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针对复杂地形的三种地震波走时算法及对比

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The comparison of three schemes for computing seismic wave traveltimes in complex topographical conditions

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摘要 复杂地形条件下地震波走时算法对于研究复杂地形地区的成像问题有着重要的意义.为了得到精度高且适应于复杂地形的走时算法,首先提出阶梯网格迎风差分法.然后将该方法与不等距网格有限差分法和混合网格线性插值法进行对比研究,得出如下结论:混合网格线性插值法的计算精度最高,但其计算效率最低;阶梯网格迎风差分法的计算精度最低,但其计算效率最高;不等距网格有限差分法的计算精度和计算效率均居中;而究竟选取哪种算法作为给定复杂地形模型的地震波走时算法,应该综合考虑地形的特点、所研究问题对计算精度及计算效率的要求等因素.最后通过一个计算实例验证了三种算法在面对复杂地形、近地表及地下复杂介质等复杂地质条件时均有很好的适应性和稳定性.

关键词 复杂地形, 走时计算, 迎风差分, 不等距差分, 线性插值法

Abstract: The traveltime computation scheme in complex topographical conditions has a great significance to seismic imaging in complex topographical regions. To obtain a scheme that can treat the complex topography with high precision and good flexibility, we firstly present a upwind finite difference scheme with stepwise grid. Then we compare this scheme with the following two schemes that we have published: finite difference scheme with nonuniform grid spacing and linear interpolation scheme with hybrid grid, and we can make the following conclusions: the linear interpolation scheme with hybrid grid has the best computational accuracy, but the worst computational efficiency; the upwind finite difference scheme with setpwise grid has the worst computational accuracy, but the best computational efficiency; the finite difference scheme with nonuniform grid spacing has the moderate computational accuracy and efficiency. We should choose the scheme by synthetically considering the characteristic of the topography, the computational accuracy and efficiency requirements of our object, and the other factors. At last, a numerical test shows that the three schemes all can treat the complex topographical region problem with satisfactory stability and flexibility.

Keywords Complex topography, Traveltime computation, Upwind finite difference, Finite difference with nonuniform grid spacing, Linear interpolation

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