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大地电磁三维数据空间反演并行算法研究

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Three-dimensional magnetotelluic parallel inversion algorithm using data space method

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摘要

目前大地电磁三维反演实际应用的主要问题是计算效率低.在对大地电磁三维数据空间反演算法进行深入分析的基础上,本文提出了基于频点和矩阵划分的大粒度并行反演方案和具体实现步骤,并在曙光TC5000A高性能计算平台上实现了基于MPI的大地电磁三维数据空间反演并行算法.该算法实现了包括三维正演、灵敏度矩阵、叉积矩阵以及模型改正量的并行执行,不仅计算效率高,而且每个节点机上灵敏度矩阵的存储空间只需原来微机上的2/*N*(*N*是参加并行计算的节点机个数),大大地减少了内存开销.通过两个理论模型合成的数据对实现的三维数据空间反演并行算法进行试算,对比分析了多个节点机下程序的执行效率.测试结果表明,所实现的三维数据空间反演并行算法是可行的、高效的,与单机相比,不仅可以提高运行速度,缩短计算时间,而且还可以扩大计算规模,极大地推动了大地电磁三维反演的实用化.

关键词 大地电磁, 三维反演, 数据空间, 并行计算, MPI

Abstract:

Up until now, the key issue to the practical applications of three-dimensional magnetotelluric (MT) inversion is the insufficiency in computing resources. By further analysis and understanding on data-space inversion approach of 3D MT, we develop a massively parallel inversion scheme on the basis of frequency division and matrix decomposition, and implement its procedure by using MPI on TC5000A high-performance computing platform. The algorithm we develop includes the parallel calculation of three dimensional forward modeling, and sensitivity matrix and cross-product matrix, as well as the update of model parameters. The algorithm has the advantages of higher efficiency in computation and lower memory storage in which the storage amount of sensitivity matrix in every single computing node is 2/*N* times that on a PC (*N* is the number of nodes included in parallel computation). Furthermore, we test the implemented scheme with synthetic data from two 3D theoretical models and analyze the computational efficiency under multiple-nodes computing. The numerical experiment results show that the 3D data-space parallel inversion algorithm is feasible and efficient. Compared with the implementation on single PC, the parallel scheme is not only able to improve the computing speed and shorten the computation time, but also enlarge the calculational scale, which would advance the practicality of three dimensional magnetotelluic inversion.

Keywords Magnetotelluric, 3D inversion, Data-space method, Parallel computation, MPI

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