

Clim. Past Discuss., referee comment RC2
<https://doi.org/10.5194/cp-2022-7-RC2>, 2022
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Comment on cp-2022-7

Anonymous Referee #2

Referee comment on "The sensitivity of the Eocene-Oligocene Southern Ocean to strength and position of wind stress" by Qianjiang Xing et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2022-7-RC2>, 2022

The manuscript addresses the question of the Eocene-Oligocene Southern Ocean and its sensitivity to wind stress strengthening and widening/deepening of the Tasmanian Gateway and Drake Passage in setting up an ACC. The paper is very interesting and provides a solid demonstration of the momentum balance at play through an analysis of the zonal momentum balance and its different terms. The results, subject to all possible limitations and caveats, are convincing. However, I found the paper poorly written, very long and repetitive at times. I have the impression the same message and results can be conveyed with perhaps half of the text, improved figures and a more structured discussion/summary.

Please find below a list of suggestions, questions and corrections.

L56 New and improved estimates could be used here: Koenig et al. (2014) estimated a fullâdepth transport of 141 ± 2.7 Sv and Chidichimo et al. (2014) and Donohue et al. (2016) estimated a fullâdepth transport of 173.3 ± 10.7 Sv.

L115 This is something that you could easily check and should be shown to test the regime change from subtropical gyre dominated to a proto-ACC: please add an analysis of the ocean heat transport and its eddy contribution.

L154-155 Please rephrase, something is odd here.

L240 Why do you use a model with no sea-ice? In understand and appreciate the idealized framework of a regional configuration but I don't see what is gained here by eliminating all possible feedbacks induced by sea-ice. Also, the model of Hutchinson et al, 2018

presumably uses sea-ice (CM2.1), so your surface restoring has that information.

L248 You use a relatively strong SST and SSS restoring of 10 days. How is that affecting your simulations and results when you try to initiate a thermal isolation of the Antarctic?

L281 I am not sure about a regional configuration, but a spin-up of 80 years and sensitivity experiments of 60 years seem a little short to me. It would be interesting to see time series of different metrics to show the circulation is stable and how it changes with the deepening of gateways and shifting of winds.

L284 Another point related to the model configuration: I am not sure what the actual shape of the zonal wind stress is. Is it a zonal mean and you simply shift it north and south? It is not clear from the text whether zonal wind stress is zonally dependent. Presumably that would matter in terms of alignments with the gateways and relative strength at the DP and TG.

L360 details of the discretization, also in L634, should go into the supplementary information (Eq. 4 is already present). Also, Eq. S3 is missing the $1/\rho_0$.

L415 Fig.4 is really difficult to read with its present choice of colours and arrows and should be improved. Consider a specific contour for the SST to highlight the change in temperature along the coast, and different/fewer arrows. Also perhaps less panels

L478 Eg. 5 is missing

Figure 7 This figure is also difficult to read. Consider adding to the same panel both the normal and doubled wind stress to highlight differences.

L632 Eq. 5 is missing as well as section 2.5

L665 I really like your results but the Discussion section is difficult to read, repetitive and often not a 'Discussion' but rather a 'Summary'. Please improve your text to ease the read.