Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

SSS024-06 Room:301A Time:May 27 10:45-11:00

Identification of Predictive Foreshock Activity by Statistical Method along the Japan Trench

Kenji Maeda[1*], Fuyuki Hirose[1]

[1]Meteorological Research Institute

Foreshocks have been thought one of the most promising phenomena to predict large earthquakes. However, foreshocks are mostly found after a large earthquake occurred and it is very difficult to distinguish them deterministically from background seismicity before a mainshock occurs. Therefore, probabilistic approach is realistic way to use foreshock activity as a precursor of a mainshock. So, we investigate probabilistic features of foreshocks and search for effective parameters to define foreshocks which present relatively high performance to predict large earthquakes. Maeda (1996) once proposed a foreshock definition which gives relatively high performance to predict large earthquakes. We basically apply the same method as Maeda (1996) to the data from 1980 to 1993 using the new JMA hypocenter catalog in which the magnitude was revised in 2003, and reevaluated the parameters to define an effective foreshock activity. We also evaluated the results when the method was applied to the testing period from 1994 to 2009.

The method to select parameters for foreshocks that present high prediction performance consists of four steps. 1) To use the data in which small aftershocks are eliminated. 2) To define a foreshock candidate as the activity that has number of Nf earthquakes with magnitude >= Mf during the period of Tf days in the segment of the size of D x D degree (latitude x longitude). 3) If a mainshock occurs in the period of Ta days after a foreshock candidate occurs, that candidate is treated as true foreshock(s). 4) To search for the values of Mf, D, Nf, and Ta which give high prediction performance by the grid search method. The prediction performance is measured mainly by dAIC, which is defined as the AIC difference between a stationary Poisson model and a model using a foreshock activity, and additionally by alarm rate (AR), truth rate (TR), and probability gain (PG). By applying the above method to the earthquakes occurred in the period of 1980 ? 1993 in the sea area of the northeastern part of Japan, we obtain the best parameters of Mf=5.0 D=0.5, Nf=3, and Ta=3 days for the prediction of mainshocks with M>=6. The prediction performance is expressed as dAIC=74, AR=13% (7/55), TR=19% (9/47), and PG=589. We also found that there is a strong regionality of the foreshock activity and foreshocks defined above are observed only in the regions of off Ibaraki, off Miyagi, and off Iwate prefectures. This suggests that the foreshock activity defined here is not effective in other regions. The performance for these three regions are dAIC=75, AR=58% (7/12), TR=38% (9/24), and PG=458. When we applied this foreshock definition to the data in the period 1994-2009 in three regions, we got the result as dAIC=8, AR=14% (1/7), TR=17% (1/6), and PG=461, which is not so good as expected. The total performance for the period 1980 ? 2009 is dAIC=87, AR=42% (8/19), TR=33% (10/30), and PG=554.

As for off Ibaraki region where characteristic earthquakes with magnitude of 6.7 to 7.2 are known to occur recurrently with the period about 21 years, the long-term probability based on the periodicity is pronounced by Earthquake Research Committee (2009). If we combine the long-term prediction and a foreshock activity defined here, we can make more appropriate prediction. The idea of probability gain will give the total probability. When a foreshock candidate occurs just after the large earthquake, the total probability does not become high, but when one occurs in the period near the next large earthquake, it rises drastically.

Keywords: foreshocks, statistical method, probability gain, along the Japan trench, alarm rate, trueth rate