Atmos. Chem. Phys. Discuss., 8, S3683–S3686, 2008
www.atmos-chem-phys-discuss.net/8/S3683/2008/

Atmospheric Chemistry and Physics Discussions

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

Anonymous Referee #1

Received and published: 13 June 2008

The paper examines the response of Arctic gas and aerosol concentrations to changes in pollutant emissions from four source regions using a multi-model intercomparison. The use of up to 17 different models makes for a more rigorous and interesting analysis. Although the results from the models varied greatly, intermodel differences were systematic allowing for general conclusions to be made about the relative importance of source regions as a function of altitude and season. The overall picture that is presented of the impact of different source regions on Arctic pollution is highly informative and confirms what earlier studies have shown (e.g., Stohl, 2006; Klonecki et al., 2003). In addition, a comparison of modeled to measured concentrations is presented indicating how much work is yet to be done in improving modeled transport of pollutants to the Arctic. The paper should be published in ACP after considering the comments

below.

Abstract, line 8: "but Asian emissions become progressively more important with altitude". Are these East or South Asian emissions or both?

Abstract, line 18: It is stated that "Comparison of aerosol with observations indicates problems in either the models or interpretation of the measurements". I suggest changing this to "Comparison of modeled aerosol concentrations with observations indicates problems in the models and, perhaps, interpretation of the measurements". Since, in many cases, the models are unable to capture the seasonal cycle that is observed in sulfate and BC, there are obviously problems with the models.

Abstract, lines 19 to 26: It is stated that, for gas pollutants such as CO and O3, the processes contributing most to the uncertainties depend on source region. Yet the last sentence says that differences in photochemistry play the largest role in intermodel variations in ozone sensitivity.

Emissions: According to Section 2 of the paper, all models used different base case anthropogenic emissions. It is acknowledged that, in many cases, emission inventories contributed to model diversity. It seems that identifying which inventories were used by each model would aid in assessing and improving those inventories; especially in cases where results from a particular model were far off of the mean and emissions made an appreciable contribution to the overall uncertainty.

p. 8392, line 15 to 17: It is stated that models tend to show comparable sensitivities for East Asian, European and North American emissions but usually with a larger spread of results than at other levels. This latter point is not obvious from Figure 2 given the different y-axis scales. For the 250 hPa level, summer sensitivities to European emissions range from 0.08 to 0.13 while winter sensitivities to European emissions range from 0.23 to 0.43.

p. 8392, lines 23 to 24: The extremely large model diversity in the Arctic is mentioned.

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Would it be possible to compare the model diversity in the Arctic to that of other regions so that the reader has a full appreciation for our current ability to model the Arctic?

Figure 7: This figure would be clearer if lines depicting the different models were distinct. For example, it is hard to tell how many models capture the seasonal cycle in sulfate at Spitsbergen since all models are shown in the same gray.

Comparison with observations: There are long time series sulfate data available from Alert (1980 to present) and Barrow (1997 to present). These data sets also include sodium which allows for the calculation of non-sea salt sulfate. These data are more appropriate for comparing Arctic concentrations of sulfate than the Denali data.

p. 8400, lines 17ff: More discussion is required for the model-measurement comparisons since this is the true test of model performance. Why is the agreement for sulfate so poor that many models are not even able to capture the seasonal cycle? Is this due to inaccurate emission inventories or to aerosol processing and removal parameterizations in the models? Is this situation unique for the Arctic? If so, why?

p. 8401, line 14: Should be changed to "...though a substantial underestimate in the models is likely". Modeled concentrations appear to be lower than measured by up to a factor of 10 in Figure 7. It is unlikely that the mass absorption efficiency used by Sharma et al. (2006) is high by a factor of 10 given that it is based on seasonal measurements of absorption and thermally-measured BC. In addition, absorption by OC in the mid-visible should not make a significant contribution to the overall absorption by the aerosol.

p. 8406, line 25: I would not define oxidation of SO2 as large scale aerosols physics. It would be more accurate to phrase this as "variations in large scale physical and chemical processing of aerosol sulfate (removal of sulfate, oxidation of SO2, etc.)". This phrasing should be changed throughout the paper.

p. 8408, lines 13 to 14: Is this saying that increasing resolution would not improve

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model performance and/or decrease model diversity?

p. 8408, line 22: Again, change the phrasing to reflect both physical and chemical processes.

p. 8413, lines 10 to 11: Please be more specific about what you mean by "better measurements of Arctic aerosols". What species? What locations? Long term measurements?

p. 8400, line 17: should be "evaluate"

p. 8403, line 18: should be "intermodel"

p. 8404, line 7: should be "intermodel"

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