

(comments of the referees are printed in blue, responses of authors are held in black)

We would like to thank the reviewer #2 for his highly constructive comments on the manuscript bg-2017-96 “Constraining a complex biogeochemical model for multi-site greenhouse gas emission simulations by model-data fusion”

## Response letter to Reviewer #2

The authors used a model-data fusion method to constrain the LandscapeDNDC model with multiple-year greenhouse gas fluxes from arable, forest and grassland sites. I appreciate the authors’ effort to parameterize biogeochemistry models using long-term field data. I would like the authors to further clarify some of my concerns:

(1) Is LandscapeDNDC a multi-layer (i.e., vertically-resolved) model? If yes, how many soil layers are included and how do you model the fluxes between layers?

The reviewer’s assumption is correct, LandscapeDNDC is vertically-resolved. We included the missing information about the number of layers (arable=85, grassland=40 and forest=45) into the description of the model set up (chapter 2.3.1) and added more details on how the fluxes are modeled: “The watercycleDNDC model simulates soil water dynamics, i.e., potential evapotranspiration based on Thornthwaite and Mather (1957), transpiration depending on gross primary productivity, the water use efficiency of the modelled plant types and soil water flow based on a cascading bucket model approach (Kiese et al., 2011). The latter determines the advective transport of nutrients into deeper soil layers.

All models refer to a one-dimensional soil column, i.e., assuming homogeneous conditions in lateral directions, and were run with a daily time step resolution.”

(2) In Tier I and TierII, do you include the same parameters, e.g., all parameters in Table A1? To my understanding, hydrological parameters (e.g., in wcdNDC module) controlling soil water (represented by WFPS) in Teir I will also influence N<sub>2</sub>O and CO<sub>2</sub> in Teir II; however, some key parameters governing the biogeochemistry processes (e.g., in METRX module) do not necessarily affect soil water.

We investigated this potential effect and found no major differences between the WFPS simulation between tierI and tierII. We included this statement into the manuscript and added also some information, which parameters of Table A1 were used in tier I and II.

(3) page 6: please further explain “within best 5% of all simulated RMSEs”. Do you mean the best 5% of total number of simulations or the best 5% of unduplicated RMSEs? If it’s the former, the number of accepted model runs depends on the total number of model runs. Since multiple objectives (e.g., WFPS in different depths) are considered, do you integrate them (RMSEs) into one single objective? If not, how do you determine the acceptance of a model run?

We added the missing information in the manuscript. The text reads now: “This time, we considered the best 5% of all RMSEs in terms of the respective N<sub>2</sub>O and CO<sub>2</sub> emissions for each land use (A1-3, G1 and W1-3).”.

(4) Table 6: what are the criteria used to classify model performance?

The criteria result from a subjective classification of the model performances compared with each other. We added this information in the table header and where it is referenced in the manuscript.

Other minor comments:

(5) Table 1: Since the model DNDC include inorganic N, what’s the inorganic N amount used in the model?

The model considers various inorganic N species (NH<sub>3</sub>, NH<sub>4</sub>, NO<sub>3</sub>, NO, N<sub>2</sub>O, NO<sub>2</sub>). Respective amounts are dynamically calculated during the simulation and depend strongly on field management such as fertilizer (i.e. inorganic nitrogen) application, which we added in Table 1. Regarding model initialization Tab. 1

presents initial values of total soil nitrogen (inorganic and organic). We changed the term accordingly. However, organic soil nitrogen represents by far the dominating initial N pool (>99%).

How do you initialize the model? Using measured values (e.g., Table 1) or implementing model spin-up?

We added the missing information in the manuscript. The text reads now: “We run simulations for all land uses at a daily time resolution for 6 years, starting on 1<sup>st</sup> January 2010, using the data from Table 1 as initialization and using a model spin-up time of two years.”

(6) please use month names (e.g., January, February,...) to indicate the month in a date (e.g., 01.11.2013)

Changed as proposed.