Bayesian Slip Model of the 2023 Mw 7.8 and Mw 7.5 Türkiye-Syria Earthquake Doublet from Geodetic Data

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On February 6, 2023, an earthquake doublet devastated the borderland between Türkiye and Syria. The Mw 7.8 left-lateral mainshock progressed over a south-western part of the East Anatolian Fault Zone (EAFZ), which appears not to have ruptured as a whole in recent history. It was followed more than 9 hours later by another Mw 7.5 sinistral earthquake, occuring along the northern strand of the EAFZ, which ruptured last time during the 1544 M 6.8 event. We use Sentinel-1 and ALOS-2 SAR-derived coseismic azimuth and range offsets, as well as GNSS coseismic static offsets for the two events to constrain the static slip along the both strands of the EAFZ. We adopt a Bayesian framework, which allows us to explore the whole solution space and relies solely on the justifiable prior information without employing artificial regularization of the solution. We also account for the epistemic uncertainties due to the imperfect knowledge of the regional elastic structure in addition to the observational errors. The EAFZ is known to be highly heterogenous, with multiple segments, as well as stepover and bend structures. Thus, accurate knowledge of the static slip distribution could provide some insights into how the rupture can be influenced by complex fault geometries.

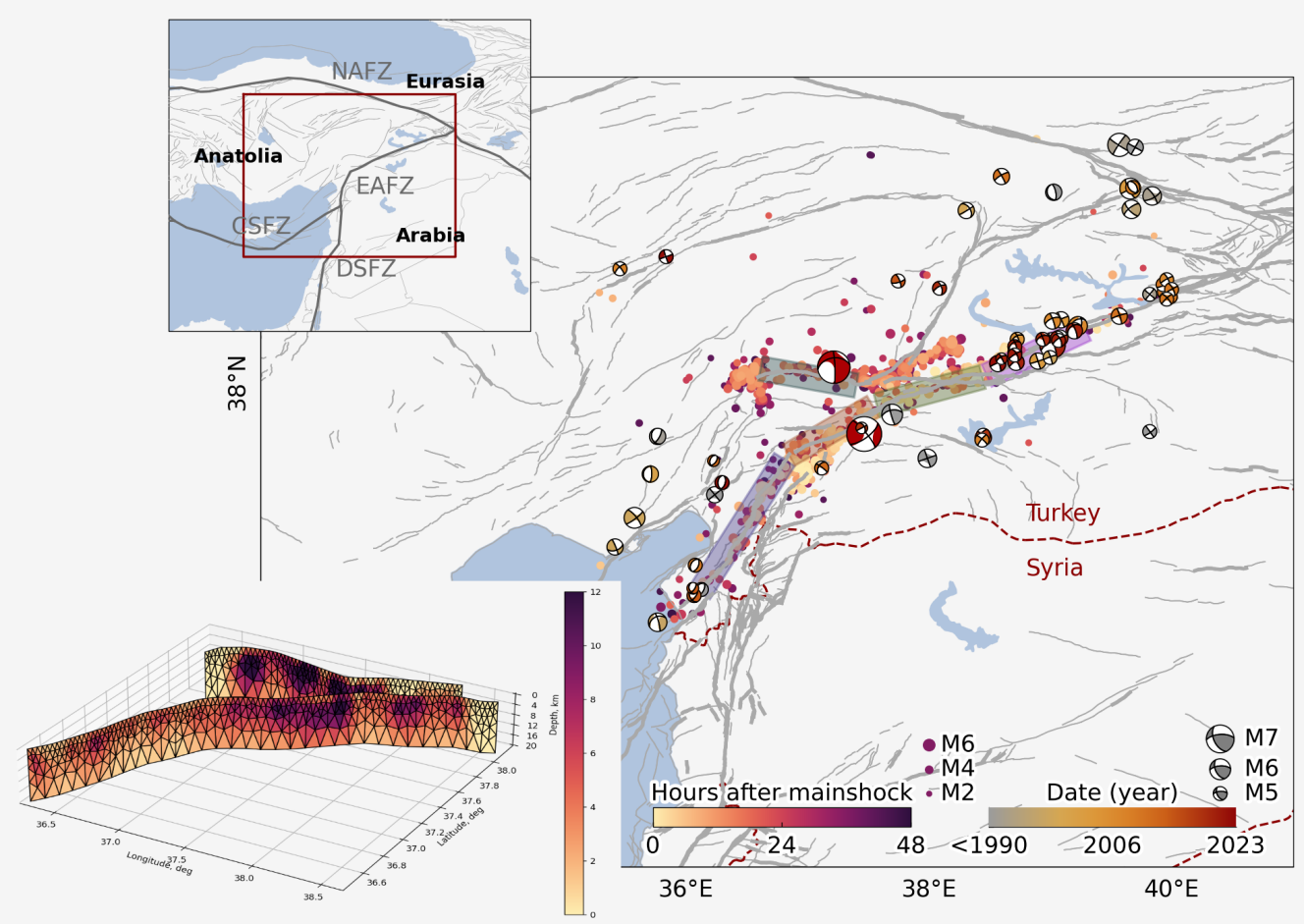

Figure 1: Tectonic map of the region. Fault segmentation, based on the historical earthquakes, as well as geology, is displayed in colors. Blue: 521 Mw 7.5 and possibly 1822 Ms 7.5 Amanos Fault earthquakes. Brown: 521 Mw 7.5 and 1513 Ms 7.4 Pazarcık Fault earthquakes. Green: 1893 Ms 7.1 Erkenek Fault earthquake. Purple: 2020 Mw 6.8 Pütürge Fault earthquake. Gray: 1544 M 6.8 Çardak Fault earthquake. Faults are taken from the Active Faults of Eurasia Database. Moment tensor solutions are obtained using IRIS Web Services. Aftershocks are taken from the Turkish Seismic Network Catalogue. Preliminary regularized least squares model is shown in the inset.