Geophysical Research Abstracts
Vol. 15, EGU2013-2934, 2013
EGU General Assembly 2013

2D stochastic inversion of radio magnetotelluric and electrical resistivity tomography data: the importance of model regularization

Marina Rosas Carbajal (1), Niklas Linde (1), Thomas Kalscheurer (2), Jasper Vrugt (3,4)

(1) Applied and Environmental Geophysics Group, Faculty of Geosciences and Environment, University of Lausanne, 1015 Lausanne, Switzerland (Marina.Rosas@Unil.ch), (2) Institute of Geophysics, ETH Zurich, Zurich, Switzerland., (3) Department of Civil and Environmental Engineering, University of California Irvine, 4130 5 Engineering Gateway, Irvine, CA 92697-2175, USA. , (4) Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam.

Stochastic inversions based on Markov chain Monte Carlo (MCMC) methods help to characterize the inherent non-uniqueness of non-linear inverse problems. By stating the inverse problem as an inference problem, the emphasis is placed on sampling the posterior probability density function (PDF) of the model parameters, which comprise all possible models that explain the data and satisfy a priori information. The drawback is that for non-linear problems involving many model parameters, MCMC algorithms may take great time to converge. This is why most geophysical applications based on MCMC rely on 1D assumptions. We present here the first fully 2D MCMC inversion of radio magnetotelluric (RMT) and electrical resistivity tomography (ERT) data, using up to 300 model parameters. We demonstrate that stochastic inversion of high-dimensional problems necessitates prior constraints on the model structure to yield meaningful results. In particular, we focus on two popular types of regularization: smoothly varying model parameters and compact anomalies. To do so, we invert not only for the PDF of each model parameter, but also for two hyper-parameters: the variance of the data errors and a trade-off between data fit and model structure. The derived model uncertainties are compared with deterministic most-squares inversions and we analyze how these uncertainties evolve when jointly inverting RMT and ERT data. Finally, we present a field application to characterize the geometry of an aquifer in Sweden. The numerical examples illustrate that model regularization not only decreases the uncertainty of the model parameters, but also accelerates the convergence of the MCMC algorithm. A drawback is that the regularization may lead to posterior PDFs that do not contain features in the true model that are insensitive to data. We also find that joint inversion of different types of geophysical data helps to better constrain the subsurface models. Results of the field data inversions are in good agreement with previous studies in that the mean model found with the stochastic inversion is very similar to the model obtained from deterministic inversion.