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Earth Surface Dynamics Discussions

Interactive comment on "Developing and evaluating a theory for the lateral erosion of bedrock channels for use in landscape evolution models" *by* Abigail L. Langston and Gregory E. Tucker

Anonymous Referee #1

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This paper describes a new approach to incorporating lateral channel erosion into landscape evolution models. This is clearly a worthwhile goal and I was excited to read this. That said, there are aspects of the model setup and motivation, as described below, that I think can be improved upon and which I think will lead to a paper with more impact.

1. Specifically, this paper uses a curvature based wall erosion law. While the authors don't expressly say they are modeling meandering, this is the implication of the choice of model. This makes sense as meanders are ubiquitous in bedrock channels and

the process is clearly important in many settings. The first numerical model of river meandering that I am aware of is Howard and Knutson (1984). Their first iteration of the model is one in which erosion scales inversely with the radius of curvature, which is basically the same as the model posed in equation 10. Howard and Knutson point out that such a model results in a channel that breaks down into 3 point bends with alternating positive and negative curvature. When applied to an existing meander bend, the bend can't be maintained. The ultimate conclusion of Howard and Knutson (1984) is that lateral channel motion can't be driven only by local curvature because such a model fails to produce realistic meander kinematics (down stream translation, cutoffs) as well as realistic meander forms. This is what leads to their downstream convolution approach, which in a simply way simulates the advection of the effects of upstream curvature downstream. Given that the setup of the model in the submitted MS is based on a centrifugal acceleration argument, and given that the morphologies of the channels produced in the model are reminiscent of the 3 point bends described by Howard and Knutson, it's not clear to me how this model represents a significant advance in understanding and modeling lateral erosion. Moreover, it's not clear how the river even changes from moving in one lateral direction to the other. Without passing information downstream, I would expect the bends to grow unstably.

What is novel, from my perspective, are the two different formulations of the wall erosion law. Why not, then, simply use the Howard and Knutson meandering model and then explore how the two different wall erosion formulations influence the emergent valley form? Given that field evidence that can discriminate between the two proposed lateral erosion processes should be straightforward to collect, I could see such an exercise leading to numerous field testable hypotheses.

2. While I like the exploratory aspect of this paper, I think it could benefit from either a sharply formulated research hypothesis or a field example or two that are targeted. As is, it's not clear how me can evaluate the performance of the model other than by simply noting that the river causes the valley walls to move. But I think we could do

better.

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