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Uncertainty of hydrological signatures predicted for ungauged basins

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Reliable information about the hydrological behaviour of an ungauged catchment is needed for a wide range of water resource management decisions, and it has been a central topic of research in hydrology for the last decade through the Predictions in Ungauged Basins initiative. Such information derived as an index value from observed data in a gauged basin is known as a hydrological signature, and has been used in a variety of studies for, e.g., change detection, model calibration and diagnostic model-structural evaluation. When signature values are predicted for ungauged catchments, they are not only affected by uncertainties in the regionalisation procedure, but also by uncertainties in the observed data for the gauged catchments used for the prediction.

In this study we investigated a method for regionalisation of hydrological signatures to ungauged catchments that accounted for both of these uncertainty sources. This also enabled us to assess the role of the different uncertainty sources in defining the overall regionalisation uncertainty – e.g. for what signatures and conditions are the data uncertainties more important than the regionalisation uncertainties and vice versa?

The study was made using an extensive dataset of catchments in England and Wales, incorporating gauging (stage-discharge) data from all the discharge stations. The uncertainties were assessed within a Monte Carlo framework that incorporated different types of uncertainties in the data as well as uncertainties in the regionalisation procedure.

The regionalisation results had a high reliability when the gauged discharge uncertainties were accounted for. The magnitude of the gauged uncertainty was often larger than the differences between deterministic gauged and regionalised values, which shows that deterministic comparisons are insufficient for evaluation of regionalisation results. The results were better for medium and high-flow signatures than for low-flow signatures. The data uncertainties from individual stations had a place-specific variability with flow range that contributed in different ways to the predicted regionalisation uncertainty for different signatures. In summary, the results constitute a strong demonstration of the need to consider data uncertainty for regionalisation predictions.