

Review: *Shaping the mid-Miocene warmth: A sensitivity study on paleogeography, CO₂ and model physics*

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Abstract

Line 1 – Because “period” has a specific geological meaning, and is not strictly needed, I would prefer this to read “The mid-Miocene (15.98 to 13.82 Ma) was characterised...”.

Lines 7/8 – The sentence starting “GMST varies by up to...” reads confusingly. I think it might be clearer to say that this refers to CO₂ sensitivity experiments first up, something like “In mid-Miocene sensitivity experiments with CO₂ concentrations two and four times pre-industrial values (consistent with estimates for the mid-Miocene), GMST varies by up to 3.2°C between simulations.”

Line 10 - ° sign missing after 1.3.

Line 14 – “equilibrium” is not needed before “ECS”.

Line 15 – “simulation” should be “simulations”.

1. Introduction

Line 23 – Please can you clarify if this is a change in flora relative to modern day, or throughout the Miocene?

Lines 48/49 – “...paleogeography of the early mid-Miocene, specifically the mid-Miocene...” needs to be rephrased. Perhaps just “...paleogeography of the mid-Miocene”, as you have already said that you are using “mid-Miocene” to refer to the Langhian.

2. Methods

Figure 1 – Please make the lat/lon axes consistent with how they appear in all other figures, with the °N/S/E/W labels.

Line 89 – “geography” should be “geographies”.

Table 1 – The formatting means I am unable to see the full table, it is cut off halfway through the initialisation column. This formatting obviously needs to be addressed by the copyeditors, but I am satisfied with the content and revised caption.

Lines 99 and 102 – CO₂ needs to be subscripted.

Line 103 – “pre-industrial” should be “PI” to be consistent with elsewhere in the paragraph. Please also check for this elsewhere in the paper (another instance on L127).

Line 109 – I would like to see the bracket moved after “climate feedbacks” on L108 to avoid potential confusion over whether these are feedbacks or forcings.

3. Mid-Miocene control state

3.1. Climate

Line 146 – “best-to-knowledge” is in quotation marks elsewhere, please be consistent.

Line 180 – “middle” should be “mid-”.

3.2. Vegetation

Line 195 – “relative” should be “relatively”.

Line 203 – Is there any ongoing work to improve our understanding in this area that you can refer to? If not, you could add a call for future research in this space.

Line 205 – “type” should be “types”.

4. Impact of CO₂

Line 209 – I think this would read better like “There have been different plausible estimates of atmospheric CO₂ concentrations...”. This emphasises the point made at the end of the sentence, that different methodologies are used in different estimates.

Figure 5 – On a first look I thought that the data here was raw temperature data rather than anomaly relative to the proxy record (some of the differences are very large!). Can the caption be reworded to make this more explicit, perhaps before explaining A), B), C)? The terminology used in the caption should also match the “surface temperature bias” scale title, or vice versa.

Manuscript-wide comment – Check for consistency in “2 and 3 times” (values, L210) vs. “three and four times” (text, L220). Also e.g. L372.

Line 226 - CO₂ needs to be subscripted, and “mid” should not be capitalised.

Line 234 – “proxy” should be either “proxies” or “proxy data”.

Line 239 – Should “model” be “models”? Or “a dynamic vegetation model”?

5. Equilibrium climate sensitivity

Line 274 – I would suggest either stating an example of what is meant by “high values”, or remove the end of this sentence.

Figure 6 caption – Please add “(TOA)” after “top-of-atmosphere” so that readers immediately understand the y-axis label.

6. Additional sensitivity studies

6.1. Impact of atmospheric model

Line 292 – Remove unnecessary (before “2012”.

Figure 10 – This is an interesting figure. Although I understand the simplicity of using the numbers from Table 2, because references in the main text are to the experiment names (e.g. Mio_Ctrl) I would prefer to see these used. Alternatively, you could add a legend to the figure linking the numbers to the experiment names so that readers don’t have to return to much earlier in the paper to remind themselves.

Line 309 – “...expected from **the** Clausius...”

Line 321 – “paleo” doesn’t need to be capitalised.

Line 323 – Specify that this is PlioMIP2.

6.2. Impact of ice sheet

Header – I would suggest “Impact of **Antarctic** ice sheet”, or “Impact of ice sheets”.

Line 343 – “...around 25°C...” rather than “...around 25 degrees...”.

6.3. Impact of solar constant

Lines 356/357 – I feel this sentence needs to be clearer. Is it meaning that global mean surface temperature in Mio_noIS-solPI is around 0.2°C warmer? If so, this needs to be explicit before mentioning the additional warming in the high latitudes.

7. Conclusions

Line 366 – You have added useful commentary around the differences and why we should consider the Miocene only as a partial analog, but I still think this could be more explicit in places. Perhaps making a concluding statement at the end of the paragraph will support this, and/or “...scale of warming **and the strength of partial**

analogy” (or similar). I appreciate that the analogy question isn’t central to the paper, but bringing a critical eye to it and going beyond the initial “has shown potential to be a partial analog” is progressing the field.

Lines 387-390 – The sentence starting “Although some issues...” is wordy and it’s easy to get lost as a reader. I would suggest a change like: “Despite uncertainties in the proxy record or model disagreements, the Pliocene (the warm epoch following the Miocene) has shown that recent warm paleoclimates can provide robust constraints on ECS (Hargreaves...)”

Line 393 – The use of “**new** emergent constraint framework” when you go onto provide examples of its previous use is a bit jarring. Perhaps a rewording like “...used within a new emergent constraint framework for the Miocene, akin to approaches used in the LGM...”?

Appendix

Header – Like the main text, I would suggest “Impact of **Antarctic** ice sheet...”