Response to comments from editor

Manuscript: A satellite-based analysis of semi-direct effects of biomass burning aerosols on fog and low cloud dissipation in the Namib Desert # EGUSPHERE-2024-1627

We would like to thank the editor for the helpful and constructive feedback. The comments and suggestions are incorporated in italics and addressed by the authors in blue. We thank the editor in the acknowledgements of the updated version of the manuscript as follows: "We are also grateful to the editor, Franziska Aemisegger, and the two anonymous reviewers for their careful and constructive feedback, which has helped improve the manuscript."

1) *L.3 ", and sometimes are reaching the coastal fog and low clouds" -can you be more precise? e.g. "Each year between June and October, in some synoptic settings, absorbing biomass burning aerosols (BBA) are overlying the stratocumulus clouds in the adjacent Southeast Atlantic, thereby modulating the time of the day when FLC dissolve. In favorable synoptic conditions, this layer of BBA reaches Namibia and its desert, where it interacts with coastal fog and low clouds ."*
This would help a bit because up until here a non-expert doesn't know what the impact of BBA is on the cloud layer.?

- Modified to: "Each year between June and October absorbing biomass burning aerosols (BBA) are overlying the stratocumulus clouds in the adjacent Southeast Atlantic. In some synoptic settings, this layer of BBA reaches Namibia and its desert, where it interacts with coastal fog and low clouds (FLCs)"
Thank you for the suggestion, it is true that splitting the sentence in two improves clarity. Additionally, we made minor corrections, as the BBA layers can generally be considered present over the Southeast Atlantic during these months, but they only reach the coastal regions in certain synoptic settings. Nonetheless, at this point in the abstract, it seems too speculative to claim that the BBA layers impact FLC dissipation, as this is explored throughout the study. This is why we prefer to simply state that interactions are present without assuming their effects.

2) *I do agree with Rev. 1 about their point on the artificial effects due to the 12h satellite data assimilation on water vapour and TCW, you may therefore add their suggested reference at L. 150. Vicencio, J., C. Böhm, J.H. Schween, U. Löhnert, and S. Crewell, 2023: A comparative study of the atmospheric water vapor in the Atacama and Namib Desert, Global and Planetary Change, 104320, https://doi.org/10.1016/j.gloplacha.2023.104320.*
For me personally this reference would help to understand what the implications of only assimilating satellite obs in the 12h time window are at this specific location of the text, while Hersbach et al. 2020 is a more general reference for the data assimilation window.

We, of course, would prefer to cite this study instead of the more general reference to the data assimilation window in Hersbach et al. (2020). However, after careful examination, we did not find any mention of this limitation in the study. The figure of hourly TCWV anomalies provided by Reviewer 1 is also not present in the study. As we understand it, the reference was given in relation to Reviewer 1's fifth comment, where the variability of boundary layer height is questioned.

3) *I do also agree with Rev. 1 on the transient nature of BBA influence: "Coming back to my suspicion that the strong pollution mainly occurs as episodes. This counteracts the assumption of a linear model to predict FLC times." Can you mention this specific limitation of the chosen prediction framework more explicitly in the conclusions. Also the final sentence from the Abstract sounds a bit like a dead end. Can you add a sentence that would show the way forward? LES modelling? Use of trajectories or combination with other tracers?.*

- Added in the conclusions: "Additionally, using this model requires the assumption of linearity in the underlying processes."

- Added in the abstract: "... and invite detailed modeling analyses of the underlying processes, for example, with large eddy simulations."

4) *Semi-direct (both reviewers): is now defined in the intro but in the abstract I also stumble over it and would very much benefit from a short explanation. Either avoid semi-direct and directly say that you mean impact on thermodynamics and stability through interaction with radiation or, explain what semi-direct is in a relative clause: "In this study, a novel 15-year data set of geostationary satellite observations in the Namib Desert is used together with reanalysis data in order to better understand the semi-direct impacts of BBA on the dissipation of FLCs in the Namib desert, i.e. through adjustments of the atmospheric stability by the interaction of the aerosols with radiation.*

- Modified in the abstract: "... i.e., through adjustments of atmospheric stability and thermodynamics via the interaction of aerosols with radiation"
Thank you for the suggestion. We think that it is important for "semi-direct" to appear in the abstract but it is true that it requires an explanation.

5) *L. 78 and 80: I agree with reviewer 1 that it is unclear at this stage (and later on) how you can disentangle the BBA effects and meteorology*

- Modified in the introduction: "The goals of this study are thus to better understand possible BBA semi-direct effects on the dissipation of FLCs in the Namib and to **attempt to** disentangle the BBA effects from other meteorological covariates. To this end, a 15-year time series of geostationary satellite observations of FLCs in the Namib is analyzed together with reanalysis data to characterize situations under contrasting BBA loading, and used in a statistical learning framework to quantify and **partially** disentangle meteorological and BBA influences on FLC dissipation time."
We added these two terms to indicate that it is not fully achieved. Nevertheless, thanks to the statistical model, the BBA effects are disentangled from the coastal circulation. However, the main challenge of separating water vapor effects from BBA effects obviously remains.

6) *L. 118-121: please shortly mention why this is the most frequent dissipation time.*

- Modified in section 2.1: "In both regions, dissipation begins shortly after sunrise, reaching a maximum at 8 UTC, which can be attributed to stronger solar irradiance (Andersen and Cermak, 2018). This is followed by a decrease until a daily minimum is observed around 12 UTC."
We added an explanation of why 8 UTC is the most frequent dissipation time. Additionally, we removed the sentences about the second phase of dissipation that occurs during the night, as this phase is not relevant to this study; the semi-direct BBA effects we focus on require solar radiation.

7) ***L.*** *300-301: Are these transient events not well captured or not captured at all? And what do you suggest as a way forward to address this point in the future?*

- Modified in section 3.2: "However, by comparing situations averaged over hundreds of days, this study does not **effectively** capture out-of-the-ordinary events, such as mid-latitude intrusion events (Zhang and Zuidema, 2021), which can sig-

nificantly impact BBA transport and distribution on specific days. **While detailed case studies using back trajectories could analyze the variability of such events, they are beyond the scope of this study**"
We argue that while our averaging captures some information related to these transient events, it is not sufficient to fully discern their effects. Additionally, it is uncertain whether these kinds of events would drastically modify the synoptic situations described in the study. For example, even if the direction from which BBA are coming changes, we can still expect longwave heating to modulate the coastal circulation and impact fog dissipation.

8) *Rev.2 "How good is this column-integrated BCAOD reanalysis, since there are aircraft measurements from the field campaigns in the region, I wonder if this product can be validated against observations?" and the next remark by Rev.2 about ACAOD from NASA: I understand the motivation for using BCAOD reanalyses data in your study, but this choice should be justified explicitly in Section 2.2. Mentioning that other more observationally-based products can be used in particular for case studies and to evaluated the reanalysis product in more detail would be helpful for the reader.*

- Added in section 2.2: "While more observational-based products exist, such as aircraft measurements from field campaigns in the region, which are very useful in case studies, a reanalysis data set is preferred in this study to avoid issues related to missing data, cloud interference, and to facilitate combination with meteorological reanalysis data in a statistical framework. Additionally, the AOD data was extensively validated using observations in Gueymard and Yang (2020), where the authors found a small but existing tendency in CAMS to underestimate AOD across Africa. However, they conclude that for many applications, this data set offers significant advantages over customary observational-based products."

9) *Rev. 2's point about why not using an approach that would accommodate for the non-linear nature of the prediction problem. Please shortly explain the rationale behind using a ridge regression model at the beginning of Section 2.5.*

- Added in section 2.5: "Spatial neural networks would be an ideal tool for this; however, they require a large number of data points, and their interpretation and sensitivity estimation are more challenging. Therefore, ridge regression, a regularized linear model..."

Technical comment: *°S and °N should not be in italics.*

Corrected in the text.

References

Andersen, H. and Cermak, J.: First fully diurnal fog and low cloud satellite detection reveals life cycle in the Namib, Atmospheric Measurement Techniques, 11, 5461–5470, https://doi.org/10.5194/amt-11-5461-2018, 2018.

Gueymard, C. A. and Yang, D.: Worldwide validation of CAMS and MERRA-2 reanalysis aerosol optical depth products using 15 years of AERONET observations, Atmospheric Environment, 225, 117 216, https://doi.org/10.1016/j.atmosenv.2019.117216, 2020.

Zhang, J. and Zuidema, P.: Sunlight-absorbing aerosol amplifies the seasonal cycle in low-cloud fraction over the southeast Atlantic, Atmospheric Chemistry and Physics, 21, 11 179–11 199, https://doi.org/10.5194/acp-21-11179-2021, 2021.