CMT inversion of offshore earthquakes along the Nankai Trough: Separated distributions of slow and regular earthquakes on the plate boundary

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Due to complex three-dimensional (3D) heterogeneous structures, conventional one-dimensional (1D) analysis techniques using onshore seismograms can yield incorrect estimation of earthquake source parameters, especially dip angles and centroid depths of offshore earthquakes. Indeed, detail analysis of 2016 southeast off the Kii Peninsula earthquake revealed that observed seismic and tsunami record could be explained by low-angle thrust faulting on the plate boundary (e.g., Kubota et al., 2018; Takemura et al., 2018; Wallace et al., 2016) but regional 1D moment tensor analysis showed high-angle reverse faulting mechanism.

Combining long-term onshore seismic observations and numerical simulations of seismic wave propagation in a 3D model, we conducted centroid moment tensor (CMT) inversions of earthquakes along the Nankai Trough. Green's functions for CMT inversions of moderate earthquakes were evaluated via OpenSWPC (Maeda et al., 2017) using the Japan Integrated Velocity Structure Model (Koketsu et al., 2012). We re-analyzed moderate (*Mw* 4.3-6.5) earthquakes listed in the F-net catalog (Fukuyama et al., 1998; Kubo et al., 2002) that occurred from April 2004 to August 2019. By introducing the 3D structures of the low-velocity accretionary prism and the Philippine Sea Plate, our CMT inversion method provided better constraints of dip angles and centroid depths for offshore earthquakes. These two parameters are important for evaluating earthquake types in subduction zones.

Our 3D CMT catalog of offshore earthquakes and published slow earthquake catalogs (e.g., Kano et al., 2018) along the Nankai Trough depicted spatial distributions of slip behaviors on the plate boundary. The regular and slow interplate earthquakes were separately distributed, with these distributions reflecting the heterogeneous distribution of effective strengths on the plate boundary. By comparing the spatial distribution of seismic slip on the plate boundary with the slip-deficit rate distribution (Noda et al., 2018), regions with strong coupling were identified.

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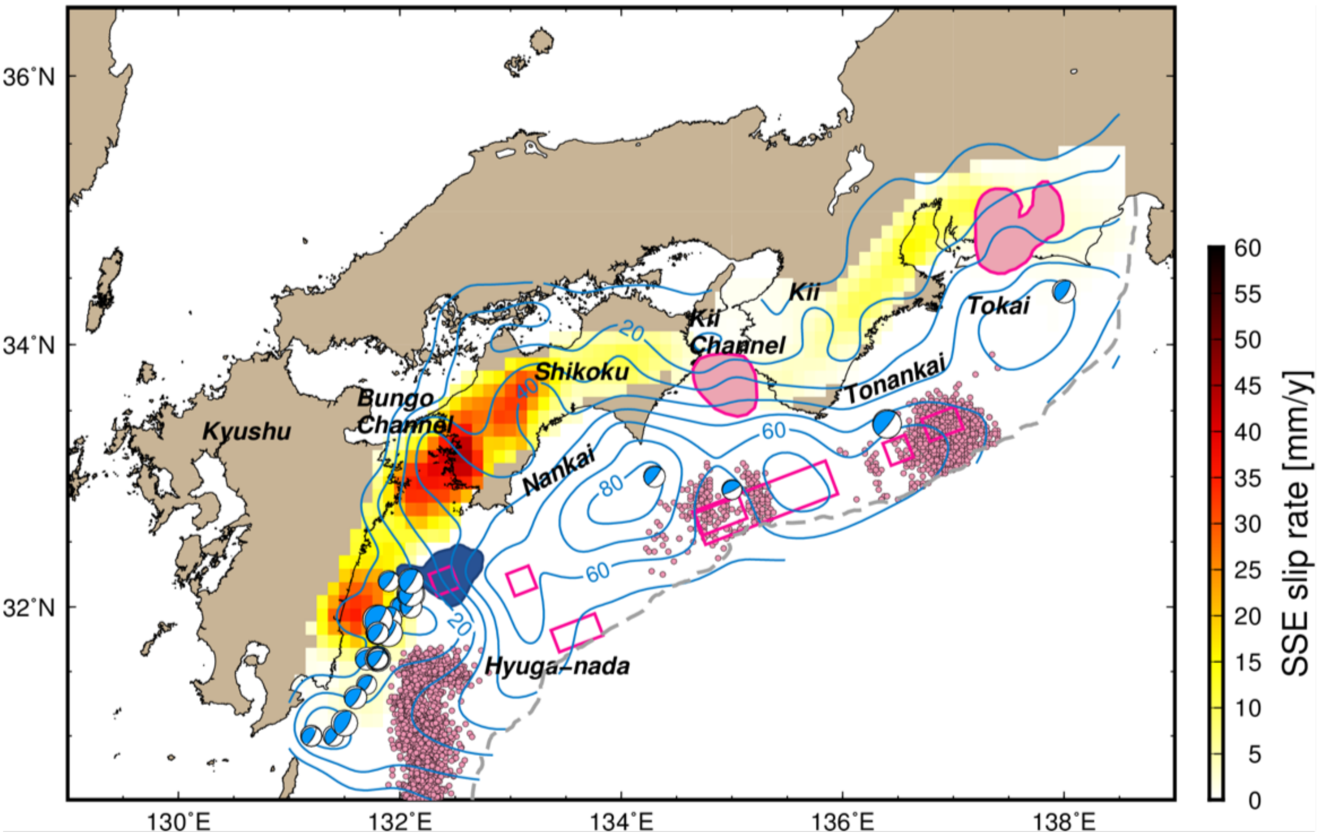
We used F-net waveform data and the F-net MT catalog (https://doi.org/10.17598/NIED.0005). Our CMT catalog and CMT results of assumed source grids for each earthquake are available from https://doi.org/10.5281/zenodo.3661116. The FDM simulations of seismic wave propagation were conducted on the computer system of the Earthquake and Volcano Information Center at the Earthquake Research Institute, the University of Tokyo. This study was supported by the Japan Society for the Promotion of Science (JSPS) KAKENHI Grant Numbers 17K14382 and 19H04626.

Keywords: Nankai Trough, CMT inversion, offshore earthquake, 3D heterogeneous structure



Spatial distribution of slip behaviours on the plate boundary along the Nankai Trough. Plotted focal mechanisms are low-angle thrust faulting solutions at depths around the plate boundary. The coseismic slip area of the 1968 *Mw* 7.5 Hyuga-nada earthquake (Yagi *et al.* 1998) is shaded in dark blue. SSE slip rates were evaluated from the combined SSE catalogues (Nishimura *et al.* 2013, Takagi *et al.* 2016, 2019). The pink circles indicate the epicentres of the shallow LFTs of the Hyuga-nada and the shallow VLFEs in the Tonankai region referred from Yamashita et al. (2015) and Takemura, Noda, et al. (2019). The pink shaded and enclosed areas indicate the large slip areas of long-term SSEs (Kobayashi 2014, Miyazaki *et al.* 2006) and shallow SSEs (Yokota & Ishikawa 2020), respectively. The blue contour lines indicate the slip-deficit rates [mm/yr] on the plate boundary by Noda *et al.* (2018) .