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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Implementing Microscopic Charcoal Particles Into a Global Aerosol-Climate Model" *by* Anina Gilgen et al.

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A very interesting modeling study to incorporate charcoal particles into the aerosol model using relatively modern charcoal accumulation rates. The work may prompt some thought in the Global Charcoal Database community about how charcoal gets transported in a full circulation model and what that may mean for interpreting charcoal accumulation rates relative to burned area. The authors describe the strengths and limits of the modeling approach nicely. I only have minor comments below that aim at clarifying a few points. Otherwise the results and technical implementation are quite useful.

p 2, line 10-11 Great statement, but the awkward sentence needs attention: "Open

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Discussion paper

questions still remain, e.g. regarding the complexity needed for global fire models (Hantson et al., 2016). Especially the anthropogenic influence on fires is difficult to simulate."

p. 2, line 12 Emissions are not calibrated exactly, but rather scaled to modern day. See Van Marle et al 2017 which is probably a paper that should be cited in this paragraph https://www.geosci-model-dev.net/10/3329/2017/

p. 3, lines 4-6 again, the Van Marle et al 2017 GMD paper would be a relevant citation here

p. 3, line 6 This makes it sound like Power and Marlon papers are "circumventing" the problem of comparing with global fire models. Re-word so that it is clear that they are circumventing problems associated with non-standardized data collection methods in the GCD.

p. 3, line 15 Useful citation here may be https://onlinelibrary.wiley.com/doi/full/10.1002/env.2450

p. 8 Radke et al: interesting use of the results from this study!

p. 8, lines 11-18 define the acronymn GFAS here; the text states that ratio of BC to submicron aerosol mass is 10 and that even BC emissions are likely underestimated by another factor of 3.4. Right now, this is confusing to me. I can see scaling up BC mass emissions as a starting point to simulate charcoal mass emissions, and I can see the extra factor of 3.4 or so arising from what may be an underestimate in BC mass emissions, but I cannot make sense of "are comparable to those of submicron particles and thus arrive at a factor of 10 based on the ratios of BC to total submicron particles and to OC". Please check the wording and clarify how SF = 34 is the starting point. Also, please clarify why SF = 40 is not used throughout the paper. For example, at line 18, why not add to the end of the last sentence "and we arrived at SF = 40 after an iterative calibration process."?

p. 9, line 19 change "which is like charcoal an inert and unreactive substance" to "which

is chemically similar to charcoal" (if this is what you are trying to say)

p. 10 section 3.1.4 the section seems overly speculative and distracting given the main goal of the paper. I agree that it might be interesting if micro and macro char were INPs but it seems equally as likely that if charcoal injected above 4 km in figure A1 is rare, then charcoal participating in Bergeron-W-F process is essentially insignificant in the model

p. 10, line 18-19 how could absorption of light leading to convective lifting of 5-10 micron particles? Can this tiny number of giant particles relative to submicron aerosol really have a dramatic impact on thermodynamic profile? Again, I find this distracting in the context of the main point of the paper, and would suggest simply stating that there is very limited study of the possibility of charcoal as INP. or CCN.

p. 11, lines 24-25 define what ACCMIP. stands for, and explain what "calculated online" means since the paper crosses across communities of researchers who may not guess what this model jargon mean

Conclusions: Several researchers in the Global Charcoal Database/Paleofire community published a study echoing some of the ideas in the conclusion that might be a useful citation supporting ideas around, line 10 on p. 15 https://www.sciencedirect.com/science/article/pii/S104061821630831X

Figures 1-5 in the caption, I suggest stating what the threshold radius actually is set to in each caption. Currently this is sometimes done and sometimes not.

Figure 3 is really interesting!

Figures 6-7 Section 3.1.6/Appendix D are a very useful diagnostic filter for subsetting model output to better match charcoal, but while Figs 1-5 and 8 show results filters for sizes greater than the threshold radius, this is not the case for Figure 6-7. Please speculate on roughly what fraction of the modeled burden might be due to the largest sized giant aerosols, and perhaps include this speculation as a part of the figure caption.

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