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Anatomy of 2013 Galati seismic swarm in southeastern Romania – implications for understanding the triggering mechanism

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The seismic swarm of Galati in southeastern Romania comprised three months of seismic activity. The main seismic sequence started on September 23 and continued with alternating enhanced and reduced intervals until November 2013. Between September 23rd and November 5th, 937 events with magnitudes of 0.2 - 4.0 have been reported (Popa et al. 2016). Despite the relatively small magnitude of earthquakes the intensity of events in the nearby inhabited areas was high enough to be felt by the local people, leading to panic in the area. The proximity of active oil fields caused additional annoyance and caught the attention of mass-media. At the present moment, there still does not exist a clear understanding of what might have been the physical mechanism behind this seismic swarm.
The region of Galati belongs to the Marasesti-Galati-Braila lineament (Raileanu et al. 2007) which generates earthquakes along the major crustal faults with predominant NW-SE orientation. The seismicity here is generally dispersed and characterised by small to moderate crustal events. Thus, the swarm of September – November 2013 was an unprecedented case for the Galati region due to its space-time characteristics: unusually long-time, swarm-like evolution oriented perpendicularly to the common NW-SE trend of the major faults (Popa et al. 2016). Five days after the beginning of the swarm, National Institute for Earth Physics installed four temporary stations in addition to the existing permanent network for increasing the spatial coverage of the area. Each station has been equipped with a broadband seismometer and an accelerometer. A system for recording acoustic signals, a magnetometer and an infrasound station were also deployed in order to complement the seismological data. This makes the Galati seismic swarm one of the best instrumented earthquake sequences in Romania up to date, giving the possibility of in-depth multi-disciplinary geophysical analyses of the underlying physical mechanism.

In this study, we apply a recently developed automatic array-based detection and location algorithm of Poiata et al. (2016) to the analysis 2013 Galati swarm. The algorithm uses time-frequency statistical representation of seismic signals, recorded by local and regional seismic networks. We compare the performance of this fully automatic method in imaging the small-scale temporal evolution of seismic energy release processes during such complex seismic sequences with traditional detection and location techniques. The preliminary analysis, carried out for 1-day continuous seismic records at five near-fault stations demonstrated, that application of such methods based on advanced signal-processing scheme can significantly improve the detectability of small-magnitude events. Further extending the analysis to the seismic recordings of the entire sequence we examine the space-time characteristics of the seismic-energy release evolution by analysing the resulted catalog of detected earthquakes. Finally, we integrate our results with other available geophysical (e.g., geodetic GPS measurements) and technological information in order to provide a plausible explanation of the mechanism that triggered the 2013 seismic swarm and controlled its evolution in time and space.