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Hydrology and Earth System Sciences
Discussions

Interactive comment on "A topological restricted maximum likelihood (TopREML) approach to regionalize trended runoff signatures in stream networks" *by* M. F. Müller and S. E. Thompson

Anonymous Referee #1

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The paper addresses an important issue in catchment hydrology: that of interpolating runoff fields in space while respecting the stream network. I used to work in this area some 20 years ago and know there are real difficulties associated with it, both hydrological and statistical. I have previoulsy followed the work on top-kriging, and am now trying to separate the proposed work from top-kriging.

In this respect, there is a presentation problem with this paper (it is rather abstract, mainly using kriging language), which prevents me from really understanding the work, interpret it hydrologically, and to assess its relative merits vis a vis top-kriging.

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Discussion Paper

Connection to Top-kriging

In spite of the fact that the authors spent a lot of space to explain the difference between top-kriging and the authors' TOP-REML, I remain confused and therefore unconvinced.

Part of the confusion arises from the derivations presented in Appendix A: the averaging presented appears to use Eucledian distance and not flow distance, which is needed if one wants to capture stream network structure. How can this be the basis for the kriging carried out here?

Likewise, I do not understand the context of Appendix B. Why are we talking about events here? What signature are we trying to regionalize here?

Focus on Signatures

Both in the title and within the body of the text, the paper talks of runoff signatures. What do they mean?

My understanding of signatures is that they are aspects of runoff variability extracted from observed runoff time series: flood frequency curve, flow duration curve, or the regime curve (mean seasonal runoff) etc. The authors do not go to any more specifics, and so I am confused. I do know that each of these signatures can be distributed across the network (including their moments). So, which of these signatures is being predicted here in an ungauged basin context?

The nature of averaging

The authors state that they make a water balance assumption to enable the spatial averaging, is this not akin to a steady state assumption?

If so, how would steady state apply to any of the above signatures? In the case of event hydrographs, don't you have to deal with timing delay between upstream and downstream locations? In the case of flood frequency curves, can you assume steady state for the same return period? In the case of flow duration curve, can you assume

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steady state for the same frequency?

Notion of point process

What is a point process? I can understand that precipitation is a point process, and runoff generation can also be a point process if it is estimated in a small pixel, but runoff leaving any point is already accumulated over an area upstream (whether on a hillslope or on a stream network). When I used to work in this area, I used to frame it as an averaging in space-time that accounts for the time needed for water droplets to arrive from wherever it is generated.

I am concerned that I do not see distance measured along the network figure prominently in the presentation anywhere. How about the time delay? It is possible that the authors are indeed using this feature but it is not presented explicitly. I want clarification.

Summary of comments

I would like substantial improvements in three areas of presentation so I can properly review a revised presentation for content:

1) The presentation is currently dominated by kriging language, but the authors should weave in hydrological language – and motivate the assumptions made hydrologically. 2) I really would like to see even more clearly the separation from top-kriging both in terms of problem formulation as well as results 3) In spite of claiming to capture river network structure I do not see the picture of a river network presented in either of the applications – this makes it less appealing hydrologically. 4) Finally, again as a hydrologist, I would like to see real results of actual signatures being predicted, in addition to the current focus on performance and uncertainty.

Overall, I still think this is potentially an important advance over current state of the art, i.e., top-kriging. However, the current presentation makes it difficult to fully grasp this advance. I will be happy to review a revised version, to properly assess this advance

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and its importance.

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