Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2019-463-RC1, 2019

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Hydrological signatures describing the translation of climate seasonality into streamflow seasonality" *by* Sebastian J. Gnann et al.

Anonymous Referee #1

Received and published: 26 October 2019

The focus of this study is on seasonality of forcings (i.e., watershed inputs) and streamflow (i.e., outputs) and how the former is translated into the latter through watersheds functioning. To understand the role of watersheds in dampening of forcings seasonality, authors develop two signatures (namely, the amplitude ratio and the phase shift) and show how combinations of linear models result in certain values for these two signatures. Subsequently, they calculate values for the same signatures using data from several watersheds in the UK and US and overlay the results on top of linear model findings. In this way, they could devise a perceptual model for a given watershed, e.g., two parallel linear reservoirs show to be suitable to model streamflow in some catchment. Finally, authors assess two hydrologic models to figure out whether or not they

could properly reproduce expected variations of these two signatures. This task helps evaluate structural adequacy of a given model. The paper is really well-written, and has high quality presentations. Because this research also provides theoretical foundations for the analyses in this paper, I consider it a great contribution. I believe that the proposed methodology has many applications in the field of watershed modeling and water resources management. Still, I have a few comments that are provided below, which might help improve the quality of this interesting manuscript. I would recommend minor revision.

Comments: Maybe my most major comment is about similarity in concepts between this study and previous studies. Authors themselves also point out that several previous research have essentially relayed the same type of information, but maybe using different techniques (such as unit hydrograph, transit time distributions, etc.). I still do not completely understand what the benefits of the proposed method are, and this requires a dedicated section in the paper. Basically, any other quantitative tools that highlight the differences between the time series characteristics of inputs and outputs could be used here too. For example, we could simply use lag time between forcings and streamflow time series, or maybe variance of these time series, to investigate watershed functioning. For instance, if the ratio between normalized variance of inputs and outputs is really small, watershed might be groundwater dominated. Such a situation would be actually the case with low amplitude ratio under the proposed method. My question is, 'what makes this method unique or better in comparison to other methods? Line 358-359: regarding limitations of this study, authors here mention that "In other climates with a less distinct seasonal pattern, or with two seasons per year our approach will not work". I would argue that there are other limiations that need to be mentioned here too. For example, the proposed method requires quite long records of data. Authors claim that 'inference from observed values of the signatures' is a potential outcome of this method, but as I said, data is needed for this purpose, right? Moreover, most likely the method won't work for sub-annual time scales (because there are lots of hydrological non-linearities at smaller time scales. Maybe, elaborate on different

limitation aspects of this research in a separate section.

Other minor comments: Line 125: explain how multiple linear regression method will be used. I haven't seen any material so far that explains how linear regression could be useful. Line 546: 'reduce the need for calibration'. . .I don't think so. Maybe, signatures calculated in this research could be used as additional calibration metrics to improve the probability of getting the right answer for the right reasons. . .but not replacing the calibration process. I have to say that, to me, the most interesting finding in this research is (lines 448-450: the attribute "fraction of highly productive fractured aquifers", which is a hydrogeological classification available for the UK, shows a much clearer pattern than any soil or geology attributes in the US.). This has great applications in model development for ungauged catchments. Minor: Line 16: give a very brief meaning for the word 'seasonality'. . .later you use terms such as 'mean seasonal regime' or 'seasonal streamflow regime' or 'seasonal signatures', which will make more sense if a clear description of seasonality is provided at the beginning Line 44-45: Shafii and Tolson (2015) is another reference that needs to be cited here Line 73-74: this sentence is a bit unclear: 'a signature describing how climate seasonality is translated into streamflow seasonaltiy adds a timing component with a focus on seasonal and thus slower dynamics.' Line 237: please explain what you mean by 'fast flow routing delay (1 to 5 days)' Thank you

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