S058-05
Joint probability density function of source parameters using the generalized Brune spectral model: low-frequency earthquake source scaling and observational limits

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Virtual

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Abstract:
The displacement amplitude spectrum of seismic body waves is a key observation for the source characterization of small-to-medium magnitude earthquakes. The Brune spectral model has been successfully able to describe what has been largely observed from earthquakes spectra. At low frequencies, the source appears as a point, and the spectrum is flat and proportional to the seismic moment M_0. At high frequencies, interference among the radiation emitted from different zones of the source emerges as a spectrum-decay. The crossover region between the two spectral behaviors is thus associated to a corner frequency f_C that is a proxy to the source dimension.

We estimate the source parameters of ~23,000 automatically and ~3,000 manually detected low frequency earthquakes (LFEs) in Shikoku, Japan during the period of 2013 - 2015. These events have an extremely low signal-to-noise ratio, and their source can only be modeled with a few macro-parameters. We thus use the Brune spectral model and the probabilistic approach of Supino et al. (2019) to evaluate the joint probability density function (PDF) of the source parameters M_0, f_C and γ (high-frequency decay exponent) from the inversion of single-station spectra. This PDF allows estimating a robust inverse problem solution that accounts for between-parameter correlations, and for the large uncertainty associated to the narrow frequency band available for the weak LFE signals.

The inferred moment-duration scaling parameter for the analyzed LFEs is ~3, close to the scaling classically observed for earthquakes. This suggests a self-similar LFE rupture process. The high-frequency decay exponents for these events are normally distributed with a mean value ~3, which is different from the omega square spectrum observed for regular earthquakes.

We explore the variation in time and space of those source characteristics, which appear to be stable. We find an along-strike variation of the product of the stress drop and the cube of rupture velocity, that could be related to weaker tremor patches in central Shikoku.

The event size distribution deviates from the Gutenberg-Richter law, exhibiting a right and left corner moment; we show that these corner moments might be the signature of observational limits due to secondary microseismic noise and network-related completeness magnitude.

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