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Reliable estimates of predictive uncertainty for an Alpine catchment using a non-parametric methodology

José P. Matos (1), Bettina Schaefli (2), and Anton J. Schleiss (1)

(1) Laboratory of Hydraulic Constructions, École Polytechnique Fédérale de Lausanne, Switzerland., (2) Faculty of Geosciences and Environment, University of Lausanne, Switzerland.

Uncertainty affects hydrological modelling efforts from the very measurements (or forecasts) that serve as inputs to the more or less inaccurate predictions that are produced. Uncertainty is truly inescapable in hydrology and yet, due to the theoretical and technical hurdles associated with its quantification, it is at times still neglected or estimated only qualitatively.
In recent years the scientific community has made a significant effort towards quantifying this hydrologic prediction uncertainty. Despite this, most of the developed methodologies can be computationally demanding, are complex from a theoretical point of view, require substantial expertise to be employed, and are constrained by a number of assumptions about the model error distribution. These assumptions limit the reliability of many methods in case of errors that show particular cases of non-normality, heteroscedasticity, or autocorrelation.
The present contribution builds on a non-parametric data-driven approach that was developed for uncertainty quantification in operational (real-time) forecasting settings. The approach is based on the concept of Pareto optimality and can be used as a standalone forecasting tool or as a postprocessor. By virtue of its non-parametric nature and a general operating principle, it can be applied directly and with ease to predictions of streamflow, water stage, or even accumulated runoff. Also, it is a methodology capable of coping with high heteroscedasticity and seasonal hydrological regimes (e.g. snowmelt and rainfall driven events in the same catchment). Finally, the training and operation of the model are very fast, making it a tool particularly adapted to operational use.
To illustrate its practical use, the uncertainty quantification method is coupled with a process-based hydrological model to produce statistically reliable forecasts for an Alpine catchment located in Switzerland. Results are presented and discussed in terms of their reliability and resolution.