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Simulating Seismic Wave Propagation in 3-D Structure: A Case Study For Istanbul City

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Investigation of the wave propagation around the Marmara Sea, in particular for the city of Istanbul is critical because this target area is identified as one of the megacities with the highest seismic risk in the world. This study makes an attempt for creating an integrated 3D seismic/geologic model and precise understanding of 3-D wave propagation in the city of Istanbul. The approach is based on generating synthetic seismograms using realistic velocity structures as well as accurate location, focal mechanism and source parameters of reference earthquakes. The modarate size reference earthquakes occured in the Marmara Sea and were recorded by the National Seismic Network of Turkey as well as the network of Istanbul Early Warning and Rapid Response System. The seismograms are simulated by means of a 3-D finite difference method operated on parallel processing environment. In the content of creating a robust velocity model; 1D velocity models which are derived fom previous crustal studies of Marmara region such as refraction seismic and receiver functions have been conducted firstly for depths greater than 1km. Velocity structure in shallower part of the study region is then derived from recent geophysical and geotechnical surveys. To construct 3-D model from the obtained 1-D model data, a variety of interpolation methods are considered. According to the observations on amplitude and arrival time based on comparison of simulated seismograms, the considered velocity model is refined the way that S delay times are compensated.
Another important task of this work is an application of the finite difference method to estimate three-dimensional seismic responses for a specified basin structure including soft sediments with low shear velocities in respect of the surrounded area in the Asian part of Istanbul. The analysis performed both in the time and frequency domain, helps in understanding of the comprehensive wave propagation characteristics and the distribution of site effects. The results from this study clearly indicate that the variability of site amplification at different frequency ranges and the presence of high amplification areas are related to complex distribution patterns which at first sight seem loosely correlated with bathymetry. This possibly refers to the impact of complicated 3D wave propagation paths and interactions due to irregular basin geometry, and strongly controlled by the source characteristics.