Geophysical Research Abstracts
Vol. 12, EGU2010-4082, 2010
EGU General Assembly 2010

Analysis of different discrete representations of the European crust for numerical wave propagation simulations

Irene Molinari (1), Martin Käser (2), and Andrea Morelli (1)

(1) Istituto Nazionale di Geofisica e Vulcanologia, Bologna, Bologna, Italy (molinari@bo.ingv.it), (2) Earth and Environmental Sciences, Ludwig-Maximilians-Universität, München, Germany

Implementation of crustal structure challenges accuracy and efficiency of practical numerical solutions of the seismic wave equation. Extremely varying thickness of sedimentary layers and depth of Moho discontinuity create the need for finding viable compromises between speed and precision.

We present a study of the influence of different numerical representations of crustal structure on synthetic seismograms. We focus our attention on the European continental scale and consider realistic models for the crust based on a new, comprehensive compilation of currently available information from diverse sources, ranging from seismic prospection to receiver function studies. We investigate different renditions of the Earth structure comparing two approaches: (i) computational meshes honoring the (laterally-varying) geometry of interfaces for a layered crust, and (ii) meshes smoothing out discontinuities of the crustal model within computational elements. The second approach results in computationally more efficient meshes, at the expense of some accuracy in the delineation of the structure, that is however known with some approximation.

We compare seismograms, computed using different model discretization accuracies along 2D cross sections, to reference solutions derived from the most accurate structural representation.

For the required seismic wave propagation simulations we use the Discontinuous Galerkin Finite Element Method (ADER-DG) providing high-order accuracy in space and time on unstructured meshes. With this approach strong and undulating discontinuities can be considered by the element interfaces and modifications of the geometrical properties can be carried out rapidly due to an external mesh generation process.

We analyze the results of the different meshing strategies with respect to accuracy and computational effort. The analysis is based on time-frequency error measures of amplitude and phase misfits and aims at a clear definition of limits in the discretization approach of the crustal structure at the continental scale.

Our results are crucial for the creation of computationally more demanding 3D tetrahedral meshes of the model of the European crust in order to understand how much structural detail has actually to be resolved to get sufficiently accurate synthetic data sets in a desired frequency band as this is essential to validate crustal models by comparisons to real seismic observations.