Synthetic Dataset To Benchmark Global Tomographic Methods

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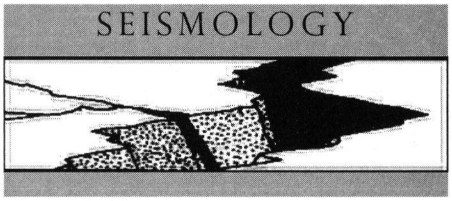
SECTION NEWS



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A new set of global synthetic seismograms calculated in a three-dimensional (3-D), heterogeneous, anisotropic, anelastic model of the Earth using the spectral element method has been released by the European network SPICE (Seismic Wave Propagation and Imaging in Complex Media: a European Network). The set consists of 7424 three-component records with a minimum period of 32 seconds, a sampling rate of one second, and a duration of 10,500 seconds. The aim of this synthetic data set is to conduct a blind test of existing global tomographic methods based on long-period data, in order to test how current imaging techniques are limited by approximations in theory and by the inadequacy of data quality and coverage.

The correlation between modern global tomographic models is generally correct at long wavelengths, but these tomographic models are less similar at shorter wavelengths [*Becker and Boschi,* 2002]. In order to interpret the fine details of tomographic models, it is a fundamental prerequisite to understand quantitatively the resolving properties of specific imaging algorithms. Without knowledge of the true model, it is difficult to properly evaluate the tomographic methods.

Within the European Union Research and Training Network for SPICE, it would therefore be a useful exercise to test global inversion algorithms through inversions of a synthetic data set built in a known model. This is the aim of the blind test presented here.

To generate a global-scale benchmark data set, a three-dimensional model of the mantle has been constructed that is realistic and contains various spatial scales and different types of heterogeneities in velocity, anisotropy, attenuation, and density. Many of the global long-period seismic data used in mantle tomography are sensitive to variations in crustal structure, so it is important to incorporate a crustal element in the model. A smooth version of the crustal model CRUST2.0 has been included as well as a smooth version of the global bathymetry and topography model ETOPO5. Information about these upper layers is provided together with the data set.

The seismic records are generated using the spectral element method (SEM), a numerical method that can synthesize the complete wavefield, has very little intrinsic numerical dispersion, and can incorporate exactly the effect of three-dimensional variations [*Komatitsch and Vilotte,* 1998; *Komatitsch et al.,* 2002; *Chaljub et al.,* 2003]. This is a very accurate, although costly, numerical method. In order to save computation time and make better use of limited computing resources, the core is kept laterally homogeneous and a modal solution in the core is coupled to the spectral element solution in the heterogeneous mantle above [*Capdeville et al.,* 2003]. Topography, ellipticity, Earth's rotation, self-gravity, and ocean thickness also are taken into account.

Computation is done for one event at a time, and including many stations does not increase the computational time. In order to get a realistic path coverage with minimum computational time, the data has been generated for 29 events located mainly along plate boundaries (Figure 1a) and recorded at 256 stations (Figure 1b) chosen from the Federation of Digital Broadband Seismograph Network (FDSN) list of stations. A minimum period of 32 seconds was chosen in order to keep the experiment within available computer resources. The source time function is a band-limited wavelet with frequency range of 800–500–35.7–32 seconds. Location, moment-tensor, and source-time function of the events are provided to the users.

The data set is released in two versions: a noise-free one, and one where noise from a typical GEOSCOPE broadband station [*Stutzmann et al.,* 2000] has been added. Figure 2 shows an example of a noise-free vertical component calculated in the 3-D model and in the 1-D reference model. The fundamental Rayleigh (R1 and R2) and higher-mode Rayleigh (X1 and X2) can be clearly identified.

The synthetic records can be downloaded from the Institut de Physique du Globe de Paris (IPGP) Web site (http://www.ipgp.jussieu.fr/~qyl/). The data sets are located in the directories named 'benchmark_no_noise' and 'benchmark_with_noise.' In each directory, there are 29

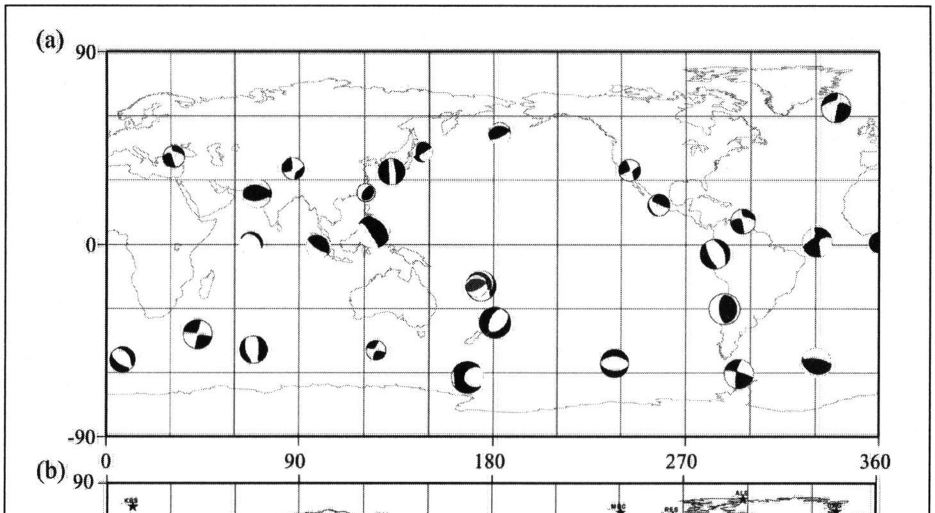

Fig. 1. Distribution of realistic acquisition geometry. (a) Distribution of 29 events located along plate boundaries, representing the real seismicity of world, with divergent, convergent and strike-slip plate margins represented in 'beach ball' diagrams. The size of beach balls is proportional to the magnitude of the events. (b) Distribution of 256 stations extracted from FDSN (Federation of Digital broad-band Seismograph Network) station book. Stations were selected for good global spatial coverage.

gzipped-compressed AH files and ASCII files. Each file is roughly 32 megabytes in size, for a total of about one gigabyte in each directory. A README file, CMT, source wavelet, crustal model, and 1-D reference model also can be downloaded.

Any group willing to contribute to this blind-test exercise is invited to download the synthetic data set and to calculate an inverse model. The true model will be released in 2007. A first comparison of the inverted models and the real one is planned for the European Geophysical Union meeting in April 2007. The goal of this blind test is not only to compare different inversion methods in terms of resolution, so as to assess their limits and advantages, but also to enable seismologists to analyze if there are parameters (3-D anisotropy and attenuation) and features (finite frequency effects at long periods, and so forth) that are often neglected but that should be included because they bias the inverted models. Therefore, this blind test should contribute to pinpointing important aspects that should be addressed by future methodological developments.

Additional information about the SPICE network and its other activities is available at http://www.spice-rtn.org

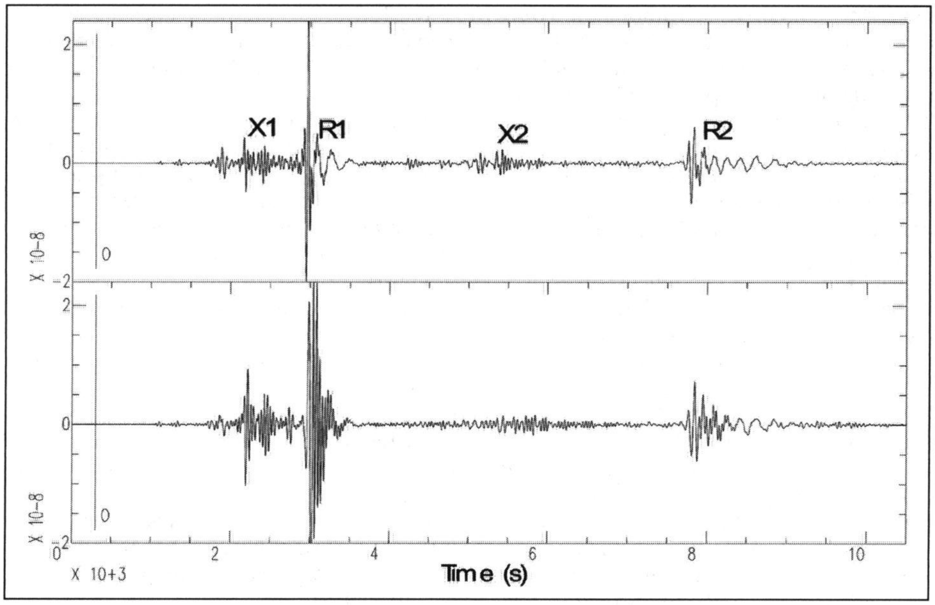

Fig. 2. Synthetic comparison for the Z-component between the (top) three-dimensional model and the (bottom) one-dimensional model.

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ABOUT AGU

At the Fall Meeting

Toward Broad Community Collaboration in Geoinformatics

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A Town Hall meeting at the upcoming AGU Fall Meeting will be held under the theme "Envisioning the future of Earth science data and knowledge access through a broad national geoinformatics collaboration."

Geoinformatics (GI) is understood as a distributed, integrated digital information system and working environment that provides innovative means for the study of the Sun-Earth system and other planets through the use of advanced information technologies. It is an emerging science and technology frontier, and it is increasingly recognized as a relevant part of the broader cyberinfrastructure for the sciences (see U.S. National Science Foundation Blue Ribbon Panel Report at http://www.nsf.gov/od/oci/reports/toc.jsp), both within the academic and applied Earth and planetary science and computer science communities as well as in federal and state agencies.

GI is built on a broad range of disciplinary activities, from major research and development efforts that develop new technologies to provide high-quality, sustained production-level services for data discovery, integration, and analysis, to small, discipline-specific efforts that develop data collections and data analysis tools that serve the needs of individual communities.

Many GI-related service and research activities have become visible over the past five years. However, the impact of GI on research and education, and the efficiency and effectiveness with which it is developed, maintained, and operated, depends on community-based coordination and integration of all these activities. At its heart, GI requires collaboration among geoscientists, information scientists, and computer scientists. The distributed and integrative aspect of GI represent its power as well as its challenges. The Town Hall meeting provides a forum for minimizing redundant GI efforts and for promoting communication and coordination efforts to increase sharing of expertise and technologies.

Over the past few years, a broad consensus has emerged from many workshops, discussions, and white papers that healthy growth in GI will require multiagency and professional society partnerships as well as collaboration among individual projects.