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Comment on cp-2021-84

Tammo Reichgelt (Referee)

Referee comment on "Vegetation change across the Drake Passage region linked to late Eocene cooling and glacial disturbance after the Eocene–Oligocene transition" by Nick Thompson et al., *Clim. Past Discuss.*, <https://doi.org/10.5194/cp-2021-84-RC1>, 2021

The authors present a palynological record from the South Orkney microcontinent in the Wedell Sea and associated environmental changes using nearest living relative-based paleoclimate reconstructions, lipid biomarker geochemistry and sedimentological changes. They identify a cooling step in the late Eocene and a vegetation turnover around the EOT boundary, which they associate with regional tectonic changes leading to oceanographic changes. The study is well-conceived and provides some unique data, since obtaining high-resolution and well-resolved terrestrial climate information from southern South America sheds light on the complex opening of the Drake Passage, specifically of the Powell Basin. Opening of the Drake Passage has long been postulated as a possible cause for global cooling at the EOT boundary (as well as the Oligocene-Miocene boundary), but this study can show that there is an offset between the timing of global glaciation at the EOT and regional vegetation and oceanographic reorganization associated with opening of the Powell Basin. I do not see any major flaws in the conceptualization of this study, nor with the conclusions that the authors draw. The results are novel and shed light on an important geological event. The figures are stellar. I suggest minor revisions based on two changes that the authors may want to consider, and one additional problem.

Suggestion 1: Table 2 contains the pollen/spore types and the associated botanical affinity. Most of the botanical affinities are based on Raine et al. (2011) and some on various other references. Raine et al. (2011) is an excellent resource and there is a strong biogeographical connection between New Zealand, Antarctica and southern South America. Still, Raine et al. (2011) base their nearest living relatives predominantly on associations made in New Zealand and to a lesser extent Australia and Antarctica. It might therefore be prudent for the authors to confirm botanical affinities as applied in South American studies, such as those by Viviana Barreda, since this is likely an important floral source at SOM. I put some references that the authors can use for this in my minor comments below.

Suggestion 2: The *Nothofagus* subgenus *Brassospora* (or Nothofagaceae genus *Trisyngyne*, if you want to follow Heenan & Smissen 2013: Revised circumscription of *Nothofagus* and recognition of the segregate genera *Fuscospora*, *Lophozonia*, and *Trisyngyne* (Nothofagaceae), *Phytotaxa*, 146) is not used separately in the nearest living relative based paleoclimate reconstructions. The reason cited is its questionable range in New Caledonia. I've added some literature in my minor comments below to the research on *Brassospora* in New Guinea, where it is native and has quite a large range and is not hampered by geographic restrictions that an island such as New Caledonia poses. A possible concern with Nothofagaceae pollen could be that they dominate any assemblage, warm or cold, and thereby homogenize any climate signal that may be obtained from these records. This is valid, considering that Nothofagaceae pollen travel far and wide beyond their place of origin. I put a recommendation in for that as well (applying an abundance threshold). Additionally, *Araucariaceae* does not seem to be included in the nearest living relative analyses either (at least it's not in Table 2). If it wasn't, then it probably should be (*Araucaria* / *Agathis*), if it was an oversight in Table 2, then the authors should revise Table 2.

Problem: A recurring reference involved in interpretations of the results is a reference to López-Quirós et al. (in review): Eocene-Oligocene paleoenvironmental changes in the South Orkney Microcontinent (Antarctica) linked to the opening of Powell Basin. Considering the importance of these results (sedimentology & organic geochemistry) in the interpretation of the opening of the Powell Basin, it seems prudent to await acceptance/publication of that paper before this paper is accepted and published.

- 28-30: "We conclude that ... directly be linked." Remove "rather", and add "... to the observed vegetation changes." At the end of the sentence.

- 30-31: "Therefore, confirming ... before the EOT." The styling of the beginning of this sentence is a bit confusing. Perhaps change to: "Our vegetation record provides further evidence that the opening of the Drake Passage and Antarctic glaciation were not

contemporaneous, although stepwise cooling in response to the opening of ocean gateways surrounding the Antarctic continent may have occurred prior to the EOT.”

- 39: “Uncertainties particularly remain over...” Suggested change: “In particular, large uncertainties remain about...”

- 41-43: “Today the ocean ... and the ocean.” Perhaps provide one or two general references here about the importance of the ACC and ocean current more generally in the distribution of heat, etc. globally. In addition, consider adding a sentence about the importance of the ACC in particular.

- 48: “well dated” -> “well-dated”.

- 56-57: “Our results reveal ... in the region.” A matter of choice; however, this sentence provides one of the main findings in the introduction of the paper. Suggest changing to something more ambiguous.

- 68: “well recovered” -> “well-recovered”.

- 73 – 75: “All palynological ... Utrecht University.” Citation(s) for these standard protocols?

- 76: “x” instead of multiplication symbols “×”.

- 76-77: “Where possible ... and evaluation.” For nearest living relative techniques, you can in addition to establishing relative abundances using 300 counts, account for rare occurrences by scanning the entire slide without counting. Was this done?

- 83-85: “Identification of ... recognised as reworked.” Was the Raine et al. 2011 framework used to identify species that were older than Eocene/Oligocene? I would rephrase this sentence to say what you used to identify older reworked species, rather than saying “easily”.

- 121: The subgenus *Brassospora* is not endemic to New Caledonia, its center of distribution is in New Guinea. The addition of New Guinea into the climate profile of *Brassospora* also makes its distribution in relation to climate less ambiguous, in fact it is quite consistently a montane rainforest component. See for example Read et al. 2005: Phytogeography and climate analysis of *Nothofagus* subgenus *Brassospora* in New Guinea and New Caledonia. Australian Journal of Botany 53. Read et al. give the MAT range of *Brassospora* in New Guinea as 10.6 – 23.5 °C and MAP of 1762 – 7733 mm, consistent with montane rainforest. It has been included in PDF-based NLR reconstructions before. See for example Huurdeman et al. 2021: Rapid expansion of

Table 2 appears to exclude Araucariaceae. Was this family not included in NLR analysis? I understand for Dilwynites, as it has a strongly relict distribution. However, if the family was excluded for some reason, this should probably be stated in the methodology.

Figure 6: This is a great figure.