EGU24-11862, updated on 20 May 2024
https://doi.org/10.5194/egusphere-egu24-11862
EGU General Assembly 2024

Experimental evidence of non-equilibrium water flow during bare-soil evaporation

Sascha Iden[1], Efstathios Diamantopoulos[2], Magdalena Sut-Lohmann[1], and Wolfgang Durner[1]
[1]Technische Universität Braunschweig, Institute of Geoecology, Division of Soil Science, Braunschweig, Germany (s.iden@tu-braunschweig.de)
[2]Chair of Soil Physics, University of Bayreuth, Germany

The Richards equation is de facto the standard model for simulating variably-saturated water flow in soils. It is based on the assumption that water content and matric potential are in instantaneous equilibrium. Their relationship is the water retention curve which is widely used to evaluate soil quality, to determine the effective pore-size distribution, and to derive the soil hydraulic conductivity curve. Experimental data collected over the last 6 decades show that the water retention curve depends not only on the history of wetting / drying, but also on the dynamics of water flow (transient vs equilibrium conditions). Many studies present experimental evidence on the hypothesis that the faster the water flow in soils, the more pronounced is the deviation of the dynamic retention curve from the equilibrium one. In this contribution, we present experimental data which show that these effects also occur during experiments in which water flow can be characterized as relatively slow. We conducted evaporation experiments on two soils, a sand and a silt loam, and varied the evaporation rate. Evaporation rates were controlled by wind speed, and flow interruptions were induced by temporarily covering the samples. We measured soil temperature and matric potential at different depths. The results show a relaxation of the matric potential with changes in wind speed, in particular during the flow interruptions. A complete analysis of the data requires a distinction between the vertical redistribution of moisture caused by changes in the evaporation rate, the effect of temperature on matric potential, and the “true” nonequilibrium between matric potential and water content. Contrary to the general assumption that bare-soil evaporation is a slow process during which equilibrium between water content and matric potential is ensured, our results show that dynamic nonequilibrium occurs even in the case of relatively slow, upward water flow. This results in a shift in the dynamic water retention curve estimated from evaporation experiments, indicating that more water is retained in the soil when water is flowing, as compared to static experiments.