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Understanding Hydrologic Variability across Europe through Catchment Classification

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This presentation is based on data-driven approaches using data from many different archives to better understand drivers to hydrologic variability across the European continent. We explored similarities in 16 flow signatures and 35 catchment descriptors across entire Europe. A database of catchment descriptors and selected flow signatures was compiled for 35 215 catchments and 1366 river gauges across Europe. Correlation analyses and stepwise regressions were used to identify the best explanatory variables for each signature resulting in a total of 480 regression models to predict signatures for similar catchments. Catchments were clustered and analyzed for similarities in flow signature values, physiography (including climatology) and for the combination of the two. From the statistical analysis, we found: (i) about 400 statistically significant correlations between flow signatures and physiography; (ii) a 15 to 33% (depending on the classification used) improvement in regression model skills using catchment classification vs the full domain; and (iii) 12 out of 16 flow signatures to be mainly controlled by climatic characteristics, while topography was the main control for flashiness of flow and low flow magnitude, and geology for the flashiness of flow.

Classifying catchments based on flow signatures or on physiographic characteristics led to very different spatial patterns, but a classification and regression tree (CART) allowed us to predict flow signatures-based classes according to catchment physiographic characteristics with an average percentage of 60% of correctly classified catchments in each class. As a result, we show that Europe can be divided into ten classes with both similar flow signatures and physiography. We noted the importance of separating energy-limited catchments from moisture-limited catchment to understand catchment behavior. For improved understanding, we interpreted characteristics in hydrographs, flow signatures, physiography and geographical location to define dominant flow-generating processes. We found that rainfall response, snow-melt, evapotranspiration, damping, storage capacity, and human alterations could explain the hydrologic variability across Europe. We believe that these empirical results are highly valuable for predictions in ungauged basins across Europe and for hydrological modelling at the continental and global scale.