Biogeosciences

Discussions

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Interactive comment on "Reciprocal bias compensation and ensuing uncertainties in model-based climate projections: pelagic biogeochemistry versus ocean mixing" *by* Ulrike Löptien and Heiner Dietze

Anonymous Referee #2

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The authors examine the effects of "reciprocal bias compensation", (compensating for errors in the physical model component of an earth system model with changes to the biogeochemical component) using a set of experiments with an earth system model of intermediate complexity. Overall, the manuscript makes an important point that is based on a simple experiment which is easy to follow. However at times it is difficult to follow the manuscript, some important information is missing, while other points are mentioned several times.

general comments:

At times, the manuscript seems very repetitive and I have tried to point out most of those instances in my specific comments below. This aspect mostly affects the second half of the manuscript; in fact, in the current version, the "Summary and Conclusions" section is followed by another "Conclusions" section. Section 6 repeats points that have been made in Section 5 which repeats many aspects described in Section 4. A thoughtful restructuring of the last sections would make the manuscript more concise and much easier to follow.

The phrase "reciprocal bias compensation" is used a lot in the manuscript but the actual bias is never examined. Beside 4 RMSD values in Table 4, differences between the configurations are not quantified. I would suggest to include bias values and more than just 2 variables in Table 4. It should include at least those variables examined in the manuscript (including physical variables) and could further include values for the projection into the future (4 columns: "MIX+ (historical)", "TUNE (historical)", "MIX+ (future)", "TUNE (future)"; variables appear in rows). Such a table would show the effects of reciprocal bias compensation on the different variables in one place, which would be very beneficial to the reader.

How were the parameters chosen for the spinup experiment used to determine the parameters for TUNE? I am not against a simple way to determine these parameter values but it would be good to know what ranges were considered and how the values were determined ... grid search, randomly chosen from an interval, latin hypercube sampling? More information is needed.

One interesting experiment would be to include the κ_h (vertical diffusion) parameter in an updated TUNE experiment, just to see if in this very simple case (all error is one parameter) the original value of κ_h could be recovered or if corrections to the biological parameters and thus reciprocal bias compensation would prevail. No further experiments (generating new projections into the future) would be necessary for this experiment.

specific comments:

p1 l7: It is not quite clear what "approach" is referring to.

p1 l14: "Vice versa" -> "Likewise"

p1 l17: remove "away"

p1 l19: "effectivity" -> "effectiveness"

p2 l1: "to" -> "with"

p2 l4: I would not call climatological products "observations"; "data" may be more suitable here.

p2 l6: It's not quite clear what "generic problems" refers to.

p2 l14: "movement" -> "transport"

p2 l15: "are contain various sources for uncertainties" -> "contain various sources of uncertainty"

p2 l18: "The reason ...": please simplify this sentence.

p2 l21: "pump of carbon" -> "carbon pump"

p3 l2: "when the biogeochemical model is unchanged." Is this different if the biogeo-chemical model is changed? I would remove this part of the sentence.

p3 l3: "must have a profound impact on the respective biogeochemical component and it's parameter settings" I would suggest to change this to: "has a profound impact on the respective biogeochemical component and should inform its parameter settings".

p3 l4: "The latter holds particularly as the development of Earth System Models is modular and module after module is coupled together." I am not sure what is meant here, rephrase?

p3 l13: "the value of diapycnal diffusivity, that is to be set in models" I'd suggest: "any

given value of diapycnal diffusivity that is used in a model"

p3 l14: "physics" -> "physical model component"

p3 l19: "based on" -> "using"

p3 l21: "biased ocean component" -> "biased physical ocean component"

p3 l25: "The model setups..." You could include the configuration names for each version in this sentence (include "MIX+" and "TUNE").

p4 l19: "dissolved inorganic carbon (DIN)": Shouldn't that be DIC?

p4 l20: "tuned tuned"

eq1: Typically, T and S denote temperature and salinity (and on page 5 "T" is used for temperature), please use different symbols here.

p4 l28: There is a "(3)" missing and μ_D0 is called μ_D in Table 1.

p4 l31: "iron mask" Surely not a face mask, what is this exactly?

p5 l1: "In one of our configurations we change..." I think it is more useful to specify the configuration or say "in our parameter tuning experiment we change" (this applies to all 3 instances of this sentence).

p5 l5: "depth" -> "depth range"

p5 l5: sometimes "nitrate" is used, sometimes "NO3"

p5 l6: "ends its route down to the sea-floor" -> "stops sinking"

p5 l8: w_D0 has already been described.

p5 l23: The reference to "ground truth" is not useful here and just confuses the reader.

p5 l26: "We define this model configuration as ground truth" this has now been mentioned multiple times.

p6 l5: "The leading thought behind these changes relative to MIX+ is to mimic the behavior of the Genuine Truth configuration even though the vertical background diffusion is substantially different to the Genuine Truth. Or, in other words, ..." This has been mentioned before and can be simplified

p6 l9: Point (1) is not part of the procedure and should appear in section 2.1 to motivate the choice of parameters there.

p6 l14: How was chlorophyll a converted via Redfield?

p6 l14: "surface chlorophyll a and oceanic phosphate": where the observations distributed evenly across the globe? Does "oceanic phosphate" imply surface values? More information is needed on how the best fit was determined.

p6 l19: It would be nice to actually list the bias alongside the RMSD in table 4.

p6 l30: It is not clear to me what the difference between the spinup and the drift runs are if both use pre-industrial atmospheric CO2.

p7 l3: This summary is repeated again in the next paragraph.

p7 l15: "Mix+" -> "MIX+"

p8 l1: "antagonistic": do you mean "twofold"? Please rephrase.

p8 l5 (and elsewhere): "inline" -> "in line" (or reword using for example "agree with")

p8 l24: "bias" but those are RMSD values, please report the bias as well.

p9 l4: It would be good to mention this feedback mechanism when the model is introduced.

p9 l7: In this paragraph the language makes it seem like Genuine Truth is evaluated with respect to the TUNE configuration (same comment applies to Fig 8), it is better to switch it around, that is: "TUNE shows ... relative to Genuine Truth."

p9 l23: Remove "also" from this sentence and following introductory sentences for

other subsections.

p10 l6: Doesn't "base currency" imply that variables like phytoplankton is measured in units of phosphate concentration?

p11 l1: Add "(b)" to figure reference (or better, switch the panel order and add "(a)").

p12 l12: The notion of "slightly changed physics" does not seem to agree with "we have to stress that our mixing parameter settings can presumably be regarded as extreme cases" just a few lines above. I would suggest to reword, emphasizing that just one physical parameter was modified.

p12 l26: "The latter change is motivated...": It is difficult to follow this and the next sentence. Please rephrase or delete.

p13 l3: "is with 21 Sv huge": is this the ensemble spread from the Reintges et al. (2017) report? If so, make this explicit; if not, please rephrase, it is difficult for the reader to follow the train of thought here.

p13 l8: "have been changed by 12.5, $\approx$200 and 115% respectively": use "%" for all numbers!

p13 l26: "In terms of the uncertainties in projected sea surface temperatures imposed by ocean mixing are locally substantial:" Something is missing in this sentence

p14 l17: "suited" -> "suitable"

Fig 2: combine with Fig 1. I would be good to show the difference between the two panels.

Fig 4, 5 and others: It would be very useful to have difference maps. If there is not enough room for extra panels I would suggest to show the regular field for Genuine Truth but difference fields for the two other configurations.

Fig 6: A label for the y-axis is missing and the background should have a color that is

not in the the color map (grey?).

Fig 6: caption says "mins"

Fig 7: Here, one the other hand, it may be useful to show the oxygen conc of the Genuine Trurth in a new first panel.

Fig 8: Differences in anomalies are not that easy to interpret. I suppose the temperature in 1850 is very similar in both simulations, so the difference in anomalies is basically a difference in temperature? If that is the case, mention this. Furthermore, based on the description, why is Genuine Truth - TUNE shown and not the other way around, like in all other plots? I would suggest to use three panels again: (1) anomaly for Genuine Truth, (2) difference TUNE - Genuine Truth (3) difference MIX+ - Genuine Truth.

Fig 11: add description and units to panel (b). It would makes sense to switch panels, so that they appear in the same order as in the manuscript text.

Table 3: combine with Table 1.