Author Response

Note: Reviewer comments in italics:

Wortmann et al. present the Earth Science Box Modeling Toolkit (ESBMTK), which is a Python library designed for building and analyzing box models in Earth science. It uses a modular, object-oriented approach to study topics like the long-term carbon cycle and the impact of atmospheric CO2 changes on seawater chemistry. ESBMTK separates model geometry from the underlying numerical implementation, and thus allows users to focus on the conceptual challenges, rather than mathematical theory. Such a tool is very useful for teaching and research requiring fast conceptual models. In addition to predefined setup, the user can customize rather easily his/her own model such as the number and volume of boxes/reservoirs, the flux between them, the isotope species, ... This tool will be very useful for the climate community, and I therefore recommend publication after minor revisions.

We would like to thank the anonymous referee for their time and thoughtful comments. Below is our detailed response:

1. *Several species are already defined in species$_{definition.py}$ such as stable water isotope 2H and 18O, 13C, ... I would recommend to add the 14C because it is quite usual to use ocean box modeling to model 14C, especially in the framework of IntCal. See for example Bard et al. (1997, https://doi.org/10.1016/S0012-821X(97)00082-4).*

    - The idea to add ^{14}C as species is a good one, and we can see the utility of it, even so it is outside our own expertise. We added ^{14}C $\Delta^{14}C$ to the list of carbon species, however, that is different from a full implementation of how ^{14}C fractionates relative to ^{12}C during air-sea transfer, photosynthesis, and CO_2 speciation. This would require that ESBMTK had the necessary data structures to express isotope systems with more than 2 components, as well as the necessary code to deal with radioactive decay. Given the universal nature of the library (as opposed to a specific model), this is no easy feat to implement, and beyond the scope of the current manuscript. We are however grateful for the suggestion as this is something we have not thought about, but will keep in mind for future revisions.

2. *In my opinion, it would be beneficial to give more details on the modeling of stable water isotopes 2H and 18O, and not only on the carbon-related species. The transport between the ocean box models are quite*

simple in that case (one to one), but the authors could mention how to set up a simulation when considering fractionation effect between atmosphere and ocean boxes e.g, the evaporation from the ocean to the atmosphere.

- We revised the isotope chapter of the manual and now show an example how to setup oxygen isotope exchange reactions during air-sea transfer, using the preconfigured values for oxygen. We additionally provide an example how to set setup oxygen isotope exchange reactions with user-defined values for the exchange and fractionation coefficients.

3. *The authors discuss the ESBMTK results with Boudreau et al. (2010a) model. They show the good ability of ESBMTK to replicate other models, which is important to encourage potential users to switch to ESBMTK. One other important aspect is to show how realistic model results are. Is there any way for the authors to compare the ESBMTK results with observations for a typical simulation (or with the setup of Boudreau et al. (2010a))?*

   - We are not sure how to respond to this comment. The MS already provides a detailed comparison with the Boudreau model. A comparison of the Boudreau model with observational data is outside of the objective for this paper, and would involve a detailed discussion on how to map the GLODAP data into an 3-box ocean model.

Minor and technical comments

- *Line 49: a point is missing.*
  - Fixed
- *Legend of Figure 1: remove ". caption".*
  - Fixed
- *Lines 62-63: In the following, we only describe the pertinent implementation details.*
  - Fixed
- *Table 2: I would show the information for the all the fluxes, and in the order F1, F2, F3, . . . , F9.*

  - Fixed

- *Legend of Table 3: all parameters are after Boudreau et al. (2010a).*
  - Fixed

References