Authors' Response to the Reviewers' Comments

Manuscript No. egusphere-2024-2985

Title of Paper: "Investigation of complex coastline geometry impact on the evolution of storm surges along the east coast of India: A sensitivity study using a numerical model"

The reply to the comments given is below:

Reviewer 2

Review of the manuscript "***Investigation of complex coastline geometry impact on the evolution of storm surges along the east coast of India: A sensitivity study using a numerical model***" by Tiwari et al., 2024.

Overview:

This paper discusses the effects of coastline shape and approach angle of a storm on peak storm surge, first using an idealised model, then expanding the analysis to the context of the coastline of India, and finally validates the model using Storm Michaung, a recent cyclone in the region. Previous literature on this topic analyses the effects of concave and convex coastlines on storm surge, while other papers in the field analyse the approach angle of the storm on the peak storm surge. This manuscript takes these analyses further by also considering the sharpness of the curvature of the coastline and combining this with varying the approach angle.

In general, this manuscript addresses some interesting questions regarding the effects of coastal geometry on storm surges, using both idealised and "real world" models, and presents some novel results along with results that corroborate with those in the aforementioned literature. It should be improved in its discussion of the results, with a more in-depth analysis in the text highlighting how the results fit into the context of the field. The presentation of some of the results also needs improvement.

Overall, I recommend that this manuscript undergoes major revisions regarding the text in the results and discussion sections. Although the results are generally satisfactory and I do not suggest new analysis, the writing needs some significant improvements. I hope this is not disheartening since I believe that there are some really interesting results in the paper which are worthy of

publication, but I feel that the work needed on the text in some sections will likely require more time than the deadline for minor revisions would allow.

Reply: ***Thank you for your encouraging comments. We have modified the manuscript accordingly and a detailed response to each comment is given below.***

General comments:

Comment: In the introduction, you refer to several papers which assess the impact of coastal geometry on storm surges, but these papers are not mentioned again after the initial literature review. You should refer back to these papers in your results and conclusion, to discuss how your results compare to theirs, whether or not they are consistent with them and why, etc. It would also be interesting to understand better from the introduction how your study is unique from the others discussed. I don't understand well from reading the manuscript which of your results are original and if some of your results mostly replicate results from other studies, or how your analysis fits into the wider context of extreme sea level events in the region. This is an important context that is missing.

Reply: ***In the introduction, we have mentioned the limitations of the prior studies. We have also mentioned the objective of our study which is different from the previous studies. Refer line no. 76-83. In the conclusion part, we have mentioned how our results align and are unique from other studies. Refer line nos.520-527.***

Comment: In the results sections, instead of referring to the left/right of the storm, use west/east. Moreover, many results are listed in the text rather than presented in the form of tables or figures, which makes them much more difficult to parse. Results that contain lists of more than a couple of values should be presented in tables or figures.

Reply: ***Corrected; replaced the left/right to west/east. We have included the tables as suggested. Please refer Table nos.1-5.***

Comment: A general remark for the figures is to consider different colour map choices for contour plots rather than the rainbow/'jet' map chosen in several figures. Please check the Ocean Science figure guidelines for more information on choosing the best colour maps: https://www.ocean-science.net/submission.html#figurestables.

Reply: ***Corrected. We changed the figures having rainbow/jet colormap according to guidelines. We have gone through the colormap as suggested in the link given above.***

Comment: In the figures you use a black dot in several time series to represent the landfall time. A vertical line would be much clearer. This is the case for figures 5, 6, and 11b.

Reply: ***Corrected, changed the blacked dot to vertical line at the time of landfall. Please refer revised. Fig. nos. 5(ii), 8 and 9.***

Specific comments:

Introduction

Comment: The first paragraph of the introduction doesn't contain any references to literature. Perhaps you can refer to a book chapter or literature review that gives a more comprehensive overview of the topic of storm surges and coastline geometry. I see that you want to introduce the topic and highlight its importance, and I think this paragraph otherwise achieves this goal well, it just needs to cite the correct sources.

Reply: ***Provided two appropriate references as suggested. Refer line no. 31 and 35.***

Comment: Line 76: add a reference to your existing Figure 1 when you describe the coastline of India.

Reply: ***Provided a reference. Refer line no. 85.***

Comment: Line 77, "*Several cyclones in the past hit these coastal stretches with different approach angles. Some of the cyclones move parallel to these areas without making any landfall.*": please provide some examples of cyclones which have followed these paths, or references from literature to studies on these types of storms.

Reply: ***Corrected. Refer line no. 86-87.***

Synoptic History of the Michaung Cyclone

Comment: I think that this section should be added to the introduction as a subsection; it's a very short paragraph to have a section to itself, and it is part of the general overview of the topic.

I recommend including a figure of Cyclone Michaung's entire track to accompany this description, labelling the significant dates and locations mentioned in the text.

Reply: ***As suggested, moved this section as a subsection (section 1.1) of the "Introduction" and added a figure representing cyclone Michaung track. Refer line no. 103-113 and revised Fig.1.***

Model Description

Comment: Line 121, "*The sea level rises one cm for each hPa decrease in atmospheric pressure. The wind load on the sea surface leads to a notable fluctuation in sea level, influenced by the maximum wind speed and geographic distribution of winds*": please include an equation or a reference for these statements.

Reply: ***Added the reference. Refer line no. 140.***

Data and Methodology

Comment: It would be useful to split this section into three subsections, one for the idealised experiments, the second for the real coastline experiments and a third for Cyclone Michaung. I would also find it useful to see a table summarising each set of experiments for reference, particularly the idealised experiments since there are lots of them.

Reply: ***Modified. As suggested, divided the section into 3 subsections and added a table summarizing experiments (Section 3.1, 3.2 and 3.2). Refer line no. 148,160 and 203 and Table.1.***

Comment: Line 133, "*The bathymetry of the region also follows a concave-shaped coastline.*": could you clarify the wording of this sentence? I'm not sure whether you mean that the coastline is concave, or that in addition, the bathymetry is smooth and follows the same shape.

Reply: ***Yes, the bathymetry of this particular region follows the concave shape which aligns with the concave shape of the coastline.***

Comment: Line 135: **a** and **b** are not defined in the manuscript. Please include some equations or a schematic figure to define them. I would suggest moving Figure S1 to the main manuscript since it shows **a** and **b** as well as being referred to later in your text.

Reply: ***We have already defined the* a *and* b. *Refer line no. 173-175. For more information we included Figure S1 to the main manuscript as Fig. 4, along with the equation. Refer line no. 191-200.***

Comment: Line 146, "*The bathymetry of the domain is generated using a constant continental shelf width of about 50 km*": is it 50km exactly or something else? I have the same comment for line 148: "*The translational speed of all cyclone tracks is maintained at about 13 km/hour*", and in a few other places throughout the manuscript.

Reply: ***Yes, it is exactly 50 km, which is the average continental shelf bathymetry over the region shown in Fig.2 having* a *= 25 km and* b *= 37.5 km. The translation speed of the idealized cyclone used in the study is 13km/hour everywhere in Exp1 and Exp2 (Refer: Revised Exp2 and Exp3).***

Results and Discussion

Comment: Line 218, 251, 264: if you want to include all of the values for the differences in MPS between parallel tracks, I suggest summarising them in a table rather than listing all of the values in the text. Consider a table also for the results in the text in Section 5.4.

Reply: ***Since we have included Table 2 and Table 3, we are not including tables showing the difference in MPS. We have included Table. 4 and 5 for summarizing the onshore and alongshore winds and energy density per unit length.***

Comment: Line 231, "*These angles bear a significant effect on the generation of the MPS as shown in the tables.*": here, I would suggest briefly mentioning the range of values of the MPS in the tables, to summarise the result, so that your reader doesn't have to open a separate document to have an overview of the result.

Reply: ***Yes, we have included Table 2 and Table 3 (previously in the supplementary) showing MPS for all the shapes and tracks along with the tangent angle.***

Comment: Line 270: Figure 4b is referred to but there isn't one.

Reply: ***Corrected; it is Fig.4 (revised Fig.7); by mistake, it referred to 4(b). Refer line no. 331.***

Comment: Line 353: please include a reference to the data used for the storm tracks of historical cyclones.

Reply: ***Corrected. Added the reference. Refer line no.429.***

Comment: Line 412: you mention that there is "good agreement" between the model and observations but there is no use of a statistical technique to confirm this. I'd suggest using RMSE here. Moreover, although you have explained in the text why the model might be underestimating the surge at landfall, you haven't discussed why the model overestimates the peak tide on other days. By eye, it looks like the model overestimates the high tide on 01/12 by at least 10cm. Why is this, and how could this bias influence biases on the day of the cyclone landfall? I'm not sure you can say the model is in good agreement with the amplitude of the tide without at least a discussion about where this isn't the case and why.

Reply: ***Corrected. Included RMSE, MAE, MSE and MBE in the text as well as in the Figure. Refer line no. 234-235. The authors agree with the observation of the reviewer regarding the model simulates overestimates initially and underestimates later. However, the difference between model and observation is about 10cm, which is small. Hence, we changed the statement as follows.***

"…….at Krishnapatnam is qualitatively in agreement with that of……."

Refer line no. 233

Conclusions

Comment: You have summarised your results and discussed their importance, but you haven't mentioned their limitations. A discussion of the limitations of the study, any drawbacks to the methods used, and the future outlook for this topic would be appreciated. For example, how does the lack of tides in the first two sets of experiments limit the study? How could this be accounted for in a future study on this topic?

Reply: ***Corrected. Included the limitations of the study. Refer line no. 528-536.***

Figures

Comment: Figure 3: A table or another type of 2D plot, or a combination like Fig. 4 could be a better way to show this result, showing each combination of T values and coastline shapes. The

caption also needs more detail: from the caption alone. I should be able to understand what the figure is showing, but here I need to read the text to understand the difference between i-ii and iii-iv.

Reply: ***As suggested, included the Tables 2 and 3 to show MPS. Improved the caption of Fig.3. Refer revised Fig.6***

Comment: Figures 8, 9 and 10: please move the text onto the land so it doesn't overlap with the data. Additionally, the colour scale should be changed since the highest values are not used (as far as I can see). Moreover, for these figures, please include the coordinates of the longitudes and latitudes of the region used.

Reply: ***Corrected. Please refer Figs. 11,12 and 13.***

Comment: Figure 11: Figure 11i would be improved by a change in the colours used: since there is no place with a sea level below ~0.5m, change the colour range to allow for better visualisation of the higher sea levels. Figures 5, 11ii: some gridlines within the plot (as in Figure 6) would allow for easier reading of the values.

Reply: Changed the colormap of figure 11 (i). The range of colorbar is 0-1 m. Incorporated gridlines in the figures. Refer revised fig.5 (i).