

Research for Improvement of the JMA Tsunami Warning System

MAEDA, Kenji^{1*}, TSUSHIMA, Hiroaki¹, HIRATA, Kenji¹, KATSUMATA, Akio¹, YOSHIDA, Yasuhiro¹, AOKI, Shigeki¹, OZAKI, Tomoaki², YOKOTA, Takashi¹

¹Meteorological Research Institute, ²Japan Meteorological Agency

1. Introduction

The 2011 off the Pacific coast of Tohoku Earthquake that is the largest earthquake of Mw=9.0 ever recorded in Japan has caused devastating damages especially by a gigantic tsunami. So many lives were lost by the tsunami, even though Japan Meteorological Agency (JMA) had issued a tsunami warning 3 minutes after the occurrence of the earthquake. So, JMA set up a committee consisting of academic and administrative experts to investigate the problems that should be solved for a better tsunami warning system. This presentation will introduce an overview of our project that aims to develop new techniques to solve the problems pointed out by the committee.

2. Problems for the Current Tsunami Warning System

The committee report says there are two major technical problems to be improved.

1) The first tsunami warning issued 3 minutes after the earthquake underestimated the tsunami heights because the magnitude was underestimated as M=7.9 at that time, and JMA could not recognize the fact of underestimation. It is crucial to develop a technique to estimate magnitude correctly for great earthquakes such as over M8.0 in a short enough time to issue the first warning.

2) The moment magnitude, which should have been calculated within 15 minutes after the earthquake, could not be calculated because of the scale out of the broad-band seismometer. Besides, the information of tsunami arrival at offshore area that was observed by ocean bottom pressure gauges (OBPGs) was not well utilized to update the tsunami warning, because the technique to utilize that information had not well been established. These prevented a prompt renewal of tsunami warning.

3. Improvement of the Tsunami Warning System

To overcome the above mentioned problems we are conducting the following researches.

1) We are developing methods to estimate the magnitude correctly for great earthquakes in a short time, or at least to judge if the magnitude becomes larger than 8.0. Four methods are proposed to estimate the magnitude and listed below.

- Method using the distribution of strong ground motion area
- Method to estimate Mwp using P arrival wave forms
- Method using duration times of strong ground motions
- Method comparing wave forms filtered with various frequency bands

2) In order to utilize the information of offshore arrival of tsunami waves, we are developing a new technique. The method consists of two steps. First, we estimate the initial variation of sea surface caused by an earthquake by applying the inversion method to the observed offshore tsunami waveform data. Then we forwardly calculate the tsunami waveforms along coasts using the estimated initial distribution of sea surface elevation. This method is applicable to forecasting tsunamis caused not only by earthquakes but also by marine landslides. As for enhancement of the offshore observation network, JMA is planning to deploy three buoy-type OBPGs late in 2012.

3) In the tsunami forecast using offshore data, the accuracy of observed tsunami plays an important role. But, there are two difficulties in getting precise tsunami waveforms when we use OBPG data observed near the seismic source region. The first is a problem concerning the thermal response of the pressure gauge to sudden temperature change on deep ocean floor. The second is to resolve the tsunami signals from contaminated high frequency pressure fluctuation that is caused by a nearby earthquake. To overcome the difficulties, we are estimating the characteristics of OBPG data and planning to develop a new type of OBPG.

4) JMA is planning to deploy the broad-band strong motion seismometers at 80 stations over Japan that do not scale out against strong ground motion, which will enable us to calculate Mw within 15 minutes after a great earthquake.

Keywords: Tsunami Warning, JMA, Prompt Magnitude Estimation, Offshore Tsunami Gauge, Waveform Forecast