# Predicting the spatial correlation of daily streamflows to understand the hydrological response of river networks

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At a catchment outlet, temporal variability of streamflow conditions result from the complex and interrelated dynamics of the hydrological processes controlling the upstream water cycle. Along river networks, these dynamics integrate spatially-variable geomorphoclimatic forcing, ultimately defining spatial patterns of flow regimes.

This work assesses streamflow correlation as a metric to interpret the spatial variability of hydrological signatures. The correlation between synchronous streamflow timeseries at arbitrary pairs of outlets quantifies, in fact, the analogies in the hydrological response of the corresponding contributing areas. We find that correlated outlets share similar water balance, flow variability, recession rates and, more in general, they feature similar flow duration curves and normalized discharge timeseries.

A catchment-scale analytical model is used to predict 350,000 seasonal correlations between 413 MOPEX catchments spanning the entire contiguous USA. The model successfully reproduces the observed inter-catchment streamflow correlations and highlights a clear hierarchy among the hydrological processes controlling streamflow similarity at different locations. Streamflow correlation is mainly controlled by the frequency and intensity of runoff-generating rain events in the two catchments, while catchment response rates bear, in general, a limited contribution.

Model prediction of streamflow correlation in absence of discharge data systematically over perform inter-catchment distance as a criterion to identify potential reference streamgauges to export hydrological information from gauged to ungauged sites. In particular, the physical description of flow dynamics allows better prediction when the streamgauge network density decreases and in case of seasonal variations of streamflow correlation.

The study opens new avenues to correlation as a tool to interpret flow regimes along hydrographic networks. Model predictions can be used to understand the spatial variability of seasonal flow dynamics, with relevant practical and scientific applications ranging from ecology and transport processes to water management and flood protection.

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