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Estimating uncertain spatial parameter fields for the DECIPHeR hydrological model across Great Britain.

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We are now progressing towards hyper-resolution hydrological models that can be applied across increasingly larger domains (Cloke et al. 2011; Bierkens et al. 2014). A key challenge for these models is defining spatially distributed parameters, with the need for spatially consistent, seamless parameter fields over diverse areas including ungauged catchments.

Here, we address that problem for our new flexible hydrological modelling framework DECIPHeR, further developed from concepts in Dynamic TOPMODEL (Beven and Freer, 2001), by applying the multiscale parameter regionalisation (MPR) technique across Great Britain. DECIPHeR splits the catchment into any form and complexity of spatially connected hydrological response units (HRUs), with each HRU acting as a separate model store capable of having different model parameter values and/or model structures to represent different and localised processes. The model can be evaluated, per gauged catchment, using Monte Carlo sampled homogeneous parameters, but it is more desirable and importantly necessary for ungauged catchments, to reflect the relative differences in parameter values per HRU across the landscape from available catchment characteristics. This requires spatially consistent fields of model parameter values to be sampled, meaning the relative differences in each realisation is a plausible representation of the underlying catchment information. We have generated these spatial parameter fields through the Multiscale Parameter Regionalisation (MPR) technique (Samaniego et al. 2010), where we now quantify the uncertainties in this process. To generate these for each parameter we have collected and processed a set of national, high-resolution spatial datasets of catchment descriptor variables, and linked them to DECIPHeR's 6 parameters via specific transfer functions. Many plausible parameter fields were then generated for the model parameters at the highest resolution through sampling the global parameters of the transfer functions, and these were then upscaled to the model resolution. Uncertainty in the parameter fields resulting from choice of transfer function and transfer function parameter values was assessed through running and evaluating DECIPHeR within the GLUE framework (Beven and Freer, 2001).

This will be the first assessment of MPR within an uncertainty framework and it's first application to Great Britain. Importantly, we assess how MPR compares to a more homogeneous Monte-Carlo calibration strategy, through evaluating model performance against gauged data in a diverse range of catchments, and develop techniques to incorporate parameter uncertainty within the MPR framework.