Geoscientific
Model Development
Discussions

Interactive comment on "Calibrating a wetland methane emission model with hierarchical modeling and adaptive MCMC" *by* Jouni Susiluoto et al.

Anonymous Referee #2

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The objective of this paper is to use observed carbon flux time series in order to optimize parameters of a peatland carbon flux model. In general, this is a timely and important work. However, I found several serious issues with this manuscript including potential flaws in the method that does not allow a publication in the present form.

Please, indicate in abstract and introduction, what is the overall objective of this model e.g. in future applications? Do you want to apply it exclusively for this one peat site and for which question? Do you want to apply it on a continental to global scale, e.g. as part of a land surface scheme? In the latter case, several model assumptions are not useful (effective peat depth, C pool-independent decomposition flux), and a lot of work

on parameter optimization seems to be questionable when only data from one specific site is used.

Major comments to sqHIMMELI assumptions:

In both aerobic and anaerobic cases, organic matter decay seems to be a constant parameter not depending on substrate availability. When peat depth would have been set constant to the observed site-level value, then this could be valid for the specific site but then we do not learn anything from the parameter optimization procedure for a generally applicable dynamic model.

Effective peat depth: This assumption makes no sense at all. Peat depth should be a constant value corresponding to the site observation. See below for related flaws in eq 5.

A2 Anaerobic respiration producing CH4: It seems from eq. A5-A8 that you apply a CH4:CO2 ratio of 1:1 for anaerobic decomposition of root exudates. If so, please make this statement explicit and cite experimental literature showing this ratio. In section 3 it is also fully unclear if you consider anaerobic CO2 production or not.

Eq. 5: is tau(cato) the mean residence time at 273.15 K? The unit (y) in Tab 3 is not correct because in eq. 5 you do not multiply with a C pool.

I expect the Finland peat being frozen with snowpack above over long time periods of the year. What are the effects of <273K soil temperature on aerobic and anaerobic decomposition? What are the effects of soil ice on gas transport and what are the effects of snow on gas transport?

Please include in results and discussions the exudate pool values.

Peat depth: Prescribing an effective peat depth will hinder any application of that model in larger dynamic models, such as land surface schemes or DGVMs. Peat depth is no parameter there that you can prescribe but included into the mass balance equations. If you define an effective peat depth then this would mean that you either introduce a

fully recalcitrant carbon pool (case peat depth > effective peat) or that you "produce" CH4 and CO2 from non-existing carbon (case peat depth < effective peat depth). That is not a valid and also not useful model assumption.

Major comments on the parameter optimization:

Tab 5: What is the reason for not including these parameters into MCMC optimization? I generally think that the information content in the data is far too low for an optimization of all model parameters, hence a selection will be useful. However, we need good reasons for such selection, either based on theory or based on a previous sensitivity analysis.

I assume there is additional CO2 flux data available at the site. It is totally unclear why this data has not been used for constraining in addition to CH4 parameters such as decomposition and transport parameters as well as oxidation parameters parameter values cannot be transferred to other similar models and even not to HIMMELI because of the peat depth parameter and because of important differences in model formulations: root depth distribution, decomposition parameterization, etc. What is the scientific value of the paper then? Do you plan to use this model version in future studies and not the HIMMELI model?

section A4: I do not understand the sentence "Due to coding mistake, the fD,a and fD,w coefficients in the aforementioned equations were set to 0.1 for gases other than CH4 in this work." Why do you set both parameters to 0.1? With a huge pore volume in peat soils I would expect a value of 0.8 or 0.9. If that is a tuning parameter then you should optimize it. These parameters are also not listed in Tab 5. Instead they are part of Fig 2 and this seems to be a real flaw in the procedure?

For clarity, please put units on all parameters in tables and figures or when describing parameters in the text.

I cannot understand the a posteriori optimized parameter values of tau_exu in the order

C3

of magnitude 0.00001 s (tab 3) when range is 3 to 30 days with a prior of 14 days (tab 2). From Fig 3 it seems there is a mistake in units in the table. I have similar problems with units of a posteriori V_0R which seems to be far too high. Zeta_exu seems to be with 0.5 also quite high and it would be good to see some comparison to literature values if available in the discussion.

tau(cato) ranges from 2000 to 20000 years (unit in tab 3 wrong however) depending on peat depth just because the model invalidly does not take the carbon pool into account for calculating the decomposition flux (eq. 5). Then of course, the deeper the peat the more C available the higher you need to have turnover time for the same flux. This is not a valid approach for a dynamic model.

A minor comment: I do not find it useful to have some methods description in the main text and some in appendix A but both relate so strong to each other that one understands it only when reading both together. Please move appendix A into main methods text.