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Comparing thermogravimetric, TDR, ERT and EMI measurements of space and time evolution of water content along a transect during an infiltration experiment

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Monitoring and modelling of soil hydrological processes at large scales require measuring the spatial and temporal evolution of soil volumetric water contents, θ_v . Direct measurement of θ_v can be done by sampling and laboratory analyses. Although such methods are straightforward, they require a lot of time and effort for the collection of several samples to account for the spatial and temporal variability. Time-domain reflectometry, TDR, can be a good alternative as it is used to indirectly measure θ_v in the field by measuring the travel time of an electromagnetic pulse in a probe. However, it is an intrusive, point-scale method making it impractical at large scales and at subsurface measurements. Other geophysical methods, such as earth resistivity tomography, ERT, and electromagnetic induction, EMI, sensors represent a practical solution for their time efficiency and the ability to measure at large scales. In particular, compared to the ERT, which still requires the insertion of several electrodes at the soil surface and their connection with a cable network, the EMI has the further advantage (in terms of measurement rapidity) of not requiring insertion in soil to take measurements. Nevertheless, the toll to pay for this larger scale applicability, is that they do not directly measure θ_v and require complex electromagnetic inversion models to obtain either the electrical resistivity, ρ_b , or the bulk electrical conductivity, σ_b , spatial distributions over time respectively from the pseudo-sections coming from ERT and the series of apparent electrical conductivity, ECa, coming from EMI. In this sense, these methods require further efforts to correctly translate the ρ_b and the σ_b distributions in as many θ_v distributions. Accordingly, this study aims at comparing thermogravimetric, EMI and ERT systems to obtain the spatio-temporal evolution of θ_v at a transect scale. For this purpose, a series of measurement campaigns were carried out at a transect 24 m long and 1 m wide at a sprinkler-irrigated field in Arborea area in Sardinia, Italy. A large database of spatially, vertically and temporally distributed measurements was created from auger samples, undisturbed samples, Campbell TDR-200, ERT and CMD mini-explorer EMI sensor. TDR measurements were used to find a relationship between θ_v and σ_b . Inversion models were then used to obtain the σ_b distribution from ERT and EMI measurements, utilizing a previously determined characterization of the soil profile, e.g., layering, depth to

groundwater table, texture, etc. The TDR-obtained $\theta_v - \sigma_b$ relationship was then utilized to estimate the θ_v distributions from EMI- and ERT-based σ_b distributions.