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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.

**Anonymous Referee #3**

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This paper fits the mixed gamma distribution to flow duration curves (precipitation, total, fast and slow flow) and seeks to understand the interplay of physical controls on flow duration curves through investigation of spatial patterns in the mixed gamma parameter values. Whole of record FDCs are analysed for 197 USA catchments and annual FDCs for 8 of those catchments. This paper is the first of three companion papers. A paper that increases understanding of the physical controls of FDCs and develops regional relationships to estimate FDCs for ungauged catchments would be worthy of publication.



However, this paper is let down by the thin analysis and discussion of results in sections 4 & 5. Maybe a more substantial analysis of this material is presented in the companion papers, but it is not presented here. Overall the paper is well written, the first three sections are fine (the introduction is excellent), but the lack of a robust analysis of the material presented weakens the paper. If one of the companion papers contains a more robust analysis of this material then it might be better to combine the two papers.

In Section 4 the spatial distributions of alpha (Figure 5) and kappa (Figure 6) are investigated. In both figures the colours don't represent consist intervals of the variable mapped for a given map or between the four maps in each figure. This makes comparison between maps very difficult. It also gives the impression of greater spatial variability than perhaps really exists. For example, Figure 5 Total Flow – an alpha value <0.01 might be represented by one of three colours, an alpha value <0.042 might be represented by one of six colours, yet an alpha value between 0.042 and 0.235 is represented by a single colour. Firstly, there is uncertainty in the value of alpha (and kappa), so are three intervals for <0.01 and six for <0.042 meaningful? Secondly, use a consistent interval within a map and for all the maps in a figure. This may mean that most of a map is one colour, but if there is little spatial variation in the value of alpha (or kappa) then show that. Don't create variation by using inconsistent intervals. Once consistent intervals are applied to these two figures the associated discussion of results may change.

In Section 5 the relationships between kappas for PDC, TFDC, FFDC and SFDC and the relationship between kappa and BI and Pmax * alphaP are investigated. Throughout the discussion of these results terms like 'closely related', 'strong correlation' and 'closely correlated' are used. Yet the strength of these relationships is never tested. Figures 7, 8 and 9 show the results discussed and in several cases (e.g., Figure 7a and Figure 8b) the strength of the relationship appears to be weaker than these terms. If statements about relationship strength are made then some form of testing of relationship strength is required. Since these relationships are mainly non-linear a Spear-

man Rank correlation would be appropriate. This would add an objective measure of relationship strength to the results discussion.

There are no plots of alpha and kappa for PDC, TFDC, FFDC or SFDC against the seasonality index in the paper. In fact after Figure 1c the seasonality index is not seen again, which makes one wonder why it is included. Figures 8 and 9 only show a single variable (BI or Pmax * alphaP) against kappa for TFDC, FFDC and SFDC. A more complete analysis of the available material would report on the relationships between alpha and kappa for each FDC and all the variables (BI, Pmax * alphaP, SI, ?). If the plots of these additional analyses don't add to the overall story, then at least report the correlation results and maybe include the plots in a supplementary material section.

Minor comments/corrections:

The reference to Zhao et al (2011) is given as 2012 in the reference list. Is it 2011 or 2012?

How is the seasonality index (SI) calculated? A reference is provided by no description of how to calculate SI is given.

The coefficient of determination equation 6 is incorrect. In the denominator the square should be outside the bracket for (qobs,i – mean qobs).

Page 7011 Line 5-6: A coefficient of determination = 1 does not necessarily mean that the observed and predicted FDCs are the same. A coefficient of determination = 1 indicates that the observed and predicted FDCs have the same shape, but may be offset by a constant value across the entire range of the FDC. Thus the shape is correct, but there may be a bias.

Page 7013 Line 14: The mixed gamma distribution has difficulty fitting the low flows, which are found in the TFDC and the SFDC. Are the low flows the 'more complex runoff processes' you mention?

Page 7017 Line 26: Replace 'each of 54 catchments' with 'each of 54 years'



Page 7019 Line 12: Replace 'fast flow and slow components' with 'fast and slow flow components'

Figure 4: Replace 'Rˆ2/Ens' with 'Rˆ2 and Ens' on the y-axis.

Figure 7: Add 1:1 lines to these plots to aid comparison.

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