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# Hypothesis testing under uncertainty at the national scale: An application of the hydrological multi-modelling FUSE methodology for ∼700 UK catchments.

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Recent discussions in the hydrological literature suggest that we may gain insights into defining appropriate model hypotheses by comparing model structures across a number of different catchments. In such a context the question is whether or not different model structures - that are deemed behavioural for a subset of catchments - can be related in some manner to catchment similarities. Conversely, do clear dissimilarities in hydrological catchment behaviour express themselves as clear differences in behavioural model structures? In this paper we employ the Framework for Understanding Structural Errors ("FUSE", Clark et al, 2008), which has been developed to facilitate comparisons between competing model structures, as a means to clarify comparison of different hypotheses of hydrological behaviour.

We report on our research to apply the FUSE methodology at the national scale in the U.K., using this within a Generalised Likelihood Uncertainty Estimation ("GLUE") approach to evaluate behavioural model structures and parameterisations for nearly 700 catchments, ranging in size from $10^0$ to $10^4$ km$^2$. The national coverage reveals how model parameters, structures and structural errors vary across space. Also, as some of the smaller catchments are nested within larger ones, intra-catchment comparisons across the different catchment scales reveal patterns of model structural and parametric uncertainty of great interest in understanding hydrological variability and consistencies of model hypotheses within sub-national regions. Crucially we believe this approach necessitates the use of uncertainty evaluation methods to try to take into account the differences in the quality of observational data between catchments. We also show how different objective function metrics of model performance affect the resultant behavioural model parameters and associated structures. In essence, this is a framework for national hypothesis testing by multi-model rejection. This research is a key contribution to the national scale modelling being conducted in the NERC 'Environmental Virtual Observatory' pilot project.