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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "Responses of surface ozone air quality to anthropogenic nitrogen deposition in the Northern Hemisphere" *by* Yuanhong Zhao et al.

**Anonymous Referee #1**

Received and published: 11 May 2017

In this manuscipt, Zhao et al. present the results of an exploratory modeling study that quantifies the potential impact of anthropogenic nitrogen deposition on ozone air quality. The GEOS-Chem chemical transport model is used to derive nitrogen deposition fields (with and without anthropogenic emissions) that are used in separate Community Land Model simulations in order to derive contrasting global vegetation properties and soil NOx emissions. These are in turn used in GEOS-Chem to simulate impacts on surface ozone concentrations. The authors find that anthropogenic nitrogen deposition can increase surface ozone by enhancing biogenic VOC, but also decrease surface ozone by enhancing dry deposition velocities. Changes in O3 resulting from increased soil NOx emissions are also spatially heterogeneous. The simulated effects on O3 from



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anthropogenic nitrogen deposition are comparable to predicted impacts resulting from land use change alone.

In my opinion, this manuscript is novel, logically presented, and mostly well-written. By asynchronously coupling the Community Land Model with the GEOS-Chem chemical transport model, the authors present an enlightening approach to isolating specific land-system processes on atmospheric chemistry. The results suggest that a more refined consideration of biosphere-atmosphere coupling can have appreciable impacts on atmospheric chemistry. Like any "exploratory" modeling study, it is difficult to evaluate the implications directly with observations, but I believe this manuscript points the research community in a constructive direction. This work will surely be of interest to the Atmospheric Chemistry and Physics audience. I have only minor concerns and technical corrections to suggest.

One concern I have is that the approach seems like it would be very difficult for others to reproduce, given the variety of simulations, the dependence on land and atmospheric data products, and the asynchronous coupling. The authors appear to try and address this challenge, offering to provide the measurements and model simulations upon request. I might encourage the authors to provide separately the N-deposition fields, soil-NOx emission fields, and land cover inputs in order to facilitate potential intercomparison studies with other models.

It is also regrettable to me that the changes to the CLM relating to soil NOx emissions, NH3 volatilization, and N uptake, are relegated to the Supplementary Information. I believe these modifications could be of great interest (and debate?) to both model communities, and might stimulate constructive discussions about model development. However, given that the present manuscript already presents a substantial amount of material (and given that model development is somewhat outside the scope of ACP), I understand the authors' motivations for doing so. Is it possible there is room for an Appendix to the article instead (and the figures could be retained in the Supplemental Information)? I leave this to the authors' discretion.

Technical Corrections:

line 66: remove "been"

line 91: replace "relatively" with "relative"

Section 2.3: It wasn't explicitly clear to me until later in the manuscript (actually, the second last sentence) that prescribed land cover/vegetation PFT/soil types in the CLM simulations with- and without anthropogenic N deposition are constant (not dynamically changing over time or between simulations). I believe this should be clarified here, since the impacts of land use change are addressed in a separate investigation. Also, what is the source of the prescribed land/vegetation cover? What time period does it represent?

Figure 3: I found the top right panel a bit confusing. This plot shows the percentage contributions to N-dep from anthropogenic emissions. Can you lay out exactly what model(s) output subtraction you are carrying out here?

line 289-290: The two numbers are both given units of Pg C a-1.

line 354: replace "expect" with "except"?

line 460: "especially in light of observations" – What observations are the authors referring to?

line 463: replace "difference" with "different".

Table 1: There is a superscript "2" under Run_soilnox, but no footnote associated with it. Furthermore, I think it could be clarified further (in the footnote or in the heading) that the GEOS-Chem simulations that address the N-deposition impact on O3 are run with present-day anthropogenic emissions. (I.e. There are essentially two families of final simulations: GEOS-Chem + anthro emissions + plant cover driven by natural N deposition _VS._ GEOS-Chem + anthro emissions + plant cover driven by natural and anthropogenic N deposition.)

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