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Transport and travel time distributions through a soil column: establishing a link between spatially integrated and spatially explicit models.

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Solute composition and dynamics in catchment storages and streamflow have long been studied, but are not fully understood yet. As solutes are primarily transported through (and out of) any hydrologic control volume by water flow, investigating the fate of water ages (the residence times of water parcels when they leave as discharge, deep loss or evapotranspiration) is key to unravel water quality in catchments and streams. A number of models exist to simulate hydrological transport in catchments and in general in control volumes of hydrologic interest. While the use of field and lysimeter observations to validate modeling approaches is generally accepted, ongoing disputes exist on whether spatially integrated or spatially explicit models should be used.

This study aims to illustrate how Storage Age Selection (SAS) functions, on which conceptual models of transport may be based, can be extracted from spatially explicit models. We use tracer data from two lysimeters that differ in climate, size, tracer type (natural and artificial), soil texture and vegetation to contrast results from two transport models, namely: tran-SAS (conceptual) and HYDRUS 1D (physically-based). For both lysimeters, the two models were calibrated on the available tracer data. Then, time-variant travel time distributions were computed for the bottom drainage and evapotranspiration.

Results show that the two models are efficient in capturing the dynamics of solute transport. Results also suggest that although the two lysimeters are characterized by rather different travel time distributions, their underlying transport mechanisms are quite similar. Moreover, the transit time distributions computed from the two models share similar features. This suggests the feasibility of inferring the parameters of conceptual models from physically-based representations of a hydrological system.