Construction of Relationship between Fourier Amplitude Spectrum and JMA Seismic Intensity

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The relation between JMA seismic intensity and PGA, PGV or response spectrum has been studied by many researchers (e.g. Sakai *et al*, 2004, Fujimoto and Midorikawa, 2010). In this study, we derive the relation between the JMA seismic intensity and Fourier amplitude spectra.
We used 178,728 strong motion records of K-NET recorded from May 1996 to June 2011. Fourier amplitudes are obtained at the frequency of 1-10 Hz by estimating the average amplitude every 1Hz within a ±0.5Hz range. We used the linear relation between the Fourier amplitude spectrum FS(f) and seismic intensity I as follows,
I = sum[A(f)*logFS(f)] + B
where, f is frequency; 1-10 Hz in every 1Hz, A(f) and B are unknown parameters.
We used the least square method to obtain the unknown parameters. However, taking into consideration previous studies on frequency distribution of seismic intensity, and because the number of lower intensity data is overwhelmingly larger than that of the higher intensity data, we also adopted the weighted least square method. The relation between frequency distribution n(I) and seismic intensity I at a certain observation station is generally written as log n(I) = a –b*I (Utsu, 1999). We used the value of b=0.5, and used 1/ n(I) for weights in the weighted least square analysis.
Comparing the calculated intensity (Ical) obtained by FS(f) to the observed intensity (Iobs) obtained directly from the seismic records, we found that the weighed least square method fits the observations better than the non-weighted method at higher seismic intensities. The slopes of the regression line based on Ical and Iobs are just about 1 (45 deg. in the figures). This means that the results of the least square analyses are plausible, while the distribution of the plots based on Ical and Iobs may show some bias.
Seismic intensity data are essential in order to estimate the source parameters of historical earthquakes, because no instrumental records exist in this period. It is preferable to calculate the seismic intensity distributions in a broad area, because the seismic intensities do not always display a concentric distribution. This kind of abnormal intensity distribution phenomenon is caused by inhomogeneities of the seismic quality factor Q. We developed a method by which strong ground motions can be predicted considering a 3-D attenuation structure (Nakamura *et al*., 2009, 2015). Using this prediction method we can obtain the Fourier amplitude spectrum at a certain station. Thus we are able to simulate seismic intensities considering a 3-D Q structure, using the relationship between the JMA seismic intensity and Fourier amplitude spectra obtained in this study. In addition, several studies have obtained a 3-D Q structure using the t* method (e.g. Panayotopoulos *et al*., 2015). Since Fourier amplitude spectrum can also be calculated by this method, seismic intensity can be obtained using the relation between the JMA seismic intensity and Fourier amplitude spectra proposed by this study.
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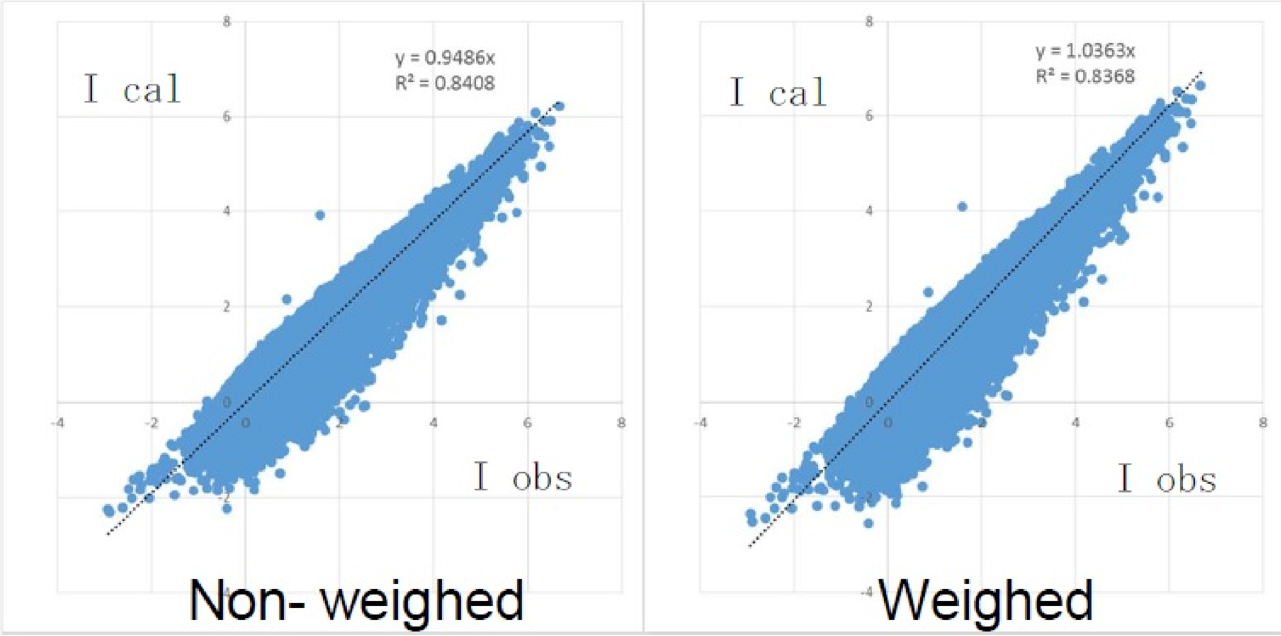
Keywords: Fourier Amplitude Spectrum , Seismic Intensity, K-NET



O-C の平均と標準偏差(赤字が良好の部分)

Data		Non-weighted	Weighted
All	ave	0.000	−0.109
	1σ	0.351	0.372
Iobs≧3	ave	0.350	0.067
	1σ	0.336	0.335
Iobs≧4	ave	0.461	0.124
	1σ	0.343	0.342
Iobs≧5	ave	0.504	0.108
	1σ	0.347	0.342
Iobs≧6	ave	0.651	0.203
	1σ	0.309	0.315

図1　回帰係数を用いた予測と観測の比較

Fig.1 Comparison between Iobs and Ical