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MULTIDIMENSIONAL ALGORITHM FOR THE INVERSION OF MAGNETOTELLURIC MEASUREMENTS

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The magnetotelluric (MT) method is a passive exploration technique using electromagnetic waves. It aims at estimating the resistivity distribution, and therefore at providing an *image* of the subsurface addressing scales varying from few meters to hundred of kilometers [1]. MT measurements can be described by Maxwells equations with a surface source located at the ionosphere. In particular, when the electromagnetic fields depend only upon two spatial variables, then two independent and uncoupled modes are derived, the so-called Transverse Electric (TE) and Transverse Magnetic (TM) polarizations. The TE mode is then solution to the Helmholtz equation which can be approximated with *hp* Finite Element Methods to compute the Impedance and/or the Apparent Resistivity required to perform the inversion. In this work, we consider an horizontally layered Earth model with possible 2D heterogeneities. The size of the direct problem and the required computational time may be excessively large. On the one hand, the model of the source requires to define an horizontally sufficiently large thick plate to avoid undesirable effects that could take place around the edges. On the other hand, the inversion of MT measurements typically requires the computation of an accurate solution at the receivers located at different positions. Since traditional *hp*-goal oriented techniques [2, 4] provide an accurate solution in one single point, we use a multi-goal-oriented algorithm [3] to ensure accurate solutions at all receivers. To obtain accurate quantities of interest at several positions, it is necessary to increase the size of the mesh. This induces high computational costs in particular because the solution of the inverse problem is based on reiterated solutions of the direct problem. To decrease the computational costs required to perform the inversion, we propose an adaptive multi-dimensional inversion algorithm, which consists in increasing step by step the dimension in which the direct problem and the inversion are solved. At first step, we compute the 1D primary field (corresponding only to the layered media) with a semi-analytical solution and we invert the 1D problem. After that, we introduce the 2D heterogeneities. Regarding the direct problem, we compute the secondary field, thereby, drastically reducing the size of the computational domain for this problem. Then, we perform the inversion using the solution to the 1D Inverse Problem as a regularization term, increasing the robustness of the inversion algorithm.

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