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Observing spatio-temporal variations in rooting depth and density as a control factor for soil moisture dynamics

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To understand and predict soil moisture dynamics it is essential to take the role of the vegetation into account. For example, hydrological processes in agricultural soils are strongly affected by seasonal vegetation dynamics in terms of rooting depth and root distribution. Here we present a new approach to monitor and model root dynamics and its influence on soil moisture in the critical zone using mini-rhizotrons combined with phenological observations.

The setup in the field observatory consists of a portable root scanner connected to a tablet computer and a number of acrylic glass tubes with a diameter of two inches that are inserted into the soil at the start of the growing season of selected crops. 360-degrees-scans of soil and roots are taken regularly at different depths in the tubes. Root parameters such as length, diameter, surface and density are identified automatically from the data for each soil layer. Complementary observations of aboveground plant phenology, obtained either by visual inspection in-situ or by remote sensing techniques, are related to the root parameters.

Results from mini-rhizotron data collected at two observatories in Germany show that vertical root distribution and maximum rooting depth in agricultural soils, which varies with plant species and phenology, weather patterns, soil type and management, irrigation etc., are crucial parameters to explain the observed temporal variability and vertical gradients in soil moisture satisfactorily. Deriving these parameters from above-ground phenology and incorporating them into a soil water model led to a significant improvement when compared to a model version based on reference rooting depths from the literature. Thus, we argue that mini-rhizotrons constitute a useful supplement to hydrological observatories and can help understand and predict soil moisture dynamics in the critical zone.