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# *Interactive comment on* "One size fits all? – Calibrating an ocean biogeochemistry model for different circulations" *by* Iris Kriest et al.

**Anonymous Referee #2**

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In this study, Kriest et al. investigate the role of different circulation realisations on their impact on the optimisation of the parameters of a biogeochemical model. They identify which parameters are most sensitive, and attribute this sensitivity to key physical aspects of the circulation states, principally relating to the scale of mixing and ventilation. They also "port" optimised parameter sets between circulation states to attempt to quantify how transferrable optimisations of models are. In particular, they note that optimisations at low spatial resolution circulations can help in simulations at higher resolution.

This manuscript deals with a significant problem affecting marine biogeochemical modelling. Essentially, because of the computational cost of full 3D simulation, especially at high resolution, we typically make do (whether this is acknowledged or not) with



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suboptimal parameterisations (and I say this as a suboptimal modeller!). Even where optimisation is attempted, its specificity to an ocean circulation state, and its portability between such states, is unexplored and unknown. As such, this study fits a definite need in the community.

Overall, this is a really well-designed and executed study. The authors have done a great job covering the main angles, and done so with a good spread of model circulations. In particular, I like the relating of model parameter values to circulation properties – that's valuable for modellers looking to compare this work with their own.

I have no significant criticisms of the work, and have only minor corrections or suggestions to make. My recommendation is publication after minor corrections.

Specific comments:

Line 28: the use of two maxima here is a little confusing; can this be clarified at all?; a range of 180% might even be explicable by such mismatch of OMZ definitions, but I doubt that's what's happened here

Line 38: "by hand" is, in part, related to keeping the number of tuning simulations down; were a model to be inexpensive to run, automatic tuning sampling a large number of parameter sets would likely be preferred

Line 59: "seems to be" -> "has proven to be"

Lines 60-69: a very nice framing of the problem; thanks

Line 81: it seems remiss not to include even a sentence or two explaining what the TMM is (or what it comprises); it would spare your readers to present something here

Line 87: move this domain information into a table instead?

Line 104: interesting numbers are reported for this domain, but not the others; it would be good to have all, or at least some other common information across the TMs



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Lines 109-110: what does "accurately represent" here mean?; is it in reference to the circulation strengths you mention, or something else?

Line 123: could a calculation of ventilation timescale (mean, max, and between basins) help separate out the differences between the TMs?

Line 129: "up to more than 800 years"; any idea why?; that does sound surprising at face value

Line 130: ah-ha - ages mentioned here, but perhaps these could be added to the table I mentioned before for clarity

Line 132: "tracer observations"?; do you mean radiocarbon?

Lines 137-138: this section feels like it could do with a sentence explaining how this information will be used later; however, it's certainly very helpful to elucidate how models might be good / bad

Line 169: per my earlier remark, how's Drake Passage transport in the models?; it has a relationship with the SO properties mentioned

Line 204: how is near steady state defined? (presumably in Kriest et al., 2017 ...)

Line 210: "many local optima"; good - this is a perennial problem with BGC models

Line 214: as these properties are tightly constrained in the real ocean (e.g. via the N:P ratio), is there an advantage to using all of them?; i.e. could N, O2 or P, O2 be sufficient?; something like carbon - which has a more plastic relationship with nutrients - might arguably be good too

Line 239: you could add the total number of simulations here to indicate the total computational load

Line 245: earlier, in relation to burial and riverine input, you suggest that the inventory is not actually fixed, and can drift by a few percent; which is right?

Line 284: why especially oxygen?

Line 290: so that readers (like this one) don't have to scramble back a few pages, perhaps reiterate the default values once when you mention changes here

Line 362: it's not *completely* independent when the model is optimised to oxygen concentration; although, I appreciate it's not a target

Line 428: should be "m3" not "m-3"; also, might want to contextualise with a percent of mean

Lines 639-640: "on the other hand ..." is a confusing point; what do you mean?; it seems to suggest that a "benefit of parameter optimisation" is "helping to search for the best parameter set"; that sounds not particularly profound; something instead about "necessary level of model complexity"?

Line 647: "through low ideal age"?

Table 1: mean ocean ventilation age from these different circulations might be an interesting metric; or some other relevant integral metric of circulation

Table 3: export production - I like this illustrating of gaps in previous work (which has been more opportunistic than this study)

Figures: a general point I'd make is that red/blue colour bars are usually for situations where a property (e.g. a delta) has a definite central point worth marking (e.g. zero); here they're used broadly, potentially skewing the reader's perspective

Figure 1: you may have tried already, but might delta plots be better? (i.e. show the observations as field values but models as differences from this)

Figure 2: as the observations are missing ice, I'd be inclined to skip it in the models as well

Figure 3: see general and Figure 1 comments

Figure 4: panel D is rather complicated and ugly

Figure 5: change to a much uglier palette; same red / blue issue

Figure 6: I really like this relating of parameter value to circulation property

Figures 8 and 9: I found these rather difficult to interpret, although I have no suggestions on how to change them

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