An earlier incomplete version of the review response was uploaded on 24/11. Please refer to the final response below and the responses to the other reviews of our manuscript. Reviewer comments are in black text and our response in blue. We do not include a tracked changes version of the manuscript or a revised manuscript at this point as the editor request is to respond to the comments only and not to prepare a revised manuscript. We do provide in the response below edits that we would intend to include in a revised manuscript.

Peter Kohler

This is a potentially interesting study, which might gain from some more discussions of what has already been done with respect to CO_2 across the MPT. Some comments, which might be of interest to the authors:

This was a very helpful review, many thanks Peter for taking the time. The main change in response is to add new comparisons and discussion of the additional CO_2 observations and proxy data suggested and to further develop our discussion of the null hypothesis, which as a result we now consider cannot be rejected. We will provide a revised Figure 2 with the suggested records included, similar to below. More detailed discussion of the comparisons in the responses below and also in the responses to R1 and R2.

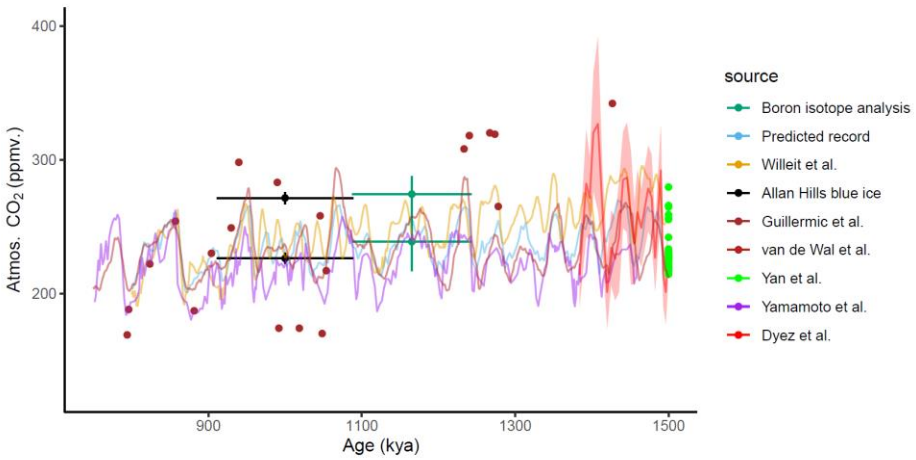

Figure 2 (revised): Predicted CO_2 (this work) and observed, proxy and modelled CO_2 from a range of other sources: $\delta^{11}B$-based pCO_2 reconstructions and measurements by Dyez et al. (2018), Guillermic et al. (2022) & Chalk et al. (2017); model simulation under a regolith removal hypothesis by Willeit et al. (2019); blue ice CO_2 measurements by Yan et al. (2019) & Higgins et al. (2015); δ13C leaf wax proxy reconstructions by Yamamoto et al. (2022); high resolution CO_2 reconstruction by van de Wal et al. (2011).

1. To be transparent in what has been done, the equation which calculates CO_2 out of the LR04 benthic $\delta^{18}O$ stack is missing. Plotting of the LR04 benthic $\delta^{18}O$, which is at the core of the approach is also missing.

We will include the form of the equation as:

$$CO_2 = -33.37 \times \delta^{18}O + 365.16, \text{ autoregressive correlation factor (AR): } 1$$

We will also include the LR04 stack in Fig 1.

2. Blue ice CO_2 data from Allan Hills have been extended in Yan et al (2019), now also containing snapshots of CO_2 at 1.5 and 2.0 Ma.

Excellent. We will include the Yan et al., 2019 data in a revised Figure 1 and in Figure 2. The data shown against our prediction is shown below (Fig R3-2). We would include new text on the resulting comparison:

> "A further argument against rejecting our model predictions is comparison to the Yan et al., (2019) Allan Hills BI-CO_2 data from 1.5 ± 0.21 Mya; here we see our predicted interglacial and glacial CO_2 levels closely overlapping with the upper and lower 25th percentiles of the BI data (Figure R1-2)."

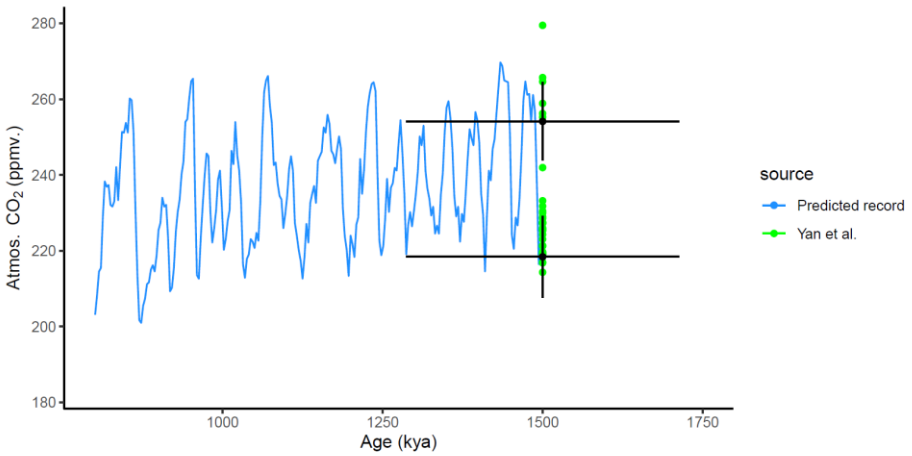

Figure R3-2: Predicted CO_2 (this work) and the Yan et al. (2019) blue ice CO_2 record from the Allan Hills. Black crosses represent the mean blue ice measurements at 1 Mya filtered into the upper and lower 25th percentiles (with 2σ errors) to represent interglacial and glacial stages respectively and averaged over their age uncertainty range (210kyr).

3. A recent paper by Yamamoto et al (2022) calculates CO_2 over the MPT from leaf wax d13C and finds that smaller glacial/interglacial amplitudes in CO_2 before the MPT are based on stable glacial CO_2, but smaller interglacial CO_2 before the MPT. This differs to the δ^{11}B-based CO_2, and if I got it right might support the here defined Null Hypothesis, which then cannot easily be dismissed.

Agree. The Yamamota data is shown against our predictions below (Fig R3-3). Their pre-MPT reconstruction trends below ours (and other observations) for glacial and interglacial stage CO_2. On the basis of this and the Yan et al (2019) BI-CO_2 data we can no-longer confidently reject the null hypothesis and will adjust the manuscript accordingly. In our view it makes for the more interesting that our simple GLS model cannot yet be rejected by the available data.

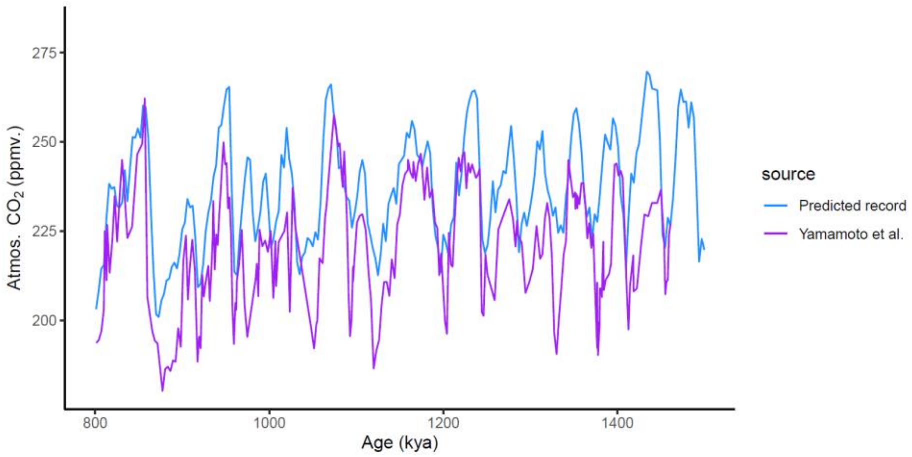

Figure R3-3: Predicted CO_2 (this work) and the Yamamoto et al. (2022) leaf wax-based proxy CO_2 record.

4. New CO_2 data based on δ11OB from Pacific cores have recently been published (Guillermic et al., 2022). Ok, data coverage across the last 1.5Ma might be weak, but worth discussing it.

You're right, average coverage across the MPT is not enough to filter into G/IG averages as we have done with δ11ON and the blue ice and many CO_2 values appear implausibly large. But we include the data in the revised Figure 2 and close up view below (Fig R3-4).

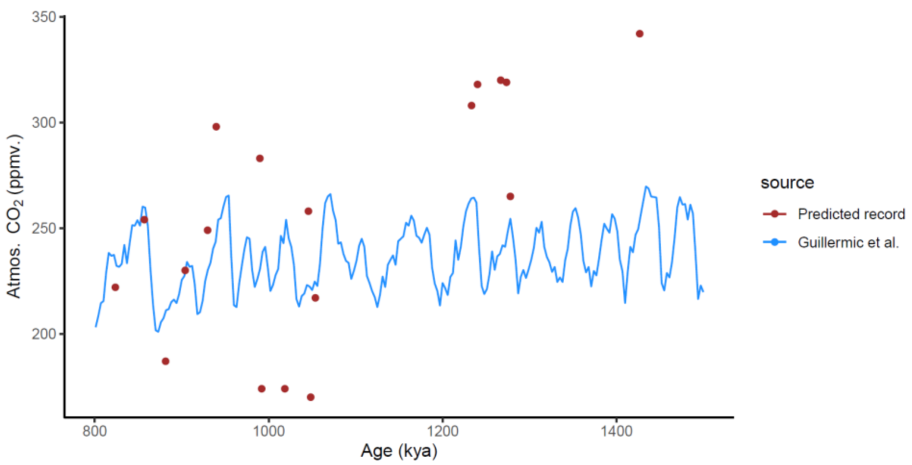

Figure R3-4: Predicted CO_2 (this work) and the Guillermic et al., 2022 δ11OB-based CO_2 data from Pacific marine sediment cores.

5. CO_2 as function of benthic $\delta^{18}O$ has in an inverse modelling approach already been calculated by Stap et al (2016). This approach has been updateded by Berends et al. (2021a). So comparison to their results might tell, how (if at all) this study shows something new.

Our CO_2 prediction, like Berends et., 2021a was both trained on data from the recent 800 kyr and motivated by comparison to the upcoming oldest ice core records. Our simple model yields a high correlation to the observed 800 kyr Bereiter et al., CO_2 record (r2 0.68) and our CO_2 predictions out to 1.5 Myr can not be confidently excluded by the available blue ice and CO_2 proxy reconstructions. From what I understand Berends et., 2021a does not make any evaluation or comparison to the discrete δ11OB and blue ice data over the MPT.

6. Maybe also discuss other approaches of CO_2 across the MPT, eg C cycle simulation results (apart from those in Willeit et al, 2020, which are cited) of Köhler & Bintanja (2006), or the compilation of at that time available CO_2 data and the calculation of a continous high-resolution CO_2 record in van de Wal et al. (2011), updated in Stap et al. (2018).

We are happy to include discussions of Kolhler and Bintanja (2006); from our understanding the paper also creates a model based on the LR04 benthic stack as a null hypothesis, which sets precedence to our method. We originally used the model by Willeit et al., as an example of a model-based trajectory in which CO_2 departs from the LR04 based predictions. We will include the data from van de Wal in Figure 2 and see close up comparison with our predicted CO_2 in Fig R-5 below.

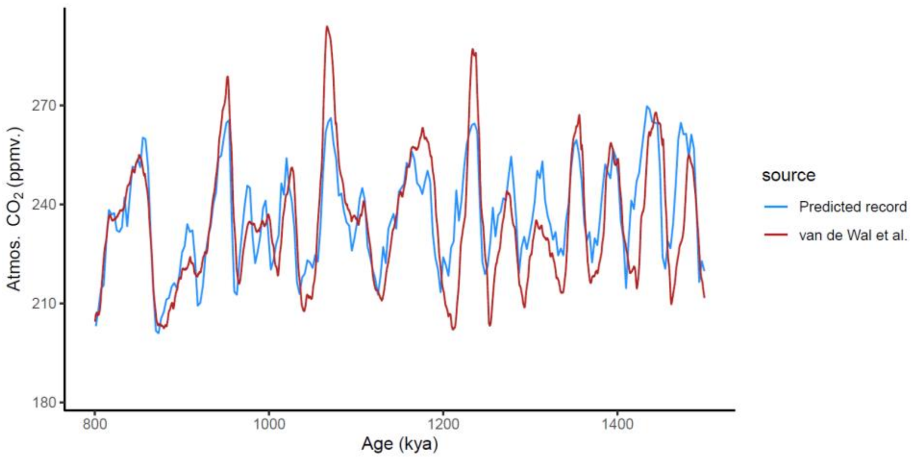

Figure R3-5: Predicted CO_2 (this work) and an alternative prediction from van de Wal et al., 2011.

7. The recent review on the MPT (Berends et al., 2021b) gives also an idea about processes including a collection of CO_2 data and discusses a potential influence of the carbon cycle on the climate transition.

Thank you. In response also to R1 and R2 we include a lot of new material and references to prior work on the potential physical basis of the regression between the LR04 stack and atmospheric CO_2 including treatment of the phase locking (or sometimes 'Antiphase') hypothesis of Raymo et al., 2006 which could alter the nature of the Southern Ocean contribution to CO_2 variability with respect to the timing of ice volume changes in the northern hemisphere ice sheets. Please refer to the response to these reviews. We will add reference to Berends et al., and include additional discussion of other proposed carbon cycle influences on the climate/ice volume across the MPT.

8. While mentioning the call for the EPICA challenge, maybe also cite / discuss its results (Wolff et al., 2005). They have been shown on 2 posters at AGU fall meeting in 2004 (PDFs for download at: https://epic.awi.de/id/eprint/11721/, https://epic.awi.de/id/eprint/11722/), on which you see, that

one of the participants to the challenge (N Shackleton) also used $\delta^{18}O$ to predict CO_2 for the 400-800 ky time window.

Thank you. We will add references and discuss the precedence in using $\delta^{18}O$ to predict CO_2 by N. Shackleton and add references to Berends and van de Wal around lines 61:

> "The use of benthic $\delta^{18}O$ to predict atmospheric CO_2 has precedence. In response to the EPICA challenge (Wolff et al., 2004), N. Shackleton (EGU, 2004) used this method to predict atmospheric CO_2 out to 800 kyr. Furthermore, inverse modelling of CO_2 using forced by the LR04 benthic stack has been undertaken by Berends et al. (2021a) and van de Wal et al. (2011)."

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