Geophysical Research Abstracts
Vol. 16, EGU2014-9182-1, 2014
EGU General Assembly 2014

Neutron radiography and modelling of water flow and D2O transport in soil and plants

Mohsen Zare, Andrea Carminati, and Eva Kröner
Georg August University of Göttingen, Soil Hydrology, Gottingen, Germany (mzareba@gwdg.de)

Our understanding of soil and plant water relations is currently limited by the lack of experimental methods to measure the water fluxes in soil and plants. Our study aimed to develop a new non-destructive method to measure the local fluxes of water into roots of plants growing in soil. We injected deuterated water (D2O) near the roots of lupines growing in sandy soils, and we used neutron radiography to image the transport of D2O through the root system. The experiments were performed during day, when plants were transpiring, and at night, when transpiration was reduced. The radiographs showed that: 1) the radial transport of D2O from soil and roots depended similarly from diffusion and convection; and 2) the axial transport of D2O along the root xylem was largely dominated by convection. To determine the convective fluxes from the radiographs, we simulated the D2O transport in soils and roots. A dual porosity model was used to describe the apoplastic and symplastic pathways of water across the root tissue. Other features as the endodermis and the xylem were also included in the model. The D2O transport was modelled solving a convection-diffusion numerical model in soil and plants. The diffusion coefficients of the root tissues were inversely estimated by simulating the experiments at night under the assumption that at night the convective fluxes were negligible. Inverse modelling of the experiment at day gave the profile of water fluxes into the roots, as well as the ration between the apoplastic and symplastic flow. For 24 day-old lupine grown in a sandy soil with uniform water content, our modelling results showed that root water uptake was higher at the proximal parts of the roots near soil surface and it decreased toward the distal parts. The results indicated the water crossed the root cortex mainly through the apoplastic pathway. The method allows the quantification of the root properties and the regions of root water uptake along root systems growing in soils.