Source decoupling and model order reduction for 3D full-time TEM modeling

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SUMMARY

This SUMMARY Krylov subspace projection model order reduction technique for matrix function has proved efficient for the modeling of three-dimensional (3D) off-time transient electromagnetic (TEM) data. However, this method is time-consuming to compute full-time TEM response due to the time-dependent source terms. In this paper, we propose a new model reduction algorithm for fast computation of full-time TEM responses. First, the governing equations of full-time TEM are spatially discretized using a finite volume with octree meshes. The transmitter source is decoupled as the multiplication of a time-varying current term and a spatially distributed constant term. Then, a shift-and-inverse (SAI) Krylov subspace based on the governing equation coefficient matrix and the spatially distributed constant term of source is constructed. A reduced-order governing equations are obtained by projecting the governing equations into the SAI Krylov subspace. Finally, the full-time TEM response is achieved by solving the reduced-order governing equations. This algorithm only needs to construct a SAI Krylov subspace once, results in significantly faster solution times than previously proposed schemes. Numerical results for typical transmitting waveforms demonstrate that the novel algorithm is more than 100 times faster than previously proposed schemes without reducing the accuracy for full-time TEM modeling.

Keywords: Transient electromagnetic (TEM), Numerical modeling, Model order reduction, Krylov subspace method.