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Forward simulation of co-seismic slip in the Marmara Sea resulting from 4D absolute stress field modelling

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We present a geomechanical model for the Marmara Sea region that simulates the 3D absolute stress field and its temporal changes. The model geometry includes the complex 3D fault system, topography, bathymetry, basement, Moho structure as well as the stress loading and de-loading due to the historical large earthquakes from the year 1719 onwards. The model is driven by lateral kinematic boundary conditions as well as by gravity and the hydrostatic pressure due to the water load of the Marmara Sea. Our model results are consistent with a number of model-independent constraints such as stress observations, GPS derived velocities from the interseismic loading phase, basin evolution, and tectonic stress regime. Given these results and provided that the model reflects the major ingredients that determine the absolute stress state, it should produce on the rupture plane of the 1999 Izmit earthquake the observed co-seismic slip. The deviation between the magnitude of the modelled and the GPS-observed co-seismic slip at the surface is less than 6%. Due to this promising result we also use the model to simulate the slip-distribution of scenario earthquakes on the segment between the bend near Istanbul and the Central Basin that experienced no major earthquake since 1766. According to the empirical relationship of Wells and Coppersmith (1994) the modelled co-seismic slip indicates that this segment is mature. Assuming a worst case scenario where the whole seismic gap between the 1912 and 1999 earthquakes ruptures in one single event, the modelled slip-distribution is equivalent to a Mw 7.6 earthquake at present. However, from the large variation of stress and tectonic loading rate along strike of the fault it is likely that the accumulated stress will release not in a single event, but in two or three of smaller size.