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Heated fiber optic distributed temperature sensing: a tool for measuring soil water content

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The use of Distributed Fiber Optic Temperature Measurement (DFOT) method for estimating temperature variation along a cable of fiber optic has been assessed in multiple environmental applications. Recently, the application of DFOT combined with an active heating pulses technique has been reported as a sensor to estimate soil moisture. This method applies a known amount of heat to the soil and monitors the temperature evolution, which mainly depends on the soil moisture content [U+F071].

This study presents the application of the Active Heated DFOT method to determine the soil water retention curve under experimental conditions. The experiment was conducted in a rectangular methacrylate box of 2.5 m x 0.25 m x 0.25 m which was introduced in a larger box 2.8 m x 0.3 m x 0.3 m of the same material. The inner box was filled with a sandy loamy soil collected from the nearest garden and dried under ambient temperature for 30 days. Care was taking to fill up the box maintaining the soil bulk density determined "in-situ". The cable was deployed along the box at 10 cm depth. At the beginning of the experiment, the box was saturated bottom-up, by filling the outer box with water, and then it kept dried for two months. The circulation of heated air at the bottom box accelerated the drying process. In addition, fast growing turf was also sowed to dry it fast.

The DTS unit was a SILIXA ULTIMA SR (Silixa Ltd, UK) and has spatial and temporal resolution of 0.29 m and 5 s, respectively. In this study, heat pulses of 7 W/m for $2\frac{1}{2}$ min were applied uniformly along the fiber optic cable and the thermal response on an adjacent cable was monitored in different soil water status. Then, the heating and drying phase integer (called Tcum) was determined following the approach of Sayde et al., (2010). For each water status, [U+F071] was measured by the gravimetric method in several soil samples collected in three box locations at the same depth that the fiber optic cable and after each heat pulse. Finally, the soil water retention curve was estimated by fitting pairs of Tcum-[U+F071] values.

Results showed the feasibility of heated fiber optics with distributed temperature sensing to estimate soil water content, and suggest its potential for its application under field conditions