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An Informal Bayesian Model for Diagnose of Hydrological Model Structural Uncertainty.

During the past decade, much attention of our hydrological community has turned to the understanding on model structure uncertainty. For uncertainty analysis in hydrological modeling, stochastic approaches, especially the Bayesian models, have become the most commonly used and powerful tools. Here to analyze the model structure uncertainty of hydrological models, we theoretically developed an informal likelihood function under the Bayesian framework by introducing a residual independence coefficient (RIC) with a feasible zone of [0, 1]. The model residuals are assumed independent with each other when RIC = 1, and perfectly dependent when RIC = 0. The best RIC coefficient leads to consistent parameter inference, which avoids both underfitting and overfitting, thus lead to the minimum of the probabilistic forecasting error in hydrological prediction which here is quantified by the continuous ranked probability score (CRPS). A case study considering flood forecasting was carried out in the Chuzhou catchment of Yangtze River in China. The results indicated that an empirical RIC coefficient is useful for subjective uncertainty estimation and the best RIC coefficient can be estimated using posterior evaluation. For the Xinanjiang model in the present case study, the best RIC coefficient is about 0.4. When systematic errors of the Xinanjiang model increased, the best RIC coefficient declined. However, the CRPS of very simple ABC model was higher than the Xinanjiang model, but lower than the Xinanjiang model with significant artificial systematic errors. At this point, we could infer that the relationship of a CRPS-RIC curve and the systematic errors is potentially useful for diagnose of structural uncertainty in hydrological modeling.