Dear Reviewer:

We sincerely appreciate your time spent in providing constructive remarks and useful suggestions, which have significantly enhanced the quality of the manuscript and enabled us to make substantial improvements. Each suggested revision and comment from the reviewer has been carefully considered and incorporated. Below, you will find our point-by-point response to the reviewer's comments and revisions.

1. The speed of the typhon's movement could also be investigated with this model, i.e. a slow-moving Nida. I miss also wind speed and wind direction.

Response:
Thank you very much for your insightful comment and kind suggestion. In our actual typhoon simulations, we observed a significant increase in storm surge with even a small increase in forward speed for slow-moving typhoons (Park & Youn, 2021). As the storm moved faster, we noticed that the storm surges also increased (Park & Youn, 2021). While the moving speed of the typhoon center does affect the storm surges in the PRE, the effect is not significant (Du et al., 2020). Our focus in this paper is on the interaction between tides and storm surges, especially the tidal phases, rather than the factors inherent to typhoon itself.

Reference:

Park, Y. H., & Youn, D. (2021). Characteristics of storm surge based on the forward speed of the storm. Journal of Coastal Research, 114(SI), 71-75.

Du, M., Hou, Y., Hu, P., & Wang, K. (2020). Effects of typhoon paths on storm surge and coastal inundation in the Pearl River Estuary, China. Remote Sensing, 12(11), 1851.

2. They mentioned, that the typhoon occurred during spring tide. Could the spring tide get higher, and the resulting total water level could be higher?

Response:
Thank you very much for your helpful advice. The maximum storm surge induced by Typhoon Nida coincided with the highest high water (HHW), which represents the highest tidal level. As the tide gets higher, the total water level will also increases. The objective of this paper is to examine the tide-surge interaction under different tidal phases.

3. I did not quite understand why the focus was only on the contributions from tide surge interaction.

Response:
We sincerely apologize if our explanation caused any confusion. The interaction between tide and storm surge represents a pivotal element of storm surge dynamics, with a sophisticated underlying mechanism. In this paper, we aim to specifically focus on the interaction between tides and storm surges, as it clearly demonstrates the significance of this interaction. Through the research presented in this paper, it is also demonstrated that at P2, the contribution of the the nonlinear effect to the storm tide can reach up to 16.4%, and the contribution to the storm surge can reach -49.61%, which are important to the water levels.

4. In the paper, I was sometimes confused about terminology. My impression was, that the

terminology storm surge included tides or not (line 20-21). My suggestion would be:
Total water level during this event, storm tide (ζ_{TS}) = tide (ζ_T) plus (atmospheric) surge (ζ_S) plus tide-surge interaction elevation (ζ_I)
$\zeta_{TS} = \zeta_T + \zeta_S + \zeta_I$
residual level, ζ_R, the 'residual' = storm tide minus tide = (atmospheric) surge plus tide-surge interaction elevation
$\zeta_R = \zeta_{TS} - \zeta_T = \zeta_S + \zeta_I$
Well, I saw in other papers they used your terminology, but I still think this one is better.

Response:
We sincerely apologize for any confusion and gratefully appreciate your valuable suggestion. In Line 20-21, we explain the three models used to distinguish the storm tide, storm surge, tide, and tide-surge interaction. The storm tide 'ζ_{TS}' in our paper is represented as 'ζ_{T+S}', which is simulated by both atmospheric and tidal forcing. The equation in Line 168-169 appears to be similar to yours. We have standardized the terminology in our manuscript. Specifically, we have replaced 'total elevation ζ_{T+S}' with 'storm tide ζ_{TS}', and 'tide-surge interaction ζ_I' with 'nonlinear residual ζ_{Non}'.

5. Sometimes the authors changed the name of the variable in the paper. Please standardize the terms in the text and in the figures.

Response:
Thank you for you kindness reminder, we have standardized the terminology in our manuscript as follows: 'total elevation ζ_{T+S}' has been replaced with 'storm tide ζ_{TS}', and 'tide-surge interaction ζ_I' with 'nonlinear residual ζ_{Non}'. Additionally, we have defined 'tide elevation' as ζ_T, 'storm surge elevation' as ζ_S, 'practical storm surge elevation' as ζ_{PS}.

6. I think with my above suggestions the abstract should be rewrite.

Response:
We gratefully appreciate for your valuable suggestion. In this paper, we focus on tide-surge interactions and its mechanisms. we revised the abstract for better understanding. The new abstract is as follows:
'Storm surge is one of the most significant marine dynamic disasters affecting the coastal areas worldwide. A comprehensive study of its mechanisms is vital for improving forecasting capabilities and developing more effective prevention strategies. In this study, a two-dimensional (2D) numerical model based on the Advanced Circulation Model (ADCIRC) was employed to examine the characteristics of storm surges and the mechanisms of tide-surge interaction in the Pearl River Estuary (PRE) during Typhoon Nida (2016). Three distinct model runs were conducted to differentiate between variations in water levels attributable to astronomical tides, storm surges, and their combined effect. The results indicated that storm surges are primarily modulated by tides through tide-surge interactions. The nonlinear effect of tide-surge interaction is primarily generated by the nonlinear local acceleration term and convection term from the tide-surge interactions in the study area, as derived from the mathematical terms. However, in regions of shallow water, such as the northern part of Qi'ao Island and Shenzhen Bay, they are predominantly governed by the nonlinear wind stress term and bottom friction term. Furthermore, the variations in the y component of the nonlinear momentum terms are more significant than those in the x component. To investigate the impact of tidal phase on storm surge response to

Typhoon Nida, the timing of landfall was altered in order to introduce variations in PRE characteristics. The results demonstrate that the contribution ratio of each nonlinear term remains relatively constant, while the magnitudes exhibit fluctuations contingent on the timing of landfall. ’

7. Line:21 I think in this case you mean with the above definition storm tide

Response:
We sincerely apologize for any confusion and thank you for your kind reminder. There may be some errors with the professional terminology, and we have taken the necessary steps to correct them in the manuscript.

8. Line:36-39 Is this still so?

Response:
Thank you for pointing out this question. In recent storm surge forecasts, many hydrodynamic models have considered the nonlinear tide-surge interaction, which is also the focus of this work. We describe them to emphasize the importance of tide-surge interaction.

9. Line:59-66 In all cases the bathymetry and the local environment should be considered.

Response:
Thank you for your valuable suggestion. It is widely recognized that the topography and local marine environment play an important role in influencing storm surges, a topic that has been extensively researched. In this paper, we aim to contribute to the existing research on the tide-surge interaction by investigating its contribution to the water levels.

10. Line:67-68 This connection is not clear to me.

Response:
We sincerely apologize for any confusion. The Pearl River Estuary (PRE), situated in Guangdong Province, South China, is believed to be one of the most extensive and significant estuaries in Asia, endowed with a distinctive geographical advantage and importance. The dynamics and tides of the PRE are greatly influenced by its intricate coastline, comprising numerous islands and other topographical features. This distinguishes the PRE from other estuaries that are directly discharged directly into the open shelf. Moreover, the PRE region is subject to typhoon activity on annual basis, which presents a significant risk to the regional economy and the safety of the population. The intricate topography gives rise to a more intricate interaction between tides and storm surges. It is both necessary and of great importance to investigate the interaction between tides and storm surges in this area.

11. Line:77 I would say that good forecasting is needed to make forward-looking decision for coastal protection.

Response:
We completely agree with you. We believe that good forecasting is indeed essential for making informed, forward-looking decisions regarding coastal protection. By predicting weather patterns, sea levels and potential storm surges, coastal managers and planners may be able to take proactive measures to safeguard communities and infrastructure against natural hazards.

12. Line:80-81 How big is the difference between neap and spring tide at the Guangzhou gauge?

Response:
Thank you for pointing out this question. At the Guangzhou gauge, there is approximately 3 m difference between neap and spring tides as shown in Fig.2. At the Chiwan gauge, the difference is approximately 2.8 m, and at the Hong Kong gauge, it is approximately 2.2 m between neap and spring tides.

13. Line:98-111 The description of the Typhoon could be more detailed. Was the Typhoon a fast or slow-moving typhoon? I miss also wind speed and wind direction.

Response:
Thanks for your kind advice, we have added some information about Typhoon Nida in the manuscript text as follows:
'As shown in Fig 1a, Typhoon Nida, classified as a sever tropical storm (STS) passed across the Philippines and entered the South China Sea (SCS) on July 31, 2016. It then proceeded westward and made landfall as a typhoon (TY) at 19:30 on August 1 in Shenzhen, Guangdong Province, China. The typhoon had a central pressure of 970 hPa and maximum wind speed exceeding 42 m/s. After that, it was weakening as a tropical storm (TS). On August 3 0:00, it as a tropical depression (TD) and dissipated.'
However, in this paper, we concerned the interaction between tide and storm surge, rather than delving into the intrinsic factors of the typhoon itself, such as its intensity, moving speed, landfall angle, and so on.

14. Line:105 -106 This sentence belongs in the introduction.

Response:
Thanks for your kind suggestion, we have incorporated information about Typhoon Nida into the introduction.

15. Line:108 Figure 1a TD, TS, STS, TY?

Response:
We apologize for our carelessness to illustrate the level of tropical cyclone (TC). According to China Meteorological Administration (CMA), the levels of TC are outlined in the following table. We have also included a new illustration in Fig 1 to clarify this further.

Name	Wind speed (m/s)
TD (Tropical depression)	10.8 ~ 17.1
TS (Tropical storm)	17.2 ~ 24.4
STS (Sever Tropical storm)	24.5 ~ 32.6
TY (Typhoon)	32.7 ~ 41.4
STY (Sever Typhoon)	41.5 ~ 50.9
Super TY (Super Typhoon)	≥ 51.0

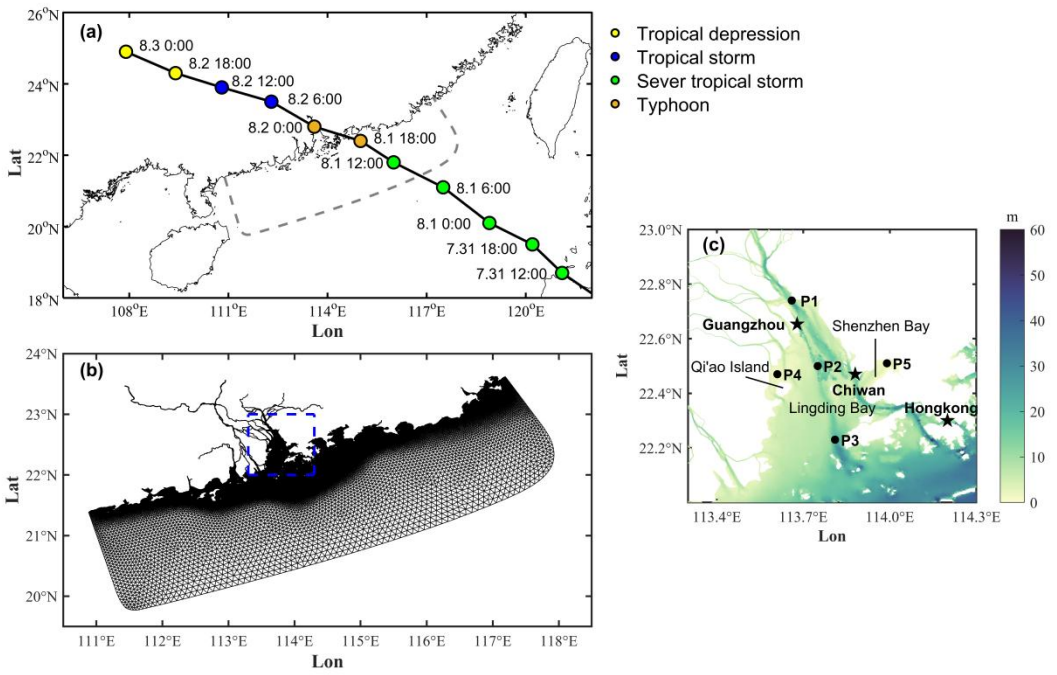

Fig 1 (a) The track and intensity of Typhoon Nida; (b) Model domain and grids of the study area; (c) Location and bathymetry of PRE. Stars represent the tidal gauges, and dots denote the calculation points of surge levels.

16. Figure1c: The scale of the bathymetry is relatively smooth. Especially, the scale the bathymetry of the estuary could be better. Why do you have -10m ?

Response:
We apologize for our carelessness that may have caused confusion. The bathymetric data has been sourced from nautical charts that have been made publicly available by the Hydrographic Department. We have revised the image, which is now depicted in Fig 1c.

17. Line:158-162 How many model days does the model need to work?

Response:
We conducted a 4-day simulation of this event, initiating with a cold start on July 30th. After a period of stabilisation lasting approximately half a day, we are pleased to present the results from 31 July to 3 August, as shown in Fig 3.

18. Line:163-165 Is this important for the model setting?

Response:
We apologize for that confused you. We intended to emphasize the importance of the tide at Lingding Bay, but it seems to be in a wrong place. We have moved this sentence to the introduction.

19. Line:166-169 To make this sentence clearer, you should delete the explanation of 'practical storm surge elevation' and explain it in the next sentence. You should change the total water elevation ζ_{T+S} to ζ_{TS}

Response:

Thanks for your insightful comment and kind suggestion. We have replaced 'the total water elevation ζ_{T+S}'to 'storm tide ζ_{TS}', and standardized the names of the terms accordingly.

20. Line:175-212 Actually, these are results.

Response:
Thanks for your insightful comment and kind suggestion. We have placed this section in the 'Results' section of the paper.

21. Line:184 Please, use the same y-axis for all stations, so from 0 to 5m

Response:
We have redrafted this figure using the same y-axis as Fig 2 shows.

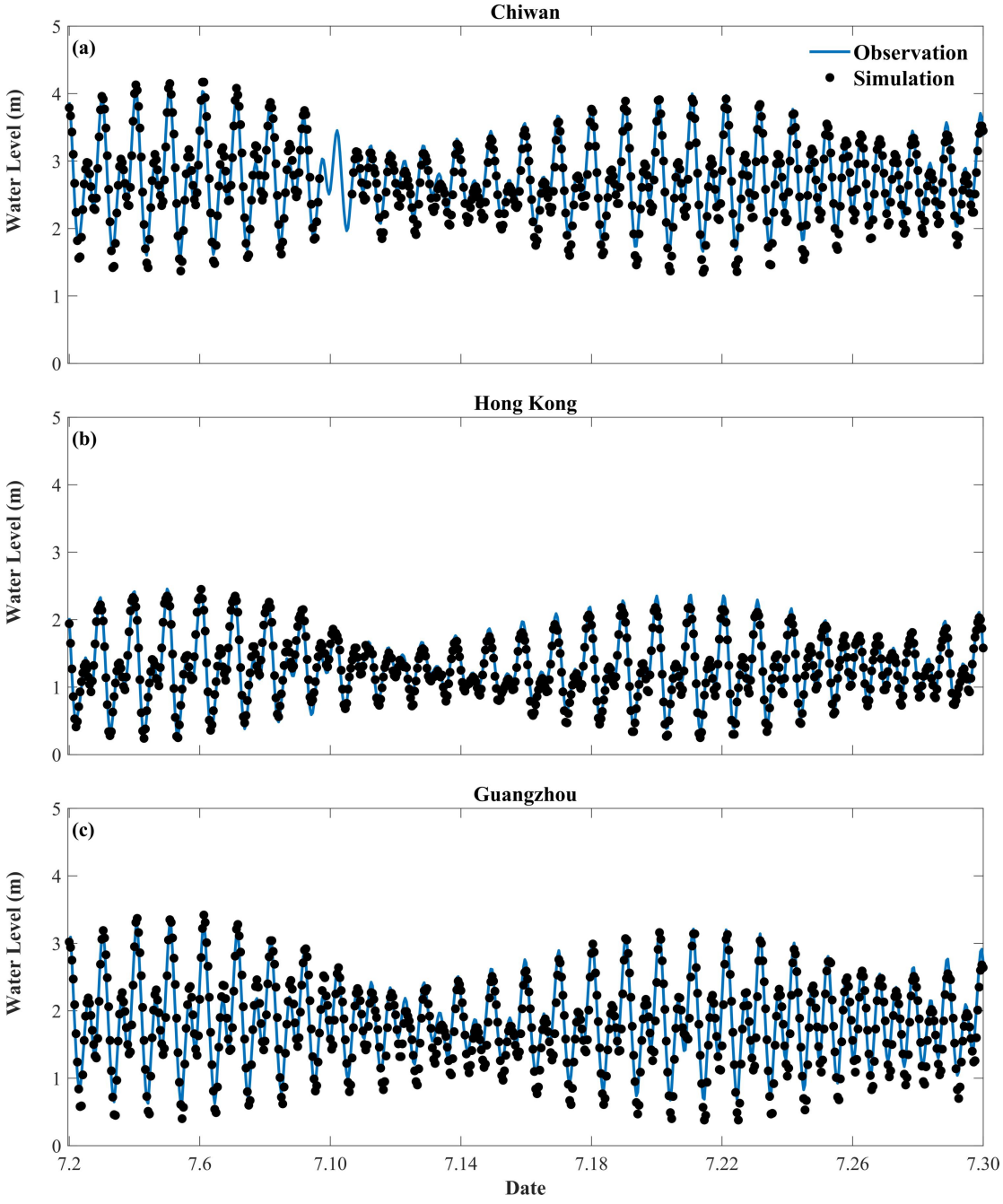

Fig 2 Time series comparisons of measured and modeled astronomical tide levels at (a) Chiwan gauge

(b) Hongkong gauge (c) Guangzhou gauge

22. Line:185 Is this really the modeled astronomical tide or the modeled total water level?

Response:
Thank you for pointing out the issue. This is the modeled astronomical tide, during 7.2-7.30, in this period, there was no significant weather influence.

23. Line:188-193 I am wondering that you compare observed water levels (including weather) with astronomical tides (without weather). The low water is not so good simulated. Why?

Response:
Thank you for pointing out this question. The forecasting of storm surge has always been a critical issue. In recent years, various models have demonstrated their strengths and weaknesses in simulation. The ADCIRC model we have chosen performs well in simulating the maximum water level increase, although there are some inaccuracies before and after the peak water level. Nevertheless, this model is already highly developed and widely utilized in practice.

24. Line:202-205 How do you define negative surge levels in this area? Please specify it clearer in the figure 3. I have not understood this comment.

Response:
We apologize for that confused you. We original intention was to convey the water level decrease caused by the storm. We have provide a revised description as follows.
'The numerical results show that the water level decrease is overestimated, resulting in significant errors in storm surge prediction. However, the simulated results for the positive extreme of storm tide closely match the observed values, demonstrating that the model used in this study effectively represents the tidal-surge interactions within the study area.'

25. Line:207: The legends could be larger

Response:
Thanks for your kindness advice. We have redrafted this figure with an enlarged legend and using the same y-axis as Fig 3 shows.

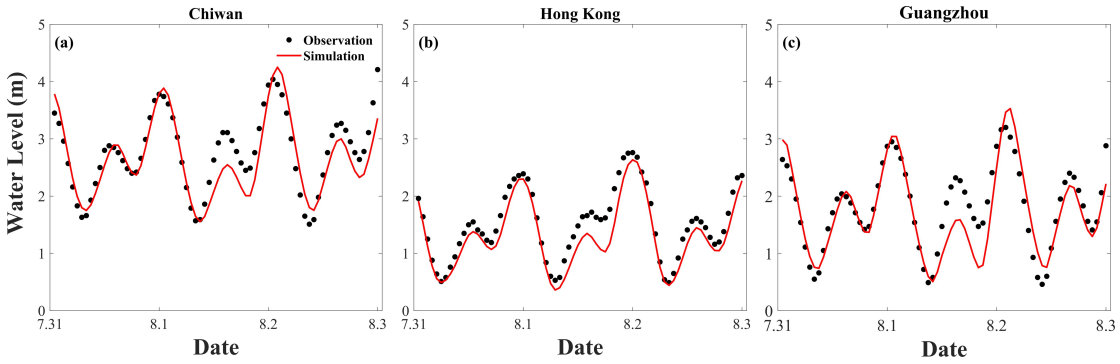

Fig 3 Time series comparisons of measured and modeled storm surge levels at (a) Chiwan gauge (b) Hong Kong gauge (c) Guangzhou gauge

26. Line:211 Table 1: What do you compare "tide plus pure storm surge" or the simulated total water level with the observations? Is there a difference between tide and storm surge or do mean the period of data?

Response:
We apologize for that confused you. It's not 'tide plus pure storm surge', the 'storm surge' represents 'storm tide'. We are merely validating the model's simulation of tide and storm tide.

27. Line:212 A table with the results for the three gauges and the five stations/points would be nice.

Response:
Thank you for pointing out the problem. The three gauges contain observational data, while the five points are based on simulated data only. Consequently, we have selected the three gauges for the validation of our model.

28. Line:215 The information, that the typhoon occurred during spring tide should be included in the motivation.

Response:
Thanks for your kind suggestion. We also introduced it in the motivation. Here, we just want to emphasize the background again.

29. Line:218 You should change storm surge to "total water level" or "storm tide"

Response:
Thank you for your helpful suggestion. We have made the necessary revisions in the manuscript.

30. Line:221 … as shown in Fig 1c… refers to the points 1-5 and not to the interaction.

Response:
We apologize for that confused you. Here, we want to illustrate that these points represent its special area. P1 to P3 represent the internal, middle, and external of Lingding Bay, respectively. P4 represents the northern part of Qi'ao Island, and P5 represents the Shenzhen Bay, which are two shallow water area.

31. Line:221 "Notably, the water depth at points P1, P2, and P3 exceeds 10 m, while the water depth at points P4 and P5 is less than 10 m." This information belongs in 2.4. Model setting. P1 to P3 look like a fairway channel. Are there changes if the points are 1 km away from the channel?

Response:
Thank you for your kind suggestion. We selected these points to investigate the interaction between tides and storm surges, and we emphasize their water depth here for analyzing the results. Regarding the spatial characteristics of nonlinear residuals as shown in Fig 5, there appears to be little difference 1 km away from the channel.

32. Line:224 You write about "nonlinear residuals levels" and in the figure 4b.,., the title is "nonlinear elevation" . Perhaps it is easier to use the term 'tide-surge interaction elevation' for both.

Response:
Thank you for your helpful suggestion. We have standardized the names of the terms in the text.

33. Line:227 Why is the decrease significant?

Response:
Thank you for pointing out this question. Shenzhen Bay is a shallow water area. The effect of nonlinear tide-surge interaction can significantly modulate water levels in shallow regions. The shallow water effect arising from the nonlinear terms related to the total water depth in both the mass conservation equation and the momentum equations.

34. Line:238 nonlinear residuals (ζ_{Non}) = nonlinear residual level (ζ_I)

Response:
Thank you very much for your suggestion. We have corrected all the terms unity accordingly.

35. Line:242 maximum negative value = minmum?

Response:
We apologize for that confused you. In fact, it does. Initially, we only wanted to emphasize the extremes values, which possess both negative and positive aspects. We have standardized the terminology throughout the text.

36. Line:246 & 250 negative maxima = minimum?

Response:
We are sorry for that confused you. In fact, it does. Initially, we only wanted to emphasize the extremes values, which possess both negative and positive aspects. We have standardized the terminology throughout the text.

37. Line:214-281 I am wondering that the bathymetry, the wind direction and the wind speed are not included in the result chapter. I think they are very important for the calculation of the tide-surge interaction elevation. Due to the shallow bathymetry and the tides, there is an overestimation and underestimation of the surge. You can already see this in Figure 4. I miss also the regional aspects, e.g. whether the P4 or P5 are upwind or downwind of the wind direction. Also, it would be easier to understand the steps, if there some vertical lines in the time series marking the date of the 2D-images on the left side in Figure 4. The same y-axis could also help to compare the results (in all figures)

Response:
Thank you for your insightful comments and valuable suggestion. The bathymetry of these five points are as follows: 15.26 m at P1, 16.73 m at P2, 22.50 m at P3, 1.67 m at P4, and 2.53 m at P5. The wind direction and the wind speed are shown in Fig 4. The wind speeds at these five points show little difference, which is likely related to the water depth. We have redraft the figure with same y-axis as shown in Fig 5.

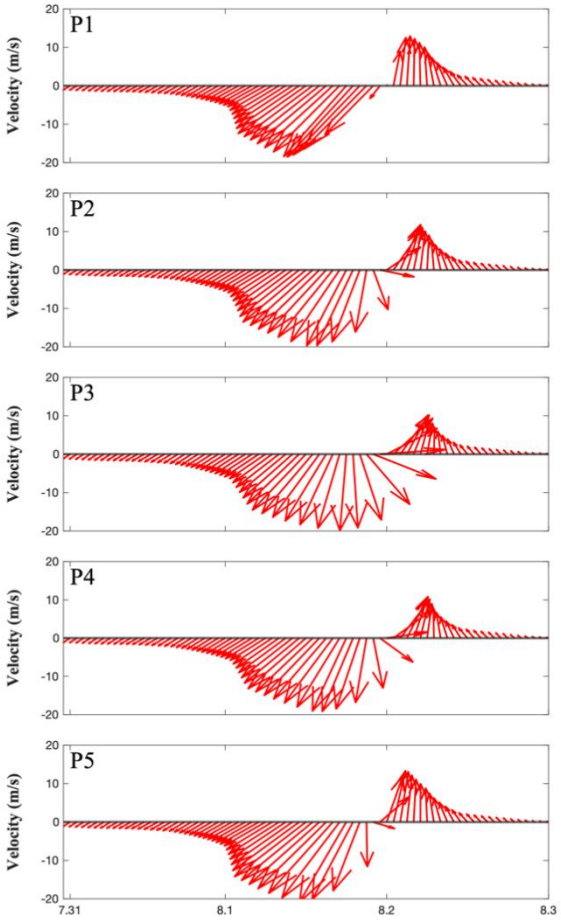

Fig 4 Wind velocity and wind direction at P1, P2, P3, P4, and P5

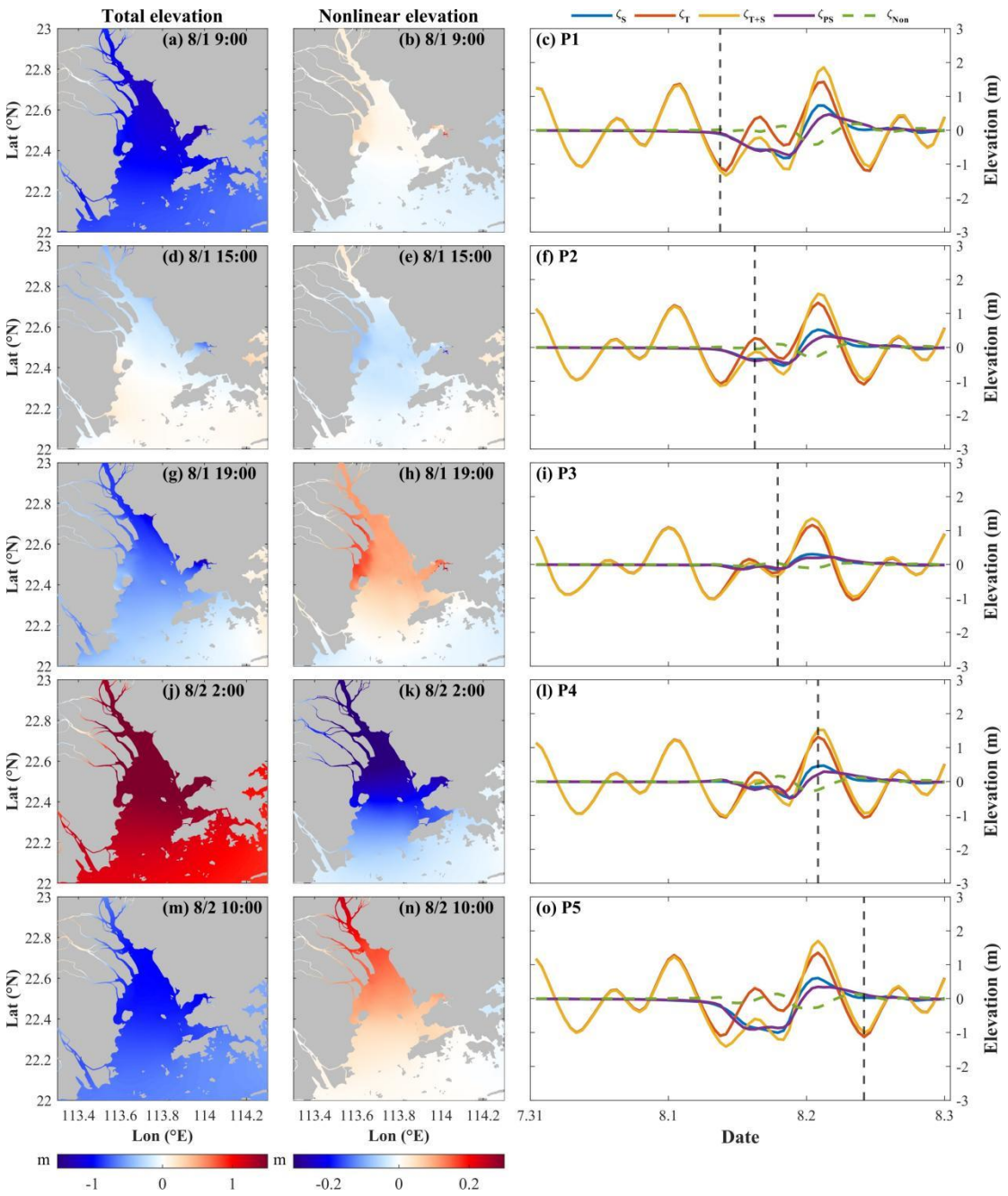

Fig 5 Total water elevation (left) and nonlinear water elevation (middle) at different tidal phase; Time series of water levels for P1, P2, P3, P4 and P5 locations (right); The dashed line indicates the time corresponding to the time on the left and middle graphs.

38. How do you define significant?

Response:

We apologize for that confused you. We considered the extremes, the ratio of contributions, and the order of magnitude to define 'significant'. For example, the spatial nonlinear effect elevation was significant in Shenzhen Bay and the north part of Qi'ao Island as shown in Fig 5h. The nonlinear effect at P2 is significant, being the biggest value among the five points as shown in Table 2.

39. Line:238 & 169 Is nonlinear residuals (ζ_{Non}) = nonlinear residual level (ζ_I) ?

Response:

We apologize for that confused you. ζ_{Non} = $\zeta_{I,}$ we have standardized the names of the terms in the revised manuscript accordingly.

40. Line:278 Table 2 and Table 3

It would be nice to have the absolute maximum water levels.

Response:

Thank you for your valuable suggestions. We have revised the titles of Tables 2-3, and corrected the name within the manuscript text.

41. In table 2, for each point 1 to 5 you have calculated the contribution to the total high water.

The sum of tide and practical tide = 100% = total high water.

In the right column, we see the overestimation of surge, because

Surge + Nonlinear effect = practical surge.

Response:

We apologize for that confused you. Well, we select the maximum value of the storm tide and calculate the contribution of surge, tide, practical surge, and nonlinear residual to the elevation of storm tide at the same time. C (storm surge, tide, practical surge, nonlinear residual) = elevation (storm surge, tide, practical surge, nonlinear residual) / elevation (storm tide). According to that, surge + tide + nonlinear effect = 100%. Absolutely, practical surge = storm tide - tide, so that surge + nonlinear effect =practical surge.

42. From Figure 4 the total water level was lower than 2m at each point. The nonlinear effect is lower than 2m times 15 %= 0.3m. What do I learn for the forecast of storm tides?

Response:

Thank you for your insightful comment. Although the nonlinear effect is smaller than the contribution caused by the storm, it should not be ignored. If we don't consider nonlinear effect between tide and storm surge, it could be increase the error in storm tide forecasting. Moreover, the mechanism of tide-surge interaction is complicated, which motivates us to do this work.

43. Line:280 For what do I need table 3? What do I learn?

Response:

Thanks for pointing out these problems. We emphasize the importance of the nonlinear effect, the ratio of the nonlinear residuals to the pure storm surge represents the extent to which the nonlinear effect amplifies or diminishes the direct impact of the storm surge.

44. At least 75 % of the total water level is from the tide. Is table 3 important for the coastal protection?

Response:

Sure, it is important. Table 3 reflects the contribution of the nonlinear effect to the storm surge. In the case of Typhoon Nida, the maximum storm surge coincided with the HHW tidal phase, which is a dangerous signal for storm tide. The contribution of the nonlinear effect to the storm surge is negative, which means it decreases the water level induced by the storm surge.

45. Line:318 Table 6, I am wondering what is the basis of the calculation. How do you calculate 193.17 % practical surge for P1

Response:
We apologize for that confused you. Well, we select the maximum value of the storm surge and calculate the contributions of the practical surge and nonlinear residual to the elevation of storm tide at the same time of different tidal phases. C (practical surge, nonlinear residual) = elevation (practical surge, nonlinear residual) / elevation (storm tide).

46. Line:282-514. The authors did a lot of investigations, but for me it is not clear for what. How can you improve the prediction of water levels with your investigations. Haven't such studies been carried out for other coasts and estuaries?

Response:
We apologize for that confused you. Our focus is on the tide-surge interaction, and we aim to identify the underlying mechanisms. The nonlinear effects of tide-surge interaction are important and relevant to the tide. Therefore, we adjusted the landfall time of Typhoon Nida to make the maximum storm surge coincide with various tidal phases.

47. For me it would be more interesting to know how high the contribution to the total water level is and what influence the bathymetry has. It is described, but very briefly and more as a by-product.

Response:
Thank you for your insightful comment and kind suggestion. Bathymetry is important for storm surge simulations, and we also consider it in our future work. This study focuses on the interaction between tides and storm surges under various tidal phases and explores the underlying mechanisms.

48. What is new and help to improve the forecast models?

Response:
Thank you for your insightful comment. We can improve the grid resolution, the precision of coastline, simulated parameter settings, and so on. At the same time, understanding the mechanism of tide-surge interaction also plays a certain role in storm surge forecasting.