Responses to comments by Reviewer #2

We thank Dr. Lewis's comments of our work. In this rebuttal, we have addressed all the comments formulated by the Reviewer by replying (in black) to his remarks (in blue).

General comments:

A very interesting study, with applications to all "downstream consequences from land management practice (e.g. reservoirs, hydro-electric, flood risk mitigation). I think the article is great and worthy of publication, but I have some concerns – listed below. Applying an analytical model to find the downstream change to volume of a river due to upstream water collection (the three gorges dam) is neat – but I am unsure how this can be used to assess impact to biology.

Our reply: Thanks a lot for the reviewer's positive evaluation of our manuscript. Due to the fact that in this study we mainly focus on the impacts of freshwater regulation of TGD on spatial-temporal patterns of tide-river dynamics in the Yangtze River estuary, we did not provide details concerning the TGD's impact on biology in the paper. However, we do mention the possible influence of TGD's operation on ecology in the sections of ABSTRACT and INTRODUCTION. In particular, the results obtained from this study can further be used to assess the impacts of TGD's operation on salt intrusion (as a general predictor of the aquatic ecosystem health in estuarine environment) when combined with an ecological or salt intrusion model. This is further elaborated in the DISCUSSION part (see Section 5.4 in the manuscript). In the revised paper, we shall explicitly mention that "*However, to quantify the potential impacts of TGD's operation on salt intrusion and related aquatic ecosystem health in general, it is required to couple the hydrodynamic model to the ecological or salt intrusion model (e.g., Qiu and Zhu, 2103; Cai et al., 2015).*"

Major comments

1. Inter-annual variability. I think some effort to resolve inter-annual variability would have been nice. Standard deviation could be added to the mean values in Figure 11 - and then a conclusion of "significant change between months 7 to 11" can be made with confidence. At present such a statement cannot be made: Significant compared to what? Where is the test of significance? At best the authors can say "the change in the mean is clear for months 7-10". If Table 2 had more data added, i.e. how the monthly mean changes each year – it would be nice. Certainly the data is sufficient (it spans multiple years), and so the inter-annual variability can be added to Figure 11. That said, perhaps the authors can defend my comment here?

Our reply: We thank the reviewer for this comment. Indeed, it is better to resolve the inter-annual variability. In the revised paper, we shall include the standard deviation information in Figure 11 (see Figure R1 below).

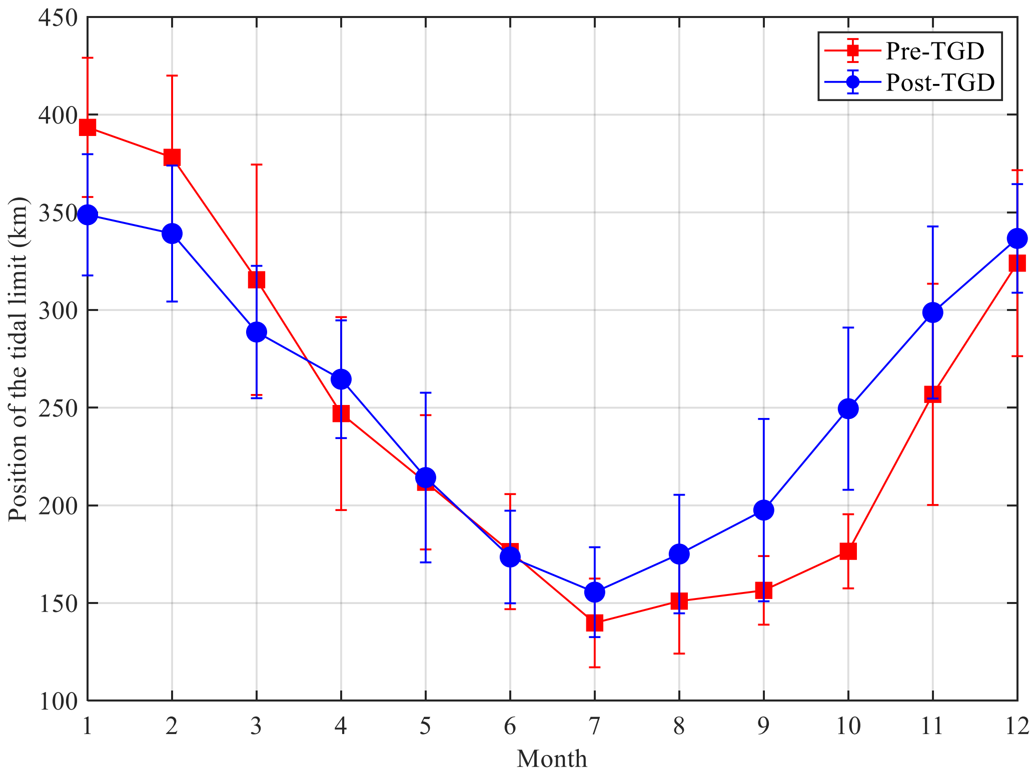

Figure R1. Temporal variation of the position of the tidal limit relative to the TSG station for both the pre-TGD and the post-TGD periods. The vertical error bar at each data point indicates the standard deviation of the analytically computed time series.

2. Sub-monthly variability impact. Another concern I have is the resolution of the model. Is the frequency of boundary forcing information sufficient to resolve extreme events? For example, daily-averaged flow rates were found to be insufficient to resolve flood risk and water quality within estuary hydrodynamic models (e.g. Robins, P.E., Lewis, M.J., Freer, J., Cooper, D.M., Skinner, C.J. and Coulthard, T.J., 2018. Improving estuary models by reducing uncertainties associated with river flows. Estuarine, Coastal and Shelf Science, 207, pp.63-73.) I guess I am simply asking: you have monthly means, but how does this down-scale to hourly means, which are likely to be important for impact to wildlife and estuary impact? For this second comment, perhaps a sensitivity test is needed to prove to the reader that you can take coarse river data and resolve estuary impact. However, perhaps this can also be defended by the authors?

Our reply: Due to the fact that the main purpose of this study lies in quantifying the impacts of TGD's seasonal regulation on the tide-river dynamics over the entire reach of the Yangtze River estuary, thus we adopted the monthly averaged river discharge conditions. This is possible to down-scale to the tidally averaged means since the proposed analytical model is obtained based on the tidally averaged conditions. For such a kind of application using tidally averaged means, the reviewer can kindly refer to our previous publications of Cai et al. (2014, 2016). However, the model cannot be used to understand the impacts of hourly varying freshwater discharge on the tide-river dynamics because of model limitation. To resolve extreme events and their impacts on flood control and water quality, as suggested by the reviewer (e.g., Robins et al., 2018), it is required to use a high-resolution numerical model adopting high-resolution boundary conditions (e.g., hourly mean river discharge).

3. Assumptions of river geometry variability. For the analytical solution method – how is river width treated for application to volume temporally variance? Is an assumption made about the river being canalised? i.e. constant bank full width? Or is there an associated flood plan? How is river depth calculated? If so, how does this effect your results?

Our reply: Indeed, in the analytical model we simplified the channel geometry to be in the shape of rectangular geometry. This means that the channel width is assumed to be time-invariant, while the water depth is variable as a function of tidal and riverine forcing. Such an assumption is particularly reasonable since the Yangtze River estuary is extremely large with the mouth width of around 90 km, and the width of river channel is convergent from around 10 km in the downstream section to around 2-3 km in the upstream section. On the other hand, the depth is only at around 10-20 m along the main course of the estuary. Consequently, the width to depth ratio is large so that the cross-sectional area variability can be primarily caused by the depth variability. The possible influence of storage area (i.e. flood plain and tidal flats) is taken into consideration by introducing the parameter of the storage width ratio r_S (i.e., the ratio of the storage width to the averaged stream width). Such a kind of rectangular shape assumption has been used in many previous studies (e.g., Van Rijn, 2011, Toffolon and Savenije, 2011, Cai et al., 2014, 2016). In the revised paper, we shall clarify such an assumption: "*We further assume a nearly rectangular cross-section, considering a large width to depth ratio; hence, the tidally averaged depth is given by* $\bar{h} = \bar{A}/\bar{B}$ *and the cross-sectional area variability can be primarily due to the change in depth.*"

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