Long-term Predictability for Repeating Earthquake using Standard Value of Lognormal Distribution

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Event numbers of sequential recurrent large/medium earthquakes listed in seismic catalog are frequently very small, because they recur at long intervals. Then it may be useful to adopt a standard value in some parameters which is commonly applied for such sequences in calculating the probability for the coming event. We are studying the predictability by two models, LN-NORM and LN-SST-Pin, involving those parameters. The standard values of σ_0=0.581 for standard deviation in log-normal distribution are determined from the 166 small interplate repeating earthquakes along the Japan Trench, which were used for the experiment of prospective forecasts from 2006 to 2010. Event data were taken in order from the last earthquake, with 3, 4, 5 and 5 or more. In 248 of 524 forecast sequences the repeater occurred during the forecast period.

(1) LN-NORM: Lognormal distribution model. The mean and variance parameters for each sequence are the sequential mean of logarithm of interval and the standard value squared, σ_0^2, respectively.

(2) LN-SST-Pin: Lognormal distribution model based on the idea of the small sample theory. The mean and variance parameters for each sequence is the same as LN-NORM and ((n+1)/n) σ_0^2, respectively.

(3) LN-Bayes: Lognormal distribution model with Bayesian approach. The parameter of the inverse gamma distribution, which is the prior distribution of σ^2, are ϕ=0.25 in shape and ζ=0.44 in scale (2006, 2008) or ϕ= 1.5, ζ= 0.15 (2009, 2010).

(4) LN-SST: Lognormal distribution model base on the small sample theory.

(5) Exp: Exponential distribution model. The parameter plugged is the sample mean.

(6)- (8) BPT-pin: BPT distribution models. The mean parameter for each sequence is the sequential mean of interval. And the parameter of coefficient of variation is the median of the values calculated from sequences of 4 repetitions, α_0=0.367, for model (6), the mean, α_0=0.52 for model (7), and the standard value by the Headquarters for Earthquake Research Promotion in Japan, α_0=0.24 for model (8), used in the long term evaluation of the large and great earthquake, respectively.

The "Mean log-likelihood" mentioned below are used to score the forecast results.
Mean log-likelihood (MLL): Average of Ev*ln (P) + (1-Ev)* ln (1-P)
Here P means forecast probability for event and Ev means presence (Ev=1) or absence (Ev=0) of the event. If the Mean log-likelihood is larger than those of the alternative, the model is considered to be superior to the alternative one.

The ROC (Receiver Operating Characteristic curve) is a diagram showing the relationship between "False Alarm Rate" and "Hit Rate" when the threshold value changes. It can be said that the model is better as the curve swells to the upper left side of the figure.

In Figure 1 the forecasts by six models become worse surely as the number of preceding events is smaller. When the number of event interval data is 2 or less, compared with the result of LN-SST-Pin model, the decline of the LN-NORM model is remarkable. The results of the LN-NORM model and the LN-SST-Pin model are inferior to those of the LN-Bayes model and the LN-SST model. When the LN-NORM model and the LN-SST-Pin model are predicted with 1 event data, the score is poor, and it is below the results of the probability of 0.5 (MLL=-0.693) for all case.

In Figure 2 the supplementation rate of the LN-Bayes model and the LN-SST model is superior to other models. And the supplementation rate of LN-NORM model and the LN-SST-Pin model is inferior to the 3 types of BPT model.

Keywords: Repeating earthquakes, Forecast, Log-normal distribution, Standard value, Mean log-likelihood, Receiver Operating Characteristic curve

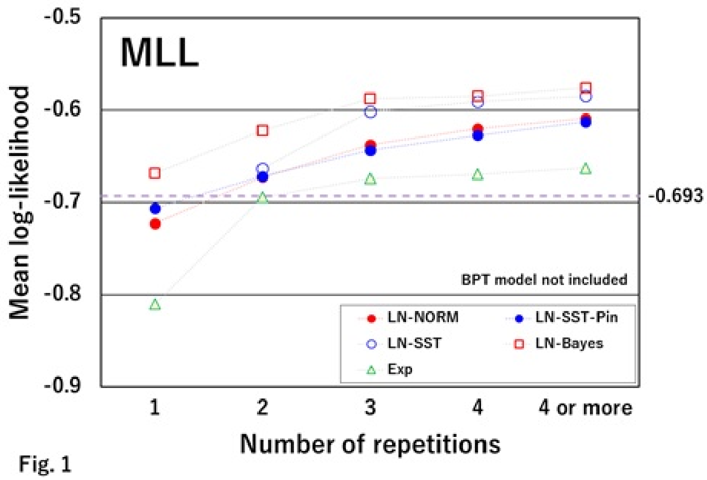

Fig. 1

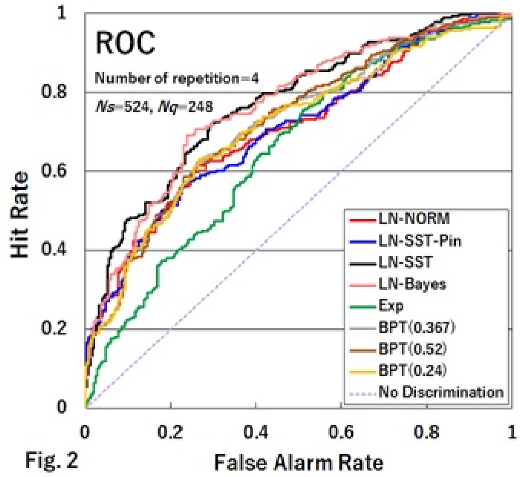

Fig. 2

Has the stress over the focal region of the 2011 Tohoku-Oki *M*9 earthquake recovered to the pre-earthquake state?

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When the logarithm of the number of earthquakes equal or above a magnitude *M* is plotted against *M*, the frequency distribution is well represented by a line in a magnitude range where almost all earthquakes are detected. In the linear distribution known as the Gutenberg-Richter law, the *b* value (slope of the line), has been pointed out to relate to the stress in the seismogenic region: the *b* value is small in a high stress area such as fault patches, while it is large in a region under low stress condition, for example, in high-pore-pressure zones. Based on the empirical knowledge, Tormann et al. (2015), having obtained a result that the distribution of the *b* value in recent years in the focal region of the 2011 Tohoku-Oki *M*9 earthquake is similar to that at pre-earthquake times, considered that the stress over the focal region has already recovered to the state before the earthquake occurrence. Then, they suggest that the renewal process of large earthquake occurrence along the subduction zone is described by a stationary Poisson process, i.e., a similar size megathrust event is potentially possible to occur in overlapping volumes sooner than expected from estimated mean inter-event times of past events. Is that true? If this is the case, we have to re-consider the basic method of long-term earthquake prediction taken by the Earthquake Research Committee of the Headquarter for Earthquake Research Promotion, Japan. This is a serious problem. Here we investigated spatio-temporal change in the *b* value over the foal region of the 2011 Tohoku-Oki *M*9 earthquake in detail. The method of our analysis is basically almost the same as that taken by Tormann et al. (2015), but we improved the analysis somewhat by separating earthquakes in the sea region into two groups, those along plate boundary and such ones that occur above the plate boundary, and by taking temporal variation of spatial distribution of earthquakes into consideration.
Our main results are as follows: The *b* value in the large slip area at the 2011 Tohoku-Oki *M* 9 earthquake has not yet returned to the small value just before the megathrust event elucidated by Nanjo et al. (2012). The *b* value had been becoming small before the 2011 Tohoku-Oki *M* 9 earthquake in the focal region of the 1987 Miyagi earthquake (*M*7.4). The *b* value in the sea region off northern Sanriku has been notably small since the time before the megathrust event and the area of the low *b* values seems to have been expanding to the west. The northern part of this low *b* value area overlaps with the starting point of the rupture of the 1944 offshore Sanriku earthquake (*M*7.5), but the southern part of the area does not overlap with any focal region of past large earthquakes.
In general, our results show that the *b* value over the focal region has not yet returned to the value before the 2011 Tohoku-Oki *M* 9 earthquake, inconsistent with Tormann et al. (2015). We think that it is necessary to monitor the progress of the low *b* value area off northern Sanriku, considering a possibility of occurrence of a large earthquake in the near future.

Keywords: the 2011 Tohoku-Oki earthquake , stress recovery, the Gutenberg-Richter law

Recent seismic activity in Italy and seismic gaps

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After the 1908 M7.1 Messina earthquake, Omori(1909) pointed that there were two seismic gaps along the Montes Appenninus seismic belt. The M7.0 Avezzano earthquake occurred at the one of them in 1915. So, the seismic gap is the one of important information to predict the place of the future earthquake. But there was no earthquake in the other seismic gap until now.
Recently destructive earthquakes occurred at the middle part of the Montes Appenninus. These were M6.1 eq in 1984 April, M6.0 eq in 1984 May, M6.4 eq in 1997, M6.3 eq in 2009, M6.2 eq in 2016 August, M5.9 eq in 2016 Oct., and M5.9 eq in 2017. The source areas were estimated by one month aftershock(M>=2.5) distributions. Italian Seismic Instrumental and parametric Data-base(ISIDe) by Institute of National Geophysics and Volcanology(INGV), Quick Epicenter Determinations by USGS and Catalog of Damaging Earthquakes in the World by Utsu(http://iisee.kenken.go.jp/utsu/index_eng.html) were used.
There are some seismic gaps along the Montes Appenninus seismic belt. One is a small seismic gap between the 1984 M6.1 eq and 1997 M6.4 eq. The area between 2009 M6.3 eq and 1984 M6.0 eq is large, but the 1915 M7.0 Avezzano earthquake occurred in this area. There is a possibility to exist a small seismic gap. Additionally, the area between 1984 M6.0 eq and 1980 M6.9 eq may be other seismic gap.

Keywords: prediction, seismic gap, Italy

Long-term increasing and decreasing changes in groundwater temperature in the Tokai region

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1. none

Stress concentration due to deformation of the crust may generate highly compressed fluids within cracks in the rocks. Those fluids tend to migrate upwards through crack system in the crust. The intrusion of water with high temperature into a shallow water layer results in an increase in the temperature of the shallow water. An increasing trend in water temperature is found since the beginning of the observation in December, 2003 at a depth of 30m in an observation well, in Yaizu City. The increasing rate is 23m degree/year. At an artesian well in Shizuoka, where we set thermometers at depths of 5 m and 30m, we found an increasing rate of 34m degree/year since March 29, 2006. However, the rate changed up to 67m degree/year around February in 2007 and turned to decrease down to 14m degree/year in September. After September, 2008, the temperature is decreasing with a rate of -40 m degree/year. This change of long-term trend is a possible precursor for the Aug. 11, 2009 Suruga Bay earthquake of M6.5. Including aftereffects , the volumetric strain meters deployed by JMA could not detect the trend changes. Recently, the Shizuoka water temperature shows another change of decreasing trend. The recent increasing and decreasing trends with impulsive events in groundwater temperature in the Tokai region is possibly due to increasing and decreasing compressional stresses deep underground, indicating a sign of the preparation process of the impending Tokai or Tonankai earthquake.

Keywords: crustal movement, earthquake prediction, groundwater temperature

A fault model of the 1946 Nankai earthquake estimated from the survey on sea level Changes

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For the Kii peninsula, we have already proposed the fault model of the 1944 Tonankai earthquake and the 1946 Nankai earthquake, respectively (Umeda & Itaba, 2016). In this study, based on the survey value of the hydrographic bureau (Fig.1), the fault model of the 1946 Nankai earthquake was estimated from the Kii Peninsula to Shikoku (Fig. 2).

Keywords: 1946 Nankai earthquake, sea level change, fault model

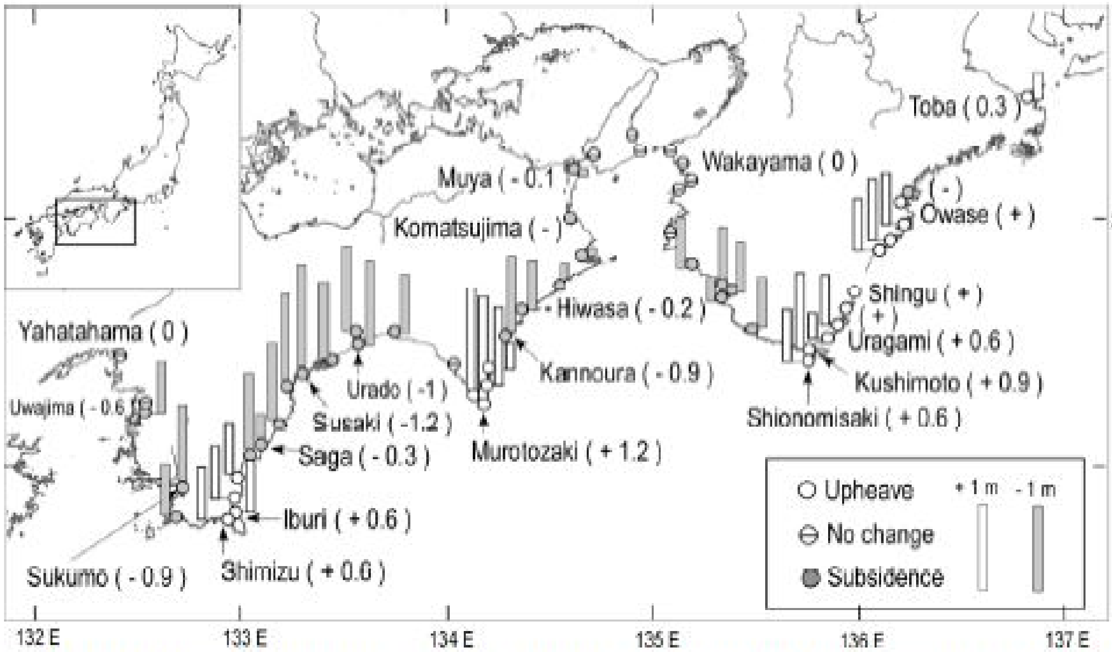

Fig.1 Co-seismic vertical variations of 1946 Nankai earthquake. Variation was obtained from the change of the sea level before and after the earthquake (Hydrographic bureau,1948). An upheaval area is seen on the east coast of the Kii peninsula.

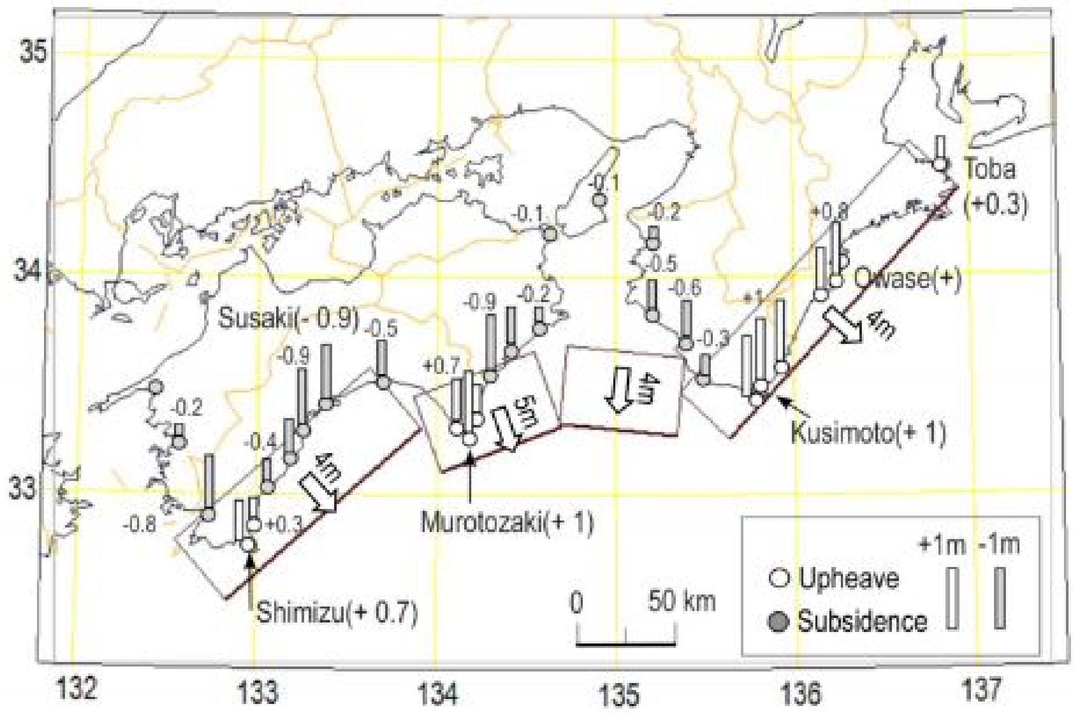

Fig.2 Four assumed faults and displacements of the 1946 Nankai earthquake. Vertical bars indicate the calculated value of upheave and subsidence. The fault extends to the east coast of Kii peninsula and the southwest of cape Ashizuri (Shimizu).

On Statistical Hypothesis Testing of Earthquake Precursory Phenomena

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There are wide variety of phenomena which possibly precede large earthquakes. Physical mechanism between these phenomena and earthquakes are often unclear, but if the link between them were statistically strong, these phenomena could be utilized in practical earthquake forecast. In this talk, we argue that statistical tests have been misused in some of the previous studies on possible precursory phenomena. We present examples from electromagnetic studies, but the lessons would be applied to other observations as well.
We argue two improper statistical hypothesis testing methods, "data snooping" and multiple testing. As Love and Thomas [2013] pointed out, we are obliged to have statistical inference before looking at the data in statistical testing. When statistical inference is set after looking at the data, this test is never validated, and such inference is referred as data snooping. Unless the hypothesis is tested with another set of data, we should refrain from making conclusive statements on its statistical significance.
Type I error is so-called "false positive", in which a true null hypothesis is incorrectly rejected. We set significance level to a small number to reduce such possibility. When we perform large number of statistical test concurrently, the expected value that we encounter Type I error increases proportionally. As Love and Thomas [2013] showed, when physical mechanism between the phenomena and earthquakes is not known, we are forced to use many sets of parameters and repeat tests. Proper corrections, such as Bonferroni correction, will reduce occurrence of Type I error, but often are not used in previous publications of precursory phenomena. Additionally, when specific combination of parameter is used without theoretical basis or strong rationale, it could be safe to assume that use of multiple testing is properly documented in such publications so that possibility of false positive remains regardless of their conclusion.

Keywords: Earthquake Precursory Phenomena

Fast Earthquake Characterization using a Single Three Component Seismic Station by Machine Learning Techniques

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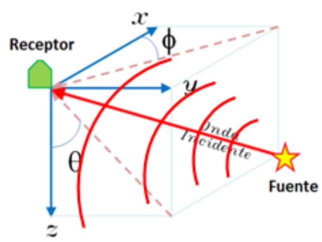
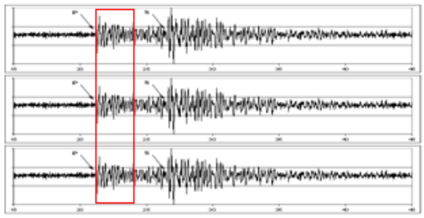
Earthquake early warning alerts generation is very useful, especially for the city of Bogotá-Colombia, given the social and economic importance of this city for the country. Based on the information from the seismological station "El Rosal", which is a broadband and three components station, located very near the city that belongs to the Servicio Geológico Colombiano (SGC) a Support Vector Machine Regression (SVMR) model was developed, using a Normalized Polynomial Kernel, using as input some characteristics of the initial portion of the P wave used in earlier works such as the maximum amplitude, the linear regression coefficients of such amplitudes, the logarithmic adjustment parameters of the envelope of the waveform and the eigenvalues of the relationship between the three seismogram components of each band.

The model was trained and evaluated by applying a cross-correlation strategy, allowing to calculate the magnitude and location of a seismic event with only five seconds of signal. With the proposed model it was possible to estimate local magnitude with an accuracy of 0.19 units of magnitude, epicentral distance with an accuracy of about 11 km, the hipocentral depth with a precision of approximately 40 km and the arrival back-azimut with a precision of 45°. Accuracies obtained in magnitude and epicentral distance are better that those found in earlier works, where a large number of events were used for model determination, and the other hipocentral parameters precisions obtained here are of the same order.

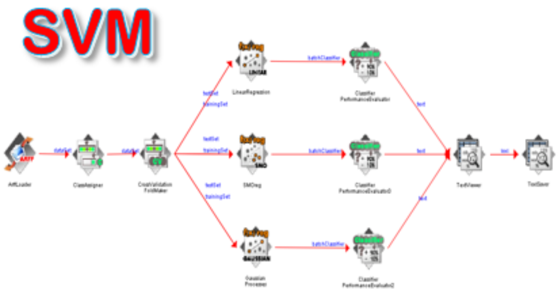
This research work makes a considerable contribution in the generation of seismic early warning alerts, not only for the country but for any other place where proposed models here can be applied and is a very good starting point for future research.

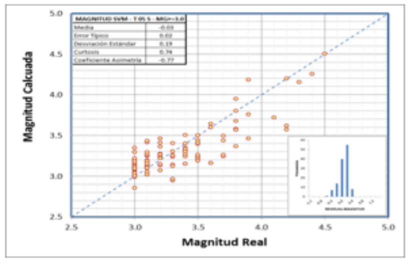
Keywords: Early Warning, Support Vector Machines (SVM), Fast Seismic Characterization, Seismology, Bogotá-Colombia





Early Warning





Groundwater macroscopic anomalies and earthquake: a case study in Xichang, South-west China

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Earthquake prediction is a debating topic in the world. One of the focused points is that whether there existed observable and identifiable precursors? What’s the objective definition of “anomalies” and what’s the quantitative physical mechanism links these precursors to earthquakes. However, anomalies are always reported before and after some major earthquakes. Identify the nature of these anomalies and understand the possible role as precursor will certainly benefit for the debating. Large scale macroscopic anomalies were reported in Xichang area during 2002. And we conducted a field survey in order to indentify the nature of these anomalies and their possible role as precursor. According our investigation, although the groundwater and animal anomalies have no relationship with the strong earthquake, they are surely controlled by the tectonic activity in that area. Because both of the temporally and spatially distribution of groundwater and animal anomalies had related with the tectonic setting and the tectonic activity which get from the seismo-geological and geodetic studies. So the anomalies in Xichang area are the result of the increasing tectonic activity in the Sichuan-Yunnan block. And the groundwater may play as good indicator for the activity in tectonic.

Keywords: macroscopic anomalies, groundwater, earthquake

A Novel Calculation for Estimating Earthquake of Magnitude>7

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The earthquake has always been the major issue of the cities near the earthquake zone. The unpredictability of earthquake has raised the attention on developing earthquake early warning systems (EEWS).
This study uses earthquake waveform data from IRIS (Incorporated Research Institutions for Seismology). By using the seismic analysis code (SAC) to process and to analyze the seismic waveform data. This study reveals that the frequency component of the first arrived complete P wave can be used to estimate the magnitude of an earthquake. A low-pass filter with cutoff frequency 3Hz is used to preprocess the waveform signal. We use Fast Fourier Transform to turn time domain data into frequency domain data. The spectrum is then obtained and can be used to identify the characteristic of the frequency component of the first arrived complete P wave. An empirical linear relation is found, and this linear relation can be used to estimate the magnitude of earthquakes.
Our result shows the magnitude of an earthquake, therefore, possible to be estimated at the very beginning of an earthquake event. This method is beneficial for minimizing the damage in order to prevent unnecessary loss.

Keywords: P wave, Fourier Transform, Linear Regression

Precursory microseismic quiescence preceding the 2016 M_L 6.6 Meinong earthquake in southern Taiwan

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Before the Meinong earthquake in sothern Taiwan, a spatiotemporal seismic gap is roughly found. During this seismic gap, only four earthquakes were located by the Central Weather Bureau Seismological Network 24 bits (CWBSN24), whose magnitude of completeness (M_C) is about M_L 1.2 in the area of the Meinong earthquake. In order to specify the range of this spatiotemporal seismic gap, this research examined the duration and spatial scale of this seismic gap. Then this seismic gap is characterized as an undoubted low seismicity rate. Here, this low seismicity was kept about 90 days before the Meinong earthquake and localized within a area with a radius of 12 kilometers from the hypocenter of this strong earthquake. Particularly, this kind of low seismicity rate could be only found before this strong earthquake. For this reason, this low seismicity should be associated with the Meinong earthquake. This low seismicity appeared before the Meinong earthquake is obvious as the data was extracted from the seismic catalog whose magnitude lower than M_L 1.5. Therefore, this research suggested that this low seismicity is characterized as the behavior of microseismicity. Between after this low seismicity and the Meinong earthquake, some foreshocks were found. According the process of a principle rupture cycle, this low seismicity could be the intermediate-term quiescence. The spatial scale of this quiescence is similar with the previous observations for some strong earthquakes. In practice the seismic quiescence had been found before some strong earthquakes and used for earthquake precursor. For earthquake precursor in southern Taiwan, this research indicates that the useful precusory signal of seismic quiescence may be buried in microseismicity which is monitored by a dense seismic network and was difficult to observed in the past.

Keywords: Meinong earthquake, seismic quiescence, microseismicity

Space-time variation of the *b* value in the Philippine Sea slab along the Nankai Trough

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A dense seismic and geodetic observation network has been established along the Pacific coast of southwestern Japan where the Philippine Sea Plate subducts beneath the Eurasian plate and a huge interplate earthquake is anticipated to occur in the near future. Since characteristics of the interplate coupling as well as associated phenomena along the Nankai Trough differ from those along the Japan Trench where the Pacific Plate subducts beneath the North American Plate, we cannot expect "precursory phenomena" observed before the 2011 Tohoku-Oki earthquake will be observed similarly before the supposed Nankai Trough earthquake. However, it has been reported that a notable seismic quiescence did appear in a wide region along the Nankai Trough before the 1944 Tonankai and the 1946 Nankai earthquakes (Kimura and Okano, 1995; Aoki and Yoshida, 2001), so that it is highly expected that seismic quiescence will also appear before the next Nankai Trough earthquake. Then, how about the remarkable decrease of the *b* value observed in the focal region of the 2011 Tohoku-Oki earthquake? Because it is known that the *b* value was low in the focal region of the 2004 Sumatra earthquake, it is very probable that decrease of the *b* value will be observed as well before the next Nankai Trough earthquake. A problem is that the seismicity in the sea region along the Nankai Trough is apparently low compared to that off the Pacific coast of Tohoku region. Therefore, it is uncertain if we can trace change in the *b* value in detail as has been done for the 2011 Tohoku-Oki earthquake. Here we report preliminary results of the space-time variation of the *b* value in the region along the Nankai Trough. We found that the *b* value is low in the Kumano-nada and beneath Shikoku where a large slip deficit rate has been elucidated (Yokota et al., 2016) and the *b* value in the sea off Shiono-misaki is high. Intriguing temporal variations that might have been related to the change in the stress in the slab are also found in some regions.
The seismic activity in the crust in southwestern Japan is comparatively high, so that we think that it is meaningful to monitor change in the *b* value at various areas. It may be possible to observe increase in *b* value related to decrease of the stress in the crust due to weakening of the interplate coupling.

Keywords: seismicity, b value of the Gutenberg-Richter law, Nankai Trough

Long-term seismic quiescence before shallow great earthquakes with M_w8.0 or larger between 1990 and 2014

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Long-term seismic quiescence was investigated in and around the focal area of 23 great earthquakes with M_w8.0 or larger and with a centroid depth shallower than 100 km in the global CMT catalog between 1990 and 2014. Earthquakes shallower than 60 km with the body wave magnitude of 5.0 or larger were selected in an earthquake catalog created by International Seismological Center (ISC). Clustered events such as earthquake swarms and aftershocks were removed from the ISC catalog by using a stochastic declustering method developed by Zhuang et al. (2002). A detailed analysis of the earthquake catalog using a gridding technique (ZMAP) shows that the seismic quiescence areas were found in and around the all focal areas of these great earthquakes except for four earthquakes. The four earthquakes are located in the area with a very low background seismicity and thus I was not able to estimate the temporal change in seismicity.

Keywords: seismicity, seismic quiescence, great earthquake

Operational forecast of large event after major earthquake

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1. none

In a large-scale earthquake disaster, a large number of people stay in shelters, and some of them may lose their physical condition or may die away. Among the 6434 deaths of the Kobe Earthquake (1995), 919 persons are "earthquake related deaths" certified by local governments. In the Kumamoto earthquake (2016), more than half of the victims were "earthquake related death". The Japan Meteorological Agency has forecasted the probabilities for large aftershocks related to 15 major main shocks since 1998. The Earthquake Research Committee of Japan published the report "Information on the prospect of earthquake activity after a major earthquake" last year. In the information immediately after a major earthquake the massage is "Please be careful about the same degree of earthquake for about a week in the strong ground motion area “, in which they call warning higher than before.
Announcing the magnitude and intensity of earthquake underestimated may increase the human injury during the earthquake. On the other hand, excessive forecast may result excessive evacuation behavior and increasing the possibility of deteriorating health or death. In the forecasting information, it is required to minimize human injury, considering both of these aspects.
I will discuss here the operational forecast of events after a major earthquake. Some points are as follows.

Maximum event following the major earthquake
Fig. 1 shows the magnitude difference between the maximum event within the next 7 days and the preceding major shallow inland earthquake of M6.5 or larger listed in report. Only the Kumamoto earthquake case (black) the subsequent event was bigger than preceding one, and only 2 cases (gray) were of the same level (magnitude difference is 0.3 or less). It is reasonable that the response after the inland earthquake of M6.5 or higher is a conventional policy that calls attention to aftershocks one size smaller than the preceding major earthquake, and new policy has a large tendency of excessive attention and warning.

Probabilistic forecast
In the report it is written that low probability of the event is received as safe information, thus they quitted issuing the probabilistic forecast. It should be more desirable to explain frequently the people on media that a large event will occur at a reasonable rate, even if the probability is small. While aftershock activity is very active, it is questionable to repeat qualitative massage without the probability of large event. Note that statistical testing is not able to applied for such qualitative information.

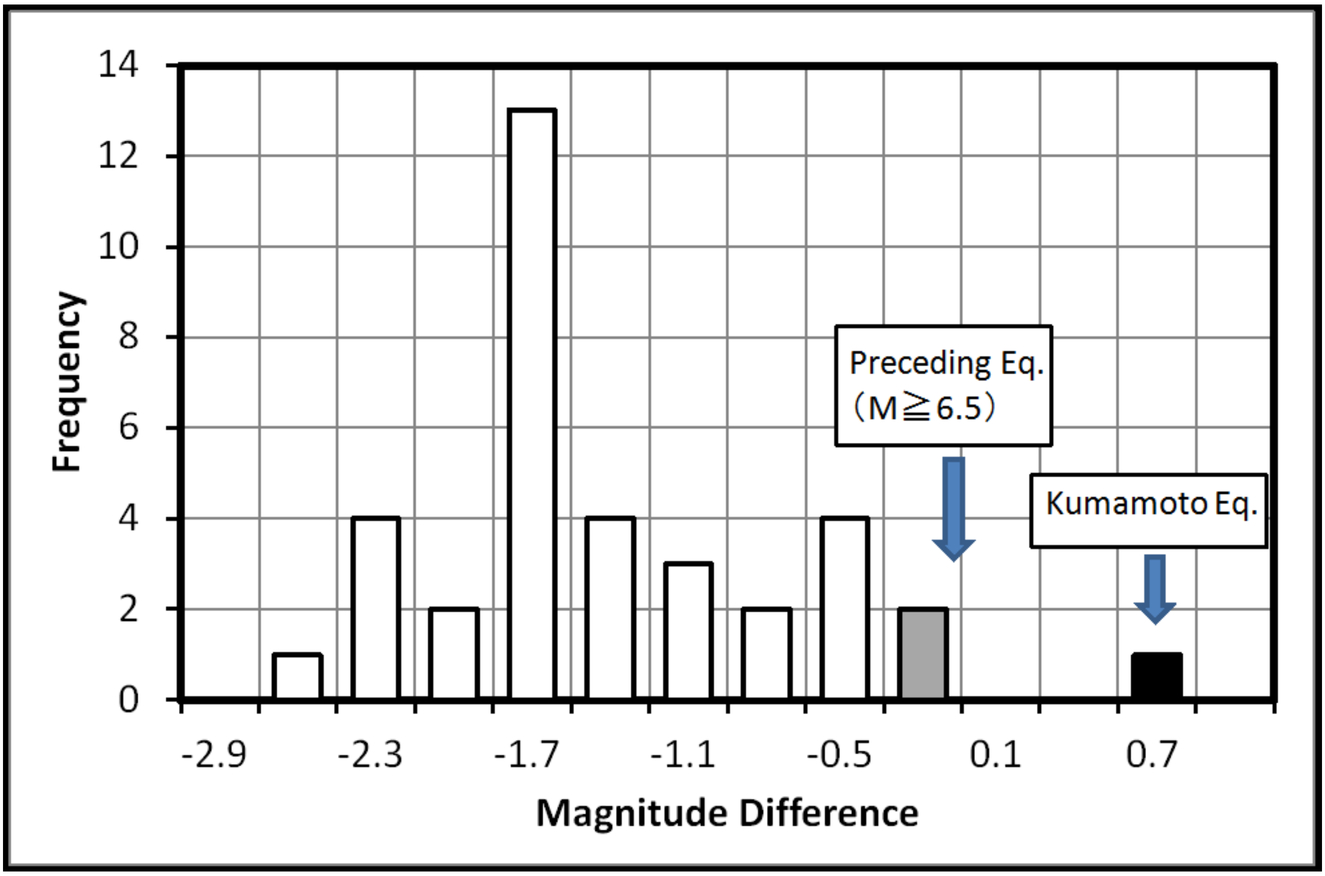
Representation of the risk
Probabilistic forecast is familiar to some people and very useful information, but for many citizens, it is unfamiliar and they do not know how to use it. The proposed forecast draft is concise and clear, but concrete is inferior to the conventional probability prediction. As another expression form, it is conceivable to display the maximum earthquake magnitude during the forecast period as a probability distribution. By looking at the result figure, it is easy to ascertain "How much is the maximum magnitude?" and "What is the forecast accuracy of magnitude?". In the weather forecast, the ordinary forecasts, precipitation probability forecast and high resolution precipitation now cast etc. are executed in parallel. As people who use earthquake forecast also have various purposes and methods, it is hopeful that the attention in sentence expression, the probability of large events, and the magnitude distribution of the

largest earthquake etc are presented in parallel.

Verification of forecast and improvement of model
It is necessary to verify and evaluate the results of forecast. The international commission examined the prediction of the L'Aquila earthquake (2009, Mw 6.3, more than 300 people dead) recommended about the method of earthquake forecasting for civil protection as follow;.
Recommendation F1: Forecasting methods intended for operational use should be scientifically tested against the available data for reliability and skill, both retrospectively and prospectively. All operational models should be under continuous prospective testing.
Therefore it had better to test and to evaluate the earthquake forecasting results by the Japan Meteorological Agency.

Fig. 1. Magnitude difference between the maximum event in the next 7 days and the preceding major shallow inland earthquake of M6.5 or larger in Japan.

Keywords: earthquake forecast, forecast of aftershock, earthquake related death



The 3-stage earthquake generation process observed during 3 months before the 2011 Tohoku earthquake (2)

*Yoshiki SUE[1]

1. none

1 Introduction
Various phenomena were observed before the 2011 Tohoku earthquake. As for the broad band seismic network; F-net, its availability was degraded from the end of December, 2010 to mid-January, 2011, then from mid-February to the beginning of March, and finally the main shock occurred on March 11, 2011. So, measuring results such as of GNSS etc. are added to further check the degraded periods of the F-net.

2 Analysis
It seems that the period of approximately 3 months before the earthquake was consisted of 3 stages indicated below.

First stage
Period: mid-December, 2010 to around January 28, 2011.
Analysis: Accumulation of strain in the continental plate reached upper limit in the Tohoku and Chubu regions. The continental plate stopped westward motion. The Pacific plate also stopped its advancement. Possibly as a result of such situation, the wide area in Japan showed abnormal situations.
Observed events:
·The Tohoku region which had been moving to west for years stopped westward motion on around January 28, 2011. On January 27, the westward motion of the ocean plate, i.e. the Pacific plate also stopped. It stopped movement till the main shock. The following situation was observed in around 1.5 months prior to this change.
·Abnormal values were observed in groundwater at the coastal area of Iwate prefecture from mid-December, 2010. On December 22, earthquake of M 7.4 occurred near Chichijima island. In January 2011, many low frequency earthquakes occurred directly under Hakoneyama mountains.
·F-net increased number of data-missing observation points since the end of December 2010, and it became four on January 14, 2011. The 4 points are Sanriku Coast - South of Hokkaido (2 points) and Noto - Izu Islands (2 points).
·According to GNSS, the entire Japan moved southward on January 5, 2011, and wide areas of Japan moved westward on January 23.

Second stage
Period: Around February 29, 2011 to around March 2, 2011
Analysis: As a result of the first stage, restless increase of stresses by the Pacific plate could not be accepted any more by the continental crust.
Observed events:
·The land that stopped westward movement on around January 28, 2011, changed direction of the movement for 180 degrees from January 29.
·Slow slip was observed near the epicenter area from January 29. This movement continued till just before M7.3 earthquake of March 9.
·February 13 to the end of February, Earthquakes of M5 or greater occurred near the starting point of the main shock.

·From February 16 to March 2, there was an increase in malfunction of the F-net. The largest number was 4 stations on February 18th. These are composed of 2 regions; Sanriku Coast - South of Hokkaido (3 places) and Gifu Prefecture (1 place).

Third stage
Period: Around March 8, 2011 to the main shock on March 11, 2011.
Analysis: Slipping of the continental plate started, and it lead to the main shock.
Observed events:
·On March 8, eastward movement of the Tohoku region was recorded by GNSS.
·The Sanriku-oki earthquake (M7.3) occurred on March 9. The earthquakes with magnitude of 6 followed.
·On March 11, The main shock of the Tohoku earthquake occurred.

Keywords: 2011Tohoku earthquake, F-net, GNSS

We were able to predict a foreshock and a main shock in an FM observation network by Kumamoto earthquake.

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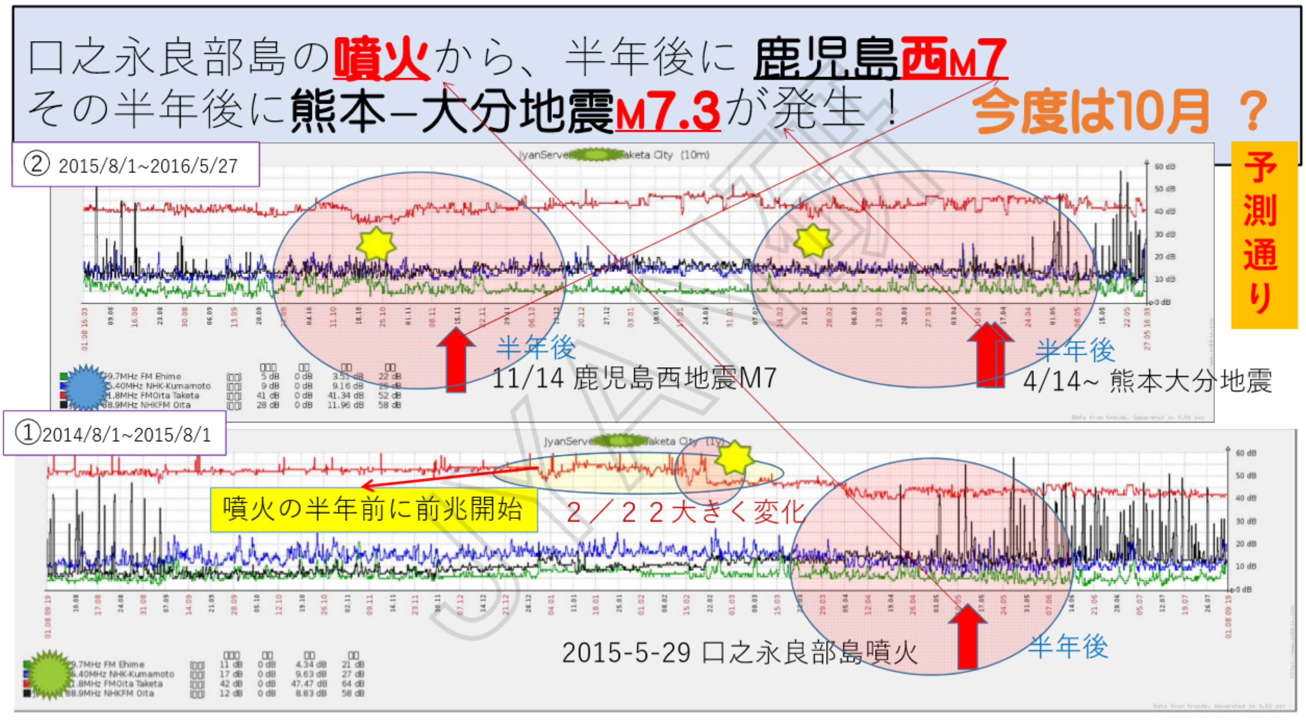
1. none

It's said that to foresee a natural phenomenon as an earthquake is difficult, but the earthquake prediction is possible. A natural phenomenon always has the cause, and as a result, a phenomenon occurs. When this cause can be grasped, you can foresee a result. So we have begun to observe the earth to grasp the cause of the earthquake. But, it's understood only from a tremor just before the earthquake occurring by a seismometer. So a radio wave with a lot of presage testimony and an electromagnetic observation have been begun. To grasp an electromagnetic field change in the surface of the earth at present, an observation network is being even constructed and observed. When this gazed at the radio wave change which propagates the ground and removes the influence by which direct observation networks of a FM broadcasting radio wave are weather changes and sporadic E layers, etc. in particular, it's possible to read direct electromagnetic field change by influence and noise from underground. There are Nagano earthquake, Fukushima earthquake, Awajishima earthquake and Kumamoto earthquake as the example. A presage of a main shock showed clearly with a foreshock because of the Kumamoto earthquake in particular. Basic theory of an electromagnetic observation is a principle street of the energy and the electromagnetism to which I say "When a thing moves, electromagnetism occurs.", but a big electromagnetic change also generates an earthquake phenomenon by a friction in the crust in an observation example. When using the big change phenomenon which shows before about 1 week in particular, it can be the accident prevention information which had a plenty of leeway timewise. So an observation example of the above other ones was elucidated, but an electromagnetic observation found out that that an eruption also exerts a big change on the crust shows in observational data. An electromagnetic change started with this phenomenon from an eruption in Okinoerabushima, and Kagoshima west and Kumamoto* followed Tottori earthquake quite and. Movement of the crust change seems to need time of the class half year, but a series of electromagnetic change which indicates the relation between the eruption and the continuous earthquake certainly shows. Please see observational data and a correlation chart. (For an observation chart, the transverse = hour and the vertical axis= electric field strength and color= observation bureau)

Keywords: Foretelling an earthquake, Electric wave observation, An observation network of Eruption, An electromagnetic field


口之永良部島の噴火から、半年後に 鹿児島西M7
その半年後に熊本−大分地震M7.3が発生！
今度は10月 ？
予測通り
② 2015/8/1~2016/5/27
半年後
11/14 鹿児島西地震M7
半年後
4/14~ 熊本大分地震
①2014/8/1~2015/8/1
噴火の半年前に前兆開始
２／２２大きく変化
2015-5-29 口之永良部島噴火
半年後