Estimation of local seismic waves and rapid magnitudes for ‘slow tsunami earthquakes’ based on moment rate spectrum

*Takahito Nishimiya[1], Akio Katsumata[1]

1. Meteorological Research Institute, Japan Meteorological Agency

The tsunami height estimation at earliest stage in JMA is based on the estimated hypocenter and rapid magnitude (rapid-M) from local seismic wave data. The amplitudes of seismic waves from ‘slow tsunami earthquakes’ are usually smaller than those from normal earthquakes because those earthquakes radiate relatively low seismic energies in the short period range. Therefore it is difficult to estimate rapid-M of ‘slow tsunami earthquakes’ accurately. We would like to evaluate rapid-M of them quantitatively. However local seismic wave data of slow tsunami earthquakes is almost not available.

We estimated moment rate spectra of ‘slow tsunami earthquakes’ using tele-seismic wave data (in JpGU Meeting 2018), and calculated synthetic local seismic waves based on those spectra (in Seismological Society Fall Meeting 2018). We estimated rapid-M from the synthetic wave data here.

JMA magnitude (M_J) and M_{100} (Katsumata et al., 2013) are evaluated as the rapid-M. M_{100} is introduced by JMA to avoid underestimation of magnitude for huge earthquakes because M_J tends to indicate “magnitude saturation” for huge earthquakes. We calculated M_J and M_{100} from the synthetic wave data. REGARD (Kawamoto, 2017) based on GNSS data is also a kind of rapid-M. However we use seismic wave data from which smaller magnitude can be estimated compared with REGARD.

We assumed that a ‘slow tsunami earthquake’ occurs at the plate-boundary off the Pacific coast of Tohoku. It has the same moment rate spectrum as the Java tsunami earthquake (M_w7.8) in 1994. M_J estimated from those synthetic waves was smaller than M_w by more than 1.0. M_{100} is larger than M_J, but M_{100} is smaller than M_w by more than 0.5. We also evaluated magnitudes for an earthquake which has the same moment rate spectrum as the Sumatera tsunami earthquake (M_w7.8) in 2010. The difference from M_w reduced for the earthquake, while both M_J and M_{100} are lower than M_w.
USGS published M_s of significant earthquakes. M_s of the 1994 Java earthquake was lower than M_w by more than 0.5 although M_s of the 2010 Sumatera earthquake was about the same as M_w.

Our results suggest that big difference between M_{100} and M_J is useful for early discriminating ‘slow tsunami earthquakes’ from normal earthquakes. Even if M_{100} is much greater than M_J, M_{100} may be underestimated for slow tsunami earthquakes.

Keywords: tsunami earthquake, spectrum, local seismic wave, magnitude

