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Characterizing root system characteristics with Electrical resistivity Tomography: a virtual rhizotron simulation

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Electrical Resistivity Tomography (ERT) is more and more used for monitoring soil water content in a cropped soil. Yet, the impact of roots on the signal is often neglected and a topic of controversy. In several studies related to soil-root system, it has been showed that the measured root mass density statistically correlates with the electrical conductivity (EC) data obtained from ERT. In addition, some studies suggest that some roots are more electrically conductive than soil for most water content. Thus, higher EC of roots suggest that it might have a measurable impact on ERT signals.

In this work, virtual rhizotrons are simulated using the software package called R-SWMS that solves water and solute transport in plant root-soil system, including root growth. The distribution of water content obtained from R-SWMS simulation is converted into EC data using pedo-physical models. The electrical properties of roots and rhizosphere are explicitly included in the EC data to form a conductivity map (CM) with a very detailed spatial resolution. Forward ERT simulations is then carried out for CM generated for various root architectures and soil conditions to study the impact of roots on ERT forward (current and voltage patterns) and inverse solutions. It is demonstrated that under typical injection schemes with lateral electrodes, root system is hardly measurable. However, it is showed that adding electrodes and constraints on the ERT inversion based on root architecture help quantifying root system mass and extent.