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 in blue below, and we hope we could address the concerns from reviewers.

Reviewer 1: In this paper, the authors evaluate soil carbon transit times in 12 CMIP5 models. They found that, compared to in-situ observations, transit times are usually underestimated by models, especially in cold regions and dry/hot regions. The authors show that some of these biases can be resolved by adopting more vertically-resolved parameterization of soil C dynamics with the CLM4.5 model.

Response: Thanks for the clear summary of our manuscript.

Major remarks:
1) I have concerns about this manuscript as it seems very similar to previous papers by e.g. Todd-Brown et al. (2013): the same models are evaluated with the same HWSD-MODIS based product. The novelty here is the comparison of models against transit times measured in worldwide soils, and I think it should be the main aim of the study. If the authors decide to keep the global evaluation, the HWSD-MODIS product should be confronted to in situ observations to justify its use as a global benchmark or, alternatively, the creation of this database could be used to derive a more robust global product.

Response: We agree that Todd-Brown *et al*., (2013) has done the wonderful evaluation on the large uncertainty of soil C turnover time based on the HWSD-MODIS products and 12 CMIPS models. As pointed out by the reviewer, the unique contribution of our study is using the in-situ observations to benchmark the global models. In order to avoid the confusion, we will follow the reviewer's suggestion to remove the results based on HWSD-MODIS products (i.e., panels c and d in the Fig. 3) in the revised version. We also fitted a three-pool model with the observations in the revised version. Please see the updated Figure 3 as below:

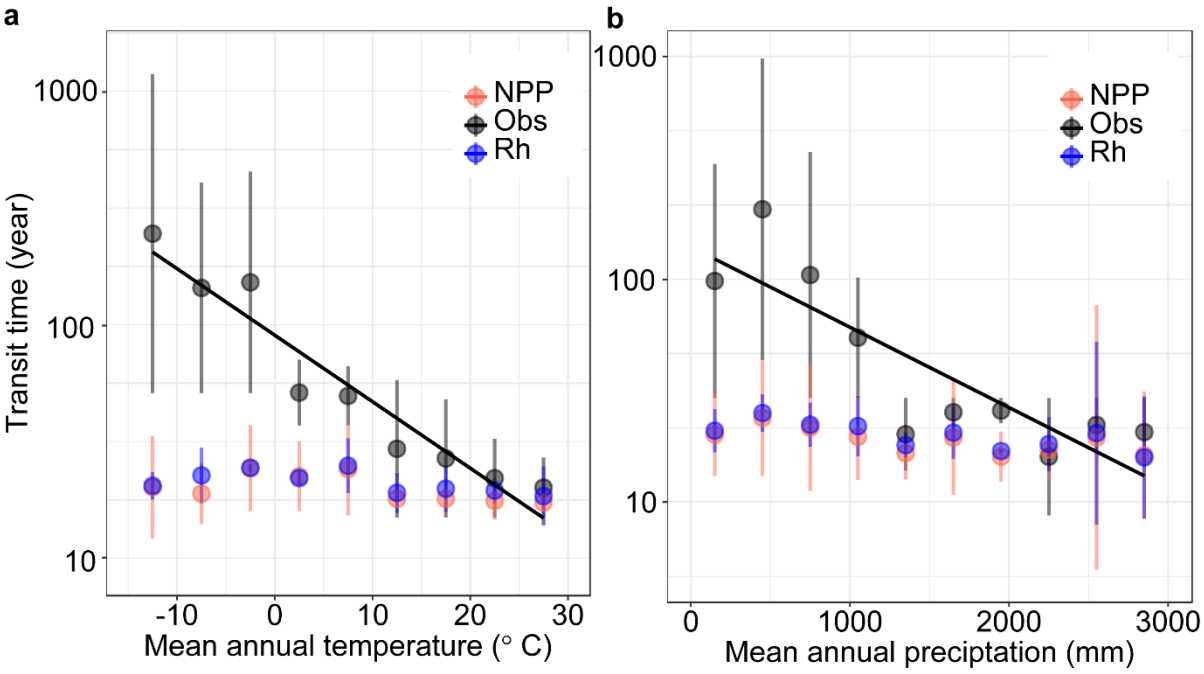

Figure R1. Relationships between transit time (log) and climate factors in both observations and CIMP5 models. The black solid lines show the negative correlation between τ_{soil} and (a) mean annual temperature and (b) mean annual precipitation. The black dots indicate the aggregated τ_{soil} over each category of MAT (y= -5.47x+1971.5, r^2 = 0.49, P<0.01) or MAP (y= -68.19x+1222.6, r^2 = 0.60, P<0.01). The red and blue dots present the mean value of the multiple models based on the ratios of carbon stock over NPP and R_h, respectively.

2) Section 3.2 is very hard to understand. It is not clear whether models are evaluated against the in-situ observations, or whether they are evaluated against the HWSDMODIS based global product (as it seems in Figure 3). The discussion around improvements due to the addition of a vertical resolution in CLM4.5 is reduced to less than 10 lines while it seems to be one of the key findings of the whole study.

Response: The Section 3.2 was mainly the evaluation of models against the in-situ observations. In this version, we will make this section clearer by:

(1) We will add more details about the comparison between model results and the in-situ observations. In brief, only the grids containing the locations of in-situ observations were selected from the models for the comparison.
(2) To avoid confusion, we will remove the HWSD/MODIS results in this version.
(3) The original results will be replaced with the new results based on the 3-pool model.
(4) The results based on the vertical resolution in CLM4.5 will be expanded.

Specific Comments:
p3 l 21-29: which period of the historical simulation did the authors consider?

Response: The historical period is from 1995 to 2005. We have made it clear in the revision.

p3 l30: I find that there is a missed opportunity here to use in situ observations to derive a more robust global dataset of transit times. HWSD and MODIS NPP both come with known biases and there may be other products to choose from e.g. soilgrids (www.soilgrids.org).

Response: As mentioned above, we will remove the results based on HWSD and MODIS in the revised version. We thank the reviewer for the suggestion of deriving a robust global dataset of transit time based on the observations. This task is scientifically very important, but is difficult at the current stage due to a few reasons. First, the available observations is limited by the unequal quality and the uneven spatial distribution of the locations. Second, no data-driven approach is ready for deriving a global dataset of C transit time based on the observations. Third, it is difficult to reduce the methodological uncertainty of data (e.g., Fig. 1b) in integrating them into a given model for global calculation. We will discuss this issue in the revised manuscript.

p6 l30-35: I do not understand what is learned by replacing MODIS NPP with TRENDY models (which ones? reference is missing here). Does that mean that TRENDY is considered as an observation of NPP against which ESMs are evaluated?

Response: The results from TRENDY and MODIS NPP will be removed in this version. Also, we agree with the reviewer that TRENDY NPP cannot used as observations.

Figure 2: from the legend, panels c and d are missing. Panel a is hard to understand and uncertainties are missing from panel b.

Response: Sorry for the confusion. We will correct the figure legend in the revised version. More sentences will be added to explain the panel a, and the uncertainties will be added in the panel b.

Figure 3: in panel a and b, do black dots represent data from the 187 sites? or were they extracted from the HWSD/MODIS product?

Response: The black dots represent data from 187 sites in panel a and b in Figure 3, we grouped them into different levels of climatic variables. We will revise the figure legend to make it clearer. Also, the panels *c* and *d* will be removed to avoid confusion.

References

Todd-Brown, K.E., Randerson, J.T., Post, W.M., Hoffman, F.M., Tarnocai, C., Schuur, E.A. and Allison, S.D.: Causes of variation in soil carbon simulations from CMIP5 Earth system models and comparison with observations. Biogeosciences, 10, 1717-1736, https://doi: 10.5194/bg-10-1717-2013.