Earthquake details (automatic solutions):

Real-time Seismological Discriminants for Tsunami Early Warning

To Inl



Early Warning: Seismic waves carry first information

Mw9.1, Tohoku, Japan 2011

P-wave OT+5min

from: Nathan C. Becker, PTWC-NOAA, 2012 http://youtu.be/sCyOfQzCnGw Tsunami wave OT+30min







Rapid rupture model: Coastal GPS networks (5m+ ??)



Blewitt et al., 2012; Singh et al., 2012







Tsunami size depends on seafloor uplift



 \rightarrow seafloor uplift

earthquake rupture

→ tsunami

Seafloor uplift not directly related to seismic moment



Seafloor uplift not directly related to seismic moment



Dominant period T_d and apparent duration T_0 , T_{50Ex}



 T_d – dominant period of early P-waves

 T_o – duration of high-frequency P-waves

 T_{50Ex} – early estimate if T_0 exceeds 50s

Dominant period T_d and apparent duration T_0 , T_{50Ex}









tsunami impact measures derived from: NOAA/WDC Historical Tsunami Database





tsunami amplitude measures derived from: NOAA/WDC Historical Tsunami Database



M_{wpd} – rapidly gives true size of large earthquakes





Real-time simulation: *M*_w9.1, Tohoku, Japan 2011 OT+6min

















HTML, JPG, PDF, JavaScript, Web-Services







Early-est Earthquake Monitor – Graphical Display: Overview



Early-est Earthquake Monitor – Graphical Display: Event Location





Real-time simulation: *M*_w9.1, Tohoku, Japan 2011 OT+0min





Real-time simulation: *M*_w9.1, Tohoku, Japan 2011 OT+1min





Real-time simulation: *M*_w9.1, Tohoku, Japan 2011 OT+2min





Real-time simulation: *M*_w9.1, Tohoku, Japan 2011 OT+3min





Real-time simulation: *M*_w9.1, Tohoku, Japan 2011 OT+4min





Real-time simulation: *M*_w9.1, Tohoku, Japan 2011 OT+5min





Real-time simulation: *M*_w9.1, Tohoku, Japan 2011 OT+6min





Real-time simulation: *M*_w9.1, Tohoku, Japan 2011 OT+7min





Real-time simulation: *M*_w9.1, Tohoku, Japan 2011 OT+8min





Real-time simulation: *M*_w9.1, Tohoku, Japan 2011 OT+9min



Real-time simulation: *M*_w9.1, Tohoku, Japan 2011 OT+10min







off-line simulation of Early-est realtime monitor - early-est.rm.ingv.it

OT+0min



Real-time simulation: Mw7.8, Mentawai 2010

OT+4min



Real-time simulation: *M*_w7.8, Mentawai 2010

OT+7min





Real-time simulation: Mw7.8, Mentawai 2010

OT+10min





Real-time Seismological Discriminants for Tsunami Early Warning

Conclusions

- We present procedures using real-time seismogram data currently available for most parts of the world to:
- 1) Estimate within 5 min after an earthquake occurs the potential of the earthquake to generate a significant tsunami
- 2) Determine within 10 min after an earthquake occurs an accurate magnitude, M_{wpd} , giving the true size of very large earthquakes
- 3) Provide basic faulting parameters to aid in early tsunami forecast modeling
- 4) Do fast, real-time data collection and processing, and interactive, web-based display of results



Further information:

early-est.rm.ingv.it early-est.alomax.net

- Lomax, A. and A. Michelini. Tsunami early warning within 5 minutes, PAGEOPH, submitted.
- Lomax, A. and A. Michelini, 2011. Tsunami early warning using earthquake rupture duration and *P*wave dominant-period: the importance of length and depth of faulting, *Geophys. J. Int.*, 185, 283–291, doi: 10.1111/j.1365-246X.2010.04916.x.
- Lomax, A. and A. Michelini, 2009B. Tsunami early warning using earthquake rupture duration, *Geophys. Res. Lett.*, 36, L09306, doi:10.1029/2009GL037223
- Lomax, A. and A. Michelini, 2009A. *M*wpd: A durationamplitude procedure for rapid determination of earthquake magnitude and tsunamigenic potential from P waveforms, *Geophys. J. Int.*, 176, 200–214, doi:10.1111/j.1365-246X.2008.03974.x

This work is supported by the 2007-2009 Dipartimento della Protezione Civile S3 project, INGV institutional funds and the EC NERA Project (n. 262330)

The IRIS DMC and GFZ provided access to waveforms used in this study.



Anthony Lomax ALomax Scientific, Mouans-Sartoux, France - anthony@alomax.net

Alberto Michelini Istituto Nazionale di Geofisica e Vulcanologia, Roma, Italy alberto.michelini@ingv.it





Real-time: *M*_w9.1, Tohoku, Japan 2011 OT+15min





Real-time: *M*_w8.6, Sumatra 2012

OT+5min





Real-time: *M*_w8.6, Sumatra 2012

OT+10min

