Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

STT56-01 Room:102B Time:May 19 11:00-11:15

Development of ocean bottom cabled seismic and tsunami observation system using ICT

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The Pacific plate is subducting below the northeastern Japan islands arc. The 2011 Tohoku earthquake occurred at the plate boundary between the Pacific plate and the landward plate below landward slope of the Japan trench. In 1996, Earthquake Research Institute, University of Tokyo had installed seismic and tsunami observation system using seafloor optical fiber in the off-Sanriku area. The cabled system observed seismic waves and tsunamis generated by the 2011 Tohoku earthquake, and the data from the system are indispensable to estimate the source process of the 2011 event. However, the landing station of the system was damaged by huge tsunami 30 minutes after the mainshock. Therefore we decide to install newly developed Ocean Bottom Cabled Seismic and Tsunami (OBCST) observation system off Sanriku to continue the sea floor observation.

Until 2010, we had already developed and installed the new compact Ocean Bottom Cabled Seismometer system near Awashima-island in the Japan Sea. After the installation, data are being collected continuously and we have continuous seismic data for approximately 2.5 years at the present. The new system for off-Sanriku area is based on this system. The new OBCST has three accelerometers as a seismic sensor. Signals from accelerometers are 24-bit digitized with a sampling rate of 1 kHz and sent to a landing station using standard TCP/IP data transmission. A precise pressure gauge is equipped as a tsunami sensor. The tsunami data are also transmitted by TCP/IP protocol. In addition, we have a plan that an observation node has an external port for additional observation sensor which will install on seafloor using Power over Ethernet technology. The data will be stored on the landing station and sent to Earthquake Research Institute in the real-time. At the present, we are producing a proto-type of the new OBCST. In this paper, we will present a system of the new OBCST in detail, and installation plan.

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STT56-02 Room:102B Time:May 19 11:15-11:30

Modeling of time series structure of seismic waveforms based on hidden Markov models

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Modeling of time series structure of seismic waveforms allows to quantitatively evaluate time-series characteristics of waveforms or obtain clues about physical processes of earthquake generation. Modeled time series structure leads to phase detection, event classification, analysis of frequency structure, analysis of rupture process, and waveform synthesis. Hidden Markov model (HMM) is one of the typical methods for modeling time series structure statistically from observation data. In this study, we focus on phase detection and develop a new automatic detection method for first arrivals of P and S wave based on time series structure modeled by HMM. The new method is expected to demonstrate higher detection capability than conventional methods because information about time series of seismic events is incorporated directly in the new method.

Seismic events which occur in Ashio area (the western part of Tochigi Prefecture) at depths of 0 to 15 km are modeled in this study. Energy, polarity and higher order statistics are extracted as features from about 1,000 clear event waveforms observed from 2009 to 2011 at E.ASO, which is one of the observation points in Ashio. Three HMMs which represent noise, P wave and S wave are constructed from time series of the extracted features. A HMM which represents time series structure of event waveform is obtained by connecting the three HMMs. Detecting first arrivals of P and S wave of given seismic waveform is performed by inferring hidden states of the HMM from the waveform.

The automatic detection method based on HMM is compared with another method based on changes of amplitude and frequency (STA/LTA-AR method) using about 1,000 clear event waveforms observed in 2012 at E.ASO. For P wave, phase picking accuracy of the HMM-based method is equivalent to that of STA/LTA-AR method. For S wave, phase picking accuracy of the HMM-based method is higher than that of STA/LTA-AR method. It is thought that this high detection capability for S wave results from the process of detecting S wave arrival after recognizing subsequent waveforms of P and S wave.

Keywords: hidden Markov model, time series structure, automatic detection, seismicity

STT56-03 Room:102B Time:May 19 11:30-11:45

Development of a laser strain gradiometer for the observation of slow earthquakes

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New schemes of observing crustal deformation were considered to detect slow earthquakes with duration of about 200 s to 1 day, which have not been easily observed. Displacement caused by slow earthquakes was analyzed in terms of point dislocation in an infinite homogeneous medium. The amplitude and the spatial scale of the background motion were also calculated by the model known as the New Low Noise Model and the observations by laser strainmeters. Comparing the expected deformation by slow earthquakes with the calculated background motion, we found that the current observation systems do not have potential to observe them but we can observe them by measuring strain gradient of deformation. We developed a prototype instrument for directly measuring the strain gradient. Its temperature dependence and the noises of photodetectors were measured in our laboratory. Then the noise of the interferometer was measured at Nokogiriyama Observatory, ERI. Its noise was composed of the unknown noise which have $1/f^2$ spectrum and the noise caused by convection of the air. $1/f^2$ noise was coupled with the asymmetry of the interferometer. These noises were compared with the spectra of slow earthquakes and the background motion. It was suggested that with less asymmetry and a vacuum chamber, lengths of baselines should be more than 300m. Reduction of the $1/f^2$ noise will be required to detect slow earthquakes with realistic instruments. We present the current situation in reducing the noises and the prospect about observing strain gradient at one place.

Keywords: strainmeter, laser interferometer, slow earthquake

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STT56-04 Room:102B Time:May 19 11:45-12:00

Automatic arrival time picking compared to manual picking (4)

Shigeki Horiuchi[1*], Yuko Horiuchi[1], Yoshihisa Iio[2], Youichiro Takada[2], Yoshihiro Sawada[3], Shutaro Sekine[3], Takashi Nakayama[4], Satoshi Hirahara[4], Toshio Kono[4], Jyunichi Nakajima[4], Tomomi Okada[4], Norihito Umino[4], Akira Hasegawa[4], Kazushige Obara[5], KATO Aitaro[5], Masaru Nakano[6], Takeshi Nakamura[6]

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1.Introduction.

Recent installation of many ocean bottom seismometers and inexpensive seismic equipments increases the number of P and S wave arrival time data to be measured. The recent increases make the number beyond the limits in which we can conduct manual picking. The increase require the development of an automatic system which can measure accurate P and S wave arrival times compatible with manual picking. We are developing an intelligent automatic system by introducing the knowledge of seismic experts.

The automatic system was installed to Tohoku University and it locates hypocenters using real-time waveform data from entire stations in Japan. The automatic system is also applied to seismic data of swarm events in Fukushima-Ibaragi prefectures. This paper presents the results of above application.

2. A new method of hypocenter location

Previously developed automatic systems could not locate accurate hypocenters at a time when two events occur simultaneously. We proposed a new technique of hypocenter location for the automatic system. The method introduces an observed function similar with synthetic seismograms. The function becomes positive values in time periods near P and S arrival times and becomes zero except for these periods. We also introduce same function computed from theoretical travel times. Hypocenter is located by the grid search method so that theoretically computed function satisfies the observed functions for all stations.

3. result

(1) We copied continuous seismic waveform data for all available stations in Japan for a period of one day on September 03, 2011 from Hi-net web site. Our automatic system locates 1,316 events. There are 588 events in the JAM catalogue of the same day. The result shows that our system can locate 2.4 times of hypocenters compared to that in JMA catalogue. There are many events with magnitude larger than two which are not located by JMA. It is found from the check of computed result by the automatic system that there are 1-2% of incorrectly located events.

(2) The present system was installed at Tohoku University in December, 2012. It started to locate hypocenters by using entire real-time waveform data in Japan. It locates almost twice of hypocenters compared to JMA, who locates hypocenter by conducting manually picking. Detail of this result is presented by Nakayama et al. in this meeting.

(3) Earthquake Research Institute, University of Tokyo installed 60 sets of temporary seismic stations in area of Fukushima-Ibaragi prefectures, where earthquake swarm occur after the Off Tohoku Earthquake with magnitude M9.0. The observed continuous waveform data are applied to the present automatic system. About 140,000 events are accurately located. The detailed result is presented by Kato et al. in the present meeting. We computed RMS residuals of P and S wave for arrival times of all stations and all events. The computed RMS for P and S wave are 0.075 and 0.098 sec respectively. RMS values computed by using manually picked data are 0.065 and 0.137 sec. The comparison of these values shows that automatic system can pick more accurate S wave arrival times than manually picking.

Keywords: Automatic picking, automatic hypocenter location, high accuracy, compared to manual, JMA hypocenter, picking accuracy

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STT56-P01 Room:Convention Hall Time:May 19 18:15-19:30

Sea trials of new generation ocean bottom seismometer

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We developed a new generation of ocean bottom seismometer (OBS) for extensive seismic study, which designed to advance compactness, user-friendliness, and electrical/mechanical transmission response. The new OBS named OBS2G (2nd Generation OBS to Grid) is integrated in a 13-inch glass-sphere and its weight is just 35 kg in air including the sinker. Access to the stored data, parameter-setting, time-synchronization, and battery-charge are available without opening the glass-sphere by wireless transmission technique. The dynamic range of the seismic recorder is 135 dB at 100 Hz-sampling. OBS2G employs newly developed low-noise (< 7ng/Hz^1/2 at 10Hz) and low-power-consumption accelerometers (15mW). The simple exterior of the OBS2G improves its mechanical transmission response compared to conventional short-period OBS that has some resonances. Observation period of OBS2G is over 4 weeks with the accelerometers.

Currently we have achieved four times of sea trials with OBS2Gs. The recent two trials were conducted at deep waters on JAMSTEC research cruise KR12-12 and KR13-01. The first experiment was held in August 2012 in a water depth of 4,000 meters, the Nankai Trough off Shizuoka. Recent one was held in January 2013 with two OBS2G in water depths of 7,000 meters, the Japan Trench off Miyagi. We have successfully obtained good quality seismic data on both experiments. In this paper, we will briefly introduce characteristics of new OBS and features of acquired data.

Keywords: OBS, seismic

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STT56-P02 Room:Convention Hall Time:May 19 18:15-19:30

Ultra-deep ocean bottom seismographic observations just above the Japan Trench

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Recent giant earthquakes such as the 2011 Tohoku earthquake show large slip zones that generate huge tsunami can be located adjacent to trench. Observations in the vicinity are essential to resolve details of phenomena where the noticeable regions are. However, it is a challenging issue to observe earthquakes and their related phenomena just above the large slip zones because most trenches, which include the Japan Trench, are below ultra-deep sea, whose depth is over 6, 000 m. A number of ocean bottom seismometers (OBSs) have been used for marine seismic studies since last century, but most of them are available at less than 6,000 m water depth. Few seismometers equipped with special vessels have been to the deeper zones, but the specialties are barriers in order to make seismic array easily. It is one of the solutions if compact OBSs would be able to be set under ultra-deep sea. We have been developing several compact free-fall/pop-up type OBSs, which include a new type OBS, ultra-deep ocean bottom seismometer (UOBS). It is slightly improved for handling and safety, but basically designed just the same as conventional model for widespread utilization. The UOBS has already enabled to obtain seismic data from just above the Japan Trench since 2012. Each UOBS has a three-component seismometer, a data-logger with a precise clock and batteries inside a housing which is a single glass sphere (dia. 17 in.) with the transponder unit for acoustic communication to vessels, and radio beacon and flashing light for recovery. A prototype UOBS was installed to the sea bottom below more than 6,500 m from sea surface on May 2012. It was recovered after using acoustic transmission. A modified UOBS was deployed below over 7,500 m on August, and recovered on October 2012. We obtained the seismic data from both UOBSs.

Keywords: Ultra-deep ocean bottom seismometer (UOBS), Japan Trench

STT56-P03 Room:Convention Hall Time:May 19 18:15-19:30

Renewal of feed-back circuit in STS-1 broadband seismometer system

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STS-1 broadband seismometer is one of most popular broadband seismometers. The high performance with low instrument noise, high sensitivity and wide dynamic range supplied huge valuable data to seismologists. The production of STS-1 sensor and spare parts had been terminated, however many broadband networks are still using as main seismometer.

OHP seismic network also operates STS-1 sensor in the Western Pacific region. Usage period of the sensors have already been over 20 years. Mechanical body part that is kept in vacuumed and dry condition is still stable and intact status. However the characteristics of electric parts in feed-back and amplification circuit varied due to their life time. Practically some unstable and artificial signal is recorded in low background noise and stable stations.

Recently new feedback circuit box (STS1-E300) is developed and some seismic networks have started to use it. Our network is considering installation of new feed-back circuit to avoid problems by parts' aging. In this presentation, we will report the

New feed-back circuit box includes three components of outer electricity part in one body. It has serial communication port for command to the box for setting measurement mode (normal/maintenance), mass position control and calibration. In trial operation, all functions of the box are checked and operation procedure in our network is produced.

For the installation on site, stable power supply, re-structure of cable wires and interface to PC are required as accessory equipment. We designed and produced new control unit for new feed-back circuit box which is enables to be improved at OHP stations even in the case of unstable power condition.

Test measurement was performed with sensor mechanical part in room and at some our station to evaluate the control unit performance and stability. After test measurement, we installed new feed-back circuit box and control unit at OGS (Ogasawara) station officially this year. In early monitoring, artificial signal that was recorded in original configuration is erased and new system is recording stable signal. By common feed-back circuit, each sensitivity of output changes from original one, which is estimated by electric device constant. Evaluation of exact coefficient is required by other procedures.

Keywords: STS-1 seismometer, feed-back circuit, broadband seismometer, OHP network

STT56-P04 Room:Convention Hall Time:May 19 18:15-19:30

Performance of quartz nano-resolution accelerometer in tidal bands

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The quartz nano-resolution accelerometer developed by Quartz Seismic Sensors, Inc. detects acceleration in the range of +/-2g with high resolution through strain measurement of a quartz oscillator connected to a test mass. This makes use of the same technology of nano-counting as used in the nano-resolution barometer developed by Paroscientific, Inc. We made a parallel observation with this accelerometer and the superconducting gravimeter T011 at the Matsushiro Seismological Observatory, Japan Meteorological Agency, in order to examine the performance of the quartz accelerometer in the tidal frequency bands.

The accelerometer was installed in the vertical orientation about 2 m apart from the superconducting gravimeter. We prepared a simple platform with adjustable feet to level the accelerometer. The sensor and the counter were covered by a polystyrene foam box for reducing the effect of ambient temperature changes. The acceleration output as well as sensor temperature were logged at the rate of 20 Hz. In addition, a platinum thermometer was installed to monitor the temperature in the box. Changes in the room temperature are about 0.1 degrees p-p per day, whereas the changes in the sensor temperature are about 0.02 degrees p-p per day.

Although at first the acceleration value indicated irregular drift and steps, the drift became almost linear with respect to time after two weeks. A tidal analysis of the data with BAYTAP-G revealed that the accelerometer records the tidal gravity signals correctly, approximately consistent with those derived from the superconducting gravimeter. On the other hand, it was also found that barometric admittance is anomalously large, suggesting existence of some instrumental effect of atmospheric pressure on the accelerometer. In addition, effects of temperature changes, which are compensated internally, are still identified in the residual data. Results of a more detailed analysis will be given in the presentation.

Keywords: nano-resolution, quartz accelerometer, superconducting gravimeter, earth tides

STT56-P05 Room:Convention Hall Time:May 19 18:15-19:30

Portable multi-channel seismic reflection system for high-resolution structural imaging

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Japan Agency for Marine-Earth Science and Technology (JAMSTEC) has been conducted seismic survey using multi-channel seismic reflection (MCS) system and ocean bottom seismometers (OBS) for understanding seismogenic and arc evolution processes. Existing seismic systems are large scale fixed-type on R/V Kairei and Kaiyo, which are research vessels of JAMSTEC, because targets are deep from crust to uppermost mantle. Recently, new demands for seismic surveys are increased as acquiring high-resolution data in shallow waters or arctic area for drilling and environmental researches. Therefore JAMSTEC has developed a new portable MCS system in 2011, which can easily be attached to or removed by vessels with cranes.

Four cruises have been conducted with newly developed portable MCS system. The first one was the first sea trial for the portable MCS system by R/V Kaiyo in the Sagami Bay, because sea condition is always calm and many previous seismic lines exist. We confirmed the high-resolution data from a comparison between the portable MCS data and previously acquired by R/V Kairei for deep imaging (Miura et al., 2013). Second cruise was dense 2D grid survey at the tow of the Japan Trench revealing deformation process at the tow of the trench (Kodaira et al., 2012), contributing for drill site selection (Mori et al., 2012) of Integrated Ocean Drilling Program (IODP). Third cruise was for high-resolution imaging of landward slope deformation and sedimentary sequences on oceanic crust around the Nankai Trough. And fourth one was the first cruise with R/V Mirai acquiring high-resolution images around the Nankai Trough partly overlapping the third cruise. In 2013, the portable MCS system will be used for seismic cruise of R/V Kairei. In this presentation, we will show the portable MCS system and examples of high resolution data comparing with existing data.

Keywords: high-resolution, multi-channel reflection seismic, seismic survey

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Evaluating performance of automatic earthquake detection and location system developed to the nationwide seismic network

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In addition to the nationwide dense Kiban seismic network, which is composed of about 1200 seismic stations, many temporary seismic networks with a variety of dimensions have been deployed in various areas in Japan. The number of seismic stations will increase even more. Ability of managing such a huge amount of seismic waveform data by manually picking P- and S-wave arrival times, P-wave polarities, S-wave maximum amplitudes etc. is limited, and therefore application of automatic earthquake detection and location system is anticipated.

Horiuchi et al. (2012) developed such an automatic processing system, and recently Horiuchi et al. (2013) have further developed the system for the application to the nationwide seismic network. This system was set up at Tohoku University, and automatic detection and location processing for the nationwide seismic network has started. It can detect and locate many earthquakes which are difficult to be located by the routine processing based on manual pickings of P- and S-wave arrivals. However, sometimes earthquakes cannot be correctly discriminated by the system: for example, when more than two earthquakes occur almost simultaneously.

In order to consider the application of automatic earthquake detection and location system to the actual seismic network, we need to know its performance. When earthquakes are detected and located by the system, how correctly P- and S-wave arrival times can be picked, and how accurately their hypocenters can be determined? How well is the detection capability of the system in region to region? In which case the system cannot detect or cannot correctly discriminate earthquakes?

To answer these questions, we have started to evaluate performance of the earthquake detection and location system presently developed for the application to the nationwide seismic network. Preliminary results obtained for 1 week period data show that the automatic system can detect and locate earthquakes about 1.5 times more than those in the JMA unified catalogue, which were located by manually picked P- and S-wave arrival times. Frequency distribution of magnitudes shows that the automatic system extends the lower limit of the detection capability to much smaller magnitude range than that by the JMA unified catalogue. Events with magnitudes greater than ˜0.0 can be located in the inland areas of Japan by the presently developed automatic processing system. We will report evaluation results of performance of the system applying to much longer period data.

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STT56-P07 Room:Convention Hall Time:May 19 18:15-19:30

Development of a system for old seismological records using ZOOMA technology

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We digitized the old seismological records that are stored in WAKAYAMA Observatory of Earthquake Research Institute, applying ZOOMA technology. The digitized data are published at http://wwweic.eri.u-tokyo.ac.jp/ZOOMA/WSO/.

Keywords: old seismological record, zooma

STT56-P08 Room:Convention Hall Time:May 19 18:15-19:30

Seismograms observed by a strong-motion seismograph at Matsushiro

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At Matsushiro Seismological Observatory, a strong-motion seismograph started from September, 1951 (Yamazaki and Kobayashi, 2006), and a strong motion seismograph has been working still now.Many of the earthquake records on strong-motion seismograph were recorded by the Matsushiro Earthquake Swarm. Matsushiro Earthquake Swarm started in August, 1965 at the Matsushiro town in the Nagano city. The greatest magnitude of Matsushiro Earthquake Swarm was 5.4 which occurred on April 5, 1966.Except the Matsushiro Earthquake Swarm, a few earthquake records on strong-motion seismograph were recorded by large earthquakes with serious damage in Japan, such as the 1995 Southern Hyogo Prefecture Earthquake, the 2004 Mid Niigata Prefecture Earthquake, and the 2011 Off the Pacific Coast of Tohoku Earthquake.In the foreign earthquake, very few earthquake records on strong-motion seismograph were recorded by very large foreign earthquake with serious damage, such as the Off of Sumatra Earthquake of Indonesia on December 26, 2004 and the Sichuan Earthquake of China on May 12, 2008.In order to use these analog records practically, we investigated seismic waveforms on the strong-motion seismograph.

(1)Magnitude

In domestic 628 earthquakes, the minimum magnitude of 346 earthquakes recorded by strong-motion seismograph in the Matsusiro Earthquake Swarm is about magnitude 3, that of 25 earthquakes recorded by strong-motion seismograph around Nagano Prefecture is about magnitude 4 and that of 257 earthquakes recorded by strong-motion seismograph outside of Nagano Prefecture is about magnitude 5.In foreign 52 earthquakes, the minimum magnitude is more than 7. The furthest earthquake recorded by strong-motion seismograph was near India on January 26, 2001(magnitude7.7).

(2) The number of events with each area

When we divided Japan into East Japan and West Japan with the boundary of Nagano Prefecture except the outskirts of Nagano Prefecture, 221 events are in the East Japan and 36 events are in the West Japan.In the foreign earthquakes, 16 events are around the Kuril Islands, 3 events are around the Vladivostok, 4 events are around the Aleutian Islands, 4 events are around the Micronesia, 7 events are around the Philippine Islands, 10 events are around the Indonesia Islands, 6 events are in the China and 2 events are around the India. Frequency of events is biased in each area.

(3) The waveform feature of strong-motion seismogram

In Japan earthquakes, the maximum amplitude and the period of strong-motion seismograph by Matsushiro Earthquake Swarm on April 5, 1966 were about 5 mm and 1-2 seconds, these of strong-motion seismograph by the Southern Hyogo Prefecture Earthquake on January 17, 1995 were about 9 mm and 4-5 seconds, these of strong- motion seismograph by the Mid Niigata Prefecture Earthquake on October 23, 2004 were about 6 mm and 2-4 seconds and these of strong-motion seismograph by the Off the Pacific Coast of Tohoku Earthquake on March 11, 2011 were about 20 mm and 4-7 seconds.In foreign earthquakes, the maximum amplitude and the period of strong-motion seismograph by the Off of Sumatra Earthquake on December 26, 2004 were about 2 mm and 15-20 seconds, these of strong-motion seismograph by the Sichuan Earthquake on May 12, 2008 were 1 mm and 10-15 seconds.In Japan and foreign earthquakes, we have no over-scale strong-motion seismograph. When magnitude of earthquake was larger than 8, the period of strong-motion seismograph was longer than 35 seconds.

For this reason, the strong-motion seismograph were recorded by large earthquakes with serious damage in domestic and foreign earthquakes, and the earthquake with the largest amplitude was the Off of the Pacific Coast Tohoku Earthquake on March 11, 2011.

Keywords: strong-motion seismograph, magnitude, maximum amplitude, period

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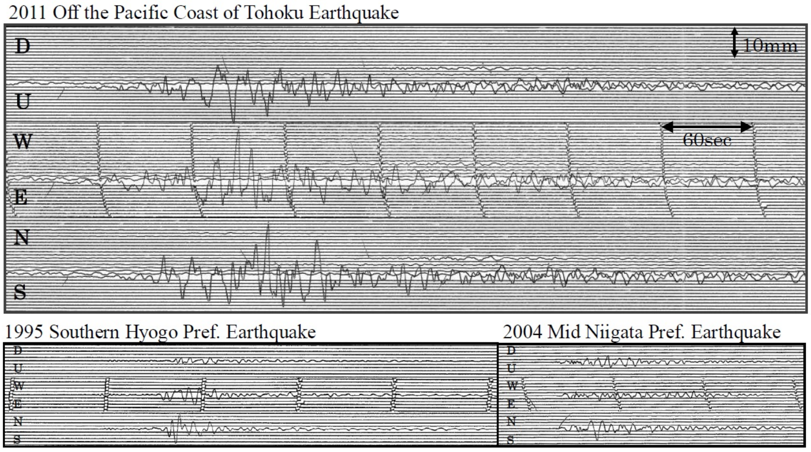

STT56-P09 Room:Convention Hall Time:May 19 18:15-19:30

The accuracy evaluation of sampling clock of Hi-net and data correction for precise measurement of travel time

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Recently, attempts have been made to detect of seismic travel time change with the use of Hi-net data by various approaches. For example, one to tens of msec of delay in seismic travel time associated with the 2011 M9.0 Tohoku-Oki earthquake were detected by the methods of ACROSS, seismic interferometry, repeating earthquake and so on. For precise measurement of slight change of seismic travel time, synchronization of clock between sources and receivers or receivers and receivers is absolutely essential, but accuracy estimation of sampling clock of Hi-net is not always sufficient so far.

In this study, sensor check signal is used to evaluation and correction of sampling clock of Hi-net data acquisition system. The sensor check signal is a response waveform of seismometer for applied square-wave voltage with 5 seconds in duration to calibration coil. The square-wave voltage is generated by ON/OFF action of DC voltage source by a mechanical relay with 1pps timing of a GPS clock. That's timing is independent of sampling clock, therefore we can potentially check accuracy of the sampling clock on the basis of the GPS clock by using the sensor check signal. The important things here are stability of mechanical relay action and seismometer phase characteristics. The timing of sensor check signal was researched by cross-spectral method at 24 Hi-net stations for the eight years from 2004 to 2012.

Consequently it was revealed that OFF timing of mechanical relay is stable at all stations and there is little variation of temporal change of phase characteristics for high frequency band at a distant from natural frequency ~ 1Hz. Delay time of sensor check signal, starting at 5 seconds past 9 a.m. every day, was analyzed by cross-spectral method. Reference waveform is a month stacked data, Dec. 2012. Delay time of sensor check signal, that is to say sampling clock timing, changes like a stepwise function overlapped with random fluctuate related to data noise level. These results applied to travel time change data Hi-net Yaotsu (11.3km) and Hi-net Hourai(56.9km). Stepwise travel time change disappeared without change in the event of large earthquake, and annual and secular travel time change became clear.

The precision of clock is a foundation of modern science. For seismic measurement to be modern science, explicit information of precision of sampling clock is absolutely needed at a very least. Hereafter, I hope to get and circulate the information of clock correction of all Hi-net stations, and replaced data logger with accurate sampling clock.

Acknowledgement: Hi-net data are provided by National Research Institute for Earth Science and Disaster Prevention, Japan (NIED). Toki ACROSS transmitting station is managed by Japan Atomic Energy Agency (JAEA). I got any information of mechanical relay from Keisokugiken corporation.

Keywords: seismic velocity change, sensor check signal, cross-spectrum, seismic ACROSS

STT56-P10 Room:Convention Hall Time:May 19 18:15-19:30

Comparison of instrumental Mercalli seismic intensities

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The Mercalli intensity scale is widely used in the world. There have been many reports about relationships among the seismic intensity and instrumental measurements such as PGV. We compared several methods to calculate instrumental seismic intensity as one of collaborative works with Chile.

We used regression relationships of the modified Mercalli seismic intensity with PGA, PGV (Wald et al., 1999 : MMI(PGA), MMI(PGV)) and with amplitude used for the JMA instrumental seismic intensity (Shabestari and Yamazaki, 2001: MMI(JMA)). The regression relationships by Wald et al.(1999) are valid in 5-8 for MMI(PGA) , and 5-9 for MMI(PGV). We used acceleration records obtain by University of Chile for the 2010 Chili earthquakes. The number of stations are nine. The JMA instrumental seismic intensity were calculated also, and they range from 4.8 to 5.6.

The differences among MMI(PGA), MMI(PGV), and MMI(JMA) reached 1.6, the the difference is not negligible. The rms of MMI(PGA)-MMI(PGV) is 0.5, 0.7 for MMI(PGA)-MMI(JMA), and 0.4 for MMI(PGV)-MMI(JMA). MMI(PGA)-MMI(PGV) clearly has positive correlation with intensity. Whereas MMI(JMA) is a little smaller than MMI(PGV), the difference does not show clear correlation with the instrumental seismic intensity.

We will increase number of data, and investigate the instrumental seismic intensities with felt seismic intensity.

Keywords: instrumental seismic intensity, modified Mercalli seismic intensity, the 2010 Chile earthquake

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Efforts for the manpower training in JMA, for system development of earthquake and tsunami monitoring

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The Japan Meteorological Agency (JMA) has been developing and operating systems to issue disaster prevention information such as Tsunami Warnings and Earthquake Early Warnings. The systems are composed by various equipments including seismographs, telemeter systems and servers with many software components installed, for handling observation data and issuing information. The units need to be rapid, accurate and reliable for our purpose. To develop such systems, we need wide range of knowledge and technologies such as geophysics and computer science. However, we have had few opportunities to acquire knowledge from these extensive fields for our purpose. The development of our systems has been depended on small number of experienced staffs. To cope with this issue, JMA has been operating "the training course of technologies for seismological service management" for three years in cooperation with Dr. Urabe and Dr. Tsuruoka, from Earthquake Research Institute, University of Tokyo. We introduce the overview of this course, and suggest a path for raising system developers of earthquake and tsunami monitoring systems.

Keywords: automatic processing system, development of human resources, disaster prevention information