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Tree root system mise-à-la-masse (MALM) forward modelling with explicit representation of root structure

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Agricultural yields critically depend on performance of the root system. Tree root system architecture and its development in time have indeed a key-impact under drought and nutrient stress conditions. Therefore, there is a need to monitor or phenotype root system, which is hidden in the soil. Electrical resistivity methods are promising for this task (Whalley et al., 2017) except that there is ambiguity in differentiating soil and root structures due to overlapping electrical conductivities of soil and root. Numerous studies also report the need for more accurate ERT methods of quantification of the root system at the plant scale, especially under field conditions (Ni et al., 2018)

We previously demonstrated experimentally on a woody species (vineyard plant and orange trees) that current density distribution in the soil-root continuum could differ significantly depending on whether current is injected into the stem of the tree or in the soil surface close to stem (Mary et al., 2018). We explained this phenomenon by assuming that an injection into the stem is most likely to exit the root system only at fine root locations. Here, we present a preliminary modelling study using an explicit representation of root structure in the MALM forward modelling as a follow-up work to support the assumptions made and to understand better how this approach can be made more robust for field-scale root phenotyping.

In this study, we quantified the sensitivity of the Mise-à-la-masse coupled with the ERT method to image the root system in respect to different soil water content (after Root Water Uptake). We also estimated how the contrast of resistivity between roots (for a range of resistance in inner layer of root, outer bark structure as well as fine roots), and different types of soil influence the geophysical measurements.

References

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