

Author: Below, we have copied the review by the referee, and have added our responses in blue and between square brackets.

R1 - Severine Fauquette (Referee)

Cramwinckel et al. present a study of the surface-circulation change in the Southern Ocean during the Middle Eocene Climatic Optimum based on dinoflagellate cysts and biomarker paleothermometry. The manuscript submitted by Cramwinckel et al. is of good quality. This manuscript is within the scope of 'Climate of the Past' and is well written and structured. This will be a very useful paper on the MECO period in the Southern Ocean that is not well known. This study will certainly help climate modelers who can introduce consistent boundary conditions into the models for this part of the globe. I recommend publication of their paper in Climate of the Past with however some revisions.

[AR: We thank the Referee, Severine Fauquette, for her positive evaluation of our manuscript and the constructive suggestions. We hope to adequately address these below.]

Main comments:

- Authors should give, in supplementary data, a detailed description of the pollen morphology (apertures, ornamentation of the exine surface...) and some photos of the main palynomorphs (dinocysts and pollen grains). This period in this region is not well known and it could help for further studies.

[AR: Referee 3 also suggested adding plates of the most important palynomorphs. We propose to add a plate containing light microscope photos of the main marine and terrestrial palynomorphs from the studied sites to the revised manuscript. We feel however, that a detailed description of pollen morphology is beyond the scope of this paper, which focuses on paleoceanography and paleoclimate rather than taxonomy, systematics and morphology of palynomorphs. Regarding the latter topic, future pollen-based studies for this region are being worked on, which will contain the requested morphological and taxonomic data.]

- The fossil pollen and spores should be identified, by comparing them to modern pollen grains, following current taxonomy of recent taxa, instead of using morphotaxa names. By applying such approach, pollen and spores may be assigned to family, genus, and sometimes, but rarely, even to species levels. Once they are botanically identified, their paleoecological requirements may be defined based on the modern taxa. This botanical approach allows reliable paleoenvironmental reconstructions, as described and done by Suan et al. (Geology, 2017) for the Early Eocene of the Arctic Siberia.

[AR: We agree regarding the utility of correlating fossil pollen to modern botanical taxa with known environmental preferences, to facilitate paleoenvironmental reconstruction. In the current version of the manuscript, we therefore provide the names of the pollen taxa followed by the known botanical affinity in brackets. As

these are Eocene taxa, indeed, this is often at the level of family or genus instead of a modern species-level designation.]

- Biostratigraphy: A table with the regional occurrences of the dinocysts could be interesting.

[AR: Bijl et al. 2013 ESR and Bijl et al. 2011 Paleoceanography already document the regional biogeographic occurrence of dinocysts. We cite these papers in our manuscript. We think that publication of this same dataset again is not necessary, and do not include the data in this work. We will more clearly state in the revised manuscript where these tables can be found.]

- A simplified diagram with the stratigraphic log and the percentages of the main terrestrial palynological data of Latrobe-1 borehole is lacking.

[AR: In the revised manuscript, we will add a supplementary figure including a stratigraphic log and palynological data from the Latrobe-1 borehole.]

Minor (technical) comments:

- p5, L1: add a S to metre; L10: call figure 2a; L11: remove one "was not".
- p6, L8: How many samples have been studied for this site?; L25: add "concentration" for the dinocyst content.
- p10, L32: add a reference for the ages given by *Lophocysta* spp .
- p14, L19: remove the "cf" in front of the reference Bijl et al..
- Figure 5, L17: add a "c" in the word dinocyst.
- Figure 2, L21: in (a), it is not the bathymetry that is illustrated as there is no mention of the depth of the ocean.

[AR: We will adapt all of these technical comments. Instead of adding "concentration" to p6, L25 we propose to adapt wording to "content in specimens per gram".]