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Correction of Magnitude depending on lapse time

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Magnitude used in Earthquake Early Waning, EEW, is estimated from the waveform with limited elapsed time from P phase. In the method of JMA EEW, magnitude, M, is estimated from maximum displacement amplitude in the limited lapse time window. The effect of the limited time window is not taken into account, so the limited time window may lead to an underestimation of M. In this presentation, we will discuss the effect of the limited time window when estimating P wave M.
JMA unified catalog and KiK-net waveform data are used in this analysis for events of M>5, focal depth <30km, and hypocentral distance <100km. For displacement waveform, filter simulating characteristics of JMA equi-magnification strong displacement meter is applied, which is the same characteristic as used in current JMA EEW.
Lapse time dependence on M estimation is analyzed. In case of short lapse time from P wave onset, estimated magnitude is underestimated. For station M estimated at an individual station, it does not depend on M in case that the time window is 1 sec from P wave onset. This means that it is difficult to forecast the final M from short lapse time. The underestimation is significant for M> 5.5 for 2 sec time window, and M>6 for 3 sec time window. Even less than the M, the underestimation is recognized. Because the maximum amplitude of acceleration waveform is earlier than that of displacement waveform and the duration of rupture process of M5 event is approximately 1 sec, the underestimation is due to wave propagation (and/or signal processing) effect in addition to rupture process.
Maximum amplitude of acceleration waveform appears earlier than that of displacement amplitude. This means that the M from acceleration amplitude may be able to estimate correctly earlier than that from displacement. However scatter of individual station M of acceleration is larger than that of displacement, which means that M of displacement is more accurate than that of acceleration when only a few stations are available. Because introduction of site amplification correction decreases the scatter for M estimation, the site correction is applied. Even after the site correction, however, the scatter of station M of acceleration is larger than that of displacement. Correction can be applied to the underestimation of M of displacement amplitude of short time window due to wave propagation (and/or signal processing). Scatter of station M of displacement amplitude is smaller than that of acceleration amplitude after site correction. These suggest that the displacement amplitude has advantage to acceleration for the purpose of M estimation when only a few stations are available.
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Keywords: Earthquake Early Warning, Magnitude, Displacement, Acceleration