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Interactive comment on "An analytical solution for tidal dynamics in the Yangtze Estuary, China" *by* E. F. Zhang et al.

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In our comment C2753 we gave the background to the equations that were used in the manuscript under discussion. In addition we would like to clarify the assumptions on the basis of which the derivation of the equations was made, and how these compare to the situation in the Yangtze Estuary.

The assumptions made for the model development are as follows:

1. The spatial variation of the cross-sectional area along the estuary can be described by an exponential function, as is the case in alluvial estuaries.

2. The ratio of the tidal amplitude to depth is less than unity.

3. The freshwater discharge is small compared to the amplitude of the tidal discharge. Although during a flood situation or in the most upstream part of an estuary this may not always be the case, in exponentially shaped estuaries this is not a restrictive assumption.

4. The Froude number is small, which is essentially the same as assumption 2, but less restrictive. The Froude number is generally smaller than the amplitude to depth ratio.

5. The tidal wave can be described by a simple harmonic function. If the tidal amplitude to depth ratio and the freshwater to tidal discharge ratio are small, then the tidal wave is not much deformed by nonlinear effects, but it is unavoidable that as the wave travels further inland, the wave deforms, resulting in a longer ebb and shorter flood duration. Implicitly this assumption is a linearisation assumption, but it is less restrictive than the linearisation of the friction term.

6. The width to depth ratio should be large (B/h » 1), and the storage width ratio (the ratio of the storage width (including tidal flats) to the stream width) should be modest (r_s < 2). This is a nonrestrictive assumption which is not really important since it only affects the second term of equation (4) which scales at the Froude number, and moreover alluvial estuaries have a large width to depth ratio.

7. The salt intrusion is partially or well mixed, which relates to assumption 3, while it is not a restrictive assumption.

8. Tidal damping is modest. It implies that the length scale of the damping/amplification process is much longer than the distance traveled by a water particle (the tidal excursion E). This assumption is also not restrictive in alluvial estuaries, as is shown empirically (Savenije, 2005).

9. The wave celerity and the phase lag between HW and HWS are constant over an estuary reach, or at least a small reach after which the equations can be solved

in multiple reaches in which they are considered constant. This assumption is fully justified in an ideal estuary where there is no tidal damping or amplification, but it is acceptable if assumption 8 is adhered to.

Of the 9 assumptions, assumptions (1-3) are the basic assumptions, the others are derivatives of these three basic assumptions, and assumption 9 is only required for the celerity equation. It can be seen that for alluvial estuaries most assumptions are not restrictive particularly for the downstream part.

For the Yangtze Estuary, the assumption 1 is justified, which is presented in Fig.2. The other assumptions are not restrictive either. The large river discharge the Yangtze Estuary receives is one of referee #1's doubts. Indeed, the Yangtze river has a large freshwater discharge but its tidal flow is an order of magnitude larger. Based on our calculation (Zhang et al., ECSS, 2011), using the average river discharge of 16,700 m3/s during the dry season and 40,000 m3/s during the flood season at Datong station, the Canter-Cremers number N (N=(QT)/Pt, where T is the tidal period, Pt is the tidal prism) during spring tide is 0.0025 (dry season) and 0.006 (flood season) for the North Branch, and 0.1 (dry season) and 0.24 (flood season) for the South Branches, respectively. So, the assumption 3 is not restrictive particularly in the dry season. In the flood season, it is true that the impact of river discharge is larger. We also think that the river discharge should be included in further studies. This has been discussed in the reply to the comment of referee #1. Corresponding with river discharge and tidal flow, the salt intrusion is partially mixed on the whole, and could be well mixed in the dry season (Shen et al., 2003).

The other doubt of the referee is the significance of the storage width ratio r_s. In previous work, some models indeed assume that the storage width is equal to the stream width, i.e. the parameter r_s is 1. However, other models do include tidal flats, i.e. r_s can be more than 1. Examples are in: Jay (1991), Friedrichs and Madsen (1992), Friedrichs and Aubrey (1994), and Savenije et al. (2008). In Jay (1991)'s paper, the tidal flats are allowed to be as wide as the channel itself, meaning r_s can reach 2.

In the work of Friedrichs and Madsen (1992), Friedrichs and Aubrey (1994), there is no clear limit to this ratio. This shows that our approach is not entirely different from what is done in the standard literature on this topic. In Savenije's model, r_s is assumed to be less than 2 (Savenije et al., 2008), but this is a nonrestrictive assumption. In our work, the parameter r_s for most channels (Table 1) accords with the assumption (r_s < 2). The large values for the channels near the mouth accord with the large areas of tidal flats. This is possible, like the Manning's coefficient which can be smaller than 0.02 in the Yangtze Estuary, different from many other estuaries. Because we did not find any data or reference about this, they were not verified. The very large value up to 3 for the downstream reach (0-5 km) of the North Branch was a mistake. We also think it should be smaller and we shall correct it in the final version.

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