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 #1

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General Comments:

This paper describes a new modeling approach to allow for analysis of downscaled dry deposition values from an atmospheric-chemistry model that typically runs with a horizontal resolution of 200 km. Grid average values of dry deposition typically available from a coarse resolution model may not be relevant to ecological important processes that occur for specific land use types. This is an important contribution to the scientific

community and will be well used to support ecosystem assessments. The manuscript is a bit lacking in some important details and analyses. There should be some discussion early on in the paper about the bidirectional flux of NH3. It is now only mentioned as future work, but the lack of consideration of this in the current modeling has implications that should be discussed. With revision, the manuscript will be appropriate for publication in this journal.

Detailed Comments:

Line 44: Characterizing dry deposition as just surface resistance is not really accurate.

Line 46: The Schwede and Lear (2014) reference is not the appropriate one for the wet deposition fluxes as the values used are those from the National Atmospheric Deposition Program National Trends Network.

Line 55: The role of organic nitrogen should be discussed as well as other unmeasured components of the nitrogen budget that are currently only widely available from models.

Lines 72-79: Greater emphasis could be provided here that a new model has been developed for including in AM3. It isn't simply that you used an approach already in another model. You combined pieces from different models.

Line 80 – 93: The tile structure is a bit confusing and it isn't clear in the use of primary and secondary tiles and what information is contained at each level. What are the categories for the secondary tiles?

Line 86, I am not clear on the use of the phrase "transition rates". Maybe specifying them as temporal transitions would be helpful.

Line 93: LAI is a critical parameter for deposition. Please provide more details on how this is determined.

Line 96: Do the management practices influence the agricultural emissions as well?

Line 101: What is the basis for your assumption that 25% of the leaf biomass is re-

moved daily by grazing?

Lines 102-103: Does LM3 include a tree growth model? How does changing the grazing frequency affect the growth of trees? Also, at line 103, the text is a bit garbled.

Lines 112-113: It would be helpful to provide the equations for Rac in this manuscript. The Bonan (1996) reference is not readily available and is not as commonly used at the Erisman approach.

Line 118: The leaf width is specified as one value for the land use type, while it is actually far more variable. How were the values in Table S1 determined? What is the sensitivity of the model to this parameter?

Line 119: Insert "species" before X here and other places.

Line 127: A right parenthesis is missing.

Line 129: After Rs(H2O), I suggest adding "is the stomatal resistance for water vapor and" before "is calculated"

Line 130-132: Water stress is included in most Jarvis based approaches which are commonly used in atmospheric chemistry models.

Line 137: The notation in Table S1 does not match the table in the manuscript. How are the scaling factors for stem/bark determined?

Lines 142-146: Please explain the nature of the modifications made to the original parameterization and how they were developed/evaluated.

Lines 148-165: The motivation for this section is not clear. Since you are only comparing between models, it is not an evaluation.

Section 2.2 – It would be helpful to include information about all model runs in this section. Later in the paper, several new runs are described that are not included here. It would also be helpful to include a table that summarizes the important options used

in the model runs. This could be included in the SI. What land use was used for the present day runs? Was there a spin-up year as was done for the future scenario run? What do you mean by across configurations at line 170? Were the emissions year specific? What year was used for the NH3 emissions that were used for the future scenario?

Section 2.3 (to be added) – There should be a section that describes the observational data used. How did you choose which ones to include? It might be helpful to include a table of the observational data to reduce the amount of text needed in the legend in Figure 3.

Lines 181-190: There is a lot more analysis that could be done in this section. For example, the differences in performance between land use types could be expanded. Are there aspects of the model that you think contribute to these differences? Canopy wetness is very important to SO2 deposition. How well does the model capture wetness compared to the observations?

Lines 191-213: This section mostly describes model development as the text describes how observations of deposition velocity were used to develop the alpha and beta parameters for equation 6. It isn't clear how the MERRA meteorological fields were included in the modeling. At line 200, reiterate that the measured compounds are those from Nguyen et al. At line 203, it would be appropriate to refer the reader back to Figure 4. How do you know what the deposition of HCN on cuticles is or are you referring to how the model treats the deposition?

Line 220: Note that the model captures the high reduced N over NC.

Line 222: In Figure 5 (middle column), what causes the streak pattern in the middle of the country?

Line 223-224: The text that appears at line 229-230 would be better placed here rather than simply referring vaguely to the supplementary materials.

Line 228: The land use is not actually changing in this analysis. Do you mean the the dry deposition of NHx would be more sensitive?

Line 235: What are you contrasting?

Line 240-241: This model run should be discussed in the methods section. How was this done in the model? Changes in the land use would also change the meteorology and the emissions. Were these considered?

Line 241: It would be helpful to insert text along the lines of "Using this run as the base case, we compare . . .". That would fit better with the text later in the section that compares the impact of anthropogenic land use changes.

Lines 254-256: Were changes in biogenic and agricultural emissions considered?

Line257: What land use takes the place of agricultural areas in the scenario?

Line 258-260: This section needs more explanation.

Line 270: Suggest adding "to natural vegetation from 2010-2050" after N deposition.

Line 273: Suggest adding "for the grid" after deposition.

Figure 3: What is the time scale for each point – e.g. monthly average? It isn't clear what you mean by "the model is sampled". The legend is far too small to be read easily. Perhaps some of the information could be included in a table. Some of the colors are hard to see or distinguish. The yellow doesn't show up at all in print and the blues are hard to distinguish. The symbols are small which makes it hard to tell them apart. Explain the symbol fill similar to how the shape is explained. How was the criteria for wet conditions determined? This could be explained in the methods section when you add a section for the observational data.

Figure 4: It would be helpful to have H2O2 and HNO3 on the same scale since these are compared in the manuscript. The surfaces listed are not consistent with the main text. Bark is listed rather than stem.

Figure 6: The wording of (with land-use – without land land-use)/with land-use is not clear.

Figure 7: Why include the 9% as an inset rather than simply stating it in the legend?

Figure S1: This figure has a lot of information in it and is not used as much as it could be. It seems like some of this would be important to discuss around line 115 in the main text, for example.

Figure S2: How do you determine the contribution of these factors?

Table S1: As noted above, the notation here does not match the main text.