

# RESPONSE TO REFEREE 1

First of all, the authors acknowledge the referee 1 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-light 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 1: This paper reports on smoke observations over southern Africa during September and October 2022 as part of the Biomass Burning Aerosol Campaign (BiBAC). The paper pulls together AERONET sun photometer data, CALIPSO/CALIOP lidar level 3 backscatter profiles, MODIS/IASI AOD and CO and CAMS aerosol analyses to describe a series of smoke events in and around Africa as well as a case of trans Atlantic transport from South America. After an overview of the intensive operations period each case is given a short observational summary meteorological analysis. I think overall it is publishable material and provides a needed overview of the meteorological conditions of BiBAC. This said, I am recommending major revisions largely on writing/communications issues.**

**Authors:** We regret for the language usage which has arisen the referee concern. 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. Indeed, this section was rewritten by corrected the inappropriate meteorological diction as suggested by the referee 1. 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 mention about the aerosol size distribution evolution over Maputo. Thereby, the revised manuscript solely focused on meteorological 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. These news synoptic conditions which occurred during the events detected during the BiBAC campaign are reported in the Figure 1 (This figure was included in the revised version, as Figure 13).

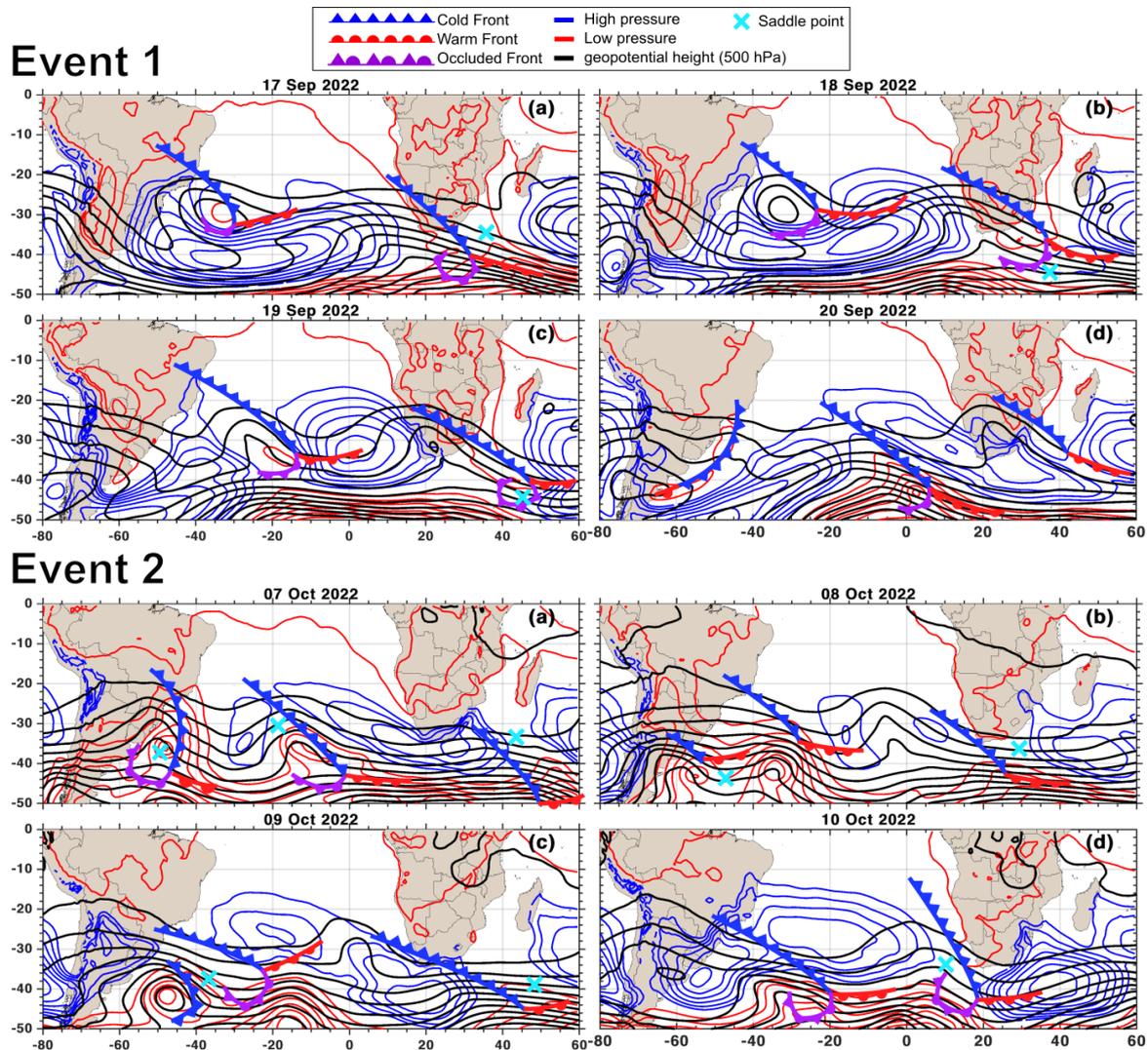


Figure 1: Meteorological features favoring the transport of aerosols and CO plume during Event 1 (top panel) and Event 2 (bottom panel). Frontal systems are : cold front in blue, warm front in red and occluded front in purple. Mean sea level pressure : low and high in red and blue lines, respectively. The geopotential at 500 hPa is represented by black lines and the location of saddle point by cyan cross.

In the previous works, the synoptic conditions responsible for the formation of the smoke river involved the propagation of a westerly wave and the development of a cut-off low (Swap et al., 2003; Stein et al., 2003; Flamant et al., 2022). However, we observed during the event 1 a river of smoke structure involved by westerly wave without a cut-off-low. The river of smoke developed in a synoptic context characterized by three successive cold fronts associated with saddle points during the event 2. Language usage has been appropriately corrected for the better readability of the article as suggested by the referee.

**Referee 1:** Language is a little bit off throughout, which might be a language/translation issue. I think the paper needs a very solid edit to ensure clarity to the reader and use of proper meteorological diction. For example, in the abstract “anti-cyclonic system, and warm air column resulted in stable conditions, which was also influenced by strong subsidence.” The language is a bit odd, in that should the anticyclone have to be in an area of subsidence? Or was it an anticyclone that was imbedded in a larger region of subsidence or as part of a ridge?

**Authors:** We thank for the referee comment. As a mentioned previously, the synoptic conditions have been rewritten in the revised manuscript. Thus, this part of the manuscript has been rewritten by using appropriate meteorological diction. Furthermore, we included new figures in order to clarify the synoptic description associated with both events (e.g, Figure 1).

**Referee 1:** Also, perhaps it is cleaner to discuss “The study investigates the long-range transport of biomass burning from South America to Southern Africa, with the plume exiting over southern Brazil, likely driven by the Southern American low-level jet (SALLJ), which is driven by climate forcing like El Niño–Southern Oscillation (ENSO) and Madden-Julian Oscillation (MJO).” Is this part of the focus of the two events discussed earlier, separate? Further ENSO and the MJO are distinctly not climate phenomena, but rather seasonal and sub seasonal. These are just minor early examples, but throughout the read I was constantly trying to figure out what the authors are trying to convey.

**Authors:** During both events, the CO and aerosols variability over South Africa are explained by regional and intercontinental transport. The confusion comes from the fact that these two transport modes have been discussed in separate paragraphs in the previous version of the manuscript. In order to reduce the confusion, this discussion have been restructured in the revised manuscript. Indeed, the discussion on the transport mode of the biomass burning plume (at regional and intercontinental scales) has been structured around the two events (See Section 4). Beyond the restructuring, the discussion on the transport mode has been rewritten by using the appropriate diction. As a consequence, the confusion pointed out by the referee 1 with the use ENSO and MJO terms has been clarified.

**Referee 1:** Another example, Introduction, line 55 “The vertical distribution of aerosols determines their radiative impact, as well as their atmospheric residence time, which will affect any aging processes and the resultant horizontal distribution following advection” One cannot really say generalities in such blanket statements, as depends on what radiative impact you are talking about, and the nature of the transport pattern. For shortwave

**fluxes, it makes almost no difference at all. If you talk about heating rates, then certainly. But also don't intensive properties such as particle phase function and absorption coupled with concentration define the radiative effects?**

**Authors:** We agree with the referee. The corresponding sentence has removed in the revised manuscript.

**Referee 1: Other major issues include undefined acronyms and figure lettering that is too small to read. All of these issues get in the way of the reader extracting meaningful information. To be sure this is a useful effort, but please have another go and pay attention to proper technical term usage and I will be happy to give it another read.**

**Authors:** We thank the referee 1 for this comment. All acronyms have been defined in the revised manuscript. Furthermore, the quality of figure and its lettering have been checked in the revised manuscript.

## 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 to 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 sun-photometer 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 wavelength 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  $\tau_{440}$  and  $\tau_{870}$  are the AOD at both wavelength ( $\lambda$ ) 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 corresponds 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 (Swap et al., 2003; Edwards et al., 2006; 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.

## **RESPONSE TO COMMENT COMMUNITY**

First of all, the authors acknowledge this referee 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-light 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 : General Assessment:** This manuscript presents an analysis of aerosol optical properties and transport during two events in September-October 2022 at Skukuza, South Africa, as part of the Biomass Burning Aerosols Campaign (BiBAC). While the study provides valuable data on aerosol characteristics during these events, there are several areas that require improvement to meet the standards of an EGU publication. The authors, however, need to improve their analysis, clarify their novel contributions, and improve the overall presentation of this paper. Reasons for this are as follows

### **Detailed Comments:**

**Referee : Abstract. (Lines 1-14)** The abstract lacks quantitative results and clear statements of the study's novelty. Suggest revising to include key numerical findings and explicitly state how this work advances our understanding beyond previous studies.

**Authors:** We agree with this referee. As a consequence, the abstract was rewritten in the revised manuscript. As it is explained here after, the manuscript was re-organized in its revised version.

### **Introduction**

**Referee Lines 15-88::** The literature review is comprehensive, but the gap this study aims to fill is not clearly articulated. Suggest adding a paragraph (around line 85) that explicitly states the research questions and how they build on previous work.

**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. 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; Chang et al., 2021). These previous works pointed out a main trans-

port 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 these new synoptic conditions leading to river of smoke over the SWIO basin. The motivations and the aims of our work was clarified in the revised manuscript.

**Referee : Line 70-72. The statement about few studies on the east coast needs supporting evidence. Consider citing specific gaps in the literature.**

**Authors:** An overview of the main campaign which held in South Africa from 1990 has been reported by Formenti et al. (2019). They pointed out that the common point with these previous campaign is interest for the characterization and transport of aerosol plume over the western part of Southern Africa. As suggested by the referee, this point was more emphasis and discussed in the revised manuscript.

**Methodology (Lines 89-199):**

**Referee : Lines 94-99. The description of the study site is good, but a map showing the regional context would be helpful.**

**Authors:** We understand the point of view of the referee. The figure 1 was re-plotted in order to provide information about the regional context as suggested by the referee.

**Referee : Lines 101-116. The use of Level 1.5 AERONET data instead of Level 2 needs more justification. What are the potential implications for the results?**

**Authors:** The sun-photometer AERONET observations are processed by two algorithms which leading to obtain data at level 1.5 and 2.0. 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. As a consequence, the quality check of the data is reinforced with the process applied to obtain data at level 2.0. The use of these latter improve the robustness of the results (no bias due to cloud or calibration). The data at level 2.0 was not available when the previous version of the manuscript was submitted. The data at level 2.0 have been upgraded only for the Skukuza site. Thus, these data were used in the revised manuscript.

**Referee : Lines 150-155 More details on the CAMS reanalysis product are needed, including its known biases or limitations in Southern Africa.**

**Authors:** Khaykin et al. (2020) revealed an underestimation of AOD values from CAMS reanalysis products over some regions of Southern Africa, Southern America and South-

ern Asia. The Modified Normalized Mean Bias (MNMB) is estimated between 0 and -25 % in Southern Africa (Langerock et al., 2024). The work of Plangerock et al. (2024) also revealed a negative bias up to 30 % in the estimation of CO over Southern Africa and Southern America during the biomass burning season. These information were added in the revised manuscript.

### **Results and Discussion:**

**Referee : Section 3 (Lines 200-250) The criteria for selecting the two events need more explanation. How do these events compare to typical conditions during the biomass burning season?**

**Authors:** The criteria for selecting the two events is based on statistical approach. The anomalies is through the calculation of the quantiles Q1, Q2, Q3 of the relative difference. This latter is calculated by comparison with typical conditions defined from observations recorded between 1998 and 2021. The anomalies were defined as the period for which the relative difference values exceeding the Q3 line. The period which occurs these anomalies define the events of our study.

**Referee : Section 4 (Lines 251-355) The analysis of aerosol transport is informative, but could benefit from more quantitative assessment. Consider adding statistical measures of the spatial and temporal variability of AOD and CO.**

**Authors:** As suggested by the referee, this kind of assessment was considered in the revised manuscript.

**Referee : Section 5 (Lines 356-530) The discussion of synoptic conditions is detailed but could be more tightly linked to the aerosol observations. *The comparison with previous "river of smoke" events (Lines 419-430) is interesting but needs more rigorous analysis.* The discussion of intercontinental transport (Lines 460-499) is speculative and needs stronger evidence or should be significantly shortened.**

**Authors:** We agree with the referee. Thus, 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. Furthermore, new meteorological CAMS products were added in the revised manuscript to better characterize the synoptic system which driven the transport of the biomass burning plume.

### **Figures and Tables:**

**Referee : Figure 3: This figure is dense and hard to read. Consider splitting into two**

**separate figures.**

**Authors:** It was corrected in the revised manuscript

**Referee : Figure 4: The aerosol classification results are important but difficult to interpret. Consider using a different visualization method or adding a summary table.**

**Authors:** The figure was re-plotted in order to allow easy read of the results as suggested by the referee. In the previous version a summary table was included and was maintained in the revised manuscript.

**Referee : Figures 7 and 10: These synoptic maps are informative but could benefit from annotations highlighting key features discussed in the text.**

**Authors:** It was corrected in the revised manuscript.

**Referee : Scientific Approach: The multi-instrument approach is a strength, but the integration of different data sources could be improved. For example, a more quantitative comparison between AERONET, MODIS, and CALIOP data would strengthen the results. The analysis of vertical aerosol distribution (Lines 314-329) could be expanded, perhaps incorporating additional data sources or modeling approaches to better characterize the 3D structure of the aerosol plumes.**

**Authors:** We understand the point the point of view of the referee. Nevertheless, the present study focuses on one scientific question : Meteorological and synoptic conditions driving the transport of biomass burning plume over SWIO basin. In order to maintain clear the purpose of the article and not to extend the overall text length, we did not consider comparative analysis between the different instruments. Furthermore, a comparative study between these instruments (AERONET, MODIS and CALIOP) over Southern Africa has been already carried out by the authors in a previous article (Ranaivombola et al., 2023). In the present study, the analysis of the vertical is helpful to characterize the altitude associated to the transport of the plume and to determine the synoptic scheme driving its transport at this altitude. The use of numerical model (in particular, FLEXPART by coupling with emissions inventories) is planed in a further-coming study. This next of our work is mentioned in the revised manuscript (in the conclusion, section 5).

**Referee : Presentation and Language: The manuscript would benefit from careful editing for grammar and clarity. There are several instances of awkward phrasing or run-on sentences (e.g., Lines 380-385, 460-465).**

**Authors:** The referee is right. The quality of the english was checked in the revised manuscript

**Referee :** The conclusion section is missing. Add a concise conclusion that summarizes the key findings and their implications.

**Authors:** This comment is quite confusing. Indeed, the previous version of the manuscript included a conclusion section (Summary and concluding remarks). Nevertheless, we can understand that this section in its initial version did not contain the points which characterize a conclusion section as defined by the referee. As a consequence, the conclusion section was rewritten in the revised manuscript.

**Referee : Data Availability:** A data availability statement is needed, detailing how readers can access the data used in this study.

**Authors:** These information were included in the previous version of the manuscript. As a consequence, these information were maintained in the revised version.

**Referee:** Compared to typical ACP papers I have seen in this line of research, this manuscript:

- Provides a good multi-instrument dataset but falls short in the depth of analysis.
- Lacks a clear articulation of its novel contribution to the field.
- Needs improvement in the presentation of results, particularly in the figures.
- Requires a more rigorous discussion that places the findings in the context of existing literature.

For clarity, major revisions are needed to:

- Clearly state the research questions and novelty of the work.
- Improve the quantitative analysis of aerosol properties and transport.
- Strengthen the discussion, particularly in relating the findings to previous studies and broader implications.
- Enhance the quality of figures and tables.
- Add a robust conclusion section.
- Improve overall clarity and organization of the manuscript.

**Authors:** 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. Indeed, this section was rewritten by corrected the inappropriate meteorological diction. To better characterize the synoptic conditions occurred during BiBAC, cloud cover products from CAMS reanalysis was added in the dataset used in this study. 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 the previous works, the synoptic conditions responsible for the formation of the smoke river involved the propagation of a westerly wave and the development of a cut-off low (Swap et al., 2003; Stein et al., 2003; Flamant et al., 2022). However, we observed during the event 1 a river of smoke structure involved by westerly wave without a cut-off-low. The river of smoke developed in a synoptic context characterized by three successive cold fronts associated with saddle points during the event 2. In order to allow an easy read and understanding of these results, the quality of the english and figures were improved in the revised manuscript.

# References

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