Atmos. Chem. Phys. Discuss.,
doi:10.5194/acp-2016-1112-RC2, 2017

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Sources of Springtime Surface Black Carbon in the Arctic: An Adjoint Analysis" *by* Ling Qi et al.

Anonymous Referee #3

Received and published: 28 March 2017

Qi et al. quantify black carbon (BC) emission sources at 5 stations in the Arctic during April 2008 using a global CTM; GEOS-Chem and the adjoint technique. The authors use a tagged tracer technique to identify the sources, and compare the contributions with observations at the sites. A 5-day pollution episode is investigated further by computing source-receptor sensitivities at finer resolution with adjoint modeling approach. They find that the largest sources during April 2008 are anthropogenic emissions from Asia and biomass burning emissions from Siberia.

Arctic bC burdens is mostly a result of long-range transport, and determining the emissions source regions is challenging. This study is therefore an important contribution to the field and within the scope of ACP. The Introduction chapter is well-written with a great overview of related work, and the authors clearly indicate their own contribution describing the GEOS-Chem adjoint approach. The overall presentation is well-

structured and easy to follow. I will highly recommend this manuscript for publication and I have a few comments, questions, and suggestions for improvements below.

1. The validity of your results depends on the emission data set. Can you please add more information about the emissions? What are the global numbers of the Bond et al. (2007) emissions combined with the Asian emissions from Zhang Q. et al. (2009)? Can you also give the total emissions from each region (those numbers can be added to Table 1)? On page 5 in Line 20 you state that Stohl et al suggests that gas flaring only accounts for 3 % of global emissions, but 42 % of the within-Arctic. Can't you report on your own emissions numbers here? Do you use ECLIPSE (v5?) emissions for the gas flaring?

2. As you state in the introduction, many studies based on analysis of observation data, attribute Arctic BC to biomass burning and anthropogenic sources in high-latitude Eurasia (e.g., Eleftheriadis et al., 2009; Hirdman et al., 2010; Matsui et al., 2011). Compared to observation-based analysis in the Arctic, models, including yours, tend to give larger contributions to sources at lower latitudes, especially for the total column burden of Arctic BC. However, models often have too course resolution to correctly simulate the Arctic front and the shallow boundary layer. Could you please add some discussion of uncertainty in simulating the transport in GEOS-Chem?

3. You compare your results nicely with other findings throughout the Results section. Could you also add a paragraph in your Conclusions with a summary of the comparison of your findings with previous studies to wrap things up? -If possible, why they differ (e.g. the 5-10 day trajectory used in other studies that you mention in the intro), and how your study contribute to greater knowledge of BC source attribution in the Arctic?

4. You report a long BC lifetime from Asian BB emissions. How realistic do you think this number is? As far as I am aware, this is considerably higher than other studies.

5. I suggest that you add 'April 2008' in your title, as readers might assume you have analyzed several years/months (as I did). Related to this; can you add some discussion

if April 2008 is representative of 'springtime'? E.g. the biomass burning plume late April 2008 was unusually strong (Warneke et al. 2010).

P5 L5: What are the lowest model levels listed related to?

P10 L28: In –> within?

P15 L11: What about the 3 other stations? You have already showed that the model overestimate the BC concentrations at Zeppelin and Summit? Is there a better agreement without WBF?

P15 L27: , after Zeppelin) .. add ' and,'

P16 L8: altitudes –> latitudes?

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-1112, 2017.