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An experiment to compare multiple methods for streamflow uncertainty estimation

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Stage-discharge rating curves are used to relate streamflow discharge to continuously measured river stage readings to create a continuous record of streamflow discharge. The stage-discharge relationship is estimated and refined using discrete streamflow measurements over time, during which both the discharge and stage are measured. There is uncertainty in the resulting rating curve due to multiple factors including the curve-fitting process, assumptions on the form of the model used, fluvial geomorphology of natural channels, and the approaches used to extrapolate the rating equation beyond available observations. This rating curve uncertainty leads to uncertainty in the streamflow timeseries, and therefore to uncertainty in predictive models that use the streamflow data. Many different methods have been proposed in the literature for estimating rating curve uncertainty, differing in mathematical rigor, in the assumptions made about the component errors, and in the information required to implement the method at any given site.

This study describes the results of an international experiment to test and compare streamflow uncertainty estimation methods from 7 research groups across 9 institutions. The methods range from simple LOWESS fits to more complicated Bayesian methods that consider hydraulic principles directly. We evaluate these different methods when applied to three diverse gauging stations using standardized information (channel characteristics, hydrographs, and streamflow measurements). Our results quantify the resultant spread of the stage-discharge curves and compare the level of uncertainty attributed to the streamflow records by each different method. We provide insight into the sensitivity of streamflow uncertainty bounds to the choice of uncertainty estimation method, and discuss the implications for model uncertainty assessment.