Geoscientific

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Interactive comment on "Long residence times of rapidly decomposable soil organic matter: application of a multi-phase, multi-component, and vertically-resolved model (TOUGHREACTv1) to soil carbon dynamics" *by* W. J. Riley et al.

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The paper submitted by Riley et al. presents a new 1D model describing several soil processes such as adsorption, DOC production, transport etc. It explicitly represents the soil profile and is able to trace every C atom during simulations. The model is quite complex and aim to be an interesting tool to better represent the soil organic matter dynamic in Earth System Models (ESM). I particularly appreciate the effort to represent several complex mechanisms and to do it with the objective to couple such model with ESMs. The paper is well written and the reading is pleasurable. Moreover,

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Interactive Discussion

Discussion Paper

it is not only a model description paper, the discussion is quite interesting and clearly show that the authors know very well the problematic. I particularly appreciate the part 4.2 and 4.3 describing the limits of increasing soil module complexity in ESMs.

Therefore I recommend this paper for publication in GMD since it totally fits with the GMD scopes. Nevertheless I have few minor comments detailed below:

1. First, the evaluation made by the authors is quite qualitative because of the difficulty to find sites where all the processes represented are measured but I would appreciate a better justification for that (even if I understood why it has been done this way).

2. I appreciate the discussion but I believe that some lines are missing to discuss about the risk to use this kind of models, with several parameters, in ESMs. Indeed, tuning or optimization possibilities are quite high with an increasing number of parameters and I believe that a particular attention must be paid to ensure that parameters values make sense even after tuning and/or optimization. It is a personal opinion but I would prefer a model that does not perfectly fit the data but with parameters measured or at least in the range of the parameters measured instead of a perfect fit with totally stupid values for parameters.

P824 l5: I did not fully understood what the authors mean with 'unfolding capability'

P825 l14: 'we did not include the effects of pH', do you mean that g(pH) is fixed to 1 in equation (2)? Please clarify

P826 equation (4), (5) and (6), why there is some minus after the '=' sign?

P827 l10: BA is expressed in mgC-wet-biomass $L-1$ but litre of what soil, or soil solution?

P833 l7: There is no Fig 3a is the figures section please modify

P834; Section 3.2, there is no words about interaction effects between parameters, are all the effects only additive? The figures suggest that interaction effects may exist.

Please present these as a result and add few words in the discussion.

P835 l10: This sentence suggests that comparison with 14C data will be done and no data are represented in the corresponding figure. It is a bit confusing, please clarify.

Fig 4a. The legend is not clear, it represents microbial biomass but why there is lignin etc?

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