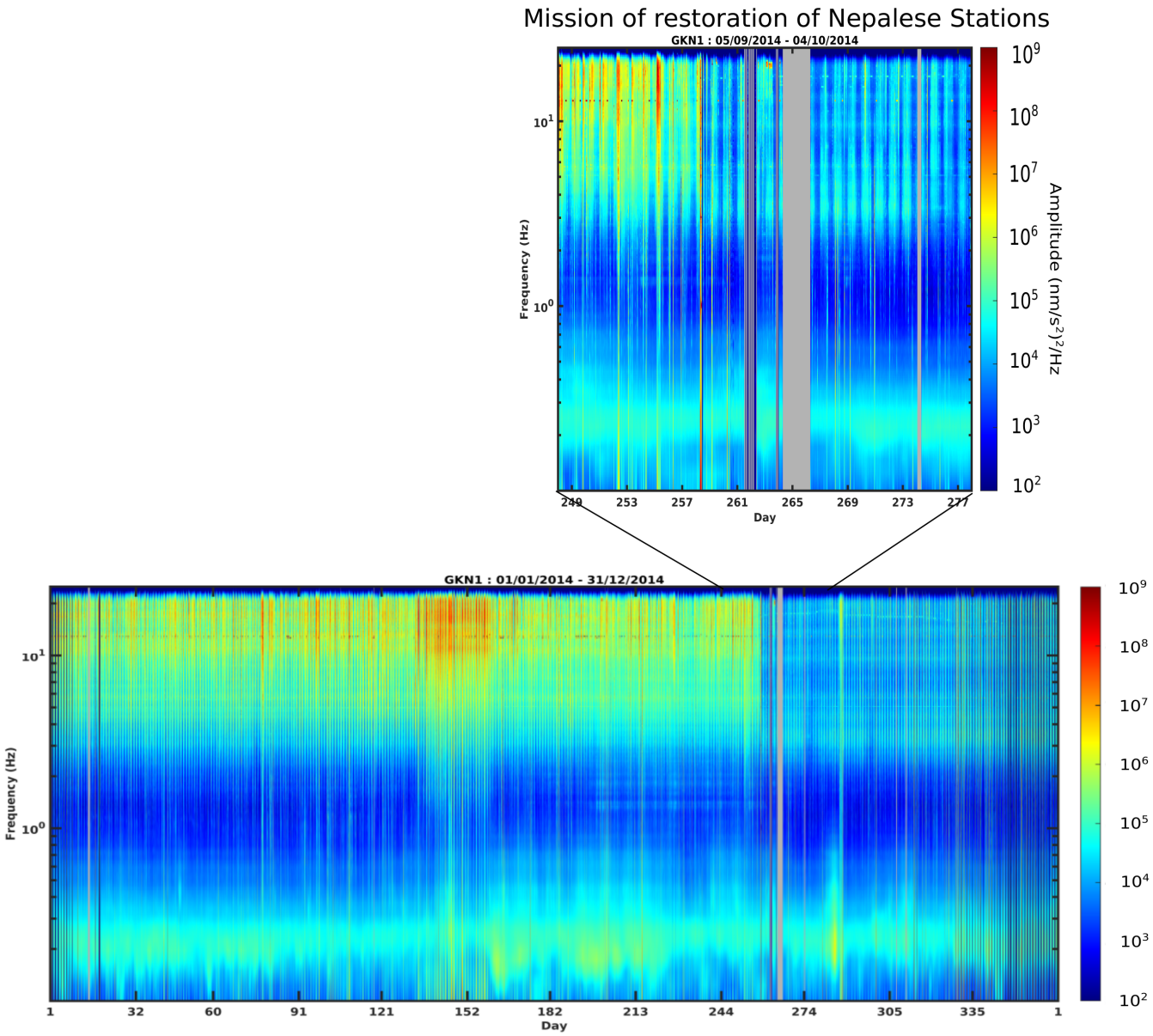

Figure 1 Spectrogram of the Power Spectral Density for the GKN station in 2014. Note the mission of restoration of Nepalese stations from the 5th of September 2014 to the 4th of October 2014. Amplitude is in $(nm/s^2)^2/Hz$

References

Mesimeri, M., Karakostas, V., Papadimitriou, E., and Tsaklidis, G. Characteristics of earthquake clusters: Application to western Corinth Gulf (Greece). *Tectonophysics*, 767:228160, 2019.

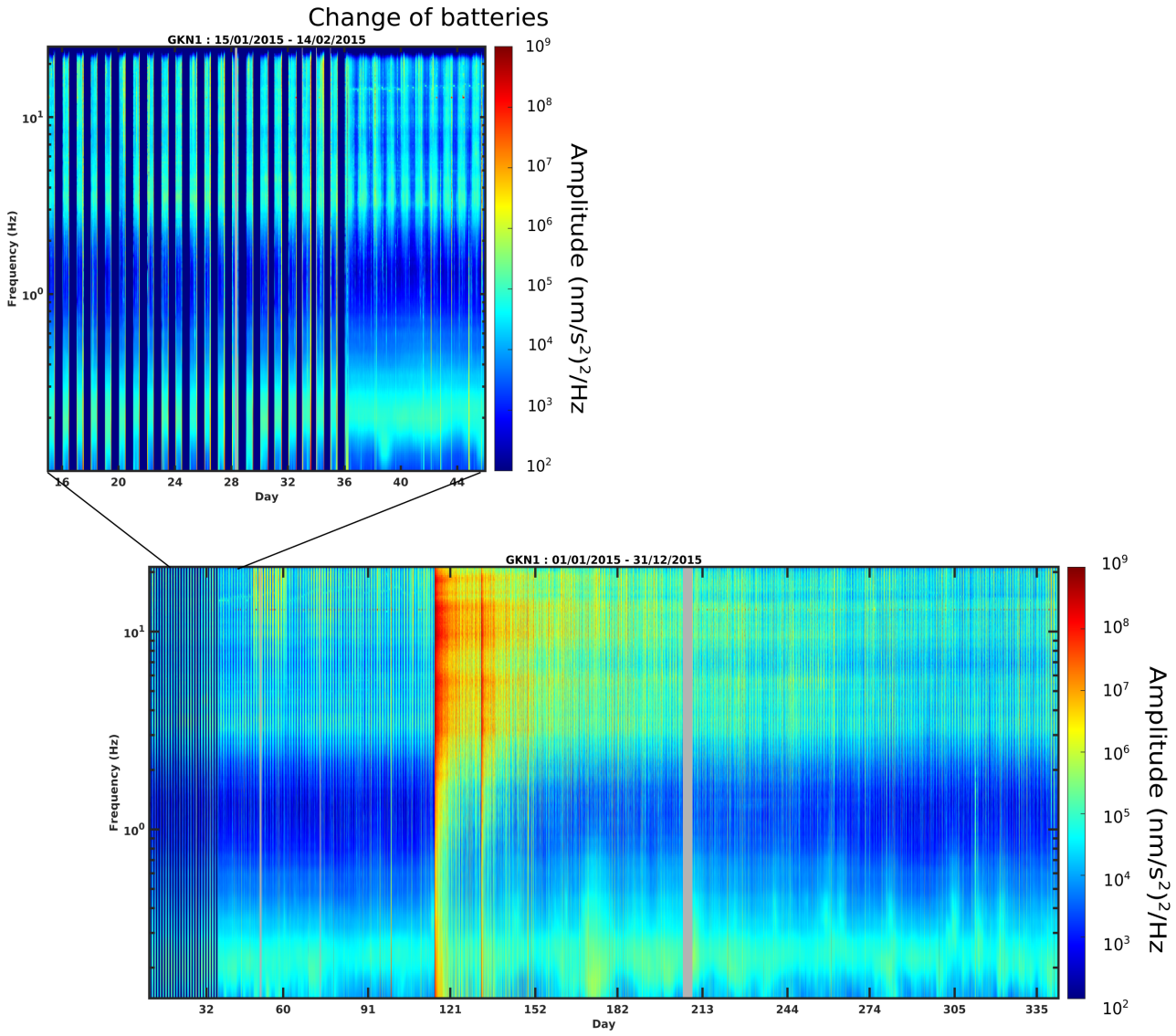

Figure 2 Spectrogram of the Power Spectral Density for the GKN station in 2015. Note a change of battery at the beginning of 2015. Amplitude is in $(nm/s^2)^2/Hz$

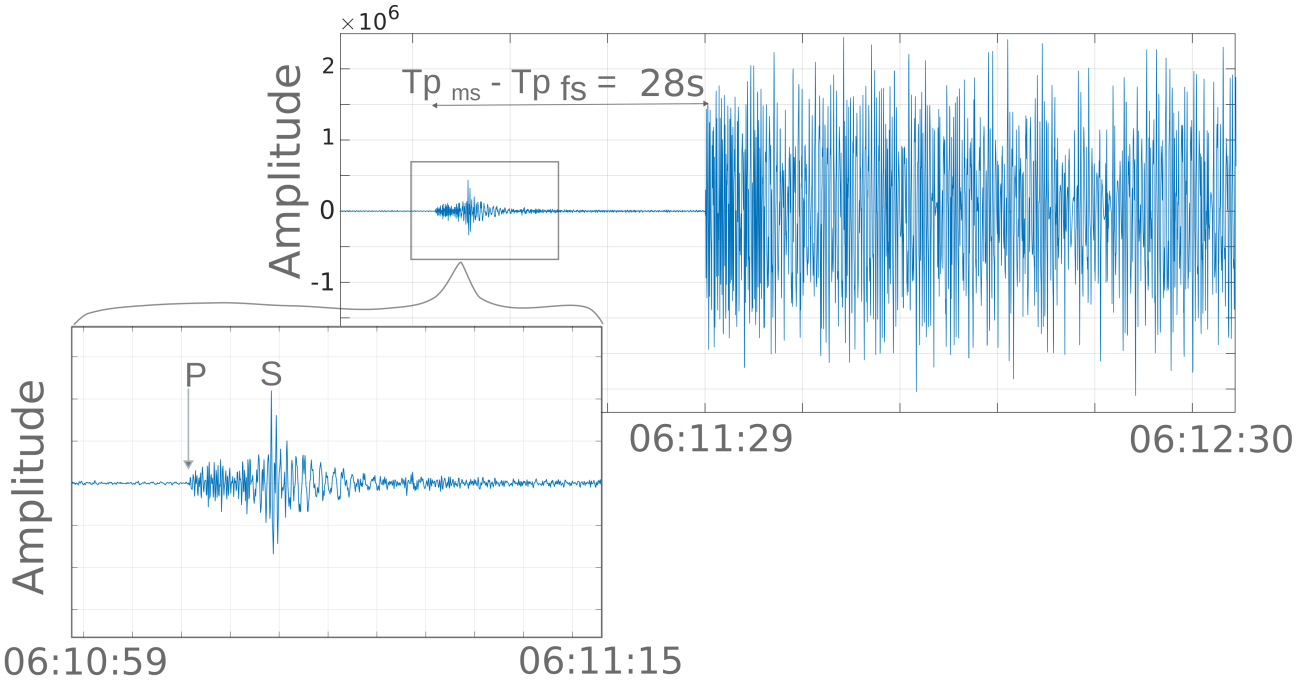

Figure 3 Record from the GKN station at the time of the Gorkha earthquake. There was an event occurring 28s before the mainshock that has the same difference of P-wave arrival times between GKN and KKN stations than the Gorkha earthquake (see Fig. 4).

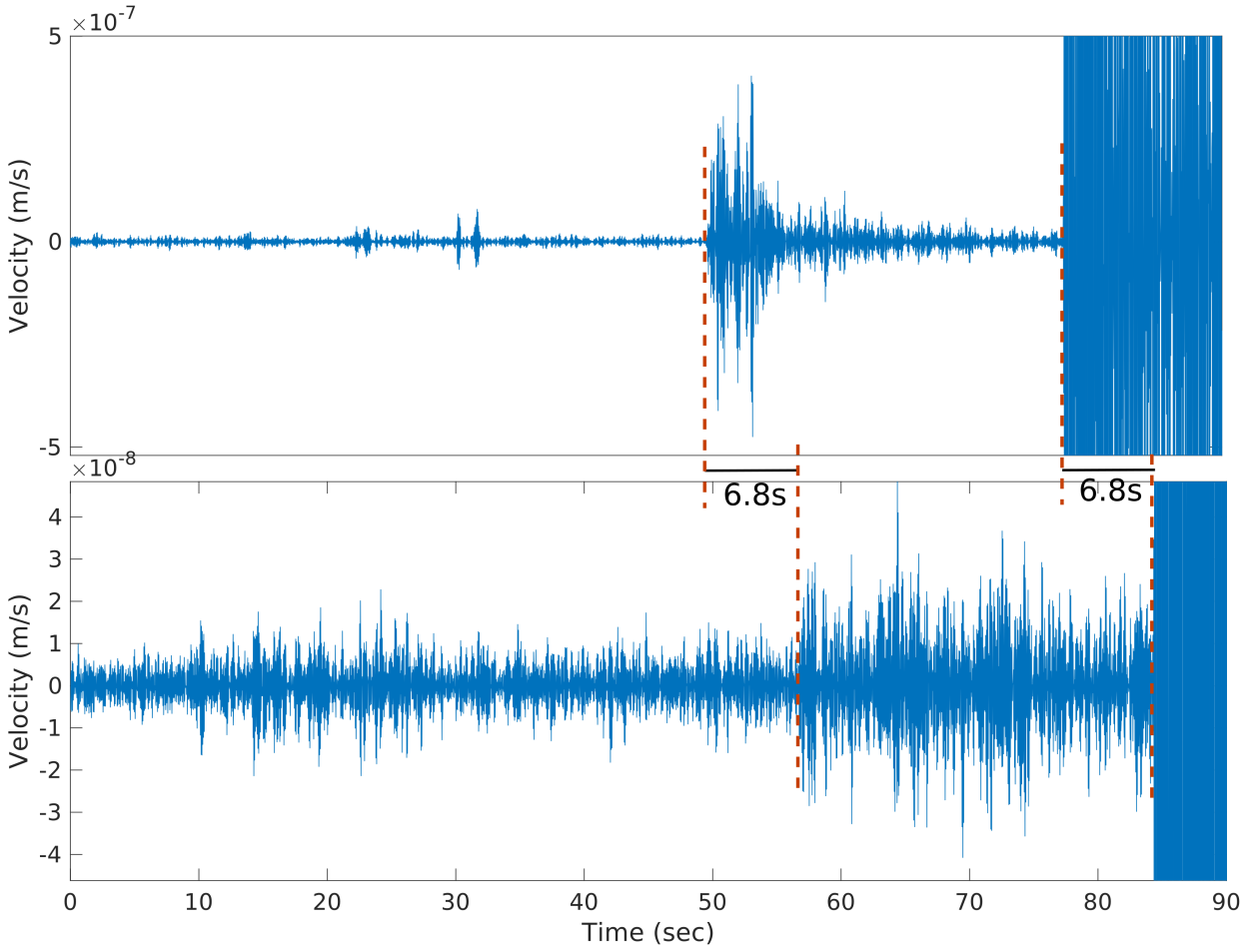

Figure 4 Recordings (in velocity) of the GKN and KKN station before the Gorkha earthquake filtering at high frequencies (f>14Hz). There was an event occurring before the mainshock that has the same difference of P-wave arrival times of 6.8s than the Gorkha earthquake between GKN and KKN stations.

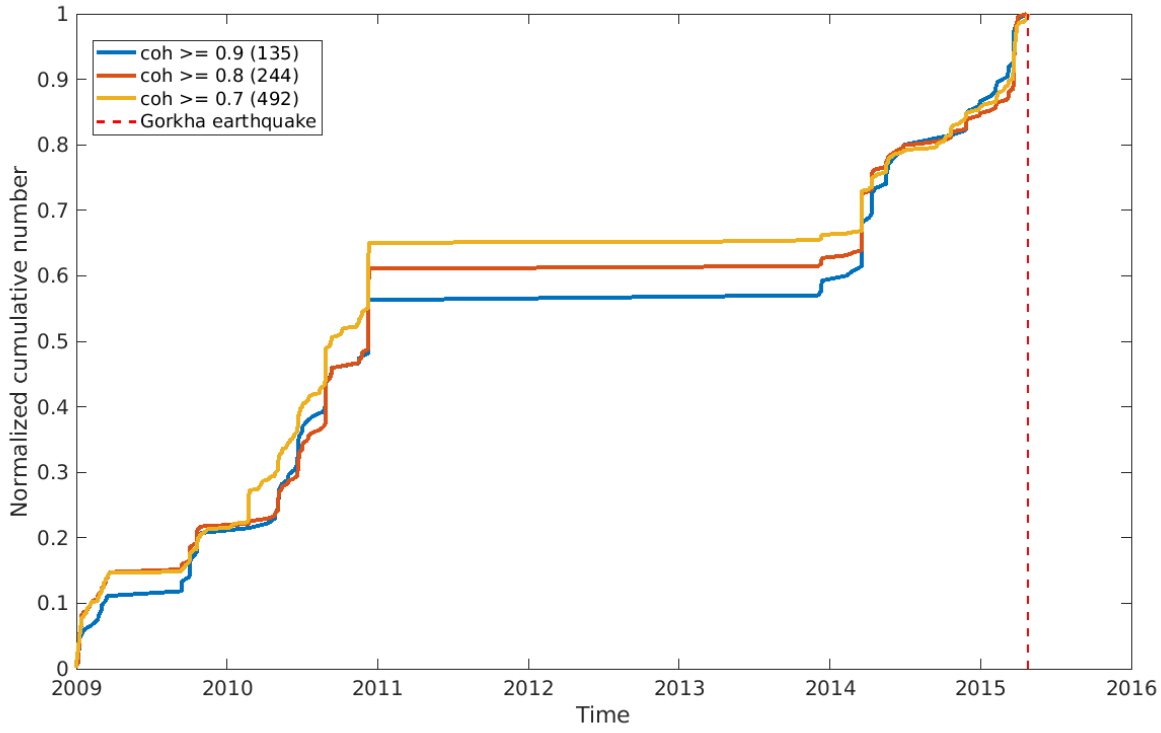

Figure 5 Normalized cumulative number of detected earthquakes for different coherency thresholds. The cumulative number of earthquakes shows very similar trends except for a group in 2010 that disappears at a threshold larger or equal to 0.8. All the other short-term increases in seismicity we detect are still present with higher thresholds, even at 0.9, and are thus robust observations that the detected earthquakes occur close to their detecting templates.

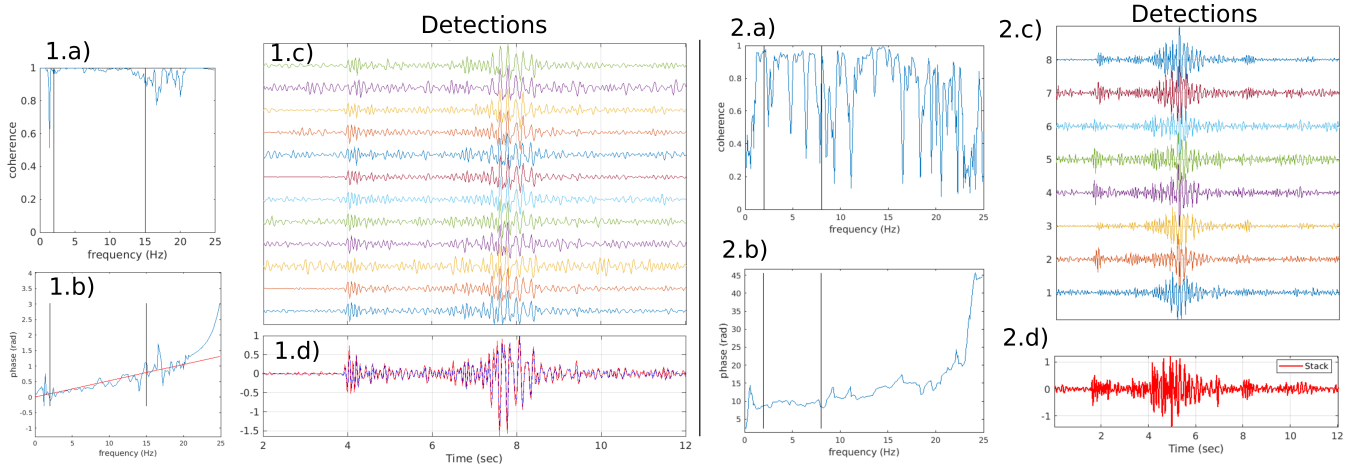

Figure 6 Example of detections made by two templates which show the highest (1) and the lowest (2) coherency values between the templates and their stacks. a) Coherency between the template and the stack of its detections (excluding itself if needed), b) phase, c) waveforms detected by the template, d) stack of the waveforms. The first cluster presents a large coherency between the templates and its stack on a large band of frequency and we see that the waveforms look highly similar one to another. When aligning on the S wave arrivals, the P waves are not well aligned and their arrival varies of 16 samples which corresponds to 0,32 seconds (2c). Assuming a P wave velocity of 6km/s, it corresponds to a distance of about 2km which is below the location uncertainty for the Nepalese catalog (which is 5km).

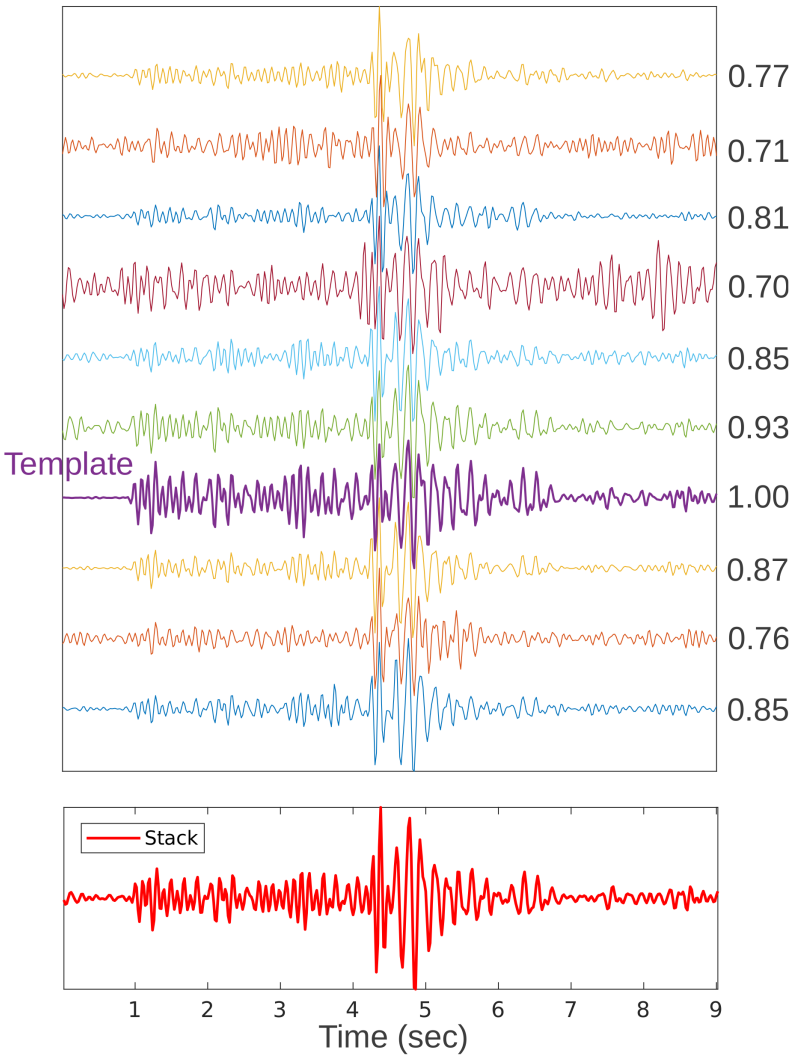

Figure 7 Example of earthquakes detected. Note that the template has detected itself (purple waveform). The correlation value between the template and the detections is given on the right side. Bottom: stack of the newly detected earthquakes.

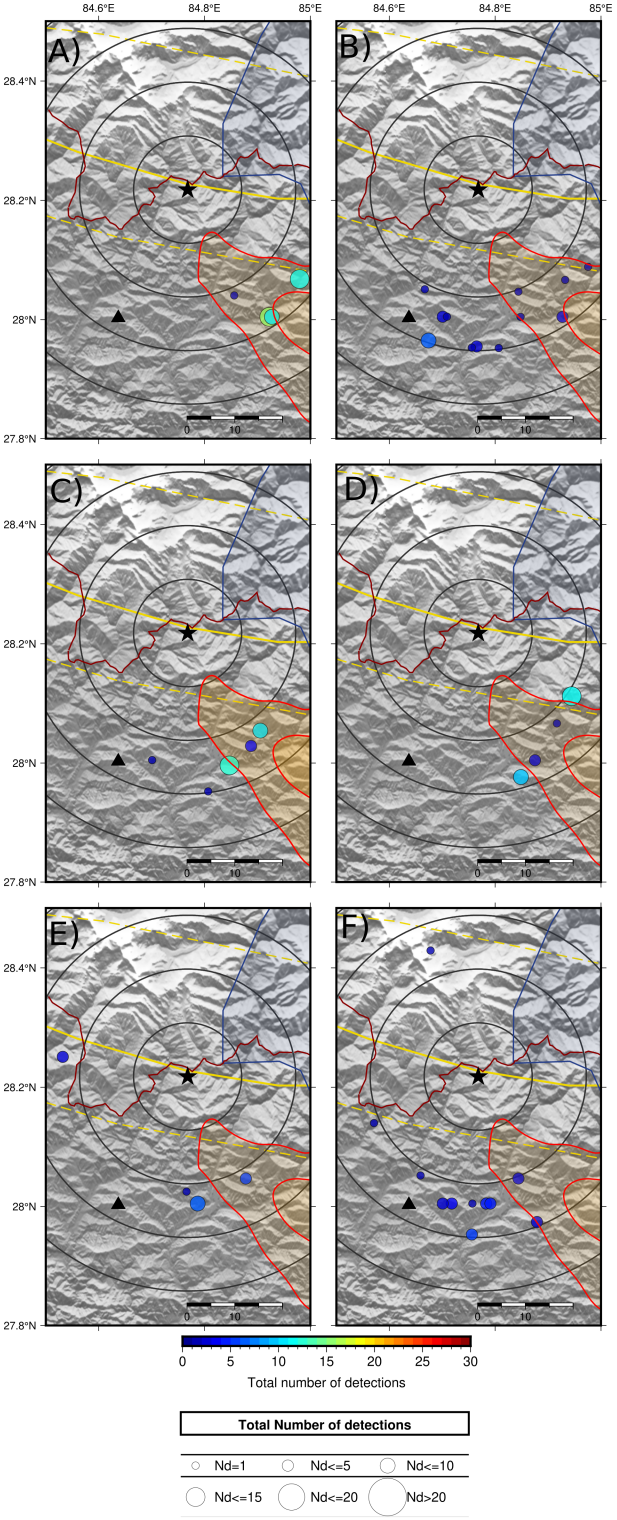

Figure 8 Snapshots of the seismic activity located between 20 to 30km away from the epicenter during the periods of time of Fig.2 middle. If the template detects during the period, it appears on the snapshot color coded with the total number of detections (over the entire period studied, i.e. 2009-April 2015) and the circle size gives the number of detections during the snapshot only. The black star indicates the epicenter of the Gorkha earthquake, the black triangle locates the GKN station the red contour lines its coseismic slip with a 2m interval starting at 2m. a) From 2009/1/1 to 2009/1/25, b) from 2009/9/20 to 2010/8/12, c) from 2010/8/24 to 2010/8/28, d) from the 2010/12/8 to the 2010/12/10, e) from the 2014/3/19 to the 2014/6/1, f) from the 2014/9/16 to the 2015/4/24.

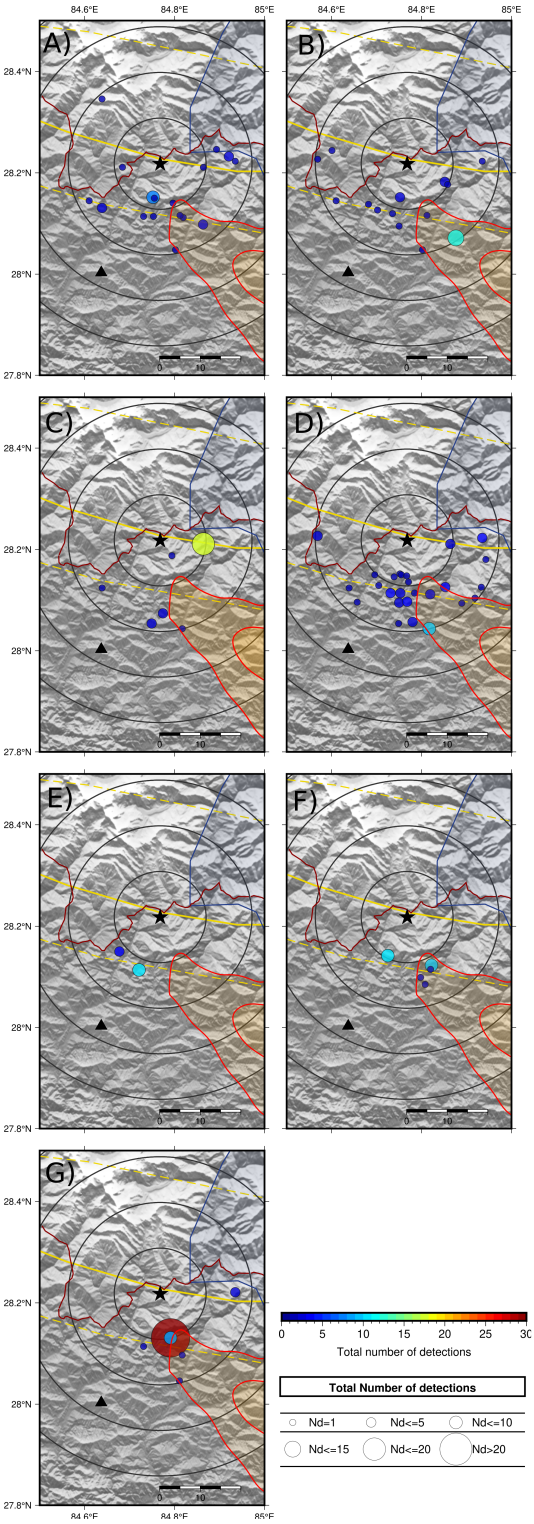

Figure 9 Same as Fig. 8 for the seismic activity located between 0 to 20km away from the epicenter during the periods of time of Fig.2 bottom. a) Period a spans from the 2009/1/2 to the 2009/3/23 with 26 earthquakes and only one cluster of 7 events; b) Period b occurs from the 2009/9/11 to the 2009/11/12 with a total of 25 earthquakes and a cluster of 11 events detected by one template; c) there is an intense seismic activity from the 2010/2/20 to the 2010/2/23 with 21 earthquakes including 16 that occur in only 3.5 hours and are detected by one template (yellow dot in c), 14 of them in only an hour (Fig. 10); d) Period d spans from the 2010/4/26 to the 2010/11/28 with a total of 47 earthquakes that includes only one cluster of 9 detections by one template (lighter blue dot); Periods e and f covers two short-term increases. e) The first one spans from the 2010/12/8 to the 2010/12/10 with one cluster of 10 earthquakes that lasts 2 days; f) the second one lasts 20 hours and starts on the 2014/3/19 at 0h35 with two clusters of 9 and 10 earthquakes detected by two templates (Fig. 11); g) the last period contains two clusters detected by very close-by earthquakes (red and blue dots overlapping), with a total of 38 earthquakes detailed in Fig.4.

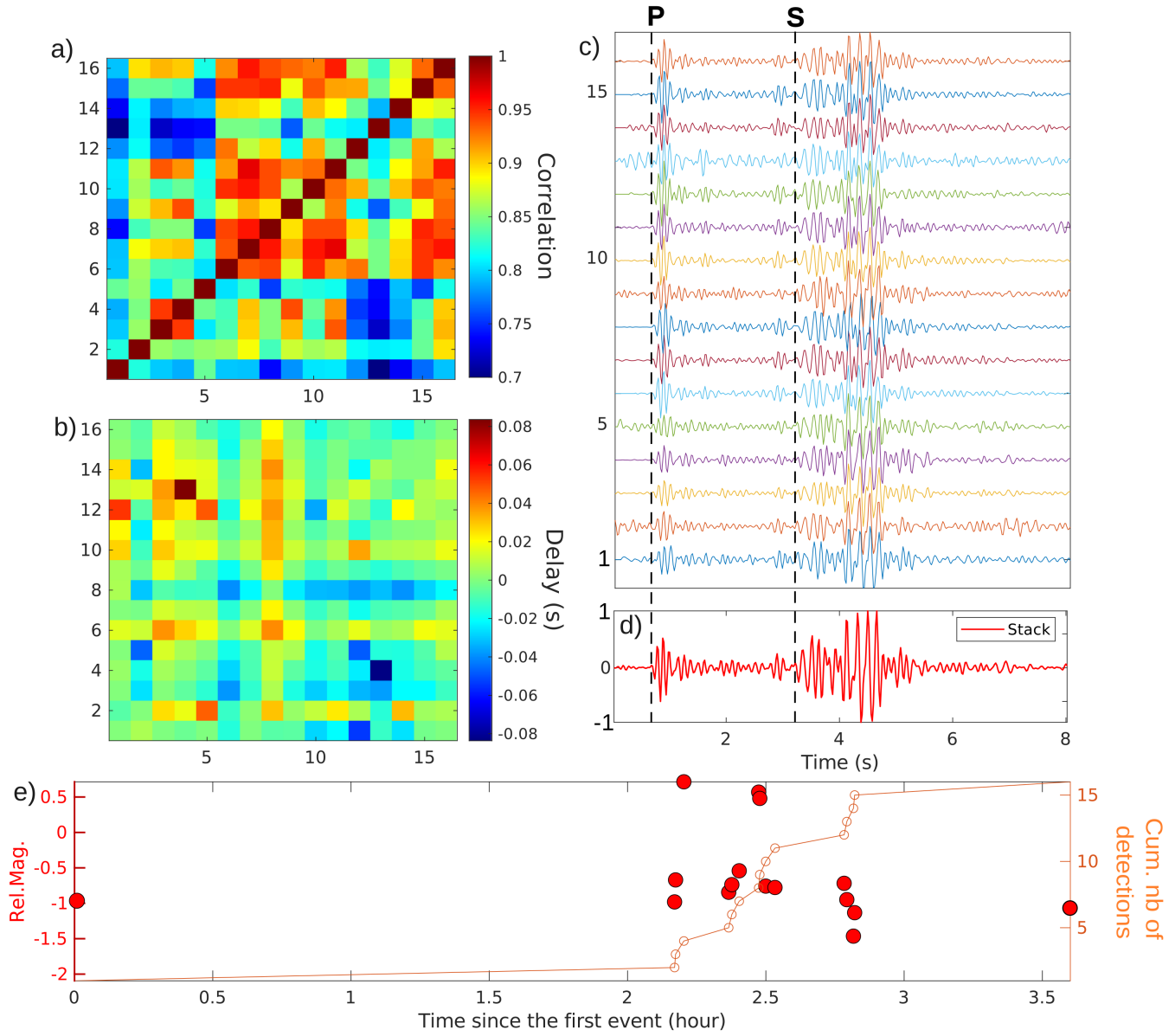

Figure 10 Group of 16 earthquakes detected during 3.5 hours in period c in Fig.2 bottom, on February 21 2010. a) Cross-correlation matrix between the earthquakes b) delay matrix; c) waveforms of the detected earthquakes with their stack at the bottom, d) cumulative number and relative magnitude of events with time with the zero at the occurrence of the first event of the swarm. The cross-correlation values are particularly high and the relative time delays low for the last ten events in the group. Note that the relative magnitudes are small and similar, suggesting that this group may be a seismic swarm.

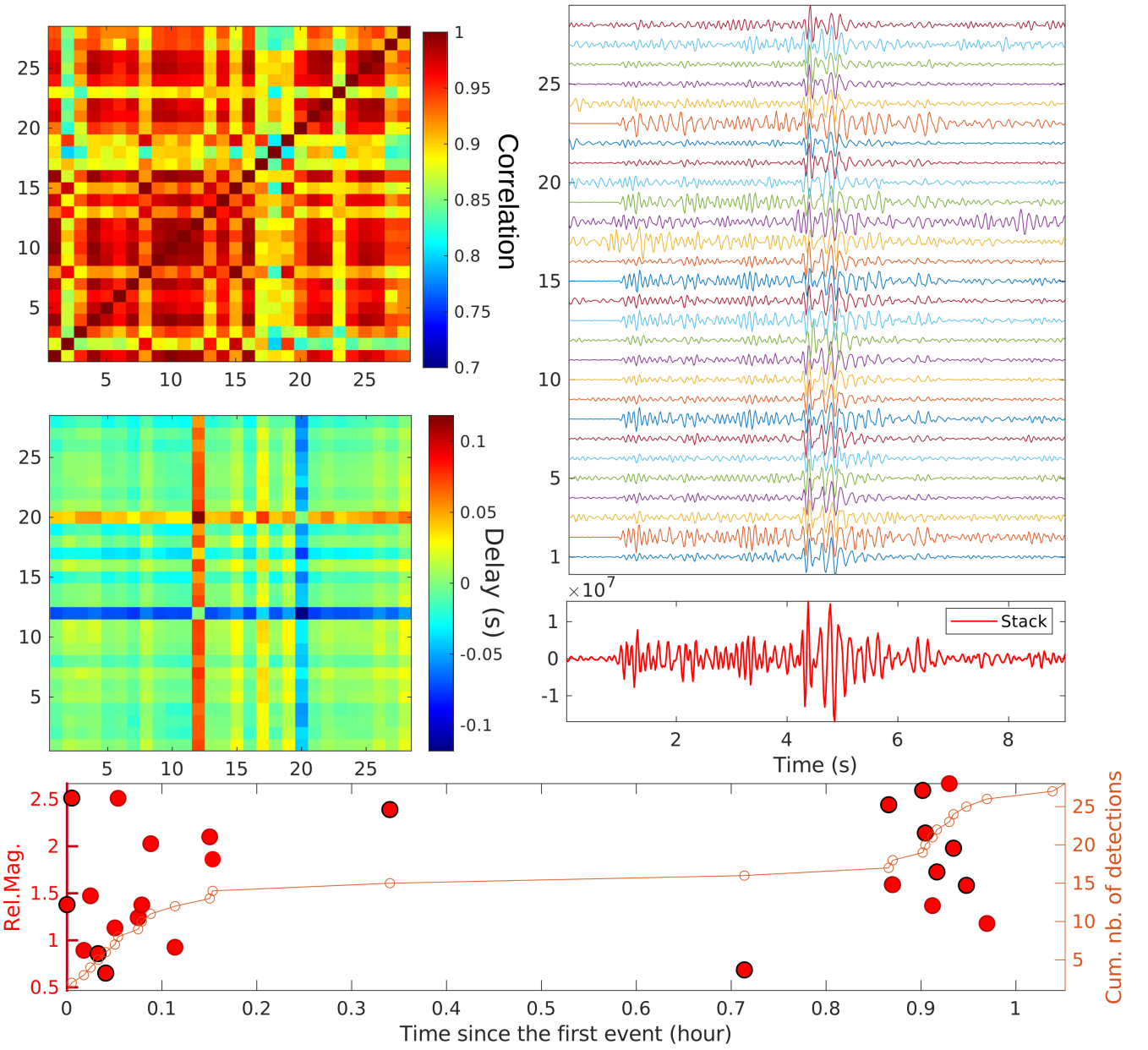

Figure 11 Cluster of 28 earthquakes occurring in period f in Fig.2 bottom just one hour on the 19/03/2014 between 00h35 and 01h39, mainly detected by three templates. a) Cross-correlation matrix between the earthquakes b) delay matrix; c) waveforms of the detected earthquakes with their stack at the bottom, d) cumulative number and relative magnitude of events with time with the zero at the occurrence of the first event of the swarm. The inter-correlation values of this group range from 0.8 to 1 with a mean of 0.91. Some events in the groups have very large cross-correlation values, with a mean of 0.95, possibly indicating that they are repeating earthquakes. Note that there is no dominant magnitude in this very short sequence.

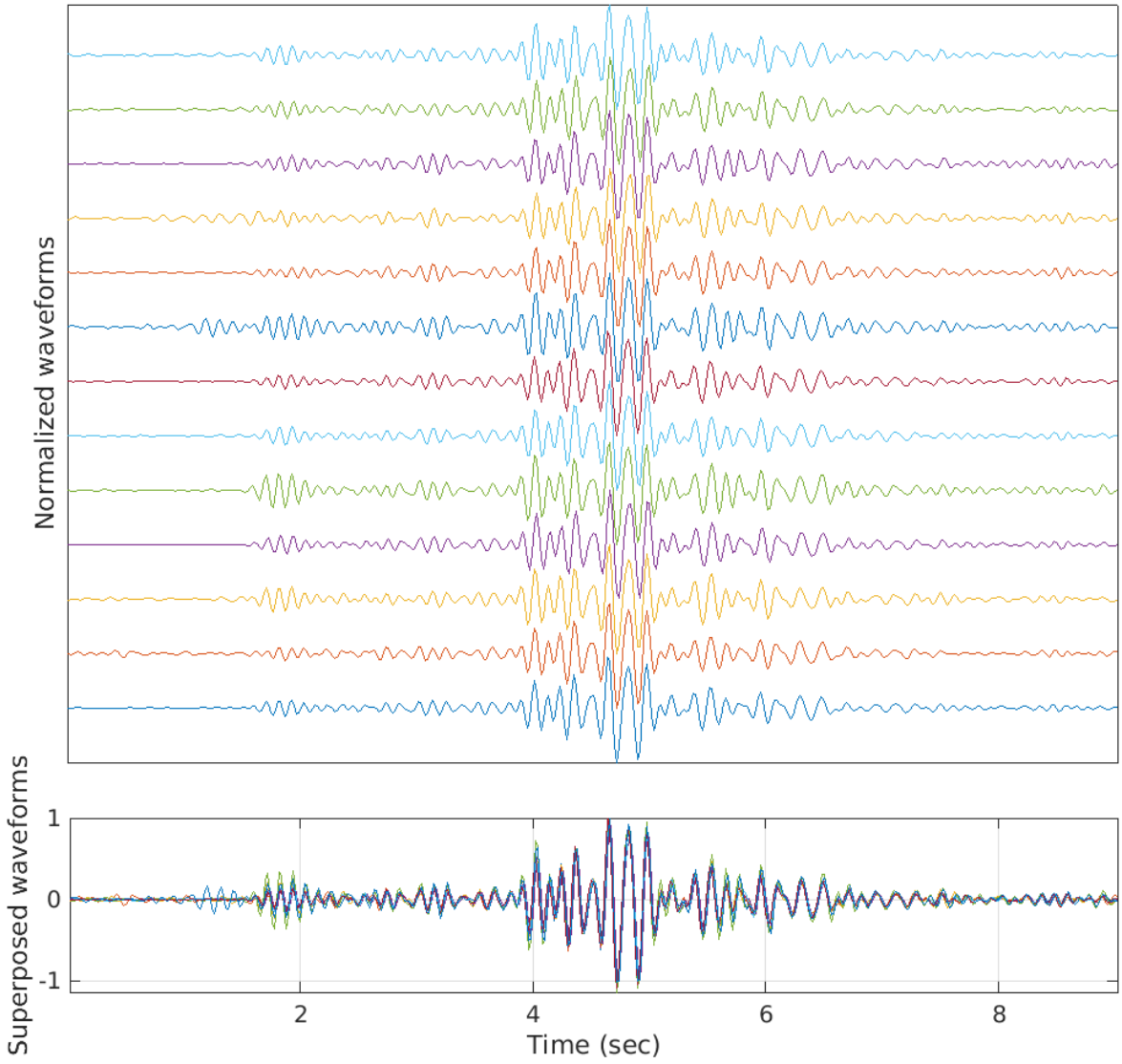

Figure 12 Top: waveforms of the 13 earthquakes that present the largest coherency values in the last cluster shown in Fig.4 with a coherency$>$0.98. Bottom: superpositions of their normalized waveforms.

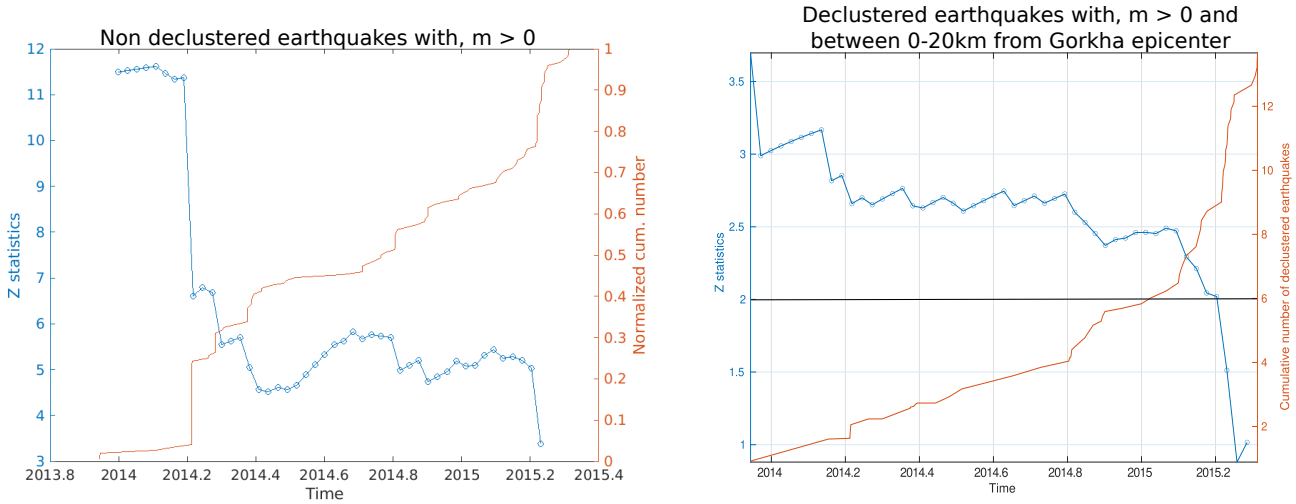

Figure 13 We performed the Z analysis taking different times of change-point from 2013/11/1 to 2015/03/26, every 10 days. As the time of beginning, we took 2013/11/1, when the continuous data are recovered for GKN station. Left: Z statistics analysis for the non-declustered M>0 earthquakes on the 2013/12/1-2015/4/25 period. Right: Z statistics analysis for the M>0 declustered catalogue, for earthquakes on the 2013/12/1-2015/4/25 period, located between 0 to 20km from Gorkha epicenter.

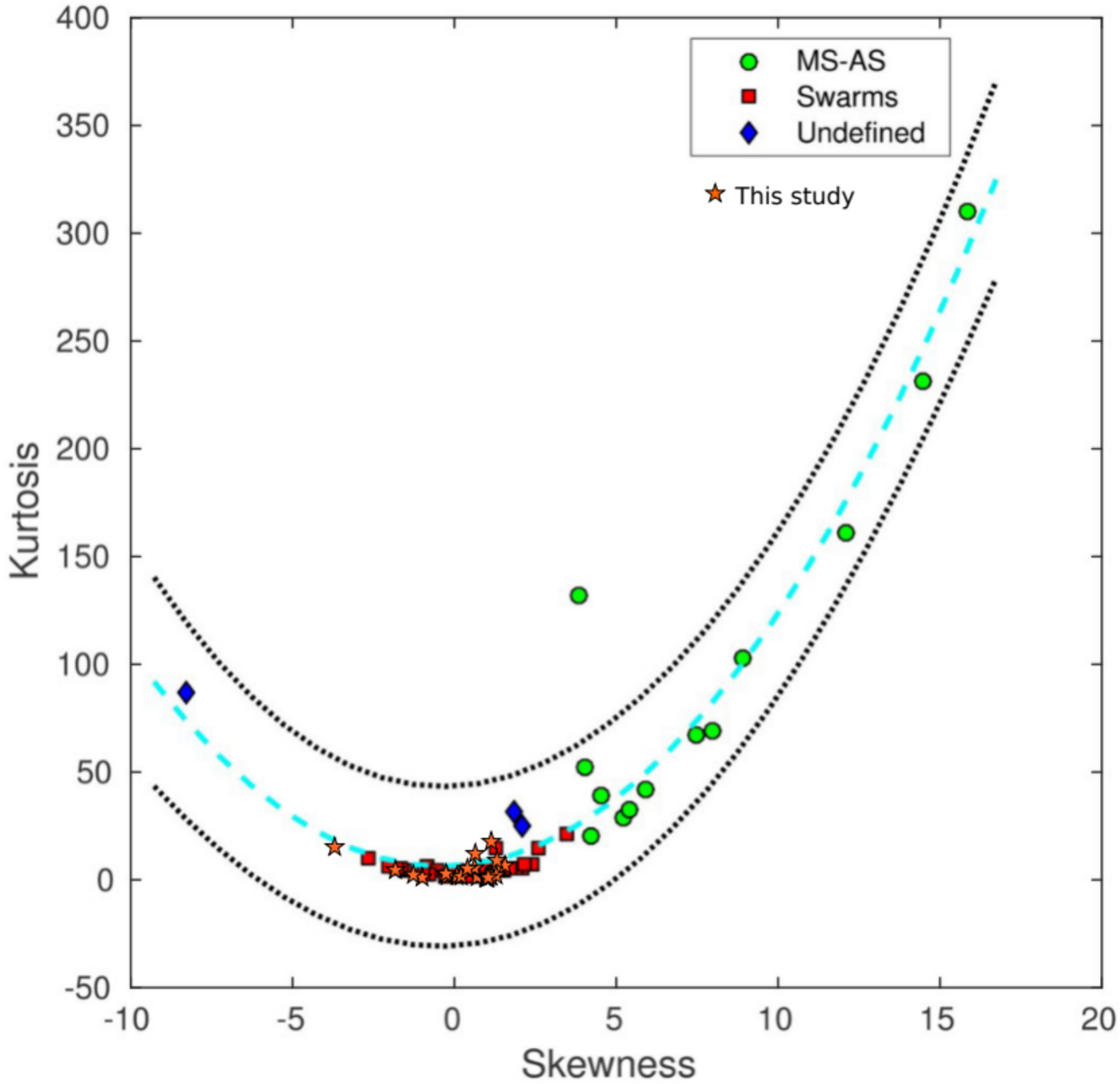

Figure 14 Parabolic relationship between the skewness and kurtosis of the detected swarms. The orange stars represent the clusters analysed in this study, modified from (Mesimeri et al., 2019).