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Hydrology and Earth System Sciences Discussions

Interactive comment on "Calibration of hydrological models using flow-duration curves" *by* I. K. Westerberg et al.

Anonymous Referee #1

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The manuscript describes the utility of flow duration curves (FDCs) in the calibration of conceptual rainfall-runoff models. The idea of using metrics or catchment signatures beyond the runoff hydrograph has gained increasing interest in hydrologic science, especially in relation to concerns such as predictions in ungauged basins. As such, this topic should be of broad interest and the method presented by the authors is flexible and sensible. Overall, however, I believe this study is flawed by not presenting a balanced view of the potential value of FDCs and by suggesting that FDC calibration may be a panacea to many ongoing concerns in model specification.

Main Points:

Overall I have one fundamental issue with the idea of FDCs as a calibration metric

that I don't think the authors have addressed adequately. The FDC removes all timing aspects of the hydrograph, so routing parameters for any model should not be identifiable. Any given catchment would have the same FDC if an entire hydrograph were shifted a number of time steps but obviously this would reflect entirely different hydrologic processes and should be simulated by entirely different model parameters. While the authors briefly mention this ("...might then conceal some limitations of the model being applied (e.g., consistent timing errors)..." page 9495) they do not sufficiently discuss the potential ramifications in considering the FDC as a sole calibration metric. I think the FDC can provide valuable information in the specification of hydrologic models, but conceptually it is severely limited in that it provides no information on the timing of catchment response. While the case studies presented in the manuscript show good general agreement to the flow hydrograph I think this largely due to potential parameter interactions and the time scale of the model. Given this potential fatal flaw in considering FDCs as a sole calibration metric, I think the study would benefit from redefining the pitfalls in using FDCs alone.

The general suggestion made by the study is that the traditional Nash Sutcliffe efficiency (NSE) is flawed and provides poor simulations in comparison to potential FDC calibration. However I think the study does not present a fair comparison between FDC and NSE calibrations. I did wonder how many of the findings of the case study would be varied if the authors had simply transformed their flows when applying the NSE. It seems a lot of the NSE shortcomings are due to the fact that the model does not capture low flows or is biased toward epistemic errors at peak flows which could be easily addressed by modifying the traditional NSE or calibrating on transformed flows. It is well known that the NSE emphasizes peak flows, but it is then compared to the FDC in terms of the simulation of low, medium and peak flows. Similarly, the NSE looks at the entire hydrograph but was largely compared via the simulation on relative volumes (as with Figures 8 and 9). In addition, it is hard to appreciate the constraints placed on the model parameters under the FDC vs the NSE when the behavioral threshold defined for the NSE efficiency is somewhat arbitrary and will have a large influence on how the

parameters are constrained.

Related to this, the study does not place the value of FDC calibrations in the context of vast improvements that have been made in hydrologic model calibrations since the NSE was introduced. Several studies explicitly incorporate discharge errors in model calibrations using hydrograph based objective functions (see for example, Salamon and Feyen, J of Hydrology, 2009). This needs to be better cited in the study as it is suggested that there is no scope for this in hydrograph based calibrations. The authors state that the FDC approach is "flexible and transparent" as regarding potential weighting of different flow regimes but surely the same degree of flexibility is possible in a reweighted NSE. By focusing solely on a comparison to the traditional NSE, the study does not recognize the many recent relevant studies that attempt to address issues related to uncertain data, variability in performance across flow magnitudes, and the influence of input errors in model calibrations.

A final comment on the language used throughout the manuscript. The authors state that they rescale the FDC so that it represents the total volume of water contributed by flows smaller than a certain magnitude. This doesn't seem to me to be a "rescaling" as it is an entirely new relationship that removes the "duration" aspect of a FDC. Can the resultant relationship really be called an FDC?

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 9467, 2010.