Commentator: Wouter Berghuijs

This paper presents an interesting analysis of streamflow and its changes across the USA. The paper i) classifies catchments based on their existing flow regime, and ii) assesses how these different flow regimes are expected to change into the future. Overall this paper seems like an interesting and relevant contribution to HESS, and enjoyed reading the paper. This short comment is not intended as a full review of the paper, but I hope that sharing the below thoughts may help to strengthen the paper.**I am aware that there is some degree of (what may be classified as) self-advertising in this comment, but my comments can be addressed without (again) citing the single self-reference that I provide.**

A key assertion and motivation of this study is that hydrological classifications have not really incorporated "temporal information in clustering hydrological catchments, [...] even though such information is potentially very useful". This statement is used as a motivation to develop a classification that incorporates such information. Overall, this is a good idea. However, while many studies indeed ignore the temporal aspect, there are existing studies that explicitly incorporate this information into their classifications (leading to very similar types of classifications as presented in this paper). Grouping based on seasonal regimes have been introduced a long time ago: e.g.:

Pardé, M. (1960). The river regime in New Zealand. Revue de Géographie Alpine , 48(3), 383-429. (And probably also in earlier works of Pardé and others) and have been applied globally: Haines, A. T., Finlayson, B. L., & McMahon, T. A.(1988). A global classification of river regimes. Applied Geography, 8(4), 255–272.https://doi. org/10.1016/0143-6228(88)90035-5, which classified global streamflow regimes into very similar type classes as done in the presented HESSD manuscript. (However, obviously with a greater variety of classes since the global spectrum of river flows was taken into account). A global analysis has been updated: Knoben, W. J., Woods, R. A., & Freer, J. E.(2018). A quantitative hydrological climate classification evaluated with independent streamflow data. Water Resources Research, 54(7), 5088-5109. This Knoben study also includes temporal information of streamflow classes into the final classification, which again is very similar in nature to what is presented in the presented HESSD manuscript. Different to the presented manuscript is that the classification metrics are not based on streamflow themselves directly. However, the classes it produces are shown to have very similar within-class seasonal streamflow regimes, which seems to make them functionally equivalent to what is presented in the HESSD paper. In addition, such analyses are also available for the United States, focusing on seasonal streamflow regimes: Coopersmith, E., Yaeger, M. A., Ye, S., Cheng, L., & Sivapalan, M.(2012). Exploring the physical controls of regional patterns of flow duration curves-Part3: A catchment classification system based on regime curve indicators. Hydrology and Earth System Sciences, 16(11), 4467.and seasonal streamflow (and all other water components) regimes: Berghuijs, W. R.,Sivapalan, M., Woods, R. A., & Savenije, H. H. G. (2014). Patterns of similarity of seasonal water balances: A window into streamflow variability over a range of timescales. Water Resources Research, 50, 5638–5661. (whereby this study, based on largely similar classes, also had similar conclusions regarding class correlations with e.g. aridity, snowiness, flood timing, low flow timing.) I understand that these studies have already mostly been cited in the main text, but their validity as classifications of seasonal flow regimes that include temporal information has sort of been dismissed by the statement that "The use of catchment characteristics can be problematic because there is often no clear link between these characteristics and streamflow indices". Yet, all of the above-listed studies (except Pardé maybe) show explicitly how their classifications lead to similar within-class behavior of seasonal streamflow regimes. I think there is an opportunity to slightly reframe the paper to acknowledge that this study complements existing classifications that also incorporate temporal information

of flow regimes, (rather than to imply that nothing (useful) exists in this field). (Or alternatively, be more precise and explicit about what the previous classifications can't do that yours does). The use of B-spline basis functions to characterize the streamflow regimes functional behavior in this HESS manuscript seems to be a useful addition to existing literature that I look forward to seeing published in HESS.

Reply: *Dear Wouter, thank you for your thoughts on the framing of our manuscript, which we considered while revising our manuscript. We did by no means intend to imply that nobody has ever looked at timing related streamflow indices in clustering but rather wanted to point out that studies that explicitly consider the temporal information in the continuous signal are rare. This is why we wrote: 'Both the catchment and climate characteristics and the streamflow index approaches neglect nearly all available temporal information embedded in a streamflow time series or regime in the form of temporal (auto-) correlation'. The keywords here are 'nearly' and 'in the form of temporal (auto-) correlation'. We agree that the subsequent sentence may seem exclusive of some contributions and rephrased it to explicitly state that some studies have clustered on streamflow indices related to seasonality and timing: 'While some of the index-based approaches have considered indices related to streamflow timing and seasonality* [*Haines et al.*, 1988; *Bower et al.*, 2004; *McCabe and Wolock*, 2014]*, only very few studies have tried to explicitly take account of temporal streamflow information in clustering hydrological catchments, e.g. by using the shape of the autocorrelation function as an index* [*Toth*, 2013]*, even though such information is potentially very useful.' We also rephrased the sentence on the weak link between certain streamflow and catchment characteristics to: 'The use of catchment characteristics is not always beneficial as certain streamflow indices do not show clear links to these characteristics* [*Ali et al.*, 2012; *Addor et al.*, 2018]*.' We cite the Knoben et al.* [2018] *study under clustering approaches related to climate characteristics as their 'classification scheme is based only on climatic information and can be evaluated with independent streamflow data.' We acknowledge the work by Coopersmith et al.* [2014] *under approaches using streamflow and climate characteristics as they use date of maximum runoff as a streamflow index, which is related to time but does not say anything about the changes of streamflow over time. We acknowledge the work by Berghuijs et al.* [2014] *under the climate indices clustering approaches (formerly mixed approaches). You use a measure for the strength of precipitation seasonality but do not directly include information on the temporal distribution of precipitation over the season. We hope that you find the updated framing more precise and inclusive.*

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