Geophysical Research Abstracts,
Vol. 11, EGU2009-4940, 2009
EGU General Assembly 2009

Evaporation from heterogeneous soil surfaces

P. Lehmann and D. Or

ETH Zurich, Soil and Terrestrial Environmental Physics, Zurich, Switzerland (peter.lehmann@env.ethz.ch)

Evaporation rate is a key process of water exchange between soil surfaces and atmosphere and is controlled by both atmospheric demand and soil hydraulic properties. Initially high evaporation rates are sustained by capillary-induced water flow from receding drying front to evaporating surface. In heterogeneous soils air invades preferentially coarse-textured regions whereas fine textured surface regions remain water saturated.
We investigated experimentally and numerically effects of hydraulic coupling on drying rate of heterogeneous porous media. Laboratory experiments with vertical contrasts between fine (0.1-0.5 mm) and coarse sand (0.3-0.9 mm) showed that the period of high drying rate was extended compared to evaporation from homogeneous materials. Water flow from coarse material to supply water evaporated from fine textured surface was monitored by neutron radiography imaging. Due to the high hydraulic conductivity of the coarse material the viscous head loss could be neglected for flow distances analyzed in the experiments (< 600 mm). We proposed a model to explore effects of hydraulic coupling on evaporation for a wide range of soil textural classes at plot scale. When the drying front in the coarse reaches a certain characteristic depth (defined by the pore size distribution) no water evaporates from the coarse surface, yet, subsurface flow from coarse to the fine textured inclusion persists and feeds enhanced evaporation rate. Assuming energy input was not limiting, evaporation from the fine textured inclusion may increase to compensate reduction of evaporating surface. For loam or silt as inclusion in sandy material, water was extracted from regions with more than 10 m in distance before flow was limited by viscous effects. In case of clay inclusions the radius of water extraction was smaller due to enhanced viscous resistance. The findings of the numerical study can be applied as well to assess the effect of shrubs or compacted trafficked zones on the drying rate from coarse textured material.