Heat and water transport in soils and across the soil-atmosphere interface: 2. Numerical analysis

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In an accompanying paper, we presented an overview of a wide variety of modeling concepts, varying in complexity, used to describe evaporation from soil. Using theoretical analyses, we explained the simplifications and parameterizations in the different approaches. In this paper, we numerically evaluate the consequences of these simplifications and parameterizations. Two sets of simulations were performed. The first set investigates lateral variations in vertical fluxes, which emerge from both homogeneous and heterogeneous porous media, and their importance to capturing evaporation behavior. When evaporation decreases from parts of the heterogeneous soil surface, lateral flow and transport processes in the free flow and in the porous medium generate feedbacks that enhance evaporation from wet surface areas. In the second set of simulations, we assume that the vertical fluxes do not vary considerably in the simulation domain and represent the system using one-dimensional models which also consider dynamic forcing of the evaporation process, for example, due to diurnal variations in net radiation. Simulated evaporation fluxes subjected to dynamic forcing differed considerably between model concepts depending on how vapor transport in the air phase and the interaction at the interface between the free flow and porous medium were represented or parameterized. However, simulated cumulative evaporation losses from initially wet soil profiles were very similar between model concepts and mainly controlled by the desorptivity, $S_{evap}$, of the porous medium, which depends mainly on the liquid flow properties of the porous medium.

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