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# Optimization of Multi-channel Ground-penetrating Radar for Quantifying Field-scale Soil Water Dynamics

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We explore the capabilities and limitations of continuous multi-offset surveys conducted with multi-channel ground-penetrating radar (GPR) systems for a fast and high-resolution mapping of near-surface soil architecture and volumetric soil water content. As a demonstration, measurements from a field site with multiple layers are analysed. Based on the multi-channel GPR ray-tracing algorithm published by Gerhards et al. (2008), the accuracy of an 8-channel setup as a function of antenna separation, reflector depth and dielectric permittivity is studied with synthetic data. A variety of cases are tested with Monte Carlo simulations by adding noise to the components of the measuring process. Results show that adapting the antenna setup to the particular situation is mandatory for an optimal accuracy. A high accuracy is particularly important for monitoring the soil water dynamics from time series of GPR measurements. We demonstrate our approach with a data set from a field experiment. There, we achieve an accuracy of about 0.1 m for the reflector depth and of about 0.5 for the layers' relative dielectric number. On this basis, we quantify the effective field-scale dynamics of soil water content for the layers between the ground-surface and the reflectors.