Geophysical Research Abstracts
Vol. 18, EGU2016-10231, 2016
EGU General Assembly 2016

3D electromagnetic modelling of a TTI medium and TTI effects in inversion

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We present a numerical algorithm for 3D electromagnetic (EM) forward modelling in conducting media with general electric anisotropy. The algorithm is based on the finite-difference discretization of frequency-domain Maxwell's equations on a Lebedev grid, in which all components of the electric field are collocated but half a spatial step staggered with respect to the magnetic field components, which also are collocated. This leads to a system of linear equations that is solved using a stabilized biconjugate gradient method with a multigrid preconditioner. We validate the accuracy of the numerical results for layered and 3D tilted transverse isotropic (TTI) earth models representing typical scenarios used in the marine controlled-source EM method. It is then demonstrated that not taking into account the full anisotropy of the conductivity tensor can lead to misleading inversion results. For simulation data corresponding to a 3D model with a TTI anticlinal structure, a standard vertical transverse isotropic inversion is not able to image a resistor, while for a 3D model with a TTI synclinal structure the inversion produces a false resistive anomaly. If inversion uses the proposed forward solver that can handle TTI anisotropy, it produces resistivity images consistent with the true models.