Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2020-472-RC1, 2020

Hydrology and Earth System Sciences
Open Access
Discussions

Interactive comment on "Simulating the evolution of the topography-climate coupled system" *by* Kyungrock Paik and Won Kim

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Received and published: 19 November 2020

The manuscript by Paik and Kim presents a novel model that better resolves the feedback between rainfall and topography than has been done before, and extracts important lessons from simulations with that model. Specifically, Paik and Kim provide a formulation of rainfall patterns that is more responsive to topography than existing formulations, which allows a close and realistic coupling between the development of a mountain range under the influence of uplift and erosion on the one hand, and the rainfall that drives the erosion on the other hand. This close coupling allows the authors to ask how different aspects of the rainfall-causing atmosphere affect orogenesis, and they arrive at the conclusion (among others) that overall wind speed arriving at the mountain front has a different impact on the rainfall field and hence on topographic

development than the time needed to develop rain out of a rain-prone airmass. Substantial impacts on stream profile concavity are also explored. I feel this is an important step beyond what we knew before, and allows us to ask new questions that we could not ask before.

The manuscript is very well written and presented, and illustrated with figures and tables that are all useful. Particularly, the pace of explaining new model components is very measured and I could follow along as a result of this paced introduction. However, I would like to note that the atmospheric component of the combined model is so new to me that I recommend relying on comments of additional reviewers to assess that component's validity.

I feel that the manuscript is very near a level that will allow publication. However, I do have a few small suggestions. Most of these are aimed at making a geomorphologist-reader have an easier time understanding the novel atmospheric component. I present them here in the order found in the manuscript.

l18 first mention of hydrometeors - perhaps explain this to the uninitiated (is it raindrops, or raindrops and/or snowflakes and/or hail, for instance).

l40 rainfall depth as well is an unusual term (to me at least). Please add a few words to explain.

l69 "wonder" - do you perhaps mean "question" ?

l92 non-orographic large-scale vertically integrated condensation rate - so, does that mean through convectional uplift? I am not sure, but if it is, maybe that is worth mentioning to clarify the contrast with orographic uplift.

l136 "the entire landscape has been assumed..." - not quite. Models by Schoorl and by Lague, for instance, deal with both conditions, as far as I understand. I placed references below.

l168 how do you deal with sediment eroding off the mountain range and entering the sea-cells? Is it assumed to disappear? The remainder of your text does suggest that, but it would be good to mention that here.

l184 "is of a significant amount and so zdeta" . I suggest: "and so IS zdeta"

l207 Please specify the amount of noise (perhaps by providing the ranges of the uniform distribution), and I also suggest to confirm in the text that the noise is not spatially auto-correlated.

l208 Please specify the initial slope value. This is especially relevant since earlier work has shown extreme sensitivity to the initial slope (in non-uplifting settings at least). I think that work used the Child model and the original may be in a paper first-authored by G.E. Tucker, but I couldn't find it anymore for you.

l211 At this point, you have explained the model in mathematical detail. As noted before, I feel that that is well done. However, I would really appreciate it if you could provide a figure about here that shows how the rainfall works out in model simulations. Perhaps showing the amount and net direction of descent of precip from the airmass moving over a hypothetical topography would work best, but any output that shows a bit of what is calculated before getting to the excess rainfall that you show from here on out, would be welcome.

l242 "landslide events" I don't believe you have yet told us that you simulate landsliding - or how it is done. Are you simply using a threshold slope gradient?

l243 "fluctuations" . That process is also discussed in Temme, 2006. I provide the reference below, feel free to disregard.

l262-264 I felt that this information is perhaps better placed in the model description section, and is distracting here.

Figure 3: The legend font is too small here. I noticed that the font size varies substantially among figures. Can you choose one font size and apply it to all figures?

Figure 3 caption: Numbers in the legend indicate (no "s")

l305-310 Can you here compare with overall topographic features in some of the world's mountain ranges that are closest to your condition that U=0? I believe the Andes have U=0, approximately. Do the Andes (or other mountains) match your simulated topography with feedbacks better than they do the topography without feedbacks, or even better than the topography with feedbacks from the Roe at al model? If this is not possible, you might consider here pointing at the difficulty of making comparisons with existing orogens.

l327 I suggest " was found to be nonlinear"

l344 Opposite: I sugggest "In contrast"

l345/6 Visualizing this rainfall displacement through wind and delayed formation is exactly what would work really well in a "Figure 0" as mentioned above.

l357 " indebted" : i suggest "due"

l398 I agree with your sentiment that cooperative efforts are needed to document co-evolution. If possible, can you share any thoughts what that could look like? I can imagine that thermochronology, for instance, can help constrain the topographic side of the co-evolution. Is the problem mostly with reconstructing spatiotemporal patterns of rainfall?

References: Davy, P., & Lague, D. (2009) Fluvial erosion/transport equation of landscape evolution models revisited. Journal of Geophysical Research B: Solid Earth, 114(3). Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-75849161206&partnerID=40&md5=f525702d700153179701b74d747455e0 Schoorl, J. M., Sonneveld, M. P. W., & Veldkamp, A. (2000). Three-dimensional landscape process modelling: The effect of DEM resolution. Earth Surface Processes and Landforms, 25(9), 1025–1034. Temme, A. J. A. M., Schoorl, J. M., & Veldkamp, A. (2006). Algorithm for dealing with depressions in dynamic landscape evolution models. Computers and Geosciences, 32(4). https://doi.org/10.1016/j.cageo.2005.08.001

<please note my choice to reveal my identity. I reveal my identity when I mention work that I was involved in myself, so that my self-suggesting is visible to the community and can be criticized if required, and so that I can tell authors that I in no way insist on my work being cited if they feel that it is not valuable to their manuscript>

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