

Clim. Past Discuss., referee comment RC2  
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## Comment on cp-2021-186

Anonymous Referee #2

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Referee comment on "The warm winter paradox in the Pliocene northern high latitudes" by Julia C. Tindall et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2021-186-RC2>, 2022

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Tindall and co-authors present a thorough examination of the role played by a range of model and data uncertainties which might explain some challenges experienced in trying to compare terrestrial proxy data with climate model outputs of the warm climates of the Pliocene. This time interval has received a lot of interest due to the CO<sub>2</sub> concentrations being comparable to present/low emission scenarios, and the contribution made by the authors here is going to be a valuable addition to the literature. The authors are thorough in their discussion of the various potential influences and uncertainties which could contribute to the data-model mismatches (Section 4). It is valuable for the data-model comparison (DMC) that the authors consider the likely uncertainty of changing orbital configuration on the modelled outputs for the high latitudes, to consider how this might be reflected in the data which is more poorly constrained in time.

The outcome of the study, that winter temperatures are more challenging to reconstruct and model than those of the summer, is an important finding which needs to be incorporated into future data-model comparisons which have otherwise tended to focus on comparing "mean annual" data.

The manuscript is written well overall, and the graphics support the text. I have some recommendations to clarify several aspects of the text, but these are minor corrections which do not take away from an otherwise well written and interesting study:

- Despite the title and the focus on "high latitudes", the manuscript does not deal with all high latitude regions. There is a note to the Yallalie data (Perth, Australia) in Figures 1 and 2, but this is located at 30°S and debatable as "high latitude". Otherwise, there is no assessment of southern hemisphere high latitudes. Feng et al. (2017) cited in line 48 was likewise a study of high northern latitudes. The manuscript title and abstract need to clarify this focus.

- The abstract is written very clearly, but would benefit from clarifying that the focus of the manuscript is not the whole Pliocene, but a narrower section of this epoch (e.g. lines 28-32 show that the focus is the Mid Pliocene Warm Period, and a shorter interval within it, "KM5c").
- line 15 might be easier to read with the removal of some commas: "For the Pliocene high latitude terrestrial summer temperatures, models and different proxies are in good agreement".
- Introduction, first paragraph: the statements here are logical, but there is no supporting evidence given through citation of literature. Do any of these concerns appear in e.g. the most recent IPCC report, or perhaps discussed in papers looking at data-model (dis)agreement?
- Line 29-30 indicates the focus in on the KM5c interval, but lines 75-76 indicate that proxy data for this narrow window is not feasible. This suggests that the model output is KM5c but the data is MPWP: this needs to be clarified here and in the abstract.
- Line 35: this could refer to subsequent PlioMIP iterations as well as the first one.
- Paragraph line 40-46: this gives a good overview of the likely uncertainties which were assessed but not a sense of what impact these different uncertainties had (or not). Did any one / combination of the uncertainties give "most likely" cause(s) for some of the mismatches, or was it perhaps uncertainty or location specific? A line of two which notes the main findings of some of these publications would be helpful.
- Line 73-74: the number of sites able to be directly compared to the models for KM5c is further reduced when a higher threshold for age control was introduced by the Pliovar working group (McClymont et al., 2020, Climate of the Past), which is worth pointing out here as the authors also use that data in Figure 1 and so line 80-81 seems to be referring it. I don't think the Pliovar data was used in the PlioMIP2 DMC described in line 73-74.
- Line 82-83: "high latitude" here is really "high northern latitude" because there is only a single data point for the entire southern hemisphere, and it has already been described as aligning well with the models (line 82)
- line 89: the authors could also cite the Pliovar comparison of McClymont (2020) since that also showed better model-data agreement? Aligning with the theme of this manuscript, the Pliovar paper includes a comparison of high northern latitude data and different monthly model outputs, which also indicates a possible role for seasonality in the oceans as well as on land.
- line 169-170: data-model agreement for the PI and "no inherent model bias" – but there seems to be a tendency for the PI MMM (blue dots, Figure 2) to sit either at the low or high end of the PI data (blue dashed lines), which is not noted. Is there a reason for this tendency in the data or models?
- line 202: is "prior to 3.5 Ma" late Pliocene as this block is to indicate? How is early/late Pliocene being defined here?
- line 217-218 and some of the preceding sections where DMC is described: I didn't see it defined anywhere, but do the authors consider "agree reasonably well" or to have "similar outputs" between data and models to be the place where there is overlap between the spread of model outputs and the data "points"? There are some places where there is quite a large difference in MMM and data points (e.g. Mirny late Pliocene Figure 3) but where there is overlap in the range of model outputs – does this count as being "similar"?
- Line 274: and cite the pliovar DMC?
- Figure 6: I became confused here by the KM5c data-model anomalies, because the authors comment that only two sites (the top two) have KM5c data. So, is the KM5c "anomaly" for Mimy and all of the sites beneath this actually "difference between KM5c model and late Pliocene data"? Some revised text in the caption to clarify what these plots represent would help a lot, because at the moment I think it implies that there is KM5c data at all of the sites shown.