Response to the comments made by Reviewer 1: Mick van der Wegen

We would like to thank the Reviewer for the time spent revising the manuscript and the detailed comments provided. Please find below responses to the each of your remarks about the manuscript in a comment-by-comment basis.

R1-Comment 1: At page 17, line 7-8 you state that the resulting bed levels are validated against data. I think this is crucial and should be mentioned much earlier, e.g. in chapter 3. Also answer questions like; How realistic is the generated bed? Did you start from a flat bed? How did you determine the initial bed level? What is the impact of a different initial bed level, e.g. on the water level bias? Was the generated bed in equilibrium? How long did that take?

We thank the Reviewer for the suggestion. We agree and will update the manuscript including a description of the procedure to derive the initial bathymetry. Nevertheless, a detailed explanation on the derivation and validation of the initial bathymetry implies an extensive description which would occupy much of the journal space. In that regard, please refer to the master thesis by Barrera Crespo (2016). Delft3D Flexible Mesh modelling of the Guayas River and Estuary system in Ecuador. Delft University of Technology, National University of Singapore, http://resolver.tudelft.nl/uuid:c8a4c2f1-208b-4332-a17f-8afb28ec71e6. The thesis presents a complete description of the procedure, which is similar to what is proposed by Van der Wegen and Roelvink (2012) for the Western Scheldt estuary in the Netherlands, and all of the above questions are answered as follows:

- How did you determine the initial bed level?
  An analytical model of the estuary was implemented based on the theory posed by Savenije (2006) about alluvial estuaries. The theory describes a general equilibrium state for alluvial estuaries in which the tidal amplitude remains constant as it propagates throughout. With this model then it is possible to assess the equilibrium condition and the subsequent mean water depth for the entire Guayas River Estuary.

- Did you start from a flat bed?
  The Delft3D morphodynamic model initial condition renders a flat bed in the area lacking topographic information. The bed level was set according to the mean water depth estimated with the analytical model.

- Was the generated bed in equilibrium? How long did that take?
  The morphodynamic simulation was run until the equilibrium condition is reached. This was determined by monitoring the evolution of the mean estuary's depth and sedimentation and erosion volumes in the area lacking topographic information. In total it took about 200 years of morphodynamic simulation to reach the equilibrium.

- How realistic is the generated bed?
  The available topographic data is scarce, only a few contour lines spaced vertically every 5 m were available in some areas of the estuary. These contours cover elevations that range between -2 and -20 m in relation to MSL. The latter information was complemented with available satellite images in order to discern characteristic morphological features like shoals and deep channels. This was

then contrasted with the topography derived by the long-term simulation. After a close visual inspection, it could be verified that most of the morphological features were captured properly in the northern and middle part of the estuary. The southern part presents larger discrepancies that could be ascribed to the presence of non-erodible layers in the proximities of the Puna Island. The final stage to validate the derived topography is to contrast the computed water levels with those pertaining to measurements at the Guayaquil tidal station over a spring-neap tidal cycle. A good correlation and a small mean square error between both measured and modelled water levels were obtained. In addition, after performing a tidal analysis for both signals, a generally good agreement could be verified for the amplitude and phases of the most energetic components.

R1-Comment 2: You relate the outcome of the scenarios to tidal asymmetry, but why not show that in terms of ebb/flood duration or changing Stokes' return flow (e.g. see Van der Wegen et al 2008 and refs therein)?

We thank the Reviewer for raising to our attention the analysis regarding tidal asymmetry in terms of ebb/flood durations. Tidal asymmetry is a concept that encompasses the asymmetry of the vertical and horizontal tide. The asymmetry of the vertical tide is linked to the difference between flood and ebb periods. As a consequence, flood-dominance renders a rising period shorter than a falling period. In the other hand, the asymmetry of the horizontal tide relates to 2 aspects: the difference between ebb and flood velocities, and the duration of the slacks. In relation to the first aspect, flood-dominance happens when the maximum flood velocity is larger than the maximum ebb velocity. For the second aspect, flood-dominance occurs when the duration of high-water slack is longer than the low-water slack.
In figures 5 and 6 we show exactly the flood-dominant behavior of the Guayas estuary as a function of the vertical and horizontal tides respectively. However, we will complement the manuscript with an analysis of the duration of the slack water throughout the estuary.

R1-Comment 3: As you admitted the EH transport is not really suitable for finer sediments. Even more, density driven (salt-fresh) flows may have considerable impact as well even on both fine and coarse sediments (see Effects of Density Driven Flows on the Long-Term Morphodynamic Evolution of Funnel-Shaped Estuaries Maitane Olabarrieta W. Rockwell Geyer Giovanni Coco Carl T. Friedrichs Zhendong Cao doi:10.1029/2017JF004527). That make your conclusions vulnerable; pls discuss. Because of the many crude assumptions (still, necessarily taken), related to, waves, sediment size, tidal movement density flows etc. you should present the results more as indicative in the abstract and conclusions.

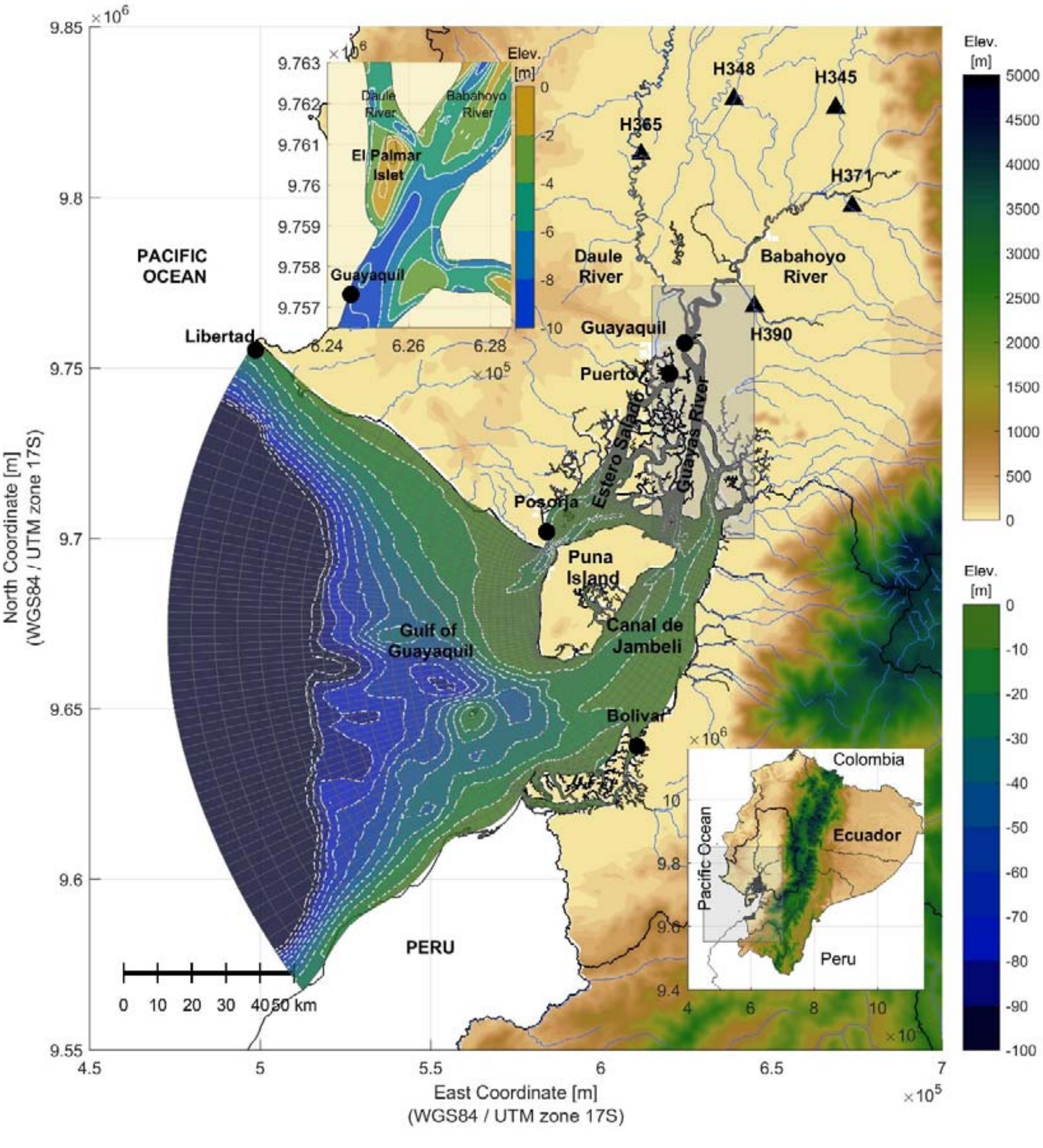
Again, we thank the Reviewer for raising this to our attention. According to the analysis presented in Barrera Crespo (2016), the importance of the river discharges is minor in relation to the tide. As a result, the Guayas river is deemed tide dominated and becomes partially mixed during the peak of the wet season, and well mixed the rest of the year, especially during the dry season. Based on this, the occurrence and impact of density driven flows is mild in a yearly basis. Measurements of actual salinity profiles taken along the Guayas estuary support these findings e.g. Twilley et al. (2000), and Laraque et al. (2002).
The distribution of sediment size throughout the estuary presented by Benites (1975) suggests a relatively coarse sediment size of 0.30 mm, this was confirmed by a personal communication from a dredger (Erik Waumans of Van Oord). Moreover, settling lag effects of suspended sediments become important if the corresponding adaptation lengths are comparable with the size of the grid cells, Mosselman (2005). In this

case, the grid resolution in the denser areas of the model renders cell sizes that are much larger than the adaptation lengths of fine suspended sediments. This was the basis to justify the usage of the Engelund-Hansen formulation.

For completeness, we will include in the manuscript the discussion of density effects and the appropriateness of the Engelund-Hansen formula.

R1-Comment 4: Minor comments to the manuscript.

We appreciate the thorough revision made by the reviewer to the overall redaction of the manuscript, we will abide by the suggestions regarding the rephrasing of some sentences. We will also include the visualization of the El Palmar islet within Figure 1 as shown below:



To support the discussion about the use of the morphological factor in tide-river environments, and the use of the OpenDA tool for calibration purposes we will include the following references:

- Guo, L., van der Wegen, M., Roelvink, D., & He, Q. (2015). Exploration of the impact of seasonal river discharge variations on long-term estuarine morphodynamic behavior. Coastal Engineering, 95, 105-116.

- Kurniawan, A., Ooi S. K., H. Gerritsen and D.J. Twigt. Calibrating the regional tidal prediction of the Singapore Regional Model using OpenDA

References

Barrera Crespo, P. D. (2016). "Delft3D Flexible Mesh modelling of the Guayas River and Estuary system in Ecuador." Delft University of Technology, National University of Singapore, Delft. (http://resolver.tudelft.nl/uuid:c8a4c2f1-208b-4332-a17f-8afb28ec71e6).

Benites, S. (1975). "Morfología y sedimentos de la Plataforma Continental del Golfo de Guayaquil." *Tesis ESPOL* 112.

Laraque, A., Cerón, C., Magat, P., and Pombosa, R. (2002). "Informe del primer estudio del impacto de la marea sobre el estuario del Río Guayas.".

Mosselman, E. (2005). "Basic equations for sediment transport in CFD for fluvial morphodynamics." *Computational fluid dynamics: applications in environmental hydraulics* 71-89.

Savenije, H. H. G. (2006). Salinity and tides in alluvial estuaries. Elsevier.

Twilley, R. R., Cárdenas, W., Rivera-Monroy, V. H., Espinoza, J., Suescum, R., Armijos, M. M., and Solórzano, L. (2000). "17 The Gulf of Guayaquil and the Guayas River Estuary, Ecuador." *Coastal Marine Ecosystems of Latin America* 144:245.

Van der Wegen, M. and Roelvink, J. A. (2012). "Reproduction of estuarine bathymetry by means of a process-based model: Western Scheldt case study, the Netherlands." *Geomorphology* 179:152-167.