

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

Anonymous Referee #3

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In this manuscript, the authors define the new concept of transient sea level sensitivity that is inspired by the transient climate sensitivity but that is adapted to the sea level problem. In particular it relates the sea level rise over a century with the average temperature anomaly compared to a steady state over the same period.

I think this concept, even with all its drawbacks, has the potential to be useful but the arguments developed in this manuscript needs to be further developed to be convincing. Especially since the authors make important claims about the underestimation of future sea level rise by the IPCC AR5 and SROCC process-based method.

General comments:

An important motivation to define the TSL is the linear relationship between sea level

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change and GMST in both observations and models. However that relationship is not very convincing. I agree with the theoretical points mentioned by referee #2 so I will not come back on those but I will focus on the observations and model data used in Figure 1:

1) The observational data used here to back up such a relationship is weak. There are only three points, moreover the pre-industrial and tide gauge periods are very close to each other. With therefore the main point driving the slope of the linear relation being the satellite period which is only around 25 years. I would suggest that if the author think 25 years is enough to estimate the TSLs then the tide gauge period could be split in a few 25 years periods.

2) For model data the uncertainty lines are obtained from the assumption of full covariance between GMST and sea level uncertainties in IPCC projections. But that is not the case at all, there are many sources of uncertainty in the sea level projection that are independent of temperature. For example Greenland and Antarctic ice dynamic contribution, glacier model uncertainty (four different models are used in AR5 and SROCC). The assumption is justified by the fact that when it is made it shows a linear relationship between GMST and sea level but this is what the authors try to demonstrate. Also for SROCC the linearity doesn't seem to hold at all.

I.47: "This does not automatically demonstrate a bias in model projections, but as a minimum call for a detailed explanation."

Since this is the main claim of this short paper I think attempting to provide an explanation falls on the shoulders of the authors. There is already some literature on that subject see for example Slangen et al. 2017, in particular section 4:

"When all the contributions are combined, the models add up to a GMSL change of 92 6 47mm for the period from 1901–20 to 1996–2015 (Table 4, Fig. 9a). Compared to the average of the four reconstructed global mean time series for the overlapping period from 1901–20 to 1988–2007 (Table 5, Fig. 9a, the model simulations clearly un-

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derestimate the observed GMSL and explain only 50% 6 30% of the observed change (using 61.65s of the models to the mean of the observations).”

And the following discussion on adding corrections to the sea level computed from the models to solve the issue.

Small comments:

- Figure 1: I can't find an explanation for the numbers in PI11, TG7, Sat9 and others.

Slangen, Aimée B. A., Benoit Meyssignac, Cecile Agosta, Nicolas Champollion, John A. Church, Xavier Fettweis, Stefan R. M. Ligtenberg, et al. “Evaluating Model Simulations of Twentieth-Century Sea Level Rise. Part I: Global Mean Sea Level Change.” *Journal of Climate* 30, no. 21 (November 2017): 8539–63. <https://doi.org/10.1175/JCLI-D-17-0110.1>.

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