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Correction of temperature and bulk electrical conductivity effects on soil water content measurements using ECH2O EC-5, TE and 5TE sensors

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For a monitoring of dynamic spatiotemporal soil moisture patterns at the catchment scale, automated and continuously measuring systems that provide spatial coverage and high temporal resolution are needed. Promising techniques like wireless sensor networks (e.g. SoilNet) have to integrate low-cost electromagnetic soil water content sensors [1], [2]. However, the measurement accuracy of such sensors is often deteriorated by effects of temperature and soil bulk electrical conductivity. The objective of this study is to derive and validate correction functions for such temperature and electrical conductivity effects for the ECH2O EC-5, TE and 5TE sensors. We used dielectric liquids with known dielectric properties for two different laboratory experiments. In the first experiment, the temperature of eight reference liquids with permittivity ranging from 7 to 42 was varied from 5 to 40°C. All sensor types showed an underestimation of permittivity for low temperatures and an overestimation for high temperatures. In the second experiment, the conductivity of the reference liquids was increased by adding NaCl. The highest deviations occurred for high permittivity and electrical conductivity between $\sim$0.8 and 1.5 dS/m (underestimation from 8 to 16 permittivity units depending on sensor type). For higher electrical conductivity (2.5 dS/m), the permittivity was overestimated (10 permittivity units for the EC-5 and 7 for the 5TE sensor). Based on these measurements on reference liquids, we derived empirical correction functions that are able to correct thermal and conductivity effects on measured sensor response. These correction functions were validated using three soil samples (coarse sand, silty clay loam and bentonite). For the temperature correction function, the results corresponded better with theoretical predictions after correction for temperature effects on the sensor circuitry. It was also shown that the application of the conductivity correction functions improved the accuracy of the soil water content predictions considerably.

References:

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