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Signature-based model calibration for hydrologic prediction in poorly gauged Alpine catchments

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We present a parameter estimation framework for a precipitation-runoff model for flood prediction in the Upper Rhône River (URR) basin, a mesoscale Alpine basin with strongly anthropogenic discharges. Even if there is a high amount of hydrometeorological data, most observed discharge series are too strongly perturbed by hydraulic infrastructure to be useful for hydrological model calibration. As a result, hydrologic prediction in this basin poses the same challenges as in ungauged or poorly gauged catchments.

The presented processes-oriented, multi-signal approach to parameter estimation is based on hydrologic information coming from various sources and periods, referring to different spatial scales and of different quality. It is a mixture of parameter regionalisation and signature-based calibration: where possible, we calibrate the model parameters on hydrological time series (e.g. discharges and snow height series) and signatures (e.g. mean annual discharge regime estimated from historical data or patterns in the snowmelt dynamics). If unavoidable (complete absence of data), we regionalize the parameters. A key feature is hereby that we do not regionalize individual parameter values but parameter groups that encode a dominant hydrologic process.

We compare the resulting model performance to a benchmark model obtained by simply using the globally optimal parameter values from the nearest gauged and non perturbed catchment. For prediction of flow seasonality and also extreme events, the calibration methodology outperforms the benchmark. Given that the type of hydrometeorological data we used is generally available in similar Alpine environments, the methodology can easily be transposed to other conceptual models for mountainous catchments.