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Micro 3D ERT tomography for data assimilation modelling of active root zone

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Within the soil-plant-atmosphere system, root activity plays a fundamental role, as it connects different domains and allows a large part of the water and nutrient exchanges necessary for plant sustenance. The understanding of these processes is not only useful from an environmental point of view, making a fundamental contribution to the understanding of the critical zone dynamics, but also plays a pivotal role in precision agriculture, where the optimisation of water resources exploitation is mandatory and often carried out through deficit irrigation techniques. In this work, we present the results of non-invasive monitoring of the active root zone of two orange trees (Citrus sinensis, cv Tarocco Ippolito) located in an orange orchard in eastern Sicily (Italy) and drip irrigated with two different techniques: partial root drying and 100% crop evapotranspiration. The main goal of the monitoring activity is to assess possible differences between the developed root systems and the root water uptake between the two irrigation strategies. The monitoring is conducted using 3D micro-electrical resistivity tomography (ERT) based on an apparatus composed of a number of micro-boreholes (about 1.2 m deep) housing 12 electrodes each, plus a number of surface electrodes. Time-lapse measurements conducted both with long-term periodicity and short-term repetition before and after irrigation clearly highlight the presence and distribution of root water uptake zone both at shallow and larger depth, likely to correspond to zones utilized during the irrigation period (shallow) and during the time when the crop is not irrigated (deep). Subsidiary information is available in terms of precipitation, sap flow measurements and micrometeorological evapotranspiration estimates. This data ensemble lends itself to the assimilation into a variably saturated flow model, where both soil hydraulic parameters and root distribution shall be identified. Preliminary results in this directions show the potential of the method and its exciting outlook.