Reviewer #2 responses

The authors appreciate the comments and feedbacks provided by Reviewer #2. Please find below a detailed description about how the authors has addressed both the general and detailed reviewer's comment on the reviewed manuscript.

(R = *reviewer comment*; A = authors response)

General comments

R: *This paper proposes a new method to simulate the evolution of decadal to centennial morphological changes and could be use to help decision making in coastal management studies. The approach is based on a new modular framework that links independent software together such as the one implemented in OpenMI.*

Here the focus is on large-scale coastal evolution and a great development effort has consisted in transposing the behavioural rules of each independent model together in order to pass the information from one model to another. Three models are currently coupled within the CoastalME framework namely: COVE, SCAPE and ASMITA. A great emphasis is made in the manuscript on the first 2 models whereas the integration of ASMITA model with the two others is lacking details and illustrations.

The framework development mainly consists in passing information between each model spatial reference system and consequently involves a lot of geometrical calculations that are fairly well described in the paper. For any given iteration, the model outputs are then stored on raster grid used by the authors as the main spatial representation for their framework. In my view, some parts of the paper in regards to how the model conserves volume through the successive interpolation and smoothing functions is still unclear and will need more explanations.

The authors do not provide any validation examples of their new framework in this paper as it is left for another paper. Two examples are however described in the last section of the manuscript but I found them not really illustrative of the framework capability, as they do not address the problem of decadal to centennial morphological changes that is what this work is about. I also think that these examples will need to be reworked quite extensively to be more appropriate for publication.

A: We are grateful that this reviewer acknowledges that CoastalME is a framework for model linkage, and not a model per se. However, CoastalME does not "link… independent software […like…OpenMI]". Instead, it links an implementation of the concepts which comprise the component models, and not the component models themselves. We do this in order to avoid those incompatibilities of spatial and temporal representation, and of assumptions regarding coastal process, which bedevil OpenMI-type approaches. As stated more than two decades ago by Raper and Livingstone (1995), the next step in model integration should be a fusion of models in a common temporal and spatial representation within anobject-oriented environment which corresponds (at least in part) to the objects comprising the real-world system which is being represented. The OpenMI approach which aims to integrate discrete incompatible systems, each of which makes assumptions regarding time, space and process, inevitably forces representational compromises. Here, we have demonstrated how the concepts which underpin two component models (cliff-beach interaction in SCAPE and the shoreline response to changes in alongshore sediment transport gradients in COVE) maybe implemented and integrated in CoastalME. ASMITA is a component model for estuaries that is not yet implemented in CoastalME.

In the revised paper, we have added new figures and have streamlined the text to better illustrate the CoastalME framework. Please note that smoothing is used only when tracing the coastline and when determining slope gradients on profiles. Mass is fully conserved within the CoastalME framework.

In this paper, we limit ourselves to a description of the framework's structure and the philosophy which underpins it, together with some results from a linkage of SCAPE and COVE as proof of concept. The test examples are an illustration of how the resulting integrated framework has extended the capabilities of the component models. We will aim in subsequent publications to demonstrate the potential of CoastalME's linked raster-vector approach for informing coastal management.

Raper, J. and D. Livingstone (1995). "Development of a geomorphological spatial model using object-oriented design." International Journal of Geographical Information Systems 9(4): 359-383.

Detailed comments (L#: Line number)

R: *Page 2 line 18: space missing "in particular be the Open Modelling Interface. . ."*

A: Amended.

R: Page 4 line 4: space missing "specific models (Murray"

A: Amended

R: *Page 4 line 16: change "provide as a significant " to "provide a significant "*

A: Amended.

R: *Page 4 line 24: change "meso-escale" to "meso-scale"*

A: Amended.

R: *Page 6 line 16: missing) after Wadden Sea).*

A: Added.

R: *Page 8 line 4 to 6: indeed CA models have been used on regular grid but I don't see why you are citing them here most current hydrodynamic/sediment transport models are based on gridded spatial discretisation. I will just delete this sentence. . .*

A: The above sentence has not been deleted. The authors argue that, as the text stands, it provides an easy-to-follow narrative.

R: *Page 8 line 14: delete "More seriously,"*

A: Deleted.

R: *Page 8 line 17: space missing "-LewyCondition"*

A: Added.

R: *Page 9 line 10: Model output of the model consists. . .*

A: Amended

R: *Page 10 line 27: "SWL can be fixed or assumed to change linearly every time step", does the user input a sea-level curve and SWL is linearly interpolated based on this curve? If this is the case you will need to make it clearer in this paragraph.*

A: At present only the value of the SWL at the end of the simulation is provided as a user input. This is now made it clear on the revised manuscript.

R: *Page 11 lines 3 & 14 and page 12 line 14: how do you ensure mass conservation when using smoothing algorithm?*

A: Grid smoothing is not now needed. The grid smoothing routinehas been removed from the updated code and is no longer mentioned from the manuscript. It is important to notice that the coastline is smoothed only in order to draw the coastline-normal profiles. The start of the coastline profiles is the raster cell identified as a coastal point by intersecting the water level at each time step with the DEM. This coastline smoothing ensures that the planform orientation of the coastline-normal profiles is not unrealistic, as would be the case with an unsmoothed coastline traced directly from the discrete cells of the raster DEM.

R: *Page 11 line 15: how to you set the profiles on the grid edge and why aren't they normal to the coastline? Additional explanation is required. . .*

A: Grid-edge profiles must run along the edge of the grid. So unless the coastline intersects the grid edge exactly at a right angle, the grid-edge profiles will not be normal to the coastline.

R: *Page 13 line 15: instead of "(code availability)" provide the link to the configuration file (maybe using a shortened url:*
(http://www.coastalme.org.uk/doku/doku.php?id=inputs_and_outputs:myinputs.dat)

A: Instead of adding the urls within the main text, the code availability section has been re-edited and all important urls have been made explicit.

R: *Page 13 line 29: again instead of code availability, provide a direct link to where this information can be found on the web.*

A: see response to comment above.

R: *Page 14/15 1ines 25 to 29 and 1 to 3: you should reference Figure 4 in this section to make it more clear to the reader and add some of the defined notations to Figure 4.*

A: Reference to Figure 4 has been included in the revised manuscript and the whole document structure re-organized to make it more clear to the reader.

R: *Page 15 line 12/13: smoothing the coastal profiles require an additional step in the computation in comparison to the method implemented in COVE, you should explain how the resulting curvature calculation improves the prediction of alongshore sediment transport algorithm in the context of CoastalME.*

A: In COVE the coastline is made of a relatively small number of discrete nodes while in CoastalME the coastline is made of a considerably greater number of discrete raster cells. Thus in CoastalME there are many more coastal points between two polygon boundaries than in COVE. Rather than

favouring any single raster point on the coastline, we have used a smoothed coastline to trace the profiles. This smoothed coastline is conceptually equivalent to the use of adjacent nodes in COVE.

R: *Page 16 line 13: you should provide the equation for the downwearing erosion "*

A: The downwearing erosion is equation is explained in detail in section 3.5. This has been now clearly stated on the revised manuscript.

R: *Page 16 line 25: Is it possible to set some spatially variable active layer availability factors for each sediment? How is the availability factor for the active layer related to the active layer through time? For example let assumes that is set to 0 for a given sediment type and that through simulation time steps some of these sediments start to be deposited, does it mean that they will never been eroded away. I guess this is not the case but it requires better explanation in this section.*

A: At present the availability factor in the active layer is constant and uniform spatially but there is nothing preventing the user modifying the CoastalME framework to ensure that this value actually varies spatially and over time. Neither SCAPE or COVE has an active layer concept but in CoastalME input file we allow the user to define different erodibilities to the different sediment fractions.

R: *Pages 17 to 19 section 3.3 will need to be shortened and will greatly be improved with a figure or diagram to help readers. This is really important as it defines the alongshore transport algorithm. Something similar to what is done in section 3.5 with Figure 11 will be really helpful.*

A: The whole document has been re-organized and shortened and more illustrative figures included in the revised manuscript.

R: *Page 21 line 28: "is considered to have its base a user-specified depth d1 below the SWL, " this sentence doesn't read well and needs to be rewritten.*

A: The sentence has been rewritten as The base of the cliff notch is considered to be at a user-specified depth d1 below the SWL, and the notch is considered to be eroded a length L1 inland (Fig. 11a). ""

R*: Page 23 line 6: is the sediment porosity depth dependent, in other word do you account for compaction of sediment with time? I guess this could be important considering that the code is designed to look at centennial morphological changes.*

A: Compaction is not considered by either COVE or SCAPE and therefore is assumed constant in CoastalME. There is nothing preventing the user adding a rule to the raster cell class that modifies the porosity over time.

R: *Page 23 line 8: like comments above I will suggest that instead of code availability, you should provide a direct link to where this information can be found on the web.*

A: Instead of adding the urls within the main text, the code availability section has been re-edited and all important urls have been made explicit.

R: *Page 23 lines 10 to 27: you only mentioned the duration of your model in the Figure 12 caption this needs to be provided in the text as well. The purpose of this new code is to work at decadal to centennial scale I understand that you are planning to do a second paper but it will be good to have an example that is relevant to this scale in this paper. I would also like to see the full DEM result as well and not only a small part of it in Figure 12. You should also provide the time involved to simulate this 1-year morphological evolution so people can judge on the performance of the code.*

A: The duration of the model simulations relative to the Figure 12 has been included in the main text of the revised manuscript. Both COVE and SCAPE are models developed to work at decadal to centuries time scale. CoastalME it is a framework that integrate these two models and therefore is by definition applicable to decadal to centuries time scale. We have increased the spatial extent of the test cases from a small 1000m x 500m domain to a larger 100 km x 20 km domain to better illustrate the applicability of the proposed framework to large scale simulations. The performance of these new test cases has now been included in the revised manuscript.

R: *Page 24 line 1: COVE2015 needs to be changed to COVE.*

A: Amended

R: *Page 24 lines 11 to 19: there is no mention of the settings of this experiment and of its duration. . . you wrote a "sufficiently long time" you will need to provide some numbers here. I think this part needs to be more developed. At the moment the description and interpretations of the results are lacking.*

A: See above the response to comment on Page 23 lines 10 to 27.

R: *Page 25 lines 7 to 9: you will need to provide some metrics of the code efficiency and CPU time to make it clearer in your manuscript.*

A: Metrics of code efficiency and CPU time (i.e. ratio of simulation duration and simulated time) has been included on the revised manuscript.

R: *Page 25 lines 10 to 12: can you be more specific are you referring to a possible alternative to model like CAESAR? This last sentence will need to give the reader a better idea of how this could be done more references or should be deleted.*

A: Yes, the proposed modelling approach is an alternative to cellular landscape evolution models such as CAESAR (Coulthard et al., 2002) and RILL-GROW (Favis-Mortlock et al. 2000). This has now been clearly stated in the revised manuscript and the references below added.

Coulthard, T. J., Macklin, M. G., Kirkby, M. J., 2002. A cellular model of Holocene upland river basin and alluvial fan evolution. Earth Surface Processes and Landforms, 27, 3: 269–288. 10.1002/esp.318

Favis-Mortlock, D.T., Boardman, J., Parsons, A.J. and Lascelles, B. (2000). Emergence and erosion: a model for rill initiation and development. Hydrological Processes 14(11-12), 2173-2205.

R: REFERENCES. Several of the references are from Wikipedia, you should provide citable references instead. In several parts of the manuscript (as pointed above) you refer to "code availability" instead you should provide the link to the places where the reader can find the information on the code website. I found 3 references which are not complete and are missing journal names or editors: - Hutton 2014 - Stive 1997 - van Rijn, 2002

A: References to Wikipedia has been replaced by peer reviewed papers and DOIs included where missing. The above cited references has been amended on the revised manuscript.

FIGURES

R: *Page 35 Figure 5 will need a color bar for the DEM on the left side and the resolution of this figure will need to be improved*

A: colour bar added and resolution increased to 600ppi.

R: *Page 36 Figure 6 line 4-5: change “”this” (white dot) coastline node” to “the considered coastline node (white dot)”.*

A: Amended as suggested.

R: *Page 37 & 38 Figures 7 & 8: resolution needs to be improved*

A: Resolution increased to 600ppi.

R: *Page 39 & 40 Figures 9 & 10: resolution of the text parts needs to be improved. In Figure 10 I think you should not plot the breaking wave height legend it is confusing as there is no colored dot on the figure itself.*

A: Resolution of the text parts on Figures 9 & 10 has been increased. There are coloured dots along the shoreline representing the breaking wave height but might be confused with the wave height colours. A different colour scheme has been selected for the breaking wave height on the revised manuscript.