Geophysical Research Abstracts
Vol. 14, EGU2012-8869-1, 2012
EGU General Assembly 2012

High resolution observation of soil water dynamics in a complicated architecture with Ground-Penetrating Radar

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Over the last decades, surface Ground-Penetrating Radar (GPR) has become a reliable tool for studying the subsurface at the field scale. However, there still is a need for detailed studies under well-controlled field conditions. Besides improving the quantitative GPR analysis, this also furthers the understanding of near-surface hydrological processes.

In this study, we present the results of **high-resolution multichannel GPR observations of fluctuating water table experiments** at the Heidelberg ASSESS-GPR test site. This site is an artificial sand-bed with a well-defined, known subsurface structure, where the pertinent boundary conditions are either measured or can be directly adjusted. During these experiments, a well-defined amount of water has been infiltrated into the structure from below over the course of several hours and was subsequently pumped out again. Concurrently, various multichannel surface GPR measurements at three different frequencies have been carried out at characteristic locations on the sand-bed. The **large number of radargrams**, which have been obtained at a **temporal resolution of about one minute** throughout the whole experiment duration, allow for a **detailed representation of the spatio-temporal water content dynamics**.

We discuss in particular (i) the conditions under which **compacted sand layers act as reflectors**, (ii) the **interference of** reflections from the **moving capillary fringe with** those from the **sand layers**, and (iii) the information that can be retrieved from observing the **dynamics of the capillary fringe** moving through different layers. From these results, we draw further conclusions for quantitative measurements at previously unknown field sites.