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Full characterization of the ML 5.4 2019/11/11 Le Teil earthquake in France based on a multi-technology approach

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Metropolitan France is a region of slow tectonic deformation rates with sparse historical and instrumental seismicity, and where geodesy is not able to reach the required resolution in order to resolve the tectonic loadings. The few faults recognized as potential active rely on rare neotectonic slip rates, often integrated over geological scales.

In this context, the M_L 5.4 Le Teil 2019 earthquake is of particular interest because it is the largest seismic event recorded in metropolitan France in the last 16 years. The last regional earthquake with a larger magnitude was the Lambesc event that occurred in 1909 about 110 km away from Le Teil epicenter. This recent earthquake offers a noteworthy opportunity to combine different technologies: seismological observations (RESIF and CEA) with satellite InSAR data and infrasound measurements, to help characterizing this stable continental region.

The analysis shows that the focal mechanism determined from the full waveform inversion of long-period seismological data is consistent with the activation of a reverse fault with a strike around 45°N and is associated with a moment magnitude of 4.8. Moreover, this event produced infrasound signals recorded by the OHP Alpine array located 110 km away. The analysis of these signals provides evidence of ground-to-air coupling in the epicentral region as well as ground shaking information.

Despite the moderate magnitude of the event, the ground deformation is resolved by InSAR with Sentinel-1 data. The interferogram is consistent with the shallow depth inverted from seismology and confirmed by the presence of surface ruptures. The inversion of multiple InSAR tracks allows characterizing the displacement at depth and along strike on the fault plane. The results are consistent with the focal mechanism derived from seismology. The earthquake has ruptured a 5-km long by ~ 1.5 -km deep fault. The displacement reaches a maximum at a shallow 1 km-depth. The source inverted from InSAR coincides with the Rouvière fault, a branch of the Cévennes fault system formerly known as a normal fault. This reverse earthquake might be an example of an inherited structure re-activation as it is often the case in intraplate regions with polyphased history.

