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Discussions

Interactive comment on "Analytical approach for determining the mean water level profile in an estuary with substantial fresh water discharge" *by* H. Cai et al.

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Dear Bin Guo,
Many thanks for your comments! Below are our point-by-point responses to each of your comments.

1. In this study, the authors have applied an analytical model to examine the contribution of river discharge and tide to the water level slope along the Yangtze River Estuary. The analytical model may be a useful method to investigate such scientific problems. However, I have two arguments for this paper as follows.

Firstly, the analytical model used in this paper have been mentioned in author's other paper (Cai et al., 2014), and therefore this paper just applied an existing analytical model.

Our reply: Because the first reviewer rose the same concern, here we repeated our response as follows:

It is true that the proposed analytical model for hydrodynamics has been detailed in Cai et al. (2014). However, the current work represents a further development of the analytical model to understand the mechanism of backwater effect due to tide-river interaction and its resulted mean water level profile in estuaries with substantial fresh water discharge (taking the Yangtze estuary as an example), which is not completely understood yet. For the first time, we used a fully analytical approach to quantify the contributions made by different components (tide, river, and tide-river interaction) to the residual water level. The method is subsequently used to estimate the frequency of extreme high water along the estuary, which is particularly useful for water management and flood control.

We realise that we have not clearly spelled out the innovation of our paper, which is not just an application of a model to a case study, but an analysis that provides new analytical tools to assess the influence of river discharge on water levels in estuaries. In particular, the equations (16)–(18) are new to the analytical method and have not been published before (see also Figure 9 in the manuscript).

2. Secondly, I doubted the applicability of the analytical model to the Yangtze River estuary. The Yangtze River estuary is a complicated branched estuary with three-order branches and four outlets into the sea. The Yangtze River Estuary branches into the North Branch and the South Branch, and further the

South Branch branches into the North Channel and the South channel, and finally the South channel branches the North passage and South passage. The South Branch has been the main channel delivering the water and sediment discharges into the sea, and the North Branch is dominated by the tide dynamic. The South Branch and the North Branch were considered as a unity (Zhang et al., 2012). There were many reports on the flow backward of water, sediment and salinity from the North Branch to the South Branch. Therefore, only applying the analytical model to analyze the tide-river interaction along the South Branch of the YRE may be doubtful in this paper.

Our reply: We do not agree that we consider the South Branch and the North Branch as an entity, since they have very different hydrodynamics characteristics. The South Branch being the main channel conveying both fresh water discharge and sediment into the East China Sea, is characterized as a riverine channel where the tide is damped along the channel. Conversely, the North Branch, barely connecting to the main channel, is dominated by the tidal dynamics from sea. Due to their distinct tidal behaviour, these two branches are usually treated independently (Zhang et al., 2011, 2012). Actually, previous studies by Zhang et al. (2011, 2012) with regard to salt intrusion and tidal dynamics in the Yangtze estuary clearly demonstrated that the branched estuary system downstream from the junction between the South Branch and North Branch does function as an entity, which allows us to investigate the tide-river interaction making use of the combined channels. A similar phenomenon was observed in the Mekong delta, which is also a multi-channel system (Nguyen and Savenije, 2006; Nguyen et al., 2008). In the revised paper, we shall clearly clarify that we only consider the branched system downstream from the junction between the South Branch and the North Branch, which in our view functions as an entity for tidal hydrodynamics, so that we may treat it as a whole.

Finally, the reviewer is right that the net water, salt and sediment fluxes from the North

Branch into the South Branch may have influence on the estuarine processes (e.g., salt intrusion) in the South Branch. However, since we focus on the dominant tide-river interaction process in the Yangtze estuary, the effect from the North Branch may be neglected. In the revised paper, we shall clarify that we assume a negligible influence of the net water, salt and sediment fluxes from the North Branch into the South Branch on the tide-river interaction.

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