

Novel Algorithms Enabling Rapid, Real-Time Earthquake Monitoring and Tsunami Early Warning Worldwide

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We have introduced recently new methods to determine rapidly the tsunami potential and magnitude of large earthquakes (e.g., Lomax and Michelini, 2009ab, 2011, 2012). To validate these methods we have implemented them along with other new algorithms within the Early-est earthquake monitor at INGV-Rome (<http://early-est.rm.ingv.it>, <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, magnitude determination, first-motion mechanism determination, ...), and for tsunami early warning based on discriminants for earthquake tsunami potential. In a simulation using archived broadband seismograms for the devastating M9, 2011 Tohoku earthquake and tsunami, Early-est determines: the epicenter within 3 min after the event origin time, discriminants showing very high tsunami potential within 5-7 min, and magnitude $M_{\text{wpd}}(\text{RT})$ 9.0–9.2 and a correct shallow-thrusting mechanism within 8 min. Real-time monitoring with Early-est gives similar results for most large earthquakes using currently available, real-time seismogram data.

Here we summarize some of the key algorithms within Early-est that enable rapid, real-time earthquake monitoring and tsunami early warning worldwide:

>>> FilterPicker - a general purpose, broad-band, phase detector and picker (<http://alomax.net/FilterPicker>);

>>> Robust, simultaneous association and location using a probabilistic, global-search;

>>> Period-duration discriminants $T_d T_0$ and $T_d T_{50}^{\text{Ex}}$ for tsunami potential available within 5 min;

>>> $M_{\text{wpd}}(\text{RT})$ magnitude for very large earthquakes available within 10 min;

>>> Waveform P polarities determined on broad-band displacement traces, focal mechanisms obtained with the HASH program (Hardebeck and Shearer, 2002);

>>> SeisGramWeb – a portable-device ready seismogram viewer using web-services in a browser (<http://alomax.net/webtools/sgweb/info.html>).

References (see also: http://alomax.net/pub_list.html):

Lomax, A. and A. Michelini (2012), Tsunami early warning within 5 minutes, Pure and Applied Geophysics, 169, nnn-*nnn*, doi: 10.1007/s00024-012-0512-6.

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- Lomax, A. and A. Michelini (2009b), Tsunami early warning using earthquake rupture duration, *Geophys. Res. Lett.*, 36, L09306, doi:10.1029/2009GL037223.
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