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

SSS01-01 Room:102B Time:May 24 14:15-14:30

Real-time Classifier of Foreshocks Using Probability Density Ratio Estimation

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Foreshock discremination is one of the most effective ways for short-time forecast of large earthquakes. Though many large earthquakes accompany their foreshocks, discreminating them from enormous small earthquakes is difficult and only probabilistic judgement may be available. Probability density ratio estimation is the statistical learning method best suited to such binary pattern recognition problems where estimates of a-posteriori probability of class membership are required. Statistical learning methods can keep learning discreminating features from updating catalog and give probabilistic recognition of forecast in real time. By using kernel functions, we can composite non-linear distribution of foreshock frequency by smooth kernel function and evaluate the possibility of foreshocks by the logit function. In this research, we classify forecasts from earthquake catalog by the Japan Meteorological Agency by some clustering methods and learn spatial and temporal features of foreshocks by the probability density ratio estimation. We use the hypocentral locations, relative locations from their mainshocks and difference in magnitudes for learning and forecasting. We discuss the spatial pattern of foreshocks from the classifier composed by our model. We also implement a back test to validate predictive performance of the model by this catalog.

Keywords: foreshock, probabilistic recognition, probability density ratio estimation, kernel method

Japan Geoscience Union Meeting 2015
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SSS01-02 Room:102B Time:May 24 14:30-14:45

Forecast uncertainty in aftershock forecasting

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Aftershock forecasting provides one of the important measures for mitigation of earthquake damages. For this purpose, statistics- and physics- based models have been developed. When forecasting using these models, we usually adopt an optimal single set of parameter values such as the maximum likelihood estimates, which is called as plug-in forecasting. However, for a given small sized and incomplete data shortly after the main shock, the estimation of the model parameters may be accompanied by large uncertainty. In such a case, the plug-in forecasting underestimates the predictive probability range, and sometimes the range significantly biases the actual observations. Alternatively, more robust and unbiased forecasts can be obtained by considering the estimation uncertainty in an appropriate way. Bayesian forecasting provides a consistent statistical framework for this, and enables us to assess the forecast uncertainty. In this talk, we will argue the importance of evaluating the forecast uncertainty in probabilistic forecasting. As an example here, we employ the epidemic type aftershock sequence (ETAS) model as a forecasting model, and we show how the plug-in forecasting can fail and how the Bayesian forecasting can improve the performance. We will argue that the Bayesian predictors should also be tested in CSEP forecasting experiments.

Reference: T. Omi, Y. Ogata, Y. Hirata, & K. Aihara, ”Intermediate-term forecasting of aftershocks from an early aftershock sequence: Bayesian and ensemble forecasting approaches”, JGR (in revision).

Keywords: Aftershock forecasting, Point process, Bayesian forecasting

Japan Geoscience Union Meeting 2015
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SSS01-03 Room:102B Time:May 24 14:45-15:00

Correlation between Coulomb stress imparted by the 2011 Tohoku-Oki earthquake and seismicity rate change in Kanto, Japan

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We show that the seismicity rate increase in the Kanto region around Tokyo following the 2011 Tohoku-Oki earthquake (Mw9.0) was well correlated with the static increases in the Coulomb failure function (ΔCFF) transferred from the Tohoku-Oki earthquake sequence. Because earthquakes in the Kanto region exhibit various focal mechanisms, the receiver faults for the ΔCFF were assumed to be reliable focal mechanism solutions of ~3,000 earthquakes compiled from three networks (F-net, JMA network, and MeSO-net).

The histograms of ΔCFF showed that more events in the postseismic period had positive ΔCFF values than those in the preseismic period (2008 April 1 - 2011 March 10). Among the 928 receiver faults showing the significant ΔCFF with absolute values $\geq$ 0.1 bars in the preseismic period, 717 receiver faults (77.3 %) indicated positive ΔCFF. On the contrary, 1,334 (88.2 %) out of 1,513 receiver faults indicated positive ΔCFF in the postseismic period. We confirmed that the result is similar for the longer preseismic period, between 1997 October 1 and 2011 March 10.

To test the significance of the difference in the distribution of ΔCFF between preseismic and postseismic periods, we used a Monte Carlo method with bootstrap resampling. As a result, the ratio of positive ΔCFF randomly resampled from ΔCFF values in the preseismic period never exceeded 83.1%, even after 10,000 iterations. This supports the findings of Toda & Stein [2013]; however, our calculation is more reliable than theirs because we used a much larger number of focal mechanisms compiled from the three networks. It also proves that the static stress changes transferred from the Tohoku-Oki earthquake sequence are responsible for the changes in the seismicity rate in the Kanto region.

Earthquakes of focal mechanisms with positive ΔCFF values drastically increased, while those with negative ΔCFFs showed no obvious changes except for immediately after the mainshock. This fault-dependent seismicity rate change strongly supports the contribution of the Coulomb stress transferred from the Tohoku-Oki sequence to the seismicity rate change in the Kanto region. Immediately following the mainshock, earthquakes of all types of focal mechanisms were activated, but the increased seismicity rate of earthquakes with negative ΔCFFs returned to the background level within a few months. This suggests that there might be other contributing factors to the seismicity rate change such as dynamic stress triggering or pore-fluid pressure changes.

Acknowledgements
This study was supported by the Special project for reducing vulnerability for urban mega earthquake disasters from the Ministry of Education, Culture, Sports, Science and Technology of Japan.

Keywords: 2011 Tohoku-Oki earthquake, Seismicity rate change, Static changes in the Coulomb failure function, Kanto region

SSS01-04 Room:102B Time:May 24 15:00-15:15

CSEP-Japan testing results with multiple runs since 2009 including the 2011 Tohoku-oki earthquake

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It is 5 years since we have established the Japanese testing center for the Study of Earthquake Predictability (CSEP) in Earthquake Research Institute, the University of Tokyo. During the period of testing, in 2011 March, Tohoku-oki earthquake with M9.0 occurred and seismic activity changed very much in entire part of Japanese Islands.

The CSEP Japan testing experiment consists of 12 categories, with 4 testing classes with different periods (1 day, 3 months, 1 year and 3 years) and 3 testing regions called AllJapan, Mainland and Kanto. Starting from 91 models in September 2009, a total of 160 models, as of January 2015, are currently under testing in the CSEP official suite with collaboration of CSEP Testing Center at the Southern California Earthquake Center (SCEC) (Nanjo et al., 2011; Tsuruoka et al., 2012). For 3-month and one-year testing experiments, more than 15 runs of fully prospective experiments have been operated. Probability gains of tested models with respective to a spatially uniform probability model show that some models have always better performances in regions of AllJapan and Kanto, but the best model varies rounds by rounds for the region of Mainland.

In the testing period including the 2011 Tohoku-oki earthquake, a model which has wider spatial smoothing radius of 100km of Relative Intensity Model (RI) shows larger probability gain than those with a narrow smoothing while in other periods a small smoothing radius of 10 km shows better performance. Probability gains of models for 3-month and 1-year testing class for each model are almost same although a magnitude of target events is different. A model of HISTETAS5PA (Ogata, 2011) shows best performance for 1 day class and a region of AllJapan before the 2011 Tohoku-oki event but after the event ETAS (Zhuang, 2011) is better than HISTETAS5PA.

Keywords: CSEP, Earthquake Predictability

Japan Geoscience Union Meeting 2015
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SSS01-05 Room:102B Time:May 24 15:15-15:30

Forecasting seismicity after the Tohoku-Oki earthquake

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It has been four years since the 2011 Tohoku-Oki earthquake of M9.0 occurred. This giant event affects very largely on the current and future seismicity in and around Japan. In this occasion, I would like to discuss on various aspects of the forecasts the future seismicity. Further talk will be made on my planning of deepening statistical models for predicting finer future seismicity.

Keywords: Probability forecast, ETAS models, Triggering seismicity, Space-time ETAS model, Magnitude distributions, Earthquake detection rates

Japan Geoscience Union Meeting 2015
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SSS01-06 Room:102B Time:May 24 15:30-15:45

Post-Disaster Damage Mapping as Tool for Risk Testing

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The Post-Disaster Damage Mapping is part of the Global Dynamic Exposure project, in which we interpret and visualize crowd-sourced and open geographic data and provide guidance to what is called the crowd in data collection. We base our work on OpenStreetMap (www.openstreetmap.org) because of the fully open geographic data and the availability of open-source software for processing the data. Because of the immense number and variety of buildings, exposure- and vulnerability-related data cannot be compiled by a small group. Furthermore, the dynamic aspect of risk, namely rapid urbanization, requires monitoring of exposure and vulnerability indicators, again a task that can only be achieved when distributing the work onto many shoulders.

The objective of the Global Dynamic Exposure project is to provide a high-resolution (on the building-by-building level) and dynamic (low-latency) exposure model for the world. It will build upon the Global Exposure Database for the Global Earthquake Model (GED4GEM) and augment it where crowd-sourced and open data exists in high quality and high density. The exposure and vulnerability indicators are derived from geographic data (e. g. building footprint, land use), building properties (e. g. type of building, occupancy), and semantic interpretation (e. g. regional types of architecture, cultural habits). Once a target area is fully captured in OpenStreetMap, further changes in the dataset indicate the change of building stock or the process of urbanization. This dynamic aspect of data collection is used for the Post-Disaster Damage Mapping. Here, the so-called Humanitarian OpenStreetMap Team (hot.openstreetmap.org), a crowd-sourced disaster mapping effort, is providing information about the status of buildings and roads in the aftermath of a disaster. These data is retrieved mainly from aerial imagery but also from mappers on the ground.

Combining the exposure and vulnerability data of buildings prior to a natural disaster with the post-disaster damage status will provide a new dataset for better understanding risk and the societal impact of a catastrophe, but will also for the first time offer an independent dataset for testing risk estimates.

Keywords: risk testing, seismic hazard, seismic risk, exposure, vulnerability

Japan Geoscience Union Meeting 2015
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SSS01-07 Room:102B Time:May 24 15:45-16:00

Comparing USGS national seismic hazard maps with DYFI intensity observations

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Verifying a nationwide seismic hazard assessment using data collected after the assessment has been made (i.e., prospective data) is a direct consistency check of the assessment. We directly compared the predicted rate of ground motion exceedance by the four available versions of the USGS national seismic hazard map (NSHMP, 1996, 2002, 2008, 2014) with the actual observed rate during 2000-2013. The data were prospective to the two earlier versions of NSHMP. We used three sets of somewhat independent data, namely 1) the USGS "Did You Feel It?" (DYFI) intensity reports, 2) ShakeMap gridded ground motions, and 3) instrumental ground motion records extracted from ShakeMap stations. The first two were not strictly observations but models calibrated by observations. The third was true observation but the amount of data is limited.

Our results indicated that for California, the predicted and observed hazards are very comparable. Discrepancy lied generally on the safe side (i.e., predicted hazard not lower than the observed one). The three sets of data gave consistent results, implying robustness. The consistency also encourages the use of DYFI and ShakeMap data for hazard verification in the central and eastern US (CEUS), where instrumental records are lacking. The result showed that the observed ground-motion exceedance was larger than the predicted in CEUS, implying a possible underpredicted hazard.

The primary value of this study is to demonstrate the usefulness of DYFI and ShakeMap data, originally designed for community communication instead of scientific analysis, for the purpose of hazard verification. The large discrepancy between the observed and predicted gorund-motion exceedance in CEUS implied that either the ground motions were not described correctly by DYFI and ShakeMap for the region, or the hazard was actually underestimated. Induced seismicity could be the cause of this underestimation.

Keywords: Earthquake Hazard, Prediction, Validation

SSS01-08 Room:102B Time:May 24 16:15-16:30

Detecting spatial variations of earthquake clustering parameters via maximum weighted likelihoods estimates

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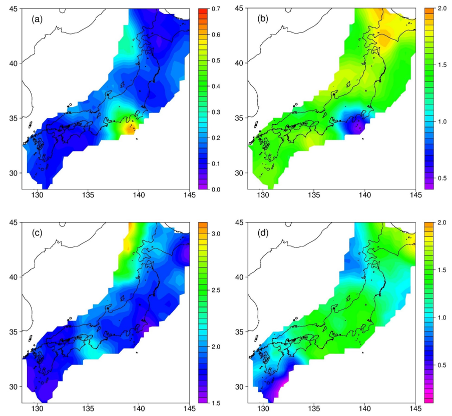
The ETAS model has been used to describe the clustering features of seismicity with just several parameters. To see how the clustering parameters and background rates change spatially, in this study, the earthquake data from the JMA catalog are used and these model parameters are estimated by using the maximum weighted likelihood estimate (MWLE) method. Even though this MWLE method is not as sophisticated as the HIST-ETAS model, which is built on a more rigorous basis of the Bayesian procedure with the smoothness prior, MWLE is simpler to implement, in both parallel and non-parallel computing environments, without loss of detecting resolution of the spatial variation of earthquake clustering parameters.

The data analysis shows that the spatial variation of the MWLEs of each parameter shows different features between tectonic regions. Also, applying the MWLE method has the potentials for improving the forecasting performance of the space-time ETAS model in evaluating earthquake probabilities.

Figure 1: Spatial variations of the ETAS parameters estimated by using maximum weighted likelihood estimate (MWLE). (a) A, (b) α, (c) q, (d) γ.

Keywords: ETAS model, earthquake cluster, earthquake forecasting, weight likelihood estimator



Japan Geoscience Union Meeting 2015
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SSS01-09 Room:102B Time:May 24 16:30-16:45

Frequency distribution of the number of earthquake occurrence

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Considering that seismic activity includes correlated events such as fore- and aftershocks, a frequency distribution of the number of earthquake occurrence must be different from the Poisson distribution. In this presentation, improved distribution functions are discussed in order to promote better understanding one of the features of seismic activity and a proper evaluation for earthquake forecast.

A frequency distribution of earthquakes has sometimes been fitted by the negative binomial distribution. However, this will be valid for the case that a mean r of the data set is large, e.g. r>>1, and it is questionable when the events occur only scarcely. In the case that the mean value is small, the distribution seems to be well fitted by a power-law distribution. Consequently, the authors proposed a following function as a possible improved distribution function (Yamashina et. al, JPGU, 2012), f(x) = c (x^-a) exp(-bx) (i.e. a discrete gamma distribution). In addition, another function, f(x) = c (x^-a) exp(-b/x) (i.e. a discrete negative gamma distribution) is discussed here. As a whole, these two functions fit the data for a wide range of the mean values. Here, in the case of a large mean value, there seems to be a tendency that the latter fits well rather than the former.

The present functions diverge at x=0, if the parameter a is positive. In the present discussion, the functions are applied only for x=1 or larger. It is because, for example, the frequency of x=2 will correlate much with that of x=1, but there are no particular reasons that the correlation with x=0 is also large. Consequently, it may be difficult to fit the frequency of x=0, 1 and 2 by the same distribution function. The frequency of x=0 is determined by the rest of the summation for those of x=1, 2, and so on.

In the CSEP earthquake-forecast project, the performance of respective forecast is evaluated with assuming the Poisson distribution. Since the actual frequency distribution of earthquake occurrence is somewhat different from the Poisson distribution, the reliability of the result is left for further discussions. In order to advance the prediction-oriented research, it will be desired to prove the difference of the result with a plausible function of the frequency distribution.

Keywords: frequency distribution, number of earthquake occurrence, CSEP

Japan Geoscience Union Meeting 2015
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SSS01-10 Room:102B Time:May 24 16:45-17:00

History of network detection completeness in Japan

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An important characteristic of any seismic network is its detection completeness, which should be considered a function of space and time. Many researchers rely on robust estimates of detection completeness, especially when investigating statistical parameters of earthquake occurrence like earthquake rates. Contrary to traditional approaches, we do not estimate completeness using methods in which the completeness magnitude is defined as the deviation of the frequency-magnitude distribution from the linear Gutenberg-Richter relation. Here, we present a method based on empirical data only: phase data, station information, and the network-specific attenuation relation. For each station of the network we estimate a time-dependent distribution function describing the detection capability depending on magnitude and distance to the earthquake. For each point in time, maps of detection probabilities for certain magnitudes or overall completeness levels are compiled based on these distributions. Therefore, this method allows for inspection of station performances and their evolution as well as investigations on local detection probabilities even in regions without seismic activity.

We present a full history of network detection completeness for Japan and discuss details of this evolution. These results are compared with estimated completeness levels of other methods and with completeness levels in other regions of the World. We present scenario computations showing the impact of different possible network failures. All presented results are published on the CompletenessWeb (www.completenessweb.org) from which the user can download completeness data from all investigated regions, software codes for reproducing the results, and publication-ready and customizable figures.

Keywords: catalog completeness, earthquake recording, statistical seismology, earthquake statistics, earthquake forecasting, seismic hazard

SSS01-11 Room:102B Time:May 24 17:00-17:15

Assessment of optimal short-term earthquake forecasts based on ULF seismo-magnetic data

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Our previous statistical studies have indicated that the ULF seismo-magnetic phenomena contain precursory information and can be useful in short-term forecasting of sizable earthquakes. In practice, for given series of precursory signals and related earthquake events, the efficiency of forecast is a function of the leading time of alarms (delta) and the length of alarm window (L). To find out the best prediction strategies, Molchan's error diagram has been employed. The same as our previous study, we utilized geomagnetic data and earthquake events registered in Kakioka (KAK), Japan during 2001-2010. Ratios of observed energy to modeled background are applied to indentify precursory signals. A modified area skill score, which measures the area between actual prediction curve and random prediction line, is introduced to assess the efficiency of different prediction strategies. The results indicate that ULF magnetic data at KAK contains higher precursory information when delta is around 1 week and L is less than 4 days or delta is 13-14 days and L is less than 1 week; the optimal strategy of short-term forecasts is: delta =8 days and L =1 day. The methodology proposed in this study could help to evaluate the prediction policy and find out the optimal solution of other different measurements for short-term earthquake forecasting.

Keywords: ULF seismo-magnetic phenomena, Molchan's error diagram, optimal short-term earthquake forecast

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SSS01-12 Room:102B Time:May 24 17:15-17:30

Earthquake mechanism in post-megathrust intraplate stress

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Megathrusts produce large permanent lithospheric displacements as well as strong transient ground shaking up to regional distances. The lateral permanent displacements construct stress shadows in a wide backarc region. The Korean Peninsula is placed in the far-eastern Eurasian plate that belongs to a stable intraplate region with a low earthquake occurrence rate and diffused seismicity, and is located in the backarc at ~1300 km in the west from the epicenter of the 11 March 2011 M9.0 Tohoku-Oki earthquake. The seismicity around the Korean Peninsula was increased significantly after the 2011 M9.0 Tohoku-Oki earthquake, which is not consistent with the expected seismic-quiescence. Strong seismic waves cause large dynamic stress changes, incurring fluid migration and increasing pore fluid pressure in the media. The lithospheric displacements directing to the epicenter on the convergent plate boundary develop transient radial tension field over the backarc lithospheres, which is subparallel with the preseismic ambient compressional field. The pore pressure growth and radial tension field decrease the Coulomb failure stress, increasing episodic increases of seismicity in both fault zones and intact media. The ambient stress field is recovered gradually as the induced stress field diminishes with time by tectonic loading. The seismicity changes with the temporal evolution of stress field. A series of moderate-size earthquakes and earthquake swarms occur as a consequence of medium response to the temporal evolution of stress field. The long-term evolution of seismicity is expected to continue until the preseismic ambient stress field is fully recovered.

Keywords: stress shadow, intraplate, megathrust, long-term evolution, Korean Peninsula

Japan Geoscience Union Meeting 2015
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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

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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
This study was supported by the Special project for reducing vulnerability for urban mega earthquake disasters from the Ministry of Education, Culture, Sports, Science and Technology of Japan.

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

Japan Geoscience Union Meeting 2015
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SSS01-P02 Room:Convention Hall Time:May 24 18:15-19:30

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

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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

SSS01-P03 Room:Convention Hall Time:May 24 18:15-19:30

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

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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