Dear reviewer:

   We appreciate your efforts in reviewing our manuscript and providing us with constructive comments. We have revised our paper accordingly, and the point-to-point responses to your comments are as follows.

The paper describes alternation of hydrodynamics and numerous other properties of a microtidal estuary following anthropogenic interventions to the estuary over a period of time. The paper is well written however some small changes will improve quality. As the editor have already highlighted some places that need attention to improve language I would not comment on those. The paper is extremely long with a very large number of figures.

**Response:**

Thank you for your approval and valuable comments. We have improved the language based on the editor’s comments, and tried to shorten the manuscript.   
  
**Detailed comments:**1. Considering the shape of the estuary a curvilinear model grid system can be a more favourable option. Please explain the selection of a cartesian grid; Please comment on the selected horizontal model resolution; Did you investigate the sensitivity of results to model resolution?

**Response:**

In fact we utilized a Cartesian grid in the mother grid, and a curvilinear orthogonal grid in the child grid for our nesting grid system. The Cartesian grid for MD2 is a typo, we correct this error in the revised version. Sorry for causing this misunderstanding.

The horizontal resolution of the MD2 is highest in the deep channel, about 85m, and lower at the side shoals, about 324m; The width of the channel is approximately 250 m, and a resolution of 85 m can guarantee about 3 grids in the channel. In Chen et al.’s study (2020a), the grid resolution ranged from 1.5 km in the open sea to 50 m in the deep channel, which is sufficient to resolve the hydrodynamics in the HE. The horizontal resolution in this study is similar to that in Chen et al. (2020a).

As the geometry and bathymetry are both complicated in the HE, we tried to obtain a solution to fit the coastline as accurately as possible, and to resolve the bathymetry in a reasonable way as well. The strongly convergent geometry imposes a constraint on the option of the model grid’s resolution, and the consideration of the model’s efficiency is another factor to limit the model’s resolution. Actually, we made several model grids with different resolutions, and the present one is a compromise between accuracy and efficiency. A more refined grid produces a similar result to those presented here.

As this model system has been extensively validated before (Chen et al., 2020a and 2020b) and in this study, we are confident that the model can resolve the hydrodynamics and sediment dynamics in the HE well.

2.Please explain the source of water level variation and currents at the offshore boundary in MD1;

**Response:**

The MD1, based on a 1‐D (for the river network) and 3‐D coupled model, covered the whole PRD and the coastal region with a horizontal resolution of 2 km near the open boundary and 500 m inside the PRE (Figure 1a). The Open sea boundaries for the MD1 comprised hourly tidal elevations and depth‐averaged tidal currents derived from nine tidal constituents (M2, S2, N2, K2, K1, O1, P1, Q1, and M4) taken from the global tidal circulation model (TPXO 8, http://volkov.oce.orst.edu/ tides/tpxo8\_atlas.html) with a resolution of 1/30° and daily water elevation, 3‐D temperature, salinity, and velocity data from the Hybrid Coordinate Ocean Model (https://hycom.org) with a resolution of 1/12° (Chen et al., 2020a).

Thus the sources of water level variation and currents at the offshore boundary in MD1 are: 1) tides; 2) non-tidal components by external forcings, such as winds, air pressure, water temperature, and large-scale circulation in the South China Sea.

3.Same driving conditions have been used to simulate estuarine dynamics in 1977, 1994, 2003 and 2010. Please explain possible impacts of sea level change, potential changes to river flow and salinity on the simulated results. It is possible the estuary dynamics to under some natural changes during that 40+ years, for example river flow may have changed over the years.

**Response:**

You are right. In this study, we focus on the impact of changes in bathymetry and geometry on the estuarine circulation for different years. The driving conditions are kept unchanged to distinguish the above effects. Otherwise, the effects will be a combination of those by the changes in bathymetry and by the changes in external forcings, which is hard to separate the individual effect.

Sea level rise can increase the total water depth and inundate more intertidal areas. It has an effect similar to that of channel deepening, to increase the salt intrusion and estuarine circulation. The river flow will be generally decreased in the PRD due to global warming and northward shift of the climate zone. With a decrease of the river discharge, the salt intrusion will be increased and thus the salinity gradient will be decreased, resulting in a weakened estuarine circulation in the HE. For the salinity at the offshore boundary, we are not certain whether it will be increased or decreased. It is influenced by the rain and evaporation, and the large-scale salt transport in the South China Sea. If it increases, the salinity gradient in the HE will be increased, and the estuarine circulation will be enhanced therefore. And vice versa.

Definitely, the estuary has undergone natural changes in 40+ years, such as the changes in river inflow, offshore boundary conditions. But as we mentioned, our focus is on the impact of changes in bathymetry on the estuarine circulation, and the paper has already been much lengthy, we leave the effect of other factors for future investigation. It should be noted that our model simulations are not used to reproduce exactly the historical evolution, but to reveal the underlying dynamics.

4.In your model validation, it is said that surface layer dynamics are poorly resolved by the model because surface waves and wind were not considered in the model. However, it is stated in the Numerical model set up section (Line 243, page 7) that atmospheric forcing at water surface is given as inputs to the model. Please clarify.

**Response:**

A good question. The atmospheric forcing was used on the surface of the parent model MD1 to provide good boundary conditions for the MD2 model. In the MD2 model simulations, we did not turn on the wind and wave effects for brevity. This configuration is aimed to focus on the changes in estuarine circulation forced by the tides and river flow. The effects of winds and waves are another topic and not explored in this study.

5.Fig. 3 gives ‘Patterns of the vertical-averaged horizontal circulation during neap tide’. As this is just a snapshot in a tidal cycle please specify the time. It may be good to look at flood tide and ebb tide separately.

**Response:**

Thanks. The result is the tidally averaged circulation for a neap tide. It should not be a snapshot at a specific time in a tidal cycle. As this study is more focused on estuarine circulation in a tidally-averaged sense, we chose to present the tidally averaged results. For the hydrodynamic characteristics of the HE during the flood and ebb tides, Chen et al., (2020a) have investigated the intratidal dynamic processes in detail.

6.Fig. 5,6 – Once again since these are snapshots in time, please provide the time of the tidal cycle. Also, comment on the effect of the selected model resolution when calculating vorticity.

**Response:**

The time of the tide cycle in this study is from March 10th 00:00 to 11st 00:00 (25h).

The resolution of 85m in the deep channel and 324m at the shoals in our model can simulate the vortex structure well, similar to Chen et al., (2020a).

7.Fig. 8-9- Absolute values of each term is very small. Therefore, I am not sure if looking at them separately add any value. Also, please specify the time in the tidal cycle. Do flood and ebb tide show differences?

**Response:**

Indeed, as you said, the magnitude of each term in Figures 8 and 9 is not large. This is always the case for momentum terms or vortex terms (a scaling analysis can confirm this). But the momentum or vortex transport balance analysis has been widely utilized to study the dynamics. Examining the relative importance of individual terms can identify the dominant momentum terms and distinguish the dynamical regimes, such as the Ekman flow, geostrophic flow and so on. To look at the changes of these terms, we can identify the changes of the dynamics and the associated mechanisms. For example, an increase or decrease in the baroclinic pressure gradient force can reflect the change in the gravitational circulation, and the change in the advection term is representative of the change in tidal rectification. (Lines 532-536). The sum of the advection terms in X and Z directions represents the effect of the lateral circulation. (Lines 593-594).

Again, the results we show are the tidally averaged ones, not for the intratidal variation.

Since some content expressed in Figure 8 and 7 is repeated, in order to simplify article, we have deleted Figure 8.

8.Page 36, Lines816-822 – Do you have evidence to show that river sediment is trapped in the estuary?

**Response:**

We have studied the sediment transport pattern in the HE before (Gong et al., 2014, CSR), and noted that the sediment transport pattern changes in response to the changes in river discharge and tidal mixing. Generally, there exists a sediment convergence zone in the middle of the estuary, and the riverine sediment is trapped inside the estuary to form a turbidity maximum.

9.It will be interesting to see what changes can be observed during spring tides as tidal circulation will be significantly larger than during neap tide. Please comment.

**Response:**

Thank you for your comments.

Estuarine circulation in an estuary is composed of several components: gravitational circulation by the baroclinic pressure gradient, tidal residual flow by the tidal rectification, tidal straining induced flow by the asymmetry of mixing between flood and ebb, Stokes return flow, and river flow. Generally, the gravitational circulation is weaker in spring tide than in neap tide owing to increased mixing; The tidal residual flow by nonlinear rectification would be stronger in spring tide than in neap tide by the increased nonlinearity. The strength of the tidal straining-induced flow depends on the stratification and tidal strength and varies. The Stokes return flow is stronger in spring tide than in neap tide for a progressive tidal wave, but for a standing tidal wave, the increase in tidal strength has insignificant effect.

The HE is a micro-tidal partially mixed estuary with a standing tidal wave, the estuarine circulation is mostly composed of gravitational circulation, and is stronger in neap tide than in spring tide.

We have conducted study on the changes in circulation during spring tides, and the results are briefly presented here: the longitudinal estuarine circulation during the spring tide reached a maximum in 2010 when the water depth was the largest, and like the neap tide, is dominated by the increase in the baroclinic term. The change in the lateral circulation is more complicated than that during the neap tide. In addition to the baroclinic term, the change in the vertical diffusion caused by the width change also plays an important role. For the upstream Section B1, the changes in lateral circulation is mostly controlled by the change in the baroclinic term; For the downstream Section B2, the contribution of the change in vertical diffusion becomes dominant.

**References:**

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