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方法技术

用优化通量校正传输技术压制数值模拟的频散

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摘要 用常规有限差分法求解波动方程,进行弹性波正演模拟,当单位波长内采样点数较少（粗网格）时会遇到严重的频散现象。通量校正传输(FCT)算法可有效地压制在粗网格情况下产生的数值频散。FCT校正假设所有的极值点都是由数值频散引起的，然后对所有网格点进行扩散通量校正处理，再对非局部极值点进行补偿的逆扩散通量校正。FCT方法用于高阶差分既具有较高的计算精度，又因适应采样间隔较大的情况而节省了计算量，从而具有较高的计算速度。在传统的FCT技术基础上提出的优化FCT技术只在需要压制数值频散处对波场进行平滑处理，可节省约40%的计算量。给出了应用优化FCT技术进行波动方程正演模拟的数值算例，当参数选取合适时不仅有效地压制了数值频散，完好地保存了真实波场，又因节省了计算量而提高了计算效率。

关键词 通量校正传输(FCT) 数值频散 计算精度 计算效率

Elimination of numerical dispersion in finite-difference modeling by optimized flux-corrected transport

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Abstract

Conventional finite-difference methods for solving elastic-wave equation suffer from numerical dispersion when too few samples per wavelength are used. Flux-corrected transport (FCT) algorithm can reduce the numerical dispersion in finite-difference wavefield continuation. The FCT correction is based on the assumption that all local extrema are caused by grid dispersion, so it first applies diffusions everywhere at each time step, then introduces an opposing antidiffusion at that time step to counteract the diffusion where it seems not to be needed. FCT yields more accurate solution for increasing order of differencing approximations. Moreover, it results in a net computation savings for allowing coarser grids. On the basis of conventional FCT, an optimized FCT correction is put forward, which incorporates diffusion into the wavefield continuation process at where needed to suppress the numerical dispersion. The computation cost of the proposed method is about 40% less than that of the conventional FCT. Through demonstration of numerical modeling, we showed that the FCT algorithm efficiently removes the numerical dispersion while do no harm to the true wavefield.

Key words

flux-corrected transport (FCT); numerical dispersion; computing accuracy; computing efficiency

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