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From perceptual representation to numerical model: quantifying the influence of spatial information carriers in a catchment model

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A significant limitation in advancing methods for hydrological prediction in ungauged basins has been the problem of parameter identification at catchment scales. Even in areas that have been intensively monitored the collation of appropriate data and its conversion into meaningful, spatially-varying, model parameters is a non trivial task. Two approaches that have shown promise for improving this situation are the utilisation of tracer data and spatial classifications of catchment characteristics. The objective of this study was to translate a perceptual representation of runoff processes in a meso-scale catchment into a numerical model, using a soil hydrological classification and topographic data to define the spatial variability in processes and tracer data to help support the model parameterisation. The study was undertaken in the Girnock catchment, which drains an area of 30km2 in the Grampian Mountains of NE Scotland. A perceptual representation of the catchment processes has been developed from a combination of field observations and spatial datasets of topography, soils, geology and land use. Data collection in the catchment included a range of hydochemical and isotopic variables at a range of scales and these have assisted in identification of the primary flow paths and estimation of residence times for a number of subcatchments. The STorage REsidence times And Mixing (STREAM) model was used as the tool to attempt to translate the perceptual representation of processes into numerical reality. The STREAM model is a conceptual semi-distributed hydrological model that can be used to model tracer fluxes in addition to stream flows, and hence allows for the application of multi-criteria calibration using tracer data as well as stream flows.

In common with the perceptual representation of the catchment, the Hydrology Of Soil Types (HOST) classification was used to represent the variability in soils within the catchment as a basis for process-based spatial delineation. A key objective of the model calibration procedure was to identify parameters for the HOST classification that generated model predictions consistent with the perceptual representation of processes, yet at the same time giving acceptable goodness of fit parameters for prediction of stream flows and tracer fluxes. Results of the model application are presented and discussed in the context of transferability to other catchments, and ultimately for prediction in ungauged basins.