Geophysical Research Abstracts,
Vol. 10, EGU2008-A-08283, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-08283
EGU General Assembly 2008

Analysis of a Frequency Domain Reflectometry forward and Inverse Modelling Technique for complete Characterization of a Water Content Profile

J. Minet (1), A. Besson (1), M. Vanclooster (1), and S. Lambot (1,2)

(1) Department of Environmental Sciences and Land Use Planning, Université catholique de Louvain (UCL), Louvain-la-Neuve, Belgium, (2) Agrosphere (ICG IV), Institute of Chemistry and Dynamics of the Geosphere, Forschungszentrum Jülich GmbH, Jülich, Germany. (corresponding author: julien.minet@uclouvain.be / Fax: +32 10 47 38 33 / Tel: +32 10 47 37 12)

Sustainable agricultural and environmental management requires the understanding and characterization of water dynamics in the vadose zone. As the dielectric permittivity of liquid water overwhelms the permittivity of other soil components, water principally governs electromagnetic wave propagation in the soil. From that point, time domain reflectrometry (TDR) has become a standard and attractive method, well adapted to estimate soil water content. Based on the reflected electromagnetic waves from a probe inserted into the soil, the method provides simultaneously the soil dielectric permittivity and electric conductivity.

TDR waveforms are commonly analyzed with techniques such that average soil water content along the transmission lines is obtained. These techniques mostly rely on the analysis of the TDR waveforms in the time domain, considering only a part of the waveform information. Recently, major steps have been made so that it is possible to characterize the soil water content profile along a TDR probe by full waveform inverse modelling either in the time or frequency domains. Following these works our study aims to describe the soil water content profile along the probe using advanced forward and inverse modelling in the frequency domain.

We use a vector network analyser as transmitter and receiver, thereby providing inter-

national standard measurements, with a traditional three-wire probe connected via a high-quality coaxial cable. The model describing the transmission line is based on the exact solution of one-dimensional Maxwell's equations for wave propagation in multilayered media. The inversion problem is formulated in the least-squares sense and optimization is carried out using the global multilevel coordinated search (GMCS) algorithm combined sequentially with the classical Nelder-Mead simplex (NMS) algorithm. Measurements are performed in the range 200-3000 MHz, with a frequency step of 10 MHz.

First, numerical experiments are conducted in order to test the inverse modelling scheme for various scenarios, i.e., homogeneous, linear and hydrodynamic water content profiles assuming two different probe lengths (0.1 and 0.4 m, respectively). Synthetic experiments demonstrate the well-posedness and the accuracy of the inverse modelling scheme for retrieving various soil water content profiles. It shows also the theoretical limitations of the technique. Then, laboratory experiments are performed to describe the frequency domain reflectometry system and determine the probe transfer functions. Through simple soil water profile measurements, we analyze the stability of the estimates with respect to actual measurements and modelling errors. Results appear to be promising for improved TDR or FDR measurements for the retrieval of soil moisture.