Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SSS02-P01 Room:Convention Hall Time:May 21 18:15-19:30

A Revision of the National Observation and Research Program for the Prediction of Earthquakes and Volcanic Eruptions

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On 28 November 2012, the Council for Science and Technology recommended the revision of the National Observation and Research Program for the Prediction of Earthquakes and Volcanic Eruptions, which has started since 2009 as a basic 5-year research program, to the government including the Minister of Education, Culture, Sports, Science.

The basic 5-year research program aims to respond to a social demand for the mitigation of earthquake and volcanic disasters. The 2011 Off the Pacific Coast of Tohoku Earthquake, which is referred to as the Tohoku-oki earthquake, occurred on 11 March 2011 just when the current 5-year program almost ended its second year. The Council for Science and Technology decided to review the current program to ensure that it would be addressing, adequately, the research on extremely large earthquakes with a magnitude (M) of 9.0 or greater, such as the Tohoku-oki earthquake. Currently significant post-seismic crustal deformations of the Tohoku-oki earthquake are still going on. These may be associated with large aftershocks and volcanic eruptions yet to come. Thus, we need urgent revision of the current research program to include researches of the extremely large earthquakes.

The Council for Science and Technology started the revision of the program to include a new research to understand the extremely large earthquake and related activities in the crust and the mantle. The program also includes researches for forecasting seismic hazards generated by the extremely large earthquakes such as a large tsunami. This revised program will be conducted until the end of FY2013 (March 2014). In this presentation, we will report a basic idea and an outline of the revised program.

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Three-dimensional earthquake forecasting model for the Kanto district

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We started a research for constructing a 3-dimensional (3D) earthquake forecasting model for the Kanto district in Japan based on Collaboratory for the Study of Earthquake Predictability (CSEP) experiments under the Special Project for Reducing Vulnerability for Urban Mega Earthquake Disasters. Because seismicity in this area ranges from shallower part to a depth of 80 km due to subducting Philippine Sea plate and Pacific plate, we need to study effect of earthquake depth distribution. We are developing forecasting models based on the results of 2D modeling. In the first step of the study, we set up evaluation tests with the latest version within the CSEP study. Next, we defined the 3D - forecasting area in the Kanto region with a grid of horizontal 0.1 x 0.1 degrees and every 10 km in a depth from 0 km to 100 km. Then, the 3D forecasting model was compared with a 2D area with non-divided column from 0 km to100 km in a depth. For example, RI10k model (Nanjo, 2010) forecasted with high expectations of earthquakes at the Izu peninsula with the depth of 0 ? 10 km and off Choshi areas with 40 ? 50 km for 3 month testing class, which demonstrated that the forecasts were reflected on depth distribution of past seismicity. The logarithm of likelihood of RI10k model on the 3D forecasting area was much better than that of 2D one indicating that 3D forecasting area considering depth distribution improved the performance of forecasting. The RI model with the smoothing radii of 5 - 10 km showed the best performance of forecasting in the 3D forecasting area from testing results of 5 rounds.

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Keywords: 3-dimensional forecasting model, Kanto district, Collaboratory for the Study of Earthquake Predictability

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Testing the probability forecasts in 2011 for small interplate repeating earthquakes along the Japan Trench

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1. Introduction

A lot of sequences of small repeating earthquakes, SREs, with nearly identical waveform have been found near the east coast of NE Japan. These events in a sequence are considered to occur on the same small asperity surrounded by creeping zone on the plate boundary along the Japan Trench (Igarashi et al., 2003; Uchida et al., 2003). In 2006 we started the prospective binary forecasts for forthcoming events, using a Bayesian model (Okada et al., 2012). The probabilities in 2011 for the 183 SRE sequences were computed from the data by the end of 2010 and posted on a web site for impartial testing. The great earthquake of Mw 9.0 on March 11, 2011, followed by large afterslip, have caused great change of the activity of SREs, therefore the consistency of the probabilities with catalog data were considerably bad, but not the worst case among five experiments.

2. Model for forecast

We calculated the conditional probability for specified repeating event in the sequence during the forecast period from January 1 to December 31, 2011, using a Bayesian approach with lognormal distribution, LN-Bayes, for inter-event time on renewal process. The prior distribution is uniform and inverse gamma for the mean and variance of logarithm of inter-event time, respectively. Parameters in inverse gamma prior distribution were given individually for three sub-regions. Alternative probabilities were computed with the lognormal distribution model based on the small sample theory, LN-SST, and the exponential distribution model on the Poisson process, EXP. The probabilities by the three models were statistically compared to each other by the R-test.

3. Forecasts and Testing

85 of 183 sequences were filled with qualifying events in 2011, which were surely larger number than the expectation of forecast, 71.4. The forecast scores in mean log-likelihood, MLL, and Brier score, BS, are -0.596 and 0.200, respectively. They are slightly worse than not only the averages of earlier four experiments, MLL=-0.570 and BS=0.194, but also those for the precipitation seven day forecast at Tokyo in recent years, MLL=-0.548 and BS=0.184. The N-test as well as the L-test rejected statistically the validity of probabilities at the 0.95 significance level, but accepted at the 0.99 level. The R-tests revealed that our forecast model was significantly superior to EXP of MLL=-0.651 and LN-SST of MLL=-0.642.

4. Discussion

In the earlier experiments we used the model of LN-Bayes with a common prior distribution for whole region. If we computed probabilities for 2011 with the same model as the 2010 experiment, the MLL would be -0.608. The R-test shows that the 2011 model with the areal variety in parameter is statistically better than the one of 2010. But we consider that the seismic activity in 2011 is too strongly affected by the great event of Mw9.0 to confirm the effect of the areal variety on forecast.

The number of the SREs in each sequence within one year was mostly 0 or one and two was a rare case in earlier experiments. In the case of 2011 experiment 29 sequences were filled with two or more qualifying events. From the areal distribution of those sequences we found that the sequences in the north of 40.5 degrees N did not have such multiple events. In the source area of the great earthquake of Mw 9.0 the SRE did not become active apparently, probably due to the change of stress field around the small asperities. In the other areas the SRE occurrence became more frequently after the great earthquake. In the area near Sanriku coast the activation of SRE was remarkably high due to the afterslip following the great earthquake.

Keywords: small repeating earthquake, forecast, probability, testing, great earthquake