Dear Dr. Simon Mudd,

Thank you for your continued guidance and for providing further insightful feedback on our manuscript, "Rainfall and Tectonic Forcing Lead to Contrasting Headwater Slope Evolutions". Your detailed comments have been instrumental in helping us refine our work further.

We have carefully addressed each of the points raised in your most recent decision letter. Below, we provide a detailed, point-by-point response outlining how we have incorporated your comments and suggestions into the revised manuscript. For clarity, our responses are shown in green, and the corresponding new or revised text is shown in blue.

We are confident that these revisions have resolved all outstanding concerns and significantly strengthened the paper. We hope you will agree that the paper is now ready for publication in ESurf.

Thank you again for your valuable input.

Sincerely,

Yinbing Zhu (on behalf of all co-authors)

Response to associate editor Simon Mudd

I have now read through the manuscript and the response to reviewer comments. I am satisfied the authors have addressed reviewer concerns.

I have a few comments about the model behavior that the authors can see in the annotated pdf. 1) There should be a statement about the pixel size and the length of hillslopes (hillslopes are shorter than 400m in many landscapes, some comment on the grid spacing is warranted.

Thank you for your helpful comment. Our model does not include sub-grid scale channels. To test whether resolution affects our findings, we have repeated selected simulations at a finer resolution of 200 m. We have illustrated the results in the supplementary document. The overall landscape and dynamic responses remained consistent across both resolutions, demonstrating that our results are not artifacts of grid size.

We have added the following sentences in the Methodology Section:

We acknowledge that our 400 m grid spacing is larger than hillslope lengths in many natural landscapes. However, a sensitivity test at a finer 200 m resolution confirmed that our primary findings are robust and not an artifact of the chosen grid size (Fig. S1 and S2).

2) There needs to be a discussion of how drainage density was calculated. If it is calculated via an area threshold then this will totally dominate the drainage density numbers. The authors need to explain how it is calculated and if it is via a threshold I don't think it is useful to report the numbers. The paper will not lose much since the interesting component is the behaviour of gradients near the top of the drainage network.

Thank you for your great comment. We used an area threshold to calculate the drainage density. We agree that using a threshold drainage area on our grid does not yield a robust measure of drainage density. This metric is sensitive to a user-defined threshold and our grid scale might be too coarse to identify channel heads reliably. Following this advice, we have removed the content about the drainage density from the manuscript and revised Figure 3. The paper is now strengthened by focusing on our more robust findings related to channel gradients and transient slope response.

3) Something should be said about how the fluvial and hillslope erosion components interact in the model and if the increases to elevation in concave portions of the landscape due to diffusion are treated as new "bedrock" for the fluvial process to erode. If this is the case, it will amplify the gradient effects and needs to be commented upon in the manuscript by the authors.

I will let the authors consider these comments and make adjustments accordingly, they have addressed almost all concerns so I am marking this a "technical corrections" decision.

Thank you for this insightful suggestion. According to the suggestion, we have added two sentences to the Methodology Section to explicitly state that the model does not differentiate between bedrock and sediment. The two sentences are as follows:

Any material delivered to a channel cell from adjacent hillslopes increases the elevation of the cell. The river then erodes this new surface as if it were bedrock, without distinguishing it from the underlying substrate.

In addition, we have revised the last paragraph in Section 3.1 of the Results to clarify the elevation increase and the amplification of the channel gradient. The revised paragraph is as follows:

Stronger diffusion smooths local slopes but also increases the flux of material into valleys. In our detachment-limited model, any material added to the channel from hillslopes is treated as bedrock, meaning the river must incise through it with the same efficiency as the underlying rock. To maintain equilibrium with a constant uplift rate, the river must therefore steepen to gain the power needed to erode both the uplifted bedrock and the additional material load (Litwin et al., 2025). This behavior represents an amplification of the channel gradient response, as the channel must become steeper than if the hillslope material were treated as easily erodible sediment. As stronger diffusion widens valley spacing and forces channels to steepen, the total relief and mean elevation of landscapes increase.