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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Current model capabilities for simulating black carbon and sulfate concentrations in the Arctic atmosphere: a multi-model evaluation using a comprehensive measurement data set" *by* S. Eckhardt et al.

Anonymous Referee #1

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The manuscript examines eleven-model simulations of sulfate and black carbon (BC) concentrations in the Arctic over a time period of two years (2008-2009), compared with both ground-based measurements and aircraft measurements. The seasonality in the simulated Arctic aerosol concentrations is underestimated in the multi-model means, with lower concentrations of BC and sulfate predicted for the late winter and spring and higher concentrations for the summer than the observations. Local BC and biomass burning sources are indicated as possible reasons for the model-data discrepancies. Most of the models also do not capture the strong correlation between observed sul-

fate and BC concentrations. This is an extensive model evaluation of BC and sulfate aerosols simulated by different model framework including several chemical transport models (CTMs) and chemistry climate models (CCMs). It provides the updated information about the aerosol model performance for the Arctic region, and is suitable for publishing in the ACP.

Several specific comments are suggested below:

1. The definition of different model types is a little bit confusing and needs to be more consistent. When the CTMs and CCMs are first introduced in the introduction, it would help to clarify the differences between these two model types and their different applications so the motivation of examining the mix of these models is clear. Next in the description of "models", two other model types: LPDM and ACM, are introduced without any explanation. How does an ACM differ from a CCM? CanAM4.2 is considered as an ACM in Table 1, but a CCM in section 2.3. Also, WRF-Chem is a regional climate model coupled with a chemistry module; technically, it is not a CTM, which refers to chemistry models driven by meteorology fields with no feedback.

2. Aerosol emissions are important for understanding the simulations of concentrations and seasonal variations. Unfortunately, the two emission papers that this paper refers to, Klimont et al. 2015 a and b, are neither published yet, nor available anywhere. In this case, the authors need to give more detail about the emissions used, such as temporal resolution of other main sectors in addition to domestic heating; are the pan-Arctic BC and SO2 emissions used in this study comparable to previous studies? Especially if underestimations of biomass burning emissions and missing Russian BC sources are suggested responsible for comparison with obs, how do the biomass burning and anthropogenic BC emissions used compare with other emission data sets in literature?

3. The conclusions of the paper could be significantly elevated, if the authors can provide more discussions and insights regarding the model-data and model-model discrepancies. For example, CanAM4.2 performs much better than any of other models

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especially for sulfate concentrations and surface aerosol. What is so unique about this model? The third conclusion seems to allude that internally mixing leads to similar removal of BC and sulfate, so are those three models that simulate the correlation between BC and sulfate better all assuming internally mixing while others not?

Some minor comments:

1. Page 10428, line 15: “eBC/rBC” reads like the ratio of eBC over rBC. Suggest to change to eBC or rBC

2. Page 10428, line 16: “previous comparisons”

3. Page 10431, line 5: sulfate originates from sea salt over the oceans? Nss-SO4 is a form of sulfate aerosol but not a source.

4. Page 10436, line 3: Klimont et al., (2015 a and b) not available. Need to give more information. See main comment above.

5. Page 10436, line 22: is the nudging in WRF-Chem applied to all the vertical levels? How frequent?

6. Page 10436, line 27: insert a “including” after “CCMs”

7. Page 10441, line 24: “data the comparison”?

8. Page 10442, line 6: references needed for “and in most other global emission inventories”

9. Page 10443, line 22: “focused”

10. Table 1: what is the simulated model domain for each model?

11. Table 2 caption : Change to “Median values of observed. . .”; insert “at surface” after “mass concentrations”

12. Figure 5: replace “eBC/EC” with “eBC or EC”

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13. Figure 6. The light red shaded areas are not visible in the figure – at least not in my printed copy

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