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Biogeosciences Discussions

Interactive comment on "Priming and substrate quality interactions in soil organic matter models" *by* T. Wutzler and M. Reichstein

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We thank reviewer one for his constructive comments. They help us to state some issues more clearly in a revised version, which is provided with the final response.

1 General comments of reviewer 1

1.1 Microbial mechanisms versus substrate interactions

Reviewer one had one main issue: that 'priming is modeled . . . adding nonlinear interactions between compartments, instead of focusing on the mechanisms'

The aim of this paper is to present a way of implementing the basic dynamics with explicitly abstracting from details of mechanisms of microbial dynamics, i.e. not focusing on these details. This is valuable because parameterization of those mechanisms in larger scale models is difficult and introduces new uncertainties. There was also some confusion about the terms priming, substrate interactions, and microbial mechanisms. We stick to the definitions as cited from the introduction of the discussion paper:

Priming effect 'the enhanced or retarded soil organic matter (SOM) decomposition due to amendment of fresh SOM'

Substrate interactions 'decomposition rate of SOM of one quality is dependent on the amount of SOM of a different quality'. This is a refined view of what is causing the priming effect without the need of comparing to a control treatment.

Microbial mechanisms 'cometabolization of different SOM qualities by the microbial biomass of active decomposer'. This is one possible way of explanation why the substrate interactions are there.

It has not become clear enough in the previous version of the manuscript that all model variants have been derived from the most explicit model variance. Hence the limitation function (eq. 1, now eq 3) is not an a posteriori addition but an abstraction of the microbial mechanisms. It describes the same processes in a simpler form, i.e. with fewer parameters. To make this point more clear, we replaced the list of model differential equations in Appendix A by a more detailed description how the model variants were derived.

However, in order to extend the paper a bit more into the demanded direction of how microbial details affect the SOM decomposition, we included another model variant (AssimExplicit). It features more microbial details. Specifically it models the uptake of assimilable substrate dependent on maximum microbial growth rate and substrate affinity.

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Interactive Comment

1.2 Assumption of microbes near steady state

Reviewer one noted 'The proposed model implicitly assumes that these fluctuations will not keep microbes are 'too far' from their quasi steady state. Is this a reasonable assumption?'

We dedicated an entire section in the discussion to this point (Section 4.2: Short term environmental fluctuations). In order to prepare the way for an answer of this question, we redid the derivation of the model variants by explicitly including environmental modification of decomposition rates in the equations. Those can be provided as model drivers that change with time ($l_{e,j}$).

Active microbial biomass can indeed differ from its steady state during transient periods (we conducted preliminary experiments with fluctuations of the environmental limitation factor). However, we argue that the mean rates over decades are modelled correctly despite of such short-term misrepresentations.

2 Specific comments of reviewer 1

All suggestions have been considered. Those not mentioned again below have been directly applied to the manuscript.

P 17168, L 19: In order to avoid overstating the novelty of microbial role in decomposition, we cite also older works at the beginning of the introduction. The similar previous works of the microbial explicit model are cited in the more detailed model description in Appendix A.

P 17171, L 19: As suggested, microbial turnover has been added to the equation of assimilable substrate.

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P 17173, L 27: Correspondence between'microbial efficiency and humification factor is explained now in more depth in Appendix A.

P 17174 The rational of deriving the equations are now explained in more detail in Appendix A. The equation of the LimFresh variant has been omitted in the main text, as it became more complicated with the inclusion of environmental modifiers of the decomposition rates. The form using a parameter of minimum uptake is now better suited for this variant (see new Appendix A)

P 17177: See our general comments if the assumptions of steady state is reasonable and the new paragraph in the discssion (4.2 Short term environmental fluctuations)

P 17177, L 20: We now explicitly note at the beginning of the results section, that we compare models with each other instead of comparing to observation data.

P 17179:'without requiring substrate limitation functions on top of the multiplicative microbial-substrate interaction: As explained above, the substrate interactions are not 'on top', but a simpler (not involving microbial biomass) expression of the same mechanism.

Sect 4.5: The seemingly unmotivated section on microbial activity had been added on request of a former pre-Review for BGD. In an updated manuscript we wrote a new short motivation at the start of this paragraph.

P 17180, L 25:'only if microbial turnover is slow' We do not understand the suggestion.

Appendices: In order to highlight the abstraction process and the derivation of less complex model variants based on the more complex ones, we chose the opposite approach to reform the appendix. Instead of an overview table we transformed Appendix A into a text describing the increasing abstraction. This is now better explained in the manuscript.

Choice of initial limitation factors: We think that microbial community in the field is adapted to supply of fresh rhizodeposition and used high values of 80% or 20%. For

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the laboratory priming scenario, we assumed that soil was stored for some time. On missing substrate supply a larger fraction of microbial biomass probably goes to sustaining states. Hence we used a low initial microbial limitation limitation factor, i.e. low initial activity for the priming scenario. This is now better explained in the manuscript.

Interactive comment on Biogeosciences Discuss., 9, 17167, 2012.