



EGUsphere, author comment AC1
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Reply on RC1

Jordan R. W. Martin et al.

Author comment on "Predicting trends in atmospheric CO₂ across the Mid-Pleistocene Transition using existing climate archives" by Jordan R. W. Martin et al., EGU sphere, <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 (r^2) 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 CO₂ is based on the relationship of ocean temperature (of which $\delta^{18}\text{O}$ is a proxy measure) with its ability to absorb CO₂ from the atmosphere. The solubility of CO₂ in the ocean decreases with increasing temperature meaning when the ocean temperature is warmer there is a lower concentration of CO₂ 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 CO₂ occurs across the MPT in the absence of interglacial draw-down (e.g., Chalk et al., 2017; Hönlisch et al., 2009). This trend is seen in our predicted record. The filtered BOR-CO₂ and BI-CO₂ 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 CO₂ 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)."