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The dynamic interplay between roots and soil moisture

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Although water uptake by roots in the soil has been investigated in numerous studies, it is still not clear which is the main factor controlling the uptake, especially under non-uniform soil moisture distribution or intermediately wet soil. Root activity or root compensation factors are frequently used to adjust 1-D root water uptake models to observations. However, they are fitting parameters, which do not rely on real observations and can probably hardly be extrapolated to other boundary conditions. Experiments incorporating more information on the root architecture and on the 3-D soil moisture distributions are therefore needed to better circumvent the interactions between plants, soil structure and boundary conditions and to understand how plant root water uptake affects the flow field variability and vice-versa.

We investigated the role root water uptake on soil moisture in an unsaturated, undisturbed soil column (orthic Luvisol) subject to known boundary conditions and cropped with summer barley. We monitored soil moisture in the monolith during 11 weeks using a noninvasive measurement method: time-lapse electrical resistivity tomography (ERT). Additionally, time domain reflectometry probes (TDR), tensiometers and temperature probes were installed at several depths to monitor local soil water content and electrical conductivity. Minirhizotron tubes were inserted in the lysimeters to monitor root growth and root length density (RLD) in the different soil layers. The 3-D ERT images allowed us to characterize the root space and time water depletion distribution during the growing season. Combined with the root monitoring method, it gave us a better insight in the way plants take up water in the soil and how they adapt there root system to changing soil moisture conditions.