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Estimating spatio-temporal dynamics of soil water content from deep ground-penetrating radar profiles

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Areal measurements of surface soil water content using ground-penetrating radar (GPR) have been demonstrated by different groups. We want to measure deeper profiles and estimate temporal changes in volumetric soil water content in a natural field soil from the changes in travel times of GPR reflections. We first develop the method for a single trace taken from a radargram and calculate the changes in volumeric water content for two soil layers. The changes in volumetric soil water content derived from the GPR data correspond well to those calculated from TDR measurements which are taken independently at different depths in the same soil layers a few meters away. After verification the method is applied to the entire radargram to estimate the dynamics of water content with a high lateral resolution. Finally, we demonstrate the method by deducing the spatio-temporal dynamics of a 90 m² area of natural soil. In case that well defined reflectors exist at a site, GPR is demonstrated as a powerful method for the estimation of volumetric water content - also for multiple soil layers - in a fast and non-invasive manner.