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Verification of the 3D numerical methods for modeling seismic motion – the case of the Mygdonian basin, Greece

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For more than two decades the Mygdonian basin (Greece) has been a subject of focused seismological and geophysical research. The earthquake activity, strong variability of ground motion and complicated sedimentary structure pose a strong challenge for numerical modeling and predicting earthquake ground motion. Recordings of local earthquakes by the Euroseistest instruments provide a reasonable basis for the verification and validation of the numerical methods.

We present results of the verification phase of the E2VP project (CEA, ILL and ISTerre UJF France, AUTH Greece) for 3D numerical-modeling methods. Teams from Europe, Japan and USA employ the finite-difference, finite-element, global pseudospectral, spectral-element, discrete-element and discontinuous-Galerkin methods.

Not only the unprecedented number of different methods but also the structural complexity of the sedimentary basin (5 km wide, 15 km long, maximum thickness 400 m, minimum VS= 200 m/s, thin surface layer and laterally varying vertical gradient) and the frequency range [0.3, 4Hz] make the E2VP verification phase an important international collaboration with anticipated impacts on both the modeling methodology and earthquake-engineering practice.

The numerical simulations by different methods are compared for a sequence of structural basin models ranging from the simplest up to the most complex. The models include laterally homogeneous sediments with a vertical gradient, 3 irregular homogenous sediment layers, and 3 irregular constant-gradient layers. Elastic and viscoelastic rheologies as well as low and large VP/VS ratios are also included.

Numerical predictions are compared using quantitative time-frequency envelope and phase goodness-of-fit criteria computed at 288 receivers. Solutions are also compared with respect to model, wavefield and computational aspects of simulations. The comparative analysis identifies non-planar material interfaces, free surface and contact of the free surface with the interfaces as key factors affecting the accuracy of simulations, and, in particular the generation and propagation of the surface waves.