The activity of small repeating earthquakes after the 2011 Tohoku-oki earthquake: an examination based on the S-net and land networks

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We examined the activity of repeating earthquakes around the 2011 Tohoku-oki earthquake, Japan based on Seafloor Observation Network for Earthquakes and Tsunamis along the Japan Trench (S-net) and permanent land stations. We used earthquakes located by Japan Meteorological Agency to find repeating earthquakes based on the waveform similarity observed at the same station. The waveform coherences for 40 second window including P and S phases are evaluated and if they are larger than 0.8 we select them as repeating earthquakes. We performed long- and short-term analyses respectively to understand long-term activity change of repeating earthquakes and to compare land-based and offshore (S-net) data analyses. For the long-term analysis, we used earthquakes larger than M2.5 for the period from 1993 to 2018 obtained by the land stations. For the short-term analysis, we analyzed land and S-net stations separately for M2.0 or larger earthquakes for the period from August 2016 to October 2018.

The long-term analysis shows that the coseismic slip area of the 2011 Tohoku-oki earthquake continued to be quiet in the activity of the repeating earthquakes suggesting that the area have not reloaded enough after the earthquake. In the shallow area (depth <= 30km), the activity of repeating earthquakes decay with fluctuations to the north of the coseismic slip but decayed monotonically to the south of the coseismic slip area. In the deep area (depth >= 30km), the repeating earthquake activity also decayed but the activity was still high in 2018 especially in the down-dip part of the coseismic slip area. These results show different behavior of postseismic slip of the Tohoku-oki earthquake.

The short-term analysis that use the same set of earthquakes to detect repeating earthquakes (August 2016 to October 2018, M>=2) by the S-net and the land stations show similar number of detected repeating earthquakes (520 and 684 for S-net and land stations respectively). This is probably because the waveforms of earthquakes that are located by land stations (JMA’s catalogue) have good signal-to-noise ratio for the land stations. Since the completeness of magnitudes of the JMA’s catalogue in far off land area is larger than M2.0, the event detection by S-net will contribute to the detection of more repeating earthquakes in the offshore area. In addition to this, the land-station based long-term analysis has more repeating earthquakes (894 M>=2.5) for the 2.2-year period of the S-net data analysis, suggesting the increase of observation period will contribute for the detection of repeating earthquakes whose intervals are larger than the short analysis period .

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Keywords: repeating earthquakes, S-net, slow slip

