Response 1

I appreciate the efforts the authors have made to reply to my comments. I have several suggestions for the clear version of the manuscript.

Thanks for review's kindly suggestion, we will revise and response for follow comments point by point:

(1) the correct format of the horizontal velocity divergence should be $\nabla_h \overrightarrow{V_h}$ (?)

Response: The correct format of the horizontal velocity divergence is $\nabla_h \cdot \overrightarrow{V_h}$, which is calculated by $\nabla_h \cdot \overrightarrow{V_h} = (\frac{\partial}{\partial x}\vec{i} + \frac{\partial}{\partial y}\vec{j})(u\vec{i} + v\vec{j}) = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}$.

(2) Section 2.1 can be reorganized to describe model (and its validation) first and then the details of particle tracking.

Response: Thanks for reviewer's suggestion. Section 2.1 was reorganized to describe the model (with model validation) first then the details of particle tracking.

Line 108-111: "This model, based primarily on climatological data, was carefully verified using satellite remote sensing and long-term observations to ensure an accurate representation of the hydrodynamic properties (Fig. S3, 4). Overall, the model accurately captured the seasonal variability of the hydrodynamic features in this region and has been used in previous studies (Cai, Liu, Liu, & Gan, 2022; Chu et al., 2022b; Cui, Liu, Chen, & Cai, 2024)."

(3) Line 204, is it 'after 30 d' rather than 'after 20 d'?

Response: Thanks for reviewer's reminder. We mentioned that almost 80% of the particles will leave the estuary seaside boundary with 20-day. Thus, we adopt the transition matrix of 20-day results in this paper to show the details of particle mass in estuary. The typo in '30-day' have corrected into '20-day' in the revised manuscript.

Line 122-123: "Particles were released every two days and tracked for 20 days."

Line 168-170: "Using the trajectories of the released particles within 20 days, we explored the final evolved state, which is used to quantify the accumulation targets, as a result of the complex hydrodynamics of estuarine circulation."

(4) correct the label in panel (d) of Figure 5 and the labels in the lower panels of Figure 7.

Response: Thanks very much. We have corrected the typo in the revised paper.

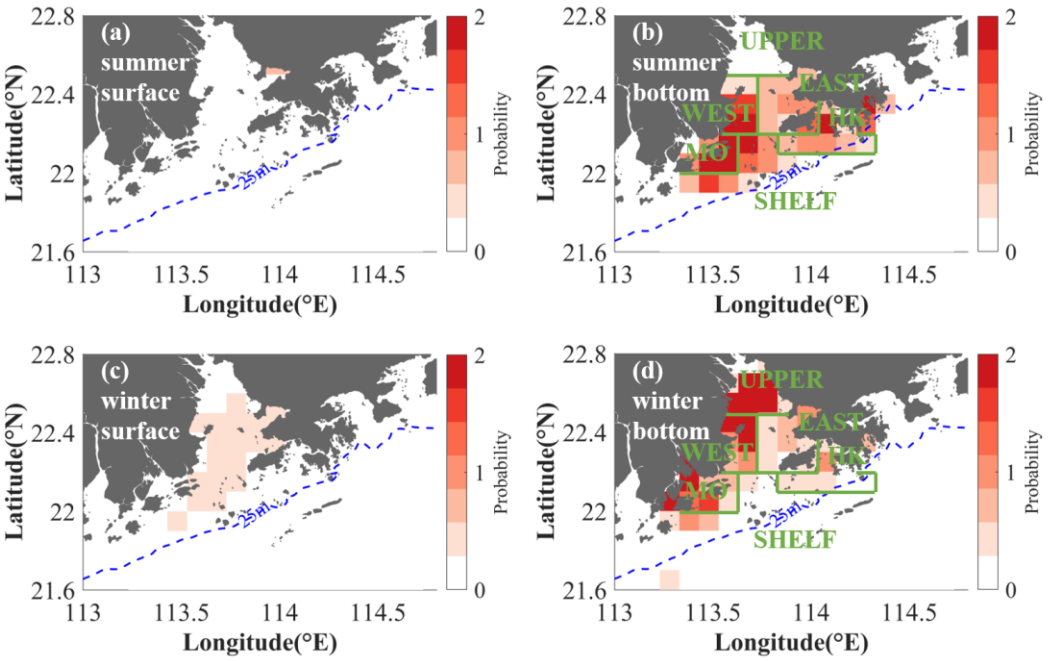

Figure R2: (a–b) Particle mass (color, D^t in Eq. (2)) at the surface layer and bottom layer during summer time, respectively. The color bar indicates the magnitude of the particle mass, higher value represents stronger accumulation. (c-d) is the same as (a-b) but winter time.

(5) Line 250: PRE was introduced as a partially mixed estuary in Line 35 but here it states "as a salt-wedge estuary".

Response: Thanks for the comments. we corrected it as partially mixed estuary.

Line 34-35: "The PRE is a partially mixed estuary in which circulation is jointly controlled by river discharge, tides, wind, and topography."

Line 247-249: "The existence of a salinity front acts as a barrier to particle transport and plays an important role in accumulation regions, such as coarse particles will accumulate at the bottom salinity front (Defontaine et al., 2020; He et al., 2018; Vermeiren et al., 2016)."

(6) correct 'river discharges' in the caption of Figure 10 to be 'tide'.

Response: Thanks for reviewer's reminder. We have corrected the typo in the revised manuscript.

Line 290-291: "Figure 8: (a-b) Particle mass (D^t) anomaly in the removing tide current case during summer and winter, respectively. A negative value represents the strengthened offshore transport without tidal current."

(7) Figure 15: what are these dashed arrows?

Response: Thanks a lot. The dashed arrows in Figure 15 in previous manuscript are same with the solid arrows, which represent the water transport directions in different

season in the PRE. We corrected them both into solid arrows in the revised manuscript.

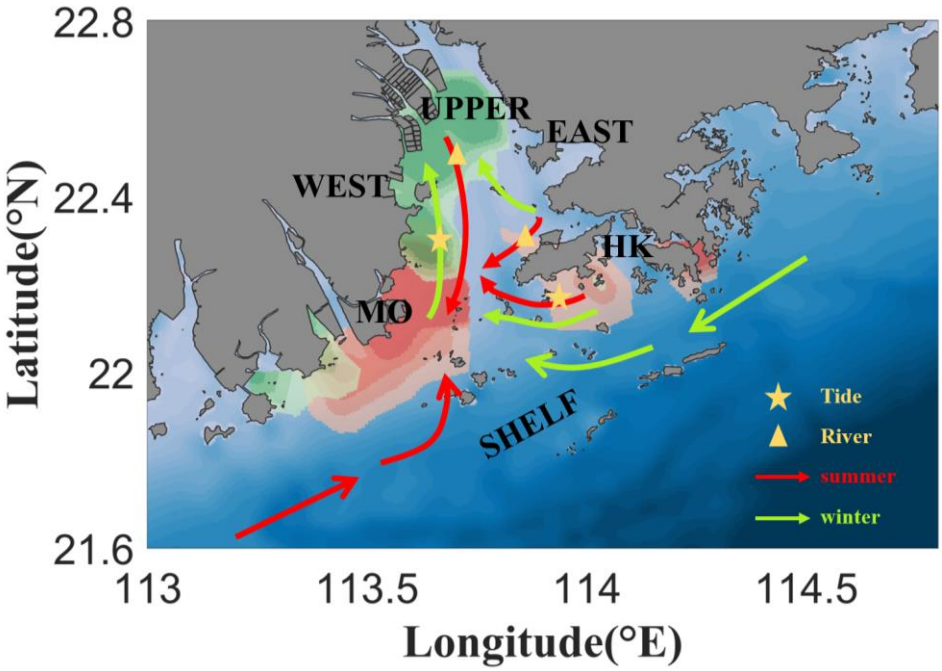

Figure R3: The accumulation connections schematic in the PRE during summer (red arrow) and winter time (green arrow). The map color in red represents the high accumulations in summer, while green represented winter. The star indicates that the tide dominated the current, and the triangle represents river discharge.

(8) In the supplementary, please add the full name of 'MUR'. Figure S3 is not mentioned in the main text.

Response: Thanks for the comment. The full name of 'MUR' is 'Multiple-scale Ultra-high Resolution', we have added in the supplementary. And Figure S3 in previous supplementary is mentioned in Line 119-120 in the revised manuscript.

Line 9-11 in the supplementary: "Figure S3: (a-b) Climatological Sea Surface Temperature (SST) anomaly during summer and winter from the Multiple-scale Ultra-high Resolution (MUR) SST reanalysis product from the Jet Propulsion Laboratory (JPL) of NASA (2002-2021). (c-d) are the same as (a-b) but for the model results."

(9) The authors may consider put some figures into the supplementary, such as those velocity field.

Response: Thanks for reviewer's suggestions. We have put all velocity field in the supplementary in the revised version, the related description in the manuscript has revised.

(10) More efforts could be made to improve the languages

Response: Thanks for reviewer's comments. We have carefully checked the languages in the manuscripts and improved some expression.

Reference:

Cai, Z., Liu, G., Liu, Z., & Gan, J. (2022). Spatiotemporal variability of water exchanges in the Pearl River Estuary by interactive multiscale currents. *Estuarine, Coastal and Shelf Science, 265*, 107730. doi:https://doi.org/10.1016/j.ecss.2021.107730

Chu, N., Liu, G., Xu, J., Yao, P., Du, Y., Liu, Z., & Cai, Z. (2022). Hydrodynamical transport structure and lagrangian connectivity of circulations in the Pearl River Estuary. *Frontiers in Marine Science, 9*. doi:10.3389/fmars.2022.996551

Cui, L., Liu, Z., Chen, Y., & Cai, Z. (2024). Three-Dimensional Water Exchanges in the Shelf Circulation System of the Northern South China Sea Under Climatic Modulation From ENSO. *Journal of Geophysical Research: Oceans, 129*(4), e2023JC020290. doi:https://doi.org/10.1029/2023JC020290

Defontaine, S., Sous, D., Tesan, J., Monperrus, M., Lenoble, V., & Lanceleur, L. (2020). Microplastics in a salt-wedge estuary: Vertical structure and tidal dynamics. *Marine pollution bulletin, 160*, 111688. doi:https://doi.org/10.1016/j.marpolbul.2020.111688

He, Q., Zhan, H., Cai, S., He, Y., Huang, G., & Zhan, W. (2018). A New Assessment of Mesoscale Eddies in the South China Sea: Surface Features, Three-Dimensional Structures, and Thermohaline Transports. *123*(7), 4906-4929. doi:https://doi.org/10.1029/2018JC014054

Lu, Z., & Gan, J. (2015). Controls of seasonal variability of phytoplankton blooms in the Pearl River Estuary. *Deep Sea Research Part II: Topical Studies in Oceanography, 117*, 86-96. doi:https://doi.org/10.1016/j.dsr2.2013.12.011

Vermeiren, P., Muñoz, C. C., & Ikejima, K. (2016). Sources and sinks of plastic debris in estuaries: A conceptual model integrating biological, physical and chemical distribution mechanisms. *Marine pollution bulletin, 113*(1-2), 7-16. doi:10.1016/j.marpolbul.2016.10.002

Wong, L. A., Chen, J. C., Xue, H., Dong, L. X., Su, J. L., & Heinke, G. (2003). A model study of the circulation in the Pearl River Estuary (PRE) and its adjacent coastal waters: 1. Simulations and comparison with observations. *Journal of Geophysical Research: Oceans, 108*(C5). doi:https://doi.org/10.1029/2002JC001451

Response 2

Second review for the manuscript

'Exploring water accumulation dynamics in the Pearl River Estuary from a Lagrangian Perspective'.

The authors have significantly improved the quality of their manuscript and have responded satisfactorily in most comments and provided appropriate clarifications wherever needed. However, there are still some ambiguities which are important to be addressed before the paper is published. In addition, I provide some comments that hopefully the authors would find useful for improving their layout.

Response: Thanks for reviewer's perceptive suggestions, we carefully revised our manuscript based on your comments and listed our responses as follow.

Major comment:

1. There is a concern regarding the use of the term probability in the figures which requires clarification. In figure 5, the authors plot D (and not D^{t_0}) which is the evolution of the initial distribution but not probability. In any case, the probability cannot be above 1. I would advise to either replace the word probability or normalize the results (e.g., by dividing with the total number of particles) so that the values remain below 1.

   Response: Thanks for the comment which helps us to further refine our manuscript. Since this and the following concerns are mainly related the calculation during Markov Chains and the meaning of different figures, we plot a schematic figure (R1) to clarity it.

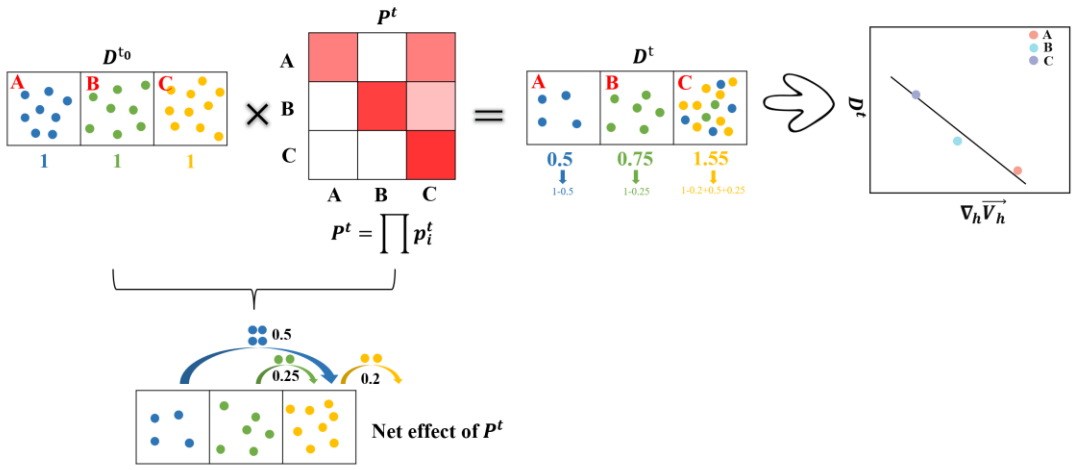

Figure R1: The schematic in the calculation of the Markov Chains.

As shown in Figure R1, the D^{t_0} represents the initial mass distribution, and its evolution was calculated from the multiplication of $D^{t_0}$with the transition matrix P^t, i.e. $D^t = D^{t_0} \times P^t$. Here the P^t is derived from the multiplication of the

probability matrix p^t within each time interval that $[t_0, t_0 + \Delta t]$,$[\ t_0 + \Delta t, t_0 + 2\Delta t]$, … $[t_0 + T - \Delta t, t_0 + T]$. The D^t is the mass distribution in future state and P^t represents net probability trend between different regions in the study area, area with high value in D^t indicates the strong accumulation target. Using the final D^t, we obtained the correlation between the regional particle mass D^t and the horizontal current divergence $\nabla_h \cdot \overrightarrow{V_h}$,

In the Figure 5 in previous manuscript, as mentioned by reviewer, the D^t was used, thus "probability" is not a proper description. Since some regions attract more particles from other regions, the value could be above 1. Following reviewer's reminder, we corrected the caption and clarified the calculation of the Markov Chains.

Line 138-142: "The D^t is the evolution of the initial condition under complicated hydrodynamic motion, which calculated from the multiplication of the D^{t_0} with the transition matrix P^t (Fig. 2). The transition matrix P^t is derived from the multiplication of the probability matrix p^t, illustrate the net probability trend between different regions in the study area. Areas with high values in D^t act as strong accumulation targets of particles."

Line 197-198: "Figure 4: Particle mass (color, D^t) at the surface layer and bottom layer during summer time, respectively. Higher value represents stronger accumulation. (c-d) is the same as (a-b) but during winter time."

2. Do the authors plot in Figure 6 accumulation probability? And is it the same with what is plotted in Figure 7? Because there seems to be a disagreement between what is plotted in figure 6 and figure 7. In figure 6, the authors plot the probability of particles moving in each region and the range of values is between 0 and 0.07. But then, in Figure 7 a and b, the range of values of accumulation probability extends between 0 and 4. How are these two figures related? Do they show both the same thing (i.e., accumulation probability)? The same concern about the probability being more than 1 applies here. Also, in Figure 6, the authors mention in the caption that the plot shows the connection between six subregions, but the legend shows probability. Please clarify these terms and modify the caption accordingly.

Response: Thanks for the comments and apology for the misleading in the captions.
In Figure 6, the P^t (Figure R1) was plotted, which shows the probability of particles moving in each region. We used it to represent the connectivity between different regions. While in Figure 7, the D^t was used illustrate the negative correlation with the net $\nabla_h \cdot \overrightarrow{V_h}$, thus the y axis ranges between 0 and 4. As reviewer reminded, they are not the same thing. In the revised manuscript, the description

of the calculation of Figure 6 and Figure 7 in previous manuscript are added, and the caption of Figure 7 in previous manuscript are revised.

Line 183: "Figure 4 shows the D^t, in which regions of high value represent the favorable targets for particles accumulation."

Line 206-207: "Subsequently, using the trajectories, the transition matrix (P^t) among each region during the tracking period is examined (Fig. 5)."

Line 227-228: "We established a connection between the average D^t in each subregion and the divergence of the horizontal current $\nabla_h \cdot \overrightarrow{V_h}$."

Line 244-245: **"**Figure 6: (a-b) Scatter plot of regional D^t against $\nabla_h \cdot \vec{V}_h$ for various subregions during summer and winter, respectively.**"**.

3. Similarly, in Figure 10 and 13 the authors mention in the captions that they plot probability anomaly. I find the word probability again irrelevant, at least based on their definition of anomaly as given in their response. Besides, probability cannot be negative. It would probably be better to remove the word probability from these figures.
Response: Thanks for your advice. Figures 10 and 13 in previous manuscript are the anomaly of D^t, not the probability. We have corrected the caption as:

Line 290: "Figure 8: (a-b) Particle mass (D^t) anomaly in the removing tide current case during summer and winter, respectively.**"**

Line 329: "Figure 10: (a-b) Particle mass (D^t) anomaly in the reducing river discharge case during summer and winter, respectively."

Minor:
1. To reduce the number of figures in your paper, I suggest the following:
- Merge the panels of Figure 3 and Figure 5
- Figure 4 can be moved in the supplementary
- Merge the panels of Figure 10 and Figure 13

Response: Thanks for your suggestions. Considering the two reviewer's suggestions, we modified figures in the previous manuscript as follow:
-Moved the figures of velocity field into the supplementary: Figure 3, Figure 9a-b, and Figure 12a-b.
-Merge the figure of vertical structure with the figure of particle mass: Figure 4 with Figure 5, Figure 9c-d with Figure 10, and Figure 12c-d with Figure 13.

2. Please add a sentence in your manuscript to describe how you define the anomaly in Figure 10 and Figure 13.

Response: Thanks for the suggestions. We added the description of anomaly in the manuscript.

Line 280: "Anomaly of D^t between the case without tides and standard case, i.e., ${D^t}_{no-tide} - {D^t}_{standard}$ is compared in Figure 8."

Line 319-320: "Similar with Figure 8, the anomaly results are calculated by using the D^t of case with reduced river discharges to subtract the D^t of the standard case (Fig. 10a, b)."

3. Please add a sentence in your manuscript with the explanation you give on your response on why you decided to focus on the bottom layers accumulation only.

Response: Thanks for the comments. We added the sentence in Line 202-204 in the revise manuscript.

Line 202-204: "Compared to the bottom layer, the quicker motion at the surface layer cannot distinctly reveal an accumulation pattern. Hence, the accumulation pattern and regional connectivity are focused on the bottom layer."

Furthermore:

1. Line 48 state instead of 'health'

Response: corrected.

2. Line 52 biogeochemical conditions instead of 'health'

Response: corrected.

3. Line 57 usually appear eutrophic.

Response: corrected.

4. Line 60 add space between sinks and (Mestres)

Response: added and thanks.

5. Line 62 remove D from Zhang

Response: corrected.

6. Line 68-71 this sentence is not very well written, please rephrase.

Response: corrected and thanks.

7. Line 97 layers instead of levels.

Response: corrected.

8. Line 101-102 I would advise to include Figure R8 in the Supplementary

Response: added and thanks.

9. Line 112 remove Elizabeth NEW

Response: corrected.

General comment: do not include authors' first name when citing papers in the

manuscript.

Response: Thanks for reviewer's suggestion. We have checked the citation and corrected them in the revised manuscript.