

***Interactive comment on* “Evaluating the simulated mean soil carbon transit times by Earth system models using observations” by Jing Wang et al.**

Jing Wang et al.

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Dear editor:

The authors thank all reviewers for the useful feedback on this manuscript. Some of those suggestion could improve my manuscript. We responded to the comments below, and we hope we could address the concerns from reviewers.

In this manuscript, the authors present observation-based estimates of transit times of carbon in soils and compare these estimates with model predictions. This is an important topic because transit times are a very good constraint for evaluating model performance. There has been a lot of recent research on this topic, motivated in part by the work of Carvalhais et al. (2014), who used a stock-over-flux approach to compute

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residence times from models and observations. Recent publications have shown that this approach has problems to compute transit times for systems of multiple pools and out of equilibrium (Lu et al., 2018; Sierra et al., 2017), and better methods for estimating transit times for systems out of equilibrium have been developed (e.g. Rasmussen et al., 2016).

Response: We thank the reviewer for the great summary. We will revise the introduction of our manuscript to highlight these milestone works as mentioned by the reviewer.

Major remark:

1) Despite these recent developments, this manuscript uses observations from incubation experiments and ^{13}C measurements from C3/C4 vegetation replacement experiments, in which the rate of soil carbon loss is estimated assuming one single pool in equilibrium. This is evidenced by equations (1) to (3) in Text S1 of the supplementary material. The implication of this assumption is that the observations are treated as a homogeneous system, without differentiating between the age of the stored carbon and the age of the carbon in the output flux. In the introductory paragraphs, the manuscript gives the impression that it provides an advance by providing observation estimates of transit times, but in reality, these estimates suffer the same problems of previous approaches. I recommend the authors to use the data they compiled to fit multiple-pool models to better estimate age and transit times from these observations. You probably would still need to keep the steady-state assumption for this type of observations, but at least you can remove the one-single homogeneous pool assumption.

Response: Many thanks for the thoughtful suggestion. We followed the reviewer's suggestion to fit the data to a three-pool model instead of the single pool approach. Then, we estimated the C transit time and age from the observations under the steady-state assumption. The estimated parameters and new results could be found as below in the Table R1 and R2, respectively. Please also find the details of the 3-pool model in supplementary material.

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2) For a fair comparison with the model output, I recommend you compute their transit time at the spin-up state, which better represent the equilibrium state of the model. In the current version, you compute model-derived transit times from a multi-year average, but this corresponds to a transient state where transit times are not unique.

Response: Thanks for the great suggestion. We will additionally analyze the modeled transit time over 1850-1860, when the models were spun up to steady state. Using the modeled data over 1850-1860 and 1995-2005 (the original results) both have pros and cons. For example, the estimated C transit time based on 1850-1860 results holds the equilibrium assumption but neglect the changes of C transit time over time (i.e., the observations are from the recent decades). The original results (i.e., over 1995-2005) were not derived from the equilibrium state, but they catch the time period of the observations. We will discuss this issue in the revised version.

3) Another aspect that requires clarification is the computation of the transit time distributions in Figure 1b. How were these distributions obtained from the data? Did you assume a specific distribution function and fitted its parameter values using the data? This seems to be the case for the 13 and the stock/flux data, but not for the incubations. Please clarify.

Response: We used the Gaussian kernel density estimation (KDE) to obtain the distributions in the Fig. 1b. We added the information in supplementary material.

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Please also note the supplement to this comment:

<https://www.biogeosciences-discuss.net/bg-2018-342/bg-2018-342-AC2-supplement.pdf>

Interactive comment on Biogeosciences Discuss., <https://doi.org/10.5194/bg-2018-342>, 2018.

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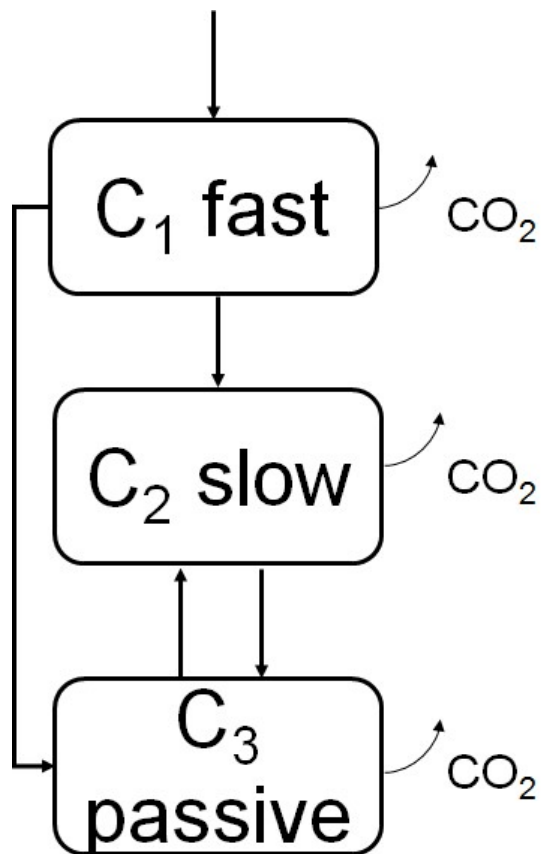


Fig. 1. The diagram of model.

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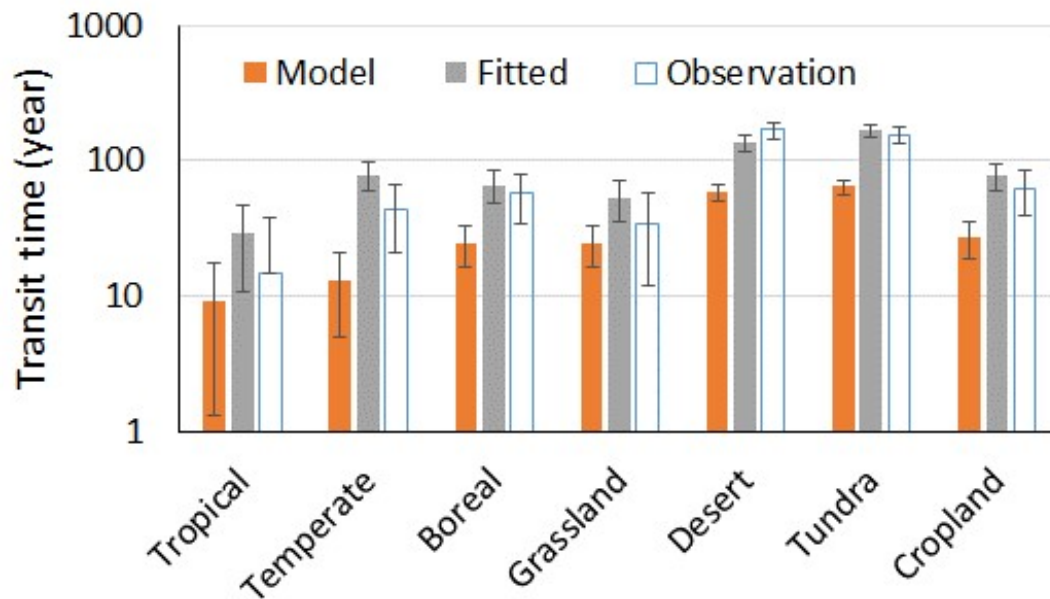


Fig. 2. The transit time calculated with CMIP5, fitted three-feedback-pools from pool-flux approach, and the whole observation transit time.

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