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Dual-frequency surface-based Ground-Penetrating Radar (GPR) for the quantitative study of soil-water infiltration

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High-resolution surface-based GPR measurements allow studying the evolution of the capillary fringe in very dynamic hydraulic regimes. We use a dual-frequency surface-based multichannel GPR system to investigate imbibition, drainage, and infiltration in a complicated but known subsurface structure. These hydraulic dynamics are induced by varying the ground water table through pumping water into and out of an observation well or by infiltration with a sprinkler system. The precision of our GPR measurements permits to place close scrutiny on the underlying hydraulic processes.

Here, we specifically focus on an experiment featuring high-resolution monitoring of two artificially induced infiltration events into two different kinds of sands at our test site by an eight channel, dual-frequency GPR system measuring at center frequencies of 200 and 600 MHz. During these infiltration events, which lasted for several hours each, 2D-common offset data were acquired along the 20 m center axis of our test site at a time resolution of approximately one radargram per minute. The subsequent relaxation of the system has been monitored by repeated status measurements for about three months.

In this presentation, we (i) show the efficacy of our dual-frequency multichannel setup for quantitative studies of both the highly dynamic infiltration phase and the increasingly small variations during subsequent months of relaxation, (ii) assess the currently attainable precision with our commercial GPR instruments, and (iii) discuss the use of observed differences in the GPR response of the different materials for estimating soil hydraulic properties from these datasets.