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Discussions

Interactive comment on "Atmospheric Circulation Changes and their Impact on Extreme Sea Levels around Australia" *by* Frank Colberg et al.

Frank Colberg et al.

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color hyperref In the text below, the reviewer's comments are shown in black, while our (the authors') responses are shown in red text.

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Their conclusion is that tide-surge interaction is strong (at least at some parts along the coast) for individual extremes but may be neglected for statistics over longer periods. For me, this is not very conclusive as potential changes in tides are also not taken into account.

While the author is correct, we conclude 2 things in this section: (1) surges occur more often during low tide for some locations when tides are included thus leading to smaller total sea levels. This means the timing of the surge and tides is interlocked at times owing to non-linear interactions. However, we also show (2) that the height of the surge regardless of including tides or not does not change when looked at it in a ranked sense (or only to a small degree). We argue that because of point (2) we do not need to include tides in the future climate scenarios as our main interest is the effect of change in coastal surge driven by atmospheric forcing.

I understand somehow that changes in the met. forcing alone may be visible in a surge-only run and potential changes may (roughly) be inferred thereof but only if relative changes in he met induced component are investigated.

We are not sure what the reviewer is suggesting here.

Climate change will also affect the base water level (MSL) which has not been considered in your experiments, right? From SLR, the propagation of the surge will be affected influencing the timing (and hights) of surge events.

We agree with the reviewer that e.g. SLR has the potential to change the speed of the gravity tidal wave and thereby also has the potential to change the distribution of tidal phases/ amplitutdes around the globe. However, in order to add such an effect into a surge model we would need to have access to newly generated tidal constituents (calculated by inverse modelling). Such a dataset is not available to date (to our knowledge). Also consider the large uncertainty in regional sea level rise projections that one needs to take into account. Furthermore changes due to SLR are in the order of meters which is small compared to errors/ uncertainty in the bathymetric datasets. I can see that one could change bottom topography to model such an effect to understand the sensitivity but this is beyond the scope of our study.

Furthermore, also the tidal propagation may/will change with SLR having the potential to further increase water levels and partly compensate for the "mostly" negative trend in ESL changes you reported stemming from the met. only approach

Yes, MSL and RSL both have the ability to increase current tidal propagation. To a first approximation components are often linearly added which leads to different exceedence probability thresholds. Note, however, that in our manuscript we only consider atmospheric driven changes in SSH. We added a paragraph discussion SLR scenarios.

The period of 20 yrs you consider for the future climate conditions are too short to draw robust conclusions. Usually a period of 30yrs is used to estimate changes in the met. forcing. Please consider extending your modelling or discuss why you chose this short period, how it affects your results.

The choice of twenty-year time slices was to align the hydrodynamic model output to wave model simulations carried out using the same climate models over the same time period that was published in Hemer and Trenham (2016). Our aim was to be able to couple hydrodynamic extremes with wave-induced extremes (e.g. wave setup or runup) in future work. We acknowledge that 20 years may be too short to assess the role of future changes to interannual variability (i.e. ENSO) on weather events that cause extreme sea levels such as tropical cyclones, but as we already note, the GCMs do not adequately resolve TCs anyway so the focus of our study is on the contribution of large scale circulation changes to extreme sea levels. We feel that 20-year time slices are adequate for assessing how large scale circulation changes will affect drivers of sea levels around much of Australia's coast where seasonally varying weather systems are a major cause of extreme sea levels.

(Hemer, M. A. and C. E. Trenham, 2016: Evaluation of a CMIP5 derived dynamical global wind wave climate model ensemble. Ocean Modelling, 103, 190-203, doi:https://doi.org/10.1016/j.ocemod.2015.10.009.)

page 3, line 30: 1' x 1', x missing

Fixed that

page 7, line 26: Due to computational constraints, we demonstrate that... From my point of view, this is not a good argumentation

Yes we agree and changed this

page 9, line 8: BM covers 1981-2012, right? so the common period is '81-'99. Should be clear

OK – fixed that

page 9, line 18: Albany not shown in Figure 1

OK – added to Figure 1

Fig1: Could be helpful to show the average tidal range (e.g. based on TPXO) over the entire area

Fig.2: Please define the dots (semi- and diurnal)

We are explaining this in the figure captions now.

Fig.4: All R2s show values of âĹij1. This is a bit misleading, as most stations over-

and/or underestimate the extremes. Also the R2 is not mentioned

Yes – we clarified this.

Fig. 6: Units missing; please highlight meaning of surge and residual again; for me, the figure shows a clear tide-surge interaction which cannot be neglected. Also for the largest events as e.g. in Rosslyn Bay or Darwin

OK – added units. We are adding more elaborate figure captions that aim to make the figure more understandable

Fig. 8: Portland not given in the Fig. , what is happening at the northern part (Milner Bay)

OK – added Portland. We assume the reviewer is referring to the large difference between the Milner Bay observations and model results. They may be explained by the fact that the Milner Bay tide gauge is located at the south side of Groote Island which is not very well resolved in the model.

All figures would benefit from detailed captions.

We have expanded/improved captions.