Geophysical Research Abstracts,
Vol. 11, EGU2009-2206, 2009
EGU General Assembly 2009


# On Estimation of Earthquake Magnitude and Intensity of Shaking

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Determination of earthquake magnitude and the strength of shaking at a site from the initial P-wave portion of ground notion is the key problems for earthquake Early Warning (EEW). In this study we selected two parameters of ground motion, namely – characteristic period, which is used for magnitude estimation, and instrumental JMA intensity, which characterizes the level of shaking. We analyzed performance of the parameters scaling relations using datasets collected in various seismic regions in respect of (a) characteristics of datasets accumulated in the regions; (b) variation of initial conditions applying when determining the parameters (length of P-wave windows, number of stations used); (c) possible combinations of the parameters. The used datasets include more than 5350 records that were obtained from more than 130 earthquakes (moment magnitude range 4.1 – 7.6) occurred in Japan, Taiwan and California. We give a particular attention to the problem of proper consideration of errors in the measured and the predicting parameters when applying statistical analysis of the data, e.g. in characteristic period – earthquake magnitude relationship.

We have found that the scaling relationship between the characteristic period and moment magnitude in general allows predicting earthquake magnitude within $\pm 1.0$ units for 90% confidence limits, when (a) using time interval of at least 2-3 seconds from P-wave arrival and (b) averaging the data from at least 3-4 close-in stations. It seems that the accuracy of prediction can be increased by taking into consideration factors, which may change frequency content of initial P-wave motion, e.g. influence of propagation path (shallow and deep earthquakes), or local site conditions.

The quality of predictions of macroseismic intensity (JMA scale) of the strongest part of shaking from the initial portion of P-wave depends on duration of the portion and availability of additional information about earthquake characteristics (magnitude and distance). For 2-seconds time interval, for example, the average errors of prediction may vary from 0.5 JMA units for the case of “blind” prediction (no information about earthquake characteristics is available) to 0.3 JMA units when earthquake magnitude and source-to-distance are known. However, the accuracy of “blind” prediction may be increased when using the characteristic period as a proxy for magnitude. The uncertainty of prediction of macroseismic intensity may also be reduced when considering local site conditions in the scaling relations or creating station-specific models.