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Interactive comment on "Modelling braided river morphodynamics using a particle travel length framework" *by* Alan Kasprak et al.

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Anonymous Referee #1

General Comments

Referee: The manuscript presents an effort of modelling braided river morphodynamics by combining a 2D hydrodynamic model and a path-length based algorithm. The topic is relevant to an important issue on the earth surface dynamics, and it is should be interesting to readers of this journal. The aim of present hybrid approach is to develop a new framework of model to predict the braided river processes with limited computation time. Model predictions have been compared with two natural braided river for multi-scalar verification. The object of this study is clear. However, basic method is not

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Discussion paper

described sufficiently, and then it is difficult to estimate the value of the new model. In addition the prediction is not close enough to the measurement even in the statistical meaning, and the discrepancy is not explained enough. Therefore, in my opinion, the current version of this manuscript should be improved before being accepted by the journal for a publication.

Response: We thank the reviewer for their positive comments on the importance and relevance of this work, and for their insightful suggestions for revising the paper. We have made changes to the methodological descriptions (Section 2) within the manuscript in accordance with the Reviewer's suggestions, and believe that this section has been considerably improved clarified by this, and the subsequent two reviewers' comments.

Specific Comments

Referee: 1. Page 5, Lines 21-25, Section 2.1: It is not clear if time derivatives are included in the model? In the model description, "Delft3D solves the shallow-water form of the Navier-Stokes equations, which related changes in momentum (left-hand terms) in time and space . . .", while the terms of time derivative are not included in Equations 1-2.

Response: They are not; the Reynolds Averaged Navier Stokes Equations are used in Delft3D. This is a time-averaging of the Navier-Stokes Equations, and thus does not require time derivatives to be included. We've updated the text to reflect that the RANS are used here.

Referee: 2. Page 6, Lines 1 & 8-9: "Where x and y, respectively, denote the streamwise and cross-stream directions of velocity (u, v), . . ." Does the "streamwise" mean the river direction? Because the "For all modelling, we employed fixed Cartesian orthogonal grids", and the velocity changes over time and space. It is unclear whether the x and y is in a Cartesian coordinate system or other curvilinear coordinate system?

Response: Cartesian coordinates were used for all model simulations; we have specified that DEMs used in hydraulic modeling were rotated such that x-directions corresponded to the streamwise direction and y-directions corresponded to cross-stream directions.

Referee: 3. Page 8, Lines 15- 20: This part is the key solution of the proposed model framework, however, it cannot be understand clearly how to calculated the morphological change rate by using Equation 7 and with the concept of "integrated sediment transport pathways". More description and comments are needed at least here. Without a confirmed understanding, the value of the new model cannot be estimated sufficiently and the results would not be analyzed correctly.

Response:Thank you for pointing this out. The succinct answer is that an Exner/continuity approach for computing bed elevation change is suitable at short model timesteps, but not at the event-scale timesteps that MoRPHED is intended for. These long timesteps, in combination with Eq (6) would lead to topographic and numerical instabilities very quickly. In lieu of the traditional Exner-based approach, we used Eq. (7) to predict bed sediment scour, and in combination sediment derived via bank erosion (2.3), this material was transported downstream and deposited according to a user-specified path length distribution (Section 2.4).We have clarified how Eq. (7) was used in the model, and also why Eq. (6) wasn't used, and believe that this will more fully convey the operation of MoRPHED.

Referee: 4. Page 9, Lines 25-30: It is not clear, when a bank erosion would occurred. Is there any relationship between the "7%" and angle of repose? What is the mean of "we set this threshold area to 30 cells, again adjusting this value to mirror the size of field-observed bank erosion patch"? This part is a key procedure for the river migration, however the meanings are too ambiguous.

Response: The 7% threshold was determined by calibrating predicted areas of bank retreat, as a function of Equation 11, to field-observed areas known to have undergone

bank erosion and lateral migration. We've updated the text to reflect that while the 7% threshold used here was certainly below the angle of repose for unconsolidated gravel, we decided to take an inclusive approach to delineating candidate cells for bank erosion. The 30-cell area threshold was used to limit bank retreat to groups of cells exceeding a certain area for computational efficiency. We believe that the edited text will improve the clarity of this section.

Referee: 5. Page 10, Section 2.4: The general meaning is not clear for this section. Firstly, "velocity vectors need not pass through the centre of each cell." Why? And what is the result for the "Bed/Bank Sediment Transport and Deposition"? Secondly, how to combine the 5x5 deposition window of cells and the path length distribution in the model? Comments and figures should be used to illustrate the complex an core relationships.

Response: We've reworded the writing in this section to clarify that (1) while MoRPHED is a raster, or grid-based model, Delft3D produced streamlines which were inherently vector-based. To reconcile these two data types, streamlines were 'snapped' to the nearest cell centre for subsequent computation of sediment scour, transport, and path-length mediated deposition, and that (2) the result of this workflow is the deposition of a fraction of entrained sediment, which is given by the downstream distance from the entrainment location and the user-specified path-length distribution.

Referee: 6. Page 12, Line 5: How to determine the Z_ACT?

Response: In response to the suggestions of multiple reviewers, we have removed the original Section 2.6, which detailed the grain size and stratigraphic evolution component of the model, as this manuscript only presents results from single-fraction modeling runs. Subsequent sub-sections within Section 2 have been re-numbered accordingly.

Referee: 7. Page 13, Lines 25-30: DoD means "Difference of DEM" or "DEM of Difference" or others?

Response: DoD refers to a DEM-of-Difference; this is articulated in the Section heading and on line 6, page 14 of the revised manuscript.

Referee: 8. Page 18, Line 30: There is only a single sub-section 4.2.1 in this section.

Response: We have removed the text that referred to Section 4.2.1 within that same section.

Referee: 9. With regard to results and discussion, it is difficult to assess the agreement and disagreement of predictions without fully understanding of the model.

Response: We believe that the clarifications made to the methods and algorithms underlying the model (Section 2) will provide a better grounding for understanding the Results and Discussion components.

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