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Geoscientific Model Development Discussions

Interactive comment on "Complementing thermosteric sea level rise estimates" *by* K. Lorbacher et al.

Anonymous Referee #1

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This manuscript introduces a relatively simple way of estimating the thermal expansion in climate models from the oceanic temperature change. This is a useful complement to the existing CMIP5 database. While not a major breakthrough for the science of sea level change, it should be shared with the community in a journal like GMD.

However, the ms. as a whole has an unfinished, hurried and patchwork-style feel to it. The Discussion section and the Abstract rest on several results that haven't been elaborated on in the body of the text at all. There are also some conspicuous features in the Figures that warrant further discussion and explanation. I would advise the authors to spend more room on elaborating on the results that they do have.

I can see this ms. being published eventually in GMD, but for now a major revision is clearly needed.

Detailed comments

There are several parts of the ms. where the reported results have not been explained in sufficient depth or where it is not clear how exactly the results have been obtained.

(1) p.1209 and Fig.3 To me it is absolutely not clear why the contribution of the deep ocean (>2000m depth) to the global mean thSLR is decreasing with time in the RCP scenarios, but not in the 4xCO2 scenario. The authors try to explain this with the increasing vertical temperature gradient in the 4xCO2 runs, but why doesn't the same explanation hold in the RCP8.5 case? Indeed, if the different RCP scenarios are compared in Fig.3, it appears that the stronger the forcing, the /faster/ the decline of the contribution of the deep ocean. The authors say that the 20th century history (which the RCP runs have, as opposed to the 4xCO2 runs) plays a role here. It certainly will, but if anything, I would have expected the opposite effect: the OHU in the 20th century would already have increased the vertical temperature gradient, so over the course of the 21st century the deep ocean should start to warm up too. Consider also Purkey & Johnson (2010) and further studies that report on the accelerate warming of AABW in observations in the early 21st century. Fig. 3 shows a very interesting result in this respect, but more explanation is needed.

(2) Fig. 4 Is there anything essential in Fig. 4 that we haven't seen in Fig.3 already? Perhaps it can be cut out altogether? If anything, what I see here is again the deeply puzzling role of the deep ocean (>2000m) in the historical runs. Why does 'historical' have the largest spread of all scenarios, and the largest contribution to the overall thermal expansion? I actually wonder whether this is a feature (or a weakness) of your 1.5D estimate of alpha? Perhaps the 6 parameters aren't well constrained in the historical runs for some reasons? Please elaborate.

(3) p.1211 l.12 How has the result on the "augmentation" of the thSLR estimates been obtained? I'm completely at a loss to see this from your ms. Is there a whole section missing? You're even mentioning this result in the abstract. If you do not show it, then

just cut these two sentences (here and in the abstract) out.

(4) p.1212 l.15 "... meridional gradients..." Another result that is mentioned in the Discussion, but is not derived at all. I would just cut this.

(5) p.1212 l.18 "errors of +/-5 and =/-9%": again, where do these numbers come from? It almost appears as if the Discussion section belongs to another paper - there are so many references to results that have not been described in the body of the paper. I would suggest to start from scratch writing the Discussion, based on what you actually write about in the previous sections. The abstract should be amended accordingly.

Technical remarks

p.1201 l.8: "we complete diagnostics" doesn't sound right. Perhaps say "extend".

p.1201 l.9: "We obtain 30% more thermal expansion ..." It is absolutely not clear how you obtained this result. See my remark on your Discussion above.

p.1203 l.1: "due to (nonlinearities of)" sounds awkward. Perhaps say "due to the nonlinear way in which the equation of state depends on the ..."

p.1203 l.4: "ocean's" should be "the ocean's" (there are several more instances of this mistake)

p.1203 l.27: "up to date": I think you mean "currently"

p.1205 l.15: for human readability it should be ".10^{-6}"

p.1207 l.9: missing URL

p.1212 l.14: "density gradients": This sentence strikes me as odd: as you say very clearly in sec.2, it is the vertical gradients of temperature and pressure that mainly determine alpha - not the density. That there is a strong vertical gradient of alpha is first year textbook knowledge and doesn't need mentioning here at all.

Fig. 2d,e: Is it useful to show the Roemmich & Gilson values all being zero in these

two panels? I would simply leave that out.

All figures, as rendered in the ms., are much too small and thus illegible. The authors will have to use much larger fonts for labeling, or rather break down the existing panels into more figures.

Interactive comment on Geosci. Model Dev. Discuss., 8, 1201, 2015.