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Inverting MT 3D data using local coordinates and taking distortion parameters into account: progress and primlimary results

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In recent years different 3D inversion codes for magnetotelluric data, using finite differences, finite elements or integral equations, have been developed, and some are beginning to become available for general use. All of these codes are designed to accommodate different aspects (e.g., topography, marine applications, including vertical transfer functions, . . .). Our inversion program presented here uses a finite-element forward engine, and differs from previous ones by solving simultaneously for galvanic distortion parameters as well as Earth structure, and by using individual, local coordinate systems for each MT site instead of one global coordinate system. The code is called MCMT3DID (Marion and Colin's MT 3D Inversion code including Distortion).

The reason for using local coordinate systems is obvious: Using a global coordinate system for modelling means that measured data need to be rotated from the coordinate system in which the data were recorded to the common, global modelling system. Therefore a rotation will be applied to the complex 2x2 impedance matrix which results in transferring noise of one channel into the others – a huge disadvantage that causes degradation in information, especially if only one channel is strongly affected by noise but the others are not. Hence our philosophy is to leave measured data in their acquisition coordinates and not to apply any rotations to them. Of course there will be a global coordinate system used for the inversion itself, but for comparison between measured data and synthetic data, the noise-free, synthetic data will be rotated to the local coordinate system of each site to avoid the noise propagation into all components.

Another common problem of magnetotelluric field data is galvanic distortion due to charges on small-scale, near-surface conductivity anomalies. Since the magnetic effects of the galvanic distortion decay rapidly with increasing periods they can be neglected in the MT case and only the electric effects, which persist to all periods, will be taken into account. Therefore the relation between the measured field data ($Z_{measured}$), the impedance tensor of the true structure (Z_{true}) and the distortion matrix (C) can be written as:

$Z_{measured} = C\, Z_{true}$

Inverting for conductivities only would result in an image of a structure related to $Z_{measured}$ rather than being an accurate representation of the subsurface. To gain a result being more alike the true structure, we invert for conductivities and distortion parameters simultaneously to accommodate these small-scale, near-surface anomalies causing the galvanic distortion.

We will present the structure of the 3D finite-element code with the focus on some of the more interesting aspects (e.g., local coordinate system and distortion) including the different options and features (e.g., different approaches to include the distortion in the inversion process and to define the starting values for the distortion parameters) as well as the status of progress at the time of the conference. We will also show some preliminary results obtained from the first test data sets using the options in the code, which are fully implemented at that stage.