Study of Average Envelopes of Small Earthquakes II: Systematic Analysis in the Area of the Tonankai-Nankai Earthquakes

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Average envelopes (mean square amplitude time histories) of small earthquakes represent a convenient basis for the construction of semi-empirical stochastic Green functions, used for prediction of future strong ground motions. Petukhin and Gusev (2003) proposed method for estimation of the average envelopes at rock sites based on assumption of self-similarity of envelopes and applied it for Kamchatka. Self-similarity means that average envelopes of small earthquakes have similar shapes and controlled by two scaling parameters: amplitude and duration. Petukhin and Kagawa (2003) applied this method for Kinki area in Japan; they also introduced and estimated average envelope site corrections for sedimentary (Osaka basin) sites. In this work we continue these studies of the average envelope shapes and will estimate average envelopes for a wide region adjoining to the Tonankai and Nankai earthquakes.

First, we slightly modified methodology: to estimate duration scaling parameter, instead of using the RMS-duration in earlier work, here we used the envelope-delay time Tenv (also known as group-delay time). The new duration parameter is less affected by the coda waves or by the asymmetry of record. Second, we divided studied region into a few large zones according to tectonical and geological structure: Volcanic Front (VF) in the north, Accretion Zone (AZ) in the south (south of the Median Tectonic Line), and a Middle Zone (MZ) between them. The last one was subdivided into West MZ (WMZ) and East MZ (EMZ) by the Hanaory-Rokko-Nojima tectonic line. Records of shallow, upper crust events were studied in these zones. Third, to study depth dependence of the average envelopes we also analyzed records from deep events, having paths cross to the Phillipine Sea subduction zone in Kinki Region. In this work we estimated dependence of scaling parameter Tenv vs. hypocentral distance R, and average envelope shapes for bedrock sites and for each zone separately.

Results of analysis of Tenv(R) show that it is well described by a twofold piecewise-linear function in log-log scale with the corner at R 30-50km for shallow events and at R 70-100km for deep events. For shallow events the exponent of the dependence Tenv(R) is larger for the short distance branch, around 0.9-1.4 depending on the zone and frequency, and smaller for the long distance branch, around 0.2-0.7. For deep events the tendency is opposite: 0.5-0.7 and 1.2-1.7 respectively. Results for Tenv(R) show minor difference between shallow zones. Stable difference (in all distance range and at all frequencies) was observed only between VF and WMZ, it is around 0.1-0.15 log10 values, smaller for WMZ and larger for VF. This indicates higher heterogeneity in upper crust under the volcanic front. Tenv values for deep events are remarkably smaller than Tenv for shallow events (see Figure 1) and indicate lower heterogeneity in lower crust and mantle wedge. For the case of Tonankai and Nankai earthquakes, similarity of results for shallow earthquakes show, that except for the deepest asperities, the same average envelopes (for example average between AZ, WMZ and EMZ zones, see Figure 2) can be used for stochastic Green function simulation of strong ground motions.

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References

Petukhin A. and A.Gusev,(2003). Pure appl. geophys., 160, 1717-1743.

Petukhin A. and T.Kagawa,(2003). 2003 Japan Earth and Planetary Science Joint Meeting, Abstracts, S046-P007.

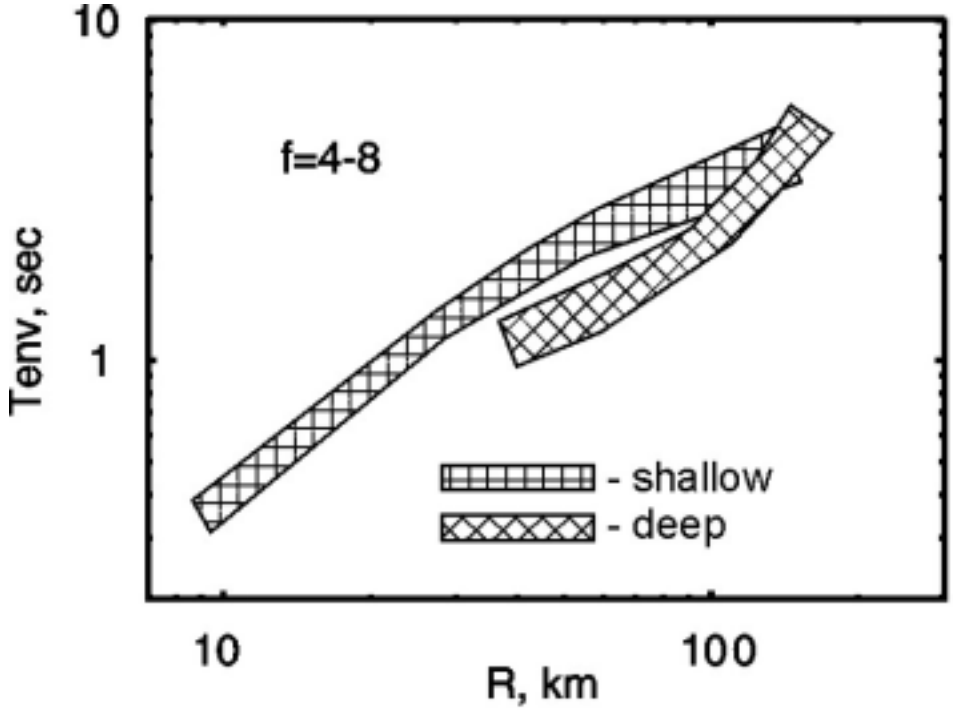
10
1
Tenv, sec
f=4-8
- shallow
- deep
10
100
R, km

Fig. 1

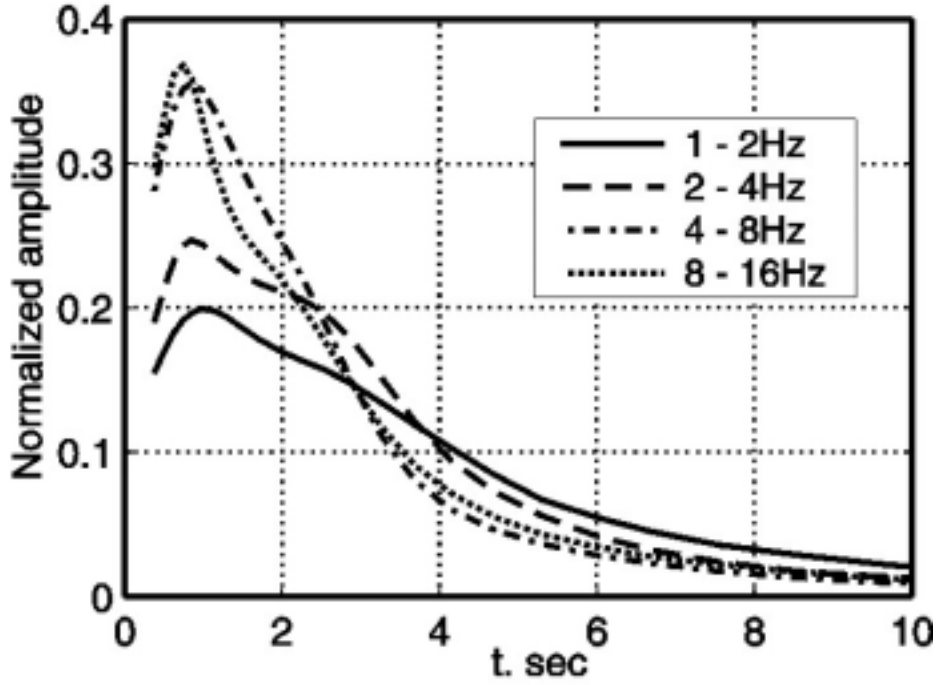
0.4
0.3
0.2
0.1
0
Normalized amplitude
1 - 2Hz
2 - 4Hz
4 - 8Hz
8 - 16Hz
0
2
4
6
8
10
t. sec

Fig. 2