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Evaluating controls on modelled residence times generated by a conceptual semi-distributed hydrological model

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The capability of most existing water quality models to quantify future responses of catchments to environmental change is limited by a range of uncertainties in physical processes, including understanding of storage, residence times and mixing of water and pollutants. Recent approaches to model parameterisation have focused on the use of multi-criteria calibration as a means of controlling the internal behaviour of models. In practice, this parameterisation process compensates for uncertainties in model structure as well as parameter values. However, for models that incorporate spatially distributed processes, model calibration focused on outlet volumes or concentrations, is unlikely to reveal the significance of spatial structure in determining model outcomes. Comparisons of internal model behaviour with process understanding, developed through experimentation, can help reduce the structural uncertainty of models.

An experimental modelling study has been carried out to analyse the principal controls governing the transport of conservative tracer through a simple catchment. The hypothetical study has been based on a sub-catchment of the Maimai experimental watershed in New Zealand, where a history of research has generated a basic understanding of controls on hydrological processes, including mean residence times of water. The modelling study involved several numerical experiments to examine the tracer response under different scenarios of tracer application and assumptions about mixing. Interpretations are centred on the relative importance of factors such as the hill-slope length, gradient and soil depth in determining the behaviour of the model.

The results of the study provide insight into the behaviour of the model with regard

to mean residence times and the spatial factors that are most important in determining the transport of conservative tracer. Implications of the model findings are discussed in relation to known behaviour of the catchment from experimental studies and analysis of mean residence times.