

Interactive comment on “Hydrologic similarity among catchments under variable flow conditions” by S. Patil and M. Stieglitz

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We thank Anonymous Referee #2 for providing a very thoughtful and constructive review. Below, we address some of his/her specific concerns:

RC 1: Page 8613, line 8-21: in fig. 2 the low flows appear more divergent (in space) than other flow quantiles. However the y-axis of figure 2 is logarithmic, meaning that differences are emphasized for small values. Analogously, the coefficient of variation is selected as indicator of spatial variability across flow percentiles and shown in fig. 3. The CV is a measure of variability relative to the mean and, to me, some of the features of fig. 3 could be explained by looking at the mean (which can be guessed by looking at fig. 2). This relates to point 5 of reviewer 1. I would suggest the authors to add a
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sentence to explain why it is better/necessary to use this variability measure (the CV) when assessing the similarity among catchments across flow conditions.

Answer: We agree with this concern of Referee #2. We used CV since it is a dimensionless measure of variability and quantifies the relative spread around the mean as the mean increases with increasing flow percentiles. In the revised manuscript, we will mention why we think CV is a better variability measure when assessing similarity across flow conditions. We will also mention the factors controlling the CV value at different flow percentiles (related to point 5 of Referee #1).

RC 2: Page 8615, line 20: In Fig. 6 I would suggest to show the monthly flows of all catchments in each basin, provided that the variability of precipitation and PET is low among them. This would add information on the spatial variability of regimes and motivate the second part of the sentence at line 20 of page 8615, i.e., "an increase in ET demand during the summer period decreases the flow magnitudes and increases the spatial variability of streamflow".

Answer: We showed Fig. 6 to illustrate that with the amount of precipitation input remaining fairly stable within a year the real controller on stream discharge appears to be the fluctuations in ET demand. However, when we added the flows of all the catchments within a basin, we felt it did not add much to our understanding, and made the figure look busy and less visually appealing. Therefore, we felt it was better to leave the plot as is.

RC 3: Page 8616, line 1: what does "isolated nature" mean?

Answer: We used the phrase "isolated nature" to emphasize that during dry conditions, different hillslope regions within a catchment are not hydrologically connected (Grayson et al., 1997; Stieglitz et al., 2003). However, we believe use of this term caused some confusion (Referee #1 also asked us to clarify it). Therefore, in the revised manuscript, we will eliminate this phrase ("isolated nature") and provide a better verbal argument in our discussion so that the reader is not confused about our interpretation of the results.

RC 4: Page 8616, line 16: "Therefore, during high flow conditions, the contribution from faster flow paths, viz., surface flow and shallow subsurface flow, becomes increasingly important. This phenomenon has been observed in several experimental studies, ...". How does this relate to the spatial variability of high flows?

Answer: This sentence was used to suggest that different parts of a catchment are better connected during wet conditions than in dry conditions, and makes the stream response increasingly dependent on the larger scale rainfall input. In the revised manuscript, we will expand further on this discussion to make a better argument.

RC 5: Page 8616, lines 22-24: to me, the high spatial CVs for high percentiles is very interesting. Does it mean that the floods are of local type (driven by local storms) while more common high flows happen in wet periods (frontal precipitation events)? This could be checked looking at the seasonality of the maximum annual peaks. Do they happen in summer?

Answer: This is an excellent point raised by Referee #2, and our initial notion after reading the suggested inference was similar (i.e., local type storms typically during summer months might be causing annual peaks). However, when we examined the streamflow records of our catchments to check the month when annual peak flows typically occur, we found that most of the annual peak flows occur during January to April period (when ET demand is low). Nonetheless, there are a few years in the record during which the annual peaks occur during summer months. We will add to the discussion to reflect this point in the revised manuscript.

RC 6: Page 8616, lines 26-29: how does the relation between peak floods vs. catchment area affect the spatial variability shown in fig. 3? Is the CV higher where the variability of catchments sizes is higher? Please add a sentence to relate this statement to the cases shown in the paper.

Answer: This is a very interesting point raised by Referee #2 and something that we gave considerable thought to prior to submitting our manuscript. Study of variability in

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peak flows is a well-studied topic in hydrology. However, we did not have sufficient number of catchments in our study to answer how variability in drainage area of catchments will affect spatial variability at peak flows. Nonetheless, we will add to the discussion to mention this point in the revised manuscript.

RC 7: Page 8617, lines 1-3: "During the high flood events, the hydraulic properties of stream channels of individual catchments assume an increasingly important role in controlling the streamflow within these basins, and therefore, might be causing an increase in regional variability". This is true, to me, for big catchments much more than for small ones. Is then the spatial variability, again, due to the difference of catchment size?

Answer: This point is similar to the concern raised by Referee #2 above (in RC 6). We certainly think that the catchment size and its channel network properties have a role to play in the variability at high flows. Therefore, we added a sentence in the discussion (which Referee #2 has referred to above) speculating about the potential causes for high CV values at extreme flow percentiles. However, the limited number of catchments in this study does not permit a robust analysis of these causes. We will add a sentence in our discussion stating this point in the revised manuscript.

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