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Deciphering deformation along submarine fault branches below the eastern Sea of Marmara (Turkey): insights from seismicity, strainmeter, GPS and InSAR data

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More and more studies worldwide show that seismic and aseismic slip can occur jointly, impacting the seismic hazard in a region. It is thus important to be able to reconstruct the deformation partitioning and fault interactions. In this study, we focus on the eastern Sea of Marmara region south of the megalopolis of Istanbul (Turkey). In this region, the plate-bounding North Anatolian Fault (NAF) is splitting into several branches. The northern branch is locked and is considered to host the nucleation zone of a M~7 earthquake expected for the region. In 2016, a 3-days long foreshock sequence preceded a M_W 4.2 event located at the junction of the two or more sub-branches. It has been argued that this sequence may have been driven by aseismic slip involved in the earthquake nucleation (Malin et al., 2018). Starting around the time of this earthquake, a large strain signal, lasting 50 days, was identified on a single strainmeter station located ~30km from the M4.2 epicenter (Martinez-Garzon et al., 2019). To better characterize this sequence, we revisit it adding new types of data: we analyze GPS and InSAR data together with reprocessed strainmeter recordings of all the availaible stations in the region during 18 months framing the observed strain signal. To enhance the tectonic features in the strainmeter data, we apply a variational Bayesian Independent Component Analysis (vbICA, Gualandi et al. 2015). Following the M4.2 earthquake, we highlight a 50 km westward migration of the seismicity starting from its epicentral area and lasting 6 months. Increases in the seismic activity correspond to variations in the tectonic components of the recordings at two nearby strainmeters. The first changes in seismicity and strainmeter data occur 2.5 months before the M_W4.2 event, and are also concomitant with a variation in the trend of the GPS data. The GPS data, along with the strainmeter ones, exhibit a second clear change at the time of the mainshock, that is also lasting two months. Similarly, the InSAR data highlight a variation in the time series around the time of the earthquake, lasting several weeks. The combination of these different types of measurements covering various signal-frequency bands of deformation in the eastern Sea of Marmara highlights the presence of a measurable large-scale and long-lasting deformation transient that begins and ends several weeks before and after the

occurrence of a Mw4.2 earthquake. These observations show that further reducing the observational gap both in terms of detection threshold and frequency band allows to decipher signals that usually remain undetected. This is non-trivial but relevant for seismic hazard and risk assessment especially in case of submarine faults collocated with population centers, as is the case of the study region.