

Clim. Past Discuss., author comment AC1
<https://doi.org/10.5194/cp-2021-84-AC1>, 2021
© Author(s) 2021. This work is distributed under
the Creative Commons Attribution 4.0 License.

Reply on RC1

Nick Thompson et al.

Author 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-AC1>, 2021

Dear referee and editorial team,

Please find below our response to the comments the reviewer rose. We thank the reviewer for constructive and positive feedback on our manuscript. We propose the changes indicated in the text below.

Kind regards

Nick Thompson, behalf of all co-authors.

Response to Reviewer #1

REV#1 General Comment:

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.

Authors response: We are pleased to hear such positive feedback and we thank the referee for these constructive comments and will respond in detail below.

REV#1 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.

Authors response: We revisited each of the Nearest Living Relatives (NLR) for fossil taxa used in our palaeoclimate estimates using the references provided (e.g., Barreda et al., 2020, 2021). Many of the taxa retained the same NLR with only a couple having different NLR.

Proposed changes: Table 2 has been amended to include references for Barreda (2020, 2021) and any new botanic affiliations. The new botanic affiliations are as follows: (1) *Laevigatosporites spp.* = Blechnaceae (Rain et al., 2011) -> *Laevigatosporites spp.* = Polypodiaceae (Barreda et al., 2020); (2) *Nothofagidites flemingii* = *Nothofagus* subg. *Fuscospora* (Rain et al., 2011) -> *Nothofagidites flemingii* = *Nothofagus* subg. *Nothofagus* (Barreda et al., 2020, 2021). Where NLR taxa were the same between Raine et al. (2011) and Barreda et al., (2020, 2021), the latter reference was used, to highlight associations in South American studies. New climate estimate calculations using the new NLR taxa were also carried out and graphs and figures adjusted accordingly. The new climate estimate results do not affect the overall trends previously observed or any of the conclusions drawn. For new temperature and precipitation estimates please see Figure 4.

REV#1 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.

Authors response: We agree with the reviewers' comments and suggestion, and we have revisited the use of each of the *Nothofagus* subgenera. However, we have not used the circumscription of Heenan and Smissen (2013) and prefer to keep using the palynologically long-established and well described subgenera *Brassospora*. In addition, we have revisited *Araucariaceae*, which was previously omitted due to the suggested NLR (*Araucaria Araucana*; Bowmann et al., 2014) having too few occurrences within the GBIF database and agree with the inclusion of *Araucaria* (Barreda et al. 2020, 2021) for the fossil taxa *Araucariacites australis*. The concern with *Nothofagaceae* pollen dominating assemblages homogenize climate and ecological patterns was discussed. Our results clearly show a decrease in *Nothofagaceae* pollen and an associated increase in *Podocarpaceae* pollen not recorded in coeval Antarctic Peninsula or South American assemblages. In our opinion this suggests a true climate and/or ecological signal and that, despite *Nothofagaceae* pollen dominance throughout the studied section, this signal has not been masked or homogenized.

Proposed changes: Table 2 has been amended to include each of the *Nothofagus* subgenera and *Araucaria* (sensu Barreda et al., 2020, 2021) now used in palaeoclimate estimates. New climate estimate calculations using the new NLR taxa were carried out and graphs and figures adjusted accordingly. The new climate estimate results do not affect the overall trends previously observed or any of the conclusions drawn. For new temperature and precipitation estimates please see Figure 4.

REV#1 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.

Authors response: The study by López-Quirós et al. (2021) was an important reference that was used to aid and complement the results of this study. At the time of writing López-Quirós et al. was still awaiting publication. However, I am pleased to say it has since been accepted and published in the journal *Global and Planetary Change*, Volume 204.

Proposed changes: The citation has been updated in the bibliography and in text.

REV#1 Specific comment, lines 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?

Authors response: Scanning for rare occurrences was not conducted. We feel that rare taxa if present would not add any more detail to environmental or paleoclimate interpretations. Very rare taxa are also often a limited value for regional environmental reconstructions as they may represent long distance pollen transport or reworking. We are convinced that the taxa that were identified already presented a robust picture of palaeo-environment and climate, together with interpretations from sedimentology and geochemical biomarkers.

Proposed changes: None.

REV#1 Specific comment, lines 272:

"also continue to ... unable to be properly identified." If it is not possible to identify these taxa, wouldn't there be a risk that these are reworked Mesozoic taxa? Undifferentiated bisaccate grains, including pollen that resemble *Podocarpidites*, are common in the Mesozoic.

Authors response: We agree with this comment and have revisited the identification of "unidentified bisaccate" taxa. The group is not reworked as indicated by their level of preservation and thermal maturity, when compared with reworked taxa from this study. We rather grouped under "unidentified bisaccate" all *Podocarpidites* that could not be further differentiated. To avoid confusion, we merged this group now into "*Podocarpidites* spp."

Proposed changes: Renaming Unidentified bisaccates to *Podocarpidites* spp. The renaming has not affected the results of this study, or the conclusions drawn.

REV#1 In text corrections:

The reviewer has proposed a number of smaller in text corrections and changes.

Authors response: We agree with the corrections proposed by the reviewer.

Proposed changes: Changes made in text per reviewers' recommendations.

REV#1 Figure 1:

very nice figure! I will only point out that on my screen the "North Scotia Ridge" was hard to read. Perhaps make it a somewhat darker hue (or black?).

Authors response: We agree with the alteration proposed by the reviewer.

Proposed changes: Font colour changed to a darker colour. Please see figure 1.

REV#1 Table 2:

Raine et al. 2011 is a great resource for nearest living relatives, but it's also somewhat risky to apply widely in the Southern Hemisphere, because the nearest living relatives in this database are primarily (though not solely) established based on New Zealand pollen types. There is a lot of biogeographic overlap with southern South America and New Zealand at the Eo/Oligocene boundary. Still, I suggest confirming the appropriateness of these nearest living relative assignments with the South American literature. Primarily Viviana Barreda's papers and Luis Palazzesi. See for example Table 1 in Barreda et al. 2020: Early Eocene spore and pollen assemblages from the Laguna del Hunco fossil lake beds, Patagonia, Argentina. *International Journal of Plant Sciences* 181. Or Table 1 in Barreda et al. 2021: The Gondwanan heritage of Eocene – Miocene Patagonian floras. *Journal of South American Earth Sciences* 107.

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.

Authors response: This issue has been addressed in suggestions 1 and 2. Please see above.

Proposed changes: Table 2 has been amended to include references for Barreda (2020, 2021) and any new botanic affiliations. The new botanic affiliations are as follows: (1) *Laevigatosporites spp.* = Blechnaceae (Rain et al., 2011) -> *Laevigatosporites spp.* = Polypodiaceae (Barreda et al., 2020); (2) *Nothofagidites flemingii* = *Nothofagus* subg. *Fuscospora* (Rain et al., 2011) -> *Nothofagidites flemingii* = *Nothofagus* subg. *Nothofagus* (Barreda et al., 2020, 2021). Where NLR taxa were the same between Rain et al., (2011) and Barreda et al., (2020, 2021), the latter reference was used, to highlight associations in South American studies. *Araucaria* (sensu Barreda et al., 2020, 2021) now used in palaeoclimate estimates and presented in table two. New climate estimate calculations using the new NLR taxa were carried out and graphs and figures adjusted accordingly. The new climate estimate results do not affect the overall trends previously observed or any of the conclusions drawn. For new temperature and precipitation estimates please see Figure 4.