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Application of a Multiple Interacting Pathways model to a shallow hillslope hydrological tracing experiment at Gårdsjön, Sweden.

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Despite the long history of the continuum equation approach in hydrological modelling, it is not the only means of formulating a physics-based representation of hillslope hydrology. The Multiple Interacting Pathways (MIPs) model is a discrete realisation that allows hillslope hydraulic response and transport to be simultaneously explored in a way that reflects the potential occurrence of preferential flows and lengths of pathways. The MIPs model uses: random particle tracking methods to represent the flow of water packets within the subsurface; velocity distributions to represent the range of possible pathways within which these water packets may travel in heterogeneous media; and transition probability matrices to control the exchange of water between the flow pathways. This combination allows concurrent simulation of water travel times, storage age, flow pathway, and origin of source, all of which are fundamental descriptors of catchment hydrology. An initial realisation of a fully dynamic MIPs model is presented here in application to a tracer experiment carried out in Gårdsjön, Sweden. The model is used as an exploratory tool, testing several hypotheses in relation to this experiment. Results show that the MIPs model can reproduce both flow and transport behaviour at a hillslope scale with reasonable success. However, the coincidence of a number of assumptions regarding slope conditions are required in order to produce a result consistent with the available discharge and tracer transport data. This may signify how informative the combination of discharge, tracer transport and flow depth data is in diagnosing the flow regime and may also indicate that the flow and transport response is highly dependant on slope conditions.