Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2019-738-RC3, 2019

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 #3

Received and published: 10 November 2019

In this case study Abel et al. analyzed observational data of aerosols, trace gases, and clouds collected in the southeast Atlantic during field campaigns to describe the evolution of a POC and its interaction with the aerosol layer sitting above. They found that boundary layer within the POC area was very clean with a large vertical gradient near the trade inversion, across which the accumulation mode aerosol increased by orders of magnitude, while in the downwind area of the POC observational evidence shows a strong entrainment of the overlying biomass burning aerosol into the closed-cell boundary layer. They conclude that the entrainment is very weak within the POC. They further developed a 19-year monthly (September) climatology of POC occurrence in the southeast Atlantic, which suggests a high possibility of biomass burning aerosol

in "contact" with POCs but without interactions. The authors also pointed out that the assumption of these overlying aerosols modulating the clouds is problematic and might be incorrectly represented in large-scale models that are incapable of simulating POCs and cloud-top entrainment.

The data and findings are novel and interesting. The paper is generally well written, although some sections, especially the results sections 3-8 can be better streamlined. Often times I got lost in the details, for example, going back and forth between different figures far away from each other. Below are specific comments.

1. The title statement is inaccurate and even a little misleading. The entrainment mixing is weaker in the POC area than in the surrounding closed-cell areas, but I don't think there is evidence in the paper that shows how the open cells "decrease" the mixing or entrainment. I suggest revising the title to reflect the main claim of the paper.

2. P2, L14-27: the use of "negative" or "positive" with direct, semi-direct and indirect effect is quite confusing. Maybe replace it with "cooling" or "warming".

3. P3, L21: the year of reference Savic-Jovcic and Stevens (2018) is incorrect.

4. P4, L31: change "vertical wind" to "vertical velocity"

5. P11, L24: Remove hyphen in "pre-cursor"

6. P11, L27: Again, is there evidence to support the important role of open-cell clouds controlling the mixing? I understand that the strong entrainment mixing in close cells can be driven by cloud-top radiative cooling, which is much weaker in open cells because of the low cloud fraction. The strong precipitation in open cells may stabilize the boundary layer. What else in open cells can control the mixing?

7. P12 and P13: The description of Figure 8 and Figure 9 is an example of giving too much detail. Much of the information can go to the figure captions and there is no need to repeat it in the main text.

8. P14, L1: Fig. 9c: are these high values for drizzle drops? They look too large for cloud droplets. 9. P15, L26: Is the number of 60 micron for rain drop radius of diameter?

10. P17, L18: Panel c of Fig. 13 doesn't seem to be aligned with the other panels.

11. P17, L32-34: Is there observation showing that the thin/quiescent clouds can last for hours and rain at 10 mm d-1? LES model results seem to show that the active cumulus only last for minutes once they start raining but the resulting cold pool outflow can produce new active clouds in the previous quiescent cloud area.

12. P18, L31: What's the background level of BC and CO at the surface?

13. P19, L18: is "20 to 12%" correct?

14. P20, L5-9: the manual identification of POC is a little arbitrary. By looking at the examples in Fig. 17, it seems that the POC identification is quite conservative. Does that mean the 0.25 open cell fraction represent a lower bound? Also, in the formulation, were clear-sky and land surface pixels counted in P_ALL or P_BLACK?

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