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Post-seismic deformation following 1999 Izmit and Duzce earthquakes, Turkey: implications for constraining subcrustal rheology

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The Anatolia - Aegean region is located at the zone of convergence between the African, Arabian and the Eurasian plates. Anatolia moves westwards with respect to stable Eurasia, from the Arabia collision zone in eastern Turkey and the Zagros, towards the Hellenic subduction zone to the southwest. This motion is accommodated by the major transform North Anatolian Fault (NAF) to the north. 1999 Izmit M7.4 and Duzce M7.2 earthquake sequence ruptured the western part of the NAF and possibly loaded the adjacent Prince's Island segment , which has been the penultimate step for one complete earthquake cycle.

The post-seismic behaviour of the zone surrounding the Izmit earthquake has been the subject of various studies. Most of these concentrated on either the afterslip and/or the viscoelastic behaviour of the deforming medium. However, recent InSAR evidence suggests that there is ongoing surface creep along the ruptured segment following the İzmit earthquake. The presence of this creep was not taken into account in any of the previous post-seismic studies. This probably led to overestimation of the afterslip at depth and erroneous conclusions in the viscoelastic regime.

In this study, we prescribe the co-seismic slip as the initial condition and use the creep model on the superficial part of the ruptured fault plane obtained from InSAR studies in order to compute synthetic time series of deformation. We use a 3D semi-analytical code RELAX to solve for displacements and stresses. We compare our results with seven years of GPS time series recorded after the İzmit earthquake. Preliminary results based on a 2D grid search on the velocity weakening parameters show that we obtain a good fit of the near-field GPS data using an afterslip patch distribution shallower than the previous models. We also show that far-field fits get slightly better if we use lateral variations of viscosity for the viscous substratum underneath the brittle layer in such a way that it is weaker to the south of the fault. This is in agreement with the bulk viscosity models obtained in the dynamical studies that use secular GPS data. Furthermore, crustal thinning and higher than average heat flow values in the southern part of the NAF, which have been evidenced by receiver function analyses and local earthquake tomography, respectively, indicate strong lateral rheological variations.