Geophysical Research Abstracts,
Vol. 11, EGU2009-10267, 2009
EGU General Assembly 2009

Soil surface water content estimation by full-waveform GPR signal inversion in presence of thin layers

J. Minet (1), S. Lambot (1,2), E. Slob (3), and M. Vanclooster (1)

(1) Department of Environmental Sciences and Land Use Planning, Université catholique de Louvain (UCL), Louvain-la-Neuve, Belgium (julien.minet@uclouvain.be), (2) Agrosphere (ICG IV), Institute of Chemistry and Dynamics of the Geosphere, Forschungszentrum Jülich GmbH, Jülich, Germany, (3) Department of Geotechnology, Delft University of Technology, Stevinweg 1, 2628 CN Delft, The Netherlands

Characterizing the spatial distribution of the soil surface water content at various scales is essential in many researches and applications. There is still now a scale gap between small-scale invasive techniques and large-scale remote sensing acquisition of soil water content data. To bridge this scale gap, we have developed a specific proximal ground penetrating radar (GPR) approach based on international standard vector network analyzer technology and full-waveform inverse modeling of the radar data. The method is particularly suited for high-resolution real-time mapping of the soil surface water content at the field scale, implying some required adaptations for facing real field conditions. In that respect, we analyzed the effect of the presence of shallow thin layers on the estimation of soil surface water content using full-waveform inversion of off-ground GPR data. Indeed, strong dielectric contrasts close to the surface are expected to occur under fast wetting or drying weather conditions, thereby leading to constructive and destructive interferences with respect to the surface reflection. Using numerical experiments, we first quantified the resulting errors in case these thin layers are not accounted for in the electromagnetic model, and then, we investigated the possibility to reconstruct them. Laboratory experiments were conducted to assess the stability of the inverse solution with respect to actual measurement and modeling errors. Results showed that neglecting shallow thin layers may lead to significant errors on the estimation of soil surface water content, increasing with the contrast between the two layers. Accounting for these layers in the inversion process strongly improved the results, although some optimization issues were encountered. In the laboratory, the proposed method permitted to retrieve thin layers parameters, i.e., the dielectric permittivity and the layer thickness, with a good agreement compared to direct measurements. Furthermore, laboratory results have strengthened numerical experiments outcomes, showing same contrast-related discrepancies when the shallow layering is not taken into account. These results suggest that the proposed GPR method is promising for field-scale mapping of soil surface water content and put up inverse modeling strategies to deal with shallow layered soil conditions.