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Mass transfer in two-domain modelling of preferential flow in structured soil

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One key component for understanding preferential flow processes is the mass exchange of water and solutes between the soil matrix and the macropores that controls local non-equilibrium dynamics. Problems exist in the upscaling the mm-scale local properties at the macropore-matrix interface into “effective” exchange properties of macroscopic scale two-domain models. Soil structure determines shapes and sizes of this interface. Compacted regions around burrows and migrated clay or organic matter at crack surfaces lead to locally distributed physical and chemical properties, such that sorption properties along macropore walls could affect preferential transport of reactive solutes. Objective of this study was to refine effective exchange terms by considering properties of biopore walls and crack coatings. Coated surfaces from the Bt-horizon of soils were analysed with respect to texture, organic matter (OM), pore geometry, density, and porosity in structured soil horizons. 2D distributed numerical modelling of reactive solute transport from coated surfaces into the matrix was based on small-scale distributed maps of OM composition indicating wettability and OM sorption properties. The simulated local-scale cumulative infiltration and solute mass fluxes into matrix blocks were compared with simplified macroscopic exchange fluxes generated by the two-domain model that was later verified by numerical description of the vertical flow and transport of reactive tracer in undisturbed soil columns. Results could help improving macroscopic mass transfer terms in dual-permeability models.