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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Representing sub-grid scale variations in nitrogen deposition associated with land use in a global Earth System Model: implications for present and future nitrogen deposition fluxes over North America" *by* Fabien Paulot et al.

Anonymous Referee #3

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The paper deals with the coupling of a large-scale chemical transport model and a higher resolution land model to evaluate ecosystem level variations in reactive nitrogen deposition. The paper uses an interesting approach that could potentially also be applied to other global CTMs to evaluate land use specific variations. The conclusions of the paper have been shown in previous publications, see e.g. Simpson et al (2011) and references therein: http://www.nine-esf.org/files/ena_doc/ENA_pdfs/ENA_c14.pdf. In general, the paper is easy to follow, but there are some parts that need restructuring, or

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Discussion paper

additional explanation. This holds especially for the information on the measurements that have been used. I suggest that the authors address the following points before publication of the paper: General remarks: - The Introduction could be extended with a short overview of what has been done sofar regarding subgrid variations in deposition. - Could the authors add another short section about the observations that are used to validate the modelled Vds? The comparison between measurements and model results is difficult to interpret without this information. - Section 2.1: Figure 2 and its interpretation seems dislocated and should be part of the Result section. - Section 2.1: for NH3 the bi-directional flux using compensation point modelling is essential to model NH3 fluxes. Furthermore, for agricultural lands fertilization rates are important to determine the net flux of NH3. - The Experimental section does not include all the steps that are taken. It would help if the authors would explain in detail what their approach was.

- I would suggest to split up section 3.2. into two different sections: one section where Figure 5 is discussed and one that discusses the land use specific changes (Figure 6). I suggest to also split up section 3.3. One section that discusses the relative changes of anthropogenic land use changes on oxidized/reduced/total N deposition, and one about the contribution of natural land and water bodies to the total change in Nr deposition.

- Figure 4 shows clear overestimation during nighttime and at the end of the day. Could the authors discuss this, also in relation to the conclusions they draw from the comparison in Figure 4?

- Can the authors elaborate on the land use changes that are used in the model? What are for instance the regions where we see the largest changes?

- Could the authors elaborate a bit more on how the changes in N deposition in natural parks (mentioned at the end of section 3.3) are computed? Did the authors assume that the national parks cover an entire grid cell or did they for instance use a mask on

the level of the land model?

Detailed remarks: Page 3 line 80-82: this seems obvious. However, can the authors give examples where a comprehensive land model is included or at least a zooming option?

Page 3 line 88: can the authors explain a little more about the tiles sizes and its use in the mosaic approach, including information about the gridcell sizes?

Page 4 line 104: management practices are important, but that also holds for fertilization.

Page 4 line 109: 25% of biomass removed during grazing seems too high. Do the authors have a reference?

Page 4 line 112 – for crops, the representation of management practices needs some more explanation. Could you elaborate on how the planting and harvesting dates were determined?

Page 6 line 158 – I suggest to move the comparison of Vd from different models (the part related to Fig 2.) to the results and discussion section.

Page 6 Figure 3: it is not clear how the simulation was done: same locations? Actual meteorology or modelled? Surface characteristics?

Page 7 – line 192 – I suggest to change the title 'Evaluation' into something more specific (for instance 'Evaluation of model Vd against observations', or something on that line). The beginning of this sections should be moved to the experimental description.

Figure 5 – could the authors add the time period of the simulations to the description of the figure, so that it is self-explanatory. The titles 'All land' are a bit vague, maybe it is better to use 'All land types' or something in that direction. How many observations were used? Furthermore, can the authors explain the pattern in nitrogen deposition in central US, which is clear in the middle part (natural/all land)?

Page 8 line 237 – How would fertilization raters and the bi-directional nature of the NH3 flux influence the results in areas near to agricultural regions?

Figure 6 – all the numbers that are mentioned on the sides of the figure are a bit hard to follow. Please consider presenting the number in a different way.

Figure 7 – same as Figure 6.

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