Tsunami source model of the earthquake off Mie Prefecture on 1 April 2016 (Mw 5.9) derived from the time derivative of the offshore pressure records observed by DONET

*Tatsuya Kubota[1], Wataru Suzuki[1], Shin Aoi[1], Naotaka CHIKASADA YAMAMOTO[1], Takeshi Nakamura[1], Narumi Takahashi[1,2]

1. National Research Institute for Earth Science and Disaster Resilience, 2. Japan Agency for Marine-Earth Science and Technology

On 1 April, 2016, an earthquake of Mw 5.9 occurred southeast off Mie Prefecture in Japan (hereafeter, the off-Mie earthquake). Tsunamis with maximum amplitude of ˜ 2 cm were clearly observed by the near-field ocean bottom pressure gauges (OBPs), of the seafloor observation networks DONET (Dense Oceanfloor Network System for Earthquakes and Tsunamis) (Kaneda et al., 2015; Kawaguchi et al., 2015). The pressure offset changes due to the seafloor displacement equivalent to a few cm were observed by the OBPs around the focal area. The OBP at the station KME18, nearest to the epicenter, observed relatively large pressure increase of ˜ 10 hPa (equivalent to ˜ 10 cm subsidence), as compared to the magnitude. This large pressure offset change was thought to be caused by the rotation or tilting of the pressure sensors, due to the strong seismic motion (Wallace et al., 2016). If the pressure data contains the pressure changes irrelevant to tsunami or seafloor displacement (hereafter, non-tsunami components), it will be difficult to correctly estimate the tsunami source model. Furthermore, it is also difficult to distinguish the non-tsunami components in real-time processing of pressure data for tsunami forecast. Kubota et al. (2017, SSJ meeting) developed the tsunami inversion method to reduce the effect of the non-tsunami components, which uses the time derivative of the pressure time series. Based on the synthetic tsunami data, they also showed this method is effective to reduce the effect of the non-tsunami components on the estimation of the tsunami source model. In this study, we estimated the tsunami source model of the 2016 off-Mie earthquake by using the time derivative of the pressure records, in order to evaluate the effectiveness of the time derivative method for estimating the correct tsunami source model.

First, we estimated the tsunami source model only using the main tsunami phases (hereafter, the reference model). In the analysis, we did not use the pressure data observed by the near-source OBP stations which possibly include the non-tsunami components (e.g., KME18). We applied the low-pass filter (60 s), and tsunami Green’ s function was calculated by the linear long wave equation (e.g., Satake, 2002). As a result, a pair of uplift and subsided areas was estimated with maximum amplitudes of ˜ +3 cm and ˜ −2 cm, which was consistent with the crustal deformation based on the CMT solution obtained from the seismic analysis (USGS). The expected vertical displacement at the station KME18 was the ˜ +1 cm, which was much smaller than the observed pressure change (˜ −10 cm). Then, from the viewpoint of the real-time forecast, we conducted the inversion by fixing the time window for all OBPs, as 5 min from the focal time. When we exclude the pressure data at KME18, the estimated tsunami source model was very similar to the reference model, whereas the large subsidence (˜ −12 cm) was estimated at around the OBP station KME18 when KME18 was used. We then carried out the inversion using the time derivative of the OBP data (KME18 was also included). The result was very similar to the reference model. The calculated pressure waveform from the source model well reproduced the observed pressure time series, except for the station KME18.

Based on this result, the time derivative of the pressure data very effectively worked to reduce the effect of the non-tsunami component for estimating tsunami source model of the 2016 off-Mie earthquake. In the presentation, we will discuss the amplitude of the forecasted coastal tsunami height from the tsunami source models obtained by the pressure waveforms or its time derivatives, or with/without KME18, by comparing them with the observation.

Keywords: Tsunami, The 2016 southeast off Mie earthquake, Ocean bottom pressure gauge, Time derivative, Tsunami source inversion