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Using oxygen-18 to study DOC transport in a macroporous forest soil

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Quantitative prediction of water movement and fluxes of dissolved substances such as organic carbon at both the hillslope and the catchment scales remains a challenge due to complex boundary conditions and soil spatial heterogeneity. In this study, water molecule 18O/16O ratios (expressed as δ18O) and dissolved organic carbon (DOC) concentrations in stormflow were analyzed using a physically-based modeling approach. A one-dimensional dual-continuum vertical flow and transport model was used to simulate the subsurface transport processes in a macroporous forest hillslope soil over a period of 2.5 years. The 18O isotope was used as a conservative natural tracer to contrast the behavior of DOC that undergoes complex transformations in the soil environment. The model was applied to describe the transformation of input signals of δ18O and DOC into output signals observed in the hillslope stormflow. To quantify uncertainty associated with the model parameterization, Monte Carlo analysis in conjunction with Latin hypercube sampling was performed. δ18O variations in hillslope discharge and in soil pore water were predicted reasonably well. Despite the complex nature of microbial transformations that caused uncertainty in model parameters and subsequent prediction of DOC transport, the simulated temporal patterns of DOC concentration in stormflow showed similar behavior to that reflected in the observed DOC fluxes. Due to preferential flow, the contribution of the hillslope DOC export was higher than the amounts that are usually found in the available literature.