Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2017-267-RC4, 2018

Geoscientific Model Development Discussions

Interactive comment on "Cohesive and mixed sediment in the Regional Ocean Modeling System (ROMS v3.6) implemented in the Coupled Ocean Atmosphere Wave Sediment-Transport Modeling System (COAWST r1179)" *by* Christopher R. Sherwood et al.

Anonymous Referee #3

Received and published: 20 March 2018

Manuscript Number: GMD-2017-267-V1 Full Title: Cohesive and mixed sediment in the Regional Ocean Modeling System (ROMS) Article Type: Research Paper Authors: Christopher R. Sherwood, Alfredo L. Aretxabaleta, Courtney K. Harris, J. Paul Rinehimer, Romaric Verney, Bénédicte Ferré

OVERVIEW OF THE MS: This manuscript describes and demonstrates algorithms for treating fine and cohesive sediment that have been implemented in the Regional Ocean

Modeling System (ROMS). These include: floc dynamics (aggregation and disaggregation in the water column); changes in floc characteristics in the seabed; erosion and deposition of cohesive and mixed (combination of cohesive and non-cohesive) sediment; and biodiffusive mixing of bed sediment. These routines supplement existing non-cohesive sediment modules, thereby increasing our ability to model fine-grained and mixed-sediment environments. Additionally, the manuscript describes changes to the sediment bed-layering scheme that improve the fidelity of the modeled stratigraphic record. Finally, the manuscript provides examples of these modules implemented in idealized test cases and a realistic application.

MY

REVIEW COMMENTS:

I see these finding to be very interesting and of great importance, especially for coastal environmental management, where the accurate prediction of the movement and transport of both purely cohesive and mixed sediments is vital, for issues such as navigational waterways and water quality.

The manuscript is generally well written and correctly structured, some relevant illustrations, and an appropriate range of relevant literature cited and referenced. The study aims and objectives are clearly defined on pp 4.

However, the following points need to be addressed in detail, before this manuscript can be considered for publication.

Well written abstract. I would like to see a few more key quantitative findings reported there, in particular in terms of typical SSC levels and hydrodynamic ranges assessed by the model, plus some key model output values. I would also suggest doing the same for the Conclusion (pp30-31).

In Section 2 – Model Processes: I would like to see a little more background on sediment transport process theory. This would assist the reader with fundamentals behind

how the new model opporates.

In Section 2.2 – Floc Processes: again, I think this section would benefit by having some brief flocculation theory review presented before the floc model description.

I think it would be good to briefly outline the range of different approaches used in flocculation modeling, and why the approach used in this model was chosen.

Other aspects that I would like to see further updated in the manuscript, are slight updates with the Introduction section, where specific aspects could be further strengthened. I would like to recommend including some of the following references in the Introduction literature review. This would significantly strengthen the literature reviewed in the manuscript. These would provide links to recent research findings that would provide synergy and context for the research reported in this manuscript. It would be good if aspects of the following publications were included in the Discussion.

These four publications provide additional insights into cohesive sediment flocculation and associated settling dynamics, together with applied modelling: - Mehta, A.J., Manning, A.J. and Khare, Y.P. (2014). A Note on the Krone deposition equation and significance of floc aggregation. Marine Geology, 354, 34-39, doi.org/10.1016/j.margeo.2014.04.002. - Mietta, F., Chassagne, C., Manning, A.J. and Winterwerp, J.C. (2009). Influence of shear rate, organic matter content, pH and salinity on mud flocculation. Ocean Dynamics, 59, 751-763, doi: 10.1007/s10236-009-0231-4. - Soulsby, R.L., Manning, A.J., Spearman, J. and Whitehouse, R.J.S. (2013). Settling velocity and mass settling flux of flocculated estuarine sediments. Marine Geology, doi.org/10.1016/j.margeo.2013.04.006. - Winterwerp, J.C., Manning, A.J., Martens, C., de Mulder, T., and Vanlede, J. (2006). A heuristic formula for turbulence-induced flocculation of cohesive sediment. Estuarine, Coastal and Shelf Science, 68, 195-207.

These two publications have demonstrated the importance of biological cohesion on bed sediments, as this has an important role on erosion threshold and bio-stability: -

Malarkey, J., Baas, J.H., Hope, J.A., Aspden, R.J., Parsons, D.R., Peakall, J., Paterson, D.M., Schindler, R.J., Ye, L., Lichtman, I.D., Bass, S.J., Davies, A.G., Manning, A.J., Thorne, P.D. (2015). The pervasive role of biological cohesion in bedform development. Nature Communications, DOI: 10.1038/ncomms7257. - Parsons, D.R., Schindler, R.J., Hope, J.A., Malarkey, J., Baas, J.H., Peakall, J., Manning, A.J., Ye, L., Simmons, S., Paterson, D.M., Aspden, R.J., Bass, S.J., Davies, A.G., Lichtman, I.D. and Thorne, P.D. (2016). The role of biophysical cohesion on subaqueous bed form size. Geophysical Research Letters, 43, doi:10.1002/2016GL067667.

This publication provides good general overviews of cohesive sediment dynamics: - Mehta, A.J. (2014). An Introduction to Hydraulics of Fine Sediment Transport, World Scientific, Hackensack, N. J.

Although the manuscript mentions mixed sediments in Section 2.5, it reports very little about the effects of mixed sediment flocculation. As much of the model application could be utilized in areas where there are sand / silt / clay, and biological cohesions, the manuscript would benefit from the citation of some of these recent key publications on the flocculation processes of cohesive and mixed fine-grained sediment suspension, as these outline key processes relating to these suspended sediment types:

* Manning, A.J., Baugh, J.V., Spearman, J.R., Pidduck, E.L. and Whitehouse, R.J.S. (2011). The settling dynamics of flocculating mud:sand mixtures: Part 1 – Empirical algorithm development. Ocean Dynamics, INTERCOH 2009 special issue, doi: 10.1007/s10236-011-0394-7. * Manning, A.J., Baugh, J.V., Spearman, J. and Whitehouse, R.J.S. (2010). Flocculation Settling Characteristics of Mud:Sand Mixtures. Ocean Dynamics, doi: 10.1007/s10236-009-0251-0. * Spearman, J.R., Manning, A.J. and Whitehouse, R.J.S. (2011). The settling dynamics of flocculating mud:sand mixtures: Part 2 – Numerical modelling. Ocean Dynamics, doi: 10.1007/s10236-011-0385-8.

In terms of the erosion-depositional cycle, Spearman and Manning (2008) have

demonstrated that the threshold shear stresses for both deposition and erosion can operate simultaneously, in order to correctly mass-balance accretion and erosion levels of cohesive sediments during tidal cycles in shallow water locations. I would like to see this commented on within the context of your own study findings. - Spearman, J. and Manning, A.J. (2008). On the significance of mud transport algorithms for the modelling of intertidal flats. In: T. Kudusa, H. Yamanishi, J. Spearman and J.Z. Gailani, (Eds.), Sediment and Ecohydraulics - Proc. in Marine Science 9, Amsterdam: Elsevier, pp. 411-430, ISBN: 978-0-444-53184-1.

I would like to see the Discussion (Section 5) expanded slightly, with some comparisons made with other commonly used sediment transport modeling approaches. Some quatification (also in a summary Table) to these comparisons would be helpful. This could advise the reader on where significant improvements and advances have been made with this new modeling approach. It would also be good to comment on the possible limitations on this new modeling approach.

In summary, I think these findings are significant and are worthy of publication in GMD.

Interactive comment on Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2017-267, 2017.