

REFLECTION TOMOGRAPHY OF TIME-LAPSE GPR DATA FOR STUDYING DYNAMIC UNSATURATED FLOW PHENOMENA

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Ground-penetrating radar (GPR) reflection tomography algorithms allow non-invasive monitoring of water content changes resulting from flow in the vadose zone. The approach requires multi-offset GPR data that is traditionally slow to collect. We automate GPR data collection to reduce the survey time significantly, thereby making this approach to hydrologic monitoring feasible. The method was evaluated using numerical simulations and laboratory experiments that suggest reflection tomography can provide water content estimates to within 5-10% vol./vol. for the synthetic studies, whereas the empirical estimates were typically within 5-15% of measurements from in-situ probes. Both studies show larger observed errors in water content near the periphery of the wetting front, beyond which additional reflectors were not present to provide data coverage. Overall, coupling automated GPR data collection with reflection tomography provides a new method for informing models of subsurface hydrologic processes and a new method for determining transient 2D soil moisture distributions.