Introduction

We have introduced new methods to determine rapidly on a regional to global scale the tsunami potential and magnitude of large earthquakes (e.g., Lomax and Michelini, 2009b, 2011, 2012). To validate these methods, we have tested them on 120 large earthquakes (9.4 ≤ M ≤ 9.5) and implemented them along with other new algorithms within the Early-est system. Early-est is available at:

http://early-est.alomax.net

Early-est is a lightweight software package for real-time earthquake monitoring (including phase picking, phase association and event detection, location, magnitudes, first-motion mechanisms, ...), and for tsunami early warning (based on the Td-T0 and Td-T50Ex discriminants for earthquake tsunami potential). In a simulation using archived broadband seismograms for the devastating Mw 9.1 2011 Tohoku earthquake and tsunami, Early-est determined: the epicenter within 3 min after the event origin time (OT), discriminants showing very high tsunami potential within 5-7 min, and magnitude Mwpd(OT) 9.0–9.2 and a correct shallow-thrust mechanism within 3 min. Real-time monitoring with Early-est gives similar results for most large earthquakes currently available, real-time seismogram data.

Here we present key algorithms within Early-est that enable rapid, real-time earthquake monitoring and tsunami early warning worldwide, and we show Early-est analysis results for the 2010 Mentawai tsunami earthquake.

Mwpd magnitude for very large earthquakes within 10 min

We previously presented a duration-amplitude procedure for rapid determination of a non-saturating moment magnitude, Mwp, for large earthquakes using P-wave recordings at teleseismic distances. With real-time data, Mwpd can be obtained within 10 minutes or less after the event origin time. The procedure determines apparent source durations, T0, from high-frequency, P-wave records, and estimates moments through integration of broadband displacement waveforms over the interval tP to tP + T0, where tP is the P arrival time. Mwpd extends Mwp for very large and long-duration events.


Also: SeisGramWeb - a portable-device ready seismogram viewer

SeisGramWeb is an interactive, browser-based viewer for seismograms obtained from time-series web services. SeisGramWeb runs within a web browser or open-source mobile devices, using open-source devices, it uses standard HTML and JavaScript. More information: http://alomax.net/software/seisgramweb.html

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Novel Algorithms Enabling Rapid, Real-Time Earthquake Monitoring and Tsunami Early Warning Worldwide
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Conclusion: The 2010, Mw7.8 Mentawai tsunami earthquake in Early-est

The 2010 Mentawai tsunami earthquake generated a large and destructive, local tsunami. Early-est characterizes this event with an epicenter constrained in the first minutes after the origin time (OT) and Mw (Mwpd(OT)) and Td-T50Ex measures available at OT+3–4 min. All three discriminants for tsunami potential, Td-T50Ex at OT+3–4 min, and T0 and Td at OT+5–6 min reliably identify a high likelihood that a tsunami has been generated. All measures stabilize to near their final values within OT+7–8 min. For this event, in addition to early indication of high tsunami potential at OT+3–4 min, Early-est gave at OT+6–9 min Mwpd(OT) 7.6 ± 0.7 that matches final Mwpd(OT+10 min) 7.6 ± 0.7, suggesting this event is a high-rise tsunami. Early-est demonstrates the power of using a probabilistic, global-search discriminant technique and estimating moment magnitude through integration of broadband displacement waveforms over a window of tP to tP+T0, where tP is the P arrival time.


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