Geophysical Research Abstracts
Vol. 15, EGU2013-10211, 2013
EGU General Assembly 2013

Differentiating earthquake tsunamis from other sources; how do we tell the difference?

David Tappin (1), Stephan Grilli (2), Jeffrey Harris (2), Timothy Masterlark (3), James Kirby (4), Fengyan Shi Shi (4), and Gangfeng Ma (5)

(1) British Geological Survey, Marine Geology, Nottingham, United Kingdom (drta@bgs.ac.uk), (2) Department of Ocean Engineering, University of Rhode Island, Narragansett, RI 02882, USA, (3) Department of Geological Sciences, 501 East Saint Joseph Street Rapid City, South Dakota 57701, USA, (4) Center for Applied Coastal Research, University of Delaware, Newark, DE 19716, USA, (5) Dept. of Civil and Environmental Engineering, Old Dominion University, Norfolk, VA, USA

When a great earthquake generates a large magnitude tsunami, the focus is on the relationship between the two, usually addressed through analysis of earthquake, tide and geodetic data, often in various combinations. These methods, however, have limitations in resolving the up-dip extent of rupture; onshore geodetic inversions have limited sensitivity to slip offshore, seismic inversions have instabilities in moment estimation where subfault segments are shallow, and tsunami inversions average over the large areas of ocean bottom uplift. Seismic wave estimates depend on the velocity structure, which affects both seismic moment estimation and inferred slip.

Validation of tsunami generating mechanism is mainly from tide gauges, although there are problems and assumptions made in their use. Models may be circular, with inversion of the data used to identify earthquake rupture that is then modeled as the tsunami source. Different slip distributions may be modelled and the results compared with recorded surface elevations offshore and inundation data, then adjusted to provide new scenarios in order to improve the agreement with tidal observations. Tide gauge data may be both from near and far fields; invalidating the identification of a contribution from local submarine mass failure (SMF). "Green's functions" used for assimilating tsunami observations in source models may be based on non-dispersive equations which may not capture the correct phase speed of shorter wave trains, e.g. such as generated by SMFs.

A major problem with identifying the generating mechanism is when tsunami magnitude is large compared to the earthquake such as with 'tsunami' earthquakes and where the earthquake is not slow, as in Papua New Guinea in 1998, where a SMF was identified as the tsunami source. However, with most great earthquakes, e.g. the Indian Ocean, it is accepted from the outset that the only source is the earthquake. Another, more recent event is the Tohoku-oki earthquake and tsunami that devastated the northeast of Japan in March 2011; although with some unusual rupture characteristics it is not a tsunami earthquake. There are now a number of simulations published, that mostly assume an earthquake source but that fail the simple test of using an independently defined earthquake rupture mechanism that can be validated by onshore fieldwork, tide gauge and offshore buoy data. Here we briefly consider some of the existing source models and present new tsunami simulations based on a combination of a FEM coseismic source and a SMF. We show that the multi-source tsunami agrees well with the available tide gauge data and field observations onshore and the wave data from offshore buoys.