We thank both reviewers for their constructive suggestions. Below are the reviewers' comments in black, and our responses in blue.

Reviewer #1:

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…"

"Period" has been removed.

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."

The sentence has been modified following the reviewer's suggestion.

Line 10 -
° sign missing after 1.3.
Line 14 –
"equilibrium" is not needed before "ECS"
.
Line 15 –
"simulation" should be "simulations".

Fixed.

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

The sentence was clarified to "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.

This has been corrected (an issue which came from a search and replace command).

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

Fixed, and an additional outline has been added onto the continents to emphasise coastlines, similarly as for the other figures.

Line 89 –
"geography" should be "geographies".

Fixed.

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).

Fixed throughout the manuscript.

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.

Bracket has been moved.

Line 146 – “best-to-knowledge” is in quotation marks elsewhere, please be consistent
Line 180 –“middle” should be “mid-”.
Line 195 –“relative” should be “relatively”
Line 205 –“type” should be “types”.

Fixed.

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.

Adjusted based on the suggestion.

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.

The caption was modified to emphasise that the values are compared to the proxy record.

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

Fixed throughout the manuscript

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

Fixed.

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

Fixed to “proxy data”.

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

Changed to “models”.

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

We have clarified that “high values” found in some warm paleoclimates (Eocene, PETM) are above 6°C.

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

Added on the y-axis label.

Line 292 – Remove unnecessary (before “2012”.

Fixed.

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.

We have added a legend on top of the figure.

Line 309 –"…expected from the Clausius…"
Line 321 –"paleo" doesn't need to be capitalised.
Line 323 – Specify that this is PlioMIP2.
Header – I would suggest "Impact of Antarctic ice sheet", or "Impact of ice sheets".
Line 343 –"…around 25°C…" rather than "…around 25 degrees…".

Fixed.

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.

Added "globally".

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.

We have emphasised that there remains uncertainties on the strength of the potential analogy of the Miocene in the Conclusion.

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…)."

We have adjusted the sentence following the suggestion of the reviewer.

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…"?

To avoid repetitions of "Miocene" in that sentence, we have modified the rest of the sentence to specify that this "new framework" is only for the Miocene, as opposed to previous frameworks for the LGM and the Pliocene. To our knowledge, there has not been any emergent constraint framework built from Miocene simulations (which is logical, since MioMIP is relatively new).

Reviewer #2:

1. Model-dependent bias in AMOC simulation must be acknowledged.
The revised manuscript omits Tan et al. (2026), a study published in Communications Earth & Environment that directly addresses the issue at the heart of this paper—the model–data mismatch in Miocene Climatic Optimum high-latitude warming. Tan et al. demonstrate that the magnitude of polar amplification is not a uniform model deficiency, but rather depends critically on model-specific ocean–sea ice dynamics.
Tan et al. (2026) simulated a modern-comparable strong AMOC using NorESM1-F under similar paleogeographic boundary conditions, achieving the best agreement with proxy data. This contradiction suggests systematic biases in CESM ocean component, particularly regarding sensitivity to Fram Strait/Greenland-Scotland Ridge depths. The authors may need to confront these model structural deficiencies rather than attributing anomalous results to insufficiently explained "complex feedback interactions."

We have added the reference of Tan et al. (2026) when mentioning the state of the mid-Miocene AMOC. Our manuscript already acknowledges model-dependent biases in AMOC simulations, by mentioning the rarity of the PMOC among models participating in MioMIP, and not supported by the proxy record (L154 - 161), as well as further discrepancies between the strength of the AMOC in MioMIP simulations versus proxy record (L226 - 231). Our manuscript is also not focused on the ocean circulation of the Miocene, as it is kept for a future study.
Our study cannot be fully compared to Tan et al. (2026). Despite what the reviewer suggests, our study and Tan et al. (2026) do not use the same boundary conditions. Tan et al. (2026) uses an updated version of the geography from Frigola et al. (2018) with fixed vegetation and lower atmospheric CO_2, while we use the updated geography of Burls et al. (2021) on one side, and the unpublished geography of Getech Plc. on the other side, both with dynamic vegetation and a higher CO_2. The latter is an update of the geography used by Farnsworth et al. (2019) for HadCM3-L, which also shows strongly reduced deep water formation in the North Atlantic. As mentioned between L72 - 89, differences in seaways (Central American, Tethys, Greenland-Scotland Ridge, Canadian Archipelago, Indonesian) are common between geographies and can lead to different results (Hutchinson et al., 2025). It is more likely that the response of our model is due to paleogeographic boundary conditions than hypothetical structural deficiencies.

2. Impact of ocean parameterization adjustments insufficiently evaluated.
The authors employed non-standard configurations for numerical stability, but failed to assess their potential impacts on AMOC strength and sea-ice simulation. Discussion of these adjustments do not systematically weaken deep ocean circulation.

The modifications we applied onto the ocean model to facilitate its numerical stability are quite standard: reducing the computational time-step is an easy way to reach CFL condition when modifying geography and handling narrow ocean grid points, and is a recommended modification of the paleoclimate user guide provided by NCAR for CESM1.2 (https://www.cesm.ucar.edu/models/paleo/faq#nl), as mentioned L131 of our manuscript. The modifications of overflows and tidal mixing is also quite standard, and in the case of CESM models (CESM1.2, CESM1.0.5…) is necessary, as these features are hard-coded on the pre-industrial boundary conditions. This is a configuration which was also adopted for simulating the Eocene by Baatsen et al. (2020).

Because these modifications are necessary for the numerical stability of our runs, we cannot verify their impacts on our mid-Miocene simulations. We have added an Appendix where we explore their impacts on PI simulations. We emphasise that the conclusions drawn from these modified PI simulations cannot be simply transferred on the mid-Miocene climate. As also mentioned L143, L161 and L231, our manuscript is not ocean-focused, as it is kept for a future paper which is currently being written. We do not mention at any point that these adjustments necessarily weaken deep ocean circulation, so we are unsure what the reviewer is referring to.