Early estimation of tsunami height from near-fault ocean bottom pressure records: Comparison of DONET and S-net data

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Ocean-bottom observation networks for earthquakes and tsunamis such as S-net and DONET have been deployed in the offshore Japan. These networks are designed to record tsunamis in terms of water pressure changes. During an earthquake, however, water pressure changes not only by tsunamis (i.e., sea surface heights) but also by water depth changes of instruments, vertical accelerations of a seafloor (i.e., reaction force from water column), and radiated P waves or ocean acoustic waves (e.g., Saito and Tsushima, 2016).

To extract only tsunami and sea bottom displacement components from coseismic ocean bottom pressure (OBP) records, we developed a new scheme based on the assumption that an OBP gauge records sea bottom acceleration at frequency range of 0.05–0.15 Hz (Mizutani and Yomogida, 2020, submitted). We applied it to DONET OBP records of the 2016 Off-Mie earthquake (M_w 6.0), and succeeded to extract tsunami and sea bottom displacement components (i.e., 100-s low pass filtered waveforms) only after 30 seconds of its origin time.

In this study, to confirm the validity of the above method, we applied it to the S-net OBP records associated with the 2016 and 2019 Off-Fukushima earthquakes of M_w 7.0 and 6.4, respectively. While relatively large tsunamis (~1 m) were observed for the 2016 event, no tsunamis for the 2019 event because of its depth was 45 km.

In both cases, the resulted waveforms show better agreement with 100-s low pass filtered waveforms than the ones that are applied simple moving average, similar to our previous result with their discrepancies reduced by half with our method. In other words, our method certainly removes the sea bottom acceleration components from the coseismic OBP records even with S-net data.

For the 2019 event, however, three stations (S2N02, S2N12, and S2N15) recorded the subsidences of about 30 cm. This may be caused by not the sea bottom displacement of each station but the rotation or tilt of OBP gauge, which were induced by strong ground motions. For more reliable tsunami early detection, we need to consider such unexpected signals.

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