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Interactive comment on "Dimensional analysis of a landscape evolution model with incision threshold" *by* Nikos Theodoratos and James W. Kirchner

Anonymous Referee #2

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The authors present a dimensional analysis on a landscape evolution model that includes an incision threshold. In their analysis, they non-dimensionalize a landscape evolution model with an incision threshold using the same length, height, and time scales from their previous analysis (Theodoratos et al., 2018). They show that adding a threshold changes the model from a 0-parameter model to 1-parameter model, named Nθ. In this model, simulations using the same value of Nθ show geometric similarity, and simulations increasing Nθ cause an increase in dimensionless relief with Nθ + 1. Last, they find increasing Nθ effectively causes fluvial processes to be isolated to valleys.

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Discussion paper

This manuscript is a thorough and straightforward presentation of a landscape evolution model including an incision threshold. This analysis is a logical and sensible next-step after the authors' previous work (Theodoratos et al., 2018), yet their results and discussion are still novel. The manuscript is well-written and understandable. I recommend acceptance of this manuscript without any modification. I look forward to the future work of the authors.

Line Comments: Page 2, Line 9-12: Interesting thought. Is there a way to implement an intermittency factor into the model to simulate this?

Page 3, Line 16: How do you expect your results of varying Nθ to change with a non-linear hillslope diffusion formulation?

Page 3, Line 29 to Page 4, Line 8: Could this paragraph by summarized into a table or set of equations?

Page 5, Line 7-8: What sets the maximum value of curvature in Figure 8?

Page 7, Line 32-38: What is the rationale behind scaling the initial conditions with the length and height scales? Without this that the landscape will not be geometrically similar, but I'm not sure why the height of the initial randomization and topography should scale with parameters. A super bumpy initial surface may look flat at a zoomed-out scale and vice versa.

Page 8, Line 28-34: Great illustrations of how your dimensional analysis works.

Page 9: A good set of illustrations to show the effects of varying Nθ. Through explanation.

Page 11, Line 1-2: I find this discussion though provoking. What sets the value of Nθ = 4? and how would your results change if the initial condition was more or less bumpy?

Page 12, Line 27-29: Can the authors hypothesize what this additional effect is? Are the smaller catchments becoming more diffusional as the incision threshold is in-

creased? This would increase the positive curvature in the valleys, but perhaps this increase in curvature does not scale with 1+ Nθ. Could plotting how the ratio between area of no incision and the total area with Nθ be informative?

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