Geophysical Research Abstracts
Vol. 15, EGU2013-9946, 2013
EGU General Assembly 2013

Elastic wave propagation in complex heterogeneous earth structures: numerical modelling by using a poly-grid spectral element method

Géza Seriani (1) and Chang Su (1,2)

(1) Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Trieste, Italy (gseriani@ogs.trieste.it), (2) Institute of Acoustics, Chinese Academy of Sciences, Beijing, P. R. of China

Elastic wave propagation in complex heterogeneous earth structures with variable physical properties generate complicated phenomena which are very difficult to reproduce via numerical simulations. Highly accurate and computationally efficient algorithms are needed in order to avoid unphysical effects and to reduce the computational costs. But even for the best method the accuracy and the computational efficiency may be seriously reduced in the case of complex earth structures characterized by fine layering or property fluctuations shorter than the minimum wavelength. In fact, a grid resolution down to the finest scales is required leading to solve problems of extremely large size. The wavelength scale of interest is much larger but cannot be exploited in order to reduce the problem size. As in multiscale problems, the quest is for a method able to solve the macroscopic behavior without solving explicitly the microscopic one.

Among the various computational techniques the spectral element methods (SEM) have excellent properties of accuracy and flexibility in describing complex models and are used as well for elastic wave modelling. In the standard SEM approach, the computational domain is discretized by using very coarse meshes with constant-property elements, and a single element may handle more than one of the shortest waves which makes the method inappropriate for solving the above mentioned problem. A poly-grid Chebyshev spectral element method (PG-CSEM) allows to overcome this limitation. In order to accurately deal with the elastic properties variation in the earth structures, temporary auxiliary grids are introduced which avoid the need of using large meshes, and at the macroscopic level the wave propagation is solved in a coarse mesh maintaining the SEM accuracy and computational efficiency as confirmed by the numerical results presented in this work.