Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2020-276-AC1, 2021

Geoscientific Model Development Discussions
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Interactive comment on "Hydrostreamer v1.0 – improved streamflow predictions for local applications from an ensemble of downscaled global runoff products" *by* Marko Kallio et al.

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Received and published: 5 April 2021

Dear Anonymous Reviewer #1,

Thank you for your remarks on our manuscript. Please find below our detailed responses (marked Rx.x) to your review comments (marked Cx.x).

Comment 1.0: In this manuscript, a useful tool is developed for non-hydrologist to use runoff products estimated by various land surface models. The tool mainly has three functions: 1) mapping the runoff components from the land surface model to units in the hydrological model, 2) modeling the river routing processes, and 3) assimilation

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via modeling averaging. The article is well written and well organized. I have a few suggestions which might help make the paper stronger. I think it could be done as a major revision.

C1.1. In the manuscript two mapping methods are provided by the developed tool. The area-to-line interpolation is not looking reasonable to me. In this approach, the intersecting portion of the river line within the source zone is used as average weight.

Response 1.1: Thank you for your remark. We agree that our proposed Area-to-Line interpolation is unconventional and does not respect the actual drainage area delineation. Reduced data requirements may provide an advantage, provided that certain conditions are met. âĂć The river network used for Area-to-Line interpolation needs to be sufficiently dense (with each source zone containing at least one river segment) in comparison to the input runoff data. We used 0.5° resolution input data with HydroSHEDS river network. The number of river segments in the source zones averages at 56 segments per source zone. âĂć Stream length does need to be a reasonable proxy for basin area. This is likely to be the case for sufficiently large basins with dense networks. We found that within our study area, the 3S basin, Pearson correlation between upstream river segment length and upstream basin area is 0.998. We acknowledge that at an individual segment uncertainty is large, and therefore the method should only be used in basins where the area of source zones entirely contained in the basin is significantly larger than the area of partially covered source zones. âĂć Performance does need to be evaluated prior to use. The discharge estimates at the gauging stations used in our case study show that there is little difference in goodness-of-fit statistics between Area-to-Line interpolation, DEM-delineated catchments, and Thiessen Polygon-based catchment estimation. This shows that the Area-to-Line interpolation can be used for catchments of a size similar to the downstream stations in 3S (approximately 30 000 km2) where the difference in performance between methods is nearly negligible (see Table A1). Results using the DEM-delineated catchments could be provided in the paper if necessary, but the Area-to-Line interpolation has been shown to have similar performance with lower input requirements.

These three points are emphasized in the revised manuscript, i.e. we explain why the good performance of the area-to-line interpolation in our case study does not necessarily transfer to every use case.

C1.2: The approach did not respect the actual drainage area controlled by the river line, actually, somehow recalculate the drainage area of each river line during the mapping process.

R1.2: The Area-to-Line method assumes that the length of the river segment within a runoff source zone approximates the drainage area of that segment within the same zone. We acknowledge that this assumption leads to a poor redistribution of runoff at an individual segment level. However, as mentioned in our answer R1.1 to the previous point, the difference to the catchment-based methods is very small at the gauging stations. This happens because the runoff contribution falling within a certain basin changes only at the boundary of the basin, and thus as the basin size increases, the contribution of the boundary segments gets increasingly small compared to the contribution of segments in the interior of the basin.

C1.3: In an extreme case, if a river line flows along the boundary of the grid, then no runoff will contribute to that river line.

R1.3: Thank you for pointing this out. We tested whether this actually happens within our code, and found that in such case, a segment is assigned runoff from both source zones according to the length at the grid boundary. We have fixed this, and the contribution is now evenly split between grid cells intersecting the line at the boundary.

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C1.4: Two simple methods are offers for river routing. I would suggest adding more routing options for example diffusive wave, hydrological routing approaches. It would be interesting to also assimilate the simulated streamflow from different routing methods, not only using different runoff inputs.

R1.4: Thank you for your suggestion. We note that the primary emphasis of the paper is on the mapping of gridded runoff onto river networks, which can then also be used with existing routing software. The two simple routing methods included are already used in different global modelling efforts or applications using data from global model runs (see e.g. Telteu et al., 2021; Lehner and Grill, 2013; Munia et al., 2018). However, after consideration of your suggestion and the application of hydrostreamer to catchment scales, we decided to implement a more comprehensive Muskingum-Cunge routing algorithm. This improves the usability of hydrostreamer particularly for sub-monthly timescales. For monthly timeseries, there is little difference between the existing simple routing methods and the added Muskingum-Cunge routing algorithm at our study area, the 3S basin. In the revised manuscript, we now provide a short comparison of the outcome resulting from the three applied routing methods in the supplementary materials, referenced in the main text.

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Interactive comment on Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2020-276, 2020.

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