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Improving sub-seasonal forecasts of high and low flows using a flow-dependent nonparametric model

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Sub-seasonal streamflow forecasts are used in a wide range of water resource management and planning applications. Practical interest includes forecasts of high flows (e.g., for managing flood events) and low flows (e.g., for managing environmental flows). However, this work reveals that while probabilistic forecasts evaluated over the full flow range can appear statistically reliable, performance specifically for high/low flows can suffer from notable under/over-estimation of forecast uncertainty, respectively. To address this challenge we consider a flow-dependent (FD) nonparametric representation of hydrological forecasting errors, and employ this representation to enhance the existing Multi-Temporal Hydrological Residual Error (MuTHRE) forecasting model. In a case study with 11 Australian catchments, the new MuTHRE-FD model achieves practically significant improvements over the original MuTHRE model in the reliability of forecasted cumulative volumes for high flows out to 7 days, low flows out to 2 days, and mid flows for majority of lead times in the range of 1-30 days. The improved performance of the MuTHRE-FD model provides forecast users with increased confidence in using sub-seasonal streamflow forecasts for applications across a range of flow magnitudes and lead times.