Comparison of difference between centroid and origin times with estimated half duration

Sadaki Hori[1]

[1] NIED

Recent enhancement of global and regional broadband seismograph networks enables us to realize the detailed nature of source process of the individual earthquakes. We are now able to obtain the earthquake information not only for the fault plane geometry but also for the asperity distribution along the fault plane via the Internet in a short time after the earthquake occurrence. However the centroid moment tensor (CMT) solutions brought to us by Harvard University group or by other research institutions still play an important role for an analysis of the earthquake mechanisms. The CMT solution is a result of simultaneous inversion of the waveform data for the best point source and for the seismic moment tensor. The solution is thus described by the six independent elements of the seismic moment tensor and the point source location, which is defined by epicentral coordinates, depth, and origin time. The spatial location of the above point source is not the hypocenter indicating the beginning point of the faulting motion but the centroid location of the stress glut throughout the total rupture. Similarly the origin time in the CMT catalog is not the time of the rupture initiation but the centroid time of seismic energy radiation history (for simplicity the former and the latter are hereafter referred to as the origin time and centroid time, respectively). Time shift of the centroid time with respect to the origin time may indicate the duration time of the total rupture.

The half duration listed in the Harvard CMT catalog is not determined directly from the observation but is estimated from a relationship to the scalar seismic moment. Dziewonski and Woodhouse (1983, JGR, 88, 3247-3271, hereafter referred to as DW1983) made a statistic analysis of the relationship between the time shift and seismic moment. According to them the half duration can be expressed by a linear equation of the cube root of the scalar seismic moment. Although the time shift has a tendency to increase with increasing moment along the curve defined by the above equation, there is much scatter. DW1983 stated that the scatter may, in part, be related to uncertainty of the centroid location and that some of the scatter is real reflecting difference in source time functions.

In the present study we analyze the time shift for the earthquakes occurring in and around Japan in detail to evaluate how much this parameter brings the source process information to us. We analyze the event data listed both in the Harvard CMT catalog and in the JMA hypocenter catalog. Total number of the selected events is 565 in a period from 1997 to 2004. The time shift measured from the origin time given in the JMA catalog ranges from -7.92 s to 30.57 s. There is obvious increase of the time shift with increasing seismic moment as pointed out by DW1983. We also calculate the time difference T'; difference between the time shift obtained above and the half duration listed in the Harvard CMT catalog. The value of T' ranges from -8.19 s to 10.89 s with an average of -1.69 s. Systematic relationship between T' and seismic moment is hardly seen but considerable scatter is still recognized. We examine the regional property of the time difference. The value of T' seems to be constant for the shallow events occurring inland area of Japan. In contrast the time difference varies rapidly from place to place for the earthquakes occurring along Kurile-Japan trenches and along Ryukyu trench. The spatial variation of T' may reflect difference in source time functions. Small (or large) T' would be corresponding to the simple (or complicated) source process. The stress drop might be also related to the value of T'. Additional analysis by using local CMT data will be required for further discussion.