Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS01-P01 Room:Convention Hall Time:May 24 18:15-19:30

Overview of Widespread Seismicity Changes inland Japan Following the 2011 Tohoku-Oki Earthquake and Its Interpretation

ISHIBE, Takeo[1*]

[1]Earthquake Research Institute, the University of Tokyo

This paper overviews the widespread changes in seismicity rate and distribution of focal mechanism after the Tohoku-Oki earthquake (Mw9.0) and summarize possible contributing factors.

In the Tohoku region, significant increases in seismicity rate were observed in N. and S. Akita, SW off Oga peninsula, and Yamagata/Fukushima boundary area as well as other surrounding areas. The most activated area was the Ibaraki/Fukushima boundary area where shallow normal-faulting earthquakes abruptly began to occur. On the other hand, swarm-like activity in the south of Lake Inawashiro suddenly terminated following the Tohoku-Oki earthquake. In addition, aftershock activities in the source regions of recent large earthquakes such as the 2008 Iwate-Miyagi earthquake (M_{JMA}7.0) have been suppressed. Focal mechanism distributions also showed significant changes in the shallow crust of the Tohoku region; strike-slip and normal-faulting earthquakes were activated following the Tohoku-Oki earthquake, while thrust-faulting earthquakes, which had been predominant due to the compression in the E-W direction, were deactivated.

In the Kanto region, abrupt increases in seismicity rate of the shallow crustal areas were typically observed in the Tochigi/Gunma and Ibaraki/Chiba boundary areas, SE Chiba near Choshi City, N. Tokyo Bay area, SE part of Boso peninsula, Tanzawa, Hakone, and Izu areas. Furthermore, two moderate earthquakes (the earthquake near the prefectural boundary between Nagano and Niigata (M_{JMA}6.7) on March 12th and the earthquake in the E. Shizuoka prefecture (M_{JMA}6.2) on March 15th) occurred. At intermediate depths, interplate earthquakes associated with the subduction of the Philippine Sea Plate (PHS) and the Pacific Plate (PAC) were activated, especially in SW Ibaraki, NE, NW, and SE Chiba areas. Belt-like seismicity that extended from the S. Miura Peninsula to the SW off Chiba area through the S. Boso peninsula, at a depth of 60-70 km, was also activated.

The most plausible factor which caused the changes in seismicity is the static changes in the Coulomb stress transferred by the Tohoku-Oki earthquake which make it possible to retrospectively forecast the changes in seismicity on some level. However, some activated seismicity showed clear counter-evidence. A typical example is a thrust-faulting earthquake sequence which started one week after the mainshock in Yamagata/Fukushima boundary area. The calculated stress changes were negative for most of focal mechanisms of post-Tohoku earthquakes.

Many remotely triggered local events, whose origin times are well coincided with the arrival of seismic waves from the Tohoku-Oki earthquake, suggest that dynamic stress changes due to the passage of seismic waves also contribute seismicity changes. Some swarm-like activities induced by the Tohoku-Oki earthquake such as those in the Yamagata/Fukushima boundary clearly show temporal expansion of the focal area, which is attributed to fluid diffusion. It suggests that pore fluid pressure changes are another possible factor because decreases in failure strength due to increases in pore fluid pressure can also enhance the faulting. The contribution of indirectly triggered earthquakes might be very important in some areas because stress changes imparted by neighboring indirect aftershocks could be comparable with or larger than those from a distant mainshock. Postseisimc slip now observed by GEONET and viscoelastic effect would play an important role for long-term seismicity rate change.

Acknowledgements
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Keywords: 2011 Tohoku-Oki earthquake, Seismicity change, Static and dynamic stress changes, Pore fluid pressure change, Postseismic slip, Viscoelastic effects

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Three-dimensional earthquake forecasting model for the Kanto district:Results of retrospective and prospective tests

YOKOI, Sayoko[1*] ; TSURUOKA, Hiroshi[1] ; HIRATA, Naoshi[1]

[1]Earthquake Research Institute, Univ. Tokyo

We constructed a 3-dimensional (3D) earthquake forecasting model for the Kanto district in Japan under the Special Project for Reducing Vulnerability for Urban Mega Earthquake Disasters. This is based on the Collaboratory for the Study of Earthquake Predictability (CSEP) experiments. Because seismicity in this area ranges from shallower part to a depth of 80 km due to subducting Philippine-Sea and Pacific plates, we needed to study the effect of earthquake depth distribution. We constructed a prototype of 3D earthquake forecasting model for the area based on the Relative Intensity (RI) model (Nanjo, 2011) [EPS, 63 (3) 261-274] which forecasts earthquake probabilities using historical data. Therefore, we analyzed completeness magnitude (Mc) of Japan Meteorological Agency (JMA) catalog by the Maximum curvature method (Wiemer and Wyss, 2000) [BSSA, 90 (4) 859-869]. The results showed that Mc has been temporally-stable having values less than M 2 since 1980s. Then, we performed retrospective tests using JMA catalog from 1 January 1998 to 1 February 2011 to examine spatial resolution of 3D forecasting area for Kanto region. Results showed that the best spatial resolution is 0.05 x0.05 degrees for horizontal grid and 5 km for depth. It is confirmed that scores in 3D-RI models are better than that in 2D-RI models. The RI models also applied for prospective forecasting test from 1 February 2015. Forecasting period in the 1st round of the test was 3 months from 1 February to 1 May 2015 for magnitudes ? 4.0. RI models calculated expectations using past events at the following time periods: 1) From 1 January 1998 to 1 January 2011: unified JMA earthquake catalog before The 2011 Tohoku earthquake, 2) From 1 January 1998 to 1 August 2014: JMA unified earthquake catalog, and 3) From 1 January 1998 to 1 January 2015: Preliminary and unified JMA earthquake catalog. The performance of the RI models will be evaluated using the observations in the future. In this paper, we present the results of retrospective test by comparing the scores form 2D-RI models and 3D-RI models, and prospective test for the 1st round using preliminary JMA catalog. The authors thank JMA for the earthquake catalog. This work is sponsored by the Special Project for Reducing Vulnerability for Urban Mega Earthquake Disasters from Ministry of Education, Culture, Sports and Technology of Japan (MEXT).

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

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Collaboratory for the Study of Earthquake Predictability & Global Earthquake Model - Testing Center Software Development

BEUTIN, Thomas[1*] ; LIUKIS, Maria[2] ; MAECHLING, Philip[2] ; MAK, Sum[1] ; SCHORLEMMER, Danijel[1] ; YU, John[2]

[1]GFZ German Research Centre for Geosciences, 14473 Potsdam, Germany, [2]Southern California Earthquake Center, University of Southern California, Los Angeles CA 90089, USA

The Collaboratory for the Study of Earthquake Predictability (CSEP) aims to improve our understanding about the physics and predictability of earthquakes through rigorous and prospective testing of earthquake forecast models. CSEP operates four testing centers in California, New Zealand, Japan, and Europe running prospective, automated evaluations of more than 430 models. These testing centers are the technical infrastructure of CSEP and implement all procedures and protocols for rigorous testing and evaluation of earthquake prediction experiments. These experiments run in various testing regions and comprise forecast periods of one day to many years. The CSEP testing center software system is the general infrastructure of all CSEP testing centers and is now being used for earthquake early warning systems and geodetic transient detectors. The Testing and Evaluation Group of the Global Earthquake Model project at GFZ Potsdam is expanding the system to test intensity prediction equations and ground-motion prediction. We present the recent developments, the ongoing experiments, and introduce the structure of the software system.

Keywords: Earthquake forecasting, Seismic hazard, Statistical seismology, Earthquake statistics, Forecast testing, Software