

ACOUSTIC WAVE MODELLING BY DOUBLE-GRID SPECTRAL ELEMENTS

Géza Seriani

Istituto Nazionale di Oceanografia e di Geofisica Sperimentale

Borgo Grotta Gigante 42/C, Sgonico

I-34010 Trieste, Italy

Phone: +39-040-21401

Email: gseriani@ogs.trieste.it

ABSTRACT

Highly efficient algorithms are needed for full wave modelling in large-scale realistic unbounded media. The spectral element methods, either based on Chebyshev or Legendre polynomial basis, have shown both high accuracy and excellent flexibility in describing complex physical models by using irregular meshes. Moreover, they can be efficiently implemented on high-performance vector and/or parallel processors. In contrast with standard grid methods, which need dense spatial meshes, the spectral element methods discretize the computational domain by using very coarse meshes. Thus, a single spectral element usually can handle more than one of the shortest waves in the computed field. With constant-property elements, this fact may in some cases reduce seriously the computational efficiency. For instance, if the medium is finely heterogeneous, it may need to be described in a much finer way than what required by the problem solution (e.g.: the wavefield).

A double-grid spectral element method is here developed that represents a convenient approach for solving wave propagation problems in media with physical properties that change continuously, or even sharply on the small-scale. In each element two coupled grids are considered. The wavefield is discretized on the first computational grid, while the small-scale variability of the physical parameters is accurately handled on the second temporary grid. This is formally expressed by using an independent set of shape functions, a coupling operator and the related transfer matrix. The main advantage of this approach is that the medium heterogeneity can be represented numerically by the most appropriate shape functions and polynomial order, independently of the polynomial basis and the order used to represent the wavefield solution. There is no need for a finer grid to handle the medium's small-scale details, moreover the spectral accuracy and the efficiency of the method in computing the acoustic wavefield is maintained.

REFERENCES

- [1] G. Seriani and E. Priolo, Spectral element method for acoustic wave simulation in heterogeneous media, *Finite Elements in Analysis and Design*, 16, 337-348, (1994).
- [2] D. Komatitsch and J.-P. Vilotte, The spectral element method: an efficient tool to simulate the seismic response of 2D and 3D geological structures. *Bull. Seis. Soc. Am.*, 88, 368-392, (1998).