

Interactive comment on “The relative roles of CO₂ and palaeogeography in determining Late Miocene climate: results from a terrestrial model-data comparison” by C. D. Bradshaw et al.

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General comments:

Bradshaw et al. conduct sensitivity simulations for the late Miocene. The scope of the paper is certainly within the scope of *Climates of the Past* and the methods used are appropriate. The question being asked is an oft recurring one and this paper combines a comprehensive compilation of proxy data with sensitivity tests of paleogeography and CO₂, which as far as I'm aware hasn't been done for the late Miocene using a coupled GCM (although a rather similar study for the preceding middle Miocene exists [Krapp and Jungclauss, 2011] and needs commenting on). The separation of flora and fauna

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also nicely illustrates their ability to capture climate.

My main concern relates to the conciseness of the manuscript. Specifically, while the thorough documentation of the methods and boundary conditions is appreciated, sections 1 to 3 are too long and constitute half the manuscript, thus the reader needs to get half way before entering the actual results. Subsections 3.2.x could be combined and shortened. Further, figure 3 and table 2 could be excluded since the former could be explained in a couple of concise sentences and the latter - although it provides a nice overview - is not necessary. Alternate or additional economisations could be made throughout the manuscript.

In summary, I support publication but after the manuscript has been revised into a more concise package, and after considering the additional points below.

Minor/technical comments:

-One of the main conclusions is that paleogeography is of much greater significance than CO₂ in reconciling proxies of MAP with model MAP. What are the possible reasons for this? Without sensitivity tests this is difficult to determine but it would be nice to put forward a few ideas of what causes the MAP changes in Fig. 5abc in the regions relevant to your proxies.

-Seasonality is discussed so it would have been nice to see how the model compares to cold month and warm month temperature estimates from proxies. IF feasible, a few sentences on this would be complimentary (if there is a large difference compared to model-data MAT comparisons).

-It should be noted that dynamic vegetation models could amplify biases in the land/atmosphere models (e.g. if there is spurious cooling/drying to begin with this may lead to cooler/drier vegetation).

-The CO₂ of the CTRL experiment is at pre-industrial levels, what about other GHG's and aerosols? Is this a pre-industrial experiment or a modern experiment with pre-

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industrial CO₂?

Page 717 line 12: “temperature” instead of “temperatures”.

Page 717 line 24: Please double-check if Jakobsson et al. [2007] is a good reference for NH glaciation.

Page 718 line 1 – 7: Split this paragraph into two sentences.

Page 718 line 18: Subscript 2 missing.

Page 718 line 21: Don't need to include references here that are included in the figure.

Page 719 line 2: remove comma.

Page 720 line 10: “our” instead of “out”.

Page 721 line 25: remove “to”.

Page 722 line 3: You should also mention uncertainties in the models, which you describe later on.

Page 723 line 25: Need a full stop.

Page 724 line 12: is this meant to be just “spinup mode”?

Page 724 line 22: Kaplan 2001 missing from the references. Are you referring to Kaplan et al. [2003]?

Page 725 “Temperatures over the land surface are generally within the range of uncertainty of the CRU-TS 3.0 modern instrumental data (Mitchell and Jones, 2005). . .” please double-check. This sounds almost too good to be true.

Page 726 line 22: replace “had” with “was”.

Section 3.2 this title is a bit vague (“Late Miocene boundary conditions?”).

Page 728 line 11: Title of the Ehlers and Poulsen reference isn't correct.

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Page 730 line 12: “Bering Strait”.

Page 735 line 12: the second half of this sentence needs correcting.

Some references missing from table 2: Herold et al. [2011], Krapp and Jungclaus [2011], von der Heydt and Dijkstra [2006] and Barron and Peterson [1991].

Page 738: It would have been nice to see CMT and WMT proxy data to compare with your model.

Page 739 line 6: remove “and Late Miocene climate simulations”.

Page 739 line 21: “colder and drier”.

Page 740 line 27: Perhaps say “the large area of reduced precipitation” instead of “drying”.

Page 741 line 4: “soil by TRIFFID” instead of “soil are by TRIFFID”.

Page 743 line 17: Use “In summary, Fig. 10a and b . . .”.

Section 5.3.1 Please make it clear here, to remind the reader, that the mega biomes are modelled by BIOME4 and not TRIFFID.

Page 746 line 6: remove “are”.

Page 746 line 21: no capitalisation for boreal.

Page 748 line 14: Replace this sentence with “However, there is an improvement in the megabiome. . .”.

Page 749 line 20: Use MAT acronym, check the rest of the manuscript for consistent use. Is section 7 is meant to be section 6.2?

Table 3 and 4: Use “Net” instead of “Global” in the title of the second last column.

References:

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Barron, E. J., and W. H. Peterson (1991), The Cenozoic ocean circulation based on ocean General Circulation Model results, *Palaeogeography, Palaeoclimatology, Palaeoecology*, 83(1-3), 1-28.

Herold, N., M. Huber, and R. D. Müller (2011), Modeling the Miocene Climatic Optimum. Part I: Land and Atmosphere*, *Journal of Climate*, 24(24), 6353-6372.

Jakobsson, M., et al. (2007), The early Miocene onset of a ventilated circulation regime in the Arctic Ocean, *Nature*, 447(7147), 986-990.

Kaplan, J. O., et al. (2003), Climate change and Arctic ecosystems: 2. Modeling, paleodata-model comparisons, and future projections, *J. Geophys. Res.*, 108(D19), 8171.

Krapp, M., and J. H. Jungclauss (2011), The Middle Miocene climate as modelled in an atmosphere-ocean-biosphere model, *Clim. Past*, 7(4), 1169-1188.

von der Heydt, A., and H. A. Dijkstra (2006), Effect of ocean gateways on the global ocean circulation in the late Oligocene and early Miocene, *Paleoceanography*, 21(1), PA1011.

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