

R003-03

D会場：11/25 AM1 (9:15-10:45)

9:45~10:00:00

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Three-dimensional Magnetotelluric Inversion based on a Data Space variant of Akaike's Bayesian Information Criterion

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We develop a three-dimensional (3-D) magnetotelluric (MT) inversion method based on Akaike's Bayesian Information Criterion (ABIC), which statistically determines the optimal regularization parameter that balances the prior constraints and data fitting, and therefore controls the smoothness of the final model by incorporating the entropy-maximization theorem into Bayesian statistics. To mitigate the high computational cost of calculating the ABIC indicator, we introduce a low-rank transformation, similar to that used in model-to-data space inversions, resulting in a data-space variant of ABIC. This adaptation significantly reduces computational complexity, facilitating the practical application of ABIC in 3-D MT inversions. Our discussion on the methodology and its application begins with a theoretical analysis of the proposed inversion method, including the underlying assumptions, the mathematical foundations of this statistical framework, a detailed derivation of the data-space ABIC formulation, and the procedure for obtaining maximum likelihood solutions in 3-D MT inversion. We then assess the method's performance using synthetic data, evaluate its stability under different inversion configurations, and benchmark it against other inversion strategies, including those based on the L-curve criterion, the cooling approach, and the original ABIC in model space. We demonstrate that the proposed inversion based on the data-space ABIC formulation yields stable performance across various configurations and offers improved objectivity compared to L-curve and cooling-based inversions. It also gains a substantial computational advantage over the original model-space ABIC formulation, achieving over a 70-fold speedup in synthetic tests while preserving statistical rigor. This facilitates a smooth transition of ABIC-based MT inversion from 2-D to 3-D and also opens the door to its broader application in other large-scale inverse problems. Finally, we briefly consider a field data application of the proposed 3-D method to the Yellowstone – Snake River Plain region using EarthScope USArray MT data to showcase its practical applicability.