

Earth Syst. Dynam. Discuss., referee comment RC2  
<https://doi.org/10.5194/esd-2021-42-RC2>, 2021  
© Author(s) 2021. This work is distributed under  
the Creative Commons Attribution 4.0 License.

## Comment on esd-2021-42

Anonymous Referee #2

---

Referee comment on "Effect of the Atlantic Meridional Overturning Circulation on atmospheric  $p\text{CO}_2$  variations" by Amber Boot et al., Earth Syst. Dynam. Discuss., <https://doi.org/10.5194/esd-2021-42-RC2>, 2021

---

Boot et al used a box model SCP-M to study the effects of AMOC on atmospheric  $\text{CO}_2$  under two climatic boundary conditions: preindustrial and LGM. They included seven additional feedbacks into the model and implemented 13 experiments under each climatic scenario by considering different combinations of these feedbacks. They also used AUTO software to scan the parameter space and detect bifurcation. It is suggested that the  $p\text{CO}_2$ -AMOC relationship relies most on the biological processes and climatic boundary conditions. The study is useful to understand the impact of each internal feedback on atmospheric  $p\text{CO}_2$  and provide insights on atmospheric  $p\text{CO}_2$  variability during glacial cycles. However, the paper is not very well written and hard to follow.

In the Introduction section, are there any papers using 3D OGCM to simulate the atmospheric  $p\text{CO}_2$ -AMOC strength relationship under PI and LGM? If so, these papers need to be properly cited.

Also, I have some major criticisms about the experiment configuration and robustness of the conclusions.

- I didn't see any experiments to test the plausibility of the box model to address the AMOC- $p\text{CO}_2$  relationship problem. I would suggest that you set up two more experiments fully including all the feedbacks you mentioned in Table 2 and check if the atmospheric  $p\text{CO}_2$  is reasonable under two scenarios.
- In general, I think all the experiments should be set up with other feedbacks properly included to make the case more realistic. For example, when studying the role of biological feedback ( $x_0$  and  $x_1$  in Table2), the  $x_0$  could be set up with all  $\lambda = 1$ ,  $x_1$  then should be only with  $\lambda_{BI}=0$ , etc.
- In lines 266-270, the three parameters are selected as control parameters: the rain ratio, the biological production and the piston velocity. Please explain the reasons for picking these parameters. Also, the multiplier changes from 0.1 to 10 without reasonable explanations. I would suggest using more realistic ranges.

Comments/concerns about specific feedbacks/parameters are below.

- In equation (2), the authors chose  $0.54^{\circ}\text{C}/(\text{Wm}^{-2})$  to compute the temperature change. As this parameter is important in equation (12) to control the AMOC strength, what is the sensitivity of this parameter to coupling AMOC-carbon cycle?