Geophysical Research Abstracts, Vol. 9, 08597, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-08597

Dye tracer infiltration into macroporous soil simulated by a dual-permeability model

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Water infiltration into the soil porous system belongs to the most fundamental processes taking place in nature. Reliable predictions of the water flow are often complicated by the presence of preferential flow effects. The study is focused on the three-dimensional axisymmetric modeling of the field infiltration experiment into the soil with macropores. The evidence of preferential pathways, formed by biopores in Calcari-Haplic Chernozem (Macov station, Danubian Lowland, Slovakia), is demonstrated by the tracer experiment and subsequently confirmed by the substantially underestimated cumulative water flux, obtained using the conventional single-continuum approach. The soil matrix hydraulic parameters were derived from the laboratory determined retention curves. The hydraulic parameters for the preferential flow domain were set to resemble a coarse textured porous material. The volumetric fraction of the preferential flow domain was estimated from a digital image analysis based on the data acquired during the dye tracer infiltration experiment. The results provide valuable information about the movement of water through the soil profile under field conditions. The dual-permeability approach delivers relatively accurate prediction of the infiltration process demonstrating its considerable potential for a quantification of preferential flow effects in soils.