

Interactive comment on “A multi-model assessment of pollution transport to the Arctic” by et al.

et al.

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We thank both reviewers for their detailed and constructive comments on our paper. We have revised the paper attempting to take into account all the comments raised by both reviewers. We apologize for the delay due to the time required to perform the requested additional analysis and comparisons with observations, to update the prescribed lifetime tracer results, and to allow the many co-authors time to look over the revisions.

Reviewer 1

Abstract, line 8: The sentence in the abstract about Asian emissions becoming more important with altitude referred to East Asian emissions. This is now stated, and we thank the reviewer for asking us to clarify this.

Abstract, line 18: We agree that the suggested wording is more appropriate, and have revised accordingly.

Abstract, lines 19-26: The summary for ozone and CO was somewhat confusing, as the reviewer indicated. We've revised this to clarify that the primary uncertainties depend upon both source region and altitude examined. We've also added that for ozone, not only photochemistry is important, but in the mid-troposphere transport plays a large role.

Emissions: As suggested, we've looked into the link between the model biases in the Arctic and the inventory used. Even for those cases where emissions appear to play a substantial role in the uncertainty in the Arctic response, emissions are poorly correlated with model biases, which is now discussed for CO and sulfate in section 4. This may be because emissions play a large role in uncertainties only for some regions, so when comparing with observations using model simulations incorporating emissions from the whole globe the regional sensitivity to emissions doesn't show up clearly. Given the lack of a clear role for emissions in Arctic model biases, we've chosen not to add details about the emissions in a table, but instead have added explicit values (global or regional, as appropriate) to section 4.

P8392, lines 15-17: This is a good point, and we've corrected these lines, which now state that the spread of results is typically similar to that seen at lower levels.

P8392, lines 23-24: The question of how the diversity of model results in the Arctic compares with that exhibited in other regions is an interesting one. To address these, we examined other equally sized regions, choosing one in a polluted area (the US) and one in a remote area (the tropical Pacific). It turns out that the other areas also show a very large range of results across models. For CO the models are slightly closer, but only marginally so, while for sulfate they are at least as divergent in other areas as in the Arctic. These results have been summarized at the end of this paragraph (1st of section 2.2) in our revisions.

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Figure 7: We've made the grey lines sharper, hopefully making it easier to count up models that behave in a particular way (there were too many to use different colors or line styles and keep the plot readable).

Comparison with measurements: We had tried to find Alert or Barrow sulfate, but these are not in the data networks we had access to. We thank the reviewer for urging us to try harder, and we have now obtained Alert sulfate data which is substituted for Denali in the revised Figure 7. The model comparisons with Alert observations are comparably poor to those at Spitsbergen (or Denali).

P8400, lines 17ff: Given the equally large diversity of model results in other locations (see reply to P8392, lines 23-24 comment above), it seems the models'; inability to capture the observed sulfate is not unique to the Arctic. Since we found large diversities over the US, where emissions are relatively well-known, and since the model-to-model sulfate concentrations vary much more than the model-to-model emissions, we believe the cause of the model/measurement discrepancies is largely different representations of aerosol processing and removal. A comment to this effect has been added to the text.

P8401, line 14: We agree, and have revised as suggested.

P8406, line 25: The suggested phrasing is better, and we have revised throughout the paper.

P8408, lines 13-14: We do not mean to imply that increased resolution would not improve models or reduce diversity. Our statement reflects the current situation, where uncertainties in processes such as aerosol processing, removal, and photochemistry are so large that they overwhelm any obvious effect of resolution on the diversity of model simulations of these trace species. Higher resolution of course allows for a more realistic simulation (but it does not guarantee it).

P8413, lines 10-11: We've tried to clarify what we meant by better observations. The

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obvious thing that would be useful would be more data, so we've changed the word better to additional. The problems seem to be largely on the modeling side, yet it would be helpful to have more than just a couple data points in the Arctic against which to evaluate the models. We also identify the species, and note that a better understanding of the mass absorption efficiency of aerosols would help us to be confident that we're evaluating the models fairly against actual BC mass.

P8400, line 17; P8403, line 18; P8404, line 7: These three words were corrected.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 8385, 2008.

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