EGU21-2839
https://doi.org/10.5194/egusphere-egu21-2839
EGU General Assembly 2021

Root system monitoring using a mise-à-la-masse (MALM) extension to time-domain IP

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The development, architecture, and activity of the plant root system has a key role in plant-soil-water interactions, and thus, in plant ecology both in agricultural and natural systems. The characterization of the flow of electric current in the root-soil system may provide non-invasive methodologies to observe the state and dynamics of this critical zone hidden in the shallow subsurface.

Inversion of Current source density (CSD) from Mise-a-la-masse (MALM) surveys provides a straightforward way to describe the shape of a conductive body that charges up. While numerous studies show a correlation between root mass density and electrical capacitance (Ehosioke et al., 2020), physical proofs of the underlying assumptions of such concepts are still missing. In particular, some authors questioned the hypothesis that the xylem behaves as a continuous conductive body with regard to its physiological state. Application of the MALM in conjunction with CSD helps distinguish the current pathway through the root system (Mary et al., 2019; Peruzzo et al., 2020).

As roots are electrically polarisable, their responses depend on the frequency of the current injection. Extending the CSD inversion to secondary voltages produced by secondary currents (after shutting down the primary current) may provide insights into transient phenomena associated with the polarization of the roots.

Based on a Self-Potential (SP) processing algorithm (Shao et al., 2018), we build and test a new inversion scheme of secondary voltages using synthetic models. Small-scale laboratory experiments are in progress on grapevine cuttings placed in water-filled rhizotrons. Root growth will be monitored using MALM in TDIP domain.