

Clim. Past Discuss., author comment AC3  
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## Reply on AC2

Peter K. Bijl et al.

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Author comment on "Maastrichtian–Rupelian paleoclimates in the southwest Pacific – a critical re-evaluation of biomarker paleothermometry and dinoflagellate cyst paleoecology at Ocean Drilling Program Site 1172" by Peter K. Bijl et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2021-18-AC3>, 2021

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Apologies, something must have gone wrong in the process. Please find the complete review to Reviewer 2 below.

Reviewer 2 (anonymous)

General comment

The manuscript presents new paleoclimatic data from high southern latitudes that is consistent with previous interpretations for the region. A strength of the manuscript is that it also evaluates the strengths and weaknesses of proxies for sea surface temperature (SST) including isoGDGTs and mean annual air temperature (MAAT) including soil-derived branched GDGTs. The authors conclude that MAAT is consistently lower than SST during the early Eocene, independent of the calibration chosen and moreover, that the proxies fail to document a rise in MAAT during the PETM and MECO. The factors contributing to this discrepancy (i.e., a change in GDGT source) are discussed, however the incorporation of mixing models may help demonstrate this now that new data (see Lauretano et al. 2021, Nature Geoscience, accepted) is available for the peat/coal of interest.

**Response to reviewer:** We thank the reviewer for this suggestion. As of today (Jul 6, 2021) the cited paper is not yet available, therefore we cannot use the information as yet.

Specific comments

The authors discuss the potential contribution of terrestrial material from Australia throughout the manuscript. As such, reference pollen-based vegetation reconstructions from southeastern Australia should be included in lines 94-96.

**Response to reviewer:** This is a good suggestion.

**Proposed changes to the ms:** we will incorporate an overview of pollen-based vegetation in the suggested section.

In lines 172-175 the authors detail the incorporation of "substantial terrestrial input". Could you please clarify whether the source of the terrestrial input is deemed

contemporaneous or reworked or both?

**Response to reviewer:** The research done on the record (e.g., Willard et al., 2019; Sluijs et al., 2020) do seem to suggest that that terrestrial OM is quasi-contemporaneous to the marine sediments it was found in.

**Proposed changes to the ms:** we will add this to the section.

Could the authors please elaborate on why smaller Eocene hypothermal events do not stand out clearly at Site 1172. Is it for the same reasons as the PETM and MECO or other factors?

**Response to reviewer:** Continental shelf records in the Southern Ocean have a general tendency not to show much climate change associated to the early Eocene post-PETM hyperthermals (e.g., Bijl et al., 2013; PNAS), e.g., in TEX86-based SST and bulk organic carbon isotopes (P.K. Bijl, unpublished data). The reason for this is unexplained.

**Proposed changes to the ms:** no changes made.

Can you please elaborate on possible mechanisms facilitating the warm bias for TEX86-based SSTs in the sw Pacific?

**Response to Reviewer:** We are unsure where the reviewer wants us to elaborate on this, in the introduction or in the discussion? It either represents an overestimation of temperature by the SST proxies, or an underestimation of regional SSTs by the coarse-resolution fully coupled climate models, or a combination of both.

**Proposed changes to the ms:** We will make sure that this is adequately presented in the paper, e.g., at lines 79-83.

The inability to document a MAAT rise during the PETM and MECO is attributed to a switch in brGDGT sources, namely from soils and peaty lakes, that dampened the proxy response. Here you cite Holdgate et al. 2009 and say the source could be peats in SE Australia. However, earlier in the manuscript you mention that "rivers flowing from southeast Australia drained into the Gippsland and Bass Basins, and that terrigenous material is unlikely to have reached the ETP." Can you please clarify whether or not you think material from SE Australia could have reached site 1172?

**Response to Reviewer:** We thank the reviewer for pointing out this contradiction, and we understand the confusion. We feel it is unlikely that all terrigenous material found at ETP came from Australian hinterland: a source from Tasmania is more likely. There might however have been a minor contribution of clay, and clay-bound organic matter, from further sources, like the Australian hinterland.

**Proposed changes to the ms:** We will make the uncertainties in the sources of the terrigenous material clearer in Section 2.4, which leaves plenty of room for further interpreting our results in the discussion.

In addition, have you considered incorporating new brGDGT data (see Lauretano et al. 2021, Eocene to Oligocene terrestrial Southern Hemisphere cooling caused by declining pCO<sub>2</sub>, Nature Geoscience) derived from co-eval peats and deriving a mixing model (see Baczynsk et al. 2016 or Lyons et al. 2020 for mixing model examples)? This way you could test whether shifting sources of brGDGTs could be contributing to the absence of MAAT responses to the PETM and MECO.

**Response to Reviewer:** As much as we are looking forward to seeing the paper by Lauretano in Nature Geoscience, the paper has not yet been published, unless we overlooked.

**Proposed changes to the ms:** If it becomes available in time, we will incorporate that work into our paper, and consider the approach of a mixing model, provided that we think that would be appropriate for our investigation.

You mention that diversity and TEX86 have a modest correlation for long-term trends and short-term trends (PETM), but not the MECO. Can you please elaborate on why this trend doesn't hold true for the MECO?

**Response to Reviewer:** The why of this was left intentionally open, because we fail to have an explanation. Possible causes might be that the climate shift of the MECO is of critically slower time scales, leading to a less-dramatic ecological disruption. It is then strange, however, that longer-term climate changes, such as that leading into the EECO, is represented in the diversity.

**Proposed changes to the ms:** We will add this discussion to the text, to at least highlight the paradox.

You regularly refer to "Australian hinterland" and "hinterland catchment". Can this please be illustrated on one of your maps?

**Response to Reviewer:** I am afraid we can put no bounds or limits to the hinterland catchment, because of the uncertainties described above, and because of the fact that the mountain ranges in southeast Australia are younger than our record (HOLDGATE G. R., WALLACE M. W., GALLAGHER S. J., WAGSTAFF B. E. & MOORE D. 2008. No mountains to snow on: major post-Eocene uplift of the East Victoria Highlands; evidence from Cenozoic

deposits. Australian Journal of Earth Sciences 55, 211–334.).

**Proposed changes to the ms:** However, we agree that that is a fair point to make, and so we will describe the uncertainties of the hinterland better in the site description.

How do the authors know the site drifted out of the zone of intense precipitation? Is there fossil or geochemical evidence for this? Latitudinal zones have shifted through time so there is no guarantee the northward movement of the Australian plate would have shifted the site into a new latitudinal/precipitation zone.

**Response to Reviewer:** Our inference of a drying of the hinterland comes purely from the northward drift of Australia, and prevailing climate conditions at those latitudes today. The coincidental evidence for a more seasonal concentration of precipitation in the middle-late Eocene we derive from our records confirms a climate shift that is not directly related to temperature (the Paleocene was cool and wet, while the middle-late Eocene was cool and drier).

**Proposed changes to the ms:** We will make that more explicit in the discussion.

Technical corrections

Line 186 – please add 'in' after brGMGTs

Line 942 – please change 'bothe' to 'both'

Line 1249 – please change `prodcution` to `production`

We thank the reviewer, and will adapt these technical errors.

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