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A Lagrangian model approach to unify observables, preferential flow and matrix fluxes

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In the search for a unified physical representation of water, solute and energy dynamics in structured soils, we soon lack observational data and techniques. Simultaneously, effective parameters override the value of the precious data we gathered. Both imply a revision of current concepts.

We present a model approach with two key elements: 1) a Lagrangian representation of water as particles and 2) an abstract representative macropore-matrix-domain. Through this, we disentangle soil matrix properties and preferential flow paths and intrinsically account for their interaction. Soil matrix properties are adequately taken from soil physical analysis and refer to the dispersive fluxes, while preferential flow through macropores is linked to advective water particle transport based on observed tracer profiles. The former takes place as conditioned random walk. The latter is captured stochastically based on random sampling from velocity distributions.

The Lagrangian representation opens up an alternative to double domain and Richards-based representations of structured soils capturing solute transport and energy balance aspects. The macropore-matrix-domain abstraction makes the approach scalable from single soil columns to the lower mesoscale and allows lateral soil moisture heterogeneity. Moreover, by solely relying on observable data it links porescale physics to preferential macroscale fingerprints without effective parameterisation.