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Transport in a field soil under transient boundary conditions: numerical simulations.

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A quantitative understanding of chemical transport in the vadose zone at the field scale is essential for the management of potentially hazardous chemicals in the ecosystem, like the application of pesticides by agricultural operations. At the field scale advective solute transport of a conservative tracer is dictated by the temporal and spatial variability in water fluxes, caused by the atmospheric boundary condition and the soil heterogeneity, respectively. Besides molecular diffusion, the variability in water fluxes contributes to solute spreading. The effect of a transient upper boundary condition on solute spreading and leaching behavior was studied using numerical simulations in three-dimensional, heterogeneous flow domains. Spatial variability in hydraulic properties was introduced by a scaling approach. The transient upper boundary condition was defined using a realistic weather record. The results were compared with simulations, having an equivalent, stationary upper boundary condition. The resultant velocity fields revealed that the transient boundary condition enhanced lateral solute mixing which leads to a redistribution of solute mass between regions with a higher and lower flux. Furthermore, the importance of molecular diffusion was demonstrated, since it is the only transport mechanism during prolonged dry periods when the water fluxes in the soil become negligible.