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1D model of water flow in vertisols of semi-arid climates

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Vertisols cover a significant part of agriculturally important area of semi-arid regions. Because of their swelling properties, their hydrology is complicated with dominant preferential flow in their typical desiccation cracks that work as conduits for both rapid infiltration and for evaporation causing soil salinisation. The hydrology of vertisols has been extensively studied and conceptually described recently, but the transformation of this knowledge into mathematical models remains a challenge. The presented model is based on dual-permeability idea by Gerke and van Genuchten (1993) and divides the flow in the area into two parts, one representing the matrix and the other the cracks. On top of that, evaporation through the cracks is described by the sink/source term in Richards equation describing the matrix. The input parameters of the model are the hydraulic properties of the matrix, the depth of cracks for evaporation, and precipitation and potential evaporation. Fitting parameters in numerical solution of the model include the hydraulic properties of cracks based on the knowledge of their width and geometry. The model results are compared with the depth distribution of chlorides in soil water. The most noteworthy outputs of the model are: the percentage of water infiltrated and evaporated through the cracks and the amount of water percolating to groundwater. In the future studies, in addition to numerical implementations, there will be a need to assess the soil hydraulic behaviour variations throughout the year. This research was funded by the Charles University Grant Agency (GAUK #1046217).