Responses to comments by Prof. Mick van der Wegen

We thank Prof. Mick van der Wegen's careful consideration of our work. In this rebuttal, we have addressed all the comments formulated by the Reviewer by replying (in black) to your remarks (in blue).

General comments:

Last weeks I read with great interest your work on inverse modeling to determine the waterdepth from hydrodynamic parameters such as tidal amplification and wave propagation. This is an intriguing technique with many potential and important applications. I am thinking of determining a representative bed level for 1D (morphodynamic) models of long tidal river systems (such as the Yangtze or Ganges) based on local water level observations, particularly usefull in (bed)data scarce environments.

The authors present a first step of such an inverse model since their model approach is based on (explicitly mentioned) assumptions like absence of river flow or head reflectance and a constant bed level in the model domain. The work presented is nice straighthforward and reads quite gently. The analysis makes use of earlier analytical methods to describe tidal propagation in estuarine systems based on few and easily derivable parameters such as estuarine shape and wave attenuation. The approach requires quite rough schematizations that may oversimplify local conditions but are necessary to come to an analytical solutions that can explain tidal dynamics in a straightforward manner.

Our reply: We thank Prof. Mick van der Wegen for your very positive assessment of our work.

Minor comments:

In the attached document I suggest some (very few) minor changes and typos.

Our reply: We very much appreciate the reviewer's detailed comments, which led to a much improved and complete revision of the manuscript. In the revised manuscript, we shall carefully address all the minor comments raised by the reviewer.

Major comments:

Here I address my major considerations:

- Figure 12 gives a depth development over time. How did you determine the observed depth? Is that depth constant along the transect that you consider? This is important since one of your assumptions is that the depth is constant along the transect and you could simply test this assumption from data.

Our reply: In order to determine the mean water depth of Lingdingyang Bay, in this study, we first collected bathymetric maps of the bay surveyed in 1965, 1974, 1989, 1998, 2009, and 2015 from the Guangzhou Maritime Safety Administration and China People's Liberation Army Navy Command Assurance Department of Navigation. The submarine contours and estuarine shorelines on these maps were digitalized to generate a 50 × 50 m digital elevation model (DEM) with kriging interpolation in ArcGIS 10.3 (see Fig. R1 below). The bathymetric benchmark was converted from the local lowest tidal level to the Pearl River datum. Subsequently, **mean annual water depths were calculated as the ratio of the estuarine volume to the planimetric area.**

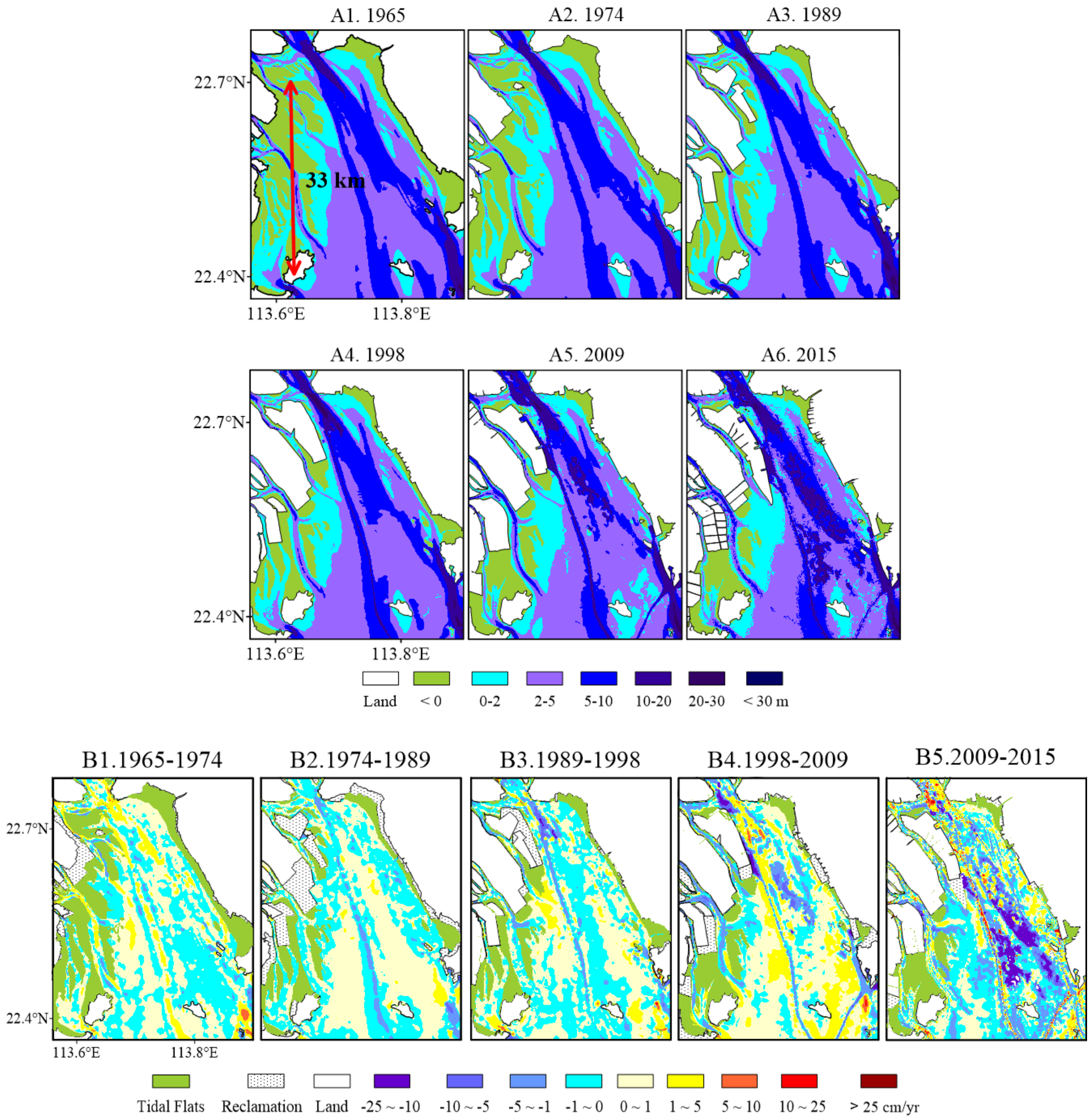

Fig. R1. Bathymetric maps of Lingdingyang Bay in 1965 (A1), 1974 (A2), 1989 (A3), 1998 (A4), 2009 (A5), and 2015 (A6) and its bathymetrical change rate during five time periods: 1965-1974 (B1), 1974-1989 (B2), 1989-1998 (B3), 1998-2009 (B4), and 2009-2015 (B5).

As can be seen from Fig. 8 in the manuscript (see also Fig. R2 below), the longitudinal water depth relative to the Pearl River datum is variable rather than constant. Here, in the inverse analytical model, it should be noted that the studied estuary was considered as an ensembled system, which is featured by a spatially averaged mean water depth and a channel width convergence length. Consequently, the estimated water depth in this work should be regarded as a bulk parameter for the system as a whole. In the section 2.2 of the revised manuscript, we shall explicitly mention that "*Here in the inverse analytical model, it should be noted that the estuary is regarded as an ensembled system characterized by a spatially averaged water depth and a specific width convergence length.*"

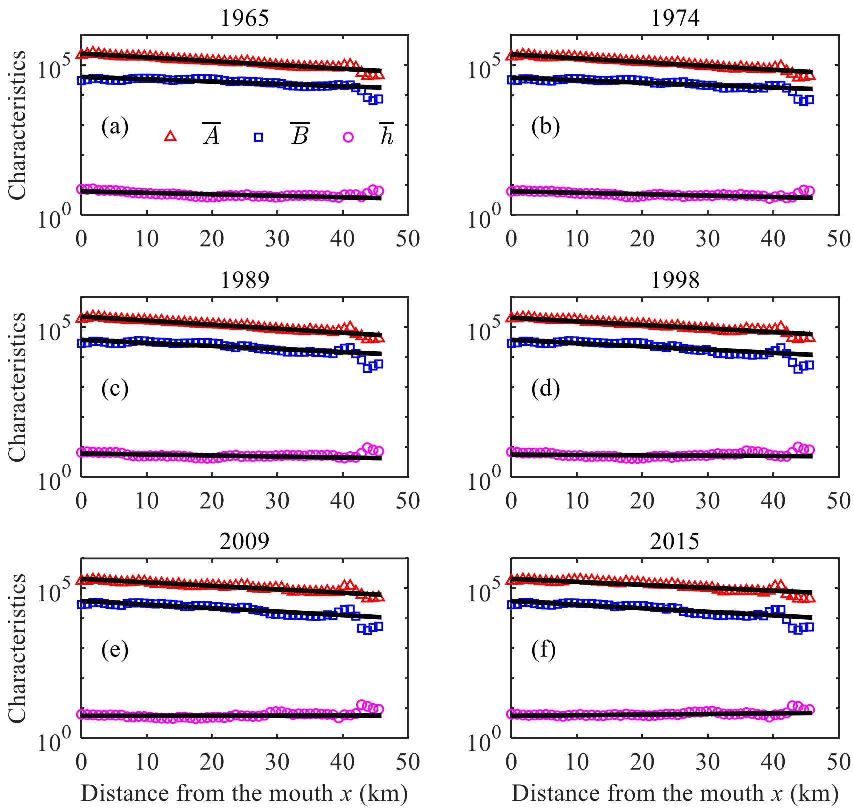

Fig. R2. Longitudinal variations of the geometric characteristics (the tidally averaged cross-sectional area $\bar{A}$, m^2, width $\bar{B}$, m, and depth $\bar{h}$, m) of Lingdingyang Bay for different years: a) 1965; b) 1974; c) 1989; d) 1998; e) 2009; and f) 2015, in which the black thin lines represent the best fitted curves according to the exponential functions (5)-(6).

-In line 351 you refer to the analytically computed tidal amplitude and phase. As far as I can oversee the equations the determination of the phase depends on the mean waterdepth, via eqs 9, 21 and 20. What waterdepth value did you use to determine the phase in figure 9? Is that the waterdepth determined in section 4.3?

Our reply: Here, in the forward analytical model we used a longitudinal variable mean water depth along the estuary. The water depth here is determined at each transverse cross section (see Figure R2 above). In the revised manuscript, we shall clarify the adopted water depth in both the forward and the inverse analytical models. Specifically, in section 4.2 of the revised manuscript, we shall explicitly mention in the model calibration process that: "*In order to account for the along-channel variations of the estuarine sections, here we adopted a longitudinal variable depth along the channel.*"

- One of the assumptions that you implicitly make is that the tide in the Bay propagates along the channel. but is this actually true? Or does the tide propagate in a different way? You do not mention this, but I think it is important to note that explicitly.

Our reply: We thank the Reviewer for this comment. As we described in the study area part, Lingdingyang Bay is a funnel-shaped subaqueous delta and has a complicated geomorphology pattern with two deep channels (i.e., East and West Channels) between three shoals (i.e., East, Middle and West Shoals) (see Figure 4c in the manuscript). From the energy point of view, it is true that the tide mainly propagates along the two deep channels, either during the flood tide or the ebb tide. In the analytical model, we consider the whole Lingdingyang Bay as an ensembled system. Thus, it is worth noting that in the analytical model the Manning-Stricker friction coefficient K should be regarded as an equivalent effective friction from the entire estuary, including the additional drag resistance due to bed forms, the influence of suspended sediments and the possible effect due to lateral storage areas (Cai et al., 2016). Hence, in the revised manuscript, we have explicitly mentioned that: "*It is worth noting that in the analytical model the calibrated Manning-Stricker friction coefficient K should be regarded as an equivalent effective friction coefficient induced by the entire estuary, including the additional drag resistance due to bed forms, the influence of suspended sediments and the possible effect due to lateral storage areas (Cai et al., 2016).*"

Reference:

Cai, H., Toffolon, M., and Savenije, H. H. G.: An analytical approach to determining resonance in semi-closed convergent tidal channels, Coastal Engineering Journal, 58, 1650 009, doi:Artn 165000910.1142/S0578563416500091, 2016.