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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Atmospheric ammonia and particulate inorganic nitrogen over the United States" *by* C. L. Heald et al.

Anonymous Referee #1

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The manuscript, 'Atmospheric ammonia and particulate inorganic nitrogen over the United States' by Heald et al. uses observations from ground sites and satellites along with a 3-D chemical transport model to study inorganic aerosol levels and ammonia concentrations in the United States. Sulfate simulations were in good agreement with observations while nitrate simulations had a positive bias throughout most of the US except in California where nitrate was underestimated. Comparisons of ammonia simulations with satellite observations suggest that current ammonia emissions are likely underestimated in the Midwest and California. The manuscript is well, written, clearly structured, and precise. It is of interest to ACP readers. I recommend its publication and only have a few minor corrections/clarifications and suggestions that are listed below.

Minor Comments:

The manuscript discusses a 'New NH3 Seasonality' regarding NH3 emissions and points out the influence of agricultural practices (page 19467, line 25). In addition to seasonality, e.g. when fields are fertilized, economic factors, i.e. type of fertilizer used, influence agricultural practices and, in turn, emissions. Livestock, in particular cattle, are a large source of NH3 to the atmosphere. The review by Hristov, et al., 2011 and work by Liu et al., 2012, for example, show that diet composition, such as, percentage of crude protein in cattle feed, affects NH3 emissions. Market factors (e.g., feed cost versus sought yield) and regional availability largely determine feed composition. Though difficult to assess (and alluded to here page 19486, lines 16-19), these issues will also have to be taken into account when analyzing seasonal and yearly variability of long-term regional data sets such as those from satellites.

Hristov, et al., 2011, Review: Ammonia emissions from dairy farms and beef feedlots, Can. J. Anim. Sci., 91: 1-35

Liu, et al., 2012, Gas Emissions from Dairy Cows Fed Typical Diets of Midwest, South, and West Regions of the United States, J. Environ. Qual. 41 doi:10.2134/jeq2011.0435

Page 19468, line 21. Can a reference be provided for the cattle inventory in Weld County?

Page 19473, lines 1-15. The authors note that time-resolved gas-particle vertical profile measurements through the boundary layer are required to investigate vertical gradients in NH4NO3 formation. Such observations have been discussed from a previous aircraft study by Neuman, J. A., et al. (2003), Variability in ammonium nitrate formation and nitric acid depletion with altitude and location over California, J. Geophys. Res., 108, 4557, doi:10.1029/2003JD003616. Section 3 does not describe the vertical spacing of the model so it is not clear if the study describe in this paper is applicable.

Figure 2. The superscript on sulfate is cut off and mostly unreadable. The unit label for

the color scale is ambiguous. Adding a unit label (as in Fig. 6) to the right of each, e.g. after 8.0 and 4.0, makes it clear. I also suggest adding a dashed line or a hash mark on the x-axis of the maps as a reference point for 100° W related to the scatter plots for those not familiar with the United States geography.

Figure 3. As in Fig. 2, the unit label for the color scale is ambiguous. Adding a unit label (as in Fig. 6) to the right of each, e.g. after 8.0 and 4.0, makes it clear. I also suggest adding a dashed line or a hash mark on the x-axis of the maps as a reference point for 100° W related to the scatter plots for those not familiar with the United States geography.

Figure 4. There is no unit label on the color scale for the first column of plots. For clarity, I suggest adding '# retrievals' on the color scale even if it is repeating the column label. Also, similar to Figs. 2 and 3, I suggest repeating the color scale unit label for the column and column difference color scales for clarity.

Figure 5. The format used for mass concentrations on the y-axis here is different than used in previous figures, i.e. no negative superscript. Here, and in Fig. 9, error bars present the standard deviation of the monthly average observation. Assuming that the emissions and meteorology are correct, is there an estimate or sense of range for uncertainty in the chemical reactions and partitioning in the model?

Figure 6. Defining the four sensitivity simulations in the figure caption makes it easier for the reader to go between the text and the figure.

Figure 7. Since the second column is showing the updated GEOS-Chem simulation, I suggest adding '(updated simulation)' under the GEOS-Chem heading as done in Fig. 4 for GEOS-Chem (retrieved).

Figure 8. Change in mass concentration format, as in Fig. 5.

Figure 9. Change in mass concentration format, as in Fig. 5.

Figure 10. Change in mass concentration format, as in Fig. 5.

Figure 11. It is hard to see the symbols representing the sites on the figure. One suggestion is to make the outline of the circles thicker. Another suggestion is to list the sites according to the corresponding season in the caption. Also, it would be helpful to state that no SO2 was measured at Big Bend N.P. in the caption. I found it confusing that Big Bend was missing in some panels and then had to go back to section 2.2 to found out why.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 19455, 2012.