Reviewer 1

General comments:
This paper develops a functional hydrologic classification method, applies it to a large number of gages in the continental US, and assesses future changes in hydrologic regime resulting from climate change using VIC model output driven by downscaled GCMs. The paper makes an important contribution to the literature on hydrologic classification because its use of functional data analysis, in which each hydrograph is represented as a function, addresses issues associated both with top-down classifications based on catchment characteristics (lack of process connections between those characteristics and streamflow) and with bottom-up classifications based on streamflow indices (requiring selection of indices that may not fully describe the hydrologic regime). As such, the paper provides an interesting and innovative approach that is useful for assessing hydrologic regimes for climate-change impact assessment or to predict the behavior of ungaged catchments.

Specific comments:
Line 30: It should be noted upfront that hydrologic regimes, defined here as those "described by mean annual hydrographs", can encompass a broader set of variables than those used here. In particular, the functional approach that analyzes mean annual hydrographs describes the seasonal patterns of stream-flow, but not patterns that occur on either shorter timescales (e.g., flashiness) or longer timescales (e.g., interannual variability). For analyzing these types of changes in hydrologic regime, the functional analysis is less useful and particular streamflow indices must instead be used. This is important because the seasonal hydrologic regime is highly sensitive to changes in temperature in the melt region because of the snow signal, but as noted later in the paper (lines 291-292), there is no clear seasonal signal in catchments that are more sensitive to changes in precipitation to temperature. It is not that those catchments will not experience hydrologic changes due to climate change, it is just that the type of changes they experience (e.g., greater flashiness or inter annual variability) are not captured by the functional analysis and its focus on seasonal changes. Also, although at the seasonal scale of analysis meteorological variables were more significant than physiographical variables in predicting class membership (lines 228-229), it is possible that physiographical characteristics would be more significant in determining class membership when it comes to flashiness or interannual variability, because of the role of land-surface characteristics like lithology, soil, and vegetation in mediating the climatic signal.
Reply: *Thank you for highlighting this point. We agree that the functional clustering approach presented here does not consider similarities in inter-annual variability when clustering catchments, also not in the change assessment. While the approach does indeed not allow for the consideration of flashiness at an event scale, it allows for a partial consideration of flashiness as the mean annual hydrographs used for the clustering and the change analysis have a daily temporal resolution. We make the following addition when comparing the FDA to the index-based clustering approaches:*
This scheme makes better use of the seasonal and temporal information stored in the hydrological regime than index-based approaches. However, it does neither consider streamflow patterns at short, event time scales such as flashiness, nor time scales longer than a year as for instance caused by inter-annual variability.
We acknowledge in the results section that: 'Catchments without predicted regime changes may still undergo changes in specific streamflow characteristics, such as variability or low and high flows (l.274-275).'
We differentiate the discussion of class predictor strengths by adding: 'The relationship of class membership to physiographical characteristics may be weaker than the one to climatic

characteristics as the clusters are formed using the mean annual hydrographs whose seasonality is strongly influenced by climate. The link to physiographical characteristics may be stronger if streamflow characteristics at an event time scale are considered.'

Lines 233-234: Would it be possible to include a map of nominal hydrologic class for ungaged catchments? If the random forest model can predict hydrologic class based on meteorological and physiographical variables, it should be able to apply the classification and predict hydrologic class for all the catchments in the CONUS (assuming data for the predictor variables are available CONUS-wide). That would be an interesting map to see because it would further illustrate the spatial contiguity and extent of the hydrologic classes beyond the gaged catchments in Figure 2.
Reply: *We agree that it would be nice to produce a map of predicted regime classes over the whole CONUS. We did not do this for two main reasons: First, the dataset of physiographical variables we used for this analysis is limited to the 671 catchments in the CAMELS dataset* [*Newman et al.*, 2015; *Addor et al.*, 2017]*. Furthermore, our classification is limited to streamflow regimes resulting from natural conditions. A classification for all catchments in the CONUS would need to encompass classes for 'human-influenced' catchments where the streamflow regime has been (strongly) altered by water abstractions and transfers, reservoir operation or other human interventions.*

Technical corrections:
Line 243: Typo: "Klomogorov" should be "Kolmogorov".
Reply: *We corrected this typo.*

Line298: Is "temporally" meant to be "temporarily"? That makes more sense to me
Reply: *Yes, we changed temporally to temporarily.*

References used in this response to the reviewer

Addor, N., A. J. Newman, N. Mizukami, and M. P. Clark (2017), The CAMELS data set: Catchment attributes and meteorology for large-sample studies, *Hydrol. Earth Syst. Sci.*, *21*(10), 5293–5313, doi:10.5194/hess-21-5293-2017.

Newman, A. J. et al. (2015), Development of a large-sample watershed-scale hydrometeorological data set for the contiguous USA: Data set characteristics and assessment of regional variability in hydrologic model performance, *Hydrol. Earth Syst. Sci.*, *19*(1), 209–223, doi:10.5194/hess-19-209-2015.