Updated empirical relationship of large tsunami height between offshore and coastal stations

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Since the first report (Takayama et al., 1994) on detection of offshore tsunami due to the 1993 Southwest off Hokkaido earthquake, offshore tsunami data detected by Nationwide Ocean Wave information network for Ports and Harbours (NOWPHAS) has been accumulated. My previous study (Hayashi, 2010) derived empirical relationships of tsunami height between offshore and coastal stations from pairs of initial tsunami height or maximum tsunami amplitude data obtained by coastal tide stations and offshore sites of NOWPHAS wave stations or RTK-GPS buoys during eight tsunami events between 1993 and 2007; and then, the ratio of initial tsunami height or maximum amplitude observed at a coastal tidal station on that at the offshore site was found to be proportional to the fourth root of the ratio of the sea-bottom depths from the mean sea level at the offshore sites to the coastal station. However, dataset used by this study has only two pairs from observation data from RTK-GPS buoys each for initial large tsunami and maximum amplitude; and the range of tsunami height in the dataset was limited to between 0.05m and 2.4m. In this study, empirical relationships of tsunami height between offshore and coastal stations are reconstructed by including maximum tsunami height data obtained during 2010 Maule earthquake tsunami (Kawai et al., 2010) and 2011 off the Pacific coast of Tohoku Earthquake tsunami (Kawai et al., 2011). In the 2011 event, some tidal stations were damaged; for these stations measured tsunami inundation heights by field surveys near tidal stations (Abe and Hiramatsu, 2012) are utilized instead, because differences between normal maximum tsunami heights observed at tidal stations and measured tsunami inundation heights by field survey cites near the station are small and within 1m (Hayashi, 2014).The new dataset on pairs of maximum tsunami heights at offshore (GPS buoys or wave) stations and the nearby tidal stations (or field survey site in case of lack of data at tidal stations) shows that the previous equations (Hayashi, 2010), based on the concept that amplification factor is proportional to the fourth root of the ratio of water-depths between at offshore and at onshore stations, severely overestimate amplification factor from offshore to the coast for larger tsunami than 3m at the coast. However, if the saturation of amplification in case of the larger ratio of tsunami height to water depth than 1/3 is assumed, this overestimation can be get rid of. Newly derived empirical relation would improve tsunami height estimation by converting from offshore tsunami height observation or calculation to the nearby coastal points, which are general parts necessary for several ways of tsunami forecasting methodology such as scenario tsunami database (Kamigaichi, 2009) or near-field tsunami forecasting by tFISH algorithm (Tsushima et al., 2009).

Keywords: GPS buoy, Nationwide Ocean Wave information network for Ports and Harbours (NOWPHAS), tidal stations, tsunami amplification factor

