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Realtime infiltration process monitoring in macroporous soil – a plot-scale experiment accompanied by high-resolution time-lapse 3D GPR

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Infiltration and quick vertical redistribution of event water through rapid subsurface flow in soil structures is one of the key issues in hydrology. Although the importance of preferential flow is broadly recognised, our theories, observation techniques and modelling approaches lose grounds when the assumption of well-mixed states in REVs collapses. To characterise the combination of advective and diffusive flow is especially challenging.

We have shown in earlier studies that a combination of TDR monitoring, dye- and salt-tracer recovery and time-lapse 3D GPR in irrigation experiments provides means to characterise infiltration dynamics at the plot- and hillslope-scale also in highly structured soils. We pinpointed that the spatial and temporal resolution requires special attention and improvement - particularly owing to the facts of high velocity (10^{-3} ms^{-1}) of advective flow and small scale (10^{-2} m) of the respective flow structures.

We present insights from a novel technique of continuous high-resolution time-lapse 3D GPR measurements during and after a plot-scale (1 m x 1 m) irrigation experiment. Continuous TDR soil moisture measurements, dye tracer excavation and salt-tracer samples are used as qualitative and quantitative references. While classical infiltration experiments either look at spatial patterns or temporal dynamics at singular gauges, we highlight the advantage of combining both to achieve a more complete image of the infiltration process. Although operating at the limits of the techniques this setup enables non-invasive observation of preferential flow processes in the field and allows to explore and characterise macropore matrix exchange.