Technical details on centroid moment tensor solutions determined using long period body wave data

Data

We analyzed earthquakes whose moment magnitudes in the Global CMT catalog were equal to or greater than 7.2 that occurred during 1994-2007. We did not analyze the following earthquakes since they are out of the range of applicability of the method used in this study: the November 3, 2002 Denali, the July 15 Carlsberg, the December 26, 2004 Sumatra (Mw 9.0), the December 26, 2004 Sumatra (Mw 7.2), the March 28, 2005 Northern Sumatra, and the July 17, 2006 Java. The number of the earthquakes was 103. We retrieved LH channel waveform data recorded at the Global Seismograph Network (GSN) stations for these earthquakes from IDM DMC. We edited the parts of seismograms between the beginnings of the records and the arrivals of surface waves to analyze long period body wave data.

Analysis

We basically followed the grid search approach of Hara (2004, 2005) to determine CMT solutions, in which Fourier spectra corrected for the instrumental responses in the frequency band 0.01-0.02 Hz are used for inversion. The center grid is placed at the epicenter reported by the USGS. For some large earthquakes, we put the center grid at the centroid location of the Global CMT solution.

We used the formulae by Vakov (1996) and Ekström et al. (1992) to have guesses for spatial dimensions of earthquake faults and source times, respectively. Based on these guesses, we set spatial and temporal grids. A magnitude guess is necessary to use these formulae. We obtained it as follows. First, we calculated inner products between
observed spectra and synthetic spectra computed for each component of moment tensor using the hypocenter and origin time determined by USGS under the condition that the trace of moment tensor is zero. Then, we chose the median among them as an initial guess for each moment tensor component, and calculated an initial moment magnitude guess from this initial moment tensor guess.

The variance reduction is sensitive to centroid time shift, while it is insensitive to changes of centroid location. We fixed the centroid location to that for which the largest variance reduction was obtained. Then, we make the temporal grid interval two fifths of the initial value, and searched the centroid time shift for which the largest variance reduction was obtained.

References