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Large sample behaviors of GLUE in assessing the uncertainty of rainfall-runoff simulations

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Several methods have been recently proposed for quantifying the uncertainty of hydrological models. These techniques are based upon different hypotheses, are diverse in nature, and produce outputs that can significantly differ in some cases. One of the favored method for uncertainty assessment in rainfall-runoff modeling is the Generalised Likelihood Uncertainty Estimator (GLUE). However, some fundamental questions related to its application remain unresolved. One such question is that GLUE relies on some explicit and implicit assumptions and it is not fully clear how these may affect the uncertainty estimation when referring to large samples of data. The purpose of this study is to address this issue by assessing how GLUE performs in detecting uncertainty in the simulation of long series of synthetic river flows. In detail, these data are generated by using a first rainfall-runoff model that is supposed to represent reality. Then, a second rainfall-runoff model, of reduced complexity, is used to approximate the simulation provided by the first model. Finally, GLUE is applied to assess the uncertainty in the output of the second model. The study aims to: (1) discuss the hypotheses underlying GLUE and derive indications about their effects on the uncertainty estimation; (2) compare the GLUE simulation and prediction limits with a large sample of data that is to be simulated in the presence of known sources of uncertainty. The results of this study provide indications about the behavior of the GLUE prediction limits with respect to the confidence envelopes given by standard statistical inference.