

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

Anonymous Referee #1

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Bian et al. compare global nitrate and ammonium budgets for 9 global chemical models in order to assess differences between the models and attribute these differences to specific processes. This is part of the AeroCom Phase III study. They find that burdens of HNO₃ and NO₃⁻ differ by factors of 9 and 13, respectively, between the different models. The modeled differences in the NH₃/NH₄⁺ burdens were unclear and should be explicitly stated. Modeled chemical production of NH₄⁺ and lifetime differed by factors of 2 and 5, respectively. They attribute these model differences to differences in 1) pH-dependent wet deposition of NH₄⁺, 2) nitrate formation on the surface of sea salt and dust aerosol, and 3) the nitrate coarse mode fraction. They find that nitrate production on sea salt and dust is important to include in models as it tends to dominate nitrate production and controls its partitioning between the fine and coarse mode. In

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that sense it seems to me that 2 and 3 above are referring to the same process. They also compare the model results to observations of nitrate and ammonium surface observations of concentrations and deposition, as well as observed vertical profiles from several aircraft campaigns.

Overall this is a well written paper and will be useful for assessing reactive nitrogen budgets in models. One thing I found confusing was the use of the phrase “heterogeneous chemistry” and the use of the term “nitrate”. For me, when I hear heterogeneous chemical production of nitrate I think of N_2O_5 hydrolysis, which this paper did not examine at all. I wonder how nitrate production from N_2O_5 hydrolysis differs in the models and if this can account for some of the inter-model variability. There was no mention at all of model differences in nitrate production ($\text{NO}_2 + \text{OH}$, BrONO_2 hydrolysis, etc) and how this might account for model differences. Perhaps this will be the subject of another paper, and if so it would be nice to mention that here. What the authors are referring to by the use of “heterogeneous chemistry” is what I would call thermodynamic partitioning between the gas and aerosol phase. Perhaps the authors should reconsider their choice of words here so that it is not confusing. Also, when I read “nitrate” I think of $\text{HNO}_3(\text{g}) + \text{NO}_3^-$, i.e., the sum of gas and particulate nitrate. In this paper, “nitrate” is specifically referring to the particulate phase. Perhaps use the term “particulate nitrate” or “ NO_3^- ” instead so it is more clear. That might also partially help with the issue above regarding the term heterogeneous chemistry.

More minor issues:

Lines 363 and 364 need subscripts.

Line 460: replace “decease” with “decrease”

Line 539: What does “the correction of pH in cloud water” mean? It sounds like the models are somehow correcting for a cloud pH calculation. If I understand correctly, it is not the pH calculation that is being corrected, but whether or not pH is being considered in the Henry’s law constant calculation for NH_3 .

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Line 569: Check the grammar

Paragraphs beginning on lines 743 and 761 should be combined for clarity.

Line 785: “model” should read “mode”

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