Stepwise Nonparametric Disaggregation of Seasonal to Daily Streamflow Volumes conditional on Hydrologic and Large-Scale Climatic Signals

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Abstract. A stepwise nonparametric stochastic disaggregation framework to produce synthetic scenarios of daily streamflow conditional on volumes of spring runoff and large-scale ocean-atmosphere oscillations is presented. The downscaling process includes a two-level cascade scheme: seasonal-to-monthly disaggregation first followed by monthly-to-daily disaggregation. We explore the use of selected climate signals (e.g., north Pacific gyre oscillation, southern oscillation, and Pacific decadal oscillation indices, NPGO, SOI and PDO, respectively) in the proposed data-driven framework by means of a cross-validation-based combinatorial approach with the aim of simulating improved streamflow sequences when compared with disaggregated series generated from flows alone. A nearest neighbor time series bootstrapping approach is integrated with principal component analysis to resample from the empirical multivariate distribution. Although the stepwise procedure may lead to a lack of preservation of the historical correlation between flows of the last day of a month and flows of the first day of the following month, we present a new and simple algorithm, based on nonparametric resampling, that overcomes this limitation. The downscaling framework presented here is parsimonious in parameters and model assumptions, guarantees conservation of mass, does not generate negative values, and preserves very well the statistical characteristics, temporal dependences, and distributional properties of historical flows. We present evidence showing that both including conditional information of climatic teleconnection signals and developing the disaggregation in cascades decrease significantly the mean error between synthetic and observed flow traces. The modeling procedure is tested with data from the Payette River basin in Idaho.

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