

Interactive comment on “Investigation of global nitrate from the AeroCom Phase III experiment” by Huisheng Bian et al.

Anonymous Referee #2

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This paper presents results from 9 global models with a focus on nitrate aerosol. Since nitrate aerosol formation is linked to ammonia, ammonium, sulfate, and nitric acid, additional species and their deposition is also evaluated. The authors provide insight into the model differences by noting which models include heterogeneous chemistry and pH depending NH₃ solubility (Henry's Law). I have one major comment and other minor comments.

Major comment:

At the end of the paper, it is not clear what processes or species future model development should target to improve nitrate aerosol formation. Some insight may be gained by more carefully considering how errors in sulfate (and ammonium) may propagate to errors in aerosol nitrate. In particular, the correlation between model predictions and

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observations for NH_4 and SO_4 is quite poor for some models (Figure 4). Consider Weber et al. (2016) and how decreases in sulfate do not necessarily lead to decreases in aerosol H^+ (in contrast to page 2, lines 78-80). As nitrate partitioning is sensitive to pH, nitrate aerosol formation could be limited due to aerosol pH. Weber et al. (2016) and Silvern et al. (2017) have indicated pH may decrease (aerosols become more acidic) in the future. Can the limiting factor (NH_3 , nitrate, or pH) for nitrate formation be better identified?

Minor comments:

1. The authors should carefully check for awkward wording
2. Line 154: reword to “emission inventories used”
3. Line 186: Was the several months of spinup for meteorology and chemistry or just meteorology? Is several months sufficient for chemistry of the upper troposphere?
4. Line 204: Can the differences in organic nitrate treatments be briefly discussed? It would be useful to have production rates of nitric acid from each model.
5. Line 225: Are solid precipitates allowed in any of the metastable configurations?
6. Line 256: typo ISORROPIA-I
7. Line 528-520: sentence is unclear
8. Line 619: Is the goal to compromise accuracy and efficiency?
9. Line 731: Can you clarify what fraction actually used the HTAP2 emission inventory vs something else?
10. Line 753: Do you mean ammonium measured on filters?
11. Line 782: Is it thus possible to recommend that all models use the pH dependent Henry's law coefficient for NH_3 ? Can other recommendations for models be succinctly stated in the conclusions?

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12. Table 1: Define CHEMDUSS (not defined until later table)

13. Figure 5: Why are the daily and monthly output results (Figure 5) so different? For the daily output, is the aircraft data matched on a daily basis?

14. Make sure abbreviations are defined in the tables (for example CheAP in 4c and ChemGP in 4d)

References:

Silvern, R. F., Jacob, D. J., Kim, P. S., Marais, E. A., Turner, J. R., Campuzano-Jost, P., and Jimenez, J. L.: Inconsistency of ammonium–sulfate aerosol ratios with thermodynamic models in the eastern US: a possible role of organic aerosol, *Atmos. Chem. Phys.*, 17, 5107-5118, 10.5194/acp-17-5107-2017, 2017.

Weber, R. J., Guo, H., Russell, A. G., and Nenes, A.: High aerosol acidity despite declining atmospheric sulfate concentrations over the past 15 years, *Nature Geosci.*, 9, 282-285, 10.1038/ngeo2665, 2016.

Interactive comment on *Atmos. Chem. Phys. Discuss.*, <https://doi.org/10.5194/acp-2017-359>, 2017.

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