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Estimating field-scale soil water content dynamics with multi-channel GPR

Ute Wollschläger, Jens Buchner, Stefan Schneider, and Kurt Roth

Heidelberg University, Institute of Environmental Physics, Heidelberg, Germany (ute.wollschlaeger@iup.uni-heidelberg.de, +49 (0)6221 54-6405)

Soil water content is a key quantity, for instance, for the exchange of water and energy between land and the atmosphere, for plant growth, and for groundwater recharge. Due to the textural heterogeneity of natural soils, estimating field-scale soil water content variability is challenging. Non-invasive geophysical measurement techniques provide the opportunity to efficiently capture this variability. Ground-penetrating radar (GPR) is a well-established and still expanding method for measuring soil water content. New multi-channel GPR systems allow to efficiently infer soil architecture and soil water content with high lateral resolution. The evaluation of reflection data gives access to the water content within the whole root zone and even deeper sections of the soil profile. This allows, for instance, to gain information about soil water stores which is of high interest to hydrologists.
In this presentation, we use examples of field measurements to demonstrate the multi-channel GPR method for estimating field-scale soil architecture and soil water content. Based on these data we conduct synthetic 2D numerical simulations of vadose zone water content dynamics using natural rainfall conditions and calculate the corresponding water contents which would be measured with GPR. Using these results we discuss the implications for the application of multi-channel GPR as a field-scale method for the measurement of soil water content dynamics and to bridge the gap between traditional small-scale point measurements and large-scale remote sensing data.