Geosci. Model Dev. Discuss., 7, C401–C403, 2014
www.geosci-model-dev-discuss.net/7/C401/2014/

Geoscientific Model Development Discussions

GMDD

7, C401–C403, 2014

Interactive Comment

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.

W. J. Riley et al.

wjriley@lbl.gov

Received and published: 25 April 2014

We thank B. Ahrens for his insightful comments on our manuscript, and attempt to address his three points below (his comments in italics and our responses in normal font).

1. You very openly discuss that under the current parameterization your model gives negative Δ14C values in the first centimeters (P.835–L.12; P.839–L.27). Visual inspection of Fig. 6 d-f would suggest Δ14C values of -100±25‰ in the first centimeters. I

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

would have expected that the modeled Δ14C in the first centimeters would easily reflect that litter inputs have had a Δ14C > +69 ‰ from 1957–2003 ("bomb-peak"). Could you elaborate which mechanisms in the model are right now responsible for negative Δ14C values in the first centimeters, corresponding to conventional 14C 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?

As you mention, the model predictions did not match expected enriched Δ14C values in the near-surface soil, which we believe indicates underlying mechanisms not represented in the model. As we discuss in the Discussion section:

"However, for context, we estimated that an increase of about 30 percent in SOC concentrations resulting from plant inputs over the past several decades would lead to a close agreement with observations. Thus, an additional young and protected carbon pool of small size (Fig. 3), and effectively not in equilibrium with the aqueous phase, can explain the difference between our predicted and commonly observed Δ14C values near the soil surface. Our model allows for an additional non-equilibrium carbon pool that could be tuned to match these Δ14C and SOC profiles, but we have avoided that type of tuning here. Processes that may be good candidates for this level of protection include aggregation and formation of colloids, which have been shown to substantially affect chemical mobility and carbon decomposition rates in soils (Daynes et al., 2013; Kausch and Pallud, 2013; Six et al., 2000)."

To clarify these points, we have indicated in the Results section that this discussion follows.

2. Throughout the text you use the Δ14C notation, but the Δ14C notation in Fig. 6d-f. Is this by accident? In my opinion, the Δ14C 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 Δ14C notation should be more appropriate for model

GMDD
7, C401–C403, 2014

Interactive Comment

output.

It was not by accident, but by error from the typesetters. Our submitted text used the Δ14C notation, and we will ensure that this problem is corrected in the final version of the paper.

3. The distribution coefficient Kd 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 kf and kr compare to the maximum specific consumption rates μi*?*

In the baseline version of the model, kf is 6.6e-8 per second and kr is scaled by the factors shown in the last column of Table 2. The maximum specific consumption rates are given in Table 3. Note that this comparison is not particularly helpful to understand the relative rates between these processes, since the maximum specific consumption rates are modified by the Michaelis-Menten kinetics (equation 1) and are therefore often much lower than the maximum values. We have added text to Section 2.6 to clarify the sorption rate values.

Interactive comment on Geosci. Model Dev. Discuss., 7, 815, 2014.