The paradox of using an old-fashioned TDR portable device to calibrate new-generation capacitance sensors

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**Abstract.** The calibration of low-cost, low-frequency capacitance sensors requires attention and should be designed carefully. The laboratory calibration of electromagnetic sensors in few repacked soil samples can yield unsatisfactory results when establishing soil moisture sensor networks in heterogeneous environments. In this study, two test sites with different soil textures (clay soil in MFC2 and loamy soil in GOR1) in the Upper Alento River Catchment (UARC) in southern Italy were instrumented with SoilNet wireless sensor networks controlling GS3 (Meter devices) capacitance sensors deployed at soil depths of 15 cm and 30 cm over twenty nodes. The GS3 sensors monitor soil permittivity as proxy for soil moisture, temperature, and apparent electrical conductivity. For converting permittivity to soil moisture we used a two-step calibration procedure: in the first step, ad hoc field calibrations were carried out using a domain reflectometry (TDR) portable device connected to a 15-cm-long metallic rod proving reference soil permittivity values that were positively and negatively correlated to soil permittivity and temperature measured by the GS3 sensor. We developed a simple multiple linear regression to estimate TDR-based permittivity from soil permittivity and soil temperature (spanning from 4.5°C and 31.9°C) taken by low-frequency sensors at z=15 cm over 20 measurement campaigns. In the second step, an intensive field calibration was carried out by relating TDR-based soil permittivity with the co-located destructive thermogravimetric measurements of soil water content on ten positions over 13 field campaigns. Our results showed that site-specific calibrations reflect seasonal soil moisture dynamics and outperform the factory calibration. Non European characters should not be used unless absolutely necessary. Please include the font's dot if you must use them.

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