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Automatic detection of low-frequency earthquakes in Southwest Japan using matched-filter technique

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The Japan Meteorological Agency (JMA) has distinguished a class of events marked as low-frequency earthquakes in the JMA's earthquake catalog since 1999 [Nishide et al.,2000]. LFEs have clear isolated S phase with dominant frequencies lower than ordinary earthquakes. The JMA's earthquake catalog has about 24,000 events of tectonic LFEs in the Nankai Trough under Southwest Japan from September 1999 to July 2014. Recent studies [Shelly et al.,2007] insist that tremor in the Nankai Trough consists of a swarm of LFEs that occur as shear faulting on the plate interface. It is thought that watching activity of LFEs is important for supposing the state of the plate interface. However, it is difficult to detect LFEs by STA/LTA ratio, because of the lack of impulsive phase arrivals, used to detect and locate hypocenters of ordinary earthquakes. Therefore, it takes time to locate their hypocenters in same procedure for ordinary earthquakes.

So, a matched-filter technique was used to detect events of tectonic LFEs in Southwest Japan automatically with the use of continuous three-component velocity seismograms at 75 stations. These stations belong to the integrated seismic network of Japan. 1,263 events which are listed in JMA's earthquake catalog are used as template events. In analysis, first 2-8 Hz bandpass filter was applied to templates and continuous seismograms, and these decimated to 20 samples per second. Template is 4 seconds time windows 1.5 seconds before the calculated S phase arrival. Next, the time window of template is shifted around the calculated S phase arrival in an increment of 0.05 second through coutinuous seismograms.At each time point, correlation coefficient value between templates and a part of continuous seismograms are computed , and the sum of correlation coefficient value for all stations is calculated. An event of LFEs can be detected when the sum of correlation coefficient value exceed a threshold. Finally, grid search method is used to make a hypocenter of detected event more precise. As a result of analysis, more events listed in the JMA's earthquake catalog have been detected after July 2014.

Keywords: low-frequency earthquakes, matched-filter technique