Geophysical Research Abstracts
Vol. 17, EGU2015-9198, 2015
EGU General Assembly 2015

Simulations and field observations of root water uptake in plots with different soil water availability.

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Root water uptake is a main process in the hydrological cycle and vital for water management in agronomy. In most models of root water uptake, the spatial and temporal soil water status and plant root distributions are required for water flow simulations. However, dynamic root growth and root distributions are not easy and time consuming to measure by normal approaches. Furthermore, root water uptake cannot be measured directly in the field. Therefore, it is necessary to incorporate monitoring data of soil water content and potential and root distributions within a modeling framework to explore the interaction between soil water availability and root water uptake. But, most models are lacking a physically based concept to describe water uptake from soil profiles with vertical variations in soil water availability. In this contribution, we present an experimental setup in which root development, soil water content and soil water potential are monitored non-invasively in two field plots with different soil texture and for three treatments with different soil water availability: natural rain, sheltered and irrigated treatment. Root development is monitored using 7-m long horizontally installed minirhizotubes at six depths with three replicates per treatment. The monitoring data are interpreted using a model that is a one-dimensional upscaled version of root water uptake model that describes flow in the coupled soil-root architecture considering water potential gradients in the system and hydraulic conductances of the soil and root system (Couvreur et al., 2012). This model approach links the total root water uptake to an effective soil water potential in the root zone. The local root water uptake is a function of the difference between the local soil water potential and effective root zone water potential so that compensatory uptake in heterogeneous soil water potential profiles is simulated. The root system conductance is derived from inverse modelling using measurements of soil water potentials, water contents, and root distributions. The results showed that this modelling approach reproduced soil water dynamics well in the different plots and treatments. Root water uptake reduced when the effective soil water potential decreased to around -70 to -100 kPa in the root zone.

Couvreur, V., Vanderborght, J., and Javaux, M.: A simple three dimensional macroscopic root water uptake model based on the hydraulic architecture approach, Hydrol. Earth Syst. Sci., 16, 2957–2971, doi:10.5194/hess-16-2957-2012, 2012.