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Enahancing the detail on low-level seismicity and swarms in central-southern Italy by template matching

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During the seismic sequence which followed the devastating L'Aquila 2009 earthquake, on 27 May 2009 the OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale) and the GeosisLab (Laboratorio di Geodinamica e Sismogenesi, Chieti-Pescara University) installed a temporary seismometric network around the Sulmona Basin, a high seismic risk area of Central Italy located right at SE of the epicentral one. This area of the central Apennines is generally characterized by low level seismicity organized in low energy clusters, but it experienced destructive earthquakes both in historical and in early instrumental time (Fucino 1915 =XI MCS, Majella 1706 =X-XI MCS, Barrea 1984 =VIII MCS).

From the 27 May 2009 to 22 November 2011, the temporary network provided a huge amount of continuous seismic recordings, and a seismic catalogue covering the first seven months of network operation ($-1.5 \le M_L \le 3.7$, with a completeness magnitude of 1.1) and a spatial area that stretches from the Sulmona Basin to Marsica-Sora area. Aiming to enhance the detection of microearthquakes reported in this catalogue, we applied the matched-filter technique (MFT) to continuous waveforms properly integrated with data from permanent stations belonging to the national seismic network. Specifically, we used the open-source seismological package PyMPA to detect microseismicity from the cross-correlation of continuous data and templates. As templates we used only the best relocated events of the available seismic catalogue. Starting from 366 well located earthquakes we obtain a new seismic catalogue of 6084 new events ($-2 < M_L < 4$) lowering the completeness magnitude to 0.2. To these new seismic locations, we applied a declustering method to separate background seismicity from clustered seismicity in the area. All the seismicity shows a bimodal behaviour in term of distribution of the nearest-neighbor distance/time with the presence of two statistically distinct earthquake populations. We focused the attention on two of these clusters (C1 and C2) that numerically represent the 60% of the catalogue. They consist in 2619 and 995 events, respectively, with magnitude $-2.0 < M_L < 3.6$ and $-0.5 < M_L < 3.2$ occurred in Marsica-Sora area. C1 shows the typical characteristics of a seismic swarm, without a clear mainshock, but with 8 more energetic events ($3.0 \le M_L \le 3.5$); the temporal evolution is very

articulated with a total duration of one month with different bursts of seismicity and characteristic time extension of approximately one week. C2 instead has a different space-time evolution and consists of different swarm-like seismic sequences more discontinuous in comparison with C1. These swarms are described in greater detail to investigate the influence of overpressurized fluids and their space-time distribution.