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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Uncertainty in hydrological signatures" *by* I. K. Westerberg and H. K. McMillan

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Referee Comments (Hoshin Gupta) on "Uncertainty in hydrological signatures by IK Westerberg and HK McMillan" submitted to HESS

I. Contributions of the Paper

A) Goals: (1) To contribute to awareness of signature uncertainty, including typical sources, magnitudes and methods for assessment. (2) To propose a general method for estimating signature uncertainty. (3) To demonstrate how typical uncertainty estimates translate to magnitude and distribution of signature uncertainty in two example catchments.

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B) Summary: A diagnostic hydrological signature quantifies information from observed data as an index value. Uncertainties in the observed data, and subjective choices in the calculation method, propagate into the signature values and reduce their information content. However, uncertainty sources and distributions are application-specific, making a general analytic solution for signature uncertainty difficult. This paper reviews the uncertainties relevant to different signatures in rainfall and flow data, and proposes that a Monte Carlo simulation can provide a generally applicable and flexible method, by sampling equally likely possible realizations of the true data values, conditioned on the observed data (where multiple data sources are needed, grouped samples are used). Each realization is then used to calculate the signature value, and the values collated to give the signature distribution. Results are demonstrated for two catchments.

C) Findings: 1) Uncertainties are often large ($\pm$10–40% relative uncertainty) and highly variable between signatures. 2) Greater uncertainty in signatures that use high-frequency responses, small data subsets, or subsets prone to measurement errors. 3) Lower uncertainty in signatures that use spatial or temporal averages. 4) Some signatures are sensitive to particular uncertainty types such as rating-curve form.

D) Conclusions: Signatures can be designed to be robust to some uncertainty sources. Signature uncertainties of the magnitudes found have the potential to change the conclusions of hydrological and ecohydrological analyses, such as cross-catchment comparisons or inferences about dominant processes.

II. Referee Comments (Hoshin Gupta): This is a very well conceived and written paper. The organization and presentation are excellent. The subject matter is both timely and addressed in a clear and comprehensive manner. I recommend publication with no reservations.

Since I am not very well versed in the sources and nuances of observation/data uncertainty, I focused my review my attention mainly on the methodology applied. In general

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I concur that the Monte-Carlo approach is a suitable way to approach the problem of estimating signature uncertainty (and is more generally applicable in the context of data assimilation – i.e., estimating attributes of a dynamical systems model from data). The key sensitivity of the results will, of course, be to the choice of sampling distribution, and a certain amount of subjectivity is necessarily involved therein.

I commend the authors on another noteworthy paper (in their growing list of excellent contributions to the literature). I wonder only if they might choose to comment on (perhaps in the conclusions) in more detail on how the inevitable subjectivity involved in choice/construction of the sampling distribution might influence any interpretations, and whether (perhaps) the use of maximal entropy forms of sampling distributions (conditional, of course, on the actual data and what is qualitatively known), might help in this regard.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 4233, 2015.