3D airborne EM anisotropic effect and identification modeling by SE method

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Spectral-element (SE) method is a kind of higher-order finite-element method based on weighted residual technique; however, the basis functions for SE are polynomial, like Gauss–Lobatto–Legendre (GLL) or Gauss–Lobatto–Chebyshev (GLC) polynomials. Because of its high modeling accuracy and flexibility, it has been successfully used in computational electromagnetism. In this paper, we use the SE method for 3D frequency-domain airborne electromagnetic (AEM) modeling for an anisotropic earth and we take horizontal coplanar and vertical coaxial coil systems as example for the modeling. We first derive the discrete governing equation from Maxwell equations, in which the conductivity tensor is obtained by 3 Euler rotations of a principal conductivity tensor. GLL polynomial is selected as the vector SE basis functions, while GLL integration is applied for calculating matrix elements. A direct solver is used for the solution of the matrix equations system. The modeling accuracy is checked against a semi-analytical solution. Further, we calculate AEM responses for different anisotropic models and demonstrate that SE method canobtain high precision by either increasing SE order or refining meshes, so that it can save computation cost vastly. Numerical results further confirm that the anisotropy of both 3D body and host rock can be identified from the polar plots of ratio of magnetic field components.