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Supporting Information for

[Mechanically coupled areas on the plate interface in the Nankai trough, Japan: A possible seismic and aseismic rupture scenario for megathrust earthquakes]

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Text S1. Smoothed plate interface model

The Japan Integrated Velocity Structure Model (JIVSM) (Koketsu et al. 2012) is one of the reference 3-D subsurface structure models, which are used in seismological studies in Japan (e.g. Maeda et al. 2017). The JIVSM includes the plate interface between the Amurian plate and the Philippine Sea plate. We modify a plate boundary for use in elastostatic responses in a homogeneous half-space medium. The plate boundary is given by the depth at grid points with 1km grid spacing in geological coordinates. Figure S1(a) plots the plate interface in the x-y coordinates after the coordinate transformation using the GMT (Wessel & Smith 1998). The trough line at 5.25 depth from the sea surface is plotted as a bold gray dashed line. We employ the Laplacian operator to evaluate short-wavelength components of the plate interface. The finite difference form of $\nabla^2 h(x,y)$ is given by

$$\begin{aligned}\nabla^2 h(x_i,y_j) \approx & \frac{h(x_i+\Delta x, y_j) - 2h(x_i,y_j) + h(x_i - \Delta x, y_j)}{(\Delta x^2)} \\ & + \frac{h(x_i, y_j+\Delta y) - 2h(x_i,y_j) + h(x_i, y_j - \Delta y)}{(\Delta y^2)}\end{aligned} \tag{S1}$$

where $h(x,y)$ is the depth of the plate interface. Figure S1(b) plots the value of (S1) as roughness of the plate interface. The area where the value is larger than 0.1 km/km^2 is widely recognized. In addition, we plot the dip angle at each point on the plate interface in Figure S1(c). We find a stripe pattern parallel to the trough line. We consider that the roughness and stripe pattern may not be real.

We employ a long-wavelength pass filter

$$\begin{aligned}f(k_x,k_y) &= \exp\left[-\frac{4k^2}{k_0^2}\right] \\ &= \exp\left[-\frac{4k^2}{\left(\frac{2\pi}{\lambda_0}\right)^2}\right]\end{aligned} \tag{S2}$$

where $k = \sqrt{k_x^2 + k_y^2}$. The cut-off wavelength is set as $\lambda_0 = 80$km. We multiplied Eq. (S2) with $\hat{h}(k_x,k_y)$ (the 2-D Fourier spectrum of the plate depth $h(x,y)$) and obtained the filtered plate depth by using the inverse Fourier transform. Since this study assumed an elastic half-space, we removed the plate depth shallower than the sea depth of 5.25 km.

The modified plate depths, roughness, and dip angles are shown in Figure S1 (d), (e), and (f), respectively. The plate interfaces after the modification (Figure S1(d)) looks almost the same as Figure S1(a). However, the roughness of the plate interface (Figure S1(e)) and the dip angle stripe pattern are removed (Figure S1(f)).

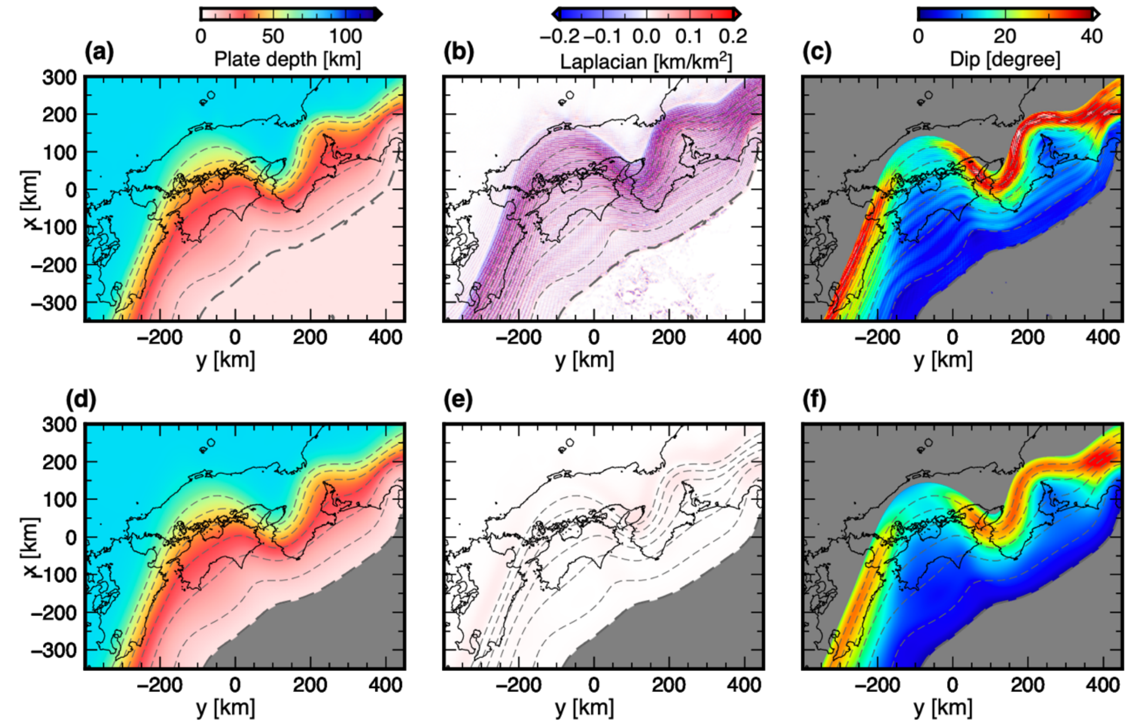

Figure S1 (a) Plate interface of the Philippine Sea plate in the Cartesian coordinates in the JIVSM. The depth of the plate interface is measured from the sea surface. (b) The value of the Laplacian of the plate boundary in the JIVSM. (c) The dip angle of the boundary in the JIVSM. (d) Low-pass filtered plate interface. This study calls this the smoothed JIVSM plate interface. (e) The value of the Laplacian of the smoothed JIVSM plate interface. (f) The dip angle of the boundary on the smoothed JIVSM plate interface.

Text S2. Stress rate and possible rupture scenarios

The estimated shear stress rate and the slip distributions of the possible rupture scenarios are plotted in the Cartesian coordinates in Figure 6 and Figure 9. Here, we plot these in the geological coordinates.

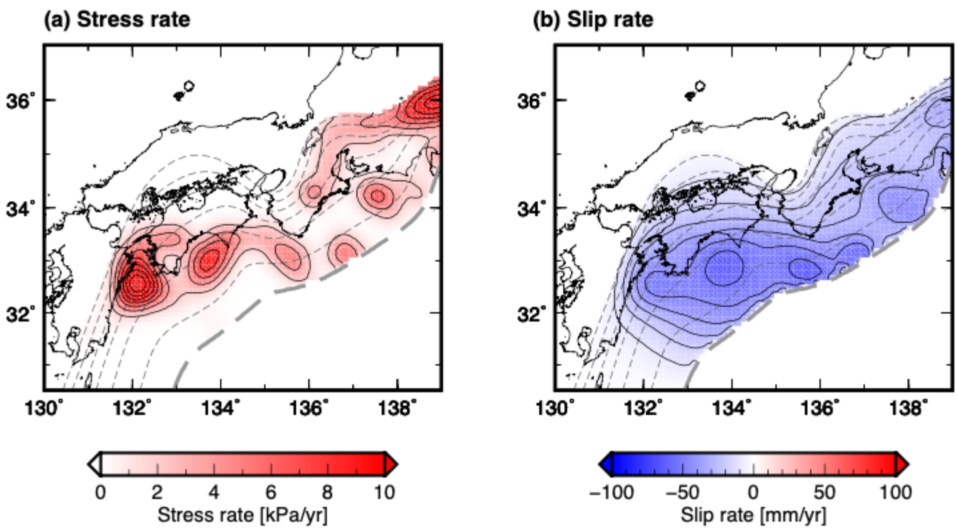

Figure S2 (a) Estimated shear stress rate at the plate interface. Contour lines are plotted at 2kPa/year intervals. (b) Slip deficit rate at the plate interface. Contour lines are plotted at 10mm/year intervals.

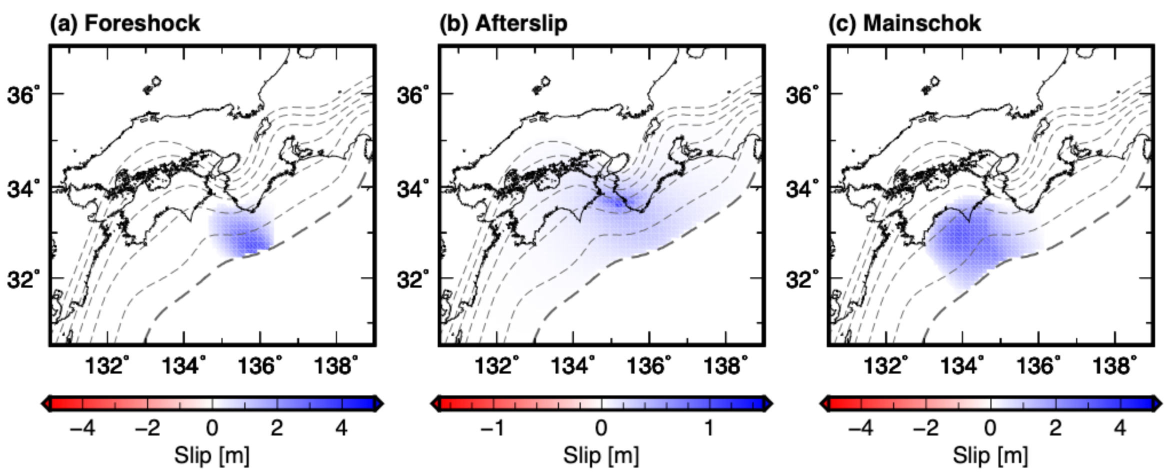

Figure S3 Slip distributions of possible rupture scenarios: (a) the foreshock, (b) the afterslip, and (c) the mainshock.

Data Set S1. Depth of the smoothed plate interface shown in Figure S1d. First, second and third columns: y [km] in EW, x [km] in NS and z [km] in the down; fourth and fifth columns: longitude and latitude. These data in a file "phsplate.yxlonlat"

Data Set S2. Stress rate distributions shown in Figure 6a. These data (stress rate [kPa/yr]) are in a file "stressrate.lonlat" in the geological coordinates, following the format used in the GMT.

Data Set S3. Sip distributions of the foreshock in Figure 9b. These data (sip [m]) are in a file "slip_foreshock.lonlat" in the geological coordinates, following the format used in the GMT.

Data Set S4. Slip distributions of the afterslip in Figure 9e. These data (sip [m]) are in a file "slip_afterslip.lonlat" in the geological coordinates, following the format used in the GMT.

Data Set S5. Slip distributions of the mainshock in Figure 9h. These data (sip [m]) are in a file "slip_mainshock.lonlat" in the geological coordinates, following the format used in the GMT.