

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 #1

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This manuscript reports observations that were obtained over the south Atlantic ocean. It documents closed and open cells under the influence of free tropospheric (FT) biomass burning aerosols. The main conclusion is that the overlying biomass burning aerosol are mixed more efficiently into the cloud layer in the overcast regions, while in the POC mixing is largely reduced. This has implications regarding aerosol-cloud interaction assessments. The study combines nicely in-situ observations with satellite and back-trajectories analysis. The manuscript is well written, though should be shortened and re-organized in some parts.

Major comments: The key results is based on aircraft observations of FT aerosols

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above and within the boundary layer. Even though that based on the presented observational data the authors arguments are convincing, I'm still questioning whether it not solely rainout and cloud cleansing processes that are responsible for the cleaner POC (a question of time-scales of mixing vs rainout). I therefore expect a more comprehensive physical discussion regarding the reason why entrainment of FT aerosol into the boundary layer is less efficient in POC. This is needed to strengthen the authors conclusion.

Many of the observational findings in this study are in agreement with previous observational studies. Given that the aim of this study is not reporting observations (as far as I understand), I would expect the text to be more concise and focused on observations that are relevant to the main point of the study, rather than reporting many (perhaps less relevant) observational details.

Along the comment above, the manuscript is too descriptive in my view. I recommend it to be shorten. Also, methodological details are given within the result sections. These parts should be moved to the Methodology section.

Minor comments:

Can you use CALIOP data to complement the aircraft analysis regarding the aerosol layer height with respect to the clouds?

P2 L 24: <https://doi.org/10.1002/2015GL066544> may be relevant to this discussion.

P2 L 34: <https://doi.org/10.5194/acp-15-7351-2015> have shown that aerosol do able to close open cells. This is supported by observations: <https://doi.org/10.1029/2012JD017981>.

P4 L1: Entrainment should get more focus in the discussion here.

P5 L15: Which data product was used?

P6 L19: Mention here and later that these are Back-trajectories.

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P6 L31: What is the size of the region over which the cloud fraction is estimated?

P7 L8: Please provide reference.

P7 L9-10: Aircraft data at cloud top? Otherwise it cannot be compared to satellite observations.

P8 L18: Sentence is not clear.

P8 section 4: Many parts in the paragraph starts here should be moved to the Method Section.

P10 L1-2: Please provide reference.

P11 L4: Not efficient in comparison to cleaning due to rainout.

P11 P26: What is the mechanism? Why open cells mixes FT air less efficiently?

P12 L12: Parts here can move to the Method Section.

P12 L15: Why lower inversion is associated with cloud clearing?

P13 L30- : Can be shorten. The caption should provide this information.

P15 L20: It's hard to see differences in Fig 11d with the current color scale (especially after printing).

P16: How these observations are relevant to the aim of the current study? Precipitation in POCs were shown in many studies in the past.

P16 L22: Figure 13 covers quite a large region. How come there is only one precipitating cell (active cu)? In open cells one can expect active cells every few tens of km.

P16 L24: remove space in 13a.

P17 L 21: shouldn't it be 0.1 cm⁻³ for quiescent clouds and 1cm⁻³ for the cumulus?

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P18 L26: It is not convincing without measurements above the inversion.

P18 L32: From MODIS true color images there are no POC over the island.

P19 L23-: Why not having this in the Method section?

P20 L17: Climatological AOD is discussed here. AOD is available only when there are no clouds. So how can you relate high AOD with overcast conditions? What about co-variability between biomass burning and Sc regime? You mentioned earlier in the text that some open cell structure are transport northward from southern latitudes- I would assume they are transported also with a cleaner air mass above the inversion.

P20 L25: Should be in the Methods section.

P20 L30: It should be mention that the assessment you provide here is not based on causality (seecomment above regarding co-variability)

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