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Interactive Comment

# *Interactive comment on* "A 2-D process-based model for suspended sediment dynamics: a first step towards ecological modeling" *by* F. M. Achete et al.

**F. M. Achete et al.**

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A:Thank you very much for the detailed review and comments to improve this work. We will update the manuscript with the following responses.

A: The responses to questions 1 will be added in the model description chapter, section 2.1 as additional paragraphs.

R: 1) Calibration/validation of the numerical model. I understand that the technical details on the numerical method and validation/comparison with other schemes have been given in Kernkamp et al. (2010), but it would be helpful to comment on alternative methods for this specific site.

R:Are there other numerical models done for the Delta, e.g. just the hydrodynamic part? For example, Delft3D in the depth-averaged mode seems to be a close competitor which handles both hydrodynamic and morphodynamic transport. A few comments would be nice, such as:

R:a) how many grid cells are involved in the calculation of the model setup presented in this work, versus how many grid cells would have to be used for the total triangular mesh?

R: b) How much time would it take for other methods to reach the same level of accuracy with the same computation power (only one desktop)?

A: Structured grid models as Delft3D and ROMS (Regional Oceanic Modeling System) have been widely used and accepted in estuarine hydrodynamics and morphodynamics modeling including San Francisco Estuary (Ganju and Schoellhamer, 2009;Ganju et al., 2009;van der Wegen et al., 2011). In all theses cases of San Francisco estuary modeling efforts, the Delta was schematized as 2 long channels since the grid is not flexible to have a 2D modeling of the rivers, channels and flooded island of the system.

There are three widely known unstructured mesh models the TELEMAC-MASCARET (Hervouet, 2007), the UnTRIM (Casulli and Walters, 2000;Bever and MacWilliams, 2013) and D-Flow FM (Kernkamp et al., 2010). The two first models are purely triangle based and are not coupled with sediment transport and/or water quality and ecology model. DFlow-FM allows for a combination of curvilinear grid and triangles, in the present model DFlow-FM grid has 63.844 cells, from which about 80% are rectangles. In the case of only triangle grid all the rectangles would be 2 triangles summing up to 114.920 grid cells. Not counting the triangular grid orthogonality and circumscription issues, in the case of entirely triangular grid the running time for a 1 year simulation would increase from ∼72 clock hours to ∼192 hours.



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Discussion Paper

—- The responses to questions 2 will be added partly in the discussion description chapter, section 4.2 as additional paragraphs, and partly in the conclusion (chapter 5). R: (2) Insights of the specific field site. As the authors stated, the Delta provides critical habitats for ecological purposes. I can see how this model and its predictions become handy for a chain of models.

R: Could the author use the model results to inform more into the monitoring and data collecting practice?

R: For example, what data set should be collected to help the model make better predictions? And where could be a good location for building a new monitoring station? Addressing issues like these, or even in a discussion of future work, will expand the scope of this work and gives a higher scientific impact.

A: The Delta is already very well measured in terms of observation stations. However, this work show that the substantial sediment is exported trough the pumping stations at the Southern Delta where no data in SSC is available. The connections between Sacramento and San-Joaquin River (DCC and GLS) are currently is being surveyed.

The present model opens the possibility for forecast and operational modeling. Forecasting the time frame of high levels of SSC (turbidity) allows planning of measurements campaigns for ecologists, as well as the possibility of tracking potentially contaminated sediment and be able to make a contingency plan. The forecast could also be a tool to guide management decisions concerning seasonal barriers as well as pumping operations.

The 2D model is a step towards the 3D model. The 2D model allows faster runs facilitating sediment parameter definition and understanding of sediment dynamics in the Delta. However, for the fully Delta-Bay coupling it is necessary fully 3D model, which is the next step of this work.

—– The responses to questions 3 will be added in conclusion chapter (chapter 5) as



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additional paragraphs. R: (3) Information on suitable systems for model application.

R: The Delta is a relatively well-surveyed region. What should be taken into account for potential users of this model, when applying to a different region with less available data?

A: As a well surveyed area the Delta offers the chance of testing how much data it is necessary to define sediment budget. This work shows with simple sediment settings as one fraction at the input boundary and simple distribution of bed sediment availability, it is possible to reproduce seasonal variations as well as define yearly sediment budget with more than 90% of accuracy. It shows also that it is extremely important to have discharge and SSC measurements at least in the input boundaries and close to the system output in order to be able to calibrate the model settings applied for hydrodynamics and suspended sediment.

R: Also, it seems that the configuration of the channel network does play a role determining the SSC level (the effects of closing/opening DCC). Would the authors give more insights into how changing the configuration of the network affects the distribution of fluxes?

A: The channel network influence in sediment budget and deposition is the topic of the work in development right now.

As for from this work results, we note that the Sacramento San-Joaquin River connecting channels DCC and GLS are important bridges to export sediment from Sacramento to Eastern Delta. On the other hand the smaller channels of the network play a minor role in the Delta sediment budget, since the discharges in these channels are considerably smaller than in the rivers.

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Regarding minor comments

Below are some minor comments: R: Page 1514, Eq. (2): “M” is also used later as the



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subscript for “Model”. A: We changed the from M to m in the other equations

R: Page 1515, Line 3: Winterwerp (2006) is missing in the reference list.

A: It will be included

(Winterwerp et al., 2006) Winterwerp, J. C., Manning, A. J., Martens, C., de Mulder, T., and Vanlede, J.: A heuristic formula for turbulence-induced flocculation of cohesive sediment, Estuarine, Coastal and Shelf Science, 68, 195-207, 10.1016/j.ecss.2006.02.003, 2006.

R: Page 1515, Line 5: sentence is not complete, “the second term in equation (Eq. 1): is close to zero?”

A: Thanks for the remark, already added. It is indeed close to zero.

R: Page 1515, Line 20-25: will changing the 5m threshold for mud/sand affect the results?

A: The 5 meter threshold is not fixed, what we observed is a big change when considering available mud in the entire channel as presented in session 3.4. We did some test varying the 5m threshold. From 3 to 10 meters the final results are quite similar to the one showed. Considering no mud availability also does not disturb the final results for more than 10 days. However, considering mud availability in the channels deeper than 10 meters starts to disturb the SSC levels.

I will include this analysis in the session 3.4 and as discussion as well.

R: Page 1519, Line 15-20: uRMSe given by Eq.(3) cannot give negative values. Seems that it needs to be multiplied by the sign of the difference between modeled and observed SD (see Eq. (7) in Bever and MacWilliams, 2013).

A: Yes, you are right, I forget the signal difference. Proper changes will be done in figure 6 and analysis.

R: Page 1519, Line 23: "Willmott, 1981" is missing in the reference list.

A: It will be included (Willmott, 1981) Willmott, C. J.: ON THE VALIDATION OF MODELS, Physical Geography, 2, 184-194, 10.1080/02723646.1981.10642213, 1981.

R: Page 1524, Eq.(7): Why is the term "[A'C'][U]" eliminated?

A: We use the same methodology as suggested by (Morgan-King and Schoellhamer, 2013). The combination of the advective, dispersive and Stokes Drift already account for more than 97% of the flux.

R: Page 1542, Fig. 5: The values of the parameters are vague by presenting them as multiples of the standard run (e.g., w*0.5, E*100). I personally prefer the form in Fig. 6 with absolute values.

A: Figure 5 x axis will be updated according with the axis presented in figure 6.

R: Page 1544, Fig. 7: the black rectangle is missing in the left panel.

A: Figure 7 updated.

References: Bever, A. J., and MacWilliams, M. L.: Simulating sediment transport processes in San Pablo Bay using coupled hydrodynamic, wave, and sediment transport models, Marine Geology, 345, 235-253, http://dx.doi.org/10.1016/j.margeo.2013.06.012, 2013. Casulli, V., and Walters, R. A.: An unstructured grid, three-dimensional model based on the shallow water equations, International Journal for Numerical Methods in Fluids, 32, 331-348, 10.1002/(sici)1097-0363(20000215)32:3<331::aid-fld941>3.0.co;2-c, 2000. Ganju, N. K., and Schoellhamer, D. H.: Calibration of an estuarine sediment transport model to sediment fluxes as an intermediate step for simulation of geomorphic evolution, Continental Shelf Research, 29, 148-158, 10.1016/j.csr.2007.09.005, 2009. Ganju, N. K., Schoellhamer, D. H., and Jaffe, B. E.: Hindcasting of decadal-timescale estuarine bathymetric change with a tidal-timescale model, Journal of Geophysical Research, 114, 10.1029/2008jf001191, 2009. Hervouet, J.-M.: in: Hydrodynamics of Free Sur-



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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 1507, 2015.