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How much information about discharge data uncertainty is needed for reliable model calibration?

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Hydrologic model calibration is impacted by a range of different errors in the model structure, the model parameterisation and the data used to drive and evaluate the model. The discharge data used to evaluate the model can often be an important source of error as a result of the indirect measurement of discharge (i.e. it is calculated from water level using a rating curve) at most gaugings stations. Several methods for estimating discharge uncertainty resulting from rating-curve uncertainty and for including such estimates in hydrologic model calibration have been suggested in recent years. Different methods use different types of discharge data uncertainty representations such as uniform, triangular or full pdf distributions. But there has been no systematic investigation into the effect the particular uncertainty representation has on the model calibration. In this study we address this research gap by asking the question: how much information about discharge data uncertainty is needed for reliable model calibration?

We choose three meso-scale Swiss catchments with different types of rating-curve uncertainty characteristics, leading to different characteristics of the uncertainty in the discharge time series. We estimated 40,000 rating curves in a Markov Chain Monte Carlo analysis using the Voting Point method and propagated this uncertainty to the discharge time series – leading to a distribution of 40,000 discharge values for each time step of the observed time series. From this distribution we derived four different uncertainty representations: a uniform distribution, a triangular distribution, the full pdf, and a sample of 1000 discharge time series realisations.

We then calibrated and evaluated the HBV-light hydrological model for each catchment at an hourly time scale within a Monte Carlo uncertainty analysis using these four different representations of uncertainty in the observed discharge time series. We used a performance measure that incorporated the three types of discharge data uncertainty distributions (uniform, triangular, and full pdf) in the calibration, and compared this to a calibration with the 1000 discharge time series realisations where we optimised the model once for each realisation. In the evaluation of the simulated results, we compared the observed and simulated distributions for different types of flow conditions and a set of 16 hydrological signatures. First results show that the weighting of different flow magnitudes in the performance measure and the impact of model errors are important to consider when evaluating the impact of discharge data uncertainty information on model calibration.