# The prospect of a tsunami early warning system based on tsunami source propagation

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The present-day's tsunami early warning systems (TEWSs) assume that a tsunami source is created instantaneously over the whole source area. In other words, the present TEWSs neglect the propagation of tsunami source, or the propagation of the earthquake rupture, that occurs in a finite area during a finite propagation time. Finite rupture propagation speeds reasonably affect tsunami generation and propagation. Travel times of the first tsunami waves generated from rupture propagation fault models have to arrive later at some regions than those from instantaneous fault models but do not arrive faster everywhere[e.g., Neetsu et al., 2005]. On the other hand, the effect of earthquake rupture propagation on tsunami amplitude has scarcely investigated based on real bathymetry, although it had studied under flat ocean assumption[Aida, 1969; Yamashita and Sato, 1974]. We investigated it for regional tsunamis (travel distance between 5deg and 30 deg) by using real bathymetry in terms of numerical simulation. The grid size is 3 minutes of arc, interpolated from ETOPO2 [Smith and Sandwell, 1997]. A constant amount of slip was given on each subfault. Other subfault parameters are the same as Hirata et al.[2006].

Effect on the first upward wave amplitudes of offshore tsunamis is summarized as follows; (1) The slower the rupture velocity, the larger the increasing rate of the tsunami wave amplitude. For instance, in the offshore of the east coast of Sri Lanka, the 1st tsunami amplitude increases 10 % at the rupture velocity of 3.5 km/sec, 14 % at 2.5 km/sec, 23% at 1.5 km/sec, and 38% at 1.0 km/sec in the case of 500km-long fault. This indicates that the rupture propagation effect on regional tsunami amplitude is large in the cases of slow earthquakes. (2) Increasing (or decreasing) rate in tsunami amplitude due to the rupture propagation is not necessarily larger in longer fault than shorter fault. In other words, even in the case of a short fault, say a few hundred kilometers, the effect of the rupture propagation on tsunami amplitude may not be neglected. This is because the increasing (or decreasing) rate in tsunami amplitude is related to whether the arrival timings of subfault tsunami components are in-phase or out-of-phase, which is strongly depending on not only rupture velocity but also combination of tsunami travel time from a set of subfaults to the station.

Finally, I would like to discuss whether the effect of the earthquake rupture propagation should be included in the next generation of the tsunami forecast/warning system. (A)Because normal earthquake ruptures propagate at 2 to 4 km/sec, the assumption that tsunami is generated instantaneously over the whole tsunami source would not be realistic. Any next tsunami forecast/warning system(s) may assume a priori given, constant rupture velocity (say 3 km/sec) instead of infinite rupture velocity. In such next tsunami forecast/warning system, tsunami calculations based on two unilateral rupture propagation directions and a bilateral rupture propagation direction would be implemented a priori for great earthquakes. (B)Coastal shallow bathymetry strongly affects coastal tsunami amplitude, perhaps than the effect of the earthquake rupture propagation; coastal shallow bathymetry can amplify tsunami amplitude a few times easily but the effect of the earthquake rupture propagation can do it only at most 50 % or so. Only if high accurate, coastal shallow bathymetry has already been obtained, therefore, the use of information on actual rupture velocity, inferred from any real-time seismic/offshore tsunami inversion technique, would be effective. Otherwise an assumption of the a priori given, constant rupture velocity seems to be enough.