Numerical stress field model for the Marmara Sea region

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During the last decades the westward propagation of large earthquakes along the North Anatolian Fault has reached the Sea of Marmara. Thus, the seismic gap along the fault crossing the Marmara Sea has the potential to generate a strong earthquake in the near future. However, the size of the gap as well as the question whether the fault will rupture in a single event or in several smaller ones due to the structural complexities is an open issue. Both information's are essential input information's for the wave propagation codes which calculate peak ground acceleration distribution and site effects in the City of Istanbul.

In order to investigate the contemporary stress state of the Marmara Sea region and its evolution during the last earthquake cycle we constructed a 3D mechanical model which incorporates the 3D structural information as well as the lithological and rheological inhomogeneities. In contrast to other work which quantify stress field changes due to instantaneous co-seismic and transient postseismic stress transfer processes, our aim is to quantify the total stress field and its evolution in time and space. Even though a wide range of numerical models have been published in the last decade, additional improvements are necessary to meet our objective: The 3D model geometry will incorporate topography and bathymetry data, Moho variations, upper/lower crust boundary, and the complex geometry of the active fault system using contact surfaces with Coulomb friction. The constitutive law of the model is a non-linear visco-elastic rheology and boundary conditions are gravity as well as tectonic forces imposed from the indentation of the Arabian plate and the retreat of the Hellenic arc subduction zone. The numerical problem is solved with the finite element method using the commercial code ABAQUS. The resolution of the model is several hundred meters near and on the fault and has in total approximately two million linear elements.

In order to control the quality of the model results we compare the model results with independent data from GPS observations (permanent stations and results from campaign measurements) and information on the tectonic regime and principal stress orientations. We present first results from different geometrical model approaches.