dominance of accumulation submicron mode particles, suggests that Henties Bay is affected by the large-scale seasonal transport of biomass burning aerosols. However, the intra-monthly variability of the AE is large, indicating that Henties Bay is affected by aerosols including coarse particles, as expected because of its coastal arid environment bearing sea spray and dust. During the biomass burning transport period, the increased AOD corresponds to a decrease of the SSA to values close to 0.9 at 440 nm, but higher at 870 nm. The SSA decreases significantly also between March and April, albeit with a different spectral dependence than in June-August, that is, with values lower at 870 than 440 nm. This corresponds indeed to a lower AE indicating an increase in the volume of the coarse mode particles, that is, a dominance of dust particles in the aerosol columnar load. From October to March, the SSA increases to values very close to unity, while the AOD is very low, indicating the dominance of scattering maritime aerosols resulting from oceanic air masses due to the prevailing seasonal cyclonic circulation (Formenti et al., 2018).*" However, we would like to keep the color coding while better specifying the correspondence in the legend.

Lines 380-381: "On the other hand, a distinct seasonal cycle with hourly concentrations as high as 400 ng m−3 is instead observed for eBC". This statement is difficult to reconcile with Figure 6 and Figure S1, where such values are not readily visible. If this statement refers to isolated hourly maxima rather than the distributions represented by the boxplots, this should be clarified explicitly.

To make things clearer, we corrected the text as follows "*On the other hand, a distinct seasonal cycle with the 75 percentile of the hourly concentrations as high as 170 ng m-3 is instead observed for eBC (Fig 6 bottom) from May to the end of July. Similar values were reported by Andreae et al. (1995) on a cruise transit in the tropical South Atlantic while approaching southern Africa at 19°S. Formenti et al. (2018) attributed this increase to the seasonal dominance of the anti-cyclonic circulation regime bringing polluted continental air masses to the site.*"

Section 3.2.4: I found the discussion surrounding the PM10 mass scattering efficiency (MSE) and Figure S5 somewhat difficult to follow. While the definition of the MSE is clear, the motivation for introducing this quantity and its connection with the subsequent discussion on the relative contributions of different aerosol species to particle scattering could be explained more explicitly. In particular, the logical transition to the discussion of eBC concentrations and the conclusion that their contribution to particle scattering is negligible is not entirely clear. Expanding this section and making the underlying reasoning more explicit would improve readability.

We agree with the referee's comment and we tried to improve the writing to make the message clearer. Fig S5 has been removed and Fig S6 now renamed Fig. S5. The text now reads "*The monthly median values of σ_{scatt} at 550 nm between 18 and 30 Mm^{-1} (Fig. 8) and the low SAE values (mean 0.5 ± 0.6) are in the expected range of measurements at coastal marine locations little influenced by air pollution (e.g., Gassò et al, 2000; Formenti et al., 2001; Pandolfi et al., 2018), consistently with measurements at GAW CPT (Andrews et al., 2019) and Ascension Island (8°S, 14.5°W), 3500 km west of Henties Bay (Zuidema et al., 2018 ; see Figure S4 in the supplementary material). Fig. S5 additionally shows that the temporal variability of scattering coefficient at the surface and the column AOD had limited to no similarity, as a result of the strong decoupling between the marine boundary layer and the free troposphere (Tyson and Preston-Whyte, 2014).*

The colocation of the measurements of particle scattering and mass concentration allow to calculate the PM_{10} mass scattering efficiency (MSE = σ_{scatt}/M_c). The MSE represents the scattering component of the mass extinction efficiency (MEE), one of the parameters needed by climate models to evaluate the aerosol direct radiative effect (Gliβ et al., 2021). At 550 nm, the MSE ranges from 0.5 (January) to 1 $m^2\ g^{-1}$ (November), on the lower side of the average MSE value (1 $m^2\ g^{-1}$) recommended by Hand and Malm (2007) for coarse mode sea salt aerosols, but in the range of values for mineral dust (MSE = 0.7 $m^2\ g^{-1}$; Hand and Malm, 2007). The HBAO values are significantly lower than the average value (1.7 ± 0.9 $m^2\ g^{-1}$) measured by Denjean et al. (2016) in the background marine atmosphere affected by long-range transport of atmospheric pollution. This is expected because, as discussed in section 3.2.2, the tracers of pollution (e.g., eBC) represent only a minor contribution to the total PM_{10} aerosol mass. The absence of a robust, independent measurement of the aerosol absorption coefficient unable the evaluation of the mass absorption efficiency (MAE), a gap that should be addressed by future observations."

Minor comments

Several figures could be improved to enhance readability. In particular, Figures 5, 6, 8 and 9 are somewhat difficult to read at publication scale due to relatively small fonts and dense graphical elements.

Figure 7, on the other hand, provides a much clearer presentation and could serve as a useful reference for improving the overall graphical consistency of the manuscript. Overall, adopting a more homogeneous graphical style across figures (font sizes, color conventions, annotations, layout, and image resolution) would improve readability. In addition, several figures could be made more self-contained, as important information such as the identity of the plotted variables or the interpretation of colors is sometimes only available in the caption or the main text. Finally, following the ESSD figure guidelines by consistently labelling multi-panel figures using (a), (b), (c), etc., instead of referring to panels as "top", "middle", or "bottom", would further enhance clarity.

We agree with the referee's comment and we propose a new ameliorated version of Figures 5, 6, 8 and 9 (now renamed Figures 4, 5, 7 and 8)

Figure 3: The comparison among AERONET sites would benefit from larger panels or improved scaling. Because different y-axis limits are used for each site, direct visual comparison n of seasonal variability is not straightforward. While this choice is understandable given the different AOD ranges (particularly for Simonstown), the authors may consider harmonizing the axes where possible or explicitly highlighting the scale differences.

Figure 4: This figure is particularly difficult to interpret without repeatedly referring to the caption. I suggest adding explicit panel labels ((a) and (b)), clearer axis labels, and legends directly within the figure. In addition, similar color schemes are used for different quantities in the two panels, which may create confusion during reading.

Those two comments are taken into account jointly. We careful considered the structure of the manuscript and its focus, and now propose to move the entire section discussing the AERONET column measurements in the supplementary as they are not the focus of the manuscript, nor the novelty (AERONET climatologies in the area have been already been published by Adesina et al. (2019) and Ranaivombola et al. (2022). We also work to ameliorate the quality of the figures and captions. Some suggestions were not taken into account directly (such as changing scales or colours of bars) but the captions were ameliorated to increase clarity.

Figure 6: This figure refers simply to ”aerosol mass concentration”, whereas the discussion concerns PM10 concentrations following the inlet change in 2014. Explicitly specifying the measured quantity in the figure or caption would improve clarity.

This is now corrected

Supplementary figures: Several supplementary figures, particularly Figure S1, are difficult to read due to the small panel size and limited resolution. Increasing the size of the individual panels or splitting some figures into multiple pages would substantially improve readability and facilitate comparison with the discussion presented in the main text.

All the figures have been redone to increase size

Table S1: Although the AERONET analysis is not the central focus of the manuscript, I suggest providing more accurate information regarding the temporal coverage and data availability of the selected stations. In particular, some sites experienced substantial interruptions in operation that are not apparent from the reported periods. For example, Maun site is indicated as operating from 2000 to 2023, whereas observations are effectively available from September-October 2000 and then from 2016 onwards. Likewise, Mongu site correspond to two distinct AERONET stations (Mongu and Mongu Inn), with the former operating approximately during 1995–2010 and the latter from 2013 onwards. Explicitly acknowledging these discontinuities and station changes would improve transparency and help readers correctly interpret the seasonal comparisons presented in Figure 3.

We agree with the Refeee’s comment and we corrected the lack of precision.

Line 448: There is the letter ”s” missing in the subscript for σscat

This is now corrected

References

Adesina, J. A., Piketh, S. J., Formenti, P., Maggs-Kölling, G., Holben, B. N., and Sorokin, M. G.: Aerosol optical properties and direct radiative effect over Gobabeb, Namibia, Clean Air Journal, 29, 10.17159/caj/2019/29/2.7518, 2019.

Ranaivombola, M., Bègue, N., Bencherif, H., Millet, T., Sivakumar, V., Duflot, V., Baron, A., Mbatha, N., Piketh, S., Formenti, P., and Goloub, P.: Aerosol Optical Properties and Types over Southern Africa and Reunion Island Determined from Ground-Based and Satellite Observations over a 13-Year Period (2008–2021), Remote Sensing, 15, 1581, https://doi.org/10.3390/rs15061581, 2023.

Referee 2

This paper presents a suite of observed datasets of aerosol, ozone and other paraemetrs in Henties Bay in Nambia. My comments are as below:

1. Good collection of observed dataset and the challenge remains for collecting regularly without any gap.

2. Most of the data is already in open source for public use.

3. Abstarct is missing any new findings or any of the results from the analyses from the dataset.

4. Overall paper is well written with one or two speliing issues.

5. Results and discussion not highlighting any specific new results. Lack of new findings.

We thank Referee 2 for useful comments – we took them into account and revised the abstract and correct the spelling mistakes.