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Climate of the Past
Discussions

Interactive comment on "Paleogeographic controls on the evolution of Late Cretaceous ocean circulation" *by* Jean-Baptiste Ladant et al.

Anonymous Referee #2

Received and published: 13 March 2020

This paper presents a set of simulations of the Cenomanian and Maastrichtian, together with selected gateway perturbations, to investigate the intermediate and deep circulation pathways of these time periods and compare with available proxy evidence. There is a substantial amount of work presented here and a thorough examination of all different circulation pathways and possible mechanisms. The text is generally well-written and the figures are well composed. This paper is likely suitable for publication in Climate of the Past, subject to revisions.

My main criticism of the manuscript is that it is very long in describing all details and some of these descriptive parts are less interesting than others. I think the authors ought to prioritise better to focus the manuscript on the most compelling results and conclusions. The text itself is 39 pages, not including references and figures, making

it heavy work to read. I have made some suggestions for shortening below; however I encourage the authors to look for their own ways of making it shorter. As a guiding principle, the authors may consider prioritising the two main experiments (Cenomanian vs Maastrichtian), and reducing the discussion of the gateway perturbation experiments.

One of the main findings of this paper is that Southwest Pacific sinking dominates the deep circulation in all cases. The authors have given some explanation as to why this region always produces sinking (generally low river runoff), but perhaps it is worth mentioning that the Pacific Ocean is the only major basin in these paleogeographies that spans from one polar region to the other (unlike a modern geography where there are two). It is thus virtually guaranteed that equator-to-pole heat transport will drive at least one mode of Pacific sinking that dominates the deep ocean.

Models and Spinups section

The color scheme used in Figure 1 suffers when in print form: It becomes hard to distinguish between land and shelf – this can easily be fixed by making the land grey. Also, it might be better to use a "cell fill" mode rather than contours, so that the topographic resolution is visible.

In Figure 2, I'm confused that the model extension runs are only plotted for roughly 300 years each. The methods state (Line 304) that each of these runs has been extended for 950 years. Where is that data?

Results section

I suggest removing Figure 5 and Figure 6, or move them to supplementary, because these figures are visually difficult to digest, require cross-referral back to the captions

in Figure 5 and Table 1 to understand properly, and I'm not sure what the story is and why it is interesting. Each of the gateways tends to increase its transport when it is deepened or widened. That is what one would expect. Table 1 already covers all the net transports – to me that is enough.

The discussion of the individual gateway perturbation experiments could be substantially shortened. Accordingly, I think parts 3.1 to 3.4 of the Results section could be either reduced or shifted to the supplementary material. Figures 4 and 12 nicely capture the major changes that are seen by altering these gateways. One can see that there is a robust mode of South Pacific sinking in all cases, and there are some modest inter-basin temperature changes resulting from changing certain gateways.

Discussion section

Section 1 of the Discussion gives a very detailed account of how these simulations agree / do not agree with Donnadieu et al (2016). I find this section unnecessarily long and suggest cutting or shortening it.

The Neodymium discussion is genuinely important, i.e. Sections 2.1 to 2.3 present the available Nd data, and how their earlier and later Cretaceous simulations line up with these data. I would still suggest that some tightening of the text could be made by prioritising the two main experiments (the Cenomanian and Maastrichtian paleogeographies) and reducing the discussion of the individual gateway perturbations.

Section 2.4 seems like a bit of an afterthought and could be greatly reduced (not nearly as informative as the Nd data comparison). Lines 1014-1016 state, "In summary, the comparison of simulated temperature changes and foraminiferal d18O between the Cenomanian and Maastrichtian does not provide strong evidence for or against proposed changes in ocean circulation patterns or the nature of ocean gateways." That sentiment ought to inspire some reductions to Section 2.4.

Line / Technical Comments

-L148-149: This sentences changes from past to present tense halfway through, which makes it difficult to read.
L150-154: Again, the tense changes from past to present in this sentence.
-L192: Antarctica Peninsula: should be Antarctic Peninsula
- L188-213: This paragraph provides a lengthy discussion of past evidence of Drake Passage, without having much bearing on the experimental design. I suggest cutting this. The following paragraph L214-225 explains what changes were made and why and that is much more important.
-L228-250: As above, this paragraph on the Caribbean Seaway doesn't serve a great deal of purpose. The actual experimental design is laid out clearly in the following paragraph.
-L251: "consistent with these interpretations": This statement is a bit vague. There is a lot of detail in the preceding paragraph, and it's hard to tell which "interpretations" are being referred to here.
-L508: "It is also interesting to note that. . .": this is unnecessary word padding.
-L543: "decrease supply": grammar.
-L548-550: The words 'slight' or 'slightly' are used 3 times in this sentence, giving the impression that the authors are not convinced about what they are saying here. I suggest removing these.
-L678-679: "each change in gateway profoundly alters the Maastrichtian deep circulation". I'm not convinced by this statement. Some of the key features of the circulation (e.g. MOC) are not greatly affected by these gateway changes.
-L828-835: This sentence is far too long.
L950: "It is noteworthy that": this is unnecessary word padding.
L958: "concur": I think concur is the wrong word here.
L1055-1057: Climate of the Past requires authors to provide an online data supplement (unless a compelling reason is given not to). This should be made available to

the reviewers before publication.

It is strange that the authors do not use numbered sections for their Level 1 Headings, but from Level 2 and downwards they number the subsections (but without a top-level section number). This leaves the reader somewhat disoriented, since there are multiple instances of Section 1, Section 2, etc throughout the manuscript. I suggest numbering the top-level headings, re-numbering the lower level sections, and thus complying with the style of Climate of the Past.

*NB: I have not read the other reviewer's report in order to remain independent.

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