

Recommendation following revision

(by Jean Braun, Associate Editor)

Manuscript entitled *Landscape evolution models using the stream power incision model show unrealistic behavior when m/n equals 0.5*

by Kwang and Parker

I wish first to thank the authors for greatly improving their manuscript by taking into account most of the two reviewers suggestions. **Reviewer 1** argued that the peculiar behaviour of SPIM highlighted by Kwang and Parker is well known but is unlikely to be realized in nature. The authors adequately refute the first argument by noting that the scale invariance they highlight has not been adequately mentioned and studied in previous studies. They added a small section in their discussion to this effect. Concerning the second argument raised by the reviewer, they note that introducing a critical hillslope length scale does not resolve the issue of relief dependence on profile length and further renders the results of the SPIM strongly dependent on the choice of the critical length scale. They added an additional section (8) in the manuscript describing this in details. **Reviewer 1** also stated that the author should widen their study to describe whether other landscape evolution models suffer from the same singularity and/or scaling behaviour. The authors responded by adding a new section (7) to their manuscript where they show that another lesser utilized model by Gasparini et al (2007) does not suffer from the problems concerning the SPIM. The authors responded adequately to the Reviewer's comments concerning the omission of hillslope diffusion and channel width dynamics in their model. **Reviewer 1** also remarked that the behaviour described by the authors is limited to a peculiar choice of the ratio m/n , but the authors responded that the relationship between scale and relief is odd for most values of the ratio m/n . I do follow the authors on this point too, although I would have appreciated that they further document their statement that *We can think of nothing about the morphodynamics of natural systems that would dictate such a behaviour*. Do we know what the natural system behaviour is? Does relief increase or decrease with scale, everything else being kept constant? A short section/sentence on how relief scale with the horizontal scale of the system in areas dominated by bedrock incision would be welcome. Finally **Reviewer 1** made two suggestions. The first concerns the consequences of using a scale-invariant model and the second whether a better model could be designed that does not suffer from scale invariance. The authors responded positively to both suggestions by adding a long section in the discussion concerning the first point and a new section concerning the second. In both cases, their arguments are valid and, in my opinion, greatly improve the impact of the manuscript.

Reviewer 2 also questions the importance of the authors' findings by calling it an *anecdotal result*. The authors argue that the value of $m/n = 0.5$ is the most commonly used value in the literature. To make the point they added a list (as supplementary material) of key papers where $m/n = 0.5$ has been used.

Reviewer 2 argued that the inclusion of a critical hillslope length scale or diffusion term is commonly used

to remedy the problem highlighted by the authors. As discussed above the authors refuted this point by inserting an adequate discussion in the manuscript on the effect of adding diffusion or a critical length scale. As proposed by Reviewer 1, **Reviewer 2** also suggested that the authors find ways to render their manuscript more *useful* and *positive* by highlighting the consequences of using m/n and proposing alternative models. The authors have, in my opinion, responded positively to these suggestions (see response to Reviewer 1 above).

In conclusion, I believe that the authors have very positively and adequately responded to the two reviewers comments, critics and suggestions. It is comforting to see that both reviewers made very similar remarks, which, in my opinion, really helped to improve the manuscript.

It is also my opinion that this manuscript highlights an interesting behaviour of the most commonly used equation for large-scale landscape evolution (at least in situations where bedrock incision dominates) that deserves to be published. Despite the fact that this behaviour is (more or less) known to those actively working with SPIM and its implementation in numerical models, it deserves to be made clearer to the community. This manuscript can also be seen now as a warning to all potential users of the potential *unnatural* consequences of using SPIM. In its improved/modified form, the manuscript also points to the existence of other representations of bedrock incision that do not suffer from this scale invariance and singular behaviour. It should, therefore, in my opinion, be sent to **Reviewer 2** who has asked to see the revised version and, unless he/she indicates that further modifications are needed to improve the impact of the manuscript, it should be accepted pending minor revisions. These revisions should include a short discussion on what we know about the scaling relationship between system length and relief in natural systems (see my comment above).