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

HDS030-01 Room:101 Time:May 26 16:30-16:45

Performance of Earthquake Early Warning of JMA ? present status and improvement

Toshihiro Shimoyama[1*], Kazuyuki Hirano[1], Yasuyuki Yamada[1], Mitsuyuki Hoshiba[2], Kazuo Ohtake[2], Kazuhiro Iwakiri[2]

[1]Japan Meteorological Agency, [2]Meteorological Research Institute

Japan Meteorological Agency(JMA) started to provide EEW to a limited number of users from August 2006, and started to the public through TV and radio in October 2007. The Meteorological Law amended in December 2007 was provided that EEW should be as forecast or warning of strong ground motions caused by an earthquake.

From October, 2007 to December, 2010, JMA issued 17 warnings to the public and issued 1756 forecasts. For 7 cases for which maximum seismic intensity "5 lower" was actually observed, JMA did not issue warnings because of underestimation of the strong ground motion. .

In 2010, warnings were issued for 5 events - M7.2 earthquake occurred at Near Okinawajima island on 27,February, M6.7 earthquake occurred East off Fukushima prefecture on 14 March, M5.7 earthquake occurred Western Fukushima prefecture on 29,September, M4.7 earthquake occurred Mid Niigata prefecture on 3,October and M4.6 earthquake occurred Ishikari depression on 2 December. For Western Fukushima prefecture event, EEW system estimated focal depth deeper than the actual one. (depth of JMA catalogue:8km -> depth of EEW Warning:120km) Therefore, EEW system overestimated its magnitude (magnitude of JMA catarlogue:M5.7 -> magnitude of EEW warning:M6.6), and issued Warning including area where observed intensity was much smaller than "5lower".

JMA has been enhancing seismic observation network, and improving the method in order to issue more accurate and more rapid EEW.

For example, until March 2011, JMA is going to apply empirically estimated site amplification factors for predicting seismic intensities. JMA is going to use new seismic stations - 10 free surface stations in Nansei-shoto Islands in Kagoshima and Okinawa prefecture , Niijma island in Tokyo prefecture and Beppu in Oita prefecture.

In addition, we are planning to use data from NIED's seismometers installed in boreholes at depth of more than 1000m from surface in Tokyo metropolitan area.

In this presentation, we will present evaluation of the performance of EEW issuance, problem and various efforts to improve EEW of JMA.

Keywords: Earthquake Early Warning, Warning event

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

HDS030-02 Room:101 Time:May 26 16:45-17:00

Examination of the On-site Earthquake Warning System by Boring Seismograph Data

Kiyoshi Takano[1*], Yusuke Awata[2]

[1]III and ERI, theUuniversity of Tokyo, [2]Graduate School of Frontier Sciences,The

In our country, a lot of public earthquake observation facilities are maintained. If the data of these seismographs will be used for the on-site earthquake warning system, we will be able to build up the ideal early warning system that can apply from the near regional large earthquakes to the far great earthquakes by combining with the JMA EEW.

In the public earthquake observation facilities, there are a lot of observation facilities where the boring seismograph set up under the soil.
The noise of these boring seismograph are very low compared with the ground level seismograph, and the earthequake detection time can be earlier if the seismobraph was set in the very deep well of about 1000m class.
However it is not easy to forecast a strong shake of the ground level from the underground observational data by the influence of the subsurface layer.

We examined the technique for forecasting a strong shake of the ground level from the P wave part of the underground observational data.
We are adopted the simple seismic intensity which can obtain by real-time processing as a predictive index.

We examined the effectiveness by using the data of the ground level and underground level strong motion record of Tokyo Electric Power Company Kashiwazaki and KiK-net of the NIED, and obtained the forecasting formula of the underground seismograph.

It is thought that it is possible to offer the on-site earthquake warning for the regional area of the site by making the similar forcasting formula for each borehole seismograph.

Keywords: Boring Seismograph, On-site Earthquake Warning, Earthquake Early Warning

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

HDS030-03 Room:101 Time:May 26 17:00-17:15

Development of the new EEW method available for the area near hypocenter

Shuichi Taya[1*], Satoshi Kodama[1], Shigeru Nakajima[1], Satsuki Shimono[2], Kentaroh Ohba[3], Hiroshi Nakamura[4]

[1]Central Japan Railway Co.,Ltd., [2]ANET Co.,Ltd., [3]MSS Co.,Ltd., [4]RION Co.,Ltd.

1. Introduction

The Earthquake Early Warning system is expected for earthquake disaster mitigation. However, the method on this system has a problem that warning for the area near the hypocenter is not in time for the arrival of the strong ground motion.To solve the problem, we proposed the new seismic intensity (called 'Iap') computed from the vertical acceleration and the new EEW method using this intensity (Taya, et.al (2007)). This report is described the best threshold level of Iap warning and new methods of judging whether detected-shake is the earthquake (called 'Earthquake-Noise Judgment').

2. The best threshold level of Iap warning

In this analysis, 84 K-NET waveform data (for events of Ijma >= 4.5 and hypocentral distance < 30km) were used. The warning thresholds were set by 3.0~3.4. Timings of Iap warning were calculated. It was found that the new method could warn earlier than old one and could reduce unnecessary warnings if the warning threshold level was set by 3.4.

3. The new methods of Earthquake-Noise Judgment

The EEW seismograph might detect an abnormal shake that causes the false warning. To prevent the false warning, it must judge whether the detected-shake is the earthquake within very short time. In addition, waveforms of abnormal shake have some types. Therefore, the EEW seismograph must have some methods of Earthquake-Noise Judgment adapted to each waveform type. One of the feature of abnormal shake, the amplitude of the initial part of wave exceeds thousands Gals so rapidly. Aiming at this feature caused by electric noises, it was found that the detected-shake was considered to be a noise if the amplitude of the initial part of the wave exceeded the certain limit, defined by the maximum amplitude of the initial part of earthquakes.

4. Development of the new EEW seismograph

The new EEW seismograph based on SM-27 (made by RION Co.,Ltd.) was developed. Now it has been tested in the factory. It will be set up on the wayside of the Tokaido Shinkansen.

Keywords: Earthquake Early Warning, seismograph, Iap, Earthquake-Noise Judgment

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

HDS030-04 Room:101 Time:May 26 17:15-17:30

A new method for estimating epicentral distance using very initial phase of single station data

Shunroku Yamamoto[1*], Shunta Noda[1], Masahiro Korenaga[1], Shinji Sato[1], Naoyasu Iwata[1]

[1]Railway Technical Research Institute

Since estimation of epicentral distance using single station data plays is an essential part of the Shinkansen EEW system or the JMA EEW system, its accuracy and rapidness are expected to be improved. The B-delta method (Odaka et al., 2003) adopted by the present systems assumes that amplitude envelope of initial P-wave is effected by both epicentral distance and magnitude. On the other hand, Yamamoto et al. (2010) pointed out amplitude envelope of very initial phase (0.0 - 0.5 sec) has little relationship with magnitude by an analysis of real-time seismic intensities. Here, a new method for estimating epicentral distance is proposed on the basis of the result mentioned above.

The proposed method uses a fitting function, $y(t) = C\,t$, where y, t and C are amplitude envelope, time after P-wave detection and coefficient corresponding to epicentral distance respectively. Once coefficient C is obtained by fitting the function to observed envelope of the very initial phase, epicentral distance can be estimated from empirical relation between C and the distance. Band pass filter (10 - 20 Hz) is applied to recorded wave as a pre-process in order to reduce effects of surface amplification or rupture process.

To confirm performance of this method, estimation errors (RMS in log scale) are calculated by using 2237 waves of 23 earthquakes recorded by K-NET. Estimation errors are 0.303 and 0.316 for 0.5-sec and 2.0-sec time window respectively. The estimation error by this method using 0.5-sec time window is reduced by 4 % comparing with the error by the B-delta method using 2.0-sec time window. This result demonstrates very high potential of the method for EEW.

Keywords: earthquake early warning, single station, epicentral distance

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

HDS030-05 Room:101 Time:May 26 17:30-17:45

Estimation of epicentral distance taking account of the effect of viscous attenuation for single station method of EEW

Shunta Noda[1*], Shunroku Yamamoto[1], Naoyasu Iwata[1], Masahiro Korenaga[1], Shinji Sato[1]

[1]Railway Technical Research Institute

1. Introduction

A single station method (an on-site method), which can estimate earthquake parameters (epicenter locations and magnitude) by using single station data, is now in use for the present Earthquake Early Warning system of JMA and Shinkansen. Although the method has higher rapidness, lower accuracy to estimate earthquake parameters is pointed out compared to multi station methods (network methods).

The B-Delta method (Odaka et al., 2003) is used as one of components of the single station method to estimate epicentral distance. In the method, a function Bt∗exp(-At) is fitted to the initial phase of P-wave in order to estimate epicentral distance (Delta), which negatively correlates with the coefficient B. The coefficient B represents increasing ratio of amplitude of the initial phase. On the other hand, Yamamoto et al. (2010) proposed a new method using a simple function Ct for fitting, called the C-Delta method. The coefficient C also represents the increasing ratio of initial phase.

In the conventional B-Delta method, relationship between B and Delta is expressed as LogB=a∗Log(Delta)+b taking account of only geometrical attenuation. Since the coefficient B or C have high correlation with amplitude, it is natural to take viscous attenuation into account. Therefore, we propose the following equation to express the relationship between B (or C) and Delta, LogB=c∗Log(Delta)+d∗(Delta)+e (B can be replaced by C). The first and second term of right side of the equation indicate geometric and viscous attenuation, respectively. In general, the farther the epicentral distance is, the greater the effect of viscous attenuation relatively is. In this study, we investigate effect of the viscous attenuation term on estimation accuracy.

2. Analysis and Result

First, B and C are calculated from K-NET acceleration records for M>5.0 earthquakes. The functions Bt∗exp(-At) and Ct are fitted to the initial phase of P-wave which is filtered by 10-20 Hz band-pass. 2-second and 0.5-second data from P-wave arrival are fitted by Bt∗exp(-At) and Ct, respectively.

Second, regression analysis is carried out by fitting equations, a∗Log(Delta)+b and c∗Log(Delta)+d∗(Delta)+e, to B or C. In this analysis, data are selected according to Fukushima and Tanaka(1990) to avoid the problem due to S/N ratio.

We calculate errors (RMS) between true Delta and Delta estimated from the relationship obtained above. As results, in case that epicentral distance is less than 100km, errors taking account of viscous attenuation are almost same to ones without viscous attenuation. However, in case that epicentral distance exceeds 100km, errors taking account of viscous attenuation are decreased by 25% compared to ones without viscous attenuation. We have the same results for both the case of B and the case of C.

Those results demonstrate that the equation c∗Log(Delta)+d∗(Delta)+e which includes viscous attenuation is more appropriate to estimate epicentral distance accurately for the B-Delta and the C-Delta methods.

Keywords: Earthquake Early Warning, single station method, on site method, B-Delta method

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

HDS030-06 Room:101 Time:May 26 17:45-18:00

Estimation of extended source area from vertical PGA saturation during a great earthquake for upgrading the EEW system

Susumu Kurahashi[1*], Masaki Kazuaki[1], Irikura Kojiro[1]

[1] Aichi Institute of Tecnology

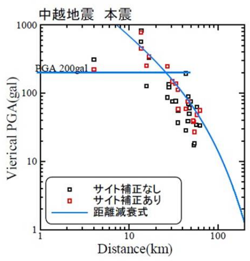
1. Introduction

The Earthquake Early Warning (EEW) system by JMA in Japan provides the coordinate of the starting point, the origin time and the magnitude of target earthquakes based on a point source assumption. The seismic intensity at each site is calculated by using an attenuation distance relation and site amplification from the magnitude and hypocentral distance provided from the EEW. However, during large earthquakes, the calculated seismic intensity might be underestimated in comparison with the observed one. Because a large earthquake has not a point but an extended source, the distances from the earthquake rupture area to observed sites are different from the hypocentral distances assuming a point source. In the Tokai area, the calculated seismic intensity might be about one or two scales smaller than the observed one as long as the Tonankai earthquake would occur off Shionomisaki. It is effective to estimate the rupture extension of the large earthquake from real-time observed records close to the rupture area to prevent underestimation of the seismic intensity in the Tokai area. We have examined to estimate the rupture extension of large earthquake from attenuation distance relation peak ground acceleration (PGA) of P-waves. As a result, we can provide the information about the rupture extension before the arrival of the S-waves (Kurahashi et al., 2009). However, the PGA so far used did not exclude the site effect. In this study, we try to obtain site effects of vertical component for estimate absolute saturation levels of PGA near rupture areas. The site effects were defined as the ratio of the observed PGA and the calculated PGA from the attenuation distance relation.

2 Attenuation distance relations of vertical motions

First, we estimated the attenuation distance relations of vertical motions. We used the observed records of the mainshocks and aftershocks in the 2004 Chuetsu earthquake and 2008 Iwate Miyagi nairiku earthquake. The observed records were used within 120 km in hypocentral distance to exclude the influence of the reflected waves from the moho on the motions. Regression equation for attenuation distance relations of vertical motions is expressed as (1). This equation corresponds to a simple point source with geometrical spreading and constant Q. Therefore this equation is appropriate for small earthquakes. The coefficients of regressions were estimated by two step method (Joyner and Boore, 1981). Next, the site effects were calculated the ratio of observed PGA and calculated PGA. As a result, there is no great distinction between the site effects of horizontal PGA and those of vertical PGA. The absolute saturation levels of PGA are obtained from the attenuation distance relations of vertical motions by removing the site effects. Figure1 shows the attenuation distance relations of PGA during the 2004 Chuetsu earthquake correcting the site effects of vertical motions. The absolute saturation levels of PGA during the 2004 Chuetsu earthquake were estimated about 200gal. However, a detailed examination is necessary for determining the absolute saturation levels because the number of data is not many.

$$\log(PGA) = aMw - \log(r) - br + c \qquad (1)$$



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

HDS030-07 Room:101 Time:May 26 18:00-18:15

Expectation of ground motion using real time data of neighbor and front stations

Mitsuyuki Hoshiba[1*]

[1]Meteorological Research Institute

Earthquake Early Warning(EEW) has been operated nationwide in Japan by Japan Meteorological Agency(JMA). JMA EEW basically adopts a network method, in which hypocenter and magnitude (source parameters) are determined quickly, and then issue warnings. In this method, though we can expect ground motions using a few parameters (location of hypocenter, magnitude, site factors), error of source parameters leads directly to the error of the expectation, and it is not easy to take the effects of rupture directivity and source extent into account. In this presentation, we propose a method which uses real time waveform data of neighbor and front stations, In the method, though real time data is needed, relatively precise prediction is expected even when effects of rupture directivity or source extent are dominant.

For the analysis, we use borehole data (depth of borehole ranges 500 to 3500m), and also data from 2003 Tokachi Oki Earthquake (M:8.0) and 1994 Sanriku Haruka Oki Earthquake(M7.6).

Regarding the borehole, at SITH01, for instance, the accelerometers are located at surface and at a depth of 3500m. The borehole accelerometer detects S waves 3 sec earlier than the surface. The difference of site factors corresponds 1.3 on JMA intensity. The intensity at surface is expected 3 sec earlier by simply adding 1.3 to the observed intensity at borehole in real time manner. Regarding the Tokachi Oki Earthquake, the intensity is expected 7 sec earlier by using data at station which located 30km apart. For Sanriku earthquake, we try to modify the fault extent.

Acknowlegments. Data from K-NET, KiK-net of NIED, and JMA seismic intensity meters are used.

Keywords: Earthquake Early Warning, Expectation of seismic intensity, Deep borehole, real time manner, source region

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

HDS030-08 Room:101 Time:May 26 18:15-18:30

Utilization of Earthquake Early Warning and On-Site Strong Motion to disaster mitigation for High-Rise Building

Tomohiro Kubo[1*], Yoshiaki Hisada[1], Masahiro Murakami[1]

[1]Kogakuin University

The building manager must make not only the fire scheme for the large-scale building such as a high-rise building, but also the disaster prevention plan, due to Fire Service Act gone into effect on June 1, 2009. However, many high-rise buildings do not have the disaster prevention plan and system.

After a major earthquake, the about 10 security officers have to manage to rescue trapping people in the elevator and respond to the people in the building, gather the damage information of the building.

According to the above problems, we developed the Initial Response Support System for High-Rise Building using Earthquake Early Warning and On-site Strong Motion Data in order to carry out the initial response during a major earthquake. Furthermore, we applied the system to a high-rise building and studied the utilization of the system based on the PDCA (Plan Do Check Action) cycle.

As the result of the disaster drill, we found many people ignored the earthquake early warning announcement and did not avoid from the hazardous area and material. Therefore, we disseminate the response when people heard the earthquake early warning and confirm the necessity of the public outreach and education to utilize the information and warning.

Keywords: Earthquake Early Warning System, On-Site Strong Motion, Earthquake Disaster drill, Initial Response Plan

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

HDS030-P01 Room:Convention Hall Time:May 26 14:00-16:30

A development of simulation tools for WIN system

Hiroshi Tsuruoka[1*]

[1]ERI, Univ. Tokyo

A simulations tool for WIN system was developed. It can play and record of real-time waveform data distribution. This tool enables us to develop and to test Earthquake Early Warning systems or real-time earthquake analysis systems.

Keywords: EEW, WIN, Simulation

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

HDS030-P02 Room:Convention Hall Time:May 26 14:00-16:30

The feature in the initial P-wave amplitude and the advanced method to estimate epicentral distance using single station

Masahiro Korenaga[1*], Shunroku Yamamoto[1], Shunta Noda[1], Naoyasu Iwata[1], Shinji Sato[1]

[1]Railway Technical Research Institute

To estimate epicentral distance using single station data, the B-delta method (Odaka et al., 2003) and the C-delta (Yamamoto, 2010) method are proposed. In these techniques, the coefficient that is calculated by fitting the function to amplitude envelope of the initial P-wave is used to presume epicentral distance. In this study, we confirmed the feature in acceleration amplitude of the initial P-wave, and verified performance of advanced method to estimate epicentral distance using single station data.

First, we grouped seismic waveform data according to hypocentral distances and magnitudes. And we averaged time histories of each group data to examine their features. It is found that the amplitude in the very initial phase (0.5 - 0.7 sec) has a tendency to monotonically increase. And the ratio of amplitude increment doesn't depend on magnitudes but depends on only hypocentral distances. In addition, the ratio can be approximated roughly by a linear function.

Next, we examined the data length to fit a function. We presumed the epicentral distance while increasing the data length by 0.1 seconds, and calculated estimation error in each case. The fitting function was assumed a simple linear function used in the C-delta method. As a result, the estimation error by the linear function using 0.3 sec data length is almost equal to the error by B-delta method (2.0 sec time length). Further, the estimation error by the linear function is converged to minimum roughly at 0.5 - 0.7 seconds, and decreases by 15% comparing with the error by B-delta method (2.0 sec time length).

Keywords: C-delta method, Single station data, Method to estimate epicentral distance

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

HDS030-P03 Room:Convention Hall Time:May 26 14:00-16:30

A proposal for Gridsearch method used in JMA EEW

Kazuo Ohtake[1*]

[1]Meteorological Research Institute

The Gridsearch method used in JMA Earthquake Early Warning, is a method being used when data from 3 to 5 stations are available. Though, when station arrangement is not good, hypocenter determined by the method is rather unstable.

In this presentation, we will introduce a new weighting technique to the Gridsearch method to stabilize hypocenter determination.

Keywords: Earthquake Early Warning, Gridsearch method

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

HDS030-P04 Room:Convention Hall Time:May 26 14:00-16:30

Improvement on Method toward Automating Determination of Earthquake Fault Planes and Slip Distributions

Hiroko Matsui[1], Keiko Kuge[1*]

[1]Dept. Geophysics, Kyoto University

The earthquake source parameters (the geometry, size, and slip distribution of earthquake faults) are important for estimating the characteristics of strong ground motions caused by large earthquakes. To reduce the time taken for the determination of the source parameters, the use of automation without the need for human inspections is inevitable. However, such automation is now limited to determination of point-source moment tensors. Generally, when a point-source moment tensor gives two candidates for a fault plane, one chooses which is the fault plane, by seeing the aftershock distribution and other information (e.g. an active fault map). Determination of earthquake fault planes and moment-release distributions has not been automated yet.

Based on seismic waveform modeling, Kuge (BSSA, 2003) proposed the method that can be automated, which composes of three steps providing point-source moment tensor solutions, fault planes and their length, and distributions of moment release on the finite faults. The method was tested for five Japanese inland earthquakes in the period from 1995 to 2000. The results suggested that the method enabled us to automate the determination of fault planes and moment-release distributions. On the other hand, most of the earthquakes tested by Kuge (2003) were strike-slip earthquakes. It was still uncertain how well the method can work with dip-slip earthquakes.

We applied Kuge (2003)'s method to recent large shallow earthquakes in the period from 2003 to 2008. The JMA magnitude of the earthquakes is larger than 6.7, and the depth is shallower than 60 km. We used the waveform data from KiK-net and K-NET. In this study, we especially focused on the results of the 2008 Iwate-Miyagi Nairiku, the 2007 Noto-Hanto, the 2005 Fukuoka Seiho-Oki , the 2004 Niigata Chuetsu earthquakes because the earthquake source processes, which include the fault planes and moment-release distributions, have been well investigated by previous studies. By comparing our results to the previous studies, we found that the method fails to determine the correct fault planes for the dip-slip earthquakes when data close to the epicenters were used. Performing further tests for the earthquakes having the problem, we improved the method in order to reduce the time and obtain correct results.

Acknowledgments: We used data from K-NET and KiK-net.

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

HDS030-P05 Room:Convention Hall Time:May 26 14:00-16:30

Expectation of seismic intensity for EEW using amplitude spectral ratio of surface and borehole

Kazuhiro Iwakiri[1*], Mitsuyuki Hoshiba[1]

[1]Meteorological Research Institute

JMA is preparing to utilize acceleration records in borehole (depth from 500m to 3510m) and on surface at the KiK-net stations (installed and operated by NIED) in Kanto district for the earthquake early warning (EEW). Iwakiri et al. (2010) picked the onset of P- and S-phase, and obtained the results that the arrival time differences between borehole and surface sensors are 1.2 sec for P-phase and 3 sec for S-phase. In the current EEW of JMA, the seismic intensity is expected using some empirical relations such as an attenuation relation based on hypocenter and magnitude. In this study, we suppose that seismic intensity on surface is expected from borehole observation data using the empirical amplification factor at surface with respect to borehole sensor without hypocenter and magnitude. As the empirical amplification factor, we evaluate maximum amplitude ratio, seismic intensity difference, and amplitude spectral ratio of surface and borehole for P- and S-wave portions.

Acceleration data recorded in borehole and on surface were obtained from NIED web site. The dominant frequency of the most earthquakes analyzed in Iwakiri et al. (2010) was high-frequency because of short epicentral distance. Therefore we add earthquakes of magnitude 6 or larger without limitation of epicentral distance, for which dominant frequency is low-frequency.

Noise level in borehole is lower than that on surface at all stations for especially high-frequency. Signal to noise ratio (S/N) in borehole is lower in all frequency than that on surface at all stations. The spectral ratio is evaluated for frequency band of S/N more than 3. The maximum amplitude ratios of surface and borehole for P- and S-wave portions are comparable at most stations. However, while the spectral ratio for P-wave portion is larger in high frequency than that for S-wave, the spectral ratio for S-wave portion is larger in low frequency than that for P-wave. The spectral ratio for S-wave portion is larger than that of P-wave portion at all stations for frequency range (0.5Hz - 1Hz) which affects JMA seismic intensity. The difference of the ratios between P- and S-wave portions is a problem in automatic processing for EEW, because it is difficult to distinguish completely between P- and S-wave. In this presentation, we will compare the accuracies of expected seismic intensity using the seismic intensity difference, and also using the spectral ratio as the empirical amplification factor.

Acknowledgment: We used KiK-net observation data operated by NIED.

Keywords: earthquake early warning, expected seismic intensity, borehole, spectral ratio

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

HDS030-P06 Room:Convention Hall Time:May 26 14:00-16:30

Investigation of intensity magnitude estimates for improving an earthquake early warning system

Paul Rydelek[1], Akiko Hasemi[2*], Kazuki Koketsu[1], Shigeki Horiuchi[3]

[1]ERI, Univ. Tokyo, [2]Yamagata Univ., [3]Home Seismometer (Corp.)

The rapid determination of earthquake location and magnitude are key parameters in an earthquake early warning system. These (and other) parameters are estimated by automated systems that perform real-time analyses of the seismic waveform data recorded by the dense seismic arrays in Japan. In particular, a new source parameter, called Mi, is used to determine the seismic intensity magnitude, which can be estimated from the P-wave data recorded during the early stages of fault rupture for larger earthquakes M $>$ 6.5. Therefore, a real-time warning can be especially beneficial in mitigating the damages from a large subduction zone earthquake. We find the use of Mi can result in a significant improvement in both the speed and reduction of uncertainty in the predicted shaking from the damaging S-waves when compared to estimates derived from earthquake magnitude. However, we are also finding systematic differences between shaking intensity magnitude and moment magnitude that are related to hypocentral distances, the locations and/or type of earthquakes and site effects.

We examined 18,250 Mi data, and found that difference from Mw becomes large with epicentral distance. Mi is larger than Mw by about 1.0 at 400km epicentral distance. Efforts are underway to understand and provide a correction factor that will help to reduce this discrepancy and therefore provide a more reliably estimate of the expected shaking intensity. A better understanding of the important site corrections is relevant not only to applications in a real-time warning system but also will help to improve the reliability of seismic shake maps that are used to access the damages from large earthquakes.

Keywords: earthquake early warning system, intensity magnitude, EEW

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

HDS030-P07 Room:Convention Hall Time:May 26 14:00-16:30

Experiment of Earthquake Early Warning system via the wireless communication network such as the WiMAX

Shohei Naito[1*], Hiromitsu Nakamura[1]

[1]NIED

The earthquake early warning (EEW) information to the general public was started by the Japan Meteorological Agency on October 2007. On the other hand, due to the recent development of telecommunications infrastructure, many kinds of wireless services such as WiMAX have been released, and have became more convenient as a result that a service area expanded and baud rate became speedy. We thought that will be able to develop EEW more easily by using the wireless communication services. Therefore, this study aims to investigate the effectiveness of using wireless network as receiving EEW.

For an overview of the experiment, we made the test environment in Tokyo, received EEW by the terminal via a public wireless access service provider, and analyzed logs obtained by a network protocol analyzer. We tested four major wireless services, and the results were shown as follows:

The capacity utilization was nearly 99 percent over all carriers.

The average delay before receiving EEW was approximately from 30 to 400 milliseconds, and it was confirmed some differences in the distribution of delay time per carriers.

All four carriers have specifications of regularly and automatically disconnecting so that produce about 2 minutes off every 6 or 24 hours.

We may conclude by these results, we have to note that there are some differences in communication characteristics of each carriers, in this regard, we can understand the wireless access has an ability to use for EEW.

Keywords: Earthquake Early Warning System, wireless communication