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Ocean Science Discussions

Interactive comment on "The transient sensitivity of sea level rise" *by* Aslak Grinsted and Jens Hesselbjerg Christensen

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General Comments: The (very short) paper looks at linear relations between global sea level rise (SLR) rates and time-mean temperatures in both observations and climate model projections- the results suggest that models may underestimate future sea level rise, which is a very important finding. The study is clearly written, and the results are interesting, though since I am not a global climate modeler, I am not sure if this result about the SLR-SST relation in models is new or already known to climate modelers. There are several caveats in the study with its very condensed presentation (only one figure and 1 table), that are needed to be explained (with potentially expanded calculations).

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Discussion paper

Major Comments: There are several assumptions that are not completely correct, so their impact should be addressed more extensively.

1. SLR rates are far from being linear, they are in general accelerating, but there are also significant multi-decadal variations in SLR rates (e.g., see Frederikse et al., Nature, 2020, doi:10.1038/s41586-020-2591-3). Therefore, the assumption that the SLR-SST linear relation in the past should be the same as in the future may not hold. Moreover, the period chosen for time-averaged SST and SLR may affect the results- some experiments to see how sensitive the results are to different chosen periods may be useful.

2. The SLR-SST relation assumes that SLR is related to SST through thermal expansion, but what about the contribution from water masses? In recent years and in the future contribution to SLR from ice melt will increase relative to thermal expansion (Frederikse et al. 2020, and many others). This by itself may explain the main results here. To see if this is the case, you may add to the calculation results from the same models over the same period as the observations to see if the results are due to model biases or the neglection of water mass contribution.

3. Linear regression in Fig. 1 is obtained from only $\sim$5 points, can accuracy be improved by regression over several models, not just the mean of each scenario? Are there for example, models (recent high-resolution) that do follow the observed line? These suggestions may be outside the scope of the study but would greatly help to explain the results and its implications.

Minor Comments: 4. Lines 9-10: “To understand this discrepancy”- I am not sure this is a real discrepancy or just different estimations of future changes.

5. Line 38: “. . . century averaged temperature”- can you define exactly over what period the averaged was calculated (in Fig. 1 it says CO2 since 1850). As mentioned before, it will be useful to know how sensitive the results are to the chosen period, given the non-linear nature of SST and SLR.

6. In Fig. 1, what are the superscript numbers above labels (numbered references left from a previous submission?)

7. In Table 1, only 1 out of 4 sensitivity numbers is statistically significant. . . can this be improved by larger set of data from different models, as suggested above? Is there physical meaning to the “balance temperature”?

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