

Spatio-temporal clustering of successive earthquakes in Japan: analyses of F-net catalogue

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This study analyzes small earthquakes closely occurring in space and time in Japan in order to clarify their characteristics. We group the earthquakes that occur in a given space-time window from a target earthquake into a cluster (i.e., a group of the earthquakes successively occurring), and count the number of the clusters. To examine whether or not these successive earthquakes occur randomly, we compare the results with simulations in which earthquakes are set to randomly occur in time (but same in locations). We analyze shallow earthquakes with depths of ≤ 70 km from Full Range Seismograph Network of Japan (F-net) for the period from 1998 to 2018 with magnitudes ($3.0 \leq M_w < 5.5$). To significantly reduce the possibility to include so called aftershocks of a very large earthquake among successive earthquakes, we divide our catalogue in two sub-catalogues: pre-Tohoku oki earthquake (from 1998 to 2010) and post-Tohoku oki earthquake (from 2012 to 2018) catalogues. The results show that, within 365 days, successive earthquakes occurring close to the target fault account for about 2% of the total number of earthquakes around Japan for both cases. However, successive earthquakes occurred before Tohoku earthquake shows homogeneous spatial distribution of clusters around Japan while those occurring after Tohoku earthquake are mainly concentrated along the Pacific coast and Kyushu island. We then compare the results to those that were previously determined from the global CMT catalogue for the period from 1976 to 2016 (Bantidi and Nishimura, AGU 2019) and JMA catalogue for the period from 1998 to 2017 (Bantidi and Nishimura, SSJ 2019). The results show an eminent homogeneity of spatial clustering behaviors around Japan for both global and regional catalogues; and the spatio-temporal distribution of cumulative number of clusters exhibit similar features in logarithmic scale. Earthquakes in the magnitude range $5.0 \leq M_w < 5.5$, are found to be triggered at the distance between 40 - 160 km and 50 - 180 km in F-net catalogue for pre- and post-Tohoku sub-catalogues respectively, those are between 50 - 130 km in JMA catalogue and 55 - 168 km in the CMT catalogue within 365 days. Furthermore, the triggering distance are roughly proportional to the cube root of the seismic moment. These consistencies in magnitude -triggering distance dependence suggest that static stress change is likely involved in the generation process of successive earthquakes.

Keywords: Spatio-temporal clustering, successive occurrence, triggering distance, earthquake generation process