

Interactive comment on “The importance of the representation of air pollution emissions for the modeled distribution and radiative effects of black carbon in the Arctic” by Jacob Schacht et al.

Anonymous Referee #3

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The authors present an evaluation of the ability for ECHAM-HAM to reproduce observed BC masses in the Arctic using different emissions datasets. There is large uncertainty in the representation of BC in the Arctic across general circulation models (GCMs) and part of this uncertainty is due to the availability of high-fidelity emissions data. This work aims to quantify that uncertainty and the consequent uncertainty in (surface and TOA) forcing. The authors use a large set of in-situ observations to evaluate the model performance and relate this to the shortcomings of each emissions dataset.

The only major concern I have with the work is in the scaling of the GFAS emissions

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dataset. The original Kaiser et al. 2012 paper suggests a scaling factor of 3.4, but this has been found to be too high in some models and is somewhat arbitrary. The authors don't discuss this scaling factor at all, or what impact it could have on the results. Ideally another simulation with a lower (or no) scaling factor would be performed as a comparison, but the factor used and the resulting uncertainty should at least be discussed in both the technical setup and summary sections. Overall however this is a well written paper appropriate for publication in ACP after this, and the more minor points listed below, have been addressed.

- P1L2: 'positive effect' is a bit ambiguous, perhaps use 'positive (warming) effect'
- P2L12: 'conclusion, that' -> 'conclusion that'
- P3L3-4: 'are contributing' -> 'contribute'
- P4L7-8: This sentence is a quite difficult to understand. I believe only dust can be in the insoluble coarse and accumulation mode, but can also be in the soluble modes along with the other species. Perhaps include a table if that makes it clearer?
- P5L28-29: The claim that models still use ACCMIP 2000 emissions routinely should have a citation, e.g. Sand et al 2017.
- P7L9-10: This will include BC semi-direct effects then though. Perhaps make this clear and say something about the uncertainty this may introduce.
- Figure 2b: Axis label should read '60-90 N'
- P7L29-31: The MAC value of 9.8 m² g⁻¹ quoted from Zanatta et al. 2018 comes with a relatively large uncertainty (+/- 1.68), what uncertainty does this introduce into the BC concentration estimates? It should be discussed at least.
- P8L16: 'layering' -> 'vertical distribution'
- P8L16: This should probably be backed with a citation (e.g. Samset et al. 2013)

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- P9L9: Typo in the 60 degrees Latex
- Fig 6: It's very hard to discern these small values, would a log scale be appropriate? The plots could perhaps also be made a bit bigger.
- P9L11: Avoid use of the colloquialism 'decent'. Perhaps 'sufficient'?
- P9L12: I would like to see a discussion here about the uncertainties introduced when comparing the in-situ aircraft measurements with a fairly coarse resolution global model (see e.g. Schutgens et al. 2016) and how this might affect your conclusions. Of particular relevance is Lund et al. 2018 who show that using monthly mean model output in comparison with aircraft BC measurements (and similar campaigns) can introduce significant biases.
- P11L6: '...atmosphere for reasonable...' -> '...atmosphere and hence reasonable...'
- P13L9-10: Could you hypothesise why this might be the case?
- Fig 9: This is a really nice diagram but it could definitely be bigger to make it clearer. The interpretation might also be easier if the correlation was indicated with a continuous color scale.
- P14L5-7: Be careful with the interpretation of these ARCTAS flights since they specifically went looking for plumes to sample and so you would expect a large sampling bias. This is implicit in some of the statements of Jacob et al. 2010.
- P16L3: This could also be due to an underestimation in removal as you've pointed out previously for other biases.
- P17L5: It's worth reiterating that this is an uncertainty due to emissions and doesn't account for the potentially large uncertainties due to removal.
- P18L5: "...by the model, the run..." -> "...by the model, but the run..."
- P18L24: I agree that wet removal seems a plausible cause for this bias, however

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recent work with the same model (Lund et al. 2018) shows that it actually produces as good BC lifetime for the Arctic campaigns studied there so perhaps there are still transport issues.

- P18L31: "layering" -> "vertical distribution"
- P18L32: I can't see any comparison with the Aerocom average in the paper, this should be presented in the results or removed from the conclusion.

References

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