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Hydrology and Earth System Sciences
Discussions
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Interactive comment on "Expansion and contraction of the flowing stream network changes hillslope flowpath lengths and the shape of the travel time distribution" *by* H. J. Ilja van Meerveld et al.

Anonymous Referee #1

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Expansion and contraction of the flowing stream network changes hillslope flowpath lengths and the shape of the travel time distribution van Meerveld et al.

General comments

This article presents an interesting thought experiment about how riverine network length can influence the mean travel time distribution in catchments. The authors present a set of feasible river network extents across a range of wetness conditions, assume surface and subsurface flow velocities, and then estimate plausible distribu-

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Discussion paper

tions of travel times to the catchment outlet within these wetness scenarios. As this study is an initial exploration of how network extent can influence travel time distributions and modeling solute transport, I believe this study would be more powerful if the authors emphasized how future studies can build off of this initial exploration. For instance, emphasizing what the limitations of this study design are, and how others can use these concepts and apply real datasets and hydrologic measurements to confirm the results and interpretations of this study, would be greatly beneficial. Since this study estimates subsurface and surface velocities, it seems appropriate to provide results from a sensitivity analysis or provide ranges in the mean travel times. While the authors state they tested surface to subsurface velocity ratios (from 10 to 10000; P 4 L 14), they do not appear to present the results of that analysis. A powerful addition to this paper would be to show possible ranges in mean transit time distributions, given minimum and maximum velocities.

Specific comments

1. P 3 L 26: How substantial of a rainfall event? Is the rainfall occurring in "wet" conditions? I suspect not as it occurs right before the "dry" conditions survey.

2. P 3 L 20: The authors say that the field mapping is too slow during rainfall events to capture the entire extent of the stream work during rainfall events due to how dynamic it is. However, it appears the authors use a survey taken during a rainfall event in this analyses. Thus, it would be helpful to the reader if more information was provided on these surveys, e.g. how long did the surveys take, did the researchers start at the channel heads and walk down (to ensure they capture the most dynamic extents), was the network actively expanding during the survey, etc?

3. P 3 L 27: It may be more clear to the reader how survey #4 was accomplished (every other survey is described in parentheses, but this one).

4. There have been several recent studies that sought to predict river network extent, which can be used to model transit time distributions as suggested by the authors on

P33. Some suggestions below for two recent studies that can be used:

P 7 L 1: Add another example of predictive modelling: Ward, A. S., Schmadel, N. M., & Wondzell, S. M. (2018). Simulation of dynamic expansion, contraction, and connectivity in a mountain stream network. Advances in Water Resources, 114, 64-82.

P 6 L 33- P 7 L 1: Add example of empirical generalization from field studies, such as: Zimmer, M. A., & McGlynn, B. L. (2018). Lateral, vertical, and longitudinal source area connectivity drive runoff and carbon export across watershed scales. Water Resources Research, 54(3), 1576-1598.

This study also relates network expansion and retraction to solute transport dynamics as well, which is suggested in this study, but few if any citations are provided.

5. TABLE 1: While it is clear why the topographic map does not have an associated streamflow, please add brief explanation in caption as to why streamflow magnitude is not provided for complete network.

6. TABLE 2: This is an incredibly interesting results table and definitely made me think about possible travel times in other catchments and across wetness conditions. While I think the authors main points from this paper were to show that travel times decrease substantially as the system wets up, the absolute values for the reported median travel times are very small. The median surface travel times are on the order of minutes – how did the authors determine this? Based on the catchment and previous field observations, does it seem reasonable that 71% of the water travel time are less than 2 days?

7. It is also interesting that the median travel time for the topographic map survey is 4.5 days and the subsurface travel time is 4.5 days, which are both longer than the “dry” conditions survey, and yet the fraction of the catchment with travel time less than 1 day is greater for the topographic map. Perhaps this is driven by the hydrologic connectivity of the river network in the topographic map survey. This is an interesting dynamic that

could be expanded on in this paper and could be related to recent papers on the topic of discontinuous network extents, such as:

Godsey, S. E., & Kirchner, J. W. (2014). Dynamic, discontinuous stream networks: hydrologically driven variations in active drainage density, flowing channels and stream order. Hydrological Processes, 28(23), 5791-5803.

Whiting, J. A., & Godsey, S. E. (2016). Discontinuous headwater stream networks with stable flowheads, Salmon River basin, Idaho. Hydrological Processes, 30(13), 2305-2316.

8. FIGURE 2: What is the role of disconnected stream channels in the model results? Do water parcels flow through these disconnected sections at the same rate as those coming from the terrestrial landscape outside the channel extent? Do the authors think that subsurface flow map be faster within the subsurface channel network than in the hillslopes adjacent to the network?

Technical corrections and editorial suggestions

P 5 L 11: missing "x" between "5" and "10". P 6 L 13: Delete "did" at end of sentence. TABLE 2: Change "travel times smaller than one and two days" to "travel times shorter than one and two days"

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