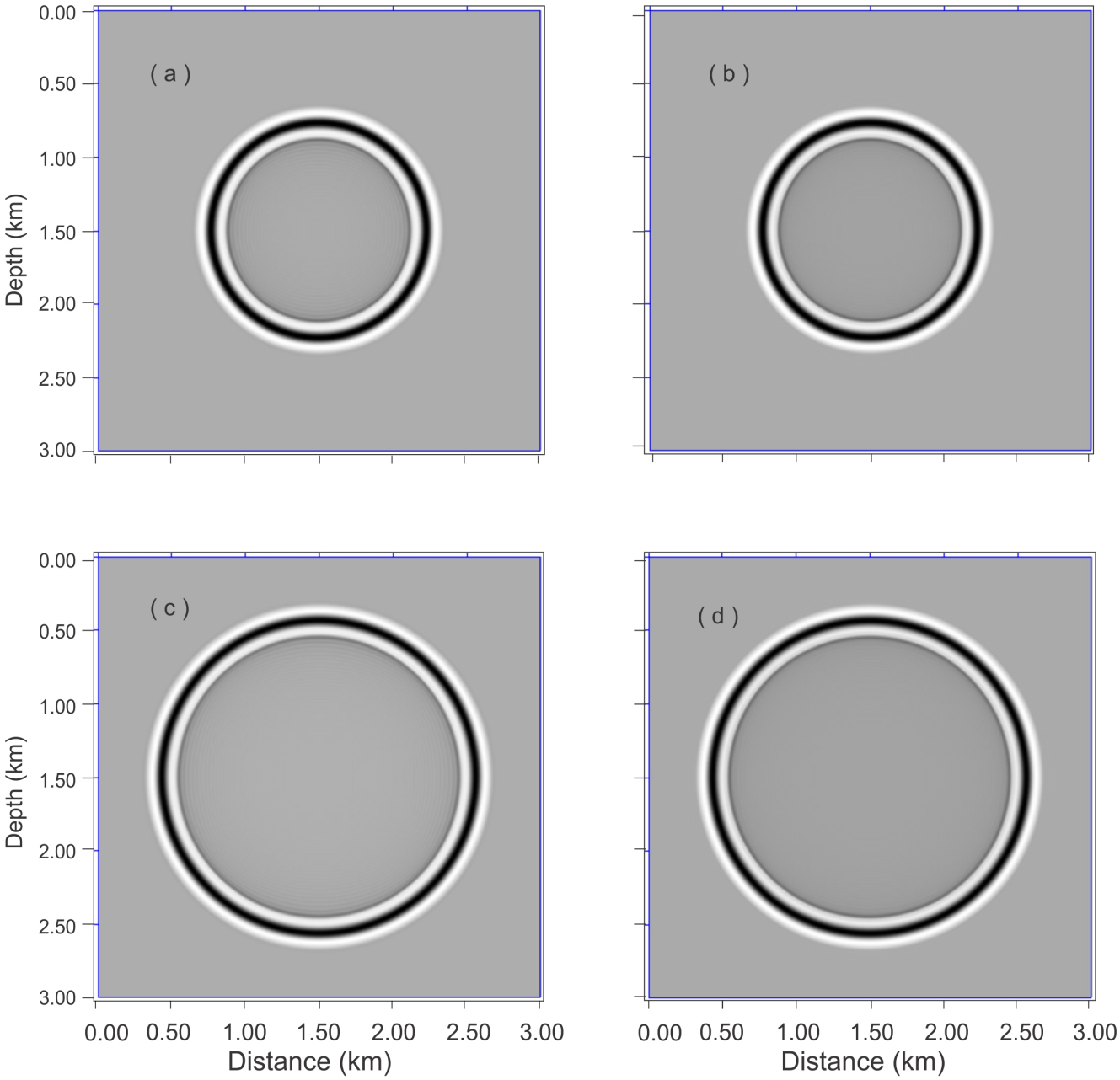
Globally optimized finite difference method to minimize the angle dependent numerical dispersion.

*DEBAJEET BARMAN[1], Dr. MAHESWAR OJHA[1]

1. CSIR National Geophysical Research Institute Hyderabad, India

Finite difference modeling is a basic and important tool to solve a differential equation like acoustic wave equation. This method is also used in high resolution seismic imaging. But it faces some challenges for two dimensional wave propagation due to propagation angle dependent numerical dispersion in square grid system. In a conventional Finite Difference Method (FDM), the coefficients are fixed for 1D and 2D propagation. So, with increase of order of approximation the dispersion may be reduced but the non uniformity of dispersion with varying propagation angle retains itself. For existing Pesudo Spectral Method (PSM) using specific window parameter the FD coefficients are constant and is not properly optimized for every angle of propagations.
Here, we propose a method to automatically optimize FD coefficients for every propagation angle. To make the method robust, at first FD coefficients for every propagation angle is optimized by minimizing phase velocity ratio error with reference to the analytic solution using genetic algorithm of certain initial population. Here, the fitness function is generated by the weighted average error in phase velocity ratio for each wave number. As we know that the error in lower wave number should be in higher priority, so we use decay type functions like linear, exponential to calculate the weighted average error by multiplying the function weight with the error at specific wave number. The stability criteria is considered for choosing best of optimized FD coefficients i.e. the FD coefficients whose stability ratio is higher than conventional is considered for the next step for the algorithm. Then final FD coefficients are generated by optimizing from those highly optimized FD coefficients for each propagation angle by genetic algorithm. In the second step, the same stability criteria technique is used for optimization. In second step the FD coefficients are optimized by using fitness function where error is average for every propagation angle. The new method is automated and it does not depend on specific window property like Pseudo Spectral Method (PSM). For some acoustic model PSM technique does not better result for lower order approximation and use of higher order approximation increase the complexity of the method. But in new method there is no such limitation.

Keywords: Genetic algorithm, Phase velocity ratio, Decay function



(a) Conventional 12th order at 500ms, (b) New 12th order at 500ms, (c) Conventional 12th order at 700ms, (d) New 12th order at 700ms velocity 2500m/sec, grid spacing 15m, sampling time 1ms, source is 10Hz Ricker wavelet

