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High Resolution Monitoring of Near-Surface Soil Hydrodynamics using a Novel TDR Array

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Surface and near-surface soil properties and processes have largely been ignored when it comes to monitoring, owing to the extreme variations in water content, temperature, etc. occurring at and near the soil surface. However, growing interest in a vast array of remote sensing applications warrants improvements in monitoring capability at the soil surface. A novel Time-Domain Reflectometry (TDR) Array was developed to provide mm- resolution of the soil moisture profile using a TDR100, an 8-channel multiplexer, and a combination of a printed circuit board and a 3-D printed housing to support a linear array of 8-TDR electrode pairs. Seven of the nine electrodes are connected to either the + or - conductor on a pair of coaxial cables, essentially doubling the measurement utility of the array's inner electrodes. A key design component was matching the spacing of the coaxial cable–TDR rod transition to avoid undesirable noise in waveforms. The TDR Array permittivity measurement accuracy is similar to conventional TDR devices and vertical spacing between electrodes is 10 mm or less, depending on installation angle (e.g., 5 mm spacing at 60 degrees). Both infiltration and evaporation processes have been tracked in the laboratory using the TDR Array and near-surface water content was monitored during planting and seed germination in the field. Remotely sensed soil moisture is also highly correlated with surface TDR Array readings. The TDR Array provides unprecedented monitoring capability for near-surface applications and as such is poised to be a valuable soil moisture - remote sensing validation resource.