Analyses of the temporal change in size distribution of the earthquakes without using “moving window”

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Since the usual methods for estimating temporal change in Gutenberg-Richter(GR)'s *b* value uses a “moving window” comprises a fixed number of events, the results necessarily show averaged characteristics of seismicity in a fixed spatiotemporal range with fixed estimation error mainly dependent on the width of the window. These methods are useful especially in the case where the spatiotemporal scale of targeted phenomena is clear and the seismicity rate is almost constant and suitable for the scale. However, since the seismicity rate can be too low or too high depending on its history, spatial- or temporal-scale sometimes comes to too large or too small unintentionally. Therefore, some methods for estimating temporal change in b value without using “moving window” can be the alternative tool especially in terms of the seismicity monitoring which targets any unusual change.

In the presentation, 2 different methods to estimate temporal change in b value without using “moving window”, estimating the Fourier amplitudes and the cumulative magnitudes respectively, are shown. Both methods are based on the idea that the change in b value can be estimated as change in average magnitude since the most likelihood estimation of b value corresponds to the inverse of average magnitude as long as GR relation holds. Since the Fourier amplitude of magnitude data contains information of periodic change of average magnitude and also that of seismic rate, the former information can be obtained by subtracting the latter, that is, the Fourier amplitude of averaged timeseries data having constant amplitude of the average of all original magnitude data and the same timestamp as the original magnitude data. The cumulative magnitudes can be used to monitoring the change in average magnitude more directly because the trend of the cumulative magnitudes plotted against event number is average magnitude itself. With some simulated data generated randomly assuming poison process and GR relation with periodic change of b value, the 2 methods show expected performance.

These methods have been applied to shallow inland earthquakes in the JMA unified earthquake catalogue. Although the Fourier amplitude of all magnitude of shallow inland earthquakes except for those around hypocenter of earthquakes whose magnitude is larger than 5 shows daily, weekly and annual change of seismic rate and average magnitude probably caused by the change of noise level of seismometers, no clear frequency components in the average amplitude has been observed in the case where the lower limit of magnitude is 0.8 or larger. Instead, a weak low-frequency broadband component of changes in average magnitude has been observed. On the other hand, the trend of cumulative magnitudes around hypocenters of earthquakes whose magnitude is larger than 4 shows a tendency to decrease after the centered earthquakes occurred. These results suggest that the earthquakes themselves affect the characteristic of the surrounding seismicity.

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