Response to comments from Anonymous Referee #2

The manuscript is well organized, and the topic is attractive. In the Introduction section, the authors made a good summary of the work of their predecessors, and then put forward their own new understanding through the method of numerical simulation. The method is reliable. I read the manuscript with great interest as it is full of important knowledge in the field of drainage system evolution. However, after careful reading and consideration, I think there are two significant issues which need to be addressed before the possible publication of this manuscript.

Major concerns:

(1) Why the mean elevation increase when the hillslope diffusion increase? This is counterintuitive. In Line 134, the authors also consider it as an astonishing phenomenon. However, the authors did not present the explanation. The topographic differences affect the migration time of the knickpoints from low to high. For example, the adjustment time of river channel in Figure 5a1 is ~2 Ma, while that in Figure 5c1 is ~4 Ma, which are the conclusion of this manuscript. Moreover, from Figure 5a1 and c2, we can also see the difference in the channel slope, which is consistent with the difference in elevation. When the area and erosion coefficient remain basically unchanged, the slope differs by three times, but the erosion rate remains the same? This is not follow the rule of the stream power model ($E=KA^mS^n$). In Lines 234 and 236, the authors use the phrases of "wider divide" and "narrower divide". Therefore, a possible explanation is that the hillslope area is not included in the drainage area. However, the divide should be a curve without width. Therefore, I suggest that the authors check the setting conditions of the numerical simulation or give a reasonable explanation for this surprising phenomenon.

Thank you for drawing attention to this point. To address this issue, we have calculated and added the "drainage density" (total channel length per unit drainage area) to Fig. 3 in the results. Drainage density decreases systematically as the hillslope diffusion coefficient increases. The runoff and erosion efficiency decreases as the drainage density decreases, resulting in an increase of landscape elevation.

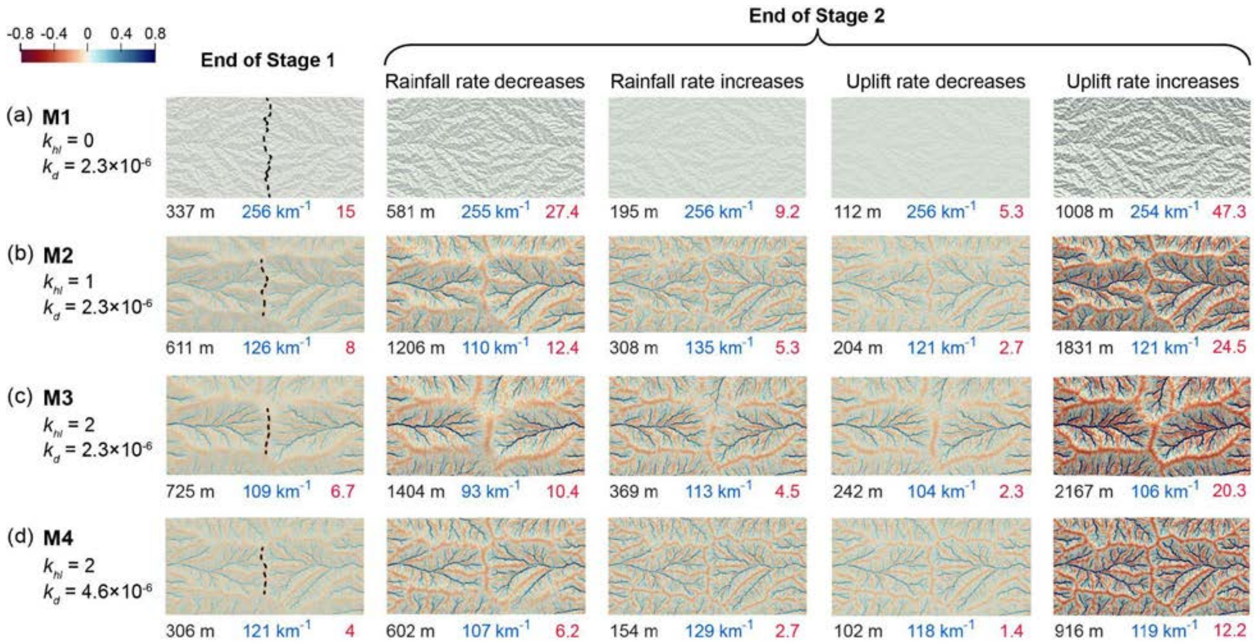

Fig. 3. Hillshade maps showing erosion and deposition rates resulting from hillslope diffusion at the end of Stage 1 and the end of Stage 2 for models M1 (a), M2 (b), M3 (c), and M4 (d). Each model differs in hillslope diffusion coefficients (k_{hl}) and erodibility values (k_d). Blue areas indicate deposition, while red areas represent erosion. Color bar values indicate depositional (positive) and erosional (negative) rates (mm/yr). Numbers below each map display the mean elevation (black), drainage density (blue), and roughness (red). Dashed lines on maps at the end of Stage 1 denote the divides. The divides in Stage 2 are similar to those in Stage 1 and are not marked in this stage.

We have made some revision to Section 3.1. Before presenting the results of mean landscape elevation, drainage density, and surface roughness, we have added the following text:

To quantitatively compare landscape responses across our experiments, we compute three metrics: mean landscape elevation, drainage density, and surface roughness. Mean landscape elevation serves as an integrated measure of the overall erosional state of the landscape, representing the cumulative effect of tectonic uplift, channel incision, and hillslope processes on topographic development. Drainage density, defined as the ratio of total channel length to drainage basin area (Strahler, 1964), serves as a proxy for channel spacing and quantifies the degree of landscape dissection and runoff efficiency (Perron et al., 2008; Perron et al., 2009; Tassew et al., 2021). This metric provides insight into the spatial organization of the drainage network and its capacity to evacuate sediment and water from the landscape. Surface roughness quantifies the local topographic variability resulting from the competing effects of processes that create and destroy relief (Doane et al., 2024). We calculate roughness as the difference between the maximum and minimum elevation values within a defined neighborhood surrounding each central pixel using the ‘roughness’ algorithm of GDAL in QGIS (Wilson et al., 2007).

We have changed *“Impact on patterns of drainage networks”* to *“Impact on drainage networks and density”,* and added the following text to the end of this section:

However, when the erodibility remains constant, the drainage density decreases systematically with increasing diffusion coefficient in the order M1 > M2 > M3. This decrease in drainage density indicates wider valley spacing and reduced network tightness under stronger hillslope diffusion. M3 and M4 share the same hillslope diffusion coefficient, but the larger erodibility of M4 yields a higher drainage density than M3.

In addition, we have added the explanation to the end of Section 3.1:

Stronger diffusion smooths local slopes and reduces river incision rates under a constant uplift rate, while also widening valley spacing and lowering drainage density. Together, these effects have resulted in reduced drainage efficiency in some areas where the uplift rate exceeds the erosion rate, resulting in a higher mean elevation.

Finally, we agree with your suggestion that a divide should be a curve without width. Therefore, we have avoided using the phrases “wider divide” and “narrower divide” in the discussion.

(2) The“transient slope change reversal”is an interesting phenomenon, and also the highlight of this manuscript. However, it is not difficult to understand that this phenomenon occurs in the numerical simulation under the set conditions. As the hillslope diffusion is not changed, the erosional difference between the river channel and the hillslope area will appear, when the rainfall changes. The erosion rate changes when the rainfall changes, while the hillslope erosion rate keeps. Then the“transient slope change reversal”phenomenon appears. Therefore, I admit that this phenomenon will occur in the numerical simulation of this study. However, in reality, the hillslope diffusion should be affected by the rainfall (Braun, 2018 GR). Therefore, Whether this phenomenon has practical significance has not been tested yet. At least the authors need to have some description on this in the Discussion section.

Thank you for this insightful comment. We agree that the hillslope diffusion should be affected by the rainfall in nature. We have added a new section "**4.3 Model limitations**" to the discussion, acknowledging that the diffusion coefficient likely is not constant in response to climate change.

Section 4.3 is as follows:

In this study, we aim to explore the first-order impact of hillslope diffusion and river incision on landscape and consider a landscape evolving under the action of hillslope diffusion and river incision only. While the linear diffusion model is a common starting point, we acknowledge that it does not capture nonlinear processes, such as those driven by shallow landslides, which can become significant on steeper slopes (e.g., Jiménez-Hornero et al., 2005; Martin, 2000; Roering et al., 1999). Furthermore, our model does not account for potential feedback between climate and the diffusion coefficient itself. In natural settings, the hillslope diffusion coefficient can vary with climatic conditions via processes such as frost-crack weathering, and near-surface processes such as soil saturation, and root growth (Andersen et al., 2015; Bogaard & Greco, 2015; Braun, 2018; Gabet, 2000; Gabet & Mudd, 2010; Perron, 2017). Considering this feedback could introduce additional complexity. For instance, an increase in rainfall rate could increase the hillslope diffusion coefficient through higher soil moisture (Perron, 2017), potentially amplifying the transient slope change reversal. Conversely, a decrease in rainfall rate could decrease the hillslope diffusion coefficient and dampen the reversal. Future work could explore the parameter space where these feedbacks become significant.

In addition, our use of a detachment-limited stream power model simplifies the complexities of sediment flux. The "transient slope change reversal" we observe is fundamentally a result of a disequilibrium between hillslope sediment supply and the channel's transport capacity following a change in rainfall. A more complex model incorporating sediment transport dynamics (a "transport-limited" or "mixed" model) would likely modulate the magnitude and duration of this reversal.

Other suggestions:
Figure 4: The blue profile should be 25 Ma, and the red profile should be 26 Ma.

Thank you for catching this. We have corrected the time labels in the figure legend of Figure 4(a).

Lines 192-199: This paragraph is exactly the same as the previous paragraph. Therefore, one of the paragraphs needs to be deleted.

Thank you for catching this. We have deleted a repetitive paragraph.

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