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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "Present and future nitrogen deposition to national parks in the United States: critical load exceedances" *by* R. A. Ellis et al.

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Anonymous Referee #1

This manuscript characterizes nitrogen deposition in the United States, in both present-day and future (2050), in the context of critical load exceedances at national parks. This is a concise topic, appropriate for publication in ACP and the manuscript is well written. I include below a few relatively minor comments and suggestions to consider prior to publication in ACP.

1. While the focus of the manuscript is on critical load exceedances, it would be useful

to include the estimates of total N deposition over the US and how this is projected to change by 2050 in the abstract and in the text. These absolute values are not subject to the relativization of harm associated with the (uncertain) CL metric, and may be more informative for those interested in atmospheric inputs to terrestrial (i.e. soil/riverine) ecosystems.

We provide these data in Figures 4 and 7.

2. Abstract: It would be helpful to clarify in the abstract that the CL values used here are designed to protect the most sensitive reception in an ecosystem (and thus that exceedance does not necessarily imply broad ecosystem damage). The current phrasing of "with the goal of protecting the most sensitive ecosystem receptors" is a little unclear: one might assume that it is a natural "goal" to protect the most sensitive elements of the ecosystem but it's not clear from the text that the metrics have specifically been defined to determine when these most sensitive elements are at risk.

Clarified wording to: "We estimate CL values in the range 2.5–5 kg N ha-1 yr-1 for the different parks to protect the most sensitive ecosystem receptors."

3. Abstract & Section 4: The authors should be careful to clearly state that all future projections consider ONLY anthropogenic emission changes. The authors have not included changes in soil NOx, lightning NOx or biomass burning emissions (as described in the RCP scenarios or predicted to respond to a future climate), which could impact future nitrogen deposition. Sentences in the abstract and throughout should be modified (e.g. page 9153, line13-14: "We then project future changes in N deposition using the RCP anthropogenic emission scenarios of 2050").

Done.

4. Abstract, line 19: Clarify that these numbers are based on two RCP scenarios (8.5 and 2.6)

Done.



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5. Page 9156, lines 7-8: Why do the emissions differ from Zhang et al? You indicate that the same years and model configuration were used. Different emission inventories?

We have clarified in the text, “Table 1 gives total 2006 NOx and NH3 emissions for the US, which are 5% lower for NOx than Zhang et al. (2012) and 10% higher for NH3 due to the use of slightly different interannual scaling factors for anthropogenic sources.”

6. Page 9161, lines 6-8: Confirm that the present-day GEOS-Chem 2006 and RCP 2006 emissions agree spatially as well (such that relative changes in regional CL exceedances can be attributed solely to growth/decline of local emissions)

We have added the following text, “For NOx, emissions also agree spatially but for NH3 there are some small regional differences. “

7. The analysis presented here focuses on annual means. Is the model performance of equal skill throughout the year? Or are there some compensating seasonal biases?

We have added the following text, “Zhang et al. (2012) found similar agreement in their comparisons for the ensemble of NADP sites, with some degradation when considering seasonal variations.”

8. What are the implications of the recent GEOS-Chem model studies suggesting ammonia emissions underestimates in the United States - esp California and the Midwest (Walker et al., 2012; Heald et al., 2012; Zhu et al., 2013) on this study?

We have added the following text, “Previous studies have revealed regional/seasonal underestimates of NH3 emissions in GEOS-Chem (Fisher et al., 2011; Heald et al., 2012; Walker et al., 2012; Zhu et al., 2013). A global inversion of wet deposition flux data by Paulot et al. (2013b) using GEOS-Chem yields an optimal NH3 emission estimate of 2.8 Tg N yr-1 for the contiguous US, as compared to 3.3 Tg N yr-1 used here.”



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