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Time-dependent Coulomb stress changes in the Marmara Sea region

F. Lorenzo-Martin (1), R. Wang (2), D. Pohl (2), F. Roth (2)

1) Aon Re Services, Hamburg, Germany (francisco.lorenzo@aon-rueck.de), (2) GeoForschungsZentrum Potsdam, Potsdam, Germany

During the last century, a sequence of strong earthquakes ruptured the North Anatolian Fault in a clear westward migration, with the Mw = 7.4 Izmit and the Mw = 7.1 Düzce earthquakes in 1999 as the most recent and westernmost events. If this sense of propagation continues, a strong shock west of the Izmit-Düzce rupture can be expected. This region would be the Marmara Sea, just south of Istanbul, a mega-city with 12 million inhabitants. A strong earthquake in the region would therefore have catastrophic consequences, both in loss of life and monetary costs.

Deformation models often assume purely elastic behaviour for the crust and upper mantle, and therefore the crust instantaneously responds to the motion on the rupture. When using the elastic approach, any time dependency of the deformation might be attributed to time-dependent fault slip. However, such an approach neglects the effect of time-dependent deformation processes like after-slip, poroelastic rebound, or viscoelastic relaxation, which have been shown to be not negligible. On the other hand, the influence of these post-seismic, time-dependent deformation processes is still a matter of discussion, as it is which process has the most important role after a strong earthquake.

In this work, we considered the historical seismicity and recent information on the faults around the city of Istanbul and the Marmara Sea to study the current state and evolution of the Coulomb stress field in the region. We show the effect of previous earthquakes on the regional Coulomb stress field, as well as its development in time due to different post-seismic deformation processes. This information might be useful for seismic hazard assessment in the region. Also, we simulate the effect that a potential realistic strong event in the Marmara Sea would have on the Coulomb stress

field, as well as its evolution in time immediately after the event. These calculations can be important for the assessment of aftershock hazard after a hypothetical strong earthquake, and are therefore relevant for the planning of the early response in the case of a strong event.