Spatio-temporal clustering of successive earthquakes: data analyses of global data.

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Spatio-temporal clustering of seismicity is an interesting phenomenon in the earthquake generation process. We investigate the earthquakes closely occurring in space and time, which have been sometimes observed at various regions. A recent example is *Mw*6.5 earthquake at Hinagu active fault on April 14, 2016, followed by a *Mw*7.3 at Futagawa active fault on April 16. The present study analyzes moderate and large earthquakes to clarify characteristics of such successive occurrence of earthquakes.

We use the Global Centroid Moment Tensor catalog for the period from 1976 to 2016. Earthquakes with moment magnitudes (*Mw*) of larger or equal to 5.0 and with depths less than or equal to 70 km are analyzed. The earthquakes that occur within some horizontal distance ranges (Δd: from 10 to 500 km), and lapse times (Δt=30, 180 and 365 days) from the occurrence of each target earthquake is grouped in a cluster, and the number of clusters are counted.

The results show that cumulative numbers of clusters almost constantly increase in the logarithmic scale with increasing Δt, and the number of clusters increases constantly in general with increasing Δd. For example, for the *Mw* 5.0 –5.5, the cumulative number of clusters at $\Delta d=100$ km are 3177, 4525 and 4808, respectively, for Δt of 30, 180 and 365 days.

To examine whether or not these successive earthquakes occur randomly, in other words, whether or not these successive earthquakes occur under some physical conditions, we compare the observed results with simulations in which earthquakes are set to randomly occur in time. The results show that the observed cumulative numbers of clusters are larger than those of simulation in short distance ranges. The former gradually approach to the latter with increasing the horizontal distance, and merge into a same number at a distance, which is defined as "triggering distance" in the present study. As Δt increases, the occurrence probability decreases and approaches to the normal condition in which the occurrence time intervals of earthquakes obey a Poisson distribution. For example, the triggering distances of Mw5.0-5.5 are 420 km and 66 km, respectively, for $\Delta t=30$ days and *365* days. The results obtained by changing the parameters related to the spatial and temporal distributions of aftershock show no significant difference in the number of clusters and triggering distances.

Keywords: Clustering, Successive earthquakes, Triggering distance

