Geophysical Research Abstracts,
Vol. 10, EGU2008-A-12010, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-12010
EGU General Assembly 2008

Testing fringe effects for bromide transport in high precision weighable field lysimeters

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In April 2005, a tracer experiment was performed to test the solute transport regime in two weighable monolithic field lysimeters with a depth of 200 cm and a surface area of 1 m^2, which have been installed at the agricultural test site Wagna (Styria, Austria). The aim was to identify possible possible fringe effects due to the excavation technique. 50 g of NaBr dissolved in 1000 ml of water were applied near the outer fringe without any additional irrigation. For a period of two years, transport driven by natural atmospheric boundary conditions was observed, with regular sampling of bromide concentrations in suction cups at three depths, bromide uptake by vegetation, lysimeter weight, soil water outflow, and bromide breakthrough. The data evaluation was based on modeling the experiment with the Richards equation and the convection-dispersion equation, using an effective one-dimensional and a radial-symmetric three-dimensional simulation with the software tool HYDRUS-2D. The analysis shows a conservative behavior of the bromide. Mass uptake by plants was proportional to the water uptake, and the total mass recovery of bromide was $>$95 %. Transport took place with an effective dispersivity of 0.1 m, and a mean transport velocity of 2.4 m a-1, reflecting a mean water content of about 17%. We found no fringe effects, which indicates that the excavation technique causes no significant disturbance. We conclude that high precision weighable lysimeters with controlled suction at the bottom are an excellent tool to reliably monitor water and solute transport in the vadose zone.