Providing *in-situ* imaging data of dynamic root-soil-interaction suited for numerical modelling

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The rooted soil zone is a dynamic environment for water, plants, dissolved substances and the related biotic and abiotic processes. Within this system the rhizosphere is a key biogeochemical interface, but narrow and of complex shape as set by the 3D root structure of a plant. By neutron imaging, especially in individual combination with other imaging methods soil, rhizosphere and roots themselves can be captured *in situ.* Our aim is to observe the whole root system of a plant and its root-soil-interface in a way that allows for predictive modelling of this specific plant root system as well as the soil around it.

By fluorescence imaging we have observed pH and oxic conditions in the rooted soil zone as time-series of 2D planar maps close to the roots. To achieve a level of quantiative interpretation that is suited for hydrochemical simulations we have deleoped an approach to obtain the 3D root structure and soil water changes to complement the information needed. In 3D tomography a recent development enables the imaging of water imbibition and soil water relocation with temporal resolution of less than a minute without severe loss of overall quality. Using heavy water as tracer we additionally have studied fluxes from soil through the rhizosphere into the plant roots. X-ray CT or MRI measurements have been added to neutron tomographies in other cases, e.g. to reveal soil structures or water mobility in the adjacent soil pores.

Typical experiments are based on young crop plants such as maize or lupine grown in soil prepared in special containers for the particular imaging task. For a period of a few days the impact of changing conditions can be retrieved, e.g. drying-wetting cycles or aerobic-anaerobic cycles, possibly with ultra-fast tomographies embedded in the schedule. This constitutes 2D or 3D data sets of the dynamic development with quantitative information on concentrations or water content. If such experiments are designed in the right way, they create an excellent basis for detailed numerical modelling of hydrochemical processes and root water uptake at the root-soil-interface, and such approaches are discussed.