An efficient 3D EM modeling scheme based on a radiation boundary approach

Rahul Dehiya[1] and Arun Singh[2]
[1]Indian Institute of Science Education and Research, Pune, rahul.dehiya@iiserpune.ac.in
[2]Indian Institute of Technology (Indian School of Mines), Dhanbad, aruns@iitism.ac.in

ABSTRACT

We present the development of an efficient 3D forward modeling algorithm of electromagnetic data based on a radiation boundary scheme. The proposed scheme computes the response at the desired resolution in two steps. The first step involves coarse-grid finite-difference modeling and the computation of a radiation boundary field vector at the boundaries of a relatively fine mesh. In the second step, modeling is performed for the fine mesh with boundary conditions modified using the computed radiation boundary vector. An initial solution derived from coarse-grid modeling is also used for fine-grid modeling. The fine-mesh discretization includes partial or no air medium and does not contain the stretched grid. The boundary of the finer mesh can have an arbitrary shape that depends on the sensors' positions. The ability to have an arbitrarily shaped boundary of the computational domain optimizes the computation in forward modeling and reduces the degree of freedom when the algorithm is used in an inversion. The proposed algorithm derives computational efficiency from a stretch-free discretization, air-free computational domain, and a better initial guess for an iterative solver. The proposed scheme is based on the finite-difference method; however, the concept of radiation boundary conditions can be employed along with other numerical techniques as well. The robustness and versatility of the algorithm are illustrated for both controlled-source electromagnetic and magnetotelluric data. Numerical experiments demonstrate that the developed algorithm is one order faster than the finite-difference modeling algorithm in most of the cases presented. The scheme is particularly suitable for data analysis of large models resulting due to the fine discretization or the large survey area such as USArray and AusLAMP.