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Identifiability of Input and Structural Errors in Hydrologic Modelling

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Calibration and prediction in conceptual rainfall-runoff (CRR) modelling is affected by the sampling and measurement uncertainty in the forcing/response data and by the structural error of the model conceptualisation. These errors significantly affect the calibration procedure, leading to biased estimates of CRR model parameters and unreliable assessment of predictive uncertainty.

The Bayesian Total Error Analysis methodology (BATEA) provides the opportunity to directly and comprehensively address these sources of uncertainty. BATEA is built on Bayesian hierarchical methods, constructing explicit error models for forcing/response data and structural errors. This communication provides a general presentation of such error models, and studies their identifiability using two synthetic data sets.

The first synthetic data set is affected by forcing and response errors, but encompasses no structural errors. In this case, BATEA is able to retrieve the actual errors corrupting the input data, resulting in unbiased parameter estimates and reliable predictive uncertainty quantification. In a second, more realistic, case study, the synthetic data set also encompasses structural errors. Results show that when these structural errors are ignored by BATEA, the estimated errors in input data overestimate the actual errors. Moreover, identifiability issues arise when both input and structural errors are to be estimated from the data.

These results illustrate the difficulty in identifying the different sources of errors affecting the calibration procedure. This is likely to be due to the insufficient information content of the data to identify several distinct error processes. A possibility to overcome this limitation is to introduce in the calibration procedure additional sources of information (e.g. radar data providing a rough estimate of the rainfall errors due to spatial averaging).