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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.

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We thank Pierre Weill for the detailed review and careful reading of the manuscript which helped us to greatly improve the manuscript.

The first general comment is that the connection between the results and the presented examples of two Dutch estuaries needs more explanation. The dataset of UK estuaries is used quantitatively to compare hydrodynamics and bar shape and size, while the Dutch estuaries are mainly used qualitatively for comparison of mud deposition patterns. This is mainly because data on surface mud in estuaries is scarce and unavailable for the UK estuaries. The Dutch data shows spatial distribution of the mud over an estuary, which is relevant because it validates the spatial patterns obtained in

our model results, so there is more similarity than only planform and hydrodynamics. We will discuss this in more detail in the resubmission and also compare the hypsometric curves for the field and modelled cases. Yet, we chose to model the Dovey instead of the Western Scheldt or Ems-Dollard because we wanted to model a largely natural estuary. The Dutch estuaries are largely influenced by dredging and dumping, which for the modelling would require significant unnatural volume displacement. In the next version of the manuscript we will add relevant hydrodynamic information of these estuaries. Furthermore we will explain more clearly why we model the Dovey in the beginning of the method section. We will also indicate the positions of the Dutch estuaries in the figure with the UK and other data that serves as context for the modelling.

The second and third general comments request more discussion on ebb- and flood dominance, in particular through time which would be novel relative to earlier work in the Dovey estuary. We will show ebb-flood peak velocity ratios over time in the resubmission and include a discussion, comparing our results to the insights of Moore et al. (2009) and Brown and Davies (2009,2010). We foresee an important difference in that ebb/flood asymmetry works different for sand and for mud, meaning that an estuary can export sand and import mud at the same time.

In response to the specific comments we added more information on the Western Scheldt and Ems-Dollard estuary. We also changed Fig. 1 by adding a small location map and the elevation datum as suggested. The caption of Table 1 was clarified and settling velocity for sand was provided.

Other questions were asked by the reviewer regarding the high critical shear stress for deposition and the dry bed density of mud in Table 1. A discussion on the subject of the deposition threshold can be found in Sanford (2008) and several papers of Winterwerp and a reference to this will be added in the new manuscript. Many papers suggest that an erosion threshold for deposition is absent and should be determined by: D=ws*c. This is approached in the model by setting a very high value for the critical shear stress for sedimentation, which is common practice in Delft3D with mud. We chose for equal dry bed densities for sand and mud because the density of mud is highly variable. The density is indeed much lower when mud is recently deposited on for example a mudflat (as in Flemming & Delafontaine, 2000, and Dyer et al., 2000, where samples are taken from the active layer), but consolidation is very strong and rapid, as soon as the mud becomes buried the density becomes higher than for sand. In principle the density can be anywhere on the line in figure 6 of Flemming & Delafontaine (2000). Since Delft3D did not account for consolidation during the modelling phase of this research we chose the dry density to be equal to sand as a conservative estimate. Consolidation was already mentioned as a discussion point later in the paper and we consider this an important uncertainty in the model. Meanwhile, Delft3D has developed a consolidation module, which we will use in future mud-modelling research.

In the method section we now also refer to Moore et al. (2009) in relation to testing certain tidal components. Furthermore, we clarified in the methods section how fluvial discharge is partitioned and flow capacity is defined.

In the results the labels, caption and red lines in Fig. 3 have been adapted and clarified as suggested. Definitions of absolute and net bed level change ware added in the manuscript. However, we abstained from using ×106 m3 instead of hm3 further in the manuscript because it saves space in the figure. Additionally, we did not experience any problems with the YouTube link and therefore remains the same.

p.14 l.33: Tidal prism is now described in words in the paragraph instead of the equation.

Regarding Figure 4: The coordinates are already explained in the caption of the method figure that shows the initial bathymetry. Dashes are changed as is the vertical scale in subfigure (g).

Section title 3.3 was changed from “Effects of mud flat formation” to “Effects of mud supply”.

p. 16 l. 4: The reference to the figure has been adapted.

p. 19 Figure 7: Caption has been changed as for the similar figures of other model runs in the appendix.

p. 24 Figure 9: Variable units are suppressed and ‘high mudflat’ is explained in caption.

p. 25 l. 13: Reference of Leussen (2011) and Mietta (2009) were added to support assumption of higher settling rates of marine mud related to flocculation processes.

p. 26 Figure 11: added “from left to right” in caption.

We added model numbers and references to appendix figures throughout the manuscript text and captions. The model numbers are related to Table 3.

Finally, all technical corrections have been implemented in the manuscript as well.

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