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Climate of the Past Discussions

Interactive comment on "Changes in the high latitude Southern Hemisphere through the Eocene-Oligocene Transition: a model-data comparison" *by* Alan T. Kennedy-Asser et al.

Alan T. Kennedy-Asser et al.

alan.kennedy@bristol.ac.uk

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We would like to thank the reviewer for taking the time to review this paper. Five main points were identified by the reviewer:

1) Regarding the horizontal resolution of the models and how they resolve the gateways 2) How the models perform for the present day or other palaeo periods 3) If regions have specific model-proxy data anomalies 4) The paucity of data in the dataset 5) The potential impact of orbital configurations

These will be addressed in turn below:

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1) The model resolution indeed could impact how the models' respond to changes in ocean gateways. We can add further discussion of the results from other studies using higher resolution, e.g. eddy resolving ocean models to highlight this. Due to time and computational constraints, we will not be able to carry out high resolution simulations for the current paper, but hope that our clear methods and openly available datasets could be used by future researchers with higher resolution model results to verify our findings. Additionally, as we noted in Section 4.1., specifically focussing on changes to the Tasman Seaway would be interesting for further research.

2) Both of these models have been verified against present day and other palaeo time periods and we can add discussion and references about their performance. Both capture major characteristics of the present day climate and reasonable variability, but notably both have cold biases over the high latitude northern hemisphere in the winter. This could account for why high latitude temperature biases exist in these models for palaeo time periods.

3) There is no specific sector (e.g. Pacific, Atlantic, Indian) that is particularly poor for all time slices. For the late Eocene and early Oligocene, the models are too cold at all sites. For the change across the EOT, sometimes models underestimate and sometimes overestimate the change, so this is harder to generalise. The New Zealand site is particularly poor for the late Eocene and early Oligocene. For the change across the EOT, the Maud Rise record has the largest anomaly between the model simulations and the data.

4) We have been able to recalculate the latitudinal temperature gradients systematically omitting single points from the datasets to test if they are particularly biased by single extreme or anomalous points. This would suggest that there is no significant difference between the gradients in the late Eocene and early Oligocene, with the early Oligocene data being more affected by extreme values. However, this analysis does not fundamentally change any of the conclusions of the paper. This is the best solution to this issue we can provide without generating many new, independent proxy records.

5) We have been able to redo our analysis using FOAM simulations with different orbital configurations and found that this has a relatively minor impact on the overall fit to the data (less than other factors such as the ice sheet size or pCO2 level). While we cannot say exactly by what magnitude the proxy records might be affected by orbital variability, it could be assumed that the magnitude of the effect would be similar to that in the model. We expect the effect on many of the proxies to be relatively small as they are generally time averaged over periods longer than single orbital cycles.

The other minor comments (mainly relating to figure presentation) can be easily addressed.

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