

# Three-Dimensional Inversion of Time-Domain Electromagnetic Data Using Various Loop Source Configurations

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## SUMMARY

We present a multi-dimensional inversion methodology for loop source time-domain electromagnetic data. The developed algorithm is a robust, efficient, and user-oriented tool for the multi-dimensional inversion of typical loop source time-domain electromagnetic configurations. A time-domain finite volume method and a direct solver are utilized for solving the 3D forward problem, while the iterative Gauss-Newton optimization method is implemented for the inversion kernel. The code is parallelized for calculating multiple sources simultaneously to accelerate the inversion. Based on different exploration tasks, we present three different inversion experiments on typical field scales for commonly used loop source TEM configurations. These examples verify the effectiveness and benchmark the developed 3D algorithm. Considering that TEM data is often gathered along profiles, we carried out an analysis using the 3D inversion algorithm for 2D data by adjusting the model roughness along the different domain directions, which seem to sufficiently constrain but not over-regularize the model along the strike direction to retrieve the true model structure. Besides using the vertical signal component for large scale moving and fixed loop configurations, the horizontal components are also included in the 3D inversion. The inversion algorithm is further verified with dense boat-towed central loop TEM data recorded on a volcanic lake on the Azores, Portugal. The reconstructed model is consistent along the profile line and the main features agree with the 1D stitched models. Moreover, the 3D model depicts additional reasonable features not visible in the 1D models.

**Keywords:** Transient electromagnetic method (TEM), loop source TEM, 3D TEM inversion.

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