Geophysical Research Abstracts
Vol. 14, EGU2012-5024, 2012
EGU General Assembly 2012

Bayesian inversion of geophysical data using combined particle swarm optimization and Metropolis sampling

T. Danek (1), M. Wojdyla (2), and C. Farquharson (1)

(1) Memorial University, Department of Earth Sciences, Canada (tdanek@mun.ca), (2) PBG Geophysical Exploration Co. Ltd., Warsaw, Poland

Bayesian inversion of geophysical data has many advantages over the classic deterministic approach. Basins of attraction of global solutions are more likely to be found, solution uncertainty can be quantified, and proper parametrizations consistent with the resolving power of the data can be chosen using Bayesian information criteria. Large sets of results, sometimes for different parametrizations, provide additional information which can help address interpretational problems with respect to noise level, changes in parametrization, equivalence or influence of other factors like multidimensional structures or anisotropy. Additionally, a large set of results is an interpretational tool itself. If some external geological information can be included, the interpreter is able to choose the best result from the database of accepted results. Sometimes a non-optimal solution that nevertheless has an acceptable misfit can be in better agreement with the geological model then the global best result. The main disadvantage of the Bayesian approach is its computational intensity and its sometimes slow convergence. These problems can be overcome by combining typical stochastic sampling methods (e.g. Metropolis algorithm) with powerful metaheuristics (e.g. particle swarm optimization) and by multilevel parallelization of computations. Due to the natural parallelism of many geophysical forward solvers (first level of parallelization) and metaheuristical optimization engines (second level of parallelization), the proposed hybrid method was implemented for use in massively parallel environments such as PC or GPU clusters. The results to be presented are focused on 1D magnetotelluric (MT) inversion for both real and synthetic data. However, examples of the application of the proposed approach to other geophysical problems will be presented and discussed. 1D MT was chosen for the main tests because of its computational simplicity, which makes it feasible for more demanding inversion, and because of the ambiguity of its results which can be used to test the efficiency of multidimensional global optimization. It should be stressed that the parallel design of the proposed approach makes it applicable for more complicated and time consuming methods as long as the forward problem solution can be accelerated using parallel computing.