Comment by Peter Bijl

I read the manuscript with great interest, it represents an interesting set of new data spanning the Oligocene-Miocene boundary. I am in general happy with the manuscript, but do feel that a lot of published information on Site 1168 is omitted, while these actually shed light on the interpretation of the data. First of all, the dinoflagellate cyst-based oceanographic reconstructions (Hoem et al., 2021; Hou et al., 2023b) shed light on the prevailing ocean conditions at the site: potential changes in upwelling, the ocean zone overlying the site, proximity of the subtropical front, presence of Leeuwin Current Influence, etc. all of which are crucial to at least qualitatively assess growth conditions and thus the ep and pCO2 reconstructions from this site. The papers referenced above would show (by the rather constant dinoflagellate cyst assemblage composition) little latitudinal migration of fronts and the high abundance of Spiniferites evidence for a persistent influence of the Leeuwin Current at the site. Secondly, the high-resolution TEX86-based SST data is also available for Site 1168 (Hou et al., 2023a). Although it makes sense to infer SST from alkenones to infer CO2 and ep, for arguments made in the paper, I think the TEX86 record still has value in the presentation of the oceanography at the site. I understand that this work was the result of a PhD project and that this part of the thesis was finished before the publication of these papers, and in that light it is understandable that the said studies were omitted. I suggest the authors do incorporate this information in a more comprehensive picture of the oceanographic development at ODP Site 1168 so that the whole study becomes more complete.

Also, the ACC development illustration in Figure 8 is somewhat outdated by recent insights that suggest that the modern-strength ACC did not start until the late Miocene (Evangelinos et al., 2022; 2024). Before that time, the ACC remained arguably weak (see, e.g., Sauermilch et al., 2021 for a recent modelling study).

Regards, Peter Bijl

We sincerely appreciate the constructive comment to further discuss the relevance of other data available at Site 1168.

We propose to incorporate in Section 2 Sites and Sediments, the additional background on the oceanographic conditions at Site 1168 as reflected by the dinoflagellate assemblage work reported in Hou *et al.*, 2023.

"…in contrast, ODP 1168 moved from 55°S to 48°S between 30 and 15 Ma (Torsvik et al., 2012; van Hinsbergen et al., 2015). ***Paleoecological reconstructions from dinoflagellates confirm that the waters above Site 1168 were continually influenced by the Leeuwin Current and located well equatorward of the Subtropical Front (Hou et al., 2023). "***

We agree with the reviewer, that the alkenone-derived SST we produced from the same samples as Ep is the most appropriate for calculations and comparison with the Ep and CO_2 discussion, because the alkenone SST derives from the same organisms and is matched to the same samples, but that is valuable to mention previously SST trends. Because the SST trends themselves are not a main focus of this paper, we propose now to describe the additional TEX_{86} results (Hou *et al.*, 2022) in section 4.3.1 where we review the long term trends in Ep and SST including:

*"****Unlike alkenone-based SST, published TEX86 SST record at Site 1168 (Hou et al., 2022) does not indicate a transition to lower temperatures from the Oligocene to early Miocene, suggesting different temperature trends in the season or depth niches of the different proxy carriers.*** *"*

We consider it beyond the scope of this paper to elaborate on potential sources of deviation between the TEX_{86} and Uk proxies and hope that a future publication by GDGTs as well as alkenone experts can further explore this issue.

Additionally, following the comment suggestion we propose to clarify in the new figure and caption that the ACC arrow refers to the shallow (surficial) circulation and is not synonymous with the late Miocene deep ACC described by Evangelinos (2022, 2024).

References used in this comment

Evangelinos, D., et al. (2022). "Absence of a strong, deep-reaching Antarctic Circumpolar Current zonal flow across the Tasmanian gateway during the Oligocene to early Miocene." Global and Planetary Change **208**.

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Hoem, F. S., et al. (2021). "Late Eocene-early Miocene evolution of the southern Australian subtropical front: a marine palynological approach." Journal of Micropalaeontology **40**(2): 175-193.

Hou, S., et al. (2022). "Lipid biomarker-based sea (sub)surface temperature record offshore Tasmania over the last 23 million years." Clim. Past Discuss. **2022**: 1-33.

Hou, S., et al. (2023). "Equatorward subtropical front migration and strong dee-sea cooling in the Neogene." Nature Communications **14**: 7230.

Sauermilch, I., et al. (2021). "Gateway-driven weakening of ocean gyres leads to Southern Ocean cooling." Nature Communications **12**(1).