Interactive comment on "Stochastic or statistic? Comparing flow duration curve models in ungauged basins and changing climates" *by* M. F. Müller and S. E. Thompson

Anonymous Referee #2

Received and published: 4 November 2015

GENERAL Comments

This paper introduces a process-based model for the prediction of flow duration curves (FDCs) in ungaged basins and for future precipitation. A complex process-based model is compared to a simple statistical method in prediction of FDCs at 25 basins in Nepal. The paper could be a fundamental contribution yet I have serious concerns about one small aspect of the work which would need to be addressed prior to publication. The comparative assessment of a physically based regional model of FDCs with a 'statistically' based approach is extremely important, because both have enormous value and in particular, the physically based approach is very novel, has broad implications and

potential, and has never been compared with a statistically based approach (the more common approach used in practice for estimating FDC's at ungaged sites.) My major concern is that the statistical method which follows the work of Chalise et al. (2003) is a very limited approach and would not likely compare favorably with the type of statistical methods which have been shown to perform well for ungaged sites elsewhere. In particular, the Chalise et al. model uses a 'linear' model for estimating annual streamflow from climatic variables. Dingman's Hydrology text Chapter 10 shows power law, nonlinear models for all regions of the US estimate annual streamflow from drainage area, precipitation and temperature with Rsquared values nearly always above 90% even in arid regions. Similarly, other studies cited in Castellarin et al. (2013) develop models for regional flow duration curves using multiple points on the flow duration curves, with multiple equations, all of which are nonlinear. This study, based on the work of Chalise et al. (2003) uses only one simple linear equation for Q95. Thus the statistical approach which is contrasted with the physically based approach is overly simplistic and would not be expected to work well in practice, given this reviewer's understanding of the current literature. For this paper to be published, the authors need to use a more realistic statistical approach for estimating flow duration curves at ungaged sites, more along the lines of one of the many studies cited in Castellarin et al. (2013).

DETAILED comments

1. Perhaps the title should be "Process-based or statistic?" because a stochastic model is a statistical model. The physically-based model introduced and termed a stochastic model is really a 'physically based' statistical model, because an FDC is a statistical model. Or it could be called 'derived distribution' approach which is the common parlance used in flood frequency analysis for models of the probability distribution of annual maximum floods which are derived from physics.

2. The number of parameters in the physically based modeling approach should be similar to the number of parameters in the statistical modeling approach or else comparisons are not meaningful. Even if after comparing the physically-based model to a

realistic statistical model, the statistical model wins there is still a very big need for the physically-based approach, if we are to understand impacts of climate and land use on flow duration curves (and this is early research so that is what one might expect.)

3. You refer to a few applications of FDCs in your introductions, but don't mention the most widespread use, lately, for combining a flow duration curve with a nearby index gage for the purpose of estimating a streamflow record at an ungaged site.

4. Page 9773, line 26, I believe you mean spatial correlation not 'autocorrelated'. Autocorrelation implies self-correlation or temporal correlation but you seem to be talking about cross correlation of flow records in space.

5. The 'index flow duration curve' approach you use is not the same as the 'index flow duration curve' approach suggested by Castellarin et al. (2004b) and elsewhere. The Castellarin et al. (2004b) method divides the daily flows in each year by the annual streamflows in that year. You are dividing by a single mean annual streamflow. (This is more like the 'index flood' method widely used, which does just what you do, divide the flows by a fixed mean annual flow.)

6. Your experiments with synthetic streamflows are not very well designed and should probably be dropped from the paper. When you generate flows from the same model used to derive your physically based flow duration curve model, it will naturally perform better than any statistical model. Still, the comparison might be a bit better if at least the statistical model was realistic as described above.

7. It would help the reader understand the results if you explain the figures more. I had trouble understanding what was reported in Table 3. Additionally, it is sometimes it is difficult to keep track of which plot is which in the compact sub-plots used. In particular, it would help to:

- Add explanations of Figures 4d-f, 5a-c

- Figure 5 the description of plot d seems to be missing?

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- Seems like reference to Fig 5a on line3 in Discussion 4.1.1 is incorrect because the figure caption labels this plot as process-based

- Figure 4c caption should specify which model rather than just "the model"

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 9765, 2015.

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