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Pseudo earthquake quiescence following the 2011 M9.0 Tohoku-Oki earthquake

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The large extensional stress perturbations associated with the 11 March 2011 Tohoku-Oki earthquake (magnitude (M) 9.0) [e.g., Ozawa et al., 2011] has boosted widespread increase in seismicity across NE and central Japan [e.g., Kato et al., 2011; Toda et al., 2011; Miyazawa, 2012]. In addition to the induced seismicity, several sequences of earthquake quiescence or sudden reductions of seismicity were reported after the Tohoku-Oki earthquake [e.g., Toda et al., 2011]. However, it has been argued that sudden rate reductions were potentially due to temporal changes in the completeness magnitude threshold of any earthquake catalogue following the immediate aftermath of large mainshock [e.g., Felzer and Brodsky, 2005; Peng and Zhao, 2009]. After the Tohoku mainshock, small magnitude earthquakes tended to be masked by overlapping arrivals of waves from immediately following numerous earthquakes occurred in not only the source region of the Tohoku mainshock but also inland regions.

For example, a seismic cluster broke out on 27 February 2011 in the Hida mountain range (near Norikura), where the present volcanic front is located, and its activity had continued until the Tohoku-Oki mainshock. The representative focal mechanisms are thrust and strike-slip faulting with the P-axis aligned WN-SE direction, which is a typical stress field in this region. Just following the Tohoku mainshock, the seismic activity reported in the JMA catalogue shows earthquake quiescence: one day later the seismicity gradually turned around its previous level. In order to investigate whether this earthquake quiescence is real or not, we applied a matched-filter technique to detect missing events with the use of continuous three-component velocity seismograms recorded by a dense network of continuous and highly-sensitive seismic stations.

In contrast to the JMA catalogue, the seismicity in the cluster has still continued even just after the Tohoku mainshock and seismic quiescence was not observed. We identified a total of several tens of events in the cluster during a time-window when the JMA has not reported any existence of seismic events. Our newly detected catalogue describes the temporal and spatial evolutions of seismicity more precisely. The newly constructed catalogue in the Hida Mountain range (near Norikura) shows that the seismicity increased in the immediate aftermath of the Tohoku mainshock. This rate increase is likely explained by a static-stress transfer model. Thus, the quiescence seen in the JMA catalogue following the Tohoku mainshock is artificial due to temporal increases in the completeness magnitude threshold of the catalogue.