EGUsphere, author comment AC1
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Reply on RC1

Jordan R. W. Martin et al.

Author comment on "Predicting trends in atmospheric CO_2 across the Mid-Pleistocene Transition using existing climate archives" by Jordan R. W. Martin et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-574-AC1, 2022

Comment: *"However, my main concern is that the work is too simple. I would encourage the authors to add more intellectual substance to the paper by exploring perhaps nonlinear regression between benthic d18O and CO2 or…"*

Response: We appreciate where this comment is coming from in terms of the simplicity of the model. However, we believe that in this case the simple generalised least squares model is adequate. A Pearson's correlation test between d18O and CO2 yields a high correlation (r2) of 0.68 indicating fairly strong linearity between the two observed variables. The idea was not to model data to accurately predict CO2 past the MPT but to make a hypothetical CO2 history under the assumption that the climate-carbon-cryosphere system has remained unchanged over the past 1.5 Myr for a) comparison to realised 1.5 Myr records, and b) to compare to existing sparse data spanning the MPT. This simple model achieves this goal in that we can be confident the predicted values (outside of the current 800 kyr observable range) are accurate under an accepted null hypothesis. We acknowledge that non linearities may exist between the two datasets, however these are not constrained by any known mechanism.

Comment: *"…discussing in more depth the underlying mechanisms relating benthic d18O and CO2 to say more about the implications of potential misfit between CO2 and the regression-based estimate."*

Response: According to another review comment we revised at lines 58-59 to "The rationale in using the LR04 stack as an input parameter to predict CO_2 is based on the relationship of ocean temperature (of which $\square^{18}O$ is a proxy measure) with its ability to absorb CO_2 from the atmosphere. The solubility of CO_2 in the ocean decreases with increasing temperature meaning when the ocean temperature is warmer there is a lower concentration of CO_2 in the atmosphere." We will also tie in approaches by N Shackleton in the original EPICA challenge, and Berends et al. 2021 (https://doi.org/10.1029/2020RG000727) who both have used a d18O to predict CO2.

We will discuss the implications of potential misfit between CO2 and the regression-based estimate further in *section 4.1*.

Comment: *Abstract, line 18*

Response: Accepted and revised.

Comment: *Line 118*

Response: Accepted and revised:

Various studies conclude that glacial stage draw-down of CO_2 occurs across the MPT in the absence of interglacial draw-down (e.g., Chalk et al., 2017; Hönisch *et al.,* 2009). This trend is seen in our predicted record. The filtered BOR-CO_2 and BI-CO_2 data shows a strong glacial stage draw-down across the MPT when comparing the two sets of data: 238.69 ppm. and 226.2 ppm respectively. However, the data also exhibits a slight interglacial stage draw-down: 274.23 ppm., and 271.33 ppm resp. (Fig. 1C). The latter seemingly contradicts the studies that suggest an absence of interglacial draw-down but could also be due uncertainty in the data.

Comment: *Line 185-186*

Response: Accepted and revised:

"The hypothesis states that prior to the MPT, local, precession-driven changes to Northern and Southern Hemisphere ice volume was out–of–phase between the two hemispheres resulting in the suppression of these changes in the global marine sediment record, and domination by the obliquity paced changes in ice volume that were in-phase at the time (Raymo & Huybers, 2008). In terms of the MPT, the theory states that terrestrial–based ice sheet margins in East Antarctica were replaced by marine margins at the onset of the transition; and that this resulted in a change from out–of–phase to in–phase Northern and Southern Hemisphere ice sheets at the precession frequency. If this were the case, then a spectral analysis of a 1.5 myr CO_2 record (once sampled) should show significant power at the 23 kyr precession frequency prior to the MPT. Our predicted record, having inherited the spectral characteristics of the LR04 benthic stack, does not display any significant power at this frequency (Fig. A)."