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Earth Surface Dynamics Discussions

Interactive comment on "Effects of mud supply on large-scale estuary morphology and development over centuries to millennia" *by* Lisanne Braat et al.

Anonymous Referee #2

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This paper by Braat et al. presents 2DH numerical experiments of idealized estuaries in order to investigate the effect of mud supply on the long term development of estuaries. Several similar studies were already performed for sandy estuaries and deltas but here the originality of this study is to consider both sand and mud. I think that this study matches well the topics usually addressed in E-surf and that it would be a worth contribution in the literature. The paper is well organized and written, the figures are clear, the predicted final morphologies are impressive, the literature cited is relevant and I think that the paper would only need moderate revisions before it can be accepted. Please note that the following relatively long list of comment is related to the length of the paper. This review is split into moderately important problems that concern the whole paper and relatively minor, along-the-text problems.

Moderately important problems:

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-Use of morphological factors. While I recognize that there is presently no alternative to morfac approaches to perform morphological simulations at millennia time scales, such approaches were never applied for sand and mud mixtures and it is not straightforward that the underlying assumptions are valid. I suggest that the authors perform a few runs over the longest period that they can (at least 5 years) and compare the final morphology obtained without morfac with that obtained with morfac of e.g. 10, 100 and 400. A figure presenting these results could be included as a new appendix and discussed in the beginning of the discussion in a section untitled "limitations of the modeling approach" or something like that. I think this would strengthen the present paper and be useful for future modeling studies.

-Development of bended channels. The model is apparently able to reproduce the development of bended channels, which is by the way noted by the authors P12, L.17 and P22, L16. However, a 2DH modelling system cannot represent the vertical circulation that takes place in bended channel and the subsequent sediment transport. Is there a special treatment in Delft3D to account for this process in 2DH as it is often the case in river morphodynamic studies?

-Section 3.6 is clearly a discussion subsection and should be moved to the discussion. As much as possible, discussion should be limited in the "Results" section and moved to the discussion section.

Along the text, minor comments:

-P1, L4: "estuaries".

-P1, L17: some estuaries are also dominantly built of mud. Find a reference or clarify.

-P2, L2: which conditions?

-P3, L2: past modelling of what? Le Hir et al., (2011) and I'm sure others already performed sediment transport simulations with sand and mud mixtures, please be more careful with "always". For instance, the authors missed a couple of paper by Geleynse

(e.g. Geleynse et al., 2011) where Delft3D is applied to idealized deltas and where both sand and silts are considered. These studies might also be considered for the discussion in section 3.2.

-P3, L13: again, please consider the series of studies by Geleynse et al. (e.g. 2011).

-P5, L5: This is somehow confusing to introduce the EMS Estuary in section 1.1 and now move to the Dovey Estuary. Please better justify why you considered these two examples.

-P5, L15: please rather use “modelling system” than “simulation program”.

-P5, L24: if Delft3D is used in 2DH, then the Saint-Venant equations are solved, which correspond to the depth integrated Navier-Stokes equations. Also, not that, as written, eqs. (1) to (3) do not represent the effect of short waves.

-P7, eq. (4): how is solved the Exner equation to compute bottom change from the divergence of bedload transport? How are treated transition zones between where Pm<Pm,cr and Pm>Pm,cr?

-P7, eq (5): Tau,cw is not explained in the text.

-P7, L23: the gradient of a vector is only the same as its divergence in 1D. In 2DH, bed level changes are caused by the divergence of sand fluxes.

-P7, L27-29: this sentence is not straightforward, please explain a bit better.

-P8, Table2: “transverse slope parameter”, do you mean a slope limiter?

-P9, L8: “rectilinear non-uniform” is a pleonasm as a uniform rectilinear grid is a regular grid. I would rather say “a rectilinear grid, which resolution ranges from WW and XX”.

-P9, L13: 3 km-wide.

-P9, L15: a depth. Is that the maximum depth?

-P9, L30: “a M2 tide”. Then “3° phase difference” with respect to what? Between the

seaward point and the shore so that tide is shore-normal? What about the Western Boundary? Why not prescribing tides?

-P10, L5-9: with such a coarse resolution and small waves, wave-induced processes cannot be represented properly. As a rough guideline, the grid should have a least 5 elements across the surfzone to represent properly wave-induced currents and setup. Here I assume that only wave stirring of sediment is represented in the model, and possibly a slight increase in bed shear stress. Please verify and clarify.

-P10, L17: why not using Delft3D in parallel? Parallel computing is common practice nowadays and would allow to use smaller morfac for instance or have your final results in <1 day instead of 20.

-P14, L4: there is indeed a phase difference of Pi/2 between water levels and velocities. Do you mean that this phase lag does not vary too much along the estuary? This is not that clear on figure 4.

-P14, L28: there are no dotted lines on figure 4.

-P14, L32: what do you mean by “not very large”? Do you mean that this is different from the 7.5% provided above?

-P14, L33: please explicit “w”.

-P21, section 3.4: this is only a thought but is that possible that an estuary that imports mud from the sea has no mud import from the river?

-P22, L12-13: is that realistic that the estuary closes in the absence of waves? I think that in reality, the only estuary that are closed are wave-dominated.

-P22, L21-24: this is not clear at all why waves would rise high water level and increase tidal range. According to previously published studies (e.g. Wargula et al., 2014; Dodet et al., 2013), wave breaking on the ebb shoal rises the water level in the estuary/lagoon by about 10% of the significant wave height at breaking. Since surf zone can hardly be

represented with the resolution employed in this study, I don't see how waves can have any effect other than stirring sediments and, marginally, increase bed shear stress. Please clarify this section.

-P24, figure 9: how can an estuary without mud supply have large surface areas covered by mud?

-P26: why Gg.yr-1 and not 10ˆ6 kg/yr?

-P26, L10: use of "which" not correct I think.

-P27, table 4: how river discharge can induce currents in the range 0.001-0.01 m/s only? Upstream, it could be much more than that? Why weren't you able to compute it from the model, for instance based on a run with river discharge only?

- P28, L15-19: in reality, tides big enough to develop estuaries imply that the associated oceanic basin is large enough to have significant short-waves as well. Short waves tend to limit ebb-dominance and subsequent estuary enlargement. If required, you'll find a review in the introduction of Wargula et al. (2014).

Cited literature:

Dodet, G., Bertin, X., Bruneau, N., Fortunato, A.B., Nahon, A., Roland, A., 2013. Wave-current interactions in a wave-dominated tidal inlet. Journal of Geophysical Research: Oceans, 118 (3), pp. 1587-1605.

Geleynse, N., Storms, J.E.A., Walstra, D.J.R., Jagers, H.R.A., Wang, Z.B., Stive, M.J.F., 2011. Controls on river delta formation; insights from numerical modeling. Earth and Planetary Science Letters, 302 (1-2), pp. 217-226.

Wargula, A., Raubenheimer, B., Elgar, S., 2014. Wave-driven along-channel subtidal flows in a well-mixed ocean inlet. Journal of Geophysical Research: Oceans, 119 (5), pp. 2987-3001.

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