Divergence correction for 3D Magnetotelluric forward modelling with general electrical anisotropy

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Summary

It was first discovered that, for a staggered-grid finite-difference (FD) solution to the magnetotelluric (MT) method in isotropic media, the convergence rate of the iterative solver slowed significantly at low frequencies. This was attributed to the decreasing significance of the conductivity term in the electric-field equation as the frequency decreased. This inherently reduces the need for the finite-difference approximation of the electric field to correspond to a divergence-free current density. A divergence correction approach that significantly accelerated the convergence rate of the FD solution for isotropic MT forward modeling is presented. This correction procedure is also employed in some other published work.

In recent years, electric anisotropy has attracted substantial attention. However, only a limited number of studies have explored the issue of divergence correction in electromagnetic (EM) methods with electric anisotropy, particularly for MT method.

In this study, we focus on integrating divergence correction into the FD solution for arbitrary anisotropic MT. We incorporate a current density divergence correction approach in the 3D MT forward computation under arbitrary anisotropic conditions. During the staggered-grid FD iterative solution of the electric-field differential equation with general anisotropy, we observed notably slow convergence, especially at low frequencies, similar to the situation in isotropic scenarios. To address this, a current density divergence correction procedure was applied to the iterative FD solution for anisotropic scenarios, significantly accelerating the iteration process. Furthermore, robust numerical examples validate the accuracy and effectiveness of our algorithm.

Keywords: Magnetotelluric forward, electrical anisotropy, divergence correction