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# Performance assessment of a Bayesian Forecasting System for real-time flood forecasting

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The paper evaluates the performance of each component of a Bayesian Forecasting System (BFS), aimed at evaluating total uncertainty in real-time flood forecasting. The predictive uncertainty of future streamflow is estimated through the Bayesian integration of two separate processors that evaluate respectively the propagation of input uncertainty on simulated river discharge and the hydrological uncertainty of actual river discharge associated with all other possible sources of error. The system herein considered assumes a stochastic model as rainfall predictor and a distributed rainfall-runoff model for simulating the hydrological response and was adapted for a small basin in the Calabria region (Southern Italy). To adequately discriminate the effect of more intense rainfalls on the hydrological response, the total uncertainty consists of a mixture of two components, conditioned on forecast rainfall, with respect to an assigned threshold, and on discharge observed at the forecast time.

The performance assessment of the system was carried out for a number of flood events with adequate verification tools suited for probabilistic forecasts of continuous variables like streamflow. Specifically, we used both graphical tools and scalar metrics to evaluate the main attributes of the entire time-varying predictive distribution, including bias, reliability, sharpness and accuracy of the median value, that characterize the forecast quality.

Besides the overall system, that accounts for both sources of uncertainty, other hypotheses resulting from the BFS properties were examined corresponding to: a) Perfect hydrological model; b) Non-informative rainfall forecast for predicting streamflow; c) perfect input forecast.

Overall the results emphasize the importance of performing a comprehensive analysis on predictive distributions by using different diagnostic approaches in order to have a multifaceted view of the attributes of the prediction. For the analyzed case study, the selected criteria revealed the interaction of the different sources of errors and in particular the crucial role assumed by the hydrologic uncertainty processor in compensating for the unreliable and biased predictive distribution resulting from the precipitation uncertainty processor at the cost of wider forecast intervals.

This work suggests other more general considerations: i) emphasizes the need for a precipitation dependent BFS that allows for an improved characterization of significant forcing events; ii) highlights the necessity to develop the complete predictive distribution, which can be strongly asymmetrical and bimodal.