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Interactive comment on “Impact of future land cover changes on HNO₃ and O₃ surface dry deposition” by T. Verbeke et al.

Anonymous Referee #1

Received and published: 3 August 2015

SUMMARY

This paper describes a modelling study of ozone and nitric acid dry deposition in a state-of-science global chemistry-climate model. The main focus is on assessing the impact of land cover changes (LCC) on O₃ and HNO₃ dry deposition between present-day (2000s) and the future (2050s). To cover a wide range of potential changes three of the four CMIP5 RCP scenarios are evaluated. The impact of LCC and climate is assessed separately.

GENERAL COMMENTS

My expectations for this paper were high, maybe a bit too high, because the process of ozone dry deposition at the surface is crucial for the understanding of atmospheric

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composition and the consequences for climate and air quality. Combining that with nitric acid dry deposition the paper promised to deliver a really interesting study.

To a fairly substantial degree, my expectations have been fulfilled. Attribution of future changes in O₃ and HNO₃ dry deposition to either LCC or climate change have been assessed and relative magnitude of both effects have been discussed. This makes this paper a valuable and very relevant addition to science.

My main reservation then is with the execution. To me the paper feels somewhat unfinished and unpolished. The paper lacks structure and depth. Too many findings are just discussed “in passing” with rather little attention to the details, it seems to me at least.

Here is what I'd like this paper to include:

+ clear division between annual mean impacts and seasonal variation + more detailed discussion of the consequences for atmospheric composition, specifically, in terms of atmospheric oxidative capacity (OH concentration), air quality and possibly exceedances (surface ozone), and potential health and ecosystem impacts (not necessarily in quantitative terms, a qualitative discussion only would already be nice) + similarly for HNO₃ in terms of acid deposition damage and N-fertilisation potentials. + analysis of the relative importance between aerodynamic and surface resistance terms to dry deposition (conceding that quasi-laminar resistance may not play a decisive role, but I do not know for sure), potentially on a per PFT basis.

Looking at this list, I appreciate that I may be asking too much, as I have already mentioned above. Let me go through the individual sections to make it a bit clearer (hopefully) what I mean.

The introductions are sound and adequate, nothing to complain there, and so are the sections on model description and description of the dry deposition scheme in LMDZ-INCA. The description of the LCC changes between PD and FU and the modelling

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strategy also have their merits.

When it comes to discussing the findings, though, the paper, to some degree, comes undone. PD ozone and HNO₃ deposition is discussed first but a bit superficially for my taste. I'd like to see the following subsections: 3.1.1 spatial patterns of O₃ and HNO₃ dry deposition under PD conditions based on annual means using the regions defined in the paper. 3.1.2 seasonal variation in the deposition fluxes for O₃ and HNO₃ (using the proper seasonal means DJF, JJA, etc., and not just monthly means for January and July, to give an example). 3.1.3 a brief discussion of the relative importance of the individual resistance terms, maybe with respect to location, vegetation composition (grassland versus forest, for instance) and seasonal variation would be extremely nice.

The next section discusses changes between PD and FU scenarios. A similar structure seems appropriate. I could imagine the following subsections: 3.2.1 changes in the annual mean deposition fluxes with respect to specific characteristics which manifest due to the three CMIP5 RCP scenarios. 3.2.2 the impact of seasonal variability 3.2.3 if apparent at all, a brief discussion of the changes in the leading terms between PD and FU, i.e., are the same resistance terms dominant or not.

Section 3.3 focuses on impacts on atmospheric composition. However, this section is rather brief and a little bit unfocused. Possible questions to address here are impacts on the a) ozone budget, b) the OH concentration and c) surface ozone concentration with a view to air quality and health/ecosystem damages. I am thinking of no more than four or five paragraphs in total for this section.

Section 3.4 is simply too short for me taste. Here, an attribution to LCC and climate change is attempted but not really discussed at any length. Just use more of the information available from the experiments.

The "Discussion and conclusions" section is quite reasonable. It could also be improved, however, by discussing in more detail what the newly added sections have revealed, i.e., the contrast between winter and summer seasons, its change with cli-

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mate change and some conclusions on what that could mean to future air quality and possibly human health and ecosystem functioning.

Once completed, these changes can also be percolated to the abstract making it stronger and more captivating, too. Anyway, these are just my thoughts.

I concede that hindsight is always perfect and that it is far more easy to criticize than to create. Hence, I suggest the paper to be accepted with minor changes only which hopefully will reflect some of the suggestions that I have made in the general comments.

What follows are some specific comments which mainly pertain to typos and such like.

SPECIFIC COMMENTS

p.18461/l.25: the symbol for the element sulphur, “S”, is a non-italic.

same/l.26-27: the sentence need editing.

p.18642/l.22: should read “beginning of the industrial era”

p.18463/l.5: should read “oxidative capacity” or “oxidizing capacity”

same/l.8: better: “...as given in the three RCP scenarios. . .”

same/l.20: citation “Lamarque et al., 2010” seems to be missing from the reference list

p.18465/l.6: “exposed” - better: “highlighted” or “depicted” or “shown”

same/same: better: “...and Europe as presented in. . .”

same/l.27: citation “Loveland et al., 2000” seems to be missing from the reference list

same/l.28: citation “Dufresne et al., 2013” seems to be missing from the reference list

p.18467/l.10: reference “See et al., 2011” seems to be missing from the reference list

same/l.23: changes in temperature, strictly speaking, are measured in Kelvin

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same: should read “mean surface temperature change is 0.93K between. . .”

p.18468/l.8: should read “sub saharan Africa”

same/l.26: reference “Walcek et al., 1986” seems to be missing from the reference list

p.18469/l.10-11: “For HNO₃. . .”; sentence needs revision

same/l.19: should read “in terms of”

p.18471/l. 7: should read “the LCC effects”

same/l.12: better “The RCP8.5 scenario leads to...”

same/l.12-13: better “due to the reduction in the deposition rate”

same/l.22: better “...an increase of the HNO₃ deposition flux...”

same/l.24: better “It thus leads to a reduction in the HNO₃ concentration by 0.2 ppb(v)...”

p.18472/l.4: should read “To this purpose,...”

same/l.5: better “0.93K”

same/l.6: better “...temperature increase projected in the RCP scenarios...”

same/l.7: should read “...this climate change on the deposition rate. . .”

same/l.10: should read “The climate effect on the deposition rate. . .”

same/l.12: better “solar irradiance”

same/l.23: better “Discussion and conclusion(s)”

same/l.21: should read “...to assess the impact of changes. . .”

p.18473/l.16: should read “..., for both of the...”

same/l.23: better “0.93K”

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same/same: should read "..., we calculate that. . ."

p.18474/l.3: should read "..., and lack of the representation of. . ."

same/l.7: better "...proper input parameters for dry deposition schemes, ..."

References:

p.18475/l.9: reference "Hurtt et al., 2010" does not seem to be cited in the text

Table 2 on p.18478: not all changes higher than 1.5% are highlighted in the table

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 18459, 2015.

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