

Review of “Aerosol first indirect effect of African smoke in marine stratocumulus clouds over Ascension Island, south Atlantic Ocean” by M. de Graaf et al.

This study uses a single instrument to study aerosol first indirect effect with one month of data collected at the Ascension Island in the middle of the south Atlantic Ocean during the southern African biomass burning season. The manuscript is relatively well written, and the scope of the study is properly fitted for ACP, however, the current form of the manuscript reads too technical (more suited for AMT), and the significance of the results shown needs to be assessed before it can be considered for publication. Moreover, upon addressing the above mentioned points, the structure of the manuscript also needs to be revised for the ease of readership.

Main concerns:

1. Statistical significances of the analyses (all 3 methods associated with Fig. 4-6) need to be included and discussed. Working with only one month of available can be quite challenging, but I believe one can still make valuable statements with proper significance assessments.
2. Attribution of the Twomey effect requires constant cloud macrophysical properties, e.g., cloud LWP, and environmental conditions, I understand this can be difficult with less than 40 sample size, but these limitations/assumptions need to be acknowledged when interpreting the results and making attributions (i.e., saying these indicate the Twomey effect).
3. Section 5.2 confuses me, if one cannot validate the representativeness of the retrieved cloud properties, how can one study the interactions of them with retrieved aerosol properties? Moreover, if the Radar retrievals of cloud properties is really problematic and biased (r_c retrieved using daily averaged or some assumed Nd values are certainly not suited for aerosol-cloud interactions studies), what’s the point of validating Lidar Nd with Radar retrievals? Furthermore, it doesn’t validate a retrieved variable when another variable retrieved using the same instrument is involved in the validation.
4. The current form of the manuscript reads too technical, especially Sections 2.1-2.4 and 5.2. These technical details can be condensed and summarized in the main text, with details provided in an appendix or a supplement.
5. The validation section needs to be moved up before showing the results. How can a reader interpret these results without knowing the retrievals that these statements based on are validated?
6. The current form of the Conclusions reads like a summary and repetitive of what have been stated. Emphasizing on the advantages (and caveats) and implications of the study would be very helpful.

Minor comments:

The authors tend to state existing knowledges without providing references, for example:

- 1) P1 Line17 and P8 Line166, the typical thermodynamical structure of the MBL clouds over Ascension during the dry season can be found in Zhang & Zuidema 2019 ACP.
- 2) P2 Line33 and P8 Line173, Zuidema et al. 2018 GRL provides a more updated overview on LASIC and some first results.

- 3) When providing information on the transport, seasonality, and distribution of the smoke aerosols to set up the context on the complex environment within which smoke-cloud interactions manifest over the SE Atlantic during the southern African biomass burning season, Adebisi & Zuidema 2016 QJRMS, Adebisi et al. 2015 JClimate, and Zhang & Zuidema 2021 are suitable references.
- 4) P11 L222, reference for the theoretically feasible values?
- 5) P13 L284, “from the literature”, which one?

Since cloud properties retrieved by the lidar only represents cloud base values, and (as the authors also mentioned) cloud droplet size is highly dependent on height, I wonder if it's more appropriate to indicate that this study focuses on the aerosol indirect effect at cloud base in the title, with “... at cloud base of marine stratocumulus clouds ...”?

The current introduction is too thin, introduction to existing knowledges on aerosol cloud interactions over the region is needed to set up the scientific question. The introduction to the Ascension Island and its environment, i.e., the smoky SE Atlantic during dry season, and the campaign info need to be moved up, preferable to the introduction. When reading the current manuscript, a reader has no idea of the context (the condition under which these measurements were made) until P7 Section 3.

If the 2017 measurements were affected by alignment problems, why all your proof of concept exemplary figures show 27 Aug 2017? Why not use a day from 2016?

Why the sample sizes of the 3 methods not consistent? (37 in Fig. 4, 39 in Fig. 5, and 32 in Fig. 6). This needs to be justified.

Is this correct that only the 2016 data is used for all you results? I think making this clear in a Data & Methods section would be nice.

Section 4.3, how is the two IEs calculated in this method? It seems you have retrievals (sample size ranging from 3 to 24) of cloud and corresponding aerosol properties for each cloudy period, from which IEs are derived? Making this clearer would be nice.

Check for spelling: P11 Line232: Ascension; Line 228: August or September? Fig. 5: daily.

P11 L220, what does “cloud inversion” mean?

Define abbreviations at first use: SNR, ATB

Fig. 7-9, validations are better illustrated with scatter plots with R^2 values provided, similarly as in Fig. 11.

Fig. 6, x-axis font needs to be adjusted.

Fig. 8-9, the range of y-axis needs to be adjusted to remove the empty space above and to see the variability in the variables better, and why filling in no-retrieval period with straight lines, if you don't have values for that time period?

Data doi needs to be provided.

References:

Adebiyi, A. A. and Zuidema, P.: The role of the southern African easterly jet in modifying the southeast Atlantic aerosol and cloud environments, *Q. J. Roy. Meteor. Soc.*, 142, 1574–1589, <https://doi.org/10.1002/qj.2765>, 2016.

Adebiyi, A. A., Zuidema, P., and Abel, S. J.: The Convolution of Dynamics and Moisture with the Presence of Shortwave Absorbing Aerosols over the Southeast Atlantic, *J. Climate*, 28, 1997–2024, <https://doi.org/10.1175/JCLI-D-14-00352.1>, 2015.

Zhang, J. and Zuidema, P.: The diurnal cycle of the smoky marine boundary layer observed during August in the remote southeast Atlantic, *Atmos. Chem. Phys.*, 19, 14493–14516, <https://doi.org/10.5194/acp-19-14493-2019>, 2019.

Zhang, J. and Zuidema, P.: Sunlight-absorbing aerosol amplifies the seasonal cycle in low-cloud fraction over the southeast Atlantic, *Atmos. Chem. Phys.*, 21, 11179–11199, <https://doi.org/10.5194/acp-21-11179-2021>, 2021.

Zuidema, P., Sedlacek, A. J., Flynn, C., Springston, S., Delgadillo, R., Zhang, J., Aiken, A. C., Koontz, A., and Muradyan, P.: The Ascension Island Boundary Layer in the Remote Southeast Atlantic is Often Smoky, *Geophys. Res. Lett.*, 45, 4456–4465, <https://doi.org/10.1002/2017GL076926>, 2018.