The improvements resulting from Armitage's significant rewrite of his article have brought it into a near-publishable state. I request only minor and typographical changes as indicated below. The "minor" changes are significnat for the clarity of the science, but should not require too much effort and do not touch on the main point of the paper or its conclusions. While I am happy to review a revised draft, I would also be happy for a slightly revised version to be published without my oversight.

– Andy Wickert, 20 November 2018, Potsdam

SELECT REPLIES TO AUTHOR REPSONSES:

p1,l12-18. Flow routing and river width are two processes that are about as separable as any become in Earth-surface processes. Flow routing occurs over the scale of a basin, is non-local, and is cumulative. River width responds to local conditions, e.g., shear stress, and is typically thought to tend towards an equilibrium see Parker (1978), Phillips and Jerolmack (2016), and Pfeiffer et al. (2017) for some background on the latter. Therefore, I find it difficult to understand why you have gone from writing that parameterizing width is hard (yes, this is true, but also necessary if it is sub- grid) to writing that therefore we just focus on flow-routing? Mustnt we do both?

I will be honest, I have no idea why rivers and flow routing are so separate in Earth-surface processes (I am out of my specialisation here). I was simply trying to argue that river width is small, in general. To resolve this problem, I have tried to consistently refer to flow routing and not mention rivers, beyond the introduction and discussion.

Informational reply: Full-physics solutions would result in these being combined. But on anything that is computationally feasible (i.e. all of surface-process modeling), the network defines the topology on which simplified dynamics are computed.

p2,l14 (eq. 2). This equation works dimensionally, but I am not convinced that it represents reality. In a typical river system, one would accumulate flow over the full landscape [m 3 s 1]. Then, after partitioning groundwater and surface water and any losses due to ET (not so common in LEMs), one would assuming a rectangular channel with minimal wall friction for simplicity, and divide water discharge by the channel width to obtain a discharge per unit width (or water flux) with units of m 2 s 1 . What you have effectively done is replaced the channel width by the distance between two cell centers. This means that the effective channel width in this case is a direct function of grid size. I think I am starting to understand why you combined flow-routing and channel width at the start of this paper, but

I think that this is a distinct downgrade from actually considering channel width!

In many LEMs width is taken from the cell width. Of course I am making big assumptions for equations 2 and 3, however I am aiming at a simple method to capture surface flow. It is not my intention to model all the processes, but create a LEM that is low on complexity but not resolution dependent. That is all. I have added a few lines to explain where equation 2 comes from and to explain that they are approximations and not reality.

Informational reply: Assuming that river width = cell width is wrong in a not-so-insignificant way: Considering the linear scaling between river width and total sediment transport capacity, this assumption can make the solultion very much grid-scale dependent. I am not as familiar with the LEM literature, but the fact that this is a common thing is disconcerting, and I think that even if it is common, it is something that should no longer be done!

Action item: I was thinking of making a suggestion, but because of the tuneable parameters in your LEM equation, I think that additional specificity on river width may well be able to be calibrated in or out in the LEM. Furthermore, I think that this is just not your goal, and so I do not want to distract from this main objective of simulating the influence of gridding schemes.

p3,l3 (eq. 3). Here you are accumulating flow with l, which again implies that the geometric relationship between the edge length of an equilateral triangle and its area is proportional to any hydrologic lossiness and a realistic channel-width function. This certainly cannot be true. However, there is a linear proportionality between the cell-side length and the cell area, so this relationship in spite of its dimensional consistency with water flux retains a linear scaling with water discharge.

I am assuming that any segment of my flow is has water added to it as a linear function of the length of that segment. That is that the flux of water is constant and independent of the area of land to either side of my flow segment. Is this completely wrong? Water flux is said to be related to catchment area, Q w $A^{0.8}$ (Syvitski & Milliman, 2007). The catchment length, l, is related to area by, $l \sim A$ $1/p$, where $1.4<p<2.0$ (Armitage et al., 2018). If I take the lower end then I get Q $w \sim l^{1.12}$. So a linear model might not be so wrong?

Informational reply: Sure, and thanks for overlooking my obvious "linear" mistake in the original question and writing a more sensible answer. But I think it is important in any reduced-complexity model to write how your equations relate to what you think is really happening.

Action item: I think that you should better describe this rationale in the area around Equation 3 and the associated text, so the readers can understand how this approximation might impact the hydrological scaling in the model.

COMMENTS ON THE REVISED MANUSCRIPT:

General: "Distributed flow routing" is a bit ambiguous, as it might just mean "spatially-distributed", which all flow-routing in this discussion is. How about the commonly-used "SFD" and "MFD" terminology for single/multiple-flow-direction routing?

1.4: delete first "of"

1.5–6: "either the steepest descent or distributed down all down-slope surfaces": missing words to make these nouns, and you can use the SFD and MFD terminology if you like

1.7: missing an article before "LEM".

1.9: "a distributive flow".... missing word? Algorithm?

1.12–13: "sub-grid scaled" $\rightarrow$ sub-grid scale ?

1.14: "the Earths": If preceded by an article, "Earth" is typically not capitalized. An apostrophe is also missing.

At this point, I have stopped making copyedits: please proofread.

3.9: "Furthermore, it cannot capture processes such as knickpoint migration": Well, of course it wouldn't, because a transport-limited system is diffusive and doesn't produce coherent knickpoints.

3.22: "This gives a water flux per unit length": This should have units of length squared per time, and a flux is [quantity]/[Area x time], so I think you mean a discharge per unit length?

4.13–14: "However, elevations are significantly lower for the cell-to-cell flow routing model as the water flux term operates across the cells rather than on individual node points (Figure 3 and 4)." I think that a more direct way to state this, so long as I understand what you are doing, is that you are actually decreasing the amount of water applied in the case in which you route flow along edges. Therefore, an equilbrium landscape slope would of course be lower whne there is is a greater driver of erosion. In other words, this aforementioned hydrologic scaling issue actually modifies the drivers between your cases. This should be acknowledged.

Figure 4: Could you describe how you have nondimensionalized the solution?

Figure 7c: Hard to read the right hand side of the color bar labels