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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Nitrogen deposition to the United States: distribution, sources, and processes" *by* L. Zhang et al.

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Comment: Nitrogen deposition in the environment is a relevant and important topic. This paper examines nitrogen fluxes, concentrations, and distributions in the US using a global computer simulation of atmospheric chemistry and transport (GEOS-Chem). The motivation, methods and assumptions are clearly set out, and overall the model does a reasonable job representing the processes involved. The resulting calculated fluxes and concentrations compare well with a suite of appropriate observations from a variety of sources, as well as with previous modelling efforts. Although there are some limitations (which the authors identify), this is a competent synthesis of the current state of knowledge on this issue. This work is relevant to the scope of ACP. The paper is nicely written and presented, and well structured. I fully recommend publication in

ACP, after addressing the minor clarifications mentioned subsequently.

Response: We thank the reviewer for the helpful comments. We have implemented them in the revised manuscript. Please see below for the itemized responses.

Minor issues:

Comment: Line 13, p 250. "The model does not capture the observed high values of wet deposition in the upper Midwest. . . ". The authors attribute this to a regional underestimate of emissions from the agricultural upper Midwest. Is it possible that some of the discrepancy is a result of scaling factors applied derived from obervations from the eastern US? Presumably this will be refined in subsequent publications. Another interesting thought is that the slightly high ammonium concentrations (e.g. Fig. 5) could be allowing more nitrate to reside in particles, thus adding to the overestimate of nitrate already present due to overly efficient N2O5 hydrolysis.

Response: We added in the text "Our national scaling factors are derived from NHx measurements in the east, and may fail to correct the regional emissions in the upper Midwest."

We think that both high ammonium and nitrate concentrations are caused by the model overestimate of HNO3 concentrations. We added in Section 3 (Figure 5) that "The HNO3 overestimate leads more ammonia to partition to the aerosol phase and form ammonium nitrate aerosol.".

Comment: Line 18, p 248. The reference used for the temperature dependence (Aneja et al., 2000) states that emission is greater in summer than winter, but that is opposite to what is found in the simulations with no applied scaling factors here, which is a little confusing.

Response: The simulation with no scaling factors applied shows that NHx concentrations are too high in winter, reflecting a lower emission in winter than summer. This is consistent with the temperature dependence in Aneja et al. (2000). We now state

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"Results agree well with measurements in summer but are too high in winter, reflecting a lower NH3 emission in winter than that in summer, as would be expected in view of the temperature dependence of NH3 emission (Aneja et al., 2000)".

Comment: Figure 8. I suspect that the vertical axis is missing the "N", as this is what all the units are in for the rest of the paper.

Response: Thanks for pointing it out. We added "N" in the vertical axis.

Comment: Line 12 p 252: "small biases −4−−1", this looks a little awkward with the all the dashes.

Response: We changed the text to "small biases (-4% to -1%)"

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 241, 2012.