Geophysical Research Abstracts
Vol. 20, EGU2018-1445, 2018
EGU General Assembly 2018
© Author(s) 2017. CC Attribution 4.0 license.

Non-invasive characterization of soil conductivity structure using probabilistic inversion and dimensionality reduction approach

Davood Moghadas (1) and Jasper A. Vrugt (2)

(1) Brandenburg University of Technology Cottbus–Senftenberg, Research Center Landscape Development and Mining Landscapes (FZLB), Cottbus, Germany (moghadas@b-tu.de), (2) Department of Civil and Environmental Engineering, University of California Irvine, 4130 Engineering Gateway, Irvine, CA, 92697-2175, USA (jasper@uci.edu)

Low frequency loop-loop electromagnetic induction (EMI) is widely used for monitoring soil electrical conductivity and water content. As a non-invasive geophysical technique, EMI allows for rapid and real-time electrical conductivity measurements. However, EMI has not yet been used much to back out the vertical (depth profile) conductivity structure due to problems with the inversion of measured apparent electrical conductivity (ECa) data. In this study, we used Bayesian inference with the MT-DREAM(ZS) algorithm to infer the electrical conductivity layering of the subsurface from EMI data. We test and evaluate our methodology using apparent electrical conductivity data measured along two transects in the Hühnerwasser catchment in Lusatia, Germany. These measurements were made using CMD-Explorer, a multi-configuration sensor with three inter-coil spacings and two antenna orientations. Three offsets and two antenna modes lead to six measurement depths. Electrical Resistivity Tomography (ERT) measurements were also carried out to provide reference conductivity values and to calibrate the EMI data. Such calibration is necessary for quantitative interpretation of the ECa values and to enable multi-layered inversion. The Discrete Cosine Transform (DCT) was used to reduce the number of unknown parameters, and different likelihood functions were used to evaluate the sensitivity of the posterior parameter distribution to residual assumptions. DCT-based inversion equates to a quasi-two-dimensional framework which incorporates all data along the profile and results in a low-dimensional over-determined optimization problem. Results demonstrated that although appropriate selection of the low frequency DCT coefficients is important, the definition of the likelihood function plays a crucial role in the estimation of parameter and predictive uncertainty. The use of a Gaussian likelihood function introduces artifacts in DCT-based inversion of EMI data. The use of a more flexible likelihood function results in more accurate results of the DCT-inversion. Integration of the DCT with the MT-DREAM(ZS) algorithm and a flexible generalized likelihood function appears promising for the inversion of low frequency loop-loop EMI data. The proposed approach promises accurate and high resolution estimation of subsurface hydrogeophysical properties from EMI data.