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How different de-biasing techniques contribute to improve forecast quality and value for hydropower operations

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Hydropower operations can greatly benefit from hydrometeorological forecasts to anticipate water resources availability and decide how to operate the hydropower system accordingly. The quality of the forecasts, i.e. the accuracy in predicting the real streamflow, significantly affects the decisions that can be taken thus determining the success or failure of the hydropower operations, i.e. the so-called forecast value. Although several bias correction techniques can be employed to improve forecast quality, the corresponding improvement in forecast value is not straightforward to predict. The objective of this work is to quantify the value of different debiasing techniques applied to pre- and post-process streamflow forecasts in improving real-time hydropower operations. We consider ensemble extended-range hydrometeorological forecasts covering lead times up to one month and two debiasing methods based on quantile mapping applied to both meteorological (i.e. pre-processing) and hydrological (i.e. post-processing) forecasts. The forecasts are then used in a rolling-horizon set-up to optimize hydropower operations. This forecast-based optimization framework is applied to the Verzasca river basin (Tessin, Switzerland), which is exploited for hydropower production since 1965 (220 GWh per year). In the case study setup, we adopt the hydrological model PREVAH, which is forced with the extended-range forecasts from the European Center for Medium Range Weather Forecasts (ECMWF) providing 5 streamflow forecast members for the hindcast period 1994-2014. We then use dynamic programming in a Model Predictive Control scheme to design the daily hydropower production. Results show that de-biasing techniques are of fundamental importance to improve both forecast quality and value by decreasing unproductive spills, especially during spring snow-melt and autumn precipitation events, and by increasing the overall annual hydropower revenue.