Atmospheric Chemistry and Physics
An Interactive Open Access Journal of the European Geosciences Union

Atmos. Chem. Phys., 8, 5353-5372, 2008
www.atmos-chem-phys.net/8/5353/2008/

A multi-model assessment of pollution transport to the Arctic

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Abstract. We examine the response of Arctic gas and aerosol concentrations to perturbations in pollutant emissions from Europe, East and South Asia, and North America using results from a coordinated model intercomparison. These sensitivities to regional emissions (mixing ratio change per unit emission) vary widely across models and species. Intermodel differences are systematic, however, so that the relative importance of different regions is robust. North America contributes the most to Arctic ozone pollution. For aerosols and CO, European emissions dominate at the Arctic surface but East Asian emissions become progressively more important with altitude, and are dominant in the upper

troposphere. Sensitivities show strong seasonality: surface sensitivities typically maximize during boreal winter for European and during spring for East Asian and North American emissions. Mid-tropospheric sensitivities, however, nearly always maximize during spring or summer for all regions. Deposition of black carbon (BC) onto Greenland is most sensitive to North American emissions. North America and Europe each contribute ~40% of total BC deposition to Greenland, with ~20% from East Asia. Elsewhere in the Arctic, both sensitivity and total BC deposition are dominated by European emissions. Model diversity for aerosols is especially large, resulting primarily from differences in aerosol physical and chemical processing (including removal). Comparison of modeled aerosol concentrations with observations indicates problems in the models, and perhaps, interpretation of the measurements. For gas phase pollutants such as CO and O_3, which are relatively well-simulated, the processes contributing most to uncertainties depend on the source region and altitude examined. Uncertainties in the Arctic surface CO response to emissions perturbations are dominated by emissions for East Asian sources, while uncertainties in transport, emissions, and oxidation are comparable for European and North American sources. At higher levels, model-to-model variations in transport and oxidation are most important. Differences in photochemistry appear to play the largest role in the intermodel variations in Arctic ozone sensitivity, though transport also contributes substantially in the mid-troposphere.

Final Revised Paper (PDF, 1906 KB) Discussion Paper (ACPD)

Citation: Shindell, D. T., Chin, M., Dentener, F., Doherty, R. M., Faluvegi, G., Fiore, A. M., Hess, P., Koch, D. M., MacKenzie, I. A., Sanderson, M. G., Schultz, M. G., Schulz, M., Stevenson, D. S., Teich, H., Textor, C., Wild, O., Bergmann, D. J., Bey, I., Bian, H., Cuvelier, C., Duncan, B. N., Folberth, G., Horowitz, L. W., Jonson, J., Kaminski, J. W., Marmer, E., Park, R., Pringle, K. J., Schroeder, S., Szopa, S., Takemura, T., Zeng, G., Keating, T. J., and Zuber, A.: A multi-model assessment of pollution transport to the Arctic, Atmos. Chem. Phys., 8, 5353-5372, 2008. Bibtex EndNote Reference Manager