Atmospheric Chemistry and Physics Discussions

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Comment on acp-2021-939

Anonymous Referee #1

Referee comment on "Smoke in the river: an Aerosols, Radiation and Clouds in southern Africa (AEROCLO-sA) case study" by Cyrille Flamant et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-939-RC1, 2021

Review of manuscript acp-2021-939 "Smoke in the river: an AEROCLO-sA case study"

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General comments:

The authors conducted a multifaceted study of an atmospheric long-distance mass (e.g., gas, aerosol) transport feature referred to as "River of Smoke" over southern African sub-continent. River of smoke refers to coherent bands of smoke (from biomass burnings) spanning hundreds of kilometers in width and extending for a few thousands of kilometers. Authors use a set of space-borne, aircraft-based, and ground-based observations in conjunction with global and mesoscale simulations for the period of the Aerosols, Radiation and Clouds in southern Africa (AEROCLO-sA) campaign in September 2017. The study presents a thorough and comprehensive investigation of combined function of tropical temperate troughs (TTTs) and cut-off lows (CoLs) in the formation of the river of smoke. Authors discuss the role of TTTs and CoLs in this context as a novel concept.

The study looks sound, and the paper reads well. I have a few questions and suggestions for possible improvements before publication.

Specific comments:

- This paper investigates a mass transport feature referred to as the river of smoke, thus the title "Smoke in the river" is somewhat misleading. Also, it might be useful to convey the key features of the article, the function of TTTs and CoLs in the formation of the river of smoke, in the title. This might be useful for the searchability of the article, as this is a novel and interesting concept. Further, and to a lesser extent, the use of the acronym AEROCLO-sA in the title can be confusing for the unfamiliar reader. I suggest a possible revision of the title.
- This study makes use of high-resolution (5 km) model simulations with Meso-NH and discusses model output in terms of investigating the atmospheric composition and locating the BBA in accordance with observational data. Given the high-resolution of the model and sharp gradients in BBA on the boundaries of the river of smoke, model transport scheme and local mass conservation can have an impact on the results. It has been shown that the inappropriate choice of mass conservation schemes (e.g., global schemes for local case studies) can result in the erroneous creation/transport of mass locally and the use of local mass conservation schemes (e.g. ILMC) can improve the model performance locally and in the presence of sharp mass/concentration gradients (Sørensen et al., 2013; de Grandpré et al., 2016; Fathi et al., 2021). Please comment on and/or provide reference(s) for the performance of the high-res model setup employed in this study in terms of mass conservation and transport schemes.
- Considering the impacts of transport and distribution of BBA related aerosols and gases (river of smoke) for example "potential important implications for the radiative and the marine productivity of the region" as mentioned in the introduction section of the article, is there value in estimating the aerosol/gas mass-flux using downwind aircraft measurements (Peischl et al.,2010; Gordon et al., 2015; Fathi et al., 2021). Are Dropsonde and Lidar measurement data useful for mass-flux calculations and has this been attempted in the context of AEROCLO-sA? Please comment.
- Line 174: At what horizontal spacing and frequency were the dropsondes released? Any relevant limitations?
- Lines 181-183: Regarding the two flights (F06 and F09), is the choice of flight path important (e.g., counter clockwise, clockwise)? If it is important, please explain why.
- Line 536: Regarding "… thick clouds embedded in the river of smoke", are there any possible interactions with BBA in terms of cloud formation (e.g., nucleation)?
- Lastly, a general comment on article structure. Results and discussions are presented simultaneously in three different sections (3, 4 and 5). It might be useful, in terms of readability, if these were grouped together under a results and discussion section. However, this is just a minor suggestion; the article is clear and easy to follow as is.

Technical corrections:

- Line 24: revise "temperate tropical trough" to "tropical temperate trough (TTT)" to be consistent with the rest of the text.
- Line 65: cite the final published version of Gaetani et al., 2021

- Line 108: TTL or TTT?
- Line 117: acronym ECMWF is not written out in full anywhere in the manuscript
- Line 226: Figure 2, subplot details (e.g., contour labels) are very hard to read (small).
- Line 234: Do you mean Potential Vorticity (PV)?
- Line 258: revise "… area of interest in under …" to "… area of interest is under …"
- Line 271: Do you mean Figure3d?
- Line 274: ~20°W or ~20°E?
- Line 340: Do you mean "west of the continent"?
- Lines 388,396: Figure 9, wrong figure panel labels are used. References to Figure 9 are generally confusing. Figure 9 shows a height-distance cross-section while the text makes time and geographical references (e.g., morning, afternoon, northern part of the flight). It would be useful if flight legs (e.g., north, south, west, east) were labeled on the graph along the distance axis and a few reference timestamps were also provided for the same.
- Line 424: Do you mean Figure S5?
- Line 481: Despite being in the title, there is no mention of TTT in section 5?
- Line 492: Revise to "The time-height cross-section of PV …"
- Line 525: Please provide figure/text reference for "… the airborne lidar measurements in the area of Windpoort."
- Line 529: Please provide figure/text reference for "…, in accordance with the lidar observations"
- Line 571: Figure 15 was never mentioned before this line, it is not common to introduce new figures in the conclusion section.
- Figure 4: End of first line in the caption, do you mean "… at 1200 UTC"?
- Figure 5: Second last line in the caption, do you mean "… geopotential at 300 hPa is a tidal effect…"? The periodic trend is observable in the 300 hPa curve (blue) more prominently!
- Figure 6: Panels don't seem to have labels (a,b,c,d,e)
- Figure 8: Details are hard to read.
- Figure 9: Panel labels don't match the figure caption and the article text.
- Figure 11: Why are wind data missing?
- Figure 13: No panel labels provided?
- Figure 14: No scale is provided for the contours, maybe label the contours!
- Figure S5: Repeated panel labels (a,b) in the right column!
- Line 744: The hyperlink doesn't seem to be valid.

References

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Peischl, J., Ryerson, T. B., Holloway, J. S., Parrish, D. D., Trainer, M., Frost, G. J., Aikin, K. C., Brown, S. S., Dubé, W. P., Stark, H., and Fehsenfeld, F. C.: A top-down analysis of emissions from selected Texas power plants during TexAQS 2000 and 2006, J. Geophys. Res.-Atmos., 115, D16303, https://doi.org/10.1029/2009JD013527, 2010.

Sørensen, B., Kaas, E., and Korsholm, U. S.: A mass-conserving and multi-tracer efficient transport scheme in the online integrated Enviro-HIRLAM model, Geosci. Model Dev., 6, 1029–1042, https://doi.org/10.5194/gmd-6-1029-2013, 2013.