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]

[1]Homeseismometer Corporation, [2]Disaster Prevention Research Institute Kyoto University, [3]Association for the Development of Earthquake Prediction, [4]Research Center for Prediction of Earthquake and Volcanic Eruptions, [5]Earthquake Research Institute, The University of Tokyo, [6]Japan Agency for Marine-Science and Technology

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