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Hydrology and Earth System Sciences Discussions



# *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 #3 for a very helpful and constructive review of our manuscript. Below, we address some of his/her specific concerns:

RC 1: The introduction could be strengthened by a motivating discussion of what similarity is (i.e. how it arises), and why we might expect it to vary across the range of flows.

Answer: This is a good suggestion by Referee #3 and we agree with his concern regarding strengthening of the introduction. In the revised manuscript, we will make additions to the introduction stating the potential causes of similarity among catchments and why this similarity can vary with hydro-climatic conditions in more details.

RC 2: Firstly, it should be established that the climatic controls on each catchment in basins are similar – a figure showing the precipitation equivalent of the flow duration curves would serve for this.

Answer: This is also a good suggestion by Referee #3. We chose the catchments within each of our four river basins based on the similarity in their annual rainfall and runoff. Using the monthly precipitation time series for each catchment from the Vogel and Sankarasubramanian (2005) dataset, we obtained the precipitation equivalent of the flow duration curve (see Figure 1 below in this document). This figure confirms that the precipitation inputs for catchments within each basin were similar for the chosen time period.

RC 3: Secondly, it would strengthen the case if the differences at low flow could be related to differences in the geology of the catchments. Do sub-watersheds with similar geologies behave similarly at low flow?

Answer: Similar point was raised by Referee #1. We completely agree that the geology of catchments has an important effect on the variability at low flows. However, an examination of the catchment geologic data of all the 25 catchments showed that there is a large variability of soil types within each catchment. We also examined the related metrics of soil properties such as permeability, % organic matter, % clay content, etc. but no distinct differences were observed in the soil types between the catchments from which we could have been able to draw some conclusions. In the revised manuscript, we will add a more detailed description of the geology and soils within each river basin in the Study Sites section and also make additions to the discussion that reflects the above observation.

RC 4: Thirdly, I think there is the potential for some spuriousness in the use of nested watersheds as though they are independent samples.



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Answer: As we mentioned in the reply to Referee #1, if we had access to large amount of non-nested catchment data that fit our selection criteria, we would certainly use it. While it might be the case that the nesting of catchments has an effect on the spatial variability of Q, our current data does not support the notion. For example, in both Allegheny (2 catchments nested) and Upper Delaware (completely non-nested catchments) basins, similar patterns of CV-Q percentile relationship are observed (Fig. 3).

RC 5: Last but not least, there is also a methodological issue that needs to be addressed. The CV is the std divided by the mean. You would therefore naturally expect it to be large when the mean is small (and vice-versa). Given that the flows are likely close to log-normally distributed, this effect will be magnified by the variability over orders of magnitude. It could be argued that your conclusions are therefore simply an artifact of the method you use to analyze the variability. To rule this out, you could compare the results to some null model of log-normal values.

Answer: This is a very insightful suggestion by Referee #3. We tested this suggestion by randomly generating 25 log-normally distributed time series that have the same statistics as the 25 catchments in our study. Then we computed the spatial and temporal CVs for these random time-series as described in our manuscript. Figure 2 below (in this document) shows the results of the random series that have same statistics as the catchments in Lower Susquehanna basin. These CV patterns are distinctly different than the CV patterns obtained with actual streamflow time series for catchments in Lower Susquehanna basin (Figures 3b and 4b in the manuscript). Moreover, identical CV patterns (as shown in Figure 2 below) were obtained for catchments in other three basins using the random series (results not shown). Therefore, the randomly generated times series are unable to replicate the inter-basin differences in CV patterns that were observed using actual streamflows. In the revised manuscript, we will add the above analysis to the discussion, which shows that the CV patterns obtained in our study are not an artifact of the methodology used.



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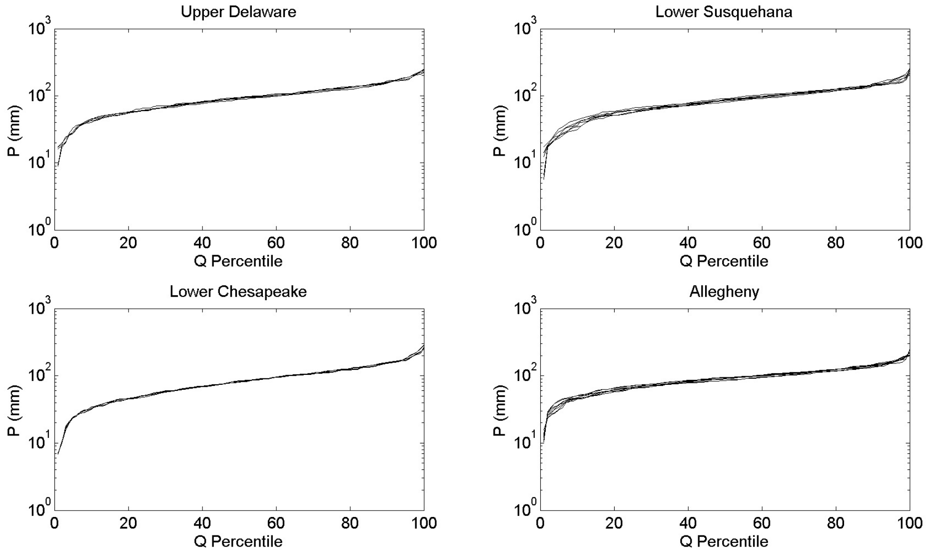


**Fig. 1.** Precipitation duration curves of catchments in each of the four river basins.



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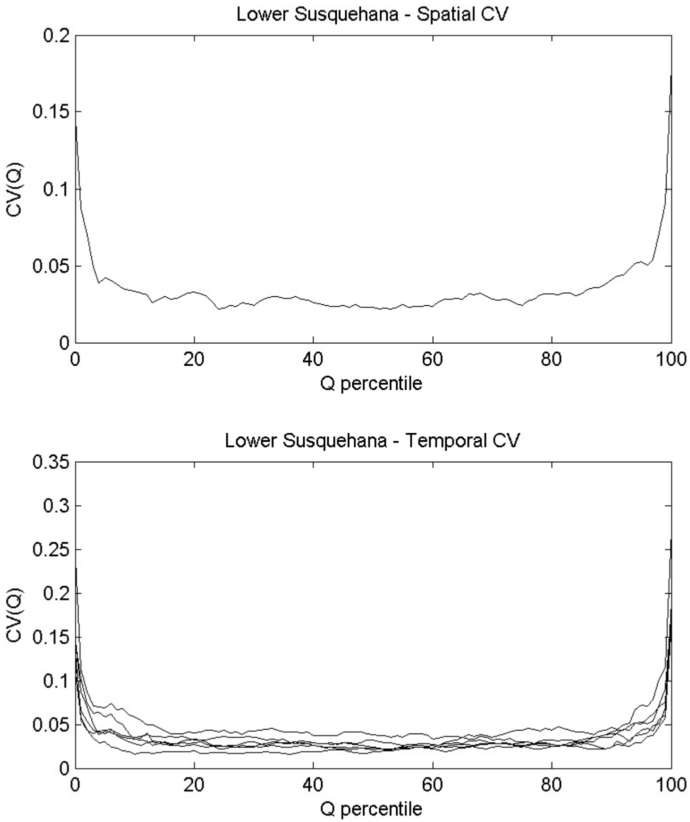


**Fig. 2.** Spatial and temporal CV of randomly generated time series with same statistics as catchments in Lower Susquehanna basin.



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