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Interactive comment on "Ecosystem carbon transit versus turnover times in response to climate warming and rising atmospheric CO_2 concentration" *by* Xingjie Lu et al.

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Dear Referee 2:

We are very appreciated your comments on our manuscript. We have carefully read your comments. Hopefully, you will find our response satisfactory.

Xingjie Lu

On Behalf of all co-authors

Reviewer 2: Lu and colleagues use the CABLE model to show: a) how turnover time and transit time diverge under transient global change simulations, and b) decompose

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the contribution of turnover time between the age structure of ecosystem pools and their contribution to the output flux. This is an exciting and important paper. Previous studies have shown how turnover time contributes to our predictive uncertainty of the future response of the terrestrial biosphere to global change (e.g. Friend et al., 2013). However, this study nicely shows that turnover times themselves can also be an uncertain metric to assess model performance and quantify carbon storage potential in the terrestrial biosphere under non steady-state conditions. The manuscript expands on previous work by Rasmussen et al. (2016) who developed formulas for the mean transit time for non-steady-state conditions. It shows how global change drivers such as warming and CO2 can modify the time that carbon requires to transit through the terrestrial biosphere. The implications are not only for comparing two different modeling metrics, but it helps to understand how global change modifies the time scales of carbon storage in the terrestrial biosphere.

Response: Thanks for the positive comments on our manuscript.

Reviewer 2: Unfortunately, the manuscript has problems with the English language (typos, grammar), but if these issues are addressed with the help of a native English speaker, the manuscript can be published with minor revisions. I only have a few minor comments to help improve the manuscript:

Response: Thanks for the suggestion. We will find an English native speaker to help edit the language.

Reviewer 2: Line 22. Increase with respect to what? Do you mean increase in the transient simulations with respect to steady-state? Please clarify.

Response: Yes, increase with respect to steady state. We will revise the sentence to be clearer.

Reviewer 2: Line 29 plus 3 other occurrences. Change Olsen to Olson.

Response: We will revise all of them as suggested. Sorry for the typos.

Reviewer 2: Figure 2. I don't understand why you plot together the turnover times from Carvalhais et al. (2014) versus the dynamic transit times. They are conceptually different and computed in very different ways. This figure gives the false impression that these metrics should be compared, and that they are roughly equal, which this very same manuscript clearly shows that they are not. I suggest removing this figure to avoid confusion.

Response: Thanks for pointing out the confusions we might have made without enough details. We agree that turnover time and transit time are calculated in different ways. However, theoretically, turnover time and transit time should be strictly equal under steady state condition (Sierra et al., 2017). Our assumption, which is also used by some other studies, is that ecosystem C cycle may be close to the steady state in present-day, however, climate change may drive C cycle to a non-steady state in the future. Therefore, C transit time is comparable with C turnover time at present-day in Fig. 2. This figure serves as a validation of our model against the observations, which is very important for a modeling study. More importantly, reviewer 1 really likes it. As such, we would keep Figure 2, but will add more details, e.g., our assumption, in the figure caption and will change "Rasmussen method" to "model simulations" to avoid any confusions.

References:

Sierra, C. A., Muller, M., Metzler, H., Manzoni, S., and Trumbore, S. E.: The muddle of ages, turnover, transit, and residence times in the carbon cycle, Global Change Biol, 23, 1763-1773, 2017.

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