On the role of Ocean Bottom Seismometers in the Earthquake Early Warning System

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Historical records showed that large earthquakes repeatedly occurred around Japan along the plate boundary. It suggests a high probability for large offshore earthquakes in these areas. An official report by Earthquake Research Committee on March 23, 2005 concluded that there was a 99% probability of an M7.5 Miyagi-oki earthquake occurring in the following 30-year interval based on January 1st, 2005. This report also stated that probabilities of a large earthquake in Tokai, Tonankai, and Nankai area in the following 30 years are 84%, 50%, and 40%, respectively. The warning time could be as long as more than 10 seconds since the epicenter distance from such offshore earthquakes to the nearby inland stations ranges from 100 to 200km. The nationwide earthquake early warning system (EEWs) operated by JMA is hence able to issue earthquake warnings with sufficient warning time and is fairly expected to take an important role for earthquake disaster prevention in the case of such large offshore earthquakes, although the warning time for an inland earthquake might be in question.

If enough ocean bottom seismometers (OBS) are deployed in those large-earthquake-expected areas, the warning time for action given by EEWs can be lengthened. To investigate the role of OBS in an EEW system, here we carried out some simulations using the real-time data recorded at six OBS deployed in Sagami Bay by NIED. We would point out that the Sagami Bay OBS network is not a strong example for improving the warning time since the epicenters in the area are not so far and some Hi-net stations deployed on small islands might record the seismic wave in a comparable time window. In spite of these limitations, we found that for some earthquakes, the OBS might bring us a 5-second improvement for the warning time. It implies that an OBS network deployed in the area where a large earthquake is expected to occur would comparably improve the effects of EEW.

For Hi-net seismograms recorded at near stations will be clipped in the case of large earthquakes, a strong motion network would be of great importance. Another possible advantage of an OBS strong motion network is that we may rapidly estimate the faulting area or the so-called asperity distribution map by comparing some typical waveform features of OBS records with those calculated from different source models. Such a real-time source model could be helpful for Tsunami warning and shaking intensity prediction since the present EEW system models an earthquake as a point source and is in lack of fault information though large earthquakes are usually observed as two-dimension (or more complicated) asperities. With the coming unification between NIED and JAMSTEC, inclusion of OBS into the present EEW system (i.e., the Horiuchi system in NIED) becomes practical and necessary. Preparedness should be considered before the introduction of OBS into the Horiuchi system. For example, to obtain real-time fault information, one should construct sufficient source models for a certain earthquake and extract the typical waveform features; one might consider to develop a new and simple method using the near field P-wave shaking intensity to constrain the asperity map; one also should test the stability of the present system with inclusion of OBS records and estimate the station correction (if necessary) based on tomography studies.