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Geoscientific Model Development Discussions

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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Thanks for introducing this interesting and highly relevant soil organic matter decomposition model. The new model (Riley et al., 2014) is based on 16 biochemical compound pools and – in my opinion – constitutes a major progress because it explicitly includes several processes that may explain the long-term persistence of organic carbon in soils.

I would like to raise three points that could help to clarify some aspects:

- You very openly discuss that under the current parametrization your model gives

too negative Δ^{14}C values in the first centimeters (P.835–L.12; P.839–L.27). Visual inspection of Fig. 6 d-f would suggest Δ^{14}C values of -100 ± 25 ‰ in the first centimeters. I would have expected that the modeled Δ^{14}C in the first centimeters would easily reflect that litter inputs have had a Δ^{14}C > $+69$ ‰ from 1957–2003 ("bomb-peak"). Could you elaborate which mechanisms in the model are right now responsible for negative Δ^{14}C values in the first centimeters, corresponding to conventional ^{14}C ages of around 900 years BP? Sorption processes? Very fast turnover of litter inputs? Could that also be related to the vertical resolution of the model?

- Throughout the text you use the δ^{14}C notation, but the Δ^{14}C notation in Fig. 6 d-f. Is this by accident? In my opinion, the Δ^{14}C notation should be preferred because it is independent of isotopic fractionation (Stuiver and Polach, 1977). Because one probably does not include isotopic fractionation due to photosynthetic fixation and microbial processing into the model, the Δ^{14}C notation should be more appropriate for model output.

- The distribution coefficient K_d is very helpful to get an idea about the sorption affinity of the different compounds (Table 2), you note, however, that you use a dynamic approach because of competing sinks and sources (e.g. microbial consumption). How do the adsorption and desorption rates k_f and k_r compare to the maximum specific consumption rates μ_i?

References

Riley, W. J., Maggi, F. M., Kleber, M., Torn, M. S., Tang, J. Y., Dwivedi, D., and Guerry, N.: 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, Geosci. Model Dev. Discuss., 7, 815–870, 2014.

Stuiver, M. and Polach, H. A.: Reporting of 14C data - discussion, Radiocarbon, 19, 355–363, 1977.