Real-time performance of probabilistic, first-motion earthquake mechanisms to improve tsunami early-warning

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The first tsunami warning messages are typically based on simple earthquake parameters: epicenter location, hypocenter depth, and magnitude. The addition of early information on the faulting mechanism can enable more reliable estimates of seafloor uplift, tsunami excitation, tsunami potential and impact, and earlier, real-time tsunami scenario forecasting. Full-waveform, centroid moment tensor solutions (CMT) are typically available in 3-15min for local/near-regional earthquakes and in 10-30min for regional/teleseismic distances. In contrast, classic, P first-motion (FM) focal-mechanisms can be available within 3min for local/near-regional events and in 5-10 min for regional/teleseismic distances.

We present fmamp, a robust, probabilistic, adaptive grid-search, FM mechanism determination procedure which generates a comprehensive set of "acceptable" FM mechanisms and related uncertainties. This FM solution, combined with fast magnitude estimates such as Mwp, forms a CMT proxy for rapid source characterization and analysis before a definitive, waveform CMT is available. Currently, fmamp runs in real-time in Early-est*, the module for rapid earthquake detection, location and analysis at the INGV tsunami alert center (CAT, "Centro di Allerta Tsunami"), part of the Italian, candidate Tsunami Watch Provider.

We show the real-time performance of fmamp and compare its speed and accuracy to CMT results. For large earthquakes in areas of sparse seismic station coverage, fmamp mechanisms are typically available in 5-10min, while CMT results take 10-30min. The fmamp solutions usually agree with CMT results for larger events, but sometimes differ, due to insufficient or noisy FM readings, or real difference between the FM mechanism, representing the faulting at the hypocenter, and the CMT mechanism representing some average, centroid faulting.

* http://early-est.alomax.net, http://early-est.rm.ingv.it, http://alomax.free.fr/posters/early-est