Atmos. Chem. Phys. Discuss., 12, C5309–C5311, 2012
www.atmos-chem-phys-discuss.net/12/C5309/2012/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Global simulations of nitrate and ammonium aerosols and their radiative effects" *by* L. Xu and J. E. Penner

L. Xu and J. E. Penner

lixum@umich.edu

Received and published: 2 August 2012

Short comment by R. Makkonen: The manuscript by Xu and Penner studies the climate forcings of nitrate and ammonium aerosols. There exists only a few studies on the direct effects of nitrate aerosols, and even fewer studies on their indirect effects. The manuscript shows that the anthropogenic nitrate forcing via direct and indirect effects can be of similar magnitude. The study by Xu and Penner explores important aspects of the global nitrate aerosol system. The last sentence mentions that the manuscript provides the first estimate of the anthropogenic indirect forcing of nitric acid gas. While this is true for the anthropogenic part, Makkonen et al. (2012) have quantified the indirect effect of the nitric acid gas. While the methods and focus behind the two manuscripts are somewhat different, there is room for comparison and some discussion. Xu and

Penner (2012) addresses both direct and indirect effects of nitrate, while Makkonen et al. (2012) focuses on the 1st and total indirect effect of nitric acid gas. Xu and Penner (2012) presents results from preindustrial and present-day simulations, while Makkonen et al. (2012) simulate presentday and future conditions. Finally, the two studies differ on the simulation setup and how the indirect effects are quantified. The method for calculating the effect of gaseous nitric acid on cloud activation is different in the two studies. Xu and Penner (2012) apply the substitution method by Chen (2006), where available gas-phase nitric acid is distributed to fine-mode aerosol and cloud droplet activation is calculated after this redistribution. Makkonen et al. (2012) apply a parameterization by Romakkaniemi et al. (2005). The parameterization calculates the effect of nitric acid on activation based on temperature, pressure, updraft velocity, aerosol size distribution and the activated fraction (calculated with Abdul-Razzak and Ghan (2000)). The diverse methods used in the two manuscripts, Xu and Penner (2012) and Makkonen et al. (2012), provide the first quantifications of the indirect effect of nitric acid and explore the related uncertainties. To help the reader in putting the results into context, I suggest adding the related references (Makkonen et al. (2012), Romakkaniemi et al. (2005)) to the manuscript. If possible, comparison of Chen (2006) and Romakkaniemi et al. (2005) would be helpful, at least with a sentence or two.

Reply: We are grateful for this short comment from R.Makkonen and the discussion of the importance of the present work as well as the discrepancy between their studies and ours. We will add the reference to (Makkonen et al., 2012) and Romakkaniemi et al. (2005) as well as the following discussion in the revised paper.

“Compared with one peer study, our present-day indirect effect of total nitrate and ammonium is only half of that estimated for the present-day indirect effect of nitric acid gas (i.e. -0.23 W m-2 in the present study and -0.46 W m-2 by Makkonen et al., 2012). This large difference could result from not only the different parameterizations of nitric acid gas on aerosol activation but also the simulated nitric acid mass concentrations that can differ significantly between different atmospheric chemistry and transport models.

ACPD

12, C5309–C5311, 2012

Although HNO3 variations might be smaller or larger than those for NO2, it has been documented that there is a factor of two or larger variation in the calculation of tropospheric NO2 column densities for different regions in different models (i.e., Eastern U.S., Europe, East Asia, Africa, South America) (van Noije et al., 2006). Since the study of Makkonen et al. (2012) did not provide a global budget and burden of nitric acid gas, we can not precisely understand the cause of the model differences at this stage."

Reference: van Noije, T. P. C., Eskes, H. J., Dentener, F. J., Stevenson, D. S., Ellingsen, K., Schultz, M. G., Wild, O., Amann, M., Atherton, C. S., Bergmann, D. J., Bey, I., Boersma, K. F., Butler, T., Cofala, J., Drevet, J., Fiore, A. M., Gauss, M., Hauglustaine, D. A., Horowitz, L. W., Isaksen, I. S. A., Krol, M. C., Lamarque, J.-F., Lawrence, M. G., Martin, R. V., Montanaro, V., Müller, J.-F., Pitari, G., Prather, M. J., Pyle, J. A., Richter, A., Rodriguez, J. M., Savage, N. H., Strahan, S. E., Sudo, K., Szopa, S., and van Roozendael, M.: Multi-model ensemble simulations of tropospheric NO2 compared with GOME retrievals for the year 2000, Atmos. Chem. Phys., 6, 2943-2979, doi:10.5194/acp-6-2943-2006, 2006.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 10115, 2012.