

Interactive comment on “On the effect of orbital forcing on mid-Pliocene climate, vegetation and ice sheets” by M. Willeit et al.

Anonymous Referee #2

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1. General Comments

This paper offers an important and significant contribution to climate modelling and data-based efforts to reconstruct the environment of a key interval of past warmth - the mid-Pliocene warm period. The authors present two kinds of simulation: 1) Equilibrium simulations which are comparable to the PlioMIP ensemble and 2) transient simulations which offer the first insight into the time-varying nature of Pliocene climate from a modelling perspective. The paper is clearly written and relatively succinct. The factorisation of the modelled contributions to Pliocene temperature change offers additional insights as to the causes of mid-Pliocene and should be applauded. Moreover, as this is the first time such a transient simulation has been undertaken, I think the paper is of key importance and I would recommend it for publication. I have a few minor comments

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which I believe would improve the manuscript.

2. Main points:

CLIMBER-2 includes a shallow-ice approximation ice sheet model over the Northern Hemisphere, which allows the ice sheets in presumably Greenland, North America and North Eurasia to respond interactively with the climate. Antarctica is prescribed based on the PRISM3 Antarctic ice sheet reconstruction. Could the authors state the reason why Antarctica is not simulated in the same way as the Northern Hemisphere ice sheets? Also, I think it would be useful for the authors to comment on the potential implications of the lack of interactive coupling over Antarctica.

1711-2: The authors use the astronomical solution of Berger and Loutre (1992) to compute the orbital forcing throughout the mid-Pliocene. However, as many of the proxy records are tuned to the more recent astronomical solutions of Laskar (e.g. Laskar et al., 2004; 2010), it would be useful for the authors to detail if these astronomical solutions differ significantly.

1712-10: Although the authors use the term synergy in the context of factorisation with a reference to Lunt et al (2012) and describe this mathematically in Appendix B, I think it would be useful for the reader to know what is implied by synergy. It is unclear how this term should be interpreted, for example when looking at Figs 1b and 2b, and therefore I think a more detailed description is required.

1715-10: The authors write that “The magnitude of NH ice sheet volume variations corresponds to approximately 15 m sea level equivalent....” As this is the first mid-Pliocene climate simulation that is likely to capture or at least move towards simulating the ‘glacial’ or colder states within the PRISM time slab, it would be very interesting to know the locations of ice growth in the model. Due to the resolution of the model, is the 15 m SLE of ice made up solely of ice on Greenland? Or is there ice growth at certain times in North America and Eurasia? It would be useful for the authors to go into more detail on this.

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1716-9: "...the summer SST increase in the NH estimated from proxy data falls well into the wide range of SSTs modelled throughout the MPWP." Although I agree with this statement generally, the blue line on Figure 5 is actually outside the modelled range northwards of 80°N. I suggest rephrasing this statement accordingly.

3. Typographical/technical points:

Figure 7: I think the colours are labelled incorrectly in the figure caption as there is no yellow bar

1704-21: replace "for" with "of"

1705-9: "tp" should be "to"

1705-19: "SST reconstructions show little changes" might be better as "SST reconstructions show little change"

1708-18: Change to: A typical feature of.....is an overestimation....and an underestimation....

1709-1: Replace "At last" with "Finally"

1714-17: "points on surface albedo" should be "points to surface albedo"

1715-11: "15 m see level equivalent" should be "15 m sea level equivalent"

1717-5: "This results..." should be "These results..."

Interactive comment on Clim. Past Discuss., 9, 1703, 2013.