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Interactive comment on "Geomorphic signatures of the transient fluvial response to tilting" *by* Helen W. Beeson and Scott W. McCoy

Anonymous Referee #1

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The authors have tackled an interesting problem in this manuscript in seeking the signature of transient fluvial network response to tectonic tilting. They identify characteristic features in simulated river profiles generated by 1- and 2-D landscape evolution models responding to tilting, propose a means to calculate the timing and magnitude of a tilting event based on river profile geometry, and compare their model results to river profiles from the northern Sierra Nevada, proposed by several studies to have undergone tilting during the late Cenozoic. The paper is well-written and the model setup and results are straightforward and clearly described. Identifying the characteristic topographic signature of tilting is a worthy goal and could be a valuable contribution toward understanding the climate-tectonics-topography system especially in extensional settings. The numerical modeling the authors have applied to the problem is a rea-

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Discussion paper

sonable approach, and in conjunction with analysis of natural landscapes, could yield useful results. The interpretations that the authors make of their model results seem sound, but there are some significant issues that need to be addressed.

- Why weren't any simulations included in which tilting is imposed gradually, or, even better, with a varying rate? While the instantaneous tilt scenarios are worth including, it doesn't necessarily seem reasonable to interpret the features resulting from an instantaneous tilt in the same way as those resulting from a realistic, gradual tilt. At the very least, if the authors maintain that the simplified model scenarios produce comparable features that can be interpreted in the same way, some explanation as to why should be included.

- In Figure 7b it's really difficult to tell what's going on in the chi plots. In general, I'd love to see a little more from 2-D model runs included, and analysis of the resulting profiles done in more detail. It's important to examine how even the complexity introduced by the tributaries not being perpendicular to the mainstem affects how well timing and magnitude of a tilt can be resolved. I think it would strengthen the case the authors are making by having detailed analysis of a 2-D tilt simulation as an intermediary between the 1-D analysis and the Middle Fork American River. The inclusion of the 1-D simulations of different sorts of perturbations and the features that appear in river profiles as a result is really nice for this sort of paper, but without some sort of intermediate complexity analysis before jumping right into the Sierra Nevada analysis it almost undermines the authors' conclusions by reminding the reader of all the different ways channel profiles can respond to various perturbations even in an highly simplified model. Then, by the time the analysis of the real river comes around, it leaves me wondering how meaningful the results actually are in a system that's so vastly more complex.

- Figure 7c, would we see a similar relationship between channel segment azimuth and ksn along a linear mountain front where uplift was not driven by tilting?

- 6.1, Line 14: Would 5 Ma. be the onset or termination of tilting?

- 6.1, Line 26: I have a hard time with any interpretations of knickzones that were above the glacial limit as containing meaningful information about tectonics.

- I don't quite understand the rationale of choosing this location to test the model results. I don't know much about Sierra Nevada tectonics, so I'll defer to others on whether recent tilt is a valid hypothesis, but even just the combination of extensive Pleistocene glaciation and lithologic heterogeneity seems like it would make it a difficult place to make a comparison to simple, 1-D model results. Even in the unglaciated reaches of these rivers, sediment supply and discharge would have been varying wildly throughout the Quaternary. Not to say the Sierra Nevada stuff should be thrown out, but it might be more convincing to include some analysis of river profiles from a simpler tilted-block range. The model results in general are straightforward, but where K, m, and n seem like they could vary so widely in space and time, I just don't know that I trust interpretation of the knickzones in this river as being tilt-related features.

- In 6.2 and Figure 11, how was it determined whether a knickzone collapsed with the mainstem? Was it just determined visually or were there some other criteria?

- 6.3, Line 23: Shouldn't this degree of tilting be causing pretty rapid migration of the main divide? That could really complicate sorting out knickpoint migration velocities.

- Along with this, it might be really cool to analyze the back-tilted catchments on the opposite side of a tilting range in conjunction with the forward-tilted ones.

- Figure 13 could really benefit from a chi plot or something to better show the capture event. It's hard to tell exactly why it's being interpreted that way.

Overall, this is an interesting and readable manuscript that with additional analysis (a detailed look at a 2-D model river network and/or analysis of river profiles from an area with simpler lithology and a simpler history) could support its conclusions much more strongly. As is, I still have some doubts about how robustly the signature of tilting is preserved.

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