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Estimation of infiltration along unsaturated soil transects with active heated fiber optics

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The water infiltration in soils is very useful information in improving irrigation methods and systems in order to maximize the efficiency of water use. Heat pulse sensors have been proposed as useful tools for measuring soil water fluxes, but have the limitation of measuring in a small portion of the soil (point measurements).

Several studies have demonstrated the validity of Distributed Temperature Sensing (DTS) fiber optic applications to measure water flux in porous media, whether passively or actively heating the fiber optic cable and studying its performance. Using this technique, the Active Heat Pulse Method with Fiber Optic temperature sensing (AHFO), water infiltration through the soil can be estimated simultaneously at many points within 0.125 m intervals and along large distances with high temporal frequency.

In order to estimate the infiltration rate and its variability in an agricultural field with sandy-loam soil, a fiber optic cable was installed in the field at two depths, 0.30 m and 0.60 m, and in 39.5 m long parallel transects. Two ring infiltrometers of 1 m diameter, spaced 0.5 m, were placed above the fiber transects to measure the infiltration and they were filled with water to a height of 0.10 m. Simultaneously, the fiber optic cable was heated by applying a power of 20 W/m to its metallic protective jacket. Temperature was recorded in the DTS unit every 2 s and its evolution over time was studied to determine the infiltration rate.

First, readings were taken in one infiltrometer, then they were taken with the other while the first was moved forward to the next location. This procedure was replicated along the transects at our defined measurement points.

The results show that the AHFO is a useful tool for studying infiltration, its evolution and its variability in the field. This could be of interest in many agricultural and environmental studies, such as designing, evaluating, and managing irrigation units.