Interactive comment on "Downscaling sea-level rise effects on tides and sediment dynamics in tidal bays" by Long Jiang et al.

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Dear Authors;
Thank you for your interesting contribution to the discussions on SLR impact in estuaries. I think you did some decent work in downscaling tidal dynamics and analysing the -potential- impact of SLR on the tidal dynamics. Also you explored the potential impact on sediment transport and tidal flats survival. I think this latter aspect deserves some more clarification and discussion. In the attached document I have made some minor comments. Below I formulate my major concerns. I have no doubt accepting your work when these are adequately addressed.

Response (1): Thank you for the constructive comments on our manuscript. We have revised the manuscript as requested and addressed all the comments as follows.

1) You disregard morphodynamic development. This may be a justified assumption in the sense that the morphodynamics potentially create an extra and yet unclear dimension to the work. It is good to restrict your efforts sometimes. However, I feel that there will be significant morphodynamic analysis coming 100 years in the ES.

Response (2): Thanks for the comment. Yes, we assumed a constant bottom topography mainly because of the uncertainties in the future. If the topography does change with time, the spatial bottom roughness can be altered in contrast to the baseline scenario, which may change the local friction and tides. In addition, the convergence can also be changed. It will require a sediment transport and geomorphology model to study all these effects. An example is that the M2 tide in the German Bight is amplified because of the bathymetric changes (Hagen et al., 2019). We have expanded the discussion of the limitation in the last paragraph (Page 11 Lines 15–27) of the "accept-changes" version of the revised manuscript and pointed out the limitation in the abstract (Page 1 Line 13) and conclusions (Page 12 Lines 1–3). Hereafter, wherever the page and line numbers occur, we refer to the "accept-changes" version.

References

Hagen R., Freund J., and Plüß, A.: The impact of natural bathymetry changes, EGU poster, http://doi.org/10.13140/RG.2.2.13292.62083, 2019.

2) You consider coarse sediment only (neglecting a settling lag) whereas muddy sediment will be relevant as well. Mud could import while sand exports. Mud could heighthen flats. A sand export could deepen channels while flats are maintained.

Response (3): It is true that the mud transport is not included in the study. We have addressed this comment in Response (13).

Drawing strong conclusions based on an analysis that disregards morphodynamics

and fine sediments seems not justified. I suggest to rephrase the summary and conclusions acknowledging more clearly that morphodynamics and fines were not considered.
You may add a discussion on why you disregarded these and what important implications of that assumption could mean to your results (like the heightening of tidal flats).

Response (4): We have revised the abstract and added a conclusion section to acknowledge the assumptions and limitations of this study. For example, the exclusion of morphodynamics and fine sediments are mentioned on Page 1 Line 13 and 17, respectively. The reasons of making these assumptions are described in Methods on Page 4 Lines 28–29 and from Page 5 Line 33 to Page 6 Line 4, respectively. The assumptions are discussed on Page 11 Lines 18–24 and Page 8 Lines 20–23, respectively.

* I believe it is also the reduced tidal range (and not only the reduced sediment supply) in the ES that makes the intertidal area to erode. Wave action is more concentrated at a speciifc height (in a smaller tidal range) causing more erosion of the tidal flats.

Response (5): Thanks for the suggestion. Yes, we agree with it. We have made the changes to suggest that the reduced tidal range also contributes to the erosion of sediment in Sections 2 (Page 3 Lines 20–21) and 4.3 (Page 8 Lines 17–20).

* I am interested in how the ES is implemented in the MArs model: can you explain that a little bit more what the assumptions and implications are of the one way coupling? To what extent does the MARs model include the effect of the ES? Are the GETM boundaries far enough at sea to have no effect of the ES dynamics under SLR?

Response (6): The MARS model does not have a high resolution in the Dutch Delta region. The Oosterschelde is sometimes closed (Fig. R1a) and sometimes open (Fig. R1b) to Grevelingen in MARS, while in reality they are isolated by dams and sluices. The water elevation in the Oosterschelde is also not well simulated due to a low spatial resolution. For example, the water elevation in the eastern part is always around 1 m whether at low (Fig. R1a) or high (Fig. R1b) tides. Therefore, a refined local model for the Oosterschelde is clearly necessary.

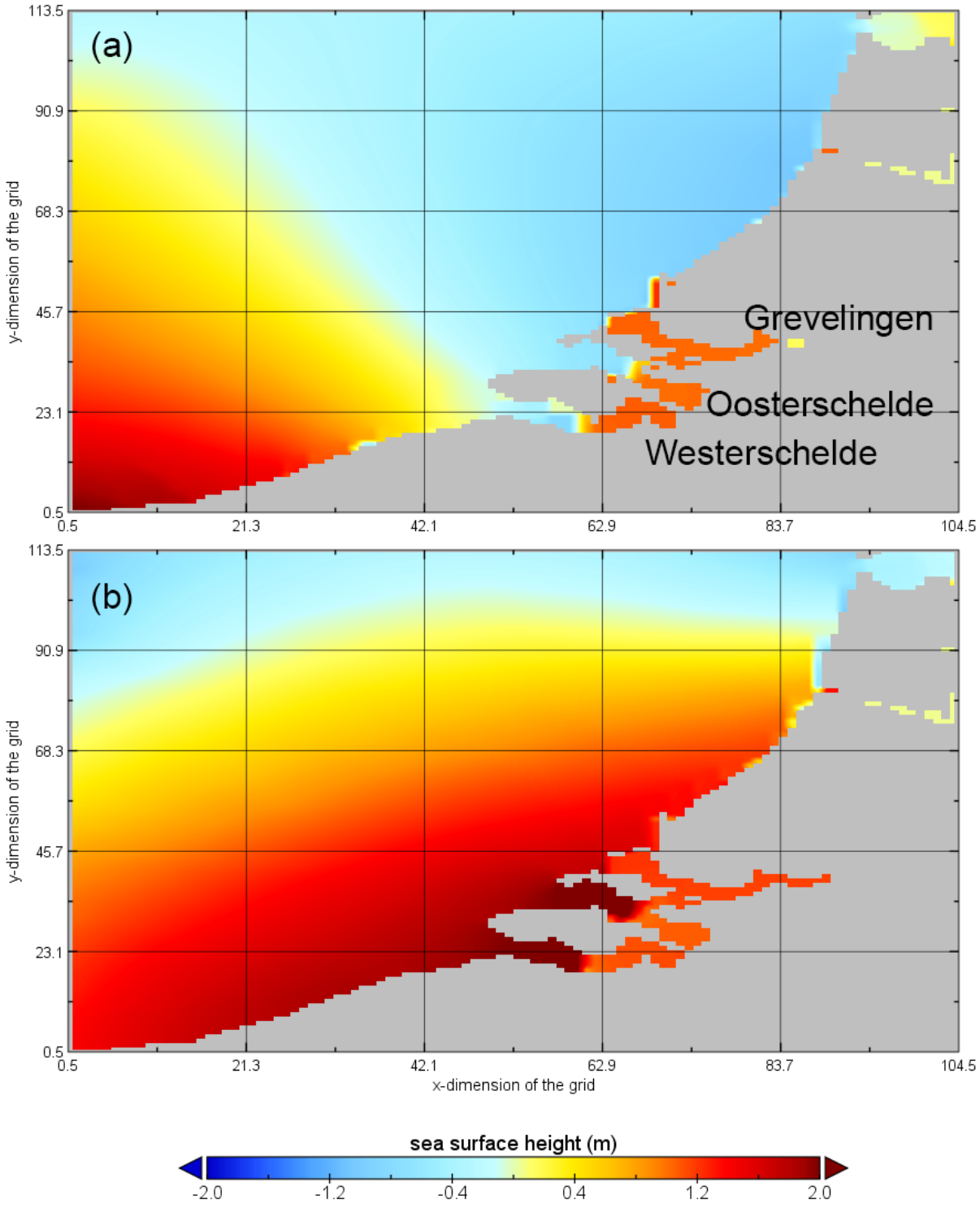

Figure R1: Snapshots of sea surface height simulated by MARS at (a) 2 Jan. 2009 14:15 and (b) 9 May 2009 14:00.

* I miss conclusions since these are merged in the discussion. Please differentiate into "discussion" and "summary". And maybe add sub-headings in the section that is now called "discussion and summary"

Response (7): We have added a Conclusion section in the end to summarize the major findings. Limitations and major assumptions are also ackowledged.

with kind regards
Mick van der Wegen

Please also note the supplement to this comment:
https://www.ocean-sci-discuss.net/os-2019-50/os-2019-50-RC3-supplement.pdf

Specific comments from the supplement:
Page 1 Lines 11-13: The conclusions are quite bold (even misleading) given that
1) morphodynamic adaptations are not accounted for.
2) you consider coarse sediment only whereas muddy sediment will be relevant as well
I would rephrase the conclusions as more provisional and within the limitations of your assumptions (your decent work suggests developments under rough assumptions)

Response (8): This comment is the same as is addressed in Response (4). The abstract is revised as suggested.

Page 1 Line 14: Cross out "model"

Response (9): It is changed to "model coupling". Now on Page 1 Line 18.

Page 2 Line 30: Actually I believe it is also the reduced tidal range in the ES that makes the intertidal area to erode. Wave action is more concentrated (in a smaller tidal range) causing more erosion of the tidal flats

Response (10): Thanks for the suggestion. We have made the changes. See Response (5).

Page 3 Line 26: I am interested in how the ES is implemented in the MArs model: can you explain that a little bit more?

Response (11): This comment is the same as is addressed in Response (6).

Page 3 Line 31: Can you explain a little bit more what the assumptions and implications are of the one way coupling? To what extent does the MARs model include the effect of the ES? Are the GETM boundaries far enough at sea to have no effect of the ES dynamics under SLR?

Response (12): We have added the explanation in the first paragraph of Section 3 (Page 4 Lines 9–11). One-way coupling in our application means the communication from the larger (MARS) to smaller (GETM) domain is resolved, but not contrariwise. The MARS model does not include the effect of the ES. It is not necessary to extend the GETM far enough. The effect of SLR on tides at the open boundary is transferred from MARS to GETM.

Page 4 Line 10: Is this assmption valid? it only considers (coarse) sand while mud concentrations are considerable. What are the consequences pls elaborate a little bit more.

Response (13): When calculating Q, only one class of sand with a specific erosion parameter α and settling velocity w_s is considered. Our study aims to focus on the hydrodynamic effects (velocity and tidal asymmetry) that can be varied by SLR and affect sediment transport. The reason of choosing sand is that the Oosterschelde after the Delta Works is mostly sandy according to our along bottom measurements of sediment grain size distribution (Fig. R6) and a previous study (Fig. R7). That said, Q is only an example of how SLR can change the asymmetry-associated transport of this type of sand. We have specified it where Q is discussed in the revised manuscript (See from Page 5 Line 33 to Page 6 Line 4). It is also clarified in Section 4.3 that the mud transport is unaddressed in this study, and therefore, this study is not a quantification of sediment budget under SLR. Please see Page 8 Lines 20–23.

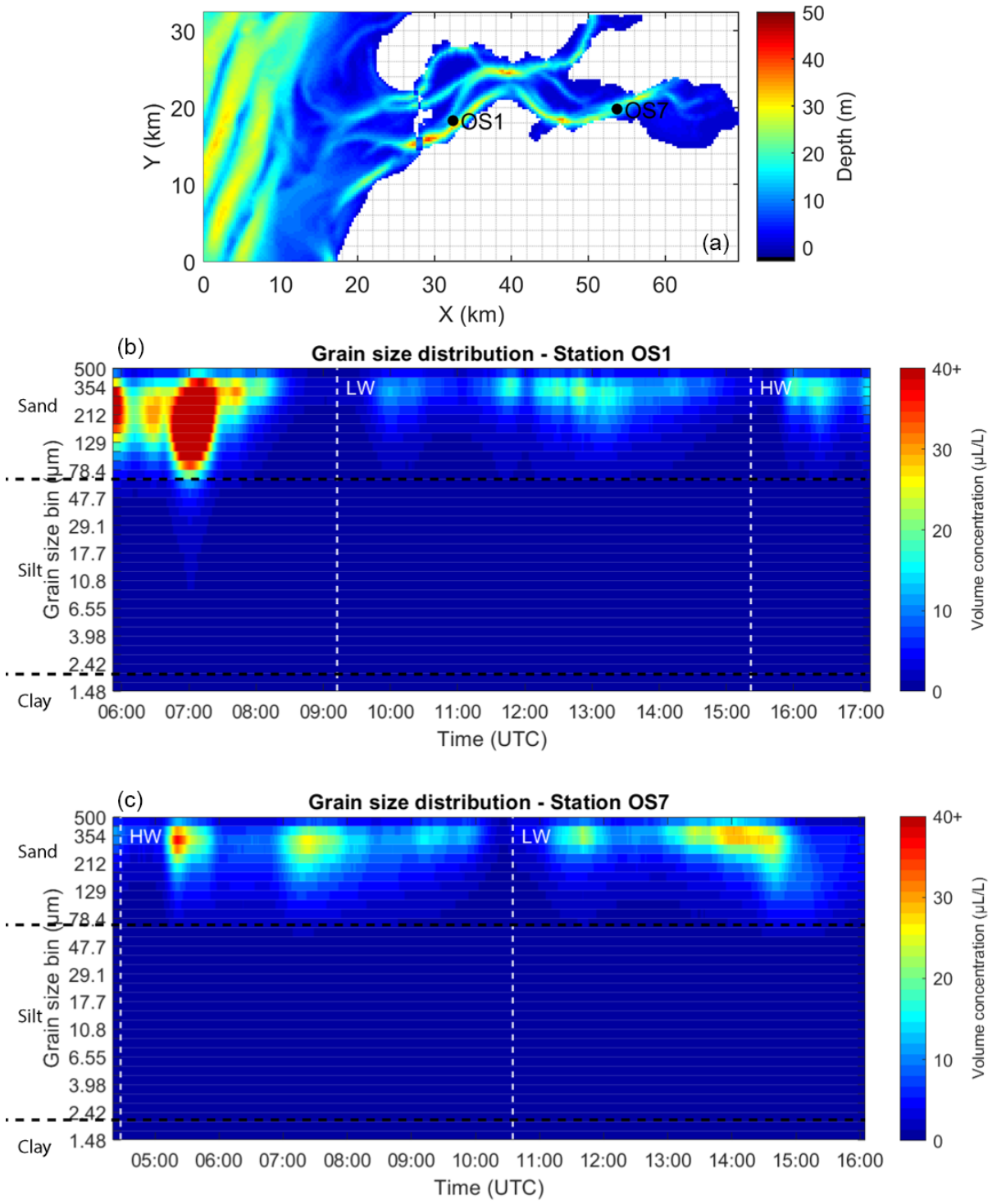

Figure R2: The near-bottom sediment grain size distribution at (a) two stations of the Oosterschelde: (b) OS1 measured on 4 June 2019 and (c) OS7 measured on 6 June 2019. The grain size distribution is measured by the LISST-200X Particle Size Analyzer.

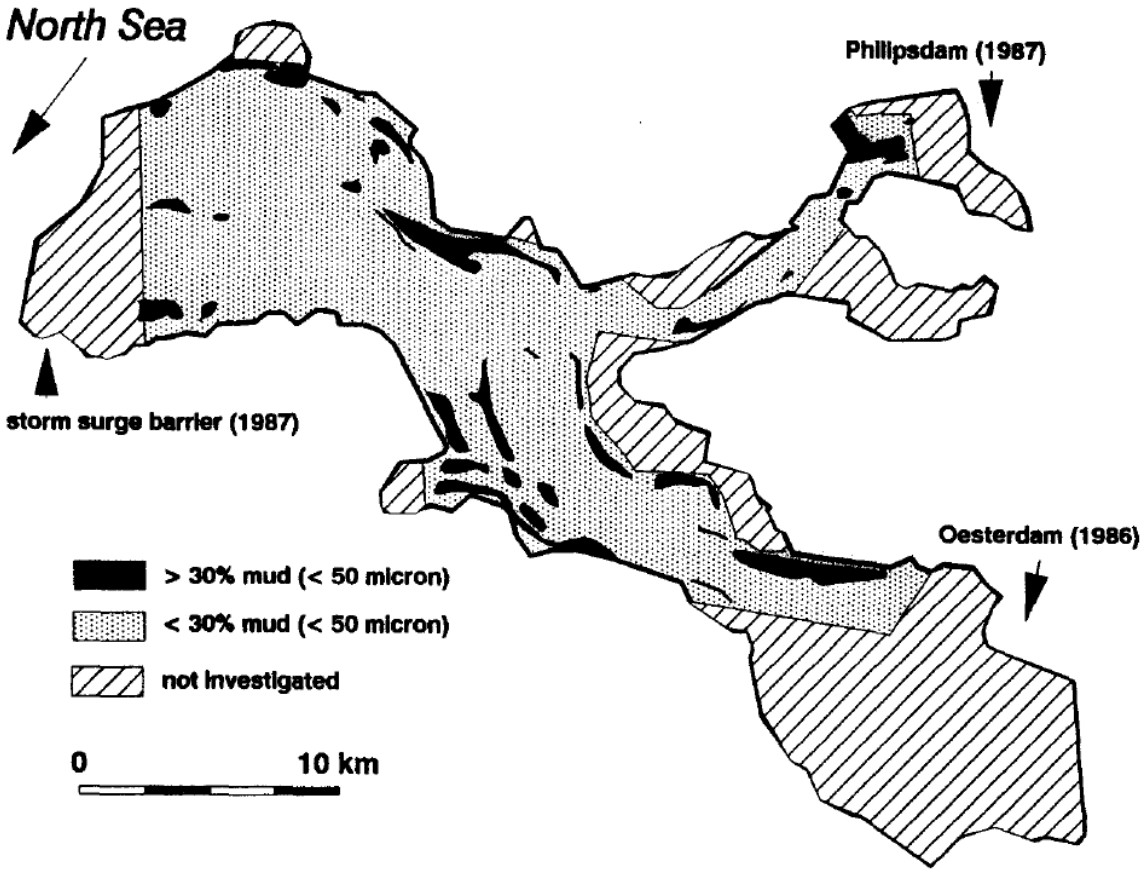

Figure R3: Fine sediment content < 53 pm of the subtidal bottom of the Oosterschelde after the completion of the storm-surge barrier and compartment dams. Source: Mulder and Louters, 1994.

References

Mulder, J. P., and Louters, T.: Fine sediments in the Oosterschelde tidal basin before and after partial closure, Hydrobiologia, 282/283, 41–56, https://doi.org/10.1007/BF00024620, 1994.

Page 5 Line 27: I would add here your nice analysis from page 7 lines 12 to 15.

Response (14): This section covers the changes in tidal range and major components, while tidal asymmetry is not discussed. We would prefer to keep the discussion on tidal asymmetry in Section 5. Now on Page 9 Lines 27–32.

Page 6 Line 13: I think there is more to this. Apart from the lowering due to less sediment supply, an increase in tidal range will reshape the intertidal area to become steeper. The question is also if the flats can follow the SLR, which, under limited sediment supply, is indeed unlikely.
eg see Van der Wegen, M., Jaffe, B., Foxgrover, A., & Roelvink, D. (2017). Mudflat morphodynamics and the impact of sea level rise in South San Francisco Bay. Estuaries and Coasts, 40(1), 37-49.

Response (15): Thanks for the suggestion. We realize that caution should be used here to predict the fate of tidal flats under SLR given the simplification of this model study. More details such as the shape of the flats and the relative strength of erosion and sedimentation as in van der Wegen et al. (2017) should be considered. The conclusion and implication here are revised. Now on Page 8 Lines 20–23.

Page 6 Line 21: but this is in contrast to coarse sediment export. pls explain

Response (16): Thanks for the comment. This is a different process from sediment transport. As found in Jiang et al. (2019), organic matter imported from the North Sea is largely deposited by benthic fauna like a biological pump. The basin is a net sink. In contrast, sediment transport is dominated by physical processes.

References

Jiang, L., Gerkema, T., Wijsman, J. W., and Soetaert, K.: Comparing physical and biological impacts on seston renewal in a tidal bay with extensive shellfish culture, J. Mar. Syst., 194, 102–110, https://doi.org/10.1016/j.jmarsys.2019.03.003, 2019.

Page 7 Line 3: “narrowing”, cross-sectional convergence?

Response (17): This sentence is removed.

Page 7 Line 4: “reduced; consequencely”, reduced. Consequently,

Response (18): This sentence is removed.

Page 7 Line 5: “Into”, behind?

Response (19): This sentence is removed.

Page 7 Lines 11-15: Maybe also explain that the reduction in a/h is apparently stronger than the reduction of Vs/Vc

Response (20): We have added the argument in the paragraph. Please see Page 9 Lines 31–32.

Page 7 Lines 11-12: “because of a stronger frictional damping during ebb” I think friedrichs explains this in a different way : A larger a/h causes the tide to propagete faster at HW than at LW; this causes a shorter flood and a tidal assymetry into flood dominance.

Response (21): Agreed. This sentence is rephrased. Now on Page 9 Lines 27–28.

Page 7 Line 12: remove “currents”

Response (22): It is changed to propagation. Now on Page 9 Line 29.

Page 7 Line 14: “less flood- and ebb-dominant state” less flood dominant and less ebb dominant

Response (23): Suggested changes made. Now on Page 9 Line 30.

Page 7 Line 14: “respectively; the shift”, respectively. The

Response (24): Suggested changes made. Now on Page 9 Lines 30–31.

Page 7 Line 25: “including” and cross-sectional convergence

Response (25): Suggested changes made. Now on Page 10 Line 19.