Geophysical Research Abstracts
Vol. 15, EGU2013-3023-1, 2013
EGU General Assembly 2013

Impact of water table fluctuations on water flow and solute transport in different porous media

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The interface between saturated and unsaturated zone is dynamic and varies spatially and temporally resulting in fluctuations of the water table. Still, little is known about transport processes under transient flow conditions at this interface and how the processes are affected by altering the water table. In order to understand transport and fate of dissolved contaminants into the groundwater and consequently the quality of groundwater, improved understanding about hydrological processes at the dynamic interface between unsaturated and saturated zone is needed. The objective of this study was to investigate the impact of water table fluctuations on one-dimensional vertical flow and solute transport in different sediments. Therefore, flow-through columns (length=50cm, diameter=9cm), filled with glass beads of different grain sizes (smaller=0.4-0.6mm, coarser=1.0-1.5mm), were constantly irrigated at 12 cm/d. Several multi-tracer experiments were conducted with a statically fixed water table and compared to experiments where the water table was fluctuated in upward and downward direction. Data modeling was performed with a lumped parameter model to simulate hydrological fluxes and to determine transport parameters. Our results showed that most tracer breakthrough curves were well simulated indicating that the systems were at steady state. The results showed that under certain hydrological conditions water table fluctuations lead to increased dispersivity. It is suggested that a falling water table can cause increased spreading when the decline is faster than the water flux resulting in a more extensive solute distribution over depth. Further, it was observed that a rising water table can cause higher tracer spreading due to diffusive solute exchange in coarse sediments with immobile water regions. In conclusion, spatial and temporal variability of the interface between vadose zone and groundwater contribute to spreading of solutes and therefore have to be considered in predicting the behavior of dissolved contaminants in the subsurface most importantly in the presence of immobile water regions.