

EGU2020-21477

<https://doi.org/10.5194/egusphere-egu2020-21477>

EGU General Assembly 2020

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Revisiting the deformation transients before the 2011 Tohoku-Oki Megathrust Earthquake with GPS

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The precursory activity leading up to the Tohoku-Oki earthquake of 2011 has been suggested to feature both long- and short-term episodes of decoupling and suggests a particularly complex slow slip history. The analysis of the F3 solution of the Japanese GPS network suggested that an accelerated slip occurred in the deeper part of the seismogenic zone during the 10 years preceding the earthquake (Heki & Mitsui, *EPSL* 2013; Mavrommatis et al., *GRL* 2014; Yokota & Koketsu, *Nat. Com.* 2015). During the two months preceding the earthquake, no anomaly in the GPS position time series has been revealed so far, although several anomalous geophysical signals have been reported (an extended foreshock crisis near the future hypocenter (Kato et al., *Science* 2012), a synchronized increase of intermediate-depth background seismicity (Bouchon et al., *Nat Geosc.* 2016), a signal in ocean-bottom pressure gauges and on-land strainmeter time series (Ito et al., *Tectonoph.* 2013), and large scale gravity anomalies that suggest deep-seated slab deformation processes (Panet et al., *Nat. Geosc.* 2018 ; Wang & Burgmann, *GRL* 2019)).

We present novel results based on an independent analysis of the Japanese GPS data set. We perform a full reprocessing of the raw data with a double-difference approach, a systematic analysis of the obtained time-series, including noise characterization and network filtering, and make a robust assessment of long- and short-term tectonic aseismic transients preceding the Tohoku-Oki earthquake. An accelerated slip on the lower part of the seismogenic zone over the last decade is confirmed, not only below the epicenter of Tohoku-Oki earthquake but also further south, offshore Boso peninsula, which is a worrying sign of an on-going slow decoupling east of Tokyo. At shorter time-scale, first results seem compatible with a slow slip close to the epicenter initiating ~ 2 months before the mainshock.