

Authors' Responses to Comments of Reviewer #2

We appreciate very much the constructive comments and suggestions of the reviewer and have revised the manuscript accordingly. In the following, we explain our response to each comment of the reviewer. All revisions are highlighted in red color in the marked manuscript.

General Comments:

The manuscript develops a land-river-ocean coupled model to simulate compound floods caused by the combined effects of storm surges, astronomical tides, storm waves, precipitation, and river flow. The model's effectiveness is validated through hindcasting of five typhoon events (including Hagupit 2008, Koppu 2009, Vicente 2012, Hato 2017, and Mangkhut 2018) in the Pearl River Delta region. The manuscript explores the contributions of ocean processes, river base flow, and precipitation to compound floods, and compares the results of one-way and two-way coupling models, revealing the impact of different coupling approaches on flood simulation outcomes.

The study is well-structured, and the methodology is sound. Nevertheless, it is expected that the manuscript will undergo further refinement before publication to address the identified issues.

Response:

The authors are grateful to the reviewer for his/her conclusion that the study is well-structured, and the methodology is sound. We try our best to address the comments of the reviewer and improve the manuscript accordingly.

Comment 1. Although the manuscript highlights the advantages of the two-way coupling model, it does not address the computational cost comparison with one-way coupling. A discussion on the computational complexity, including whether two-way coupling significantly increases computation time and if optimization can reduce costs, would be

valuable.

Response:

Thanks for the comment. Introducing a physically more reasonable description of the air-sea interaction as well as the river-ocean interaction, the accuracy of the numerical results is very much improved. In addition, the accuracy of the numerical results becomes less independent on the location of the river-ocean boundary, or the robustness of the model is enhanced. The price of doing so is a more than doubled computational cost. As a future work, we shall try to further optimize the model to reduce computational time without a significant loss of accuracy and robustness of the model. In this study, we focus on the effectiveness of the coupled model while retaining an acceptable computational efficiency. We added some discussions in the revised manuscript [Page 21, Lines 387-404].

Comment 2. The manuscript mainly focuses on the Pearl River Delta region. Although it mentions the model's general applicability, it would be helpful to include a discussion in the conclusion on the model's applicability to other regions, such as large river deltas or low-lying areas, and assess whether the model needs to be adjusted based on the characteristics of different regions.

Response:

Thanks for the comment. The theories on which the model is based is generally valid. Major components of the model system have been widely applied to various problems and well verified. All of the data required in model, except for high-resolution bathymetry data of the delta region, are publicly accessible and globally covered. Thus, we believe that the established model potentially has a global applicability. When applied to other large river delta regions, the mesh size may need to be carefully adjusted considering a balance between numerical accuracy and computational coast. We added some discussions in the revised manuscript [Page 11, Lines 225-227].

Comment 3. The manuscript demonstrates the advantages of two-way coupling by comparing

it with one-way coupling. It would be beneficial to further compare this model with existing coupled models, particularly the most advanced ones, and discuss its strengths and limitations, especially in terms of accuracy and efficiency.

Response:

Thanks for the comment. An important improvement of the model is the description of the air-sea momentum exchange. In most previous studies, the wind stress in the storm surge model is estimated with linear formulas, which oversimplify the air-sea interactions (Gori et al., 2020; Du et al., 2024). In order to compare our model with existing models, we added results from numerical experiments that use the default wind stress formula in ADCIRC (Garratt, 1977). The maximum storm surge level is compared in Figure R1. It is evidently shown that the maximum storm surge levels obtained with the e-AWBLM are more accurate than the default method. The limitations of the proposed model are mentioned in our response to Comment 1. We added some discussions in the revised manuscripts based on the reviewer's comments [Page 13, Lines 266-269; Figure 6].

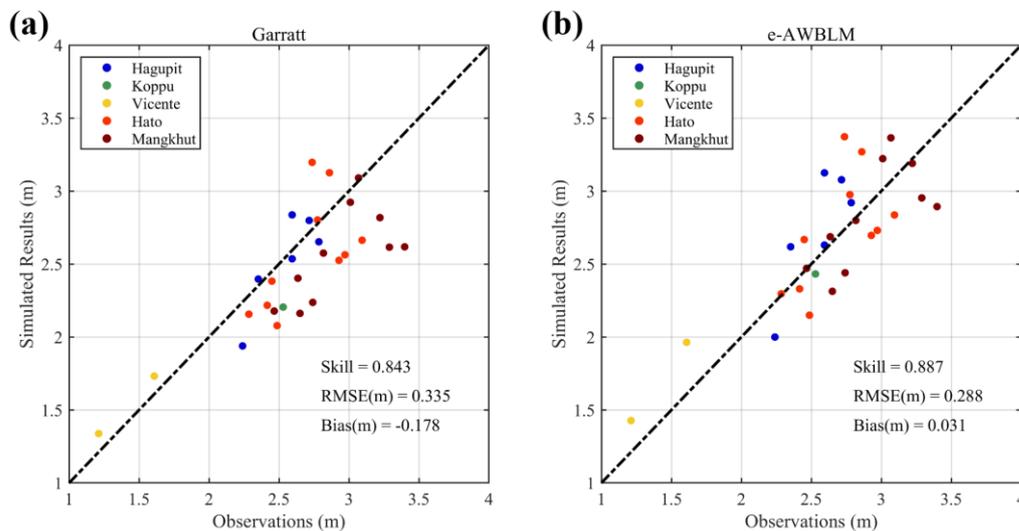


Figure R1. The simulated maximum surge levels are compared with observations in two methods: (a) Garratt (1977) and (b) e-AWBLM

Comment 4. LN 152-155: " In this study, we perform ... simulate compound floods." - The original sentence is too long and contains too much information. It should be split into two

clearer and simpler parts to improve readability. - "This study hindcasts five tropical cyclones (TC) events [Hagupit (2008); Koppu (2009); Vicente (2012); Hato (2017); Mangkhut (2018)] that caused destructive floods in the Pearl River Delta over the past two decades, to validate the model developed for simulating compound floods."

Response:

Thanks for the kind comment. We have revised the relevant sentence [Page 7, Lines 156-159].

Comment 5. LN 358-359: " ...induced by five Typhoon events occurred..." - "Occurred" is in the past tense, but since "induced" is in the past participle form, they should be consistent. Therefore, "occurred" needs to be changed to the past participle "that occurred" to maintain tense consistency in the sentence.

Response:

Thanks for the kind comment. We have revised the relevant sentence [Page 21, Lines 393].

Comment 6. The image quality is insufficient. It is recommended to replace the image with a vector format.

Response:

Thanks for the comment. We revised all figures and guaranteed their quality.

Reference

Du, H., Fei, K., Wu, J., and Gao, L.: An integrative modelling framework for predicting the compound flood hazards induced by tropical cyclones in an estuarine area, *Environ. Modell. Softw.*, 105996, <https://doi.org/10.1016/j.envsoft.2024.105996>, 2024.

Garratt, J.: Review of drag coefficients over oceans and continents, *Mon. Weather Rev.*, 105, 915-929, [https://doi.org/10.1175/1520-0493\(1977\)105<0915:RODCOO>2.0.CO;2](https://doi.org/10.1175/1520-0493(1977)105<0915:RODCOO>2.0.CO;2), 1977.

Gori, A., Lin, N., and Xi, D.: Tropical cyclone compound flood hazard assessment: From

investigating drivers to quantifying extreme water levels, *Earth's Future*, 8, e2020EF001660, <https://doi.org/10.1029/2020EF001660>, 2020.

Xu, Y. and Yu, X.: Enhanced atmospheric wave boundary layer model for evaluation of wind stress over waters of finite depth, *Prog. Oceanogr.*, 198, 102664, <https://doi.org/10.1016/j.pocean.2021.102664>, 2021.