

Interactive comment on “Estimating CCN number concentrations using aerosol optical properties: Role of particle number size distribution and parameterization” by Yicheng Shen et al.

Anonymous Referee #2

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The paper is on an interesting subject and the parameterization of CCN concentrations by optical parameters can be useful. The data are carefully analyzed and the parameterization is developed step by step, which helps understanding the resulting complicated formula. Overall, I find that this is a paper that is in principle publishable after moderate to major revisions. One reservation I have, is that it is clearly a method paper that can certainly be very useful, but does not have major scientific results (as to e.g., actual CCN in various environments and larger implication), so ACP is in my opinion not the best journal for this. It fits much better in a method-oriented journal. I would strongly suggest to submit it somewhere else. However, in case it is published in ACP the following comments should be addressed:

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Parts of the steps taken could be better motivated and better interpreted (see comments below), which would make the manuscript easier to follow and less technical and dry. Overall I think the length of the paper and the 13! Figures are a bit excessive. Please think of a way to summarize the information in a more compact way.

The writing needs to be improved overall and the English corrected in some places (many formulations are unclear and sometimes grammatically incorrect). While I cannot correct all of these, I will give some examples and the further corrections should not pose a big problem to some the co-authors on this paper.

Specific comments:

- 1) Page 3, line 4: Explain better, why they are not adequate. I assume you mean the spatial coverage? Are optical properties really more widely measured than size distributions? Support this claim!
- 2) Page 3, line 26: Do you mean $N_{\text{CCN}}/\sigma_{\text{sp}}$ instead of $R_{\text{CCN}}/\sigma_{\text{sp}}$? Later you call this ratio $R_{\text{CCN}}/\sigma_{\text{sp}}$ please be consistent.
- 3) Page 8, line 6-9: This paragraph consists of several incomplete, grammatically incorrect sentences and as a result, it is unclear what you are actually doing in this calculation. Please formulate clearly and explain in more detail.
- 4) Page 9, line 5: How well do you think a unimodal size distribution can describe a realistic situation, where size distributions are at least bi-modal? Give some motivation already here for choosing this approach.
- 5) Page 9, line 13: The section is called “Overview of measured properties”, but it does not contain an overview of measured properties, more a quality control. It should be merged with the method section.
- 6) Page 9, line 14-24: This Paragraph seems out of place here. At the beginning of a new section, before the sub-sections, I would expect some general introduction. Instead we get some details of only one station that are neither well explained nor well

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motivated. Please rearrange this section and find a better place for this information (after you clarify it).

7) Page 9, line 19: You do not make clear how you make this fit (e.g., how you determine k) and why it does not fit. Is this relevant for the paper in any way? It well known that an error function gives a much better fit to CCN spectra.

8) Page 9, line 24: From the previous discussion it is not clear, why/how this parameterization involved absorption data. If this paragraph is absolutely necessary, please explain in more detail, otherwise I would suggest to omit this discussion entirely.

9) Page 10, line 13/14: Give an interpretation of this fact and a motivation, why you investigate this dependence.

10) Page 11, line 11/12: Please use the appropriate reduced major axis regression then, instead of a regression that is not suitable for your data

11) Page 12, line 3/4: I am not sure what you mean by “underlying reason”? b_0 is the limiting value for $SS=1$ and the range of SS stays the same. So go from $N_{ccn} \sim 0$ at approx. $SS \sim 0$ to a higher b_0 at $SS \sim 1$, obviously $\ln(SS)$ must be multiplied by a higher b_1 . I would omit the corresponding figure 6.

12) Page 12, line 19: Why? try to give a qualitative interpretation of this fact. . .

13) Page 14, line 13ff (Fig10): I would need a better motivation here, why these piecewise linear fits were tried in the first place – looking at this figure an exponential fit would be much more appropriate and at this point it is not clear what the authors are trying to do here – it gets a bit clearer later on, but a good explanation and motivation here would help. What does the linear approximation represent physically?

14) Page 14, line 16: $CMDe$ has not been clearly defined here at first use – what is a “particle size that is used for describing the size range of each regression”?

15) Page 14, line 27: In line 22 you described the different behavior of slope and offset

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here you say that they vary simultaneously? Please be precise with the language. Also “simultaneously” implies temporal variation, which is not the case here . . .

16) Page 14, line 27/28: “This is the link . . .” What precisely is the link? You discussed several variations in the sentences before, but none of them seem a clear “link” to me.

17) Page 15, line 9-13: This argument is very technical and also in my opinion the linear relationship has nothing to do with dependence on GMD and GSD (see point 12). There are much better, more qualitative arguments, why these coefficients should depend on the size distribution and how – please argue more along those lines.

18) Page 18, line 17/18: Please give an interpretation of this fact.

19) Page 19, line 15/16: What coefficients are you taking about? There are many discussed in the manuscript. Please be more precise with your language throughout the manuscript.

Minor comments:

Page 1, line 27: SAE_{10} and BSF_{min} not defined

Page 2, line 1: supplementary -> replacement (or similar), “supplementary” means supporting or additional; please check for similar mistakes throughout the manuscript, or have it proofread by a native speaker

Page 2, line 4: Do you mean “or” instead of “of”, otherwise this sentence does not make sense to me.

Page 4, line 25: What do you mean by “likewise in Smale . . .”?

Page 5, line 28; “Instrument mentors” is not a valid term, please check manuscript throughout for such wrong use of vocabulary.

Page 6, line 5: coal is also a fuel

Page 6, line 9: is this not a coastal site, rather than marine?

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Page 6, line 9: "emphase" is not a word

Page 6, line 9/10: The sentence is not grammatically correct

Page 16, line 13: is -> are

Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2019-149>, 2019.