The Use of Preliminary First-Motion Mechanisms and Later Moment Tensor Solutions for Rapid Tsunami Early-Warning Scenario Forecasting

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Following the ICG/NEAMTWS guidelines, the first tsunami warning messages for events with magnitude $M \geq 5.5$ are based only on seismic information, i.e., epicenter location, hypocenter depth, and magnitude. However, in order to provide more informative, real-time tsunami scenario forecasting, reliable faulting mechanism information is needed.

Full-waveform, moment tensor solutions (MT) are typically available in 3-15 min after event origin time for local/near-regional events and in 15-20 min for regional/teleseismic events. Classic, P first-motion (FM) focal-mechanisms can be available within 3 min for local/near-regional events and in 5-10 min for regional/teleseismic monitoring, depending on station coverage.

We present first a robust, probabilistic, adaptive grid-search, FM inversion which, combined with fast magnitude estimates such as M_{wp}, forms a preliminary mechanism estimate and proxy for MT solutions. This MT proxy allows rapid event characterization and analysis, such as estimation of shaking distribution and initial modeling of tsunami waves, before a definitive, waveform MT is available.

Secondly, we present a near real-time MT inversion using waveforms band-pass filtered from $0.01 - 0.02 Hz$ band and a minimum of 6 min of signal after the event origin time for events in the Mediterranean area. The solution is then updated every minute by adding 1 min of signal and using the epicenter parameters available in real time from the automatic localization provided by the Early-Est rapid earthquake location system. Tests on events since 2000 in the Mediterranean area indicate that reliable solutions are available within 7-15 minutes after event origin time.

Implementing both methodologies in our system allows the use of FM mechanisms for rapid, preliminary tsunami forecasting within a few minutes after the earthquake occurrence, and the use of a definitive MT solution a few minutes later for further forecasting updates.