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Discussions

Interactive comment on "Disentangling timing and amplitude errors in streamflow simulations" *by* S. P. Seibert et al.

Anonymous Referee #2

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This paper is about recent developments in the Series Distance (SD) approach to analysing simulated streamflow hydrographs. SD is one of a small group of approaches that automate processes similar to those performed when a hydrologist visually compares a simulated hydrograph against the corresponding observed hydrograph. There is independent evidence that such approaches have merit and could be useful in operational rainfall-runoff modelling (Lines 771-4), so new work on SD is to be welcomed. The SD approach is quite elaborate, but software has been made available (Line 777).

In terms of scientific novelty, the interest lies in the coarse graining algorithm, which is an optimisation procedure designed to find the best way to break the hydrographs into segments, such that segment 1 in the simulated hydrograph is matched with segment 1 in the observed hydrograph, segment 2 with segment 2, etc. This is similar to the unconscious process when a hydrologist visually links features (e.g. rising limbs,

short-term rainfall responses, and recessions) in a simulated hydrograph to the corresponding features in the observed hydrograph. Coarse graining is therefore a central part of what could be called the pattern matching procedure in SD; pattern matching is of fundamental interest and importance in all work based on the "visual" analysis of hydrographs. The secondary part of the pattern matching in SD, the matching at fine scale, uses linear interpolation (Line 270). My interpretation of this is as follows. Say, for example, that coarse graining gives that a simulated segment starting at time ts and lasting for Ts hours corresponds to the segment to,To in the observed hydrograph. Using linear interpolation, the timing error, e, associated with the points at fraction x along these segments is:

e(x) = to-ts + x(To-Ts) Equation R1

The amplitude error associated with this is the difference between the simulated discharge at time ts + xTs and the observed discharge at time to + xTo.

There is simply too little discussion, exploration and testing of the coarse graining algorithm in the manuscript. For example, the final term in the objective function is for amplitude errors, so would seem to have central importance, but this term is switched off in the single example presented in the manuscript (line 470-1). It was switched off on the grounds that this was sufficient in a "proof-of-concept" study (line 474). For this work to be scientifically sound, the coarse graining algorithm needs to be explored fully for several types of hydrograph, and tested properly, in detail, against an appropriate benchmark. HMA (Line 552) might be suitable as a benchmark, especially given that it is a very simple algorithm.

A large part of the manuscript is about "error dressing". This is a statistical method used to obtain uncertainty clouds for simulated hydrographs (i.e. clouds of points that show where the actual hydrograph might lie). Error dressing involves: (1) collecting together the timing and amplitude errors into pools (i.e. the errors detected using coarse graining and linear interpolation); (2) drawing from these pools; and (3) applying the draws to the simulated discharge to generate an uncertainty cloud. I found the work on error dressing unconvincing (see below). Perhaps it should be removed from the manuscript to make more room for demonstrations and discussions on coarse graining.

The few results shown for error dressing (e.g. Figure 6) show that it introduces considerable false inflation (so gives over-large error clouds), which makes the clouds difficult to interpret physically and limits their usefulness operationally. False inflation is a sign that the link has been lost between the actual local errors and the errors drawn to represent the local errors. This is not surprising given that the draws are from pools that are collected from the hydrographs as a whole, so are relevant to a huge range of different types of discharge response, and not just to the response at the time when the draw is applied. There is a nod to refining the pools, by the use of separate pools for rising and falling segments, but this, clearly, is not enough to avoid substantial inflation. Note that the use of linear interpolation in the fine-scale pattern matching adds to inflation because it neglects local information about timing. Rather than depending on local (i.e. within segment) timing, Eq. R1 shows that the local timing errors are assumed to depend only on the t and T values generated in coarse graining.

Other Points

(Line 25) The word “elaborated” does not work here.

(Line 241) Is some normalising factor or term needed here to make ISEG sum to unity?

(Line 245) This process seems to reduce the number of segments by two. What happens if an odd number needs to be eliminated.

(Line 254) It is not entirely clear why the name “coarse graining” was chosen, especially given that this required citing two otherwise irrelevant papers about other things that are commonly called coarse graining.

(Line 330) What is done if there is no local minimum in the objective function?

(Line 454) It is the gold standard in work like this to use split-sample testing because

this is the best way to test how the method would work when used operationally. Split-sample testing is trivial to apply, so there seems no reason not to use it here. The defence that the example is used simply to aid “discussion of the SD concept” (line 453) is very weak.

(Line 561) An advantage is claimed for SD that “unique relationships of points in obs and sims are established”. This advantage, however, comes from using linear interpolation, which, as discussed earlier, comes at the cost of neglecting local (within segment) timing information.

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