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Ocean Science
Discussions

Interactive comment on "The significance of coastal bathymetry representation for modelling the tidal response to mean sea level rise in the German Bight" *by* Caroline Rasquin et al.

Anonymous Referee #1

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1 General comments

In this work, the authors describe the impact of different bathymetric resolution on the tidal response to sea level changes in the German Bight. The authors use two different model setups to compare the responses to sea level changes and investigate the differences in response between the two models with different sensitivity experiments. The paper is well written and the figures presented are of high quality. Parts of the manuscript could benefit from some improved reasoning. The methodology could be expanded and clarified by including a more detailed description of the tide relevant methods in the models. The analysis appears to be carried out thoroughly, though

some further model – tide gauge evaluation should be added. I am not quite sure that the authors reach the correct conclusions with regards to the large sea level change scenario, however, apart from this point, their conclusions are sound.

2 Specific comments

P1 Line 23: The first sentence feels clumsy – consider omitting (you explain in more detail later on anyway) or at least add a reference for this (quite bold) statement

P1 Lines 23 – 28: what is the point you are trying to make by mentioning the acceleration in MSLR? Maybe it would be more helpful to look at total increases in SLR? This is what really will affect coastal areas. Are there more recent references?

P1 Line 28-29: worth including a reference and eluding to the reasons for this.

P1 Line 28: highlight why changes in the tides are important – water level variations, extreme water levels, species distributions, changing currents, etc

P1 Line 29 – P2 Line 7: are the changes you mention here due to changing tides or changing sea level? If the latter then they feel slightly out of context.

P2 Line 25: what sort of shelf models are you referring to here? Tide models? OGCMs?

P3 Shelf Model description(s): Given that your work is all about tides it would be helpful to include more information on the calculations of the tides in the model.

How is bed roughness dealt with? Internal tides? Is this a 2D or 3D model? What happens at the open boundaries?

P3 Line 19: are you really using GOT00.2? The latest version is GOT4.7

P4 Line 5: why would you want sediments in your model?

P4 Line 7: What parameters are used in the subgridscale option? How does this feed into the shallow water equations? Do both models have this option? How does turning this option on and off affect the results?

Table 1: It would helpful to include a root mean square error here as this gives an additional measure of the absolute model error rather than the relative error you get with the bias.

P6 Line 7: explain RMSE*?

P6: Given that you mainly discuss changes in M2 amplitude later on, it would be helpful to include an evaluation of the model performance in simulating the tides against the amplitudes at the stations and possibly also against a product such as TPXO or FES. This is probably more important than including an analysis of the water levels as it is not clear through which processes the water level errors arise (i.e. your model could perform very well at simulating tides but not for storms or vice versa).

P7 line 12 – 13: This statement is not clear to me – why do you add SLR at the open boundary rather than over the whole domain? Is this the case for both models?

Can you explain in more detail how the model deals with flooding areas, i.e. the

wetting and drying scheme? How does that work at low water and sea level rise?

Surely, with SLR more normally dry areas are flooded and more energy is lost there?

P7 Simulations: How do you deal with open boundary tidal forcing with sea level rise? Harker et al. (2019) show that using present day tides at the model open boundaries leads to large changes in tidal responses on the Australian Shelf – can you comment on this for your work? Similarly, global studies such as Mawdsley et al. (2015) show global changes in water levels. Work by Wilmes et al. (2017) show global tidal responses to large-scale sea level changes on the levels of your 10 m simulation.

Do you allow for flooding in the large SLR scenario? What coastal defences do you assume?

Figure 4: Why does Emden have such a large error?

Figure 3: what are the units? Explain mNHN in the caption

P10 Line 3: How do you calculate tidal amplitudes?

P10 line 4-5: omit sentence

Figure 6. Which model performs better at the present-day tides?

P19 lines 4-5: '"The response to a MSLR of 10 m is more comparable in both models" – the differences between the two model setups are probably on a similar magnitude or larger as for the 0.8m SLR scenario, however, they are masked by the larger-scale differences occurring on the whole shelf area (whereas for a 0.8 m

SLR the shelf-scale changes are much smaller). I would, however, argue that there are pretty big differences between Figure 6 e and f, especially around the islands in the southern part of the domain where the difference amounts to over 1 m in amplitude.

P19 lines 32-33: I'm not sure I agree – see comment above. The differences locally are pretty significant. Your large-scale, regional or shelf-wide responses are similar, but then arguably they are also similar (i.e. not very much happens) for small sea level increase.

P20 line 24: "For higher mean sea level rise scenarios (10 m) the resolution of the bathymetry is less important" see comments above. I would conclude that, if looking at complex coastal areas such as the German Bight, highly resolved near-shore bathymetry is important for assessing the impact of sea level changes in these complex areas as the local responses can differ from the regional, offshore tidal changes. This is the case whether the forcing is large or small.

3 Technical comments

P2 Line 21: "1m" – space needed; also check remainder of the document

P2 Line 23: defence -> defences

P2 Line 28: After "Thus" add a comma

P10 Lines 3 – 4: Figure 6 shows for both numerical models the M2 amplitude and its changes in response to mean sea level rise in the region of the German Bight.

-> Figure 6 shows the M2 amplitude and its changes in response to mean sea level rise in the region of the German Bight for both numerical models.

Table 2: You have quite a lot of different cases – remembering what case study 1 referred to later on in the manuscript is hard – why not label them something intuitive like GBM_ref_CS1 -> GBM_ref_NE and GBM_80_CS2 -> GBM_80_NE_CB

Figures 7 onwards: rather than having lots of single plot figures it would be better to condense your individual images into one or two figures with more subplots like you have done in Figure 6.

P13 lines 8 - 9: Similar to the shelf model the M2 amplitude increases in this case study in the German Bight. -> The M2 amplitude increases in the German Bight in this case study are now similar to the shelf model changes.

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