Dear authors,

Thank you for the revised manuscript, which has much improved. As referee #1 comments, your manuscript has changed a lot compared to the previous submission. Even if it has much improved, there are still significant comments by both referees, which you should account for in a new revised submission. I encourage you to resubmit, accounting for the useful comments by both referees.

Thanking you and with best wishes

Mario Hoppema

Dear Editor Dr. Hoppema,

Thank you for your time and effort in handling our manuscript. We sincerely appreciate your positive feedback and the opportunity to revise and resubmit.

In response to both reviewers' useful comments, we have carefully revised the manuscript, corrected previous errors, and made substantial improvements. All points have been addressed in detail in the response letter.

Additionally, Sun Yat-sen University has multiple campuses in different cities. All authors are based at the School of Marine Sciences on the Zhuhai campus, so the affiliation in the manuscript is accurate and should remain unchanged.

Thank you again for your kind support. We look forward to your further feedback.

With best regards,

Wenping Gong

Response to Reviewer 1

General comments and summary:

I have read the responses to both reviews of the initial submission, and the revision. The authors have done a conscientious job of revising the manuscript to address concerns. Note that this is a very different paper than the initial submission and has a different focus than the original (e.g. “winds” was removed from the title). The initial submission compared two model runs (“with winds and waves” and “without winds and waves”). The revision compares SEVEN model runs, only one of which was in the first submission. The revision removed two discussion sections.

This submission seems much closer to the standard expected for your journal, but the paper will benefit from some additional revisions, as outlined below.

My review of the first submission raised four major concerns: “(1) some of the analysis seem poorly justified … ; (2) the organization should be improved …; (3) the skill assessment has geographic and temporal limitations; and (4) the findings are not generalized to other systems.” The authors have addressed most of these; they removed the analyses that were poorly justified, improved organization, and included a more comprehensive skill assessment in the Supplement.

Dear Reviewer:

We greatly appreciate the time you spent reviewing our manuscript and providing constructive comments and minor revisions. These comments and insights are helpful for improving the quality of our paper. We address your comments point-by-point as follows.

Below are general comments that will improve the paper:

1. The introduction is improved upon the original submission. It is better organized and includes more context. However, most of the citations are based on fairly localized, often small-spatial scale, studies of estuaries. This seems inappropriate, given that the model domain is a ~1700 km scale continental shelf. The introduction should rely on continental shelf papers moreso than estuarine. Some suggestions (Geyer et al. 2004; McKee et al 2004; etc.); continental shelf modeling papers (Warner et al. 2017; Dalyander et al, 2013; Harris et al. 2008; Wang et al. 2020; Zang et al. 2019; Xu et al. 2016).

Response:

Thank you for the thoughtful comment. We appreciate the suggestion to incorporate more references focused on continental shelf processes to better align with the scale of our model domain. In response, we have revised the Introduction to include all the key references you mentioned (Geyer et al., 2004; McKee et al., 2004; Harris et al., 2008; Dalyander et al., 2013; Xu et al., 2016; Warner et al., 2017; Zang et al., 2019; Wang et al., 2020). These additions strengthen the contextual foundation of our study and ensure that the literature cited reflects the appropriate spatial scale of the continental shelf system we investigate.

References

Dalyander, P. S., Butman, B., Sherwood, C. R., Signell, R. P., and Wilkin, J. L.: Characterizing wave- and current- induced bottom shear stress: U.S. middle Atlantic continental shelf, Continental Shelf Research, 52, 73-86, https://doi.org/10.1016/j.csr.2012.10.012, 2013.

Geyer, W. R., Hill, P. S., and Kineke, G. C.: The transport, transformation and dispersal of sediment by buoyant coastal flows, Continental Shelf Research, 24, 927-949, 10.1016/j.csr.2004.02.006, 2004.

Harris, C. K., Sherwood, C. R., Signell, R. P., Bever, A. J., and Warner, J. C.: Sediment dispersal in the northwestern Adriatic Sea, Journal of Geophysical Research, 113, 10.1029/2006jc003868, 2008.

McKee, B. A., Aller, R. C., Allison, M. A., Bianchi, T. S., and Kineke, G. C.: Transport and transformation of dissolved and particulate materials on continental margins influenced by major rivers: benthic boundary layer and seabed processes, Continental Shelf Research, 24, 899-926, https://doi.org/10.1016/j.csr.2004.02.009, 2004.

Wang, C., Liu, Z., Harris, C. K., Wu, X., Wang, H., Bian, C., Bi, N., Duan, H., and Xu, J.: The Impact of Winter Storms on Sediment Transport Through a Narrow Strait, Bohai, China, Journal of Geophysical Research: Oceans, 125, e2020JC016069, https://doi.org/10.1029/2020JC016069, 2020.

Warner, J. C., Schwab, W. C., List, J. H., Safak, I., Liste, M., and Baldwin, W.: Inner-shelf ocean dynamics and seafloor morphologic changes during Hurricane Sandy, Continental Shelf Research, 138, 1-18, 10.1016/j.csr.2017.02.003, 2017.

Xu, K., Mickey, R. C., Chen, Q., Harris, C. K., Hetland, R. D., Hu, K., and Wang, J.: Shelf sediment transport during hurricanes Katrina and Rita, Computers & Geosciences, 90, 24-39, https://doi.org/10.1016/j.cageo.2015.10.009, 2016.

Zang, Z., Xue, Z. G., Xu, K., Bentley, S. J., Chen, Q., D'Sa, E. J., and Ge, Q.: A Two Decadal (1993–2012) Numerical Assessment of Sediment Dynamics in the Northern Gulf of Mexico, Water, 11, 938, 2019.

2. The paper models the dispersal of the Pearl River sediment on the continental shelf. However, in many cases, the paper presents the study as if it were a Pearl River Estuary (PRE) study rather than a continental shelf study. Most of the analyses is done for the region of the shelf outside of the PRE (i.e. Regions 2 – 8 on Figure 1). In these cases,

the paper should refer to the shelf region rather than the estuary.

Response:

Thank you for your comment. We have carefully revised the manuscript to clarify that our focus is on sediment dispersal across the continental shelf rather than within the Pearl River Estuary (PRE). Where applicable, we now explicitly refer to Regions 2–8 (Figure 1) as the shelf region rather than the PRE. This adjustment ensures consistency with the study's broader spatial scope.

3. The abstract and motivation should be more clear about what will be analyzed. The analyses focuses on the dispersal of Pearl River discharged sediment (classes 4 and 5); and not the seabed sediment (seabed and riverine, classes 1 – 3)?

Response:

Thank you for pointing this out. We have revised both the abstract and the motivation section to clearly specify that our analysis focuses on the dispersal of Pearl River-derived sediment, namely sediment Classes 4 and 5 in Table 1. These correspond to slow-settling single fine grains (Class 4) and fast-settling flocs (Class 5), in contrast to background seabed sediments (Classes 1 to 3), which are not the focus of this study.

Specific Comments (by line number in the preprint)

4. Lines 297 – 328: This section is confusing and should be revised for clarity. For example, better clarify whether Pearl River sediment (classes 4 and 5) was delivered during the 15-month spinup.

Response:

We thank the reviewer for pointing out the ambiguity. We have substantially rewritten lines 297–328 to improve clarity. In particular, the revised text now explicitly states that Pearl River sediments (Classes 4 and 5) were indeed delivered continuously throughout the 15-month spin-up period. The updated text reads:

The initial prototype field underwent a 15-month spin-up period (from January 1, 2016, to March 31, 2017), during which the bottom sediment composition evolved under realistic hydrodynamic forcings from the ROMS, SWAN, and CSTM models. This method has been utilized in numerous previous studies, including those by Bever et al. (2009), van der Wegen et al. (2010), and Zhang et al. (2021). This process allows the initially idealized sediment distribution to evolve under realistic dynamic forcings, including tides, waves, and currents, thereby minimizing unreasonable spatial patterns introduced by the Kriging interpolation method. Such unreasonable spatial patterns may arise due to limitations in the number, representativeness, and timing of field sediment samples relative to the model start date. As a result, the sediment field after the spin-up period (Figures 2g–i) exhibits spatial patterns that are more physically plausible and better aligned with the hydrodynamic conditions of the study region. During both the 15-month spin-up period and the subsequent 12-month formal model experiments (see Section 2.6 and Table 2), the CSTM utilized five sediment classes (Table 1), representing a range of sediment sizes and characteristics. These included three types of seabed sediments (clay, silt, and sand, corresponding to sediment Classes 1 to 3 in Table 1) and two types of Pearl River-derived sediments (Class 4 and Class 5 *in Table 1). The riverine sediments consisted of slow-settling single fine grains (Class 4) and high-settling flocs (Class 5), which were delivered into the model domain during both the 15-month spin-up period and the subsequent 12-month formal model experiments. The riverine flocs correspond to the flocculated fractions of clay and silt, whereas the single fine grains represent the non-flocculated components within the Pearl River-derived sediments, following the setting of Bever and MacWilliams (2013). To clarify, at the start of the 12-month formal model experiments, the retained Pearl River-derived sediments (Classes 4-5 in Table 1) that entered the model during the 15-month spin-up period were added as Class 1 and Class 2, respectively, to avoid contaminating the data analysis of the formal experiments. This approach allows for a better distinction between Pearl River sediment and seabed sediment, enabling separate analysis of the suspension, transport, and deposition of Pearl River-derived sediment (Harris et al., 2008; Zhang et al., 2019). Specifically, the fractions of the two types of Pearl River-derived sediments were set at 40% and 60%, respectively, following Zhang et al. (2019) and Zhang et al. (2021). The parameters for all five sediment classes are summarized in Table 1. Sediment density, porosity, and erosion rate for all sediment classes were set to 2650 kg m-3, 0.672 (Zhang et al., 2019; Zhang et al., 2021), and 1 × 10-4 kg m-2 s-1 (Ralston et al., 2012), respectively. The settling velocity (ws), critical shear stresses for erosion (τce), and other parameters were set following previous studies or were based on model calibration (Ralston et al., 2012; Warner et al., 2017; Zhang et al., 2019; Dong et al., 2020; Zhang et al., 2021; Cao et al., 2025).*

5. Section 2.6 is confusing. Perhaps a table would be helpful.

Response:

Thank you for your valuable feedback. In response to your suggestion, we have added Table 2 to Section 2.6 which summarizes the key parameters and their relationships. For your convenience, we're including the table below:

Table 2. Experiment Settings

Experiments	Tides	Waves	Ambients	τ_{ce}	w_s	Re-run
Exp 1 (Control)	✓	✓	✓	Variable	Original	×
Exp 2 (NTS)	×	✓	✓	Variable	Original	×
Exp 3 (NWS)	✓	×	✓	Variable	Original	×
Exp 4 (NAS)	✓	✓	×	Variable	Original	×
Exp 5 (NVS)	✓	✓	✓	Constant	Original	×
Exp 6 (DSV)	✓	✓	✓	Variable	Double	×
Exp 7 (Cycle)	✓	✓	✓	Variable	Original	✓

The term 'Ambients' denotes ambient shelf currents and residual water levels. Variable indicates simulations employing seasonally varying τ_{ce} values (from Table 1), while 'Constant' refers to runs using exclusively the summer τ_{ce} value throughout the entire experiment. 'Original' designates cases utilizing the settling velocities specified in Table 1, whereas 'Double' indicates simulations with these values doubled."

Some specific points:

5a. Lines 413 – 414: Run 5 uses the same critical shear stress for winter and summer, but the paper does not say what value is used?

Response:

Thank you for your comment. To clarify, Exp 5 employed a constant critical shear stress (τ_{ce}) value throughout the entire simulation period, using the summer τ_{ce} value from Table 1 for both winter and summer seasons (i.e., without seasonal variation). We have revised the manuscript to explicitly state this in the Methods section:

Exp 5 (NVS hereafter) replicated the setup of Experiment 1, but with one modification: it used a constant critical shear stress for erosion (τ_{ce}) across both seasons, specifically adopting the summer τ_{ce} value from Table 1 throughout the simulation (i.e., no seasonal adjustment between winter and summer).

5b. Lines 416 – 423; model run 7 is described as considering the impact of the initial sediment bed. But, it actually seems to evaluate whether the original spinup time was sufficient for supplying riverine sediment (classes 4 -5) to the seabed. It does not seem to consider uncertainties in the distribution of size classes 1- 3.

Response:

Thank you for your comment. The main difference between Exp 7 and Exp 1 is that Exp 7 uses the final state of Exp 1 as its initial condition. This means that when Exp 7 starts, it already includes all the changes in sediment classes 1–5 that occurred during the Exp 1 simulation, and thus classes 1–3 are also affected. We agree with your observation: compared to the Cycle 2 case, Exp 7 (Cycle) indeed focuses more on assessing how the presence of previously deposited riverine sediments influences the evaluation of riverine sediment transport. To avoid misunderstanding, we have revised and clarified the text. The updated version is as follows:

Finally, to assess the model's sensitivity to the spin-up duration of Pearl River-derived sediment, particularly regarding the retention of riverine sediments in both the water column and the seabed, we adopted the sediment distributions (Classes 1 to 5) from the Control run on March 31, 2018, as the alternative initial conditions for the Cycle experiment (designated as Exp 7, Cycle hereafter). This setup carries over the full year's evolution of riverine sediment transport and deposition from the Control run (Exp 1), including changes in all sediment classes, into the start of Exp 7. As a result, Exp 7 mainly evaluates how the presence of previously deposited riverine sediments influences subsequent sediment transport estimates.

5c. Lines 423 – 427 seem out of place. It provides the wind forcing used for all model runs. Perhaps move this to the beginning of the section.

Response:

Thank you for the suggestion. We agree that the original placement of Lines 423–427 was not optimal. In the revised manuscript, we have moved this content to the beginning of Section 2.6 to improve the logical flow and clarity of the methods section.

6. Section 3.3 is difficult to follow, suggest revising it. It is long (12 pages). Each of the 5 figures contains several panels that each compare a different model to the Control run. Each paragraph of the text, however, discusses one model run, so the reader needs to

look at several figures to understand each paragraph.

Suggest you redo the figures to be organized like the text. If a paragraph describes one model run (e.g. NTS), it can refer to 1 figure that shows the comparison between the model and control for multiple variables (bed stress, SSC, currents, flux, etc).

Response:

Thank you for your comment. We appreciate your suggestion and, in fact, initially intended to organize the figures as you proposed—i.e., having each figure represent one model run and include multiple variables (e.g., bed stress, SSC, currents, fluxes, etc.). However, we encountered several challenges with this approach:

1. It would increase the number of figures. Currently, Section 3.3 contains 5 figures, but under the proposed structure, at least 6–7 figures would be needed, potentially making the manuscript more cumbersome.
2. This organization would lead to inconsistencies in the number of subpanels across figures, as different experiments impact different variables. For instance, Experiments 2–4 affect hydrodynamic processes such as bed stress and currents, whereas Experiments 5–7 do not. As a result, some figures would contain 5–6 subpanels, while others would have only 3–4, which could make comparisons more confusing.
3. Even if we follow the approach where each figure represents a single model run and includes multiple variables (e.g., bed stress, SSC, currents, fluxes, etc.), it is still unavoidable to compare results across different experiments. As a result, it remains necessary to reference multiple figures within a single paragraph.

Therefore, we adopted the current format, following the presentation style used in Xue et al. (2012). In their paper, Figures 5 and 6 present summer and winter current velocity and the difference in Mekong River-derived SSC between experiments and the Control run, and Figure 8 illustrates annual simulated Mekong River-derived sediment deposition in the Mekong River Shelf. Similarly, in their Section 3.2, each paragraph refers to multiple figures (e.g., Figures 5, 6, and 8). This structure has proven effective, as their work was successfully published in Continental Shelf Research and has been cited 112 times as of May 7, 2025 (Google Scholar), indicating its impact and clarity. That said, we fully agree that Section 3.3 was overly long and difficult to follow. In response, we have revised the text and split the original Section 3.3 into two sections (now Sections 3.3 and 3.4) to make the descriptions more concise and precise, thereby enhancing both readability and overall coherence.

References

Xue, Z., He, R., Liu, J. P., and Warner, J. C.: Modeling transport and deposition of the Mekong River sediment, Continental Shelf Research, 37, 66-78, 10.1016/j.csr.2012.02.010, 2012.

7. Section 4.1 should be edited for clarity, and should be shortened.

7a. One example, lines 829 – 837 describe using a critical shear stress that is seasonally dependent, but it is confusing whether the authors feel that this was important. Line 837: “it has a more significant effect on the bed sediment grain size distribution”: not sure what this means and it does not reference a figure.

Response:

Thank you for the comment. We have removed the ambiguous sentence in line 837 ("it has a more significant effect on the bed sediment grain size distribution") to avoid confusion. In addition, we have expanded our discussion to include direct comparisons between our findings and previous studies of the effects of seasonally dependent critical shear stress on sediment transport on continental shelves, which have documented clear seasonal variations in critical shear stress. These additions help to contextualize the role of a seasonally dependent critical shear stress in our model results.

7b. Suggest removing the "Cycle 2" description or moving it to the supplement (Lines 847 – 857).

Response:

Thank you for the suggestion. We agree that the "Cycle 2" description may be too detailed for the main text. Accordingly, we have moved the relevant content to the Supplementary Material to streamline the manuscript while preserving the information for interested readers.

7c. Lines 802 – 902 could provide more comparisons with the results from this study and previously published papers, especially for continental shelves. Papers have shown evidence for seasonal dependence in critical shear stress (Xu et al. 2014; Briggs et al. 2015); and sensitivities to settling velocity (Harris et al. 2008).

Response:

Thank you for the suggestion. We have expanded Lines 802–902 to include additional comparisons with continental-shelf studies, specifically incorporating evidence for seasonal variations in critical shear stress (Xu et al., 2014; Briggs et al., 2015) and sensitivities to settling velocity (Harris et al., 2008).

References

Briggs, K. B., Cartwright, G., Friedrichs, C. T., and Shivarudruppa, S.: Biogenic effects on cohesive sediment erodibility resulting from recurring seasonal hypoxia on the Louisiana shelf, Continental Shelf Research, 93, 17-26, https://doi.org/10.1016/j.csr.2014.11.005, 2015.

Harris, C. K., Sherwood, C. R., Signell, R. P., Bever, A. J., and Warner, J. C.: Sediment dispersal in the northwestern Adriatic Sea, Journal of Geophysical Research, 113, 10.1029/2006jc003868, 2008.

Xu, K., Corbett, D. R., Walsh, J. P., Young, D., Briggs, K. B., Cartwright, G. M., Friedrichs, C. T., Harris, C. K., Mickey, R. C., and Mitra, S.: Seabed erodibility variations on the Louisiana continental shelf before and after the 2011 Mississippi River flood, Estuarine, Coastal and Shelf Science, 149, 283-293, https://doi.org/10.1016/j.ecss.2014.09.002, 2014.

8. Section 4.2 the writing could be more clear. Could probably be shortened.

Response:

Thank you for the suggestion. We have removed some contents and revised the text in Section 4.2 to improve clarity and conciseness.

9. Lines 999 – 1019: these paragraphs do not add much to the paper. They summarize the findings from the results but do not compare this to other systems, and do not put the results into context.

Response:

Thank you for the helpful suggestion. We agree that the original paragraphs (Lines 999–1019) primarily summarized the results without providing sufficient broader context or comparative insight. In response, we have removed these paragraphs from the revised manuscript to improve clarity and avoid redundancy.

10. Conclusion section 5. This seems like a summary and a restating of the results section. Suggest revising this so that the major messages are reinforced without repeating other parts of the paper. I would avoid the “underestimation” and “overestimation” phrases (e.g. lines 1085 – 1107). The lessons learned by the reduced physics processes are that tides, waves, and remote forcing impact sediment dispersal and are important drivers of sediment transport.

Also, I do not think that the “initial sediment bed” experiments (Cycle and Cycle2) are truly tests of the initial bed so much as a test of the length of the spinup time for riverine sediment dispersal.

Response:

We have revised the Conclusion (Section 5) to synthesize key insights rather than restate individual results. The updated takeaways emphasize the roles of tides, waves, and remote forcing in shaping sediment dispersal, aligning with the reviewer’s recommendation. To avoid misinterpretation, we also removed terms such as 'underestimation' and 'overestimation' (Lines 1085–1107) and clarified that all comparisons are made within the model framework. Regarding the experiments, the

Cycle case was designed to examine the influence of riverine sediment spin-up by analyzing the redistribution of retained Pearl River–derived sediments during the second simulation year. In contrast, the model exhibits only minor sensitivity to the duration of seabed sediment spin-up, as demonstrated in the Cycle2 experiment (see Supplement), in which riverine sediments present during the spin-up period were added to seabed sediment classes 1–2 at the start of the Cycle2.

Technical Corrections (by line number in the preprint)

11. Line 236: Confusing and vague wording: "More than one year of hydrodynamic and sediment spin-up is sufficient…".

Response:

Thank you for pointing this out. We agree the wording was unclear and have removed the sentence in Line 236 to prevent any potential misunderstanding.

12. Lines 502, 504, etc: the units of sediment flux seem incorrect. g-1 m s-1?

Response:

We appreciate your careful review. This was indeed a typographical error, and we have now corrected it accordingly.

13. Figures 5 and 6: it is difficult to compare the sediment panels (c-f) because they use very different color scales.

Response:

Thank you for your insightful observation regarding Figures 5–6. You are correct that the differing color scales made direct comparison challenging. While we initially employed variable scales to account for the substantial seasonal variations in sediment concentration ranges, we agree that uniform scaling enhances comparability.

Accordingly, we have revised both figures to maintain consistent color scales wherever possible. This adjustment indeed improves clarity of cross-seasonal variation while preserving data representation.

However, we should note that Figures 5F and 6F still require distinct value ranges and color scales due to their differing data characteristics:

- **Figure 5F** displays the thickness of Pearl River sediment deposits on the seabed at the end of summer (positive values only).
- **Figure 6F**, in contrast, illustrates the *change* in sediment thickness between the end of winter and the end of summer (including both positive and negative values).

Since these subplots represent fundamentally different metrics, a shared color scale could not be applied without compromising interpretability.

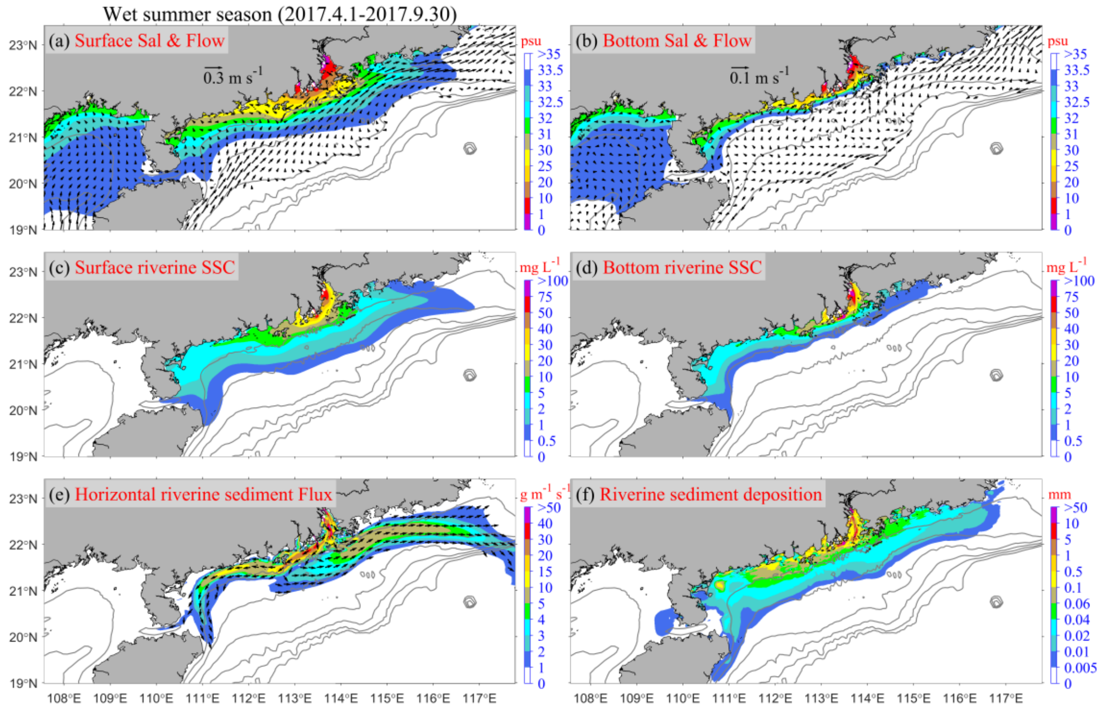

Figure 5. Patterns averaged over the entire wet summer season in the Control case: (a) surface and (b) bottom salinity (color, psu) and flow (arrows, m s^{-1}); (c) surface and (d) bottom riverine (classes 4 and 5 in Table 1, as follows) SSC (mg L^{-1}); (e) depth-integrated horizontal riverine sediment transport rate (color, g m^{-1} s^{-1}) and direction (arrows); and (f) riverine sediment deposition thickness (mm) on the seabed during the wet summer season. Flow vectors in regions with water depths exceeding 100 m are masked for clarity.

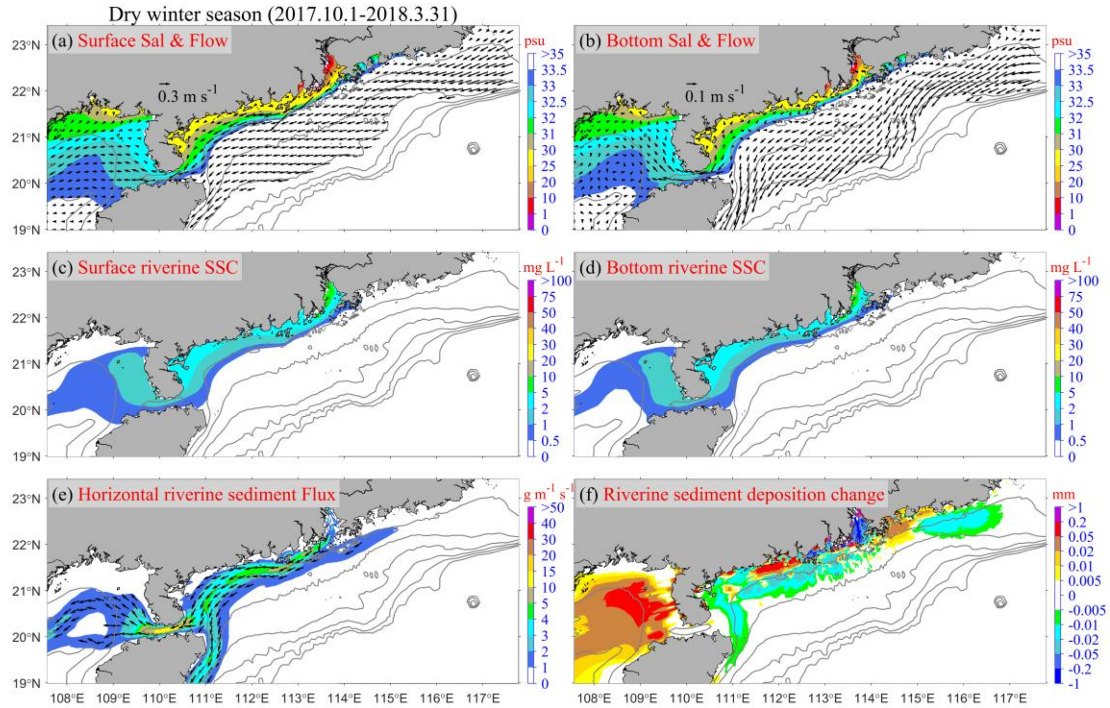

Figure 6. Same as Figure 5, but for the dry winter season in the Control case. Notably, (f) illustrates the changes in riverine sediment deposition (classes 4 and 5 in Table 1) on the seabed at the end of the dry winter season compared to the end of the wet summer season.

14. Line 613: are the "red and blue values" on Figure 7?

Response:

Thank you for catching this discrepancy. Due to a file import error during our extensive revisions, an incorrect version of Figure 7 was inadvertently included. We have now corrected the figure and verified its accuracy. The updated version clearly displays the red and blue values as intended. For clarity, the corrected Figure 7 is shown below. We apologize for any confusion caused by this oversight.

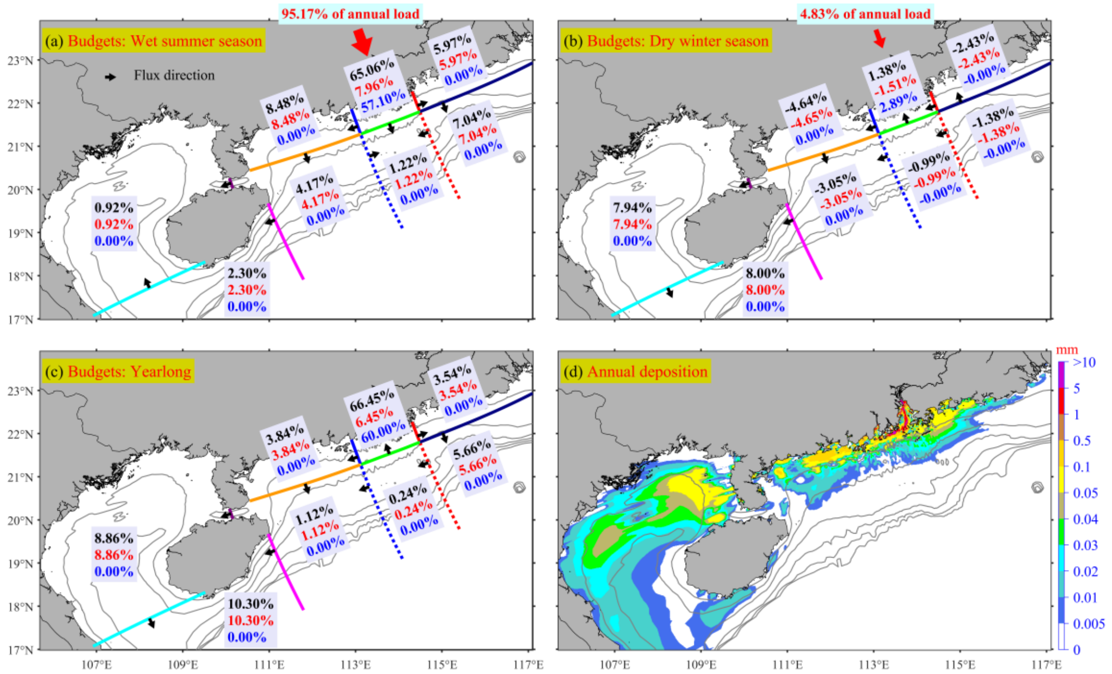

Figure 7. Riverine sediment (classes 4 and 5 in Table 1) retention budget percentages at eight regions (see Figure 1) during (a) the wet summer season, (b) the dry winter season, and (c) the entire year in the Control run case. (d) the annual deposition patterns spanning from April 1st, 2017, to March 31st, 2018 in the Control Run. All percentages displayed in the figure are relative to the annual riverine sediment load (see Figure 3a). The black percentage values represent the combined total of riverine sediment Class 4 and Class 5, while the red and blue values denote sediment Class 4 and Class 5, respectively. Arrows indicate the direction of net riverine sediment flux at each transect during the specified period.

15. Line 698: These represent the concentrations of classes 4 and 5 and do not include classes 1 – 3? Suggest you clarify this in the figure caption and perhaps in the text.

Response:

Thank you for pointing this out. Yes, the concentrations shown represent only sediment classes 4 and 5, excluding classes 1–3. We have clarified this in both the figure caption and the main text accordingly.

16. Figure 12 is complicated. Can it be simplified by removing some of the numbers?

Response:

Thank you for the helpful suggestion. We have revised Figure 12 to improve clarity by removing the percentage labels for sediment class 4. To obtain the values for class 4, readers can simply subtract the total percentage of class 5 sediment (blue numbers) from the combined total of sediment classes 4 and 5 (black numbers). We believe this adjustment simplifies the figure while still allowing readers to derive the full information if needed.

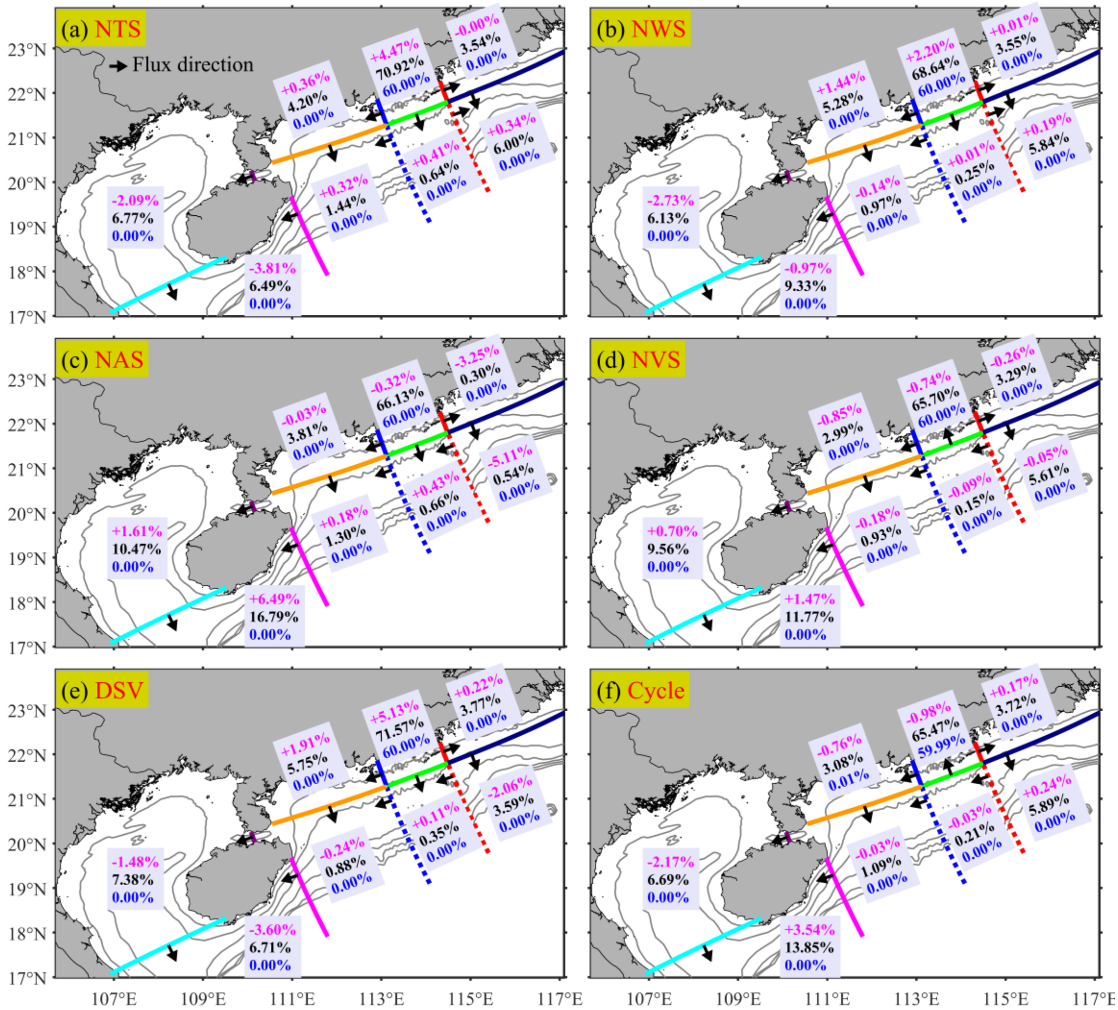

Figure 12. Same as Figure 7c, but for the other six cases: (a) NTS, (b) NWS, (c) NAS, (d) NVS, (e) DSV, and (f) Cycle, respectively. All percentages shown in the figure are expressed relative to the annual riverine sediment load (see Fig. 3a). Magenta values denote the differences in retention percentage of riverine sediments (Classes 4 and 5; Table 1) between the Control run and each sensitivity case. Black values represent the combined retention of Classes 4 + 5, while blue values indicate Class 5 alone. To obtain the retention percentage for Class 4, simply subtract the Class 5 percentage (blue) from the combined Classes 4 + 5 percentage (black).

17. Line 827: it seems inappropriate to refer to the original manuscript (preprint).

Response:

Thank you for pointing this out. We agree that referring to the original manuscript (preprint) is unnecessary in this context. We have removed the reference to the preprint and revised the sentence accordingly. The revised sentence now reads:

"*After realistic reworking during the spin-up, the bed sediment grain size distribution (used as initial conditions in the Control run and all Sensitivity cases except the Cycle case) is quite close to the initial prototype (Figures 2d–f vs. 2g–i).*"

18. Table 1, Line 863, and elsewhere: it seems a bit misleading to cite the Ralston paper for the settling velocities used for the riverine sediment because Ralston used a salinity-dependent settling velocity, whereas this paper partitioned sediment into fast- and slow-settling flocs.

Response:

Thank you for your comment. We agree with your observation, and we have removed the citation of the Ralston paper from both Table 1 and Line 863 to avoid any confusion.

19. Line 918: suggest you say "finding is consistent with the earlier…" instead of "confirm.

Response:

Thank you for your valuable suggestion. We have modified the wording on Line 918 to "*This finding is not only consistent with the earlier speculation proposed by Ge et al. (2014) but also supplements the conclusions drawn by Lin et al. (2020).*" to improve clarity and precision.

20. Line 934: suggest saying "Within this framework, riverine sediment deposition is characterized using …".

Response:

Thank you for your valuable suggestion. We have modified the wording on Line 934 to "*Within this framework, riverine sediment deposition is characterized using key factors, including riverine sediment discharge (greater or less than 2 megatons), shelf width (greater or less than 12 km), and wave and tidal range conditions (greater or less than 2 m) (Walsh and Nittrouer, 2009).* " to improve clarity and precision.

21. Lines 971 – 975: this is confusing because you cite several studies of estuaries. However, your numerical model focuses on the continental shelf dispersal. Should you instead say "The PRE exhibits distinctive geomorphological features, yet dispersal of its fine-grained sediment on the continental shelf conforms to general patterns observed offshore of other monsoon-influenced estuarine systems. … documented offshore of various major …".

Response:

Thank you for pointing out the confusion. Our wording was indeed imprecise, as the studies we cited address sediment transport from the estuary out onto the adjacent continental shelf. We have therefore revised the sentence to read:

The PRE exhibits distinctive geomorphological features, yet dispersal of its fine-

grained sediment transport on the continental shelf conforms to general patterns observed offshore of other monsoon-influenced estuarine systems. Similar multiple-stage sediment delivery and dispersal mechanisms have been documented offshore of various major estuaries and their adjacent shelves, including the Yellow River Shelf (Bian et al., 2013; Zeng et al., 2015), Changjiang River Shelf (Zeng et al., 2015), and Mekong River Shelf (Xue et al., 2012; Eidam et al., 2017), demonstrating comparable sedimentary processes under monsoon climatic influences.

22. Line 980 and elsewhere: Instead of saying "Like the PRE", suggest you say "Like the PRE Shelf". This paper focuses on the continental shelf offshore of the PRE, not on the PRE itself. The paper should be more clear about this.

Response:

Thank you for the suggestion. We have revised the text replace "Like the PRE" with "Like the PRE Shelf" where appropriate, to more accurately reflect the study focus on the continental shelf offshore of the PRE.

23. Lines 1026 – 1035: many of these citations are focused on the estuary itself or on global drivers, rather than continental shelf processes. There are no citations for line 1034 (episodicity of shelf transport for "many systems").

Response:

Thank you for your comment. We have expanded our reference list to ensure that continental-shelf processes are properly cited. In particular, we now reference interannual variations of shelf circulation (Liu et al., 2020; Deng et al., 2022) and Kuroshio intrusions (Caruso et al., 2006; Nan et al., 2015; Sun et al., 2020). We have also supported the statement on the episodicity of shelf transport by adding citations that demonstrate how a large fraction of sediment flux on many shelf systems occurs during short-lived, high-energy events such as storms and hurricanes (Xu et al., 2016; Warner et al., 2017; Georgiou et al., 2024).

The revised text now reads:

interannual variations of the shelf circulations (Liu et al., 2020; Deng et al., 2022) and Kuroshio intrusions (Caruso et al., 2006; Nan et al., 2015; Sun et al., 2020). Therefore, while this study sheds light on seasonal and annual timescale patterns, it cannot fully represent the short or long-term transport and deposition trends of the Pearl River sediment. Yet for many shelf systems, a lot of sediment transport happens during short-lived events such as hurricanes (Xu et al., 2016; Warner et al., 2017; Georgiou et al., 2024). Consideration of the episodicity of transport would be helpful for future studies (Xu et al., 2016; Warner et al., 2017; Georgiou et al., 2024).

References

Caruso, M. J., Gawarkiewicz, G. G., and Beardsley, R. C.: Interannual variability of the Kuroshio intrusion in the South China Sea, Journal of Oceanography, 62, 559-575, 10.1007/s10872-006-0076-0, 2006.

Deng, Y., Liu, Z., Zu, T., Hu, J., Gan, J., Lin, Y., Li, Z., Quan, Q., and Cai, Z.: Climatic Controls on the Interannual Variability of Shelf Circulation in the Northern South China Sea, Journal of Geophysical Research: Oceans, 127, e2022JC018419, https://doi.org/10.1029/2022JC018419, 2022.

Georgiou, I. Y., FitzGerald, D. M., Sakib, M. M., Messina, F., Kulp, M. A., and Miner,

M. D.: Storm Dynamics Control Sedimentation and Shelf-Bay-Marsh Sediment Exchange Along the Louisiana Coast, Geophysical Research Letters, 51, e2024GL111344, https://doi.org/10.1029/2024GL111344, 2024.

Liu, N., Geng, B., Xue, H., Xiu, P., Wang, Q., and Wang, D.: Interannual Variability of Shelf and Slope Circulations in the Northern South China Sea, Journal of Ocean University of China, 19, 1005-1016, 10.1007/s11802-020-4446-9, 2020.

Nan, F., Xue, H., and Yu, F.: Kuroshio intrusion into the South China Sea: A review, Progress in Oceanography, 137, 314-333, https://doi.org/10.1016/j.pocean.2014.05.012, 2015.

Sun, Z., Zhang, Z., Qiu, B., Zhang, X., Zhou, C., Huang, X., Zhao, W., and Tian, J.: Three-Dimensional Structure and Interannual Variability of the Kuroshio Loop Current in the Northeastern South China Sea, Journal of Physical Oceanography, 50, 2437-2455, https://doi.org/10.1175/JPO-D-20-0058.1, 2020.

Warner, J. C., Schwab, W. C., List, J. H., Safak, I., Liste, M., and Baldwin, W.: Inner-shelf ocean dynamics and seafloor morphologic changes during Hurricane Sandy, Continental Shelf Research, 138, 1-18, 10.1016/j.csr.2017.02.003, 2017.

Xu, K., Mickey, R. C., Chen, Q., Harris, C. K., Hetland, R. D., Hu, K., and Wang, J.: Shelf sediment transport during hurricanes Katrina and Rita, Computers & Geosciences, 90, 24-39, https://doi.org/10.1016/j.cageo.2015.10.009, 2016.

24. Line 1040: can you be more specific? How much “less” freshwater and sediment do these small rivers contribute? Otherwise, this paragraph is a bit vague, and it does not put this system into the context of other systems where the relative contributions of small and large rivers have been considered.

Response:

Thank you for the valuable comment. We agree that the original wording was vague. In response, we have revised the paragraph to include quantitative data on freshwater and sediment contributions from the smaller rivers, based on published sources. The revised paragraph is as follows:

Additionally, it's important to note that this article primarily focuses on the fate of the Pearl River sediment on the inner shelf. However, within the expansion range of the Pearl River buoyant plume, a number of smaller rivers, including the Jiulong River, Han River, Moyang River, Jian River, Nanliu River, Changhua River and Nandu River, also contribute freshwater and sediment to the northern South China Sea (Milliman and Farnsworth, 2011; Zhang et al., 2012; Liu et al., 2016). Although these rivers contribute significantly less freshwater and sediment compared to the Pearl River, they still impact seawater salinity, suspended sediment concentration, and seabed geomorphology (Liu et al., 2016; Wang et al., 2023; Zong et al., 2024). Since the 1950s, South China delivers approximately 102 Mt/year of fluvial sediment to the SCS, with the Pearl River alone accounting for 84.3 Mt/year—about 83% of the total sediment load (Milliman and Farnsworth, 2011; Zhang et al., 2012; Liu et al., 2016). The specific contributions of each river are detailed in Table 3. While the data highlight the Pearl River's dominant role in sediment delivery, a comprehensive understanding of sedimentary processes and impacts in the northern South China Sea also requires systematic investigation into the roles of the smaller contributing rivers.

Table 3. *Annual mean runoff and annual suspended sediment load of major rivers in South China that flow directly into the northern South China Sea since the 1950s (Milliman and Farnsworth, 2011; Zhang et al., 2012; Liu et al., 2016).*

River name	*Runoff ($m^3\ s^{-1}$)*	*Suspended sediment load (Mt/year)*
Pearl River	*9075*	*84.3*
Jiulong River	*476*	*3.1*
Han River	*825*	*10*
Moyang River	*269*	*0.8*
Jian River	*174*	*1.5*
Nanliu River	*162*	*1.1*
Changhua River	*120*	*0.08*
Nandu River	*179*	*0.4*

25. Line 1084: should this say "in the PRE" or "within and offshore of the PRE"? The model domain extends very far beyond the estuary.

Response:

Thanks for pointing this out. We've revised it to 'within and offshore of the PRE' to accurately reflect the model domain's coverage.

26. Figure S1: use different types of markers (circles, squares, triangles, etc.) for the different types of observation points (tide gages, wave stations, survey stations, etc).

Response:

Thank you for your suggestion. We have revised **Figure S1** to improve clarity in distinguishing observation types by adopting different marker styles for each station category, as recommended. The updated **Figure S1** now uses:

- **Colored squares** (■) for wave stations (*W1*: black, *W2*: blue),
- **Colored triangles** (▲) for tidal gauge stations (*Zhapo*: green, *Qinglan*: cyan, *Quarry Bay*: red),
- **Colored diamonds** *(♦) for mooring stations (M2*: red, *M1*: green),
- **Uniform blue dots** (•) for all 43 survey stations.

This scheme ensures immediate visual differentiation between station types while aligning marker colors with those used in the main figures for consistency.

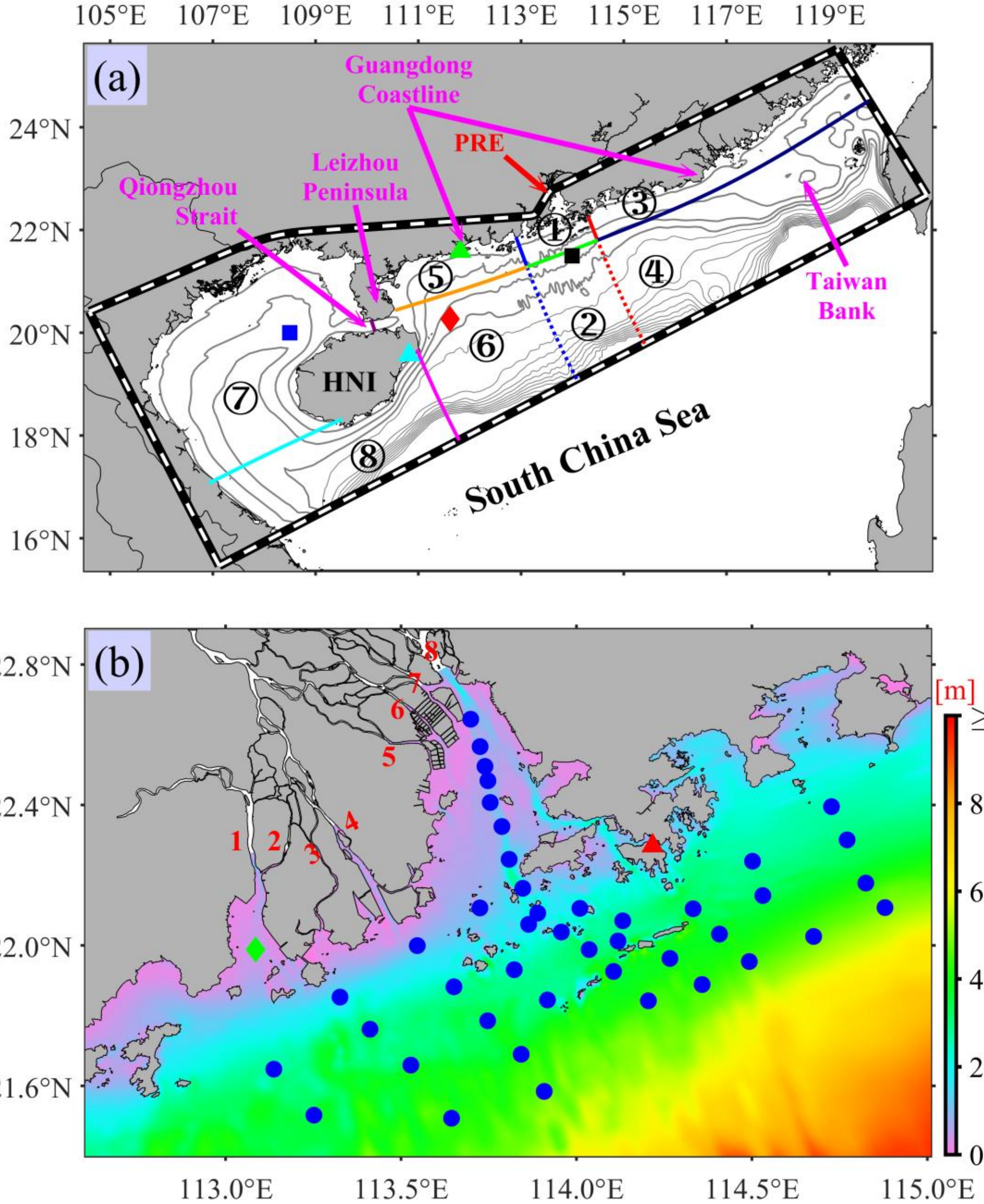

Figure S1. (a) Bathymetry contours and the model grid domain (black to white dashed lines), with circled numbers ①-⑧ indicating the eight regions: Proximal, Southern, Eastern, Southeastern, Western, Southwestern, Gulf, and Distal regions, which are delineated by transects and are described in detail in Section 4.2 of the main text. Thick gray contour lines mark the 20 to 80 m isobaths at 20 m intervals, while thin gray lines indicate the 100 to 1000 m isobaths at 100 m intervals. The abbreviations HNI and PRE refer to Hainan Island and the Pearl River Estuary, respectively. (b) A detailed bathymetry map of the PRE and nearby waters. In panel (a), observation stations are marked by green and cyan triangles (Zhapo and Qinglan tidal gauge stations), black and blue squares (W1 and W2 wave stations), and a red diamond (M2 station), respectively. In panel (b), stations are represented by: a red triangle (Quarry Bay water level station), a green diamond (M1 station in the PRE), and blue dots (43 cruise survey stations), respectively. The red numbers 1-8 indicate the eight outlets of the PRE, where freshwater and sediment from the Pearl River (specifically the fourth and fifth sediment sizes listed in Table 1 of the main article) are discharged into the estuary.

27. All figures should have the units (for example, figure S7C does not identify the units of SSC mg/L?; Figures S9 and S10 do not provide the units of velocity)

Response:

We sincerely appreciate the reviewer's careful attention to the details in our manuscript. We apologize for the oversight in labeling the units in the supplementary figures. We have now revised the figures as follows:

1. **Figure S7C:** Added the unit "mg/L" for SSC.
2. **Figures S9 and S10:** Added the unit "m/s" of velocity.

These corrections have been updated in the revised supplementary materials. Thank you for bringing this to our attention, and we hope the revised version meets the journal's standards.

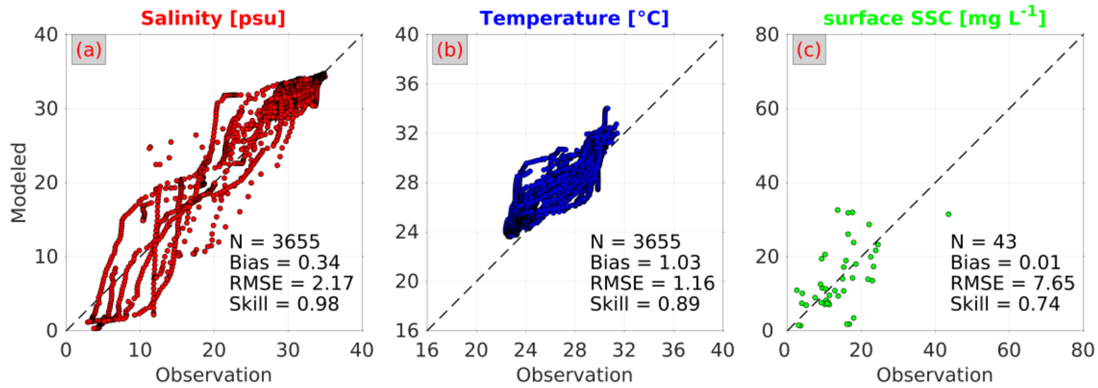

Figure S7. The validations of (a) salinity, (b) temperature, and (c) surface SSC at the 43 stations during the 2017 SYSU cruise survey.

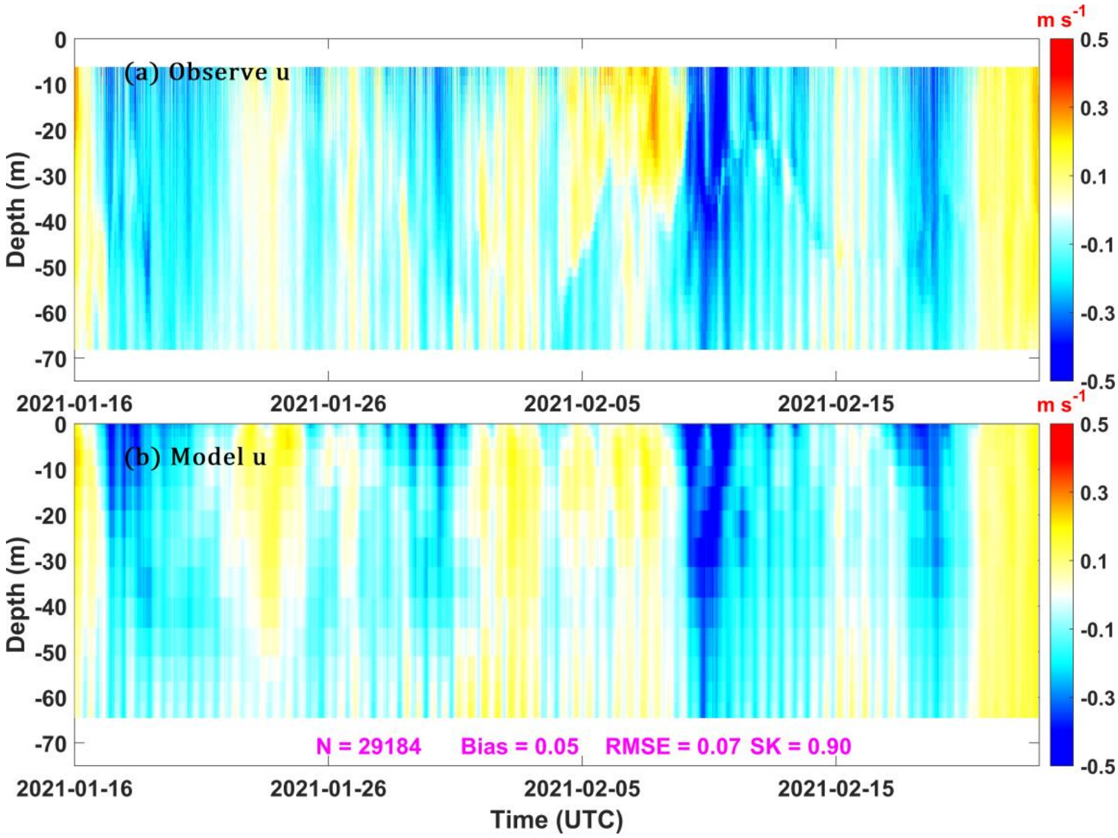

Figure S9. (a) Observed and (b) simulated eastward current velocity at M2 station.

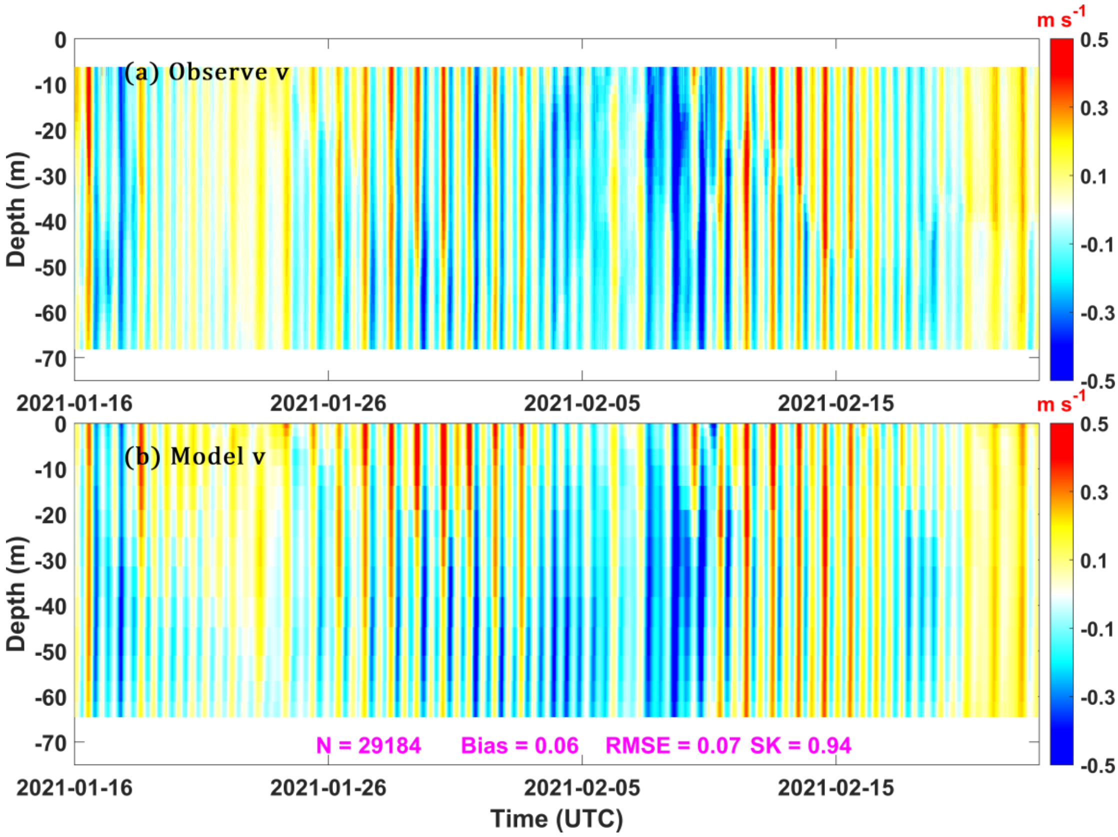

Figure S10. (a) Observed and (b) simulated northward current velocity at M2 station.

28. The font sizes in many figures is very small and hard to read, especially in the supplement figures.

Response:

We appreciate your feedback. We have carefully revised all figures in the main text and supplementary materials to ensure the font sizes are now clearly legible. Thank you for pointing this out.

Response to Reviewer 2

1. Introduction

This is my first time reviewing this manuscript, and my assessment has been conducted independently without taking earlier versions and previous referee comments into account.

Using a numerical case study, this paper investigates the dispersal of river-derived sediment over a continental shelf. It does well to provide insights into the spreading of sediment from the river plume over the coastal shelf, taking several processes, such as tides, waves and wind into account. While I think the paper does provide new insights into these main dispersal mechanisms, I think the attempt to form a generalised interpretation is currently not attained, and it might be more appropriate to shift the focus more to the specific case that is investigated. As I do see the value of the developed model and the on/off sensitivity analysis of several model aspects, I think a more careful presentation of the results is required for suitable embedding. Therefore, I recommend publication of the manuscript after major revision.

Dear Reviewer:

We sincerely appreciate the time and effort you devoted to reviewing our manuscript and providing thoughtful and constructive comments. We value your independent assessment and acknowledge the importance of your perspectives in strengthening our study.

We have carefully revised the manuscript in response to your suggestions. Your feedback helped us refine our analysis, clarify our presentation, and better position our work within the specific context of the Pearl River-derived sediment dispersal.

Below, we provide a detailed, point-by-point response to each of your comments, along with the corresponding revisions made to the manuscript.

Thank you again for your valuable insights and support in improving the quality of our work.

2. General Comments

Clarification of "Overestimation" and "Underestimation"

The manuscript frequently refers to the "overestimation" or "underestimation" of sediment-related quantities (e.g., deposition, resuspension, retention, and bed shear stress) in several instances (e.g., lines 24, 27, 631, 667, 830, 1004, 1011, 1085, among others). These terms imply comparison with real-world field data, which, to my knowledge, is not available for validation (as also noted in lines 805–808). Instead, these quantities appear to be evaluated relative to the "Control" model run. To avoid potential misinterpretation, I recommend revising the phrasing to clarify that differences are being assessed within the model framework rather than against observational data.

Response:

We agree with you that these terms could be misleading without observational validation. We have revised all instances (Lines 24, 27, 631, etc.) to clarify that comparisons are made relative to the Control run (e.g., "higher/lower than the Control case" instead of "over/under-estimation"). This change appears in the revised text with track changes.

Evaluation of Research Objective (2)

It is unclear whether research objective (2) (line 156) has been fully achieved. My interpretation is that the model is calibrated based on hydrodynamics to establish the "Control" run, but it remains uncertain whether the model continues to behave as expected when certain processes (NWS, NTS, NAS) are omitted. Additionally, it would be beneficial to clarify whether the chosen methodology is capable of addressing objective (2).

There is potential for deeper insights into the contributions and interactions of different processes in sediment transport. Since sediment transport exhibits nonlinear responses to environmental forcing, an analysis of how tides and waves interact to influence overall sediment dynamics could strengthen the study. Currently, the approach primarily isolates individual processes, but a more integrated interpretation of process interactions could add value.

Some of the study's findings may already be anticipated based on fundamental process-based reasoning. For instance, the following statements confirm well-known expectations:

- Lines 525–527: "With sediment load during winter nearly negligible, the suspended concentration of riverine sediment is significantly lower compared to the wet summer."
- Lines 657–658: "For the NTS case versus the Control case, tides significantly affected bottom stress."
- Lines 667–668: "However, NWS underestimated the nearshore bottom stress."

- Lines 713–714: "This enhanced settling velocity resulted in an increased deposition."

A more nuanced discussion of these results—particularly emphasizing interactions between multiple processes rather than confirming expected trends—would enhance the manuscript.

Response:

We appreciate your insightful suggestion. As you noted, our manuscript has undergone extensive revision, including responses to previous referee comments, so your assessment, while independent of those changes, remains valuable.

Originally, our preprint was titled "Wind and Wave Effects on the Dispersal of Pearl River Derived Sediment over the Shelf" and included detailed momentum-balance and sediment-diagnostic analyses of combined wind, wave, and tidal forcings. However, earlier reviewers found those sections overly technical and recommended focusing instead on seasonal hydrodynamic differences and sediment delivery to distal regions such as the Beibu Gulf. In response, we refocused the paper, now titled "Modeling Dispersal of Pearl River Derived Sediment over the Shelf", to emphasize the Control run's summer and winter sediment distributions across the shelf and the ultimate fate of Pearl River derived sediment after one year. We then designed a series of sensitivity experiments that omitted physical forcings (NWS, NTS, and NAS), adjusted sediment parameterizations, and varied spin-up durations to isolate the individual impact of each process on sediment transport.

You raise an excellent point regarding the nonlinear interactions between tides and waves, which remains a frontier topic in our field. We explored these combined effects in detail in our earlier JGR publication (Zhang et al., 2021), which demonstrated how waves, tides, wind, and freshwater jointly shape both longitudinal and lateral sediment transport and deposition in the Pearl River Estuary. Although a comprehensive analysis of tide and wave interactions lies beyond the streamlined scope of the current study, our present goal was to establish a clear baseline (Objective 1) and then assess how omitting specific forcings or altering sediment characteristics and spin-up durations modifies those baseline results (Objective 2).

To address your comment, we have:

1. Quantified statements that previously confirmed well-known expectations.
2. Revised the Objective (2) to clarify how our methodology evaluates model behavior under different combinations of forcings.
3. Substantially updated the Results and Discussion sections to better explain the impacts of each forcing.

We believe these changes enhance the manuscript's logical flow and align it more closely with its stated objectives, while also laying the groundwork for future investigations into complex process interactions.

References

Zhang, G., Chen, Y., Cheng, W., Zhang, H., and Gong, W.: Wave Effects on Sediment Transport and Entrapment in a Channel-Shoal Estuary: The Pearl River Estuary in the Dry Winter Season, Journal of Geophysical Research: Oceans, 126, 10.1029/2020jc016905, 2021.

Numerical Model Performance and Limitations

The manuscript could benefit from a more detailed discussion of numerical model performance, particularly regarding:

- Grid sensitivity: While the hydrodynamic validation appears strong, has numerical behaviour and model convergence been tested under grid refinement?
- Model limitations: Section 4.3 primarily discusses the exclusion of certain physical processes but does not address intrinsic model limitations. Consider including a discussion on potential numerical constraints.
- Sigma-coordinates (Line 189): The sigma-coordinate system is known to introduce challenges in accurately modelling salt transport in regions with steep gradients, where Cartesian coordinates may perform better (Bijvelds, 2001). Given the importance of salinity in estuarine turbidity maxima (ETM) formation, it would be helpful to clarify whether ETM development is well captured in the model and whether any limitations arise from the chosen coordinate system.

The study presents interesting insights into sediment budgets and overall sediment dynamics. In particular, the introduction of the "Cycle" model run is a compelling aspect. It may be beneficial to highlight its implications more prominently, especially regarding the conclusions drawn in lines 730–731.

Response:

We sincerely appreciate the reviewer's careful reading and insightful comments. You are right: we inadvertently mischaracterized the coordinate system in the original manuscript. In fact, we used an S-coordinate system in which cell heights vary vertically to provide increased resolution near the surface and bottom.

We employ the COAWST model, which uses an S-coordinate system in the vertical direction with increased resolution near the surface and bottom layers (Song and Haidvogel, 1994). This vertical layering allows cell heights to vary, enabling finer resolution in dynamically important regions and improving performance in areas with sloping bathymetry compared to traditional sigma-coordinate systems (Bryan, 1969; Song and Haidvogel, 1994). In addition, our model includes horizontal grid refinement in the Pearl River Estuary, enhancing its ability to resolve estuarine features. As a result, the model effectively captures estuarine turbidity maxima and horizontal salinity fronts (Figures S11 and S12; see also in Supplement). During summer, multiple turbidity maxima appear near the estuary bottom (Figure S11b). These features persist in winter but with varying concentrations (Figure S12b), consistent with findings by Wang et al. (2018), Zhan et al. (2019), Zhang et al. (2021), Ma et al. (2022) and Ma et al. (2024). Horizontal salinity fronts shift upstream from high-discharge summer conditions to low-discharge winter conditions (Figures S11e–f and S12e–f), in agreement with previous studies by Zhang et al. (2021) and Ma et al. (2024). Nonetheless, compared with the S-coordinate system, models that employ vertically adaptive layering such as SCHISM (the Semi-implicit Cross-scale Hydroscience Integrated System Model; Zhang et al., 2016) or Cartesian vertical coordinates such as MITgcm (the MIT General Circulation Model; Marshall et al., 1997a, 1997b) generally perform better in regions with steep topographic gradients (Bijvelds, 2001). Therefore, future research could benefit from adopting models with higher horizontal resolution and Cartesian vertical coordinates to improve the simulation of Pearl River-derived sediment dynamics across the estuary and adjacent shelf.

The text has been revised to accurately describe the vertical grid configuration as follows: “The vertical grid uses a terrain-following S-coordinate system (Song and Haidvogel, 1994) with 20 layers and a stretching transformation for higher resolution near the surface and bottom.” We regret any confusion caused by this oversight and thank the reviewer for bringing it to our attention.

The “Cycle” model run, which examines the effect of spin-up duration, demonstrates that Pearl River–derived sediment entering and accumulating in various regions of the model domain during the first year continues to migrate southwestward into the second year. This migration is driven by the annually averaged net alongshore current, which remains predominantly directed toward the southwest. The current becomes stronger during the winter monsoon under the influence of prevailing northeasterly winds, whereas the opposing summer southerly winds are comparatively weaker.

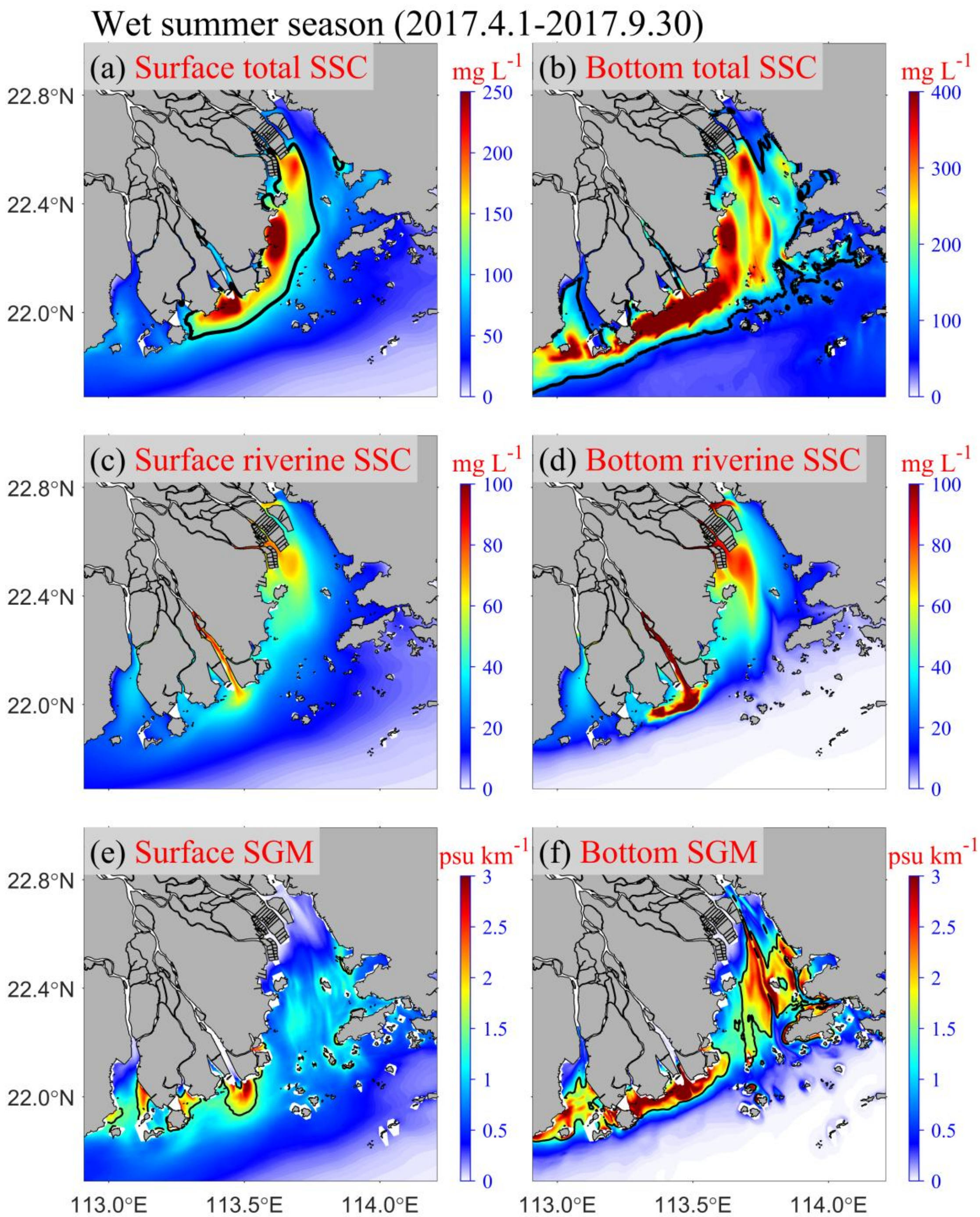

Figure S11. Summer-averaged (a–b) total suspended sediment concentration (classes 1–5 in Table 1) and the black lines mark the 100 mg L^{-1} contours, (c–d) Pearl River–derived suspended sediment concentration (classes 4–5 in Table 1), and (e–f) horizontal salinity gradient magnitude (SGM) and the black lines mark the 1.5 psu km^{-1} contours. Columns 1 and 2 represent surface and bottom layers, respectively.

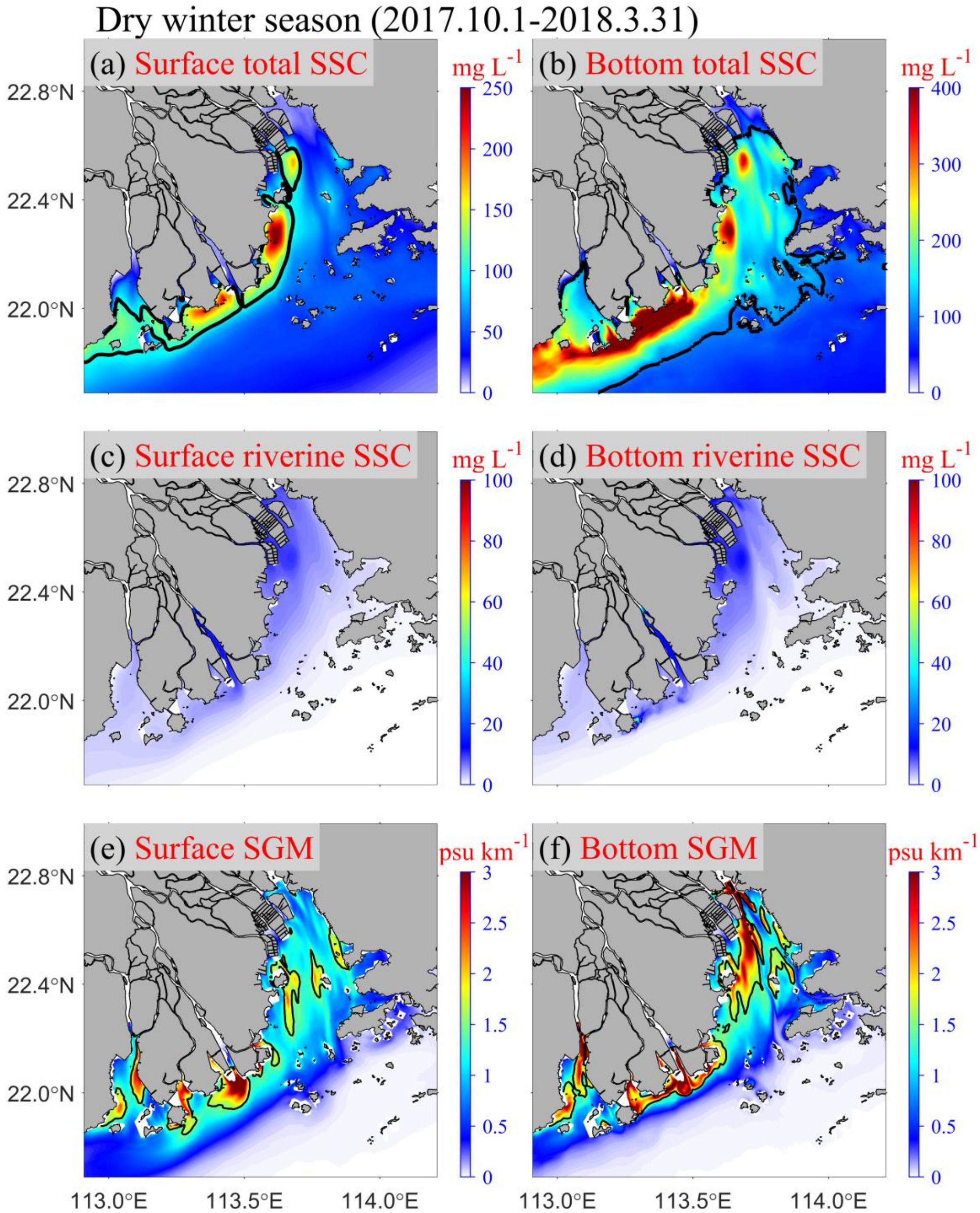

Figure S12. Same as Figure S11, but for winter-averaged ones.

3. Technical comments

The level of significance reported for measured percentages is inconsistent across the manuscript. Given the model's inherent (in)accuracy, the precision of percentage values should be adjusted accordingly. This applies particularly to the Abstract, Section 3.2, and Section 5 (Conclusions).

Response:

Thank you for the valuable suggestion. In response, we have revised the numerical expressions in the Abstract to better reflect the model's inherent uncertainty. Specifically, we now use approximate language such as "approximately two-thirds" to convey key findings without implying excessive precision. In the main text, we have also added clarifying statements to emphasize that the reported percentages are model-derived estimates based on specific simulation conditions. These changes are intended to prevent any potential misinterpretation of the results as overly precise or directly comparable to observational data.

Line 192: Song and Haidvogel (1994) introduce a new s-coordinate system, not the general sigma-coordinate system introduced in the manuscript. It is unclear which system is actually used and what the two θ-values are, as these are not explicitly described in Song and Haidvogel (1994). Please clarify and revise accordingly.

Response:

We sincerely appreciate the reviewer's careful reading and insightful comment. You are right; we inadvertently mischaracterized the coordinate system in the original manuscript. In fact, we used an S-coordinate system. The text has been revised to accurately describe the vertical grid configuration as follows: "*The vertical grid used a terrain-following Sigma S-coordinate system (Song and Haidvogel, 1994) with 20 layers and a stretching transformation for higher resolution near the surface and bottom.*" We regret any confusion caused by this oversight and thank the reviewer for bringing it to our attention.

Lines 303-305. The statement "The realistic spin-up greatly reduced the irregularities and prepared a more suitable seabed sediment particle size distribution field for subsequent simulations than the initial prototype (Figures 2d-f vs. 2g-i)." needs further clarification. Could you elaborate on why this "realistic reworking" is necessary and why it results in a more suitable initial sediment distribution? The figures suggest the presence of spurious oscillations in the model interior and near the open southern boundary, which raises concerns.

Response:

Thank you for the helpful comment. We agree that further clarification of the spin-up procedure is warranted. The "realistic spin-up" refers to a 15-month model integration using the coupled hydrodynamics (ROMS), wave (SWAN), and sediment transport (CSTM) components. This process allows the initial, idealized sediment distribution to evolve under realistic dynamic forcing, including tides, waves, and currents, thereby minimizing artificial gradients or unrealistic spatial patterns that may arise due to limitations in the number, representativeness, and timing of field sediment sampling relative to the model start date. As a result, the sediment field after spin-up (Figures 2g to 2i) exhibits spatial patterns that are more physically plausible and better aligned with the hydrodynamic context of our study region. In response to the reviewer's concern about spurious features, the observed patterns are indeed located near the open southern boundary, where water depths are relatively large. These areas lie well outside our primary region of interest—the Pearl River Estuary and its adjacent continental shelf. As shown in Figure 1 and Figure S1a, the deep bathymetry in this boundary zone can occasionally amplify numerical noise. However, these features are geographically distant and exert minimal influence on sediment dynamics within our focus area. The modeled grain size distributions and bottom shear stress fields across the core domain remain robust and unaffected by these peripheral boundary effects.

To improve clarity, we have revised the manuscript as follows:

The initial prototype field underwent a 15-month spin-up period (from January 1, 2016, to March 31, 2017), during which the bottom sediment composition evolved under realistic hydrodynamic forcings from the ROMS, SWAN, and CSTM models. This method has been utilized in numerous previous studies, including those by Bever et al. (2009), van der Wegen et al. (2010), and Zhang et al. (2021). This process allows the initially idealized sediment distribution to evolve under realistic dynamic forcings, including tides, waves, and currents, thereby minimizing unreasonable spatial patterns introduced by the Kriging interpolation method. Such unreasonable spatial patterns may arise due to limitations in the number, representativeness, and timing of field sediment samples relative to the model start date. As a result, the sediment field after *the spin-up period (Figures 2g–i) exhibits spatial patterns that are more physically plausible and better aligned with the hydrodynamic conditions of the study region.*

Line 483-487. The precise definition of a "river plume" is unclear. How is it quantitatively defined, and what correlation does it have with regions of high suspended sediment concentration (SSC)? Additionally, a more in-depth analysis of the freshwater plume's role in transporting riverine sediment—relative to the overall sediment transport—would strengthen this section. Could you expand on this aspect?

Response:

Thank you for this insightful comment. In our study, we define the river plume based on surface salinity, using a threshold of 33.5 psu to delineate the plume boundary. This definition is strictly salinity-based and independent of suspended sediment concentration (SSC). However, there is indeed a seasonal correlation between the river plume and high surface SSC. During the summer, when river discharge is high and water column stratification is strong, surface SSC is primarily influenced by advection from the buoyant river plume. In these conditions, high SSC regions closely align with the freshwater plume, as sediment is efficiently transported by the low-salinity, high-momentum freshwater outflow. In contrast, during winter, when river discharge is low and vertical mixing is more intense, the correlation between the plume and SSC is much weaker. In this season, SSC is largely governed by resuspension processes driven by strong winds and waves, rather than by freshwater transport. We have added clarification on this point in the revised manuscript and expanded the discussion of the river plume's seasonal role in sediment transport to better reflect its relative contribution across different regimes.

Line 493: Please explain how the sediment flux is determined. Is it computed purely as advective horizontal transport, or are other processes included? Please specify.

Response:

Thank you for the insightful comment. We have revised the main text to clarify this point. The sediment flux in our study refers specifically to the depth-integrated horizontal advective transport of riverine sediment. It is calculated as the product of the horizontal velocity field and the suspended sediment concentration, integrated over the water column. This calculation does not include vertical fluxes or other processes such as settling or resuspension, which are accounted for separately within the model framework. The clarification has been added to the manuscript for transparency.

Line 541. Figure 6 shows significant salinity gradients near the estuary, which suggests the potential formation of an estuarine turbidity maximum (ETM). Is such an ETM captured in the model? If so, could you comment on its role in sediment transport within the system?

Response:

Thank you for this insightful comment. As you noted, our model has been well validated and demonstrates good skill in reproducing suspended sediment concentrations. Although the primary focus of this study is on the dispersal of Pearl

River-derived sediment over the continental shelf, the model does indeed capture the formation of estuarine turbidity maxima (ETMs) within the estuary. Recent studies by Ma et al. 2024 have thoroughly investigated the seasonal evolution and spatial connectivity of multiple ETMs in the PRE. While our original intention was not to revisit those previously addressed topics, your comment highlights an important aspect of the sediment dynamics. In response, we have now included the modeled ETM results in the Supplement and have cited the relevant literature by Ma et al. (2023, 2024) to provide proper context. Additionally, we have revised the manuscript and Supplement to reflect these updates.

References

Ma, M., Zhang, W., Chen, W., Deng, J., and Schrum, C.: Impacts of morphological change and sea-level rise on stratification in the Pearl River Estuary, Frontiers in Marine Science, Volume 10 - 2023, 10.3389/fmars.2023.1072080, 2023.

Ma, M., Porz, L., Schrum, C., and Zhang, W.: Physical mechanisms, dynamics and interconnections of multiple estuarine turbidity maximum in the Pearl River estuary, Frontiers in Marine Science, Volume 11 - 2024, 10.3389/fmars.2024.1385382, 2024.

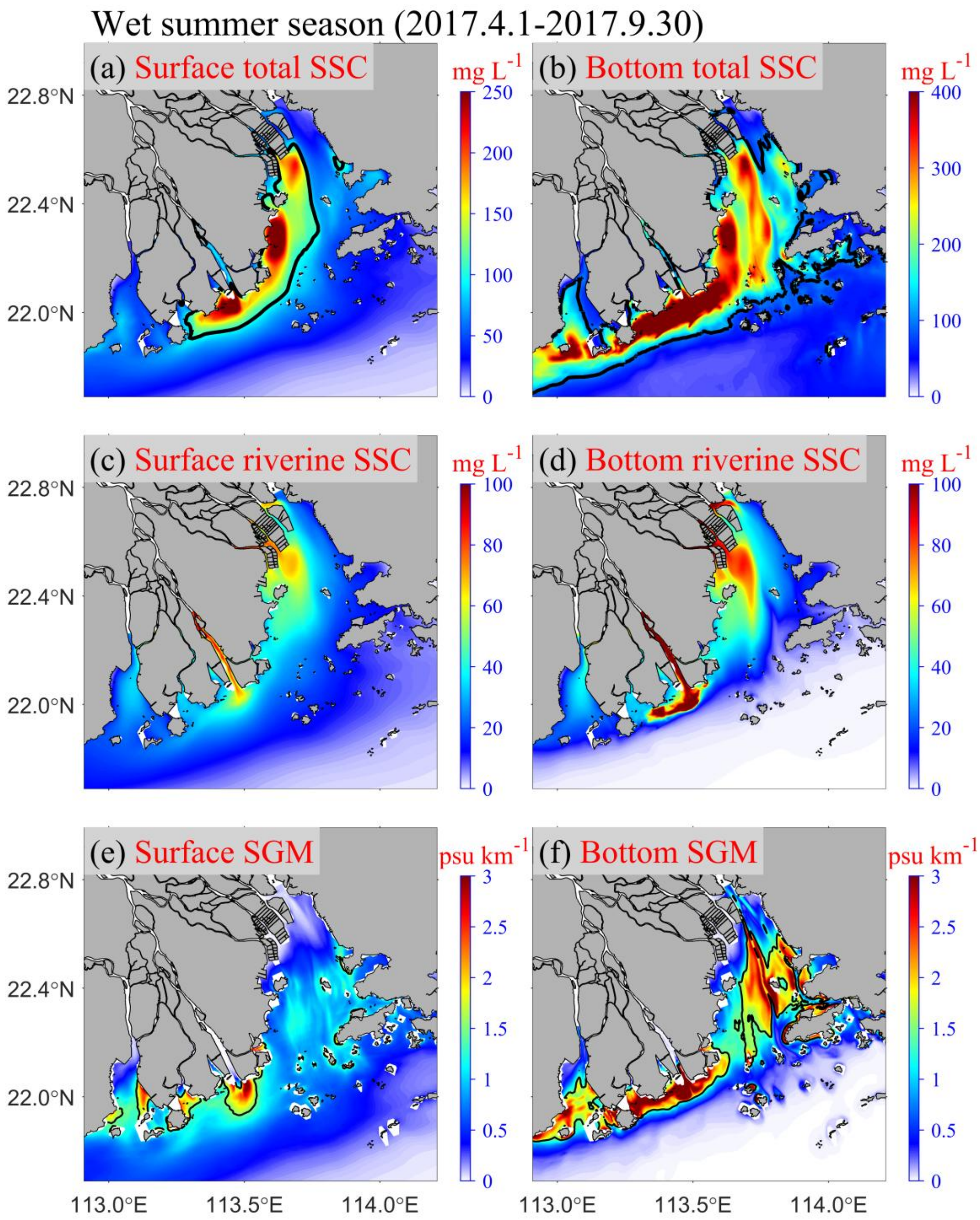

Figure S11. Summer-averaged (a–b) total suspended sediment concentration (classes 1–5 in Table 1) and the black lines mark the 100 mg L^{-1} contours, (c–d) Pearl River–derived suspended sediment concentration (classes 4–5 in Table 1), and (e–f) horizontal salinity gradient magnitude (SGM) and the black lines mark the 1.5 psu km^{-1} contours. Columns 1 and 2 represent surface and bottom layers, respectively.

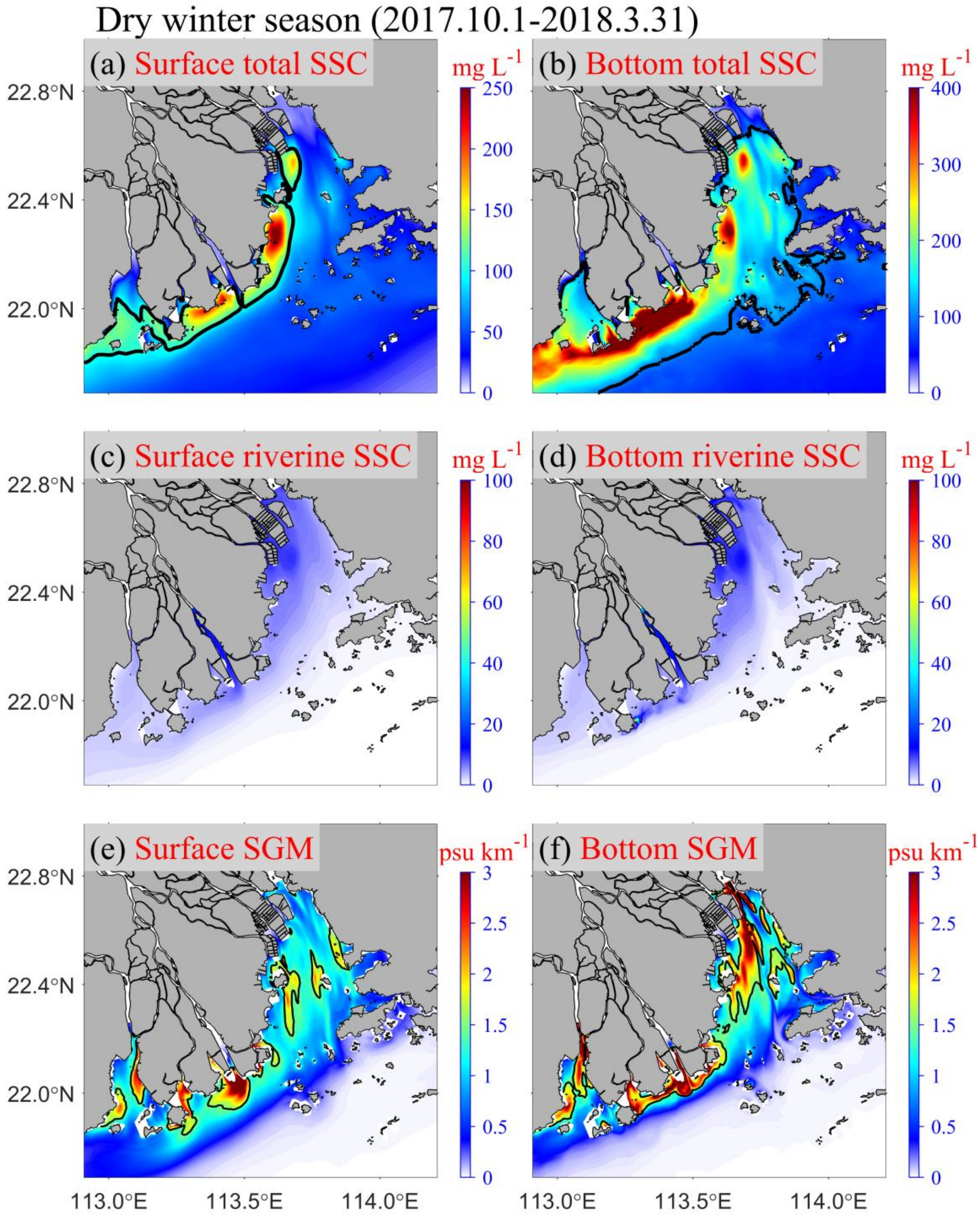

Figure S12. Same as Figure S11, but for winter-averaged ones.

Line 639: the term “probably being artefacts” is vague. Could you clarify what kind of numerical artifacts these are? While they appear as local deviations in deeper regions, they span several kilometres and multiple grid cells. Given their scale, could they significantly influence hydrodynamics across the domain? Furthermore, how does this uncertainty impact confidence in the NAS model results? A more detailed explanation would be helpful.

Response:

Thank you for your thoughtful comment. We agree that our previous wording may have been unclear. We have revised the text for clarity. The regions showing abnormal values are not located on the continental shelf, but rather in the deeper areas near the southern boundary of the model domain, where water depths exceed 200 m. As such, the changes in bottom stress observed in these localized zones, although spanning several kilometers and grid cells, occur far from the areas influenced by Pearl River-derived sediment. Therefore, they do not significantly impact the nearshore or shelf-scale sediment dynamics that are the focus of this study.

Additionally, we acknowledge that the term "overestimations" may misleadingly imply comparison with observational data, which is not available for bottom stress validation in this context. To avoid misinterpretation, we have revised the phrasing to clarify that the differences are relative to the Control model run rather than against field observations. The revised text now reads:

Some pronounced deviations are noted in localized deeper areas near the southern boundary of the domain (Figures 8e-f). These deviations, likely arising from boundary condition effects, are situated far from the Pearl River-derived sediment distribution areas (Figures 5-6). Consequently, they do not influence the dynamics of the Pearl

River-derived sediment transport over the continental shelf (Figures 8e-f).

Line 694+733. Figures 9 and 10 include arrows that are somewhat unclear. While the colours indicate differences between model runs, it appears that the arrows represent only the non-Control run. Could you clarify their specific purpose and whether they provide a direct comparison with the Control case?

Response:

Thank you for your comment. Specifically, Figures 9 and 10 present the seasonal surface currents and the differences in suspended sediment concentration (SSC) between the control and sensitivity runs. The colors indicate riverine SSC differences between model runs, while the arrows represent surface currents from the non-Control runs. We need to show both the circulation patterns in each experiment and the differences in riverine SSC relative to the Control run. Because the experiments in Figure 10 use the same hydrodynamics as the Control run, comparing Figures 9 and 10 reveals the circulation differences between NTS, NWS and NAS and the Control case. This presentation style has been used in previous studies. For example, Xue et al. (2012) illustrated current velocity and SSC differences in their Figures 5 and 6 by comparing experimental cases with the Control run on the Mekong River Shelf. We fully acknowledge your concern and have therefore enlarged the arrows in Figures 9 and 10 to more clearly depict the flow fields in each case. This adjustment improves the clarity of the figures and enhances the overall coherence of the descriptions.

References

Xue, Z., He, R., Liu, J. P., and Warner, J. C.: Modeling transport and deposition of the Mekong River sediment, Continental Shelf Research, 37, 66-78, 10.1016/j.csr.2012.02.010, 2012.

Lines 728-731 describe the deposition seen in Figure 11f but provide no reason for it by the driving hydrodynamics. To me, it is unclear why the sediment distribution would change. What is the process behind this? Does this not provide us with the conclusion that a more complete sediment spin-up, as performed in Cycle, is necessary for robust results?

Response:

Thank you for the thoughtful comment. We agree that the driving hydrodynamic processes behind the sediment redistribution shown in Figure 11f were not clearly explained in the original text. In the Cycle experiment, the initial conditions for the five sediment classes were established using the Class 1–5 sediment suspensions and depositions from the end of the Control run on March 31, 2018, thereby initiating a second control simulation. The new riverine sediment input and its transport processes during the Cycle experiment are nearly identical to those in the Control run. Therefore, compared to the Control run, the Cycle experiment specifically focuses on evaluating the impact of the presence of pre-existing Pearl River-derived sediments on estimates of riverine SSC and the annual seabed riverine sediment budget in the second year.

To clarify, the observed changes are primarily driven by the annually averaged net alongshore current, which remains predominantly southwestward. This current intensifies during the winter monsoon, dominated by northeasterly winds, while the summer southerly winds are comparatively weaker. Consequently, sediments deposited during the first year are resuspended and transported farther southwestward during the second year. Thus, the sediment distribution changes observed in the Cycle experiment are attributable to this annually persistent, seasonally modulated hydrodynamic forcing. Furthermore, we fully agree with the reviewer's observation that these results emphasize the importance of incorporating pre-existing sediments through a more comprehensive spin-up process, as demonstrated in the Cycle experiment. Excluding previously deposited sediments may constrain the model's capacity to represent long-term sediment transport and accumulation. We will revise the manuscript to clearly describe these processes and explicitly link the hydrodynamic drivers to the sediment redistribution shown in Figure 11f.

Line 793. The caption of Figure 12 explains the significance of magenta values, but it is unclear what the other values (black, blue, red) represent. Could you specify their meaning?

Response:

Thank you for pointing this out. We acknowledge that the previous caption was not clearly written, and we have now updated it for better clarity. Additionally, we have revised Figure 12 by removing the separate percentage labels for sediment Class 4. Readers can now derive the Class 4 retention percentage by subtracting the Class 5 percentage (blue) from the combined Classes 4 + 5 percentage (black). We believe this adjustment streamlines the figure while still allowing readers to access all necessary information. The revised Figure 12 and its caption now read:

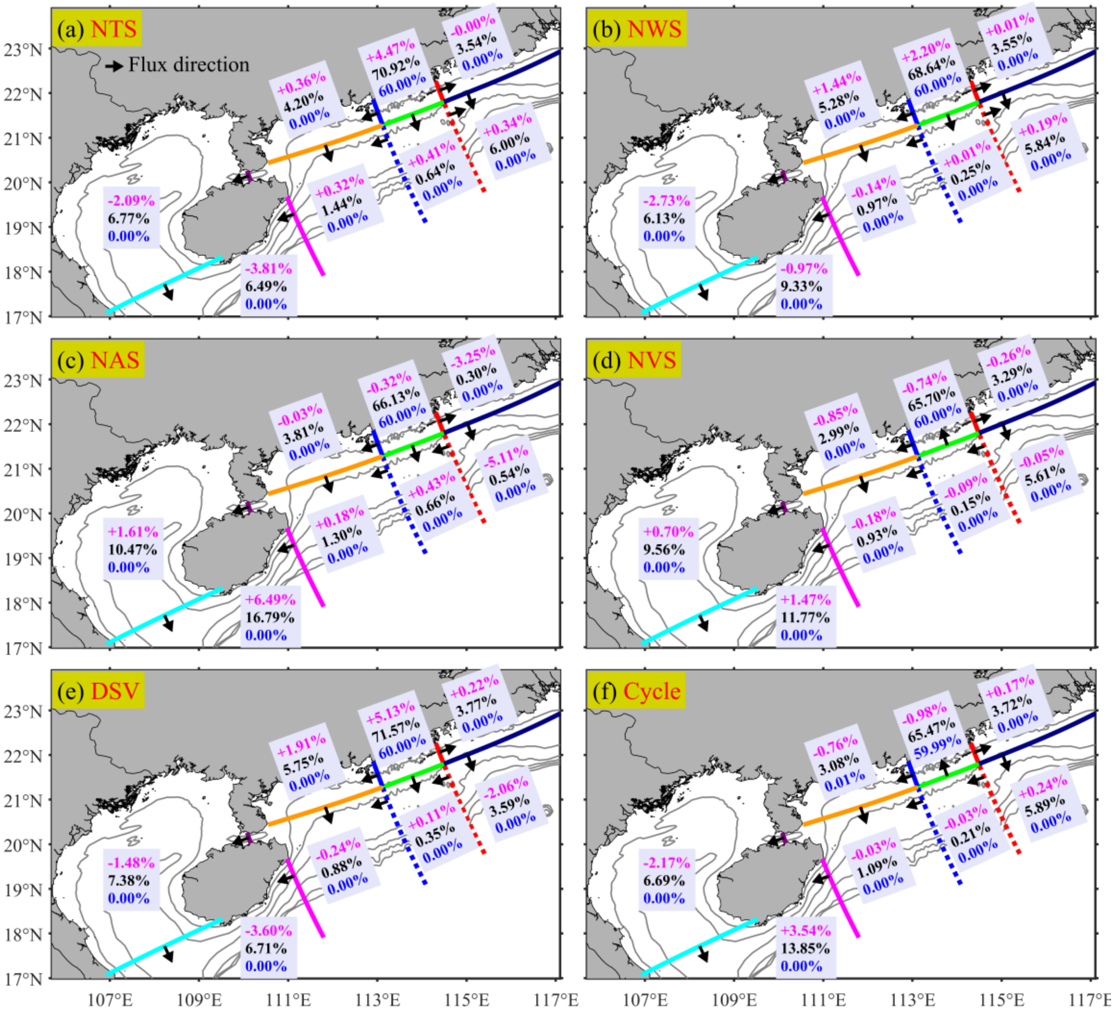

Figure 12. Same as Figure 7c, but for the other six cases: (a) NTS, (b) NWS, (c) NAS, (d) NVS, (e) DSV, and (f) Cycle, respectively. All percentages shown in the figure are expressed relative to the annual riverine sediment load (see Fig. 3a). Magenta values denote the differences in retention percentage of riverine sediments (Classes 4 and 5; Table 1) between the Control run and each sensitivity case. Black values represent the combined retention of Classes 4 + 5, while blue values indicate Class 5 alone. To obtain the retention percentage for Class 4, simply subtract the Class 5 percentage (blue) from the combined Classes 4 + 5 percentage (black).

4. Textual remarks

Line 25: The term “distal retention” may not be appropriate in this context. If sediment is never transported to distal regions in the first place, it does not necessarily imply a lower distal retention. Consider rephrasing for clarity.

Response:

Thank you for pointing this out. We agree that the term “distal retention” may have caused confusion in this context. We have revised the sentence to remove this ambiguous expression and improve clarity.

Line 219: The abbreviation Hsig appears without an introduction. If it refers to significant wave height, please define it properly when first mentioned.

Response:

Thank you for pointing this out. We have revised the text to properly define the abbreviation. The updated sentence now reads: “*This exchange included significant wave height (Hsig), surface peak wave period, mean wave direction and length, wave energy dissipation, and the percentage of breaking waves from SWAN to ROMS, as well as water level and current from ROMS to SWAN.*”

Line 298: I am not sure what “realistic reworking” means, could you explain or rephrase?

Response:

Thank you for the comment. By "realistic reworking," we refer to the natural redistribution of initially idealized sediment distribution through physical processes such as tides, waves, and currents during the spin-up period. This reworking allows the sediment field to adjust to the prevailing hydrodynamic conditions, resulting in spatial patterns that are more physically plausible and representative of natural sediment dynamics. To improve clarity, we have revised the manuscript as follows:

The initial prototype field underwent a 15-month spin-up period (from January 1, 2016, to March 31, 2017), during which the bottom sediment composition evolved under realistic hydrodynamic forcings from the ROMS, SWAN, and CSTM models. This method has been utilized in numerous previous studies, including those by Bever et al. (2009), van der Wegen et al. (2010), and Zhang et al. (2021). This process allows the initially idealized sediment distribution to evolve under realistic dynamic forcings, including tides, waves, and currents, thereby minimizing unreasonable spatial patterns introduced by the Kriging interpolation method. Such unreasonable spatial patterns may arise due to limitations in the number, representativeness, and timing of field sediment samples relative to the model start date. As a result, the sediment field after the spin-up period (Figures 2g–i) exhibits spatial patterns that are more physically plausible and better aligned with the hydrodynamic conditions of the study region.

Line 495: The sediment flux is not strictly westward and eastward. Please consider rephrasing for accuracy.

Response:

Thank you for the suggestion. We agree that the original wording was not sufficiently accurate. We have revised the sentence to: "*The riverine sediment exhibits both southwestward and northeastward fluxes (Figure 5e).*"

Line 502 and 504. The units used for sediment flux are not correct -> g/m/s

Response:

We appreciate your careful review. This was indeed a typographical error, and we have now corrected it accordingly.

Line 524: The term "salinity front" is somewhat vague. Does this refer to a specific isohaline? Please clarify.

Response:

Thank you for the comment. We agree that the term "salinity front" could be more clearly defined. We have revised the sentence for clarity as follows:

The expansion of the Pearl River buoyant plume is constrained to the southwestward direction by strong northeasterly winds (Figure 6a), resulting in a narrow cross-shore width of the buoyant plume and the formation of a strong horizontal salinity gradient (i.e., a salinity front, particularly within the 30–33.5 psu range shown in Figure 6a) outside the estuary (Figure 6a). Flow velocity increases near this salinity front, facilitating the westward extension of the buoyant plume through the Qiongzhou Strait into the "Gulf" region.

Line 542. Figure 6e: “2D riverine Flux” is unclear phrasing to me. Perhaps “Horizontal sediment flux” would be a more precise alternative, as “riverine” may be ambiguous without additional context..

Line 542. Figure 6f. The term “riverine Deposition reworking” is unclear. Consider rephrasing to include “difference,” “change,” or another term that better captures the intended meaning.

Response:

Thank you for the helpful suggestions. In response, we have revised the subplot titles in Figures 5e and 6e from “2D riverine Flux” to “Horizontal riverine sediment flux” for improved clarity and precision. The figure captions have also been updated to specify that this refers to the depth-integrated horizontal flux of riverine sediment (corresponding to classes 4 and 5 in Table 1). Additionally, the title in Figure 6f has been changed from “riverine Deposition reworking” to “Riverine sediment deposition change” to more accurately reflect the intended meaning.

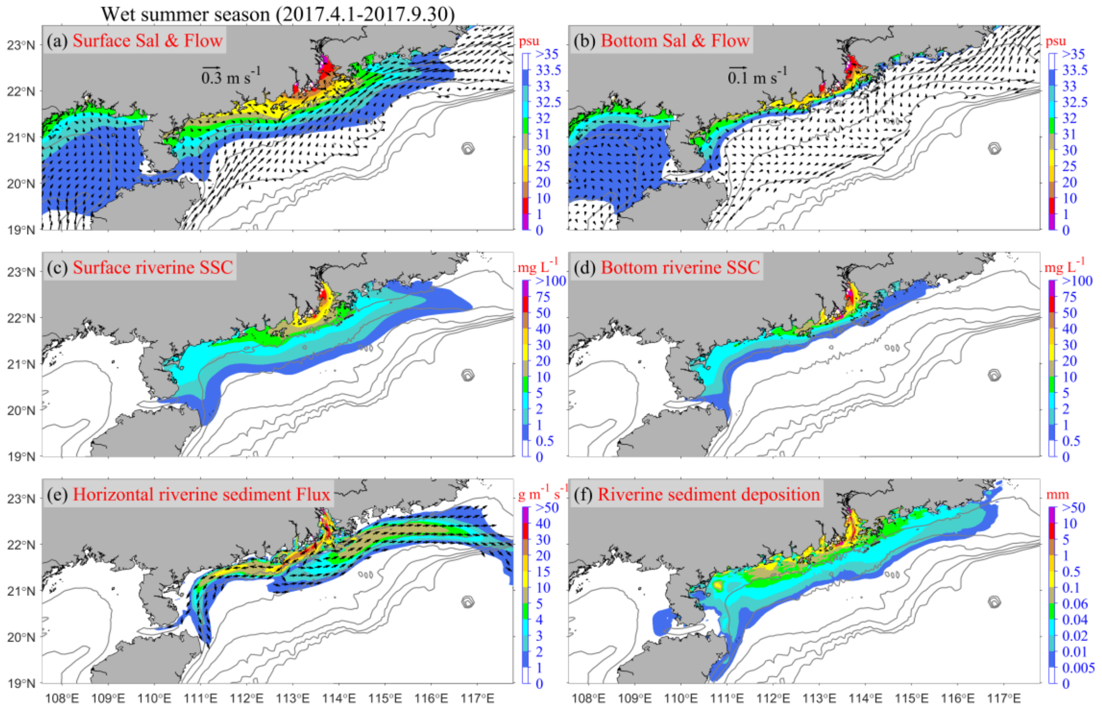

Figure 5. Patterns averaged over the entire wet summer season in the Control case: (a) surface and (b) bottom salinity (color, psu) and flow (arrows, m s^{-1}); (c) surface and (d) bottom riverine (classes 4 and 5 in Table 1, as follows) SSC (mg L^{-1}); (e) depth-integrated horizontal riverine sediment transport rate (color, g m^{-1} s^{-1}) and direction (arrows); and (f) riverine sediment deposition thickness (mm) on the seabed during the wet summer season. Flow vectors in regions with water depths exceeding 100 m are masked for clarity.

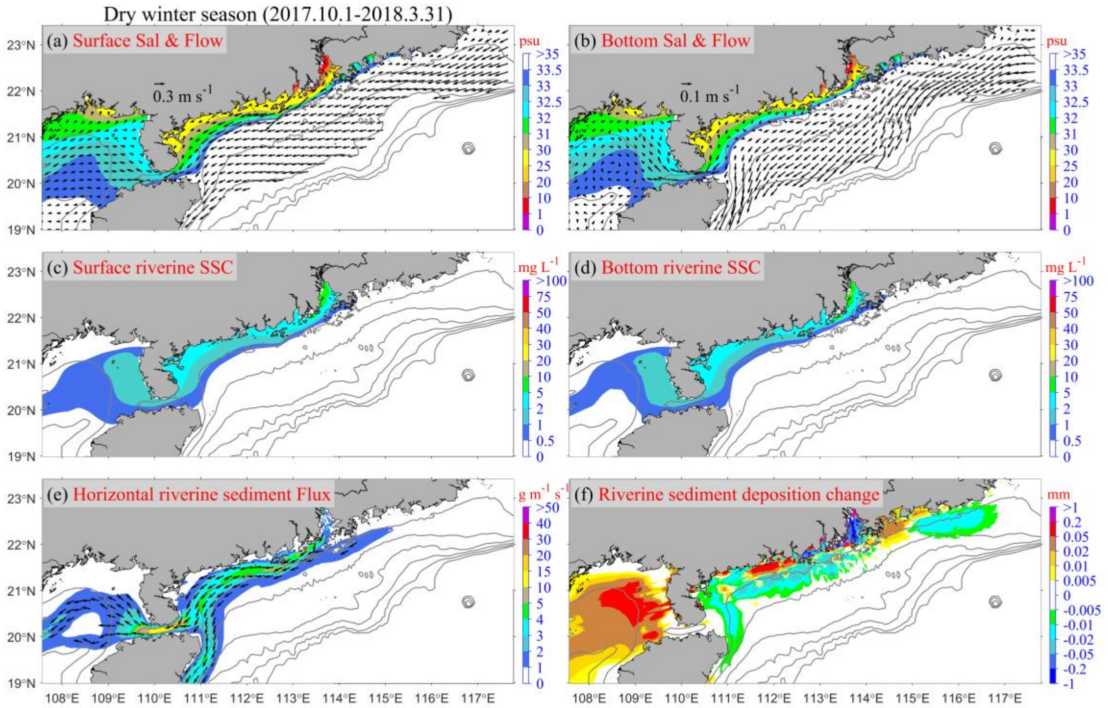

Figure 6. Same as Figure 5, but for the dry winter season in the Control case. Notably, (f) illustrates the changes in riverine sediment deposition (classes 4 and 5 in Table 1) on the seabed at the end of the dry winter season compared to the end of the wet summer season.

There are some inconsistencies in terminology throughout the manuscript. For example, “Distal” regions is sometimes written in quotation marks, while in other places it appears as distal regions without emphasis. Similarly, “Gulf” regions and gulf regions are used interchangeably. Please ensure consistency in terminology throughout the text.

Response:

Thank you for pointing out the inconsistency in terminology. We have carefully reviewed the manuscript and standardized the usage by consistently placing terms such as “Distal” regions and “Gulf” regions in quotation marks throughout the text for clarity and emphasis.