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Interactive comment on "The importance of management information and soil moisture representation for simulating tillage effects on N_2O emissions in LPJmL5.0-tillage" *by* Femke Lutz et al.

Anonymous Referee #1

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Comment on Lutz et al. - The importance of management information and soil moisture representation for simulating tillage effects on N2O emissions in LPJmL5.0-tillage

General comment

In this manuscript, Lutz et al. validate N2O emissions from the recent tillage version of the LPJmL model using field data from four sites and DayCent model outputs. They analyze the effect of management information and soil moisture representation on the model performance. Estimating the effects of tillage /no-tillage on GHG emissions the

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Discussion paper

regional and global scale is a topic of great scientific relevance. To establish a fair representation of that effect in biogeochemical models is important for upscaling and thus relevant, confirming the scientific interest of the paper.

The manuscript is well structured and used sound modeling experiments to compare the main effect of tillage in LPJmL to field sites, but also to investigate underlying causes of mismatches. The authors analyze the effect of exact management information on agricultural activities affects the simulation of tillage effects on N2O emissions LPJmL. They further show that the soil moisture content in LPJmL was overestimated at one site, and modifications of the hydraulic properties in the model improved soil water simulations and associated N2O emissions for this site. The manuscript shows that there is still room for improvement in process understanding related to tillage effects and its implementation in biogeochemical modeling.

A main weak point in the manuscript is that measured N2O fluxes were only in low temporal resolution. It is known that due to the sporadic nature of N2O fluxes and enormous flux variability, measurements in low temporal resolution lead to extremely high uncertainties (Barton et al., 2015). Measurements on a biweekly basis might miss entire N2O peaks which dominate annual fluxes.

Further several parameters in LPJmL (hydraulic properties) were not directly compared to measured data but with DayCent values (which can have their own issues). Still, the discontinuously measured values which are closer to DayCent values seem to justify this approach and also the results seem to prove this approach plausible.

Soil moisture was only investigated at one specific site, which reflects a certain pattern of properties, while it is not known if these results would hold for all sites.

There is one methodological issue in the modeling: Under completely anaerobic conditions, no more N2O will be emitted, instead there occurs complete reduction to N2. An exponential increase of N2O with soil moisture at very high moisture levels does not make sense.

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I have a major concern about the input data on soil C and N stocks given in Table 3, which cannot be correct. In case the observational data was used exactly as depicted in the table, the concerned model runs need to be redone with corrected data.

Acknowledging the scientific value and the overall quality in the structure and the scientific quality of the paper, I would recommend to publish the manuscript in GMD after major revisions.

Barton, L., Wolf, B., Rowlings, D., Scheer, C., Kiese, R., Grace, P., Stefanova, K. and Butterbach-Bahl, K.: Sampling frequency affects estimates of annual nitrous oxide fluxes, Sci. Rep., 5(1), doi:10.1038/srep15912, 2015.

Specific comments

L 20: The sentence sounds a bit strange since the formation of GHGs is not a biogeochemichal process.

The introduction is well-written and gives a good overview on the topic.

L99: In this paragraph you describe one part of the curve, I would urge to describe the whole dependency of denitrification N2O on WFPS (full range of WFPS) as well as for N2O production during nitrification, since these relationships are very important for your research question.

Describe briefly the effects of incorporating residues at tillage on the soil pools.

L101: The N2O emissions from denitrification increases exponentially when the WFPS reaches a threshold value of $\geq$ 90%, as denitrification occurs only in oxygen deficit conditions (see also Krysanova and Wechsung, 2000).

Does not make sense to me. Do you mean decreases instead of increases? Or do you refer to increasing N2?

How does the relationship N2O produced by denitrification vs WFPS differ in your LPJmL version from DayCent?

L129: N2O emissions from denitrification increases exponentially when the WFPS exceeds the texture related threshold value and levels off as the soil approaches saturation. This suggests that there would be no decrease in N2O production at extremely high WFPS in Daycent? Which is missleading – please describe the whole relationship, also the decrease at high WFPS; (see Parton et al 2001)

Table 1: The order of the paragraphs describing the sites should be consistent with the site order in the tables.

Table 2: Soil pools: Units are incomplete: g C per what, g N per what?

When I look at the C-N ratios in Table 2, it becomes obvious that something must be wrong here. In Michigan (obs) this is rather low (8.6), however in Nebraska a Soil C/N ratio of 1.2 – this is impossible. Please check your values for C and N pools thoroughly. If really the values as written were used in the modeling, the respective runs must be redone with corrected values.

L 192: all is applied at sowing - So does this mean exactly at sowing date? (-> farmers would often do it rather 1-2 weeks later.)

L 195: 0.7 for maize, what about the other crops?

How do you explain the large differences in soil N between observed and simulated values (Table 2) in Michigan and Nebraska? The given depths are consistent between obs and sim, right?

Overall, the method section is clearly written and comprehensive enough to allow the reader to thoroughly understand the modeling experiment.

L276: "We analyzed the experimental site in Nebraska“. Here I was quite surprised that the analyses of soil moisture was only performed at one site. I would add quite early, when you first mention the soil moisture analyses in the Intro or beginning of methods the specification “at one selected site”.

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L 298: “The significance of r corresponds to the tests, null hypothesis: r=0.“ The sentence as it is now, makes no sense since it is unclear to which test it refers. Please clarify.

L 315: In this paragraph, it would help the reader if you first briefly point out what tillage effect the observed data show, and only after that present the model results; then the reader has a chance to compare without again looking to the plot. As it is now, it is a bit cumbersome to read.

I would strongly urge to order: Observed results, then model results, then details.

L 336 Also in this paragraph sentences, I think for each it makes it easier to put first observed results (which I think shout be reference), then model results.

Fig 2: Is this the difference between no-tillage and tillage, N2Onotill – N2Otill? You could add this to the caption.

L 316: LPJmL.G.Orig showed an increase in emissions with no-tillage (Fig. 2 A)

L 326: use "more detailed“ instead of different

L353: You give values for LPJmL only on no-tillage, but for DayCent tillage and no-tillage?

Fig 4: You use RMSD throughout the manuscript, but switch to RMSE here: Probably this is a typo so you meant RMSD and referred to WFPS as a fraction?

Fig 4: There is no need to extend the y axes from 0 to 1, which results in half of the area without information - instead the plot could be a bit larger.

How much differ the PTFs used in Daycent and LPJml?

L 433: Under completely anaerobic conditions, no more N2O will be emitted, instead there occurs complete reduction to N2. An exponential increase with soil moistures at very high moisture levels does not make sense.

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Fig A1: Adding r values for each run would help to get insights about the degree of association. The mean and distribution give only a very limited picture.

Technical correctionsf

Methods: use past tense consistently e.g. L67 (whether the deviations are were)

L68:Four experimental sites with detailed information on management available were identified.

Table 2 I think that the numbers after the dot give the impression that these values would have this high precision. I would advise to round consistently.

L276: “we focused on the uppermost 0.2 m of the soil“

L288: “Therefore, we calculated the deviation between simulated and observed values were by the root mean squared deviation (RMSD in g N ha−1 d−1) for the different sites as in equation 9:“

The sentence makes no sense and needs to be revised.

L 318: “years.In observations“ : Missing space after the point

Fig 3: Use capital letters for the sites, use n = 123 instead of n= 123; What is the number on top of each box? (-> add explanation to the caption); round consistently.

How would the relationship of WFPS vs N2O for nitrification and denitrification look like? Could you plot these for DayCent and LPJmL?

Result section: Use past tense consistently.

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