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Transient and steady state expansions for water infiltration into dual permeability soils

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In the vadose zone, preferential flow in strongly heterogeneous soils is more the rule than homogeneous flow in uniform soils. Consequently, research activity has recently focused on the investigation and the modeling of preferential flow in heterogeneous soils and the characterization of hydraulic properties of heterogeneous soils including dual permeability soils. Within this framework, some studies have investigated the quantification of water infiltration at the surface of dual-permeability soils (Lassabatere et al., 2014). These authors developed a new analytical model for water infiltration into dual-permeability soils. However, the proposed model is based on an implicit formulation quite tricky to compute. In this study, we proposed new explicit approximate expansions for transient and steady states for the model of Lassabatere et al. (2014). The proposed methodology to compute these approximations is based on the methodology proposed by Haverkamp et al. (1994) for modeling water infiltration at the surface of single permeability soils. The main point to overcome is related the fact, in dual-permeability soils, the two subdomains, namely the fracture and the matrix domains, may have contrasting time intervals for transient and steady states. More explicitly, quasi-steady state flow may be reached in advance in the fracture domain. Consequently, at a given time, there may be the concomitancy of steady state in the fracture domain and transient state in the matrix. This point is developed further with mathematical and practical consideration. Approximate expansions and related validity time intervals are clearly identified and discussed with regards to both numerically generated and experimental data.

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