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含噪声数据反演的概率描述

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摘要 根据贝叶斯理论给出了对含噪声地球物理数据处理的具体流程和方法，主要包括似然函数估计和后验概率计算.我们将数据向量的概念扩展为数据向量的集合，通过引入数据空间内的信赖度，把数据噪声转移到模型空间的概率密度函数上，即获得了反映数据本身的不确定性的似然函数.该方法由于避免了处理阶段数据空间内的人工干预，因而可以保证模型空间中的概率密度单纯反映数据噪声，具有信息保真度高、保留可行解的优点.为了得到加入先验信息的后验分布，本文提出了使用加权矩阵的概率分析法，该方法在模型空间直接引入地质信息，对噪声引起的反演多解性有很强的约束效果.整个处理流程均以大地电磁反演为例进行了展示.

关键词 反演 概率密度 噪声 不确定性 贝叶斯

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Inversion of noisy data by probabilistic methodology

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Abstract Based on Bayesian theory of parameter estimation, we present specific and detailed procedures to demonstrate how to invert noisy data in applied geophysics. The probabilistic methodology of inversion consists of evaluation of likelihood function and calculation of posterior probability. To obtain the likelihood function indicating the uncertainty of observed information, noisy data is firstly expressed by a set of data vectors instead of a single vector, and then transferred to probability density curve defined in model space through confidence value defined in data space. Because the artificial operations are avoided in data space when processing, the probability density functions of model parameters only reflect data noise; observed information and feasible solutions can be preserved as much as possible. At the second stage of Bayesian theory, in which prior information and likelihood function should be combined to get posterior distribution, we propose a method of probabilistic analysis using weighting matrix. This method can impose strong restriction on non-uniqueness of inversion due to noises, since geological information is imported into model space directly. The entire process of probabilistic methodology is exemplified and explained by inversion of magnetotelluric sounding.

Key words Inversion Probability density Noise Uncertainty Bayesian

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