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Applying a Multivariate First-Order Markov Chain for selecting Ensemble Streamflow Prediction's Members in seasonal forecasting

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Hydrological forecasting plays an important role in reservoir management and hydropower generation. Nowadays, as a future planning tool, most hydropower plants depend on probabilistic forecasts rather than deterministic ones, since relying on a single inflow scenario limits the amount of information available to the stakeholders. Classically, Ensemble Streamflow Prediction (ESP) proposes historic events (its 'traces') as probable scenarios for the period of interest. In this way, each trace is considered equiprobable, in that all possible outcomes are equally likely to occur in the future period. However, due to Natural Variability (NV) and Climate Change (CC), it is likely that some traces have increased probability to occur as compared to the other members in the ensemble. The goal of this study is to develop a method to select ESP members by applying a multivariate first order Markov Chain (MC) conditioned on the historical data. The MC is applied on temperature and precipitation time series while considering different climatological indices such as cumulative precipitation on previous and future periods. Therefore, climatological scenarios are selected among ESP members to reflect the MC transition probabilities. In such cases, the ESP members are intrinsically weighted to better reflect the long-term natural variability. We applied the method on snow-dominated catchments in Quebec, Canada. To test the method, we set aside between 10 and 15 of the most recent years and built the Markov Chain transition probability matrix using the remaining 25-35 years. Our results show that the method's performance varies based on the period of the year that is to be forecast and climatological indices used as determining criteria for selecting ESP's traces. It is likely that some improvements to the ESP methodology can be implemented to improve these long-term hydrological forecasts.