Geophysical Research Abstracts
Vol. 15, EGU2013-9656, 2013
EGU General Assembly 2013

Time-lapse 3D electrical resistivity tomography to monitor soil-plant interactions

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In this work we present the application of time-lapse non-invasive 3D micro- electrical tomography (ERT) to monitor soil-plant interactions in the root zone in the framework of the FP7 Project CLIMB (Climate Induced Changes on the Hydrology of Mediterranean Basins). The goal of the study is to gain a better understanding of the soil-vegetation interactions by the use of non-invasive techniques. We designed, built and installed a 3D electrical tomography apparatus for the monitoring of the root zone of a single apple tree in an orchard located in the Trentino region, Northern Italy. The micro-ERT apparatus consists of 48 buried electrodes on 4 instrumented micro boreholes plus 24 mini-electrodes on the surface spaced 0.1 m on a square grid. We collected repeated ERT and TDR soil moisture measurements for one year and performed two different controlled irrigation tests: one during a very dry Summer and one during a very wet and highly dynamic plant growing Spring period. We also ran laboratory analyses on soil specimens, in order to evaluate the electrical response at different saturation steps. The results demonstrate that 3D micro-ERT is capable of characterizing subsoil conditions and monitoring root zone activities, especially in terms of root zone suction regions. In particular, we note that in very dry conditions, 3D micro ERT can image water plumes in the shallow subsoil produced by a drip irrigation system. In the very dynamic growing season, under abundant irrigation, micro 3D ERT can detect the main suction zones caused by the tree root activity. Even though the quantitative use of this technique for moisture content balance suffers from well-known inversion difficulties, even the pure imaging of the active root zone is a valuable contribution. However the integration of the measurements in a fully coupled hydrogeophysical inversion is the way forward for a better understanding of subsoil interactions between biomass, hydrosphere and atmosphere.