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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Evaluating Secondary Inorganic Aerosols in 3-Dimensions" *by* K. Mezuman et al.

Anonymous Referee #1

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General comments

The authors reported a comprehensive comparison of secondary inorganic aerosols between the model results and measurements. The sensitivities to aerosol configurations and agricultural ammonia emissions were explored. The results shown in this paper are interesting. However, the treatment of the NH3/NH4 partitioning is too simplified in the model, and more advanced techniques have been applied in global models. Even though the authors confirm that the heterogeneous chemistry on dust is important sink for nitric acid, this is ignored for the simulations with the microphysical scheme. Consequently, the simulations with the microphysical scheme worsen the agreement of nitric acid. I think that the paper needs substantial work to be published in ACP.

Specific comments

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Discussion paper

p.1, l.19:

The higher mass concentration of sulfate with the microphysical scheme improved the agreement in summer when underestimated, but not in winter. It is not clear whether this scheme can improve mass concentration of sulfate significantly. Please clarify if the improvement is statistically significant.

p.1., l.24:

Why do you ignore the heterogeneous chemistry on dust with the microphysical scheme, even though this is important sink for nitric acid?

p.l., l.25:

The model overestimated ammonia concentration. Please rephrase this (see comment on p.16, l.338).

2.1 Model description

p.4, l.81:

Please explain the correction clearly.

p.4, l.88:

In Bauer et al. (2007), the heterogeneous uptake is taken place on the four size bins. Please describe the five size bins and the reason of the changes.

3. Results and discussion

p.10, l.213:

Please explain how the changes in size distribution of sulfate lead to longer lifetime of sulfate. Please also explain why the changes in solubility do not matter.

P.11, l.235:

How is the existence of smaller particles with longer lifetimes related to more pro-

nounced peak in summer? In other words, how do you explain lower sulfate with the microphysical scheme in winter?

p.14, l.302:

Shindell et al. (2006) discussed the nitric acid simulations performed with and without the inclusion of heterogeneous chemistry on dust, and for a run without the use of the liquid tracer budget. They also noted, "The model's stratosphere-troposphere exchange (STE) agrees well with values inferred from observations for both the global mean flux and the ratio of Northern (NH) to Southern Hemisphere (SH) downward fluxes". It is not clear whether the overestimate of nitric acid is due to too strong stratosphere-troposphere exchange. Please show the flux and the sensitivity to it.

p.16, l.338:

We know that the treatment of the NH3/NH4 partitioning is too simplified in the model, and the model overestimates NH3 concentrations with the standard NH3 emissions. Why do you need to show the model-measurement comparison for implausible case? This should be moved to the Supplement and replaced by improved simulation, as is outlined in conclusions.

References:

Bauer, S. E., Koch, D., Unger, N., Metzger, S. M., Shindell, D. T. and Streets, D. G.: Nitrate aerosols today and in 2030: a global simulation including aerosols and tropospheric ozone, Atmos. Chem. Phys., 7, 5043–5059, doi:10.5194/acp-7-5043-2007, 2007.

Shindell, D. T., Faluvegi, G., Aguilar, E., Schmidt, G. A., Koch, D. M., Bauer, S. E. and Miller, R. L.: Simulations of preindustrail, present-day, and 2100 conditions in the NASA GISS composition and climate model G-PUCCINI, Atmos. Chem. Phys., 6, 4427–4459, 2006.

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