RESPONSE TO REFEREE 2

First of all, the authors acknowledge the referee 2 and the editor for the time spent to review this manuscript and also for their constructive comments. Note that the reviewer's comments are highlighted in blue font and our answer can be read in normal font. The modifications are indicated by blue font, and the removed text is shown in red and crossed out in the revised manuscript.

Referee 2: This submitted manuscript analyse aerosol properties during two large biomass burning events using data from multiple sources, including the ground-based networks, satellite remote sensing, and reanalyses over South Africa. With these data, the authors confirmed two dust events during Sep and Oct, 2002 based on the classification results. All subsequent analyses on the spatiotemporal distribution of AOD and CO, the vertical profile of aerosol extinction coefficient are conducted on a daily basis. The work is within scope for the journal and there is new material for this publication to be warranted. As the authors claimed, few such studies have been conducted in South Africa, which may attract readers' interest and contribute to the aerosol community. Additionally, the figures are nice and informative. There are, however, some important missing aspects and points that need clarification. This submitted manuscript is not well prepared, e.g., I can find some abbreviations are not defined or defined at a wrong place. Another big issue that needs to be addressed is the language. I'm aware that the authors are not native English speakers, while it is extremely important to ensure the language is polished for successful publication in this prestigious journal. Please pay attention to the language in your revised manuscript, I recommend major revisions and would like to review the next version.

Authors: The purpose of the present study is to highlight the transport modes which explain the transport of biomass burning plumes over the Southwest Indian Ocean (SWIO) basin during the BiBAC campaign. In order to clarify the objective of the paper, this latter was re-organized in the revised manuscript. In particular, Section 4 which treats on the synoptic and meteorological conditions driving the transport of the biomass burning plume during the BiBAC campaign was significantly re-organized in the revised manuscript. In the revised manuscript, the AERONET data at level 2 was used in order to improve the significance of our results. To better characterize the synoptic conditions occurred during BiBAC, cloud cover products from CAMS reanalysis was added in the dataset used in this study. In order to emphasis on the synoptic conditions and not to extend the overall text length, we removed the paragraph treats on the size distribution evolution over Maputo. Therefore, we now solely focus on one scientific question in the revised manuscript : meterological and synoptic conditions driving the transport of biomass burning plume over SWIO basin. The motivations come from the fact that few studies treating on the transport of the biomass burning plume in the SWIO basin (Flamant et al., 2022 ; Swap et al., 2003 ; Schmid et al., 2003). These previous works pointed out a main transport mode over the SWIO basin which shaping like a river of smoke. In the present study, the structure of smoke river is also found but under different synoptic conditions than those reported by these previous works. We focused our effort to describe properly (with the appropriate language) these news synoptic conditions leading to river of smoke over the SWIO basin. In order to allow an easy read and understanding of these results, the quality of the English was checked in the revised manuscript (as suggested by the referee 2).

Referee 2: Abstract. I recommend the authors to follow a more typical structure, including the general background of the study, the aim, the objectives, the novelty, and the main findings in the results. The current form is not mature for a renowned journal like ACP. Additionally, not every abbreviation is fully defined, e.g., what are CALIOP, SWIO, and COL? Only mentioned without definitions.

Authors: As suggested by the referee 1, the abstract was rewritten in the revised manuscript.

Referee 2: Line 17, Page 1. What does "their effects on radiative forcing" mean? The scattering and absorbing effect and the indirect effect on cloud microphysics of aerosols all affect atmospheric radiation budget. This sentence should be checked.

Authors: The referee 2 is right. The corresponding sentence was rewritten in the revised manuscript.

Referee 2: Line 19, Page1. I cannot agree with the authors on that the lack of aerosol observations is the reason for the more importance of assessing climate change. Rather, it can be the reason for that the related assessment work is difficult.

Authors: We understand the point of view of the referee 2. The sentence was misstated. The main idea of this sentence was to point out the geographical specificity of the Southern Hemisphere which is a low number of observation stations in comparison with the Northern Hemisphere. This geographical specificity induced some difficulties in the assessment of the aerosol properties in the Southern hemisphere. In order the reduce the confusion, this sentence was rewritten in the revised manuscript.

Referee 2: Line 22, Page2. "biomass burning activities" should be plural.

Authors: It was corrected in the revised manuscript.

Referee 2: Line 25 Page 2. Again, the authors should make sure the submission is well

prepared. "AOD" should be defined when it appears for the first time.
Authors: It was corrected in the revised manuscript by adding the meaning of "AOD".

Referee 2: Line 27, Page 2. "low number of observations" of what? Aerosols or greenhouse gases?
Authors: This was corrected in the revised manuscript.

Referee 2: Line 65, Page 3. Did SAFARI-92, SAFARI-2000 and AEROCLO-sA observe vertical profiles for aerosols?
Authors: The vertical profiles for aerosols was recorded during the AEROCLO-sA (Chazette et al., 2019) and SAFARI-2000 campaigns (Schmid et al., 2003). The common point with these two previous campaigns (and the others previous campaigns) is their interest for the characterization and transport of aerosol plume over the western part of Southern Africa. There is very few campaign which dedicated on the characterization of the aerosols properties over the eastern part of Southern Africa and their transport over the SWIO basin.

Referee 2: Figure 1. Only three sites involved in this study. I recommend the authors to label all their names in each panel.
Authors: We understand the point of view of the referee 2. This figure was re-plotted in the revised manuscript.

Referee 2: Line 104, Page 4. AERONET measurements are not only made during daytime.
Authors: We agree with the referee 2. In the framework of the AERONET network, the sunphotometer measurements are performed during the daytime and nighttime. In the present study, we used the data from AEROSOL OPTICAL DEPTH (V3)-SOLAR collection which accumulates the observations collected during the day.

Referee 2: Line 106, Page 4. What's the difference between AERONET data at Level 1.5 and Level 2.0 ?
Authors: The algorithms used on the data to obtain these two level of data are different. In the case of AERONET data at level 1.5, a cloud mask is applied automatically without final calibration of the dataset. In the case of the AERONET data at level 2.0, a cloud mask is also applied with a final calibration of the data set. In the revised manuscript, we have used the level 2.0 dataset.

Referee 2: Lines 107-108, Page 4. Spectral channel information should be provided for SSA, EAE, and FMF. "Ångström Exponent (AE) at 440nm and 870nm" is not clear. This should be confirmed.

Authors: The referee 2 is right. The corresponding wavelenght for SSA and FMF data used in the present study are 440 nm and 550 nm, respectively. The EAE is used in the spectral regime 400-870 nm. The Angstrom exponent (AE) provides insight on aerosol with evolving wavelength. In the present study, the AE is calculated in the spectral channel 440-870 nm as follows :

$\alpha = -\frac{ln(\tau_{440}/\tau_{870})}{\lambda_{440}/\lambda_{870}}$. where τ_{440} and τ_{870} are the AOD at both wavelenght (λ) of 440 and 870 nm. The spectral channel mentioned here above were included in the revised manuscript.

Referee 2: Lines 111 to 113, Page 4. The two citations "Eck et al., 1999" and "Dubovik et al., 2006" were published many years ago. Giles et al., (2019, `https://doi.org/10.5194/amt-12-169-2019`) is a more appropriate study for AERONET AOD validation for the latest V3 product.

Authors: We agree with the referee. This reference was included in the revised manuscript.

Referee 2: Lines 114 to 118, Page 4. The latest AERONET V3 database has been released for several years and related articles about its accuracy have also been published. Why authors only cited papers for the former version of AERONET data.

Authors: We thank the referee for this comment. In the revised manuscript, we included more recent references such as Giles et al. (2019) and Sinyuk et al. (2020).

Referee 2: Line 123, Page 5. What does "all-point" data mean?

Authors: All-points data corrsponds to the complete available measurement obtained by the sun photometer throughout the day at every 15 minutes time interval.

Referee 2: Lines 124 to 142, Page 5. I understand the authors want to highlight how the selected parameters classify aerosol types. As the authors said, they set many thresholds for different parameters but they didn't explain how and why they set such values and the references. So, I recommend rewrite this paragraph to focus more on the current study and interpreting figure 2.

Authors: We thanks the referee for the recommendation. This paragraph has been rewritten by following the recommendation suggested by the referee 2. We note that the method used in the present study has already introduced and validated for our study region in previous works (Kumar et al., 2020, 2014; Lee et al., 2010; Kumar et al., 2017; Adesina et al., 2017).

Referee 2: Line 140, Page 5. Where is the equation 2? If the authors cite this equation in another study, they should give this equation and cite the study.
Authors: This equation was in the work of Ranaivombola et al. (2023) and was included in the revised manuscript.

Referee 2: Line 150, Page 5. Not clear. My understanding is that MODIS is only carried on Aqua.
Authors: We apologize for the language mistake which has caused the referee concern. In the present study, we used only the MODIS data carried on Aqua.

Referee 2: Line 156, Page 5. "MOD08_D3_v6.1" is not correct. The MODIS/Aqua product is named as "MYD08_D3".
Authors: This was corrected in the revised manuscript.

Referee 2: Line 156, Page 5. The study uses the MODIS AOD product, but the authors give much information of MODIS bands and original spatial resolution for raw data. I recommend the authors to include more information on the MODIS AOD product, e.g., its spatial resolution, accuracy compared to AEROENT data, quality control flags, etc.
Authors: We agree with the referee 2. As a consequence, information concerning the MODIS AOD product was included in the revised manuscript.

Referee 2: Line 186, Page 7. Please refer to my comment on MODIS data. Why did you select the IASI/MetOp-B CO dataset? Because of high accuracy or spatial data coverage?
Authors: We used IASI observations in order to have a regional view of CO distribution . The spatial and time coverage of IASI allow to follow correctly the transport of the biomass burning plume (Bencherif et al., 2020 ; Boynard et al., 2018 ; Turquety et al., 2020). Given the lifetime of CO (∼1 to 3 months in the troposphere), this latter is often used as tracer to study the long-range transport of biomass burning. In the present study, the transport of the biomass plume was investigated by using CO and AOD observations from IASI and MODIS, respectively.

Referee 2: Line 199, Page 7. Why mslp is not capitalized?
Authors: This typo error was corrected in the revised manuscript.

Referee 2: Line 200, Page 7. The units within brackets should be formatted using a different font style from the surrounding text.
Authors: It was corrected in the revised manuscript.

Referee 2: Line 284, Page 10. Though AOD shows similar patterns with CO, it cannot be easily considered that AOD is the result of biomass burning. Besides, differences are large during the event 2.
Authors: We thank the referee for this relevant comment. In spite of the difference between AOD and CO plume, it is possible to relate their evolution with the biomass burning by combining different sensors. In the present study, we used a multi-instrumental approach in order to discriminate the influence of the biomass burning activity on the aerosol distribution. Through the use of CALIOP observations, we can reasonably conclude that the AOD observed during the two events is due to biomass burning. Furthermore, our study period is ranging from September to October which is usually characterized by a predominance of biomass burning aerosols in South Africa (**??**Hersey et al., 2015). To conclude, our analysis of the contribution of the biomass burning activity on the AOD variability is based on the use of complementary data set (not exclusively on similar pattern between CO and AOD distribution).

Referee 2: Line 339, Page 11. I might miss something. How do biomass burning activities increase the aerosol radius?
Authors: We thank the refer for clearly remarked our mistake. The biomass burning activity did not contribute on the increase of the aerosol radius. This increase of the aerosol radius can explain by the ageing processes which take place inside the aerosol plume during its transport (Bègue et al., 2015). Nevertheless, we can reasonably suggest that the biomass burning activity contribute on the increase of the concentration in the accumulation mode. In order to emphasis on the synoptic conditions and not to extend the overall text length, we removed the paragraph dealt with the size distribution evolution over Maputo.

Referee 2: Lines 369 to 370, Page 12. The numbers do not correspond to what they should indicate.
Authors: It was corrected in the revised manuscript.

Referee 2: Line 435, Page 14. Figure 13?

Authors: This typo error was corrected in the revised manuscript.

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