Atmos. Chem. Phys. Discuss., 12, C3099–C3102, 2012
www.atmos-chem-phys-discuss.net/12/C3099/2012/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Investigation of source attributions of pollution to the Western Arctic during the NASA ARCTAS field campaign" *by* H. Bian et al.

Anonymous Referee #2

Received and published: 29 May 2012

This paper describes the modeling of CO, black carbon (BC) and SO2/SO4 in the western Arctic during the ARCTAS campaigns using the GEOS-5 model. The main goal of this modeling effort is to determine the source attributions of pollution in the Arctic using tagged CO species for different source regions and types. In general the paper is well written and provides an important contribution to pollution modeling in the Arctic, but it lacks specifics and originality and major and minor comments are listed for needed additions and improvements.

Major Comments:

- The authors state in various places such as the introduction and conclusion that the

measurements during ARCTAS are not representative for the Arctic, especially during July. Aircraft campaigns are not designed to be "representative" for specific regions by just simply averaging along the flight track. Especially during ARCTAS-B one of the major goals was to characterize boreal forest fire emissions and chemistry and therefore fire plumes were specifically targeted and clearly represent a larger fraction of the sampled air masses than the Arctic average. With a more careful analysis than just averaging along the flight track "representative" conditions can surly be found during the aircraft campaign. I suggest removing this as one major conclusion of the paper or at least add the above caveat to the manuscript.

- I think the main problem with this paper is that all the source attribution is done using CO only. This has in principle been done for ARCTAS previously (Fisher et al 2010). It has been shown that for the more climate relevant and shorter-lived species BC the source attribution might be quite different from CO (Warneke et al 2010). BC has been modeled in this study as well although not as tagged species. I assume that a complete source attribution is therefore not feasible, but it might be possible to use correlations of BC with the tagged CO tracers to estimate a source attribution.

- A much more detailed model-measurements comparison for BC, SO2, and SO4 is also missing. A comparison is only done qualitatively for the two case studies and those two do not look very encouraging. Altitude profiles and correlation plots similar to CO should be given and main reasons for discrepancies need to be discussed with focus on the BC loss processes during the transport and the possible underestimate due to the emission inventories.

- I would also like to see a more detailed description of the used emission inventories, which are given as one of the main reasons for model-measurement discrepancies. Especially the biomass burning inventory should be discussed and compared to previously used inventories for other modeling efforts such as GEOS-Chem and FLEXPART.

- Two case studies are discussed in the paper, but I do not find the second one a good

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representative example for the ARCTAS campaigns. First of all both examples are from the July campaign and none from April and secondly the second case study is a transfer flight and includes lots of pollution from California, which was not the focus of the ARCTAS campaigns. I think it should be possible to find a good flight from ARCTAS-A that shows typical Arctic background air and ASFF and BOBB plumes.

- page 8835 line 18 - page 8836 line 6: For me this is the paragraph that contains the most interesting results, but it completely lacks any real discussion. It seems from Figures 3 and 4 that GEOS-5 significantly over predicts BC in clean Arctic background air. Is this because of to slow removal or over-prediction of the emission inventories? Is this also observed in April? What are the possible implications of this for climate modeling? The SO2/SO4 ratio is basically not discussed at all. The SO2 in Figure 4 does not seem to agree very well. Again, is that emission, chemistry or transport? What is also not discussed is, what this means for the modeling presented here.

- Various tracers, such as acetonitrile for biomass burning, were measured during ARCTAS. How does acetonitrile compare to BOBB? How does SO2 compare to ASFF? Other halocarbons or CFCs could be used as well for Asian pollution.

Minor Comments:

- Abstract: please define what is used for western Arctic.

- Chapters 3.1. and 3.2.2: These chapters seem to belong together since they both discuss the model-measurement comparison. I would re-organize the paper with: 1: comparison, 2: case studies and 3: source attribution.

- page 8834 line 18ff: The first part of this flight samples what I would call Arctic background air and the authors call it clean, so I would not describe the source regions here.

- page 8834 line 23ff: These two sentences are a repeat of what was said before and should be deleted.

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- page 8835 line 6-17: A description what BC/CO and SO2/SO4 are used for in this chapter should be moved to the introduction.

- page 8836 line 20: What are the slopes and correlation coefficients for individual flights? The slope in Figure 5 of 0.79 is pretty encouraging, but looking at Figure 5 it seems that individual flights are clearly not as good. I think at least a range of the slopes should be given, but preferably every flight should be given.

- page 8837 line 14: While this statement seems true for total CO, is this also the case for the tagged CO species and also for BC and SO2?

- Figures: All the Figures in the original manuscript are too small. In the supplement the Figures have about the right size.

- Figure 3 and 4: The color scales should be labeled.

- Figure 6: Label for the green trace is missing.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 8823, 2012.