Mwp and other Rapid Estimates of Source Parameters for Tsunami Warning

Barry Hirshorn, NOAA/NWS/Pacific Tsunami Warning Center

Abstract

The Richard H. Hagemeyer Pacific Tsunami Warning Center (PTWC), located in Ewa Beach, Oahu, Hawaii, is responsible for issuing local, regional, and distant tsunami warnings to Hawaii, and for issuing regional and distant tsunami warnings to the rest of the Pacific Basin, exclusive of the US West Coast and Canada. The PTWC must provide these tsunami warnings as soon as technologically possible, based entirely on estimates of a potentially tsunamigenic earthquake's source parameters. We calculate the broadband P-wave moment magnitude, Mwp, from the P or pP wave velocity seismograms [Tsuboi et al., 1995, 1999]. This method appears to work well for regional and teleseismic events [Tsuboi et al (1999), Whitmore et al (2002), Hirshorn et al (2004)]. Following Tsuboi, [1995], we consider the displacement record of the P-wave portion of the broadband seismograms as an approximate source time function and integrate this record to obtain the moment rate function, Mo(t), and the moment magnitude [Hanks and Kanamori, 1972] as a function of time, Mw(t).

We present results for Mwp for local, regional, and teleseismic broad band recordings for earthquakes in the Mw 5 to 9.3 range. As large Hawaii events are rare, we tested this local case using other Pacific events in the magnitude 5.0 to 7.5 range recorded by nearby stations. Signals were excluded, however, if the epicentral distance was so small (generally less than 1 degree) that there was contamination by the S-wave too closely following the P-waves. Scatter plots of Mwp against the Harvard Mw for these events shows that Mwp does predict Mw well from seismograms recorded at local, regional, and teleseismic distances. For some complex earthquakes, eg. the Mw 8.4(HRV) Peru earthquake of June 21, 2001, Mwp underestimates Mw if the first moment release is not the largest. Our estimates of Mwp for the Mw 9.3 Sumatra-Andaman Island's earthquake of December 26, 2004 and for the Mw 8.7 (HRV) Sumatra event of March 28, 2005, were Mwp 8.1, Mwp 8.7 respectively, from p-waves recorded at 15 - 90 degrees from each hypocenter. We are very interested in other methods characterizing the earthquake source in real time.