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Interactive comment on "Constraining a complex biogeochemical model for multi-site greenhouse gas emission simulations by model-data fusion" *by* Tobias Houska et al.

Anonymous Referee #1

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General comments

In this study the authors compare the DNDC model simulations of N2O and CO2 emissions against measurements across three different landuse types (arable cropping, grassland, forest). This comparison against different land-use types, as well as the multi-objective Bayesian model calibration method should be of interest to other researchers in this area.

One weakness of this study is that there is no attempt to verify the model calibrations with a independent data. Given that there were three years' data it would have been possible to use two years for the parameterisation and then test the model using the third year's data. (Although this might not work so well for the arable land where the

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crop types change between years).

Another problem is that the CO2-equivalent values of N2O emissions are incorrectly calculated. It should be noted that the GWP values convert from kg N2O to kg CO2, not kg N2O-N to kg CO2-c.

This MS would benefit from editing by a native English speaker as there a numerous grammatical errors. Also, results should be consistently presented with their corresponding errors.

Specific comments

2.2 Trace gas measurements

- Were any measurements other than CO2 and N2O made?

2.3 Modelling approach

- This section contains very little information about how the LandscapeDNDC model works. What processes does it consider, what timestep does it work at, what drivers does it consider? Is it 1, 2, or 3-dimensional? Later in the MS it is mentioned that the model does not consider lateral flows of water and nutrients. This should be mentioned here as many readers might expect that a "Landscape" model would consider horizontal flows.

- pg 5, line 3: If only G1 can be modelled then G2 should not be included in Tables 2 and 3. If G2 is sufficiently different from G1 then it does not make sense to average the results for these two systems

Table 1

- A column with management practices applied (e.g. manure and fertiliser applications) would also be informative

- Why are the ranges for organic C and N expressed as high-low when all the other

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ranges are low-high?

3.1 Measured N2O fluxes

- pg 6, line 27: Need to clarify what you mean by "no statistical difference over time". Do you mean no differences in the annual cumulative emissions?

- pg 6, line 27: "Highest emissions occur after management events". This is not always true. For example, between May and Sept 2014 there's a measured peak several months after the last management practice

- pg 6, line 30: CO2e incorrectly calculated. 4.5 kg N2O-N = 7.07 kg N2O (4.5 * 44/28) = 2107 kg CO2e (7.07 * 298) = 575 kg CO2e-C (2107*12/44)

- Grassland N2O: Given that the grazed site and the wetland have different management, soil and vegetation properties it seems strange to combine them both as a single "grassland" type.

- pg 7, lines 21-22: Conversion of emissions to CO2-Ce is incorrect (see comment for pg 6, line 30)

- pg 7, line 22: How was the emission factor of 5.4% calculated? According to Table 4the manure N input was 7.57 kg N/ha/a. Assuming no background emissions this gives an emission factor of 0.29/7.57 *100% = 3.8%

- pg 7, line 7: The percentage differences between the forest transects are incorrectly stated. For example, W1 has 3x the emissions of W2, but this is a difference of +200% not +300%. Similarly for the difference between W3 and W2

- pg 7, line 30: The measured negative fluxes are all small compared to the measurement error. Therefore, how do you know that the negative fluxes are real and not just the result of measurement error?

- pg 7, line 33: Figure A3 shows the WFPS, but it doesn't the correlation between negative emissions and WFPS

- pg 7, line 34: Conversion of emissions to CO2-Ce is incorrect (see comment for pg 6, line 30)

- pg 8, line 1: 0.08 is almost two orders of magnitude smaller than 5.1

Table 2

- The A3:A3 and G1:G1 squares should be blocked out

- G1 and G2 should be separated into two separate categories (grassland and wetland)

3.2 Measured CO2 fluxes

- I disagree with the decision to use different definitions of 'CO2 emission' depending on land use. I think it would be clearer to use distinct terms such as TER and below-ground respiration to avoid the potential for reader confusion

- In general measured values should be quoted with uncertainties in this section

- pg 8, line 21-22: It is confusing to talk about a weekly measured value and then give the units in dayˆ-1

- pg 8, line 21-22: What are these results "not significantly different" from?

- pg 9, line 5: What were the measured CO2 fluxes negatively correlated with?

Table 3

- The measurements from G1 and G2 should not be averaged as these systems were sufficiently different that only G1 was able to be modelled. Also, Table 2 explicitly states that G2 was not modelled. This should also be stated in Table 3

Figures 3 and 6

- For the arable and grassland sites the total DNDC results contain values higher than any that occur in the individual seasons. How is this possible?

- It is confusing to include G2 in the grassland results as the model was only run for the

G1 system

3.3 Modeled N fluxes

- pg 10, line 17: The uncertainty in NO3- leaching is actually the largest in Table 4

- pg 11, line 1: Need to be more specific about what you mean when you say emissions were highest in spring. Are you talking about the total, mean, median, variance, upper quartile, or maximum of the emissions?

- pg 11, line 16: It is not clear what is the simulated N loss large in comparison to? It could be the grassland N inputs or the losses from the arable system.

- pg 11, line 19: Do you have any evidence of what is happening to organic N stock in the real system?

- pg 11, 19-20: It does not make sense to say that the model is mimicking an additional N source that is not included in the model. The model can only simulate what has been included in the model.

- pg 11, line 26-29: What stocking rate was used for the grazing? Note that for grazed systems the emissions will be spatially as well as temporally peaky. In the grazed system the animal urine patches will create emissions hot spots. With only 5 chambers it is possible that the measurements could miss these hot spots. Meanwhile, the DNDC model will assume that the manure is uniformly spread over the field, producing emissions that are likely to be higher than those from non-urine patches, but lower than those from urine patches.

- pg 11, line 34: Total output is 1.82, total leaching is 0.04, therefore leaching is 0.04/1.82 *100% = 2% of output.

- pg 12, line 7-9: Measured range 0.18-0.48 kg N2O-N/ha/a does not overlap the measured range of 0.03-0.09 kg N2O-N/ha/a.

Table 4

- Should the forest NH3 emission be "<0.01" rather than ">0.01"?

3.4 Modeled C flux

- pg 14, line 12-13: Not sure what the relevance of Figure 7 is here. The statement "mean modeled fluxes are substantially lower than measured ones" contradicts the results in Table 3

- Arable C cycle: There will be some confounding effects in the before/after tillage and before/after harvest emissions in Figure 7. Unless there is a >2 week gap between harvest and tillage the "pre-tillage" results will include some post-harvest effects and the "post-harvest" results will also include some post-tillage effects. Some discussion of how the model handles tillage and harvest events might be informative here.

- pg 15, line 6: it is a little odd to describe increasing soil C as an "output" as the C is remaining within the system

- pg 15, line 6: Include uncertainties here. In particular it is important to note that the model cannot determine whether the system is net gaining or losing carbon.

Table 5

- Should DOC leaching be "<0.01" rather than ">0.01"?

Conclusion

- Table 6: New results shouldn't be presented in the conclusions. This Table should be in the Results and discussion. There also needs to be an explanation of how the model performance was classified as good, medium, or poor.

- Include uncertainties with results

- It is uncertain whether the grassland was acting as a sink or source of C as the balance 1.35 +/- 4.74 t C/ha/a. Therefore both positive and negative values are within the uncertainty range.

Technical corrections

pg 2, line 14-15: Models are not "driven by" uncertainties. Might be better to use "with"?

pg 2, line 15-16: Revise to "During model application further uncertainties arise due to the uncertainties in the applied forcing data"

pg 6, line 24-25: reference to (Fig. 3), (Fig. 4), and (Fig. 5) should be (Fig. 2), (Fig. 3), and (Fig. 4) respectively

pg 6, line 25: Table 4 is referred to before Table 3

pg 7, line 28: "contribute" should be "attribute"

pg 8, line 20: "N" should be "C"

pg 14, line 10: Delete "perfect"

pg 14, line 17: There is no section 3.1.2

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