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Discussions

Interactive comment on "Seasonal behaviour of tidal damping and residual water level slope in the Yangtze River estuary: identifying the critical position and river discharge for maximum tidal damping" *by* Huayang Cai et al.

Anonymous Referee #1

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This manuscript investigates the influence of river discharge on tidal damping and residual water level slopes in the Yangtze River estuary at the seasonal scale. Building on previous work by the same author(s), an analytical model for river-tide dynamics is used to understand the underlying mechanisms responsible for the observed variability. Of particular interest, the authors identified (1) a critical value of river discharge, at a given location, beyond which tidal damping is reduced with increasing discharge, and (2) a critical position along the estuary, for a given discharge (e.g. wet or dry season), upstream of which tidal damping is reduced in the landward direction. Although the

methods used were presented before, this application to a large estuary reveals new insights into the seasonal patterns of river-tide dynamics, which have implications for sustainable water management and sediment transport, as stressed by the authors. The subject is thus quite relevant; the manuscript is well written, well documented and clearly structured. The result analysis is thorough and a good discussion is presented. Overall, this is a very good paper. I recommend its publication after minor revision. My comments are detailed below.

General comments:

Do the critical values found in (1) and (2) (see above) represent the same phenomenon after all? It seems like, for a given (constant) discharge, when you move upstream a tidal river, the relative influence of river discharge increases, which is analogous to a discharge increase at a given (fixed) location. Is this a good reasoning? If relevant, a word on the similarity/dissimilarity between the two processes could be said.

Discussion: A word on applicability/transferability of the method to other systems or other dynamical contexts should be added in the discussion. In particular, would this analytical approach work in systems with mixed diurnal/semidiurnal tides, in non-convergent estuaries, or in estuaries with irregular (non-rectangular) cross-sections? Would it be possible to reduce the temporal averaging window to analyse the neap-spring variability in tidal damping and residual water level slopes? Similarly, could the method be adapted to rapidly varying flows? What adaptations would be necessary to include these aspects, if possible? I am not asking that the authors make those changes, but a discussion on limitations (and possible upgrades) of the proposed methodology would be useful.

The Yangtze River estuary does not seem to have sharp morphological breaks, based on Fig. 4. However, in systems where they occur, a shift in the tidal-fluvial conditions may be observed near these breaks. In such a case, the location of the boundary between the tide-dominated and river-dominated reaches may be invariant to changes in river flow (Hoitink & Jay, 2016). In this situation, what should be expected to be the consequence on the position of maximum tidal damping and maximum residual water level slope along the estuary, under different discharge conditions?

Specific comments:

L55-56: "the effect of river discharge on channel convergence, which is the other control factor for tide-river dynamics": Can you provide a reference, or is this new knowledge? Also, it is not quite clear at this stage in the manuscript how discharge can affect channel convergence. Can you explain in a few words?

L81-90: "Recently, idealized (or analytical) models with a strongly simplified geometry and flow characteristics were applied [. . .]. [The model] can reasonably reproduce the first-order tide-river dynamics (only considering a predominant tidal constituent)": In terms of justification of the method, considering the limitations of the analytical model, can you explain the interest or benefit of using such a simplified model compared to full numerical models?

L92: "previous studies mainly focused on the tidal properties near the estuary mouth": Can you please provide references supporting this affirmation?

L123-124: "The tidal amplitude is determined by averaging the flood and ebb tidal amplitudes": What do you mean by "flood and ebb tidal amplitudes"? Please clarify.

L126: Consider adding "monthly averaged" before "tidal amplitude and water level" and replacing "tidal amplitude" by "tidal range", if appropriate.

L232-235 and Fig. 3a: "there is a threshold, corresponding to a critical value of river discharge, beyond which the relationship between the tidal damping rate and river discharge switches from negatively to positively correlated": This does not show clearly in Fig. 3a, because of the straight regression lines. Can you illustrate the observed shifts with dotted lines maybe?

L255: Using two different friction coefficients K for the seaward and landward regions

creates a break in the results. Is it real? If not, consider making a smoother transition of friction between the two regions.

L284-285 and Fig. S3: "the seasonal behaviour of the critical phase lag is relatively irregular": It looks regular to me in Fig. S3, but inversely correlated with Q. Please adjust the text accordingly.

L304-308: It should be said more explicitly that both the maximum value of residual water level slope Smax and its position along the estuary (Fig. 7) are correlated with river discharge.

L310-312 and Fig. S4: Can you briefly explain why the position of Sr,max is landward of the other two terms (St,max and Str,max)?

L326-327: The position of maximum tidal damping is almost coincident with the maximum (not minimum) values of the wave celerity and the minimum values of the velocity number. Please correct.

L327-328: "The slightly lagged responses [. . .] are due to nonlinear interaction between these main tide-river dynamics parameters": Are you able to provide a more detailed physical explanation for it?

L329-330: Replace "is directly followed by" by "directly follows from". Can you explain the correlation between the phase lag ε and the other variables and its role in tidal wave propagation (damping and celerity) based on your results?

L353: Replace St by Sr.

L361-362: Please specify whether the negative (positive) gradient indicates a strengthening (weakening) damping with respect to Q or to the landward position along the estuary, or both.

L434-435: "this is the first study that shows the gradient switch of the cross-sectional area and tidal damping with the river discharge": This gradient switch in tidal damping was also recently documented by Matte et al., (2019) in the St. Lawrence River at the neap-spring and seasonal scale. I suggest referencing their work, here or elsewhere in the manuscript.

L451-456: There is a duplication of references: Cai et al. (2012a) and Cai et al. (2012b) are the same.

Fig. 1: Can you add river kilometers at each station in panel (b)?

Figs. 2 and 8: I find it hard to differentiate the pink, red and/or dark red curves. Can you use more contrasting colors?

Fig. 10: Add “x 10ˆ4” to the scale for river discharge Q. In Fig. 10a, there is another gradient switch happening around 15 000 m^3/s with respect to the position along the estuary. At lower discharges, maximum damping occurs seaward, whereas at higher discharges, it occurs landward. This was not described in the text (section 5.2), although explanations are provided elsewhere in the manuscript. Still, it might be worth pointing out the occurrence of this other gradient switch in Fig. 10a and relating it with the gradient switch that occurs with the increasing discharge (appearing in the same figure).

References:

Hoitink, A. J. F., & Jay, D. A. (2016). Tidal river dynamics: Implications for deltas. Reviews of Geophysics, n/a-n/a. https://doi.org/10.1002/2015rg000507

Matte, P., Secretan, Y., & Morin, J. (2019). Drivers of residual and tidal flow variability in the St. Lawrence fluvial estuary: Influence on tidal wave propagation. Continental Shelf Research. https://doi.org/https://doi.org/10.1016/j.csr.2018.12.008

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