Study on matching method of the ocean bottom pressure waveforms toward real-time tsunami forecast

*Wataru Suzuki[1], Shin Aoi[1], Kenji Hirata[1], Naotaka YAMAMOTO[1], Hiromitsu Nakamura[1], Shingo Suzuki[1], Tetsuya Takeda[1], Makoto MATSUBARA[1], Takashi Kunugi[1]

1.National Research Institute for Earth Science and Disaster Prevention

We are developing a real-time forecast system of the tsunami inundation as well as the coastal tsunami heights for the Pacific coast of Chiba prefecture (Kujukuri and Sotobo regions), using the real-time ocean bottom pressure data (Aoi et al., 2015) observed by the Seafloor Observation Network for Earthquakes and Tsunamis along the Japan Trench (S-net; Kanazawa et al., 2012; Uehira et al., 2015). We employ the database-driven method to forecast the inundation, which is a nonlinear phenomenon, for relatively broad region. We use the densely observed data set probably including the data obtained in or close to the tsunami source area to perform the rapid and accurate tsunami forecast. The database is called as “Tsunami Scenario Bank” and includes “Tsunami Scenario” composed of the possible tsunami source model, and the simulation results of the ocean bottom pressure data at S-net observation stations, coastal tsunami heights, inundation areas and flow depth, for each source model (Suzuki et al., 2015). The system starts to search scenarios whose ocean bottom pressure data match the observed data reasonably well. Selected scenarios from this matching then provide the information of forecasted tsunami heights, inundation areas and flow depth, adequately considering the uncertainties of the forecast. Now, the matching algorithm implemented for the forecast system compares the spatial distributions of ocean bottom pressure changes using the correlation coefficient and two kinds of variance reductions (Yamamoto et al., 2016). To advance the robustness of forecast and warning, it is better to implement several different approach for real-time tsunami detection and forecast. In this study, therefore, we examine the matching for the time series of the ocean bottom pressure change at each station for selecting the tsunami scenarios that explain the observation well.
To evaluate the fitness between the observed and scenario pressure data, we examine the L1 norm---the absolute values of differences---and L2 norm, which corresponds to the least square evaluation. We applied the two norms to the synthetic ocean bottom pressure data at 150 S-net stations calculated from the tsunami source model of the 2011 Tohoku-oki earthquake. For scenario bank, the results calculated from the non-linear tsunami simulation based on approximately 1,800 tsunami source models that would affect the Pacific coast of East Japan (Hirata et al, 2014). Matching using both L1 and L2 norms resulted in slightly underprediction for the amplitude of coastal tsunami height as well as the amplitude of the ocean bottom pressure data. In addition, we found that matching with the L1 norm tends to underestimate the tsunami scale more in the early stage of the tsunami propagation. We will, then, comprehensively capture the characteristics of the evaluation using the L1 and L2 norms from the examination of the other synthetic tsunami data and develop the appropriate method to match the observed and scenario ocean bottom pressure data.
Acknowledgement: This work was partially supported by Council for Science, Technology and Innovation (CSTI), Cross-ministerial Strategic Innovation Promotion Program (SIP), "Enhancement of societal resiliency against natural disasters" (Funding agency: JST).

Keywords: Real-time tsunami forecast, Tsunami inundation, Scenario bank, S-net

