Determining Magnitude of Large Earthquake in Japan using Seismic Stations in China

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Rapid determination of earthquake magnitude is of importance for estimating shaking damages, and tsunami hazards. However, due to the complexity of source process, it is still a challenge for great earthquakes to accurately estimate magnitude in minutes after origin time. A recent example is the 2011 M 9 Tohoku, Japan earthquake.
Here we determine the magnitudes of eleven M ≧7.0 (USGS) shallow earthquakes that occurred in and around Japan from 2008 to 2016, using seismic data recorded in China and across the global. The magnitude is estimated by considering P-wave maximum displacement of global stations and source duration derived from back-projection using dense seismic stations in China.
The results agree well with the Mw estimated from W-phase inversion, with a standard deviation of 0.19, and suggest that the magnitudes can be accurately estimated in 3 to 9 min after origin times of earthquakes, depending on the epicenter distances to seismic stations in China. For the case of the 2011 M 9 Tohoku, Japan earthquake, the magnitude is estimated as to be 9.1, 9.0, 8.8, 8.9 at 3, 5, 7, 9 min after the origin time, respectively.
We use station corrections derived from nearby earthquakes to perform back-projection. The final source durations don’ t show significant variations, demonstrating that the magnitude of earthquake can be estimated with the pre-stored database of station corrections. Therefore, we propose to build an automated system for determining magnitude of large earthquake in and around Japan using real-time seismic data in China and across the global, for disaster mitigation right after a damaging earthquake, especially when dealing with the tsunami evacuation and emergency rescue.

Keywords: real-time, large earthquakes, back-projection

