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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Open cells can decrease the mixing of free-tropospheric biomass burning aerosol into the south-east Atlantic boundary layer" *by* Steven J. Abel et al.

Anonymous Referee #2

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Abel et al. (2019) present an observational case study focused on a pocket of open cellular (POC) convection that formed under a biomass burning aerosol layer in the southeast Atlantic. They utilize a range of aircraft observations from several flights in the CLARIFY field project, as well as ground observations from an ARM Mobile Facility deployed to Ascension Island for the LASIC project, back trajectories and satellite retrievals of aerosol and cloud properties around their area of study. The authors nicely synthesize this wide range of datasets. They conclude that the POC must have reduced entrainment rates relative to a nearby area of mostly stratiform cloud cover. This result would have important implications for aerosol-cloud interactions, especially over the southeast Atlantic.

One of my main comments is primarily editorial/organizational. There were several examples – notably Section 3, Section 5 and Section 9 – of a mismatch between the ordering of the figures/subfigures and presentation of results in the text. For example, I think it helps make the paper as clear as possible if you don't have to jump between looking at Figures 5e and 5f while reading the analysis, then go to Figure 6, which is a totally new type of result and is mostly disconnected, then go back to Figure 5a etc. . ., to continue with those results. For the most part, I found the analysis of individual subfigures and results easy to follow. This would just be to make sure each section and the full figures are organized and presented sequentially.

The primary conclusion of the paper is based on the comparison of the observations in the POC region to the downwind stratiform region. The trajectory analysis seems to indicate that prior to the formation of the POC, that airmass was unlikely to have been entraining smoky air from above given the separation between the aerosol layer and cloud top seen in the CALIPSO curtain. It then moves into a region where the base of the aerosol layer is lower and there could be entrainment of particles into the MBL. One point that I think would be good to make very explicit is that the same history holds for the region that later gets sampled as the downwind stratiform area. I think indicating this point specifically for both sampling regions, rather than just for the POC, would strengthen your argument about differences in entrainment rates.

I also think more specific discussion of connection to prior results (a handful of papers are already cited) around differences in entrainment rates in and around POCs would bolster the paper.

A few other minor comments:

Page 2, Line 14: "lead to a reduction in the outgoing flux at the top of the atmosphere. . .". Just clarify which flux (e.g. shortwave, net radiative etc. . .)

Page 3, Lines 18 – 19: ". . .there being no in-situ measurements of these events to date." I think that phrasing could be more specific that you are pointing out there have

been no in-situ observations of the formation of a POC, not a POC generally.

Figure 2: A legend in the figure marking what the color of the curves mean would be helpful for quicker interpretation.

Figures 5d,e,f: Do you have any thoughts on why CO would be well mixed under the POC even though the thermodynamic profiles indicate decoupling?

Figure 6: I'm not clear what Figure 6 brings specifically to this analysis since it mostly just generally confirms other prior observations. Is there a direct connection to the entrainment rate argument?

Page 10, Line 34: You use the word 'pristine' to refer to aerosol concentrations of 1 – 2 cm-3 in the ultra-clean layer of the upper boundary layer, but it seems pretty likely that even the slightly higher 28 cm-3 closer to the surface would also be pristine (if referring to the absence of continental or anthropogenic influence).

Figure 17: I'm not sure this figure was particularly necessary as a main figure. Perhaps this could be included in a supplement if needed.

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