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Hydrology and Earth System Sciences Discussions

Interactive comment on "Exploring the physical controls of regional patterns of flow duration curves – Part 1: Insights from statistical analyses" *by* L. Cheng et al.

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GENERAL COMMENT

Being the interpretation, analysis and modelling of flow duration curves (FDC's) one of my specific research interests I really enjoyed reading the manuscript by Cheng et al., which presents a comprehensive analysis of empirical duration curves (i.e. rainfall, total, fast and slow runoff duration curves) over a large geographical area (i.e. continental US) and a number of gauged basins (i.e. 197) aimed at deepening our knowledge on dominant geomorphological and climatic factors controlling the shape of

FDC's. The research question is of broad international interest, and addresses several practical applications, such as the predictions of the curves in ungauged basins. The presentation is clear and the manuscript is well written and concise. I am reporting below a few main comments and some specific remarks, which I hope the authors will find to be useful while revising their manuscript.

Regards,

Attilio Castellarin

- Supporting the utilization of the mixed-Gamma distribution

In my opinion, the use in this study of the mixed Gamma distribution, a 3-parameter distribution in which one parameter -alpha- is used to mimic the zero-flow (or zero-rain) duration, while the other two control the 1st and 2nd order moments, should be further discussed and supported in the text. Since the analysis focuses on the shape of standardized (i.e. unit-mean) duration curves, one may wonder if the modelling of each curve (i.e. rainfall, total, fast and slow runoff) through the proposed model is really necessary. Similar findings could perhaps have been reached through the analysis of empirical values of alpha (done in the study) and variance (the study refers to the parameter k instead). A similar approach would have been more general (no limitation to a specific model). Also, one may argue that representing a complex distribution such as a flow (or rainfall) duration curve with a 2-parameter model may work in some areas but could be over simplistic elsewhere (see e.g. LeBoutillier and Waylen, WRR, 1993, Castellarin et al., WRR, 2004).

- Deepening the discussion on how to move forward

The authors clearly show how the rainfall duration curve can be associated with the fast-runoff duration curve. They also show how the FDC for medium to large durations is strongly linked to the slow-runoff duration curve. Finally, the authors show clear geographical patterns of these curves over the study area. It is argued in the study that

these outcomes may be particularly relevant for the prediction of FDCs in ungauged basins through a more process-oriented approach, and I perfectly agree with the authors on this point. Concerning this point, though, I also believe that the manuscript would be enriched by a brief discussion speculating further on how to practically exploit these results for regionalization of FDCs. Should this involve a recombination of the different duration curves? If so, the authors should anticipate how to perform such a recombination, since summation of runoff components for given duration values is not correct.

SPECIFIC REMARKS

Abstract - "... revealed significant space-time symmetry.", I find this passage to be unclear.

p. 7003, l. 27 – please replace "Castellarin et al. (2004b) developed procedures to regionalize FDCs based on similarity of catchment climatic and morphologic characteristic in Italy" with "Castellarin et al. (2004b) reviewed the regionalization approaches proposed in the literature and compared their performance in the context of predictions in ungauged basins for a large region in central Italy".

p. 7004, l. 10 - "FDC cannot, strictly speaking, be regarded as a probability distribution (Mosley and Mcerchar, 1993)" I find this statement to be misleading. It also contradicts what is stated on p. 7009, l. 10-11. The authors may consider dropping this statement.

p. 7004, l. 17 - "the logistic distribution (Castellarin et al., 2004a)". This quotation is not accurate. Castellarin et al. (2004a, 2007) used the 2-parameter logistic distribution for representing the annual climatic signal and combined it with a more complex distribution (3-parameter Generalized Pareto, or 4-parameter Kappa distributions) for deriving the daily streamflow regime.

p. 7006, l. 18 – "the various FDCs,..." I would replace this with "the various duration curves", since it refers also to the rainfall duration curve.

p. 7008, l. 16 – please briefly recall the definition of the seasonality index for the sake of completeness.

Baseflow Index, BI – Given the relevance of this study to PUB, the authors should highlight in the text that BI is a streamflow regime index and cannot be computed for ungauged basins, if possible they should also discuss consequences in the PUB context. Also, later on in the text and in some figures BI is recalled as a geological variable. I find this to be misleading. While I acknowledge that BI may be "used as a surrogate for the collective impact of of landscape properties such as geology, ...", I would recommend not to identify it with a geological variable, making it crystal clear that BI is a property of the streamflow regime, whose empirical values are available for gauged basins only.

p. 7009, l. 5 - "robust" has a very specific meaning in statistical language, I fear the term is miss-used here, please check.

p. 7010, l. 2 - "theta largely affects the vertical shift", would that be the mean? If so, this statement does not seem to agree with eq. (4), that shows that theta and kappa both control the mean to the same degree (at least analytically).

R^2 and Ens – Why R^2 is used here? Ens is more meaningful and the redundancy of using both indexes appears also in Fig. 4.

Eq. (7) – The meaning of "i" in the notation is unclear. i=1,...n, with n=54 times 365.25?

p. 7011, l. 10 - "observed duration curves", please consider replacing observed with empirical.

p. 7011, l. 11 - "since the mean daily streamflow is strongly related to AI", from what I understood, each duration curve is standardized by dividing its values by the long-term mean of the same variable. One may wonder if the above consideration applies also to the other considered long-term mean (e.g. precipitation, etc.). Please discuss.

p. 7012, l. 1-2 – Is this a repetition from the previous paragraph?

p. 7016, l. 1 - “to regionalize FDC”, BI cannot be directly used for this task (see my comment above).Please include a discussion.

p. 7017, l. 26 - “54 catchments”, please check.

“8 selected catchments” - It would be good to compare their relevant indices (i.e. SI, AI, BI, etc.) with the indices of the whole set of 197 catchments (boxplots?).

Fig. 1 – This representation highlight dependence of the measure of interest from the geographical location only. Is there any dependence of these measures on catchment area (which spans more than an order of magnitude in the study area)?

Fig. 8 and Fig. 9 - “geological variables”, please revise.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 7001, 2012.