

For the second revision of our manuscript, we would like to thank the editor and two referees again for the positive comments and suggestions. Detailed response to all comments are given below (responses are shown in blue and relevant changes are marked in red in the revised manuscript).

Anonymous Referee #1

Comments

The points I raised are basically addressed. I have two concerns still.

1. table 2 mentioned the statistics between DO and some environmental parameters. I am curious that for samples in 2006 sep and 2001 sep, why DO showed contradictory relation with bottom S? namely 0.6637* in sep 2006 whereas -0.2953 in sep 2001. similar conflicting things also can be found for T and NO₃.

Response: Thank you for providing these comments. We have noticed that the correlations between DO and other water quality variables (including salinity, temperature, and NO₃) in the bottom waters in September 2006 were opposite to those in September 2001. Such contradictory relation suggests that the key factors controlling low-oxygen conditions in the Pearl River Estuary (PRE) were likely different between these two early-autumn periods (also with different spatial patterns of DO and low-oxygen conditions; please see Figure 8 in our manuscript). Specifically, in September 2006, the bottom DO showed a significantly positive correlation with salinity (Table 2 in our manuscript), indicating the significant impact of river discharge. As affected by the river discharge (with higher temperature and nutrient concentrations but low DO levels when compared to the seawater end-members), the bottom DO therefore had a significantly negative correlation with temperature and a significantly positive correlation with NO₃. With respect to September 2001, no significant correlation was found between the bottom DO and environmental parameters. However, it is noted that the bottom DO showed a relatively good correlation with NH₄ among the environmental factors, which implies that the low-oxygen events on the eastern side of the PRE (Figure 8b1) were mainly resulted from the sewage effluents discharged from the adjacent coastal cities (i.e. Shenzhen and Hong Kong). This could be further supported by the significant correlation between the surface DO and NH₄ (with the correlation coefficient r reaching -0.5686, $p < 0.05$; please see Table 2 in our manuscript). Collectively, the DO content was relatively low on the eastern side of the PRE, where salinity was relatively high (please see Figure r1 below). Therefore, the bottom DO exhibited a negative correlation with salinity (although not significant) overall in September 2001, which was opposite to that in September 2006.

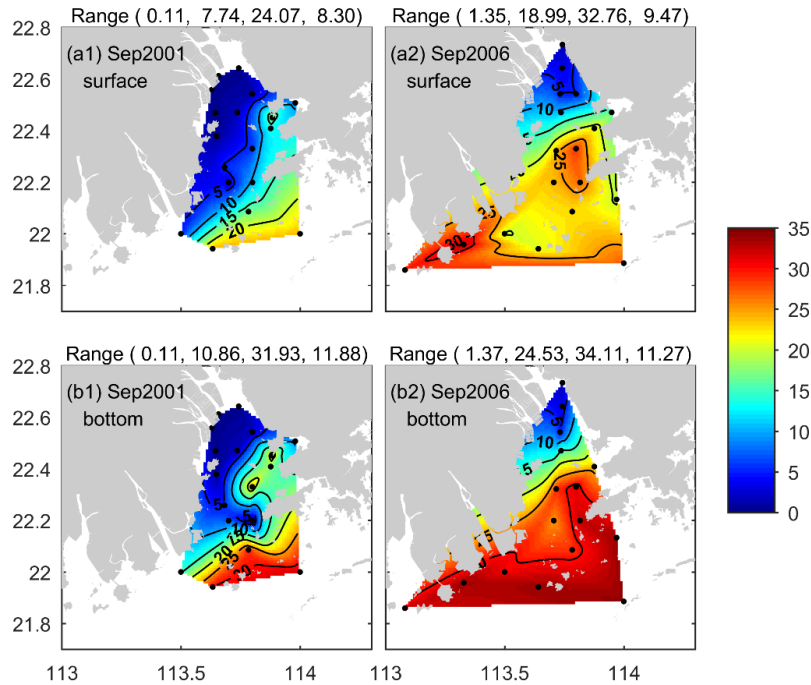


Figure r1. Salinity distributions in the (a) surface and (b) bottom waters of the PRE for September of 2001 (left panels) and 2006 (right panels).

As we have mentioned in our manuscript, the differences between September of 2001 and 2006 indicate that in the periods of early autumn, there was considerable interannual variability in the spatial extents and intensity of low-oxygen conditions (and also the underlying mechanism as discussed above). At current stage, there is still a lack of in-depth investigation on the formation processes, interannual variations and driving factors of low-oxygen conditions in the early autumn of the PRE. We urge that more attention should be paid to this issue in future studies.

Based on the reviewer's comment, we have provided more discussions on the differences between these two early-autumn periods (please see lines 367-371 in our revised manuscript).

- I suggest authors integrate and upload their 1976-2017 raw DO and environmental data that mentioned in current ms to a public repositories like figshare or any other free-downloaded and open source, in order to make the data accessible to public. Current data availability statement is strict to a few years sources (1999, 2013, 2014) while the strength of the paper, especially the title and how authors claims, clearly is based on a 1976-2017 time series data set.

Response: As suggested, we have made the observational data during 1976-2014 (Datasets 1-4 as listed in Table 1) available at <https://doi.org/10.5281/zenodo.5195759> (latest access on August 15, 2021). Please note that the oxygen data in July of 2014-2017 (Dataset 5) derived from literatures can be downloaded directly via the links provided in the corresponding literatures.

Anonymous Referee #2

Comments

I appreciated the author team answered the question very responsible, including both my review comments and reviewer 1's comments. The author has published several papers on this topic on BG, most of them are model based. Although as a pure data analysis work, the paper is kind of old style for hypoxia science overall (I guess that is why the review request of the paper was turned down by many other researchers), it still deserved being published on BG as the first piece of work compiling long-term data for PRE hypoxia. However, I think the paper has two major technique issues and should be solved thoroughly before final acceptance on BG.

Response: We wish to thank the reviewer again for the positive comments and recognition of this work. We have revised the manuscript as suggested.

(1) Figure 1: I found that figure was used by the author team multiple times in different journals.

For example:

Liang, B., Hu, J. T., Li, S. Y., Ye, Y. X., Liu, D. H., & Huang, J. (2020). Carbon system simulation in the Pearl River Estuary, China: mass fluxes and transformations. *Journal of Geophysical Research: Biogeosciences*, 125, e2019JG005012. <https://doi.org/10.1029/2019JG005012>

Figure 1 was the same as this one. That should be replot.

Response: Figure 1 did use the same base map as the one in Liang et al. (2020), which also focused on the Pearl River Estuary (PRE), but they are not exactly identical (e.g., the study area being shown). However, we have to admit that these figures still have a certain degree of similarity (especially the color map in use) and we fully understand the concerns from the reviewer and the editor. Therefore, in order to avoid the duplication, we have replotted Figure 1, using a different color map for the bathymetry with different contour levels. Please see the revised figure below.

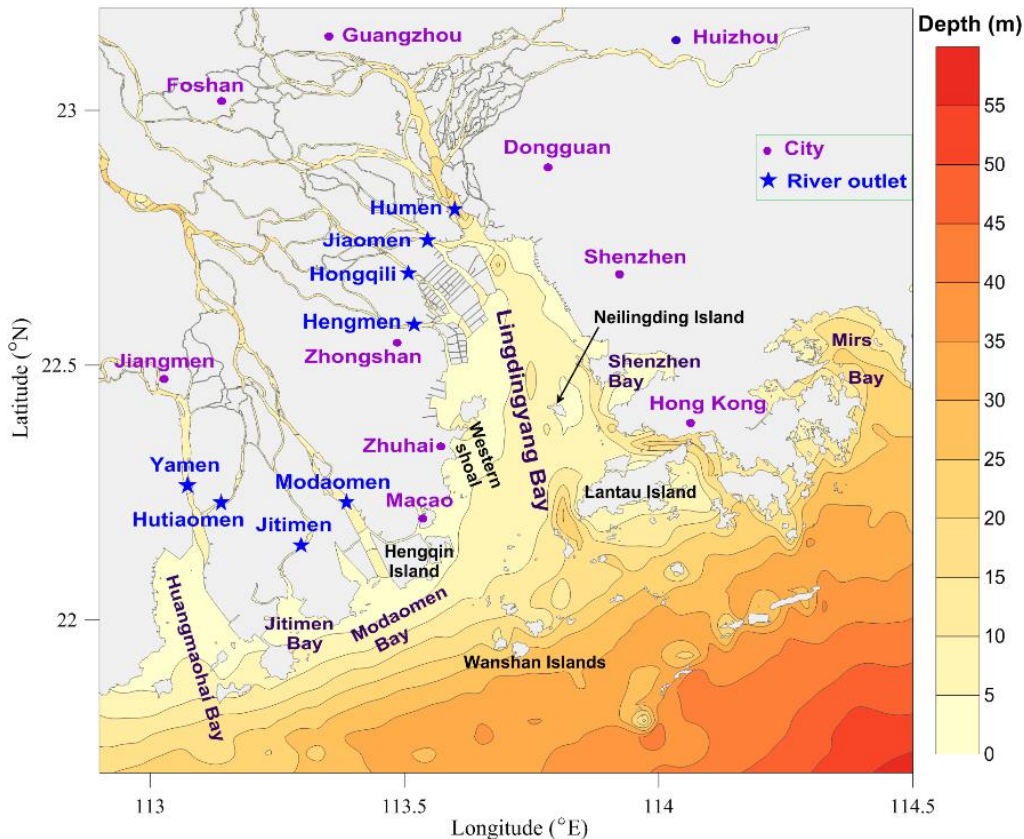


Figure r1. Map of the Pearl River estuary (PRE) and adjacent coastal waters. Note that the purple dots denote cities in the Guangdong-Hong Kong-Macao Greater Bay Area, and the blue stars indicate the locations of eight outlets of the Pearl River freshwater discharged into the PRE; Humen, Jiaomen, Hongqili, and Hengmen are typically called the eastern four river outlets, while the others are called the western four river outlets.

(2) The data conformity and availability issue. I do not think complicated method, e.g., numerical model and machine learning system, are only solutions. Although all extrapolation of oxygen data into unobserved stations will introduce uncertainties, there has been many other advanced statistical methods to solve the extrapolation problem specially

One example is:

Obenour DR, Scavia D, Rabalais NN, Turner RE, Michalak AM. Retrospective analysis of midsummer hypoxic area and volume in the northern Gulf of Mexico, 1985-2011. *Environmental Science & Technology*. 2013 Sep;47(17):9808-9815. DOI: 10.1021/es400983g. PMID: 23895102; PMCID: PMC3823027.

I believed because the observational data availability and data quality issue in Chinese coastal community. Collecting data and processing them are all really a lot of work for one piece of publication. I was OK with reviewer's response. But the author team should really make the data available on site.

The data availability statement "The in-situ observation in July 1999 and 2013-2014 will be

available at a public data storage, while “...” is not acceptable for modern top research journal these days. There should be an ftp website with last access date and checked by both reviewers. I personally felt that the data transparency issue impeded the Chinese community from promoting coastal science. A real opening data will be helpful for researchers to work together to promote the estuary-coastal ocean science to a world leading level. The Chinese community do not really lack number of papers these years, isn't it? Did hypoxia community in other parts of world learn anything from it?

Response: We totally agree with the reviewer's comments on the importance of data sharing and the issue related to data transparency. In fact, it took us several years and tremendous efforts to collect the observational data used in this study. This is not a technical issue at all, but it is a very important and basic step that enables us to promote the research progress on the long-term oxygen changes in the PRE. It is also our hope to have more data available and accessible so that we could fill the data gaps to better quantify the decadal changes in low-oxygen conditions in the PRE and clarify the key mechanisms controlling their expansions over recent years.

As suggested, we have made the observational data during 1976-2014 (datasets 1-4 as listed in Table 1) available at <https://doi.org/10.5281/zenodo.5195759> (latest access on August 15, 2021). Please note that the oxygen data in July of 2014-2017 (dataset 5) derived from literatures can be downloaded directly via the links provided in the corresponding literatures.

(3) The method part reads tedious in the new version and draw out the attention for the science itself. I noticed reviewer 1 challenged the data quality issue. I suggest move Line 111 to Line 125 to the supplementary.

Response: As suggested, we have moved lines 111-125 to the supplementary materials of our revised manuscript.

I think all other questions are answered very well.

Response: Thank you for your support.