Focal parameters estimation method to be used in JMA Nowcast Earthquake Information -2- Magnitude estimation

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Magnitude estimation method to be used in JMA Nowcast Earthquake Information is introduced. Considering the reliance of the dedicated link and time delay, acceleration waveform data from JMA seismic network is used for the time being.

To supply reliable information to the customer with enough time to get ready for the strong motion arrival, quick and precise focal parameters estimation is essential. But, larger the event is, which is exactly the target of Nowcast Earthquake Information, more difficult the magnitude estimation becomes in a short time, because of the finite time to complete the rupture. So, JMA will begin to estimate the magnitude from 3 seconds after the P phase detection, and continually update it using the latest updated hypocenter and maximum amplitude.

From the first 3 seconds of the waveform, A-value(Odaka et.al.(2001) : Bt*exp(-At) fitting to the envelope) can be extracted as well as the maximum amplitude. We calculated 957 A-values for 32 events, and found only one sample with final magnitude(Mj:JMA magnitude) less than 6.0 out of 67 negative A-values. We will judge that final magnitude will be more than or equal to 6.0 for negative A-value in a high probability. This is in accordance with the scaling law that the source duration is about 5 seconds for magnitude 6 event, because negative A-value represents the continuous growth of the envelope in the first 3 seconds.

We will use the following formula to calculate magnitude by using the latest updated hypocenter and maximum amplitude.

a1*M = log10(Amax) + log10(R) + a2*R + a3 , where R : Hypocentral distance(km)

Two formulas are prepared, one with Amax within P phase, the other irrespective of the phase type, and switched from the former to the later at the time of predicted S arrival, to get reliable magnitude estimation as quickly as possible.

We used two step stratified method(Joyner & Boore(1981)) for the formula coefficients determination using maximum acceleration amplitude, and got the consistent coefficients with previous studies that a1 should be less than 1.0 for velocity or acceleration and a2 is about 1to3E-3.

Thus determined formula with maximum acceleration amplitude gave substantial scatter of estimated station magnitude around referenced Mj, we determined the similar formula using maximum displacement amplitude by the integration and highpass filtering, and found scatter reduction to about 60% of that for acceleration.