

Real-time forecasting of near-field tsunamis using offshore tsunami data

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Japan Islands are located in the subduction zones and are often damaged by disastrous near-field earthquakes and tsunamis such as the 2011 Mw 9.0 Tohoku earthquake. Real-time tsunami forecast is one of the effective ways to mitigate the tsunami disasters. In Japan, Japan Meteorological Agency (JMA) has responsibility for operational tsunami forecast and warning. In this paper, we present the JMA's tsunami-forecasting procedure, especially focusing on the forecast from offshore tsunami data.

When a tsunamigenic earthquake occurs around Japan, JMA issues tsunami warning 3 min after the earthquake using seismic-wave data, and then the warning is often updated based on tsunami measurements. For the rapid and reliable update, offshore tsunami data take an important role, because tsunamis can be detected at offshore stations earlier than at coastal sites, and the data provide direct information about the impending tsunamis. Actually, when the 2011 Tohoku earthquake occurred, JMA promptly updated the warning by using offshore GPS buoy data 28 min after the earthquake. At present, dense offshore tsunami network (~230 stations) is deployed around Japan, that consists of GPS buoys and ocean-bottom pressure gauges (OBPGs). Those observation data are now used in the JMA's real-time tsunami operation.

OBPG data includes pressure variation due to oceanic tide, seismic wave and crustal deformation, as well as tsunamis. Especially, when an OBPG is located inside source area, pressure fluctuations due to seismic wave, crustal deformation and tsunami are simultaneously measured at the OBPG, resulting in complex record. To obtain pure tsunami waveform from the original records, JMA is applying real-time noise reduction procedures as follows: digital low-pass filter with 60 s of cut-off period is applied in order to reduce high-frequency pressure fluctuation due to seismic waves, and a theoretical tide waveform is subtracted from the record for de-tide. The resultant waveform data are used for real-time tsunami monitoring and forecasting.

In the present operation of JMA, Green's law is used to predict coastal tsunami-height from the offshore tsunami-height observation. For more accurate forecast, JMA plans to put into operation another tsunami-forecasting method that is based on tsunami source estimation using offshore tsunami data, developed by Meteorological Research Institute (MRI) of JMA. Because offshore tsunami waveform keeps source signature without distortion due to the complex coastal topography, the source-estimation is one of the approaches that take advantages of offshore tsunami data. The method was retrospectively applied to the real observation data of the 2003 Tokachi-oki earthquake and the 2011 Tohoku earthquake, and we obtained good forecast results. At present, MRI and JMA are improving the method to obtain accurate results robustly in the real-time operation. The technical details will be presented at the meeting.