A forward model for electrical conduction in soil-root continuum: a virtual rhizotron study.

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Electrical Resistivity Tomography monitoring of soil-root system water fluxes have received growing interest in the past decades. Some studies suggest that roots can be more electrically conductive than soil. We suggest that ERT data taken in agricultural fields is impacted by plant roots and might contaminate estimates of soil water content based on bare soil petrophysical relations. To understand how do roots impact electrical current flow and thus ERT data, a numerical electrical model was coupled with a mechanistic maize-soil water flow model. All the maize roots with a radius larger than 0.05 cm were explicitly accounted for in the finite element mesh and associated to their specific electrical properties. Root growth and water uptake processes continuously affected the EC contrast between soil and root. We demonstrated that high contrasts between root and soil EC lead to errors in the estimation of soil water content, which could be diminished by using an appropriate biopedophysical correction term. The effective EC (bulk properties) of the medium computed using simulated plate electrodes at rhizotron boundaries reveal directional anisotropy induced by root processes and is more pronounced in sand medium when compared to loam. The percentage change in bulk EC due to change in direction ($EC_{horzontal}$ .vs. $EC_{vertical}$) starts at ~30 % in sand and ~3 % in loam when root is young and increases up to ~500% in sand and ~20% in loam at day 22 when root is three weeks old. Directions in which there is more anisotropy contains more information on the root processes and hence they can be used as prior information for ERT injection scheme to retrieve better information.

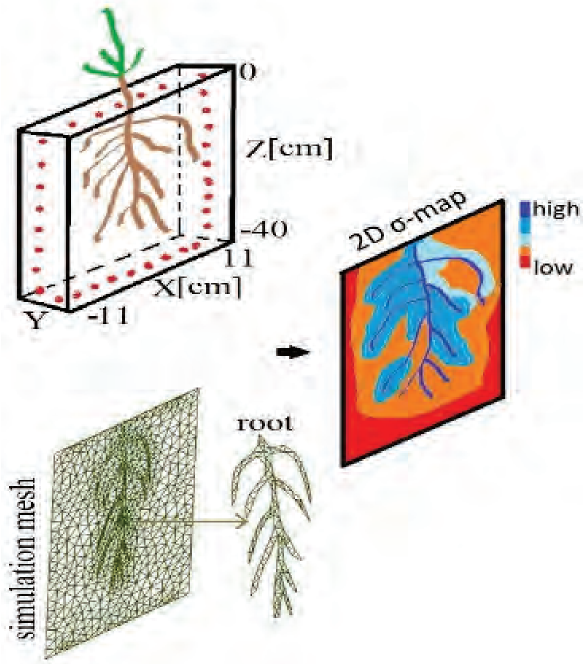

Figure: Schematic of plant-soil virtual rhizotron model