

## Review comments: egosphere-2023-2371

### General comments:

The authors of the study have conducted a comprehensive investigation into the radiative effects of biomass burning aerosols on atmospheric circulation at low and mid-levels over southern Africa. The study, contextualized within the AEROCLO-sA field campaign on September 5, 2017, utilized both in situ and remote sensing observations, alongside sets of ensemble simulations using the Meso-NH mesoscale model.

Their findings highlight that the simulation incorporating BBA radiative effects was shown to represent regional dynamics, thermodynamics, and compositional features more convincingly. In contrast, simulations neglecting these effects presented unrealistic dynamics, such as a weakly formed LLJ and inaccurately represented mid-level dynamics critical for the transport of BBAs. Specifically, the absence of BBA radiative effects resulted in discrepancies such as an inadequately established LLJ overnight and a convective planetary boundary layer (PBL) that was too deep in comparison with observational data. Additionally, the research connected the enhanced near-surface extinction coefficient values observed over Etosha with the downward mixing of BBAs in the convective boundary layer, rather than dust emission due to LLJ breakdown after sunrise.

The study concludes with a clear and important message that for accurate forecasting of dust emissions in Namibia, it is essential to consider the radiative effects of biomass burning aerosols, underscoring their significant influence on atmospheric behavior. However, I have some reservations about some aspects. It is good that this is a very detailed paper, but there is a lot of bouncing backwards and forwards between figures in the results section. I would suggest removing some redundant details in the paper and streamlining the text. The details of the model configurations are somewhat missing. I recommend a minor revision before publication.

### Specific comments:

**Comment 1: Page 3, line 59** “In particular, we detail the ensemble simulations designed with and without BBA radiative impact...”

Please provide a short overview of ‘ensemble simulation’ of what? In the introduction emphasize the importance of model simulations in the context of the current topic of interest. Include details that underscore the synergistic method combining both measurement and modeling techniques.

**Comment 2:** Could you provide a very short background information on the overall data collection during the campaign and explain the reasons for selecting this particular day for the current analysis? This point seems somewhat obscured in the text and is not clearly articulated.

**Comment 3: Page 5, line 120** “Wiggs et al. (2022) have estimated the threshold wind velocity to be  $7.25 \text{ ms}^{-1}$  over Etosha during the dry season.”

Can you explain what is meant by ‘threshold wind velocity’?

**Comment 4: Page 6, Section 3.2** Please add the details of the model configuration: boundary layer scheme, aerosol scheme, etc. Is the model's horizontal resolution set at  $5 \times 5 \text{ km}$ , and does it reach a maximum altitude of  $600 \text{ m}$ ? Please provide more details about BBRAD and NORAD to help the readers understand their relevance better.

**Comment 5: Page 7, line 169-171** “In early September, climatological mean...”

Could you specify the exact time period?

**Comment 6: Page 8, Line 179-180** “over Angola and Zambia to the north are associated with the easterly flow along the northern fringes of the semi-permanent anticyclone (Fig. 2c).”

Is this the average at 07:00 UTC?

**Comment 7: Page 8, Figure 2.** Are 'E' and 'W' in the lower two panels referring to Etosha and Windpoort, respectively? Please mention this in the captions.

**Comment 8: Page 9, Figure 3** Figure caption

Is this the result from one of the BBRAD ensemble members or the average of all the members?

Are the values from the model hourly? If the model outputs are on an hourly basis, could the infrequent recording of the data introduce uncertainties when representing phenomena on a sub-hourly scale?

**Comment 9: Page 13 Line 252-254** “The southeasterly BBA transport within the river of smoke is illustrated by the strong wind at 4 km amsl (Fig. 8b). The river of smoke propagated rapidly across southern Africa between 5 and 6 September 2017, under the influence of the fast evolving temperate tropical trough.”

The first sentence is slightly unclear from the figure, and the river of smoke propagating between 5 and 6 September is not illustrated in the figure.

Also, please discuss about the uncertainty or biases between the MODIS derived AOD and that of the modeled.

Why is NORAD AOD higher than BBRAD AOD?

**Comment 10: Page 14 Figure 7** Figure caption: “Results are shown for the BBRAD and NORAD members starting at 00:00 UTC on 1 September 2017.”

Please revise the caption for Figure 7 to clarify the timeline. Additionally, consider using a more distinct color, such as black, for the dust extinction contours, as the yellow is blending into the background plots.

**Comment 11: Page 16 Figure 9** Figure caption: “...the cyan contour the cloud fraction at 10 %...”

Do you mean ‘at’ or ‘>’ 10%?

**Comment 12: Page 19 Line 338-341** “It is also consistent with the wind speed anomaly at 3.5 km amsl (Fig. 11d) with a positive anomaly ( $> 3\text{ms}^{-1}$ ) superimposed on the positive AOD anomaly, and a negative wind speed anomaly ( $< -3\text{m s}^{-1}$ ) where the negative AOD anomaly is located (Fig. 11c).”

The consistencies are not readily apparent, as the negative AOD anomaly depicted in Figure 11c does not correspond to the area with a negative wind speed anomaly at 3.5 km. Instead, the negative anomaly aligns with what is shown in Figure 11a. Could you please provide clarification?

**Comment 13: Page 19 Line 341** “Both Windpoort and Etosha are located in the area of negative wind speed anomaly.”

Do you mean at an altitude of 3.5 km? Also, could you mark Etosha on the map for better reference? The rationale for using 3.5 km as the reference altitude is not entirely clear. Please clarify.

**Comment 14: Page 20 Figure 11c** Although there is a strong positive anomaly in dust emission over the region around Windpoort, the DOD does not exhibit any change. Please explain.

**Comment 15: Page 20 Line 352-355** “Further south, over southern Namibia and northwestern South Africa, a bipolar dust-AOD anomaly pattern (reversed with respect to the one further north) is seen, with positive anomalies ( $> 0.2$ ) to the west and negative anomalies to the east. It is consistent with the dust emission anomaly pattern and likely due to the eastern shift of the river of smoke in the NORAD simulation and the associated change in low-level dynamics.”

This is slightly unclear.

**Comment 16: Section 6.** Manuscript bounces about a bit from here onwards, referring back Fig. 5 and Fig. 3 frequently. Potentially some repetition of material in these sections which could be consolidated.

**Comment 17: Page 23 Line 396** “off BBA” or “of BBA”?

**Comment 18: Page 23 Line 397** Is it possible to avoid the word “twin” in “twin ensemble simulations.”

**Comment 19: Page 23 Line 397-398** “one including the direct and semi-direct radiative effects of aerosols (BBRAD)”

This is only mentioned in the conclusion, please add the details in the methodology.