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Shallow water table affects solute transport parameters in silty-loam soils

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Shallow water table can greatly affect the solute movement in the agroecosystems by modifying both the soil hydraulic properties and solute dynamics. In this study, we aimed at estimating solute transport parameters through bromide tracer experiment and inverse modelling in mesocosms comparing different water table levels. In a battery of 12 buried lysimeters (1 m2 area and 1.5 m depth each), the water table level was set at 120 cm (WT120), 60 cm (WT60) and with free drainage (FD). Soil moisture and matric potential were monitored using TDR probes and electronic tensiometers at different depths (15, 30 and 60 cm). A tracer solution of 250 mg L-1 bromide concentration was added with a 40 mm simulated rain event on November 5th 2013. Soil solution was sampled with suction cups at different depths for the following 56 days. An automated system was developed by modulating the suction through matric potential readings combined with an electronic vacuum regulator. The soil lysimeter was divided in three layers (0-20, 20-45, 45-150 cm) in order to estimate solute transport parameters, dispersivity (λ) and soil-water repartition coefficient (Kd), by inverse modeling using HYDRUS 1D software package. Two different approaches were compared: the equilibrium model, that solves the convection-dispersion equation (CDE), and the physical non-equilibrium mobile-immobile model (MIM), that includes mass-transfer (α) and immobile water content (θim) parameters. Results of bromide concentration from inverse modelling were well correlated with the experimental ones, both with CDE (R2 = 0.788) and MIM (R2 = 0.761). CDE dispersivities were often larger than the layer length, suggesting that preferential flow may occur mostly in deeper layers in case of FD and shallower layers in case of WT. In general, MIM showed lower dispersivities than CDE by simulating the immobile water effect all along the soil lysimeter, which resulted higher with shallow water table boundary conditions. High dispersivities persisted on the topsoil layer in WT120 lysimeters with MIM, highlighting that solute movement behaves differently according to the water table level. As a consequence, groundwater pollutions can be worsened by preferential movement of agrochemicals occurring in shallow water table conditions.