Japan Geoscience Union Meeting 2011
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HDS030-P01 Room:Convention Hall Time:May 26 14:00-16:30

A development of simulation tools for WIN system

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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

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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

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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

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

A proposal for Gridsearch method used in JMA EEW

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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

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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

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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.

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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

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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

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

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

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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

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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

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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