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Atmospheric Chemistry and Physics Discussions

# *Interactive comment on* "Impact of the Variability in Vertical Separation between Biomass-Burning Aerosols and Marine Stratocumulus on Cloud Microphysical Properties over the Southeast Atlantic" *by* Siddhant Gupta et al.

**Anonymous Referee #3**

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Review of "Impact of the Variability in Vertical Separation between Biomass-Burning Aerosols and Marine Stratocumulus on Cloud Microphysical Properties over the Southeast Atlantic" by Gupta et al.

This study reports on the important issue of smoke-cloud interactions with a focus on the vertical separation of aerosol layers from cloud tops, which is of importance in the southeast Atlantic Ocean region where there can be large smoke plumes above and within the boundary layer. This study makes use of ORACLES data, specifically from six research flights. Statistics are provided about the number of cases where the



aerosol layers (> 500 cm-3) are within 100 m of cloud tops ( "contact") or in excess of 100 m from tops (called "separated"). Subsequently, cloud properties and free tropospheric humidity are compared for these two categories of cases. A finding was that droplet evaporation (from entrainment drying at cloud top) was enhanced in cases where plumes were above 100 m from cloud tops (called "separated"); this was coincident with greater reductions in cloud drop number concentration and liquid water content near cloud tops. Another finding was that sub-cloud aerosol number concentrations were typically higher for "contact" cases (> 350 cm-3). Also, the "contact" cases with high aerosol concentrations in the boundary layer had higher drop concentrations as compared to "separated" cases. The paper was well written and easy to follow. At least one of the tables was difficult for me to digest but in general the tables and figures were clear too. The results are important and I am fully supportive of publication after the comments below are addressed.

Specific Comments:

Table 5: Took me several time to read the caption to try to understand the table and I am still not sure I understand it.

Line 76-85: I suspect it may be important to refer to this study somewhere here or elsewhere in the paper owing to its high relevance:

Rajapakshe, C., et al. 2017. Seasonally transported aerosol layers over southeast Atlantic are closer to underlying clouds than previously reported. Geophysical Research Letters, 44, 5818–5825. https://doi.org/10.1002/2017GL073559

Line 118-119: Give a brief description of how the collection efficiency was computed and handled for the data presented.

Line 182: Are the authors sure they mean LWC > 10 g m-3? That seems too high (by 2 orders of magnitude).

Throughout the paper I suggest the authors consult with 3 other recent references to

at least mention them for the sake of comparison and contrast. The Mardi et al. (2018) paper quantifies in detail smoke layer separation from stratocumulus cloud top heights, while their 2019 paper digs into cloud-smoke interactions that are related to results from this study. The Diamond et al. (2018) examines smoke-cloud interactions too over the same region as that of this study. In particular I find that the threshold to use for what constitutes a smoke plume (i.e., its base altitude) to be quite important, for which results of studies like this can be sensitive to; I found it interesting that the criteria in this study seemed to be Na > 500 cm-3, whereas that in the Mardi et al. papers was 1000 cm-3.

References:

Mardi, A.H., et al. 2019. Effects of Biomass Burning on Stratocumulus Droplet Characteristics, Drizzle Rate, and Composition. J Geophys Res-Atmos 124, 12301-12318.

Mardi, A.H., et al. 2018. Biomass Burning Plumes in the Vicinity of the California Coast: Airborne Characterization of Physicochemical Properties, Heating Rates, and Spatiotemporal Features. J Geophys Res-Atmos 123, 13560-13582.

Diamond, M. S., et al. 2018. Time-dependent entrainment of smoke presents an observational challenge for assessing aerosol-cloud interactions over the southeast Atlantic Ocean. Atmospheric Chemistry and Physics, 18(19), 14623–14636. https://doi.org/10.5194/acp-18-14623-2018

Line 374-375: Are the authors sure they have unambiguous evidence of these causal relationships? This is always a tricky thing with aircraft data and I caution the authors to reconsider if they want to use this strong language.

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