Abstract:

Titel: "Magnetic resonance imaging on roots and root zone processes"

Against the background of climate change and exploding world population we need an efficient and sustainable use of our resources soil and water but at the same time a higher crop yield. Typically, the latter is achieved by breeding and genetic eneginering with subsequent control by screening for phenotypes mostly of the above ground plant part. However, in addition to the genetic disposition there is also the possibility to improve the interactions in the soil-root compartment for nutrient and water uptake. For this one needs exact knowledge about available structures and the involved root-zone processes. Classically these processes are investigated in rhizotrones which restrict growth and observation in a very thin 2D layer or one concludes only indirectly by analysing breakthrough curves, treating the soil-root compartment as black box. This type of macroscopic characterization fails to see the details to unambigiously resolve root-zone processes like water uptake, solute transport and changes in hydraulic properties.

In the first part of the talk we will demonstrate with examples and in comparison with neutron imaging how low-field MRI can be used to visualize with high accuracy the root system architecture, which is a prerequisite for the subsequent investigation of root-zone processes. One of the most important but also challenging root-zone processes is solute transport. We show that MRI in combination with inversion-recovery preparation can quantitatively map in 3D concentration changes of a model solute, Gd-DTPA and thus allows to draw conclusions on the underlying solute uptake mechanisms. The presentation concludes with first data from the complementary use of MRI and neutron imaging on the same plant. While neutron imaging is extremely sensitive to the proton density and therefore guarantees accurate measurements of the total water content, MRI provides synergistic information about local water dynamics based on relaxation times and relaxation time contrast. The experiments focus on changes in hydraulic properties of the root zone occuring during drying and rewetting scenarios, which are relevant for root-water uptake.