3D resistivity inversion using a nonlinear partial derivative

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Inappropriate treatment of nonlinearity has been the roots of many unresolved issues on geophysical inversion. We therefore propose a novel approach, which provides better partial derivatives beyond the first-order sensitivity matrix (i.e. linear Fréchet derivative) thereby improving both the convergence behaviour and the resolving power of the inversion.

The essence of our approach lies in building a nonlinear partial derivative (NLPD), which is the key player of nonlinear inversion. We show that the NLPD operator provides means to include high order sensitivity terms which are ignored in conventional linearized inversion, therefore paves the way to a nonlinear sensitivity matrix.

While constructing this nonlinear sensitivity matrix, our approach introduces (1) the evaluation of the so-called contrast sources and (2) the update of fields within the computation domain using these contrast sources, which will affect the sensitivity matrix to behave nonlinear.

Numerical examples on synthetic datasets are presented to demonstrate the merits and effectiveness of our algorithm on geoelectric data.