

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2021-275

Anonymous Referee #2

Referee comment on "Sunlight-absorbing aerosol amplifies the seasonal cycle in low-cloud fraction over the southeast Atlantic" by Jianhao Zhang and Paquita Zuidema, Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-275-RC2>, 2021

This manuscript seeks to explain the role of absorbing aerosol on cloud structure throughout the biomass burning season in the southeast Atlantic as opposed to focusing on a single month or the biomass burning season as a whole using observations collected during 2016 and 2017 at Ascension Island. The work is certainly a worthwhile contribution to the literature however there are some concerns that should be rectified first, as listed below. Many of the figures contain a lot of information, so much so, that it can become overwhelming.

Line 120: Is there any concern about subgrid box variability and sharp gradients with such a large grid box? Could this explain why figure 3a shows roughly the same cloud fraction for more and less smoky cases in September, but Figure 5a indicates more clouds (or thicker) with smoky conditions.

Paragraph beginning on Line 121, Page 4: This assessment seems difficult to follow, and subjective. The terms "mostly tracks", "track each other well", "tracks fairly well" are used to characterize three distinct periods and three different variables, yet it is hard to distinguish between these. The second half of July 2016 and July 2017 are indeed in excellent agreement, but the character of the agreement between the surface and free troposphere is very different during the other months and this is the point that I believe is trying to be made. This paragraph could benefit from some refinement, with connections made to what was learned from the histograms.

Line 140: A careful assessment should be conducted regarding the selected days for high and low smoke loadings with regard to the composites. A larger number of low smoke days, for example in July, could have a muted composite compared to the smaller number of high smoke days. Furthermore, the large scale circulation in the southeast Atlantic differed between the two 2016 and 2017 (as pointed out by the earlier shift in regime in 2016) so it should be established whether the difference in the large scale meteorology composites were due to more cases in one year over the other.

Lines 160-162: This sentence seems out of place.

Line 165: How is stratiform vs cumuliform determined? The surface observers?

Line 181: typo (should be bases, not based)

Line 223: typo (days **WITH** little smoke)

Section 7: Important details are missing regarding the RRTMG simulation. What exactly is being fed into RRTMG? Clouds must be represented somehow due to the peak in SW warming and LW cooling at the top of the PBL, and the kink in LW at cloud base around 750 m. Is an angstrom exponent specified? Does SSA not vary by wavelength or humidity for simplicity? I also feel that more can be done with this type of simulation as the section seems somewhat incomplete. How does the change in height of the aerosol layer from

July/August to September/October alter the heating structure and stability of the atmosphere?

Figure 1: Please add panel labels

Figure 2: 1) fine mode AOD should be in the legend box; 2) τ_{AC} is used in the caption, but ACAOD is used everywhere else; 3) The amount of information in this figure is almost overwhelming. Consider making panel b its own figure and rearrange so that the winds are in separate panels from the other variables.

Figure 8: This figure should be split into 2 panels, one with observations, the other with the radiation output. Q_v and θ should also be displayed with different colors or line styles. Variable names should be consistent with previous figures which use potential temperature