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Operating Status and Technical Improvement Plan of JMA Earthquake Early Warning

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Japan Meteorological Agency (JMA) started from August 2006 to provide Earthquake Early Warning (EEW) to a limited number of users who understand the technical limit of EEW and can utilize it for automatic control. This type of JMA EEW was defined as "Forecast" on 1 December 2007 in the Meteorological Service Law. Then, JMA started to provide EEW to the general public in October 2007. This adding type was defined as "Warning" on 1 December 2007.

JMA's EEW definitely means information of expected seismic intensity and arrival time of the strong ground motion after fault rupture occurs. In other words, the JMA's EEW is defined as a forecast of a strong ground motion before the strong motion arrival. It is issued by using JMA seismic intensity scale. JMA's EEW has mainly two techniques. One is quick determination of location, magnitude and origin time. The other is expectation of JMA seismic intensity by using attenuation relation in which the strong motions are evaluated based on the magnitude and location.

There are two categories for JMA EEW, that is, "Warning" and "Forecast".

When the expected JMA seismic intensity exceeds 5Lower on JMA scale, EEW will be issued as "Warning" to general public for regions where seismic intensity 4 or over is anticipated. The Warning is to the general public through various media such as television, radio, cellular phone, etc. The "Warning" notices merely anticipation of strong ground motions without respective seismic intensities nor arrival time.

When the expected JMA seismic intensity exceeds 3, or magnitude of the detected earthquake exceeds 3.5, EEW will be issued as "Forecast". The forecast includes expected JMA seismic intensity and expected arrival time of S-phase of the seismic wave for regions where the expected seismic intensity is 3 or over. Estimation of the location and magnitude will be revised successively as available seismic data increase. The Forecast is to advanced users through EEW receivers, dedicated systems that provided by private companies.

For the Iwate-Miyagi Nairiku Earthquake (M7.2, June 14, 2008; seismic intensity 6Upper was observed near the epicenter), JMA provided an EEW message to the general public (Warning) 4.5 seconds after the first detection of the seismic wave, which means 15 seconds before S wave arrival at Sendai city where seismic intensity of 5Upper was observed. For this event, a revised EEW Warning was issued 22.4 seconds after the first detection of the seismic wave. In this event, a lot of reactions from recipients of EEW were reported. It is reported that managers successfully controlled elevators, factory systems, and even the airplane using EEW. There were also reports of utilization at kindergartens or nurseries where infants and children got together in the middle of the room to prepare for the strong motion safely under the supervision of the adults.

In this presentation, we will summarize the 4 years performance of the EEW system. We evaluate 2435 cases for which JMA issued EEWs during August 2006 - July 2010, and show some cases of "Warning" which are issued to general public, and then report recent EEW's technical improvement. For example, in August 2009, JMA applied new method of magnitude of P-wave and began to use new seismic stations - 5 ocean bottom seismographs and 2 free surface stations -.

Case study: The Iwate-Miyagi Nairiku Earthquake(2008/6/14 8:43 M7.2)

Table 1 Time history of EEW

Issuance #	Issue time	Elapse time from the detection (in second)	Latitude (degree)	Longitude (degree)	Depth	M	Estimated maximum intensity	
1st	08:43:54.2	3.5	38.9	141.1	10km	5.7	5Lower	*estimated with a single station
2nd	08:43:55.2	4.5	39.1	141.0	10km	6.1	5Upper	EEW for General Public (1st Warning)
3rd	08:43:56.1	5.4	39.0	140.9	10km	6.2	5Upper	
4th	08:43:56.8	6.1	39.0	140.9	10km	6.3	5Upper	
5th	08:43:59.1	8.4	39.0	140.9	10km	6.7	6Upper	
6th	08:44:02.1	11.4	39.0	140.9	10km	6.7	6Upper	
7th	08:44:13.1	22.4	39.0	140.9	10km	6.9	6Upper	EEW for General Public (2nd Warning)
8th	08:44:21.1	30.4	39.0	140.9	10km	7.0	6Upper	
9th	08:44:42.1	51.4	39.0	140.9	10km	7.0	6Upper	
10th	08:44:53.6	62.9	39.0	140.9	10km	7.0	6Upper	

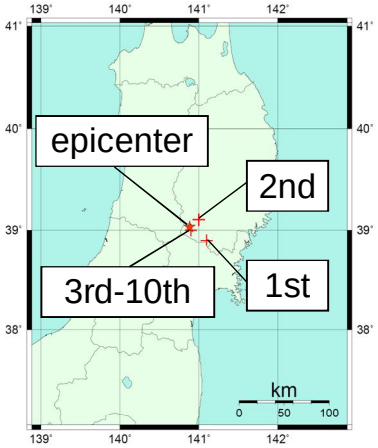

Fig1. Time history of estimated epicenter location

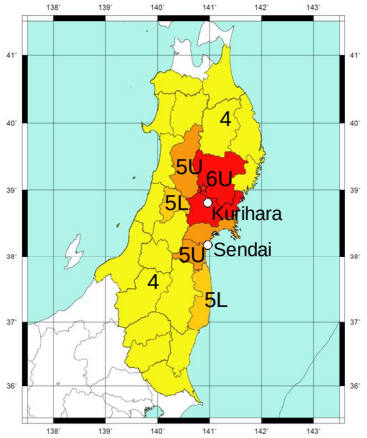

Fig.2 Observed maximum seismic intensity in each subprefectural area

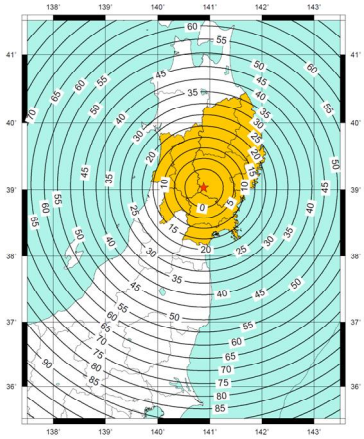

Fig.3 1st warning Concentric circles with numerals denote contour curves of available time, in seconds, for S- wave arrival.