Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2018-65-RC1, 2018

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Source Sector and Region Contributions to Black Carbon and $PM_{2.5}$ in the Arctic" *by* Negin Sobhani et al.

Anonymous Referee #1

Received and published: 14 March 2018

This study quantifies the contributions of different emission regions and sectors to Arctic Black Carbon (BC) and PM2.5 concentrations using a chemistry transport model. First, the authors evaluate their model to the ARCTAS flight campaign and two stations in the Arctic. Then, by using a sensitivity analysis they identify the main sectors contributing to Arctic PM2.5 (the power, industrial and biomass burning sector), and the largest contributors to BC surface concentrations (the residual and transport sector). Further, they look at the seasonal cycle and emissions from Europe and China in particular.

The study is well-written and concise and the figures are clear and easy to understand. I really appreciate the seasonal focus in this study. I recommend this manuscript for publication after some clarifications, more details given below.

1. Methods:

- Emissions. Can you please add a paragraph describing the emission dataset in more detail instead of just referring to Kulkarni et al. 2015? E.g. can you explain the different sectors? I like the plots of the data showing the geographical distribution (Fig 1), but could you also say something about the seasonal cycle? Do all sectors have a seasonal cycle? How is this calculated? E.g. is there a correlation with outdoor temperature in the residual sector? Is the seasonal cycle the same every year except for biomass burning? Could you say something about the uncertainties in the emissions?

- STEM model coupled to WRF. Could you also add a paragraph describing this model? Are there any known biases?

- How is the model setup regarding the sensitivity analysis? How did you perform the experiments? Simulation period? Please add a paragraph describing this as well.

2. Figures:

In general, I think the captions could contain more information about the data shown (and what the boxes, lines etc. represent).

FIG3: I suggest moving figure 3 to the Supplementary.

FIG4: Could you add more text in the manuscript on Figure 4? What does the boxes represent? Is it each flight averaged over the column? Maybe you could replace this figure with SM3, which is easier to read I think. Or is your point here to show the flight by flight variation?

FIG5: Again, can you explain what the boxes and whiskers represent? The model, as you say, is biased high at higher altitudes. This is common for many models. Could you maybe speculate a little on the reasons for why your model overestimate BC at high altitude, as you do for SO4?

FIG6: Impressive seasonal cycle in the model. Not many models have such a distinct

seasonal cycle. To be clear: in the data at Barrow used here the BB contributions were removed, right?

FIG7: Could you make the dots representing the IMPROVE observations larger? It is a bit hard to spot them. In the text you say that this is 'annual mean', but the simulation period is April 2008 to July 2009. How did you average the data? Over the whole period? Is 0.16 ug/m3 averaged over the entire US in the model? If so, is that number very different by just averaging the grid boxes containing stations? Are the IMPROVE monthly or daily data? How did you compare missing data etc?

FIG8: The caption says 'Dust' for the 'SO4' plot. Again, you say in the text that this is annual average, but in the caption that this is an average over the simulation period?

FIG10: OPM2.5? This is the first time we see OC, and it is not mentioned in the text.

FIG14: The row with the Dust plot seems a bit out-of-place here. At least change the 'Base' to BC in the first row and have the same color scale as dust? Is this fine-mode dust as in FIG10?

3. Conclusions:

Last paragraph: Could you be a bit more specific here? I miss a discussion on the uncertainties in the emission inventories, observations and the data you have used, but that can be written elsewhere e.g. in the Methods section. You highlight high-resolution modeling; why would high resolution modeling studies be the most necessary to reduce the uncertainties in the future? Do your conclusions fit well with what other studies have shown? What are the implications of your study?

Minor:

Page 2, L8: With 'albedo reduction' do you mean the general warmer temperatures → sea-ice is melting → more open water, or the albedo reduction caused by BC deposition only? If the latter, as it is written now it seems like the largest feedback in the Arctic causing the doubling of temperature increase is caused by BC.

Page 4: L1: You say here that you studied organic carbon? As far as I can see, there is no mentioning of OC except that it is included in the bottom panel of FIG10. And what about dust?

Page 9, L21-23: Where is this shown? Can you point us to a figure?

Page 9, L24: What is the average in the Arctic region? You compare your range to Sharma et al 2013; can you add a sentence about what this number (0.06 ug/m3) represents (e.g. all surface stations?)?

Page 9, L28: Can you add chapter reference for IPCC instead of just the whole report?

Page 10, L10: Can you add why ($\sim$ the natural sources are larger in size)?

Page 10, L18: 'global warming' or you only mean (local) warming over the Arctic?

Page 11, L1: Could you add numbers?

Page 12, L25. Move or remove the parenthesis

Page 15: L4: I guess you refer to 14-l (not 14-i)

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2018-65, 2018.