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Efficiency of Pareto joint inversion of 2D geophysical data using global optimization methods

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Pareto joint inversion of two or more sets of data is a promising new tool of modern geophysical exploration. In the first stage of our investigation we created software enabling execution of forward solvers of two geophysical methods (2D magnetotelluric and gravity) as well as inversion with possibility of constraining solution with seismic data. In the algorithm solving MT forward solver Helmholtz's equations, finite element method and Dirichlet's boundary conditions were applied. Gravity forward solver was based on Talwani's algorithm. To limit dimensionality of solution space we decided to describe model as sets of polygons, using Sharp Boundary Interface (SBI) approach. The main inversion engine was created using Particle Swarm Optimization (PSO) algorithm adapted to handle two or more target functions and to prevent acceptance of solutions which are non – realistic or incompatible with Pareto scheme. Each inversion run generates single Pareto solution, which can be added to Pareto Front. The PSO inversion engine was parallelized using OpenMP standard, what enabled execution code for practically unlimited amount of threads at once. Thereby computing time of inversion process was significantly decreased. Furthermore, computing efficiency increases with number of PSO iterations. In this contribution we analyze the efficiency of created software solution taking under consideration details of chosen global optimization engine used as a main joint minimization engine. Additionally we study the scale of possible decrease of computational time caused by different methods of parallelization applied for both forward solvers and inversion algorithm. All tests were done for 2D magnetotelluric and gravity data based on real geological media. Obtained results show that even for relatively simple mid end computational infrastructure proposed solution of inversion problem can be applied in practice and used for real life problems of geophysical inversion and interpretation.