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Slow slip events along the North Anatolian Fault

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While some faults remain locked for tens to hundreds of years, some active faults slip slowly, either continuously or episodically. The discovery of slow, generally silent, slip at the turn of the century led to a profound modification of our understanding of the mechanics of faulting, shedding light on the dynamics of fault slip. Such dynamics areis controlled by the past history of stress along the fault plane (i.e. historical ruptures), fluids circulating in the crust and the rheology of the crust and fault plane. Understanding the influence of these different factors requires dense observations, as suggested by the large range of spatial and temporal scales involved in the control of the slip velocity along a fault. Specifically, the smallest scales of slow slip have beenwere inferred by the observation of tremors or low frequency events, interpreted as the chatter of a fault plane while it slips slowly. We are missing direct observations of such kilometer-scale slow slip events and continental creeping faults are an obvious target for such observationsfor such observations.

Aseismic slip along the North Anatolian Fault was recognized in the 1960's by the observation of offset man-made features without earthquakes recorded. Following these early observations, multiple geodetic studies focused on recording aseismic slip and analyzed the average rate of shallow slow slip in the vicinity of the town of Ismetpasa. GPS, InSAR and creepmeter data all converge toward an aseismic slip rate reaching 1 cm/yr in places, with significant along- strike variations. Furthermore, earlyHowever, creepmeter measurements in the 80's, confirmed by records from a more recent instrument, suggest aseismic slip is currently episodic, occurring in bursts of slip. Recent InSAR data from the Cosmo-SkyMed constellation captured a month-long slow slip event with a maximum of 2 cm/yr of slip.

We propose to analyze the geodetic record to search for slow slip events over the 2015-2020 period. We take advantage of a dense network of continuous GNSS stations installed in 2017 and of time series of Sentinel 1 SAR data to identify at least 3 slow slip events along the North Anatolian Fault. Thanks to the dense temporal sampling of the GNSS records, we describe faithfullyobserve the onset of slow slip. We use a deep learning algorithm to extract the surface signature of the slow slip events from the InSAR time series, highlighting a slow rupture front propagating along strike. We compare the occurrences of slow slip events with the local fault geometry, the average distribution of kinematic coupling and the historical seismicity. We discuss the mechanical implications of such detailed description of slow slip along an active fault. In conclusion, while slow slip rate averaged over periods longer than 2-3 years seems constant over the last 40 years, identification of slow slip events suggests this apparently constant rate results from slow slip events over multiple spatial and temporal scales.