

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2021-924

Anonymous Referee #2

Referee comment on "Observation Based Budget and Lifetime of Excess Atmospheric Carbon Dioxide" by Stephen E. Schwartz, Atmos. Chem. Phys. Discuss.,
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This study by Stephen E. Schwartz used a five boxes model to trace turnover time of anthropogenic carbon emissions. This manuscript actually simplified the complex global carbon-cycle in real world by a simple box-model, but indeed is a long and "complex" paper. After reading the manuscript, I agree that simple box-model can answer the questions raised in this study. As I do not have expertise on ocean carbon cycle, I did not check the equations for the ocean part. For the terrestrial carbon cycle, I would like to remind the progressive nutrient limitations on CO₂ fertilization, which may have impact on the turnover time estimated in this study. Overall, this study could be publishable on scientific views, but the organization and representation could be improved more friendly to readers.

Before showing results of this study, one figure of a five boxes model and fluxes between boxes with their notations most shown in Table 1 would be helpful to understand the text.

I believe the principle "Entities should not be multiplied unnecessarily", and support the simple box-model used here to investigate the turnover time of excess carbon on a global scale. But lots of uncertainties should be acknowledged for the simple model or assumptions, such as nutrients limitation on CO₂ fertilization mentioned above, land use and land over change, and land-to-ocean carbon flux/exchange (<https://www.nature.com/articles/s41586-021-04339-9>), tipping points of carbon cycle (e.g., forest dieback, permafrost thaw) etc. These caveats should be uncovered to readers along with the conclusion in this study.

I suggest that the text would be more concentrated on turnover time estimates, now validation or/and calibration of the box-model mixed with the scientific questions. Mixing all together is difficult to find the threads.

In the abstract, line 19, what are the current carbon-cycle models? Not clear here.