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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

Anonymous Referee #3

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This manuscript presents a global study of nitrate and ammonium formation in aerosol, and then estimates direct and first indirect radiative effects of nitrate and ammonium aerosols. The material is interesting and appropriate for ACP. I have a few questions that need to be addressed, before its publication:

(1) In section 2.2, it says the equilibrium model is applied in size bin 1 for 5 aerosol types "consecutively": does it mean that the thermodynamic equilibrium is not solved simultaneously between gas phase and five aerosol types (with the same size cuts)? If so, does the order of solving equilibrium make any difference in calculated concentrations of nitrate and ammonium?

(2) Also in section 2.2, the assumption of externally mixed pre-existing aerosols needs reference. Are there any improvements in the predictions of nitrate and ammonium

concentrations by assuming external aerosol mixtures and adding nucleation of sulfate aerosols in the present study? as they significantly increases the computation cost.

(3) In section 4, in the calculation of AOD, are the calculated nitrate and ammonium concentrations being re-distributed following the non-sulfate aerosol size distributions? Why? This is not consistent with the global transport model results of size-resolved aerosol concentrations. If internal mixing is assumed, why is the constitute composition described as "coated" in Table 2. What time-averaged aerosol concentrations does the radiative transfer model use? And what relative humidity data is used to estimate aerosol wet size? Which year of AERONET data is used in comparison? The global model is driven by the meteorology for year 1997 and most of the aerosol emissions are representative for the 1990s. Observations used in model evaluation should be comparable with these model simulations.

(4) In section 5.2, how good is the treatment of nitrate acid in cloud droplet activation used here, i.e., compared with parcel model calculations?

(5) In the Summary, the statement of "nitrate and ammonium is generally more hygroscopic than sulfate" is incorrect.

Other comments: 1) Introduction is a little bit long. Consider to shorten the discussions about the different treatments of gas-aerosol partitioning, as the focus of this paper is not about introducing a new method, but applying the hybrid method in aerosol and radiative forcing estimates.

2) The authors may consider to shorten some of the discussions in section 3, since they are largely similar to those in previous studies, or move them to the supplement.

3) On page 10117, line 3, change "have" to "has"

4) On page 10119, line 20, what "equilibrium"? please clarify.

5) On page 10136, line 27, change "earth" to "Earth"

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Interactive Comment