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Third corner frequency of moderate Kamchatka earthquakes: station estimates agree over a network

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An acceleration spectrum of a local earthquake, after reduction to the source, is typically approximated (following Aki, 1967; Brune, 1970) by high frequency (HF) plateau. At the low-frequency side this plateau is bounded by a cutoff at the corner frequency f_c; often this corner is split into two located at f_{c1} and f_{c2}. Hanks (1982) emphasized the "f_{max}" phenomenon: even after correction for along-path attenuation the spectral plateau shows HF cutoff at a certain frequency f_{max}. Gusev (1983) and Papageorgiou and Aki (1983) ascribed its origin to the source. Anderson and Hough (1984), however, have shown that a near-site constant-Q attenuation layer of limited thickness commonly exists, whose effect mimics source-related cutoff. Therefore, source acceleration spectrum can be thought as flat up to infinity. Still, evidence was accumulating year by year which indicates that the "f_{max}" feature may represent, at least sometimes, a combined effect of two constituents: "source-controlled f_{max}" and "site-controlled f_{max}". Recently Gusev and Guseva (2014) showed the existence of "source-controlled f_{max}", relabeled as f_{c3}, for majority of moderate Kamchatka subduction earthquakes using single-station data for 1993-2005. In that study, observed spectra were approximated, after reduction to the source, by a three-cornered shape, and three parameters f_{c1}, f_{c2}, and f_{c3} were picked from them. The present study employs similar approach. S-wave records were used of horizontal channels of six rock-ground Kamchatka stations obtained from 372 subduction earthquakes of 2011-2014. The range of magnitudes is *ML* = 4-6.8, the range of hypocentral distances is 50–250 km. To reduce a recorded spectrum to the source, loss parameters used were estimated beforehand (Gusev and Guseva, 2015). Spectral amplifications of individual stations due to site effects were found empirically using both S-waves and coda. Using site corrections, loss-corrected spectra were reduced: first to the hard-rock PET station; second, to uniform medium. Overall, 1252 S source spectra were analyzed; and corner frequency sets were obtained for each, consisting of $\{f_{c1}, f_{c2}, f_{c3}\}$ triples; some of these were incomplete. Event estimates for f_{c1}, f_{c2}, and f_{c3}, obtained independently from data of each station, were then analyzed. About 90% of spectra featured f_{c3}; in 10% of cases, no HF cutoff was seen up to 25 Hz. The inter-station scatter among $\log_{10} f_{c1}$, $\log_{10} f_{c2}$ and $\log_{10} f_{c3}$ estimates is characterized by standard deviations equal to 0.17, 0.14 and 0.11, correspondingly. This level of accuracy was considered as acceptable. As the mere existence of f_{c3} is not generally recognized, it was expedient to check the fact in a different way. Pair correlation analysis was employed. We compared f_{c3} estimates obtained for the same event at two stations. Coefficient of correlation between several such pairs was estimated as 0.62 on the average, with 95% confidence interval equal to (0.58 0.66). This degree of correlation permits us to claim the existence of f_{c3} as proven for our data. The study was supported by the grant from the Russian Science Foundation (project 14-17-00621), and was carried out at the Kamchatka Branch of the Geophysical Survey of Russian Ac. Sci.