Spaciotemporal change of source parameters of repeaters due to the 2011 Tohoku-Oki earthquake

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A number of small to moderate repeating earthquakes occur at the upper boundary of subducting Pacific plate in NE Japan. Understanding the source characteristics of repeating earthquakes and their spaciotemporal changes give us insight about the loading rate and its variation due to the plate motion and physical mechanisms of earthquakes, which can be common with major earthquakes because they would have the same occurrence structure as the small repeaters. In this study, we investigated the spatiotemporal change of source parameters of repeating earthquakes occurred on the Pacific interplate before and after the 2011 Tohoku-Oki earthquake. We analyzed seismic waveforms from about 3,000 repeating earthquake groups and about 7,000 repeating earthquakes in total. In this study, we show the results obtained by analysis of repeaters located off-Kamaishi and near Iwaizumi, Iwate, NE Japan.
In off-Kamaishi, repeaters are observed in a very constant recurrence cycle (~5.5 yr) and magnitude (~4.9) before the Tohoku-Oki earthquake, however, the recurrence interval was extremely shortened and the size of the earthquake was substantially enlarged immediately after the Tohoku-Oki earthquake. The recurrence interval and magnitude are becoming close to those of before the Tohoku-Oki earthquake with time. Although stress drop calculated with spectral ratio method is about 14 MPa before the Tohoku-Oki earthquake, it is estimated that stress drop after the Tohoku-Oki earthquake became smaller than before to have roughly a constant value (~2 MPa). The radius of ruptured fault estimated from corner frequency become about 5 times larger just after the Tohoku-Oki earthquake and later it became about 1 km. The radius of rupture fault of post-Tohoku events is becoming close to that of pre-Tohoku event with time. These results agree with Uchida et al. (2015) that estimated the rupture area of off-Kamaishi sequence by slip inversion. We consider that these changes of source parameters before and after the Tohoku-Oki earthquake are caused by its afterslip.
On the other hand, the repeating earthquake sequences in Iwaizumi does not have obvious changes in magnitude and stress drop before and after the Tohoku-Oki earthquake. If this region was less affected by afterslip than off-Kamaishi, small aftership might make the difference from the results of off-Kamaishi. We found the directivity estimated from corner frequency is observed only for repeaters of M<4, which indicates these small repeating earthquakes are composed of complex rupture. As it was suggested that repeaters of Iwaizumi sometimes rupture multiple patches in previous study (Arao et al., 2007), such complexities in rupture and the interaction between small ruptures would affect the recurrence of repeaters.

