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Tsunami simulation method assimilating ocean bottom pressure data for real-time tsunami forecast; A case study for the 1968 great earthquake

Yuichiro Tanioka
Hokkaido University, Institute of Seismology and Volcanology, Facult of Science, Sapporo, Japan (tanioka@sci.hokudai.ac.jp)

Due to a serious disaster caused by the 2011 Tohoku-oki tsunami, improvement of the tsunami forecast has been an urgent issue in Japan. National Institute of Disaster Prevention installed a cable network system of earthquake and tsunami observation (S-NET) at the ocean bottom along the Japan and Kurile trench. This cable system includes 150 pressure sensors (tsunami meters) which are separated by 30 km. The system is the densest tsunami observation network in the world.

Real-time tsunami forecast has depended on estimation of earthquake parameters, such as epicenter, depth, and magnitude of earthquakes. Recently, we developed a tsunami simulation method assimilating ocean bottom pressure data near tsunami areas for tsunami forecast (Tanioka 2018, Tanioka and Gusman 2018). The method does not need any tsunami source information nor earthquake source information. The method uses only initial parts of observed waveforms at ocean bottom pressure sensors. Therefore, the under-estimation of forecast tsunami heights due to the under-estimation of earthquake source or tsunami source should be prevented. However, it was tested only for an equally distributed ocean bottom sensor network (with a 30 km separation). This is not realistic because we do not have such an equally distributed network along the Japan and Kurile trench.

In this paper, the 150 ocean bottom pressure sensors were located at exact positions of the S-NET sensors. We developed an interpolation method of observed heights at the S-NET sensors to create data at equally distributed stations with a 10 minute (about 18 km) separation. Then, we applied the tsunami simulation method assimilating those data for the 1968 Tokachi-oki earthquake case. First, the tsunami waveforms at the S-NET stations were numerically computed from a simple rectangle source model of the 1968 Tokachi-oki earthquake (Mw8.2). The fault parameters, strike=156, dip=20, rake=38, were obtained from the previous studies. The fault length of 200 km, the fault width of 100 km, and the slip amount of 4 m, are assumed. By using those computed tsunami waveforms as observation data at the S-NET stations, the tsunami numerical simulation with the assimilation was carried out using the assimilation method in this study. Those computed tsunami wave fields from the method were compared with those computed directly from the earthquake source model. The tsunami heights are slightly overestimated by the assimilation. The wavelength of tsunami from the assimilation method were slightly larger than those directly from the earthquake source model.
The result suggests that the tsunami wave fields from the assimilation were overall similar to those from the earthquake source model. However, it also suggests that we may need more stations to improve an accuracy of the tsunami forecast.