Geophysical Research Abstracts
Vol. 21, EGU2019-16031, 2019
EGU General Assembly 2019

The self-similar nature of low-frequency earthquakes in Nankai subduction zone

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In the last years, several data analysis methods have been developed to enhance the detection of low-frequency earthquakes (LFE) and thus to provide very large LFE catalogs. Nevertheless, their characterization in terms of size, stress drop and rupture propagation still remains uncertain, the main difficulty owing to the low signal-to-noise ratio.

In this work, we characterized the source of ∼11000 LFEs extracted from tectonic tremor sequences occurred from 2012 to 2016 in western Shikoku region, detected and located with the BackTrackBB technique (Poiata et al., 2016).

Assuming a circular source model, we described the S-wave displacement amplitude spectrum, which is expected to be characterized by a plateau at low frequencies and a coherent decay at high frequencies; the frequency of transition between these two regimes is the corner frequency. The source parameters are estimated using a probabilistic approach (Supino et al., 2019), based on the conjunction of states of information between data and model. We estimated the joint probability density function of the parameters, allowing to provide the uncertainties which take into account the correlation between parameters. Processing of this large data set is performed using accurate quality criteria, which allow to automatically reject noisy data and unconstrained solutions.

Estimated moment magnitudes from low-frequency plateau range between Mw 0.9 and 2.2, while the corner frequencies vary between 0.8 and 12 Hz. Corner frequencies are thus lower than expected for ordinary earthquakes, as already observed for LFEs. We found that LFE sources exhibit a power-law scaling between corner frequency and seismic moment, with an exponent of -3.5, very similar to the scaling observed for classical earthquakes. Using the analytic circular fault model of Sato and Hirasawa (1973), we finally provided a framework for exploring the relation between the corner frequency, the rupture size and the static stress drop as a function of the LFE's rupture velocity.