Earthquake nowcasting: further development and application to Japan

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We adopted and further developed the earthquake nowcasting method (Rundle et al., 2016). This method determines the current state of the fault system in a predefined region and its current level of progress through the earthquake cycle, using only empirical data: magnitudes (M) and times of earthquakes in the region. The characteristic is that the method does not involve any model other than the idea of an earthquake cycle. We performed a case study from southern Kanto, using the earthquake catalog maintained by Japan Meteorological Agency (JMA). Two earthquake magnitudes are selected, one large ($M \geqq M_L$), and one small ($M \geqq M_S$), where $M_L > M_S$. The method utilizes the number of small earthquakes that occurs between pairs of large earthquakes. The cumulative probability distribution of these values is obtained. The earthquake potential score (EPS), an index of the current level of the progress through the earthquake cycle, is defined by the “natural time”, the number of small earthquakes that has occurred since the last large earthquake, the point where this number falls on the cumulative probability distribution. For southern Kanto, we used earthquakes since 1926 with depths shallower than 150 km and set M_L=6.0 and M_S=4.2. The obtained result as of December 20, 2018 is EPS of 8%. This is interpreted as an indication that if a large (M6+) earthquake occurred on this date, the recurrence interval would be relatively short. Errors that arise from statistics-based estimation such as this must be considered so that we introduced the calculation of uncertainties to the earthquake nowcasting, using a bootstrap approach. Taking into account the contribution of these errors to the EPS calculations, we conclude that the earthquake nowcasting generates stable estimates of EPS for southern Kanto (Nanjo, 2018). To check the stability estimation for other regions, we computed EPS and its uncertainty for selected regions in Japan. We also discuss a technique of spatial mapping of EPS over the Japan’s mainlands. This technique allows us to move towards a full description of current EPS as a function of space, providing possible usability for ranking locations on the earthquake hazard.

キーワード：ナウキャスティング、地震、ナチュラルタイム
Keywords: nowcasting, earthquake, natural time

