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Interactive comment on "Numerical modelling landscape and sediment flux response to precipitation rate change" *by* John J. Armitage

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We would like to thank Laure Guerit for taking the time to review our manuscript. Below we respond to the major comments raised:

(1) This work would benefit from some rewriting and reorganization to make the purpose of the authors more clear and easier to follow: some paragraphs could be reorganized and/or developed in particular to better highlight the state of the art in the domain (Introduction) or to develop some important aspects of the work (Method).

We have rewritten the introduction and methods section. In the introduction we have now tried to better place the numerical models within our current understanding of system response to precipitation rate change. However, rather than move the main

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equations for the stream power model and the transport model, we would prefer to keep them within the methods section. This way they follow logically from the derivation and basic assumptions. To a non-specialist it can be a bit distracting to launch straight into the stream power law equation, for example.

The methods section has been reorganized. We now include Appendix B within the methods, which allows us to demonstrate how the transport model and stream power model evolve with out a perturbation, and where their predicted slope-area metrics are similar.

A particular point was raised in the review relating to the different grids used for the transport and stream power models. In the transport model, we us a triangular mesh and for the stream power model we use a rectangular mesh. The model resolutions are therefore not exactly the same.

The transport model solves the equations using a finite element approach, and a triangular grid is 2nd order accurate and an appropriate. The stream power model uses a finite difference approach with a rectangular grid, which is also 2nd order accurate. It is known that resolution can effect the drainage patters predicted in these sorts of models (see Schoorl et al., ESPL, 2000). For this reason we attempted to get the model resolutions to be similar. We also checked that the sediment flux was not influenced by grid resolution for both models. We are not convinced however, that this detail requires to be discussed within the manuscript.

The second point relating to the methods was the choice of perturbing the model at either 10 or 5 Myr. The non-linear models were perturbed sooner, at 5 Myr, because the 1D models were at steady-state by 5 Myr, and we did not see reason to run them for longer before the precipitation rate was changed. This point has been clarified within the methods section.

(2) The second major comment related to how we only changed the final precipitation rate, and held the initial precipitation rate fixed at 1 m/yr for all models. It was suggested

that we explore how the model response is a function of the initial precipitation rate.

This was a good suggestion. We have added a new section exploring how both models, in their linear and non-linear forms respond to a change in initial precipitation rate where the final precipitation rate is held fixed at 1 m/yr for all scenarios (Figure 1). We have found that for the transport model, the response time is sensitive to the initial precipitation rate (Figure 1a). However the proportionality does not fit a power law as was found for the relationship between response time and the final precipitation rate. Furthermore, the change in response time as the initial precipitation rate changes is of an order of magnitude, suggesting that response times are predominately a function of the final precipitation rate (Figure 1a).

For the stream power model we find that the response time is not a function of the initial precipitation rate (Figure 1b). We believe this difference is in how the transport model responds directly across the whole catchment, so that slopes at the uppermost reaches of the catchment still have a memory of the previous precipitation rate. For the stream power model, the erosion increases bottom-up and so there is no memory of the previous slope and topography.

(3) The third major comment relates to the discussion, that we are overestimating the duration of the Claret Conglomerate deposition. Furthermore, Laure Guerrit asks what evidence there is that sediment fluxes changed.

We have incorporated the Schmitz and Pujalte 2007 reference which Laure suggests; this paper suggests the timescale of deposition of the Claret conglomerate could be less than 10 kyrs. We have deleted any reference to palaeosols in the Bighorn basin and have simplified the calculation of the duration of the PETM conglomeratic deposition. We know that the sedimentation rates and sediment fluxes must have increased – Taking the Schmitz and Pujalte rates which Laure advocates suggests a sedimentation rate of 1 mm/yr – this is an order of magnitude bigger than for the rest Tremp Group and we now mention this explicitly.

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(4) Laure Guerit asks if we could plot the stream power model response as a function of precipitation rate for other values of m.

The relationship between response time and m has been published elsewhere (e.g. Wipple, 2000). We are not convinced it is necessary to add further plots of response time for the stream power model in this manuscript, particularly when we wish to focus on model cases where the landscapes are similar.

Finally, we have addressed all the minor comments in the revised manuscript.

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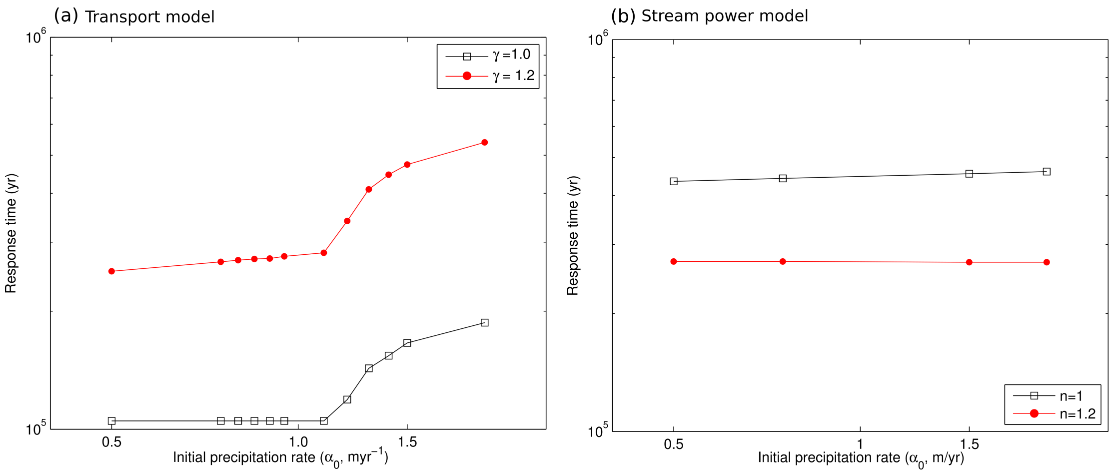

Fig. 1. Log-log plots for the transport model and the stream power model in 1-D for a step change in precipitation rate, where the initial precipitation rate is changed.