Earth Surface Dynamics Discussions

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Comment on esurf-2021-20

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Referee comment on "Effect of rock uplift and Milankovitch timescale variations in precipitation and vegetation cover on catchment erosion rates" by Hemanti Sharma et al., Earth Surf. Dynam. Discuss., https://doi.org/10.5194/esurf-2021-20-RC1, 2021

Very good paper. It contributes to our conceptual understanding of climate-veg-weathering-erosion interactions. The authors pose two hypotheses and do extensive model runs to test them. The only comment I have is that the authors explain the model results based on interpretations of what might be happening in the model. For example, they show the lag behaviors in erosion rates (especially in Fig 8,9 – 100 kyr), discuss what might be happening in the model that lead to the lag in erosion but they don't actually prove that by looking at the model state variables themselves that lead to lags. Changes in the landscape relief/mass and slopes are not discussed. Phase diagrams by plotting model evolving model states against each other can be done to further explore the model behavior and causalities. I just put this out there as perhaps for future work for the authors, as this paper is already thick.

The reference below has some similar work for the authors to include in their discussion, if they see relevant.

Yetemen O., Saco P., and E. Istanbulluoglu (2019). Ecohydrology controls the geomorphic response to climate change, *Geophysical Research Letters*, 46.

The authors should check the figure captions to make sure they refer the plots correctly. I had some difficulty relating caption alphabetic references to those on the figures.

I suggest you give the hypotheses in shorter sentences and make them clear in the Intro. The summary section had them a lot more direct, perhaps you can move those to intro and shorten a bit.

In the wetter climate simulations MAP does not follow a perfect sinusoidal function. Why?

Fig 5. 10PV. Why not just use 10%V.

Fig 5. -2ky and +3kyr phase lag for entrainment and bedrock erosion but no lag in the catchment-scale erosion. Did the mean bedrock erosion include weathering? I guess it did

not.

Fig 6. Why is there 5 times higher erosion rate for bare soil. Are these results after spin up using 21kyr periodicity. Because I suspect the low-veg catchment should maintain a lower relief and slopes. The higher veg catchment should develop steeper slopes and when thresholds are exceeded the higher veg catchment could produce more sediment at the outlet. If Fig 6e averaged mean erosion rates that correspond to the same time stamps within each cycle, the area under the curve should have giving you about the same amount of sediment mass, unless there are details in the weathering function such that vegetated landscape would produce more sediment.

Interesting that the dry-phase is all depositional in fig 6, while there is net bedrock erosion during the dry phase… are the bedrock erosion rates happen partially in places where there were no deposition?

Can you please clarify these higher rates in the bare and that if these results are obtained after spin up for 21kyr.

Fig 8, 9 are very interesting. The double-peak in catchment mean erosion is very interesting, especially with 100kyr cycle which was more clear to detect visually.

I see that in the discussion section you explain the role of bedrock erosion on higher erosion modeled erosion rate in the sparsely vegetated scenario.

Lines 417-419 – good explanation and a conceptual model. I felt the same while I was looking at the plots.

To add to the limitations – you don't seem to have vegetation disturbance by flow and entrainment. That had a large impact on the simulations of Collins et al 2004 and Istanbulluoglu and Bras 2005. Probably with some veg loss in channels you would have gotten a hybrid result between 10% and 70% veg cases (including their oscillations).