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Near-real time estimation of tsunami sources using a classification of waveforms observed at dense ocean bottom pressure sensor

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A dense cabled observation network, called the seafloor observation network for earthquakes and tsunami along the Japan Trench (S-net), was installed in Japan. This study aimed to develop a near-real time tsunami source estimation technique using a simple classification of waveforms observed at the ocean bottom pressure sensors in S-net. To investigate the technique, synthetic pressure waveforms at those sensors were computed for 64 tsunami scenarios of large earthquakes with magnitude ranging between M8.0 and M8.8. The pressure waveforms within a time window of 500 s after an earthquake were classified into three types. Type 1 has the following pressure waveform characteristic: the pressure decreases and remains low; sensors exhibiting waveforms associated with Type 1 are located inside a co-seismic uplift area. The pressure waveform characteristic of Type 2 is that one up-pulse of a wave is within the time window; sensors exhibiting waveforms associated with Type 2 are located at the edge of the co-seismic uplift area. The other pressure waveforms are classified as Type 3.

Subsequently, we developed a method to estimate the uplift area using those three classifications of pressure waveforms at sensors in S-net and a method to estimate earthquake magnitude from the estimated uplift area using a regression line. We systematically applied those methods for two cases of previous large earthquakes: the 1952 Tokachi-oki earthquake (Mw8.2) and the 1968 Tokachi-oki earthquake (Mw8.1). The locations of the large computed uplift areas of the earthquakes were well defined by the estimated ones. The estimated magnitudes of the 1952 and 1968 Tokachi-oki earthquakes from the estimated uplift area were 8.2 and 7.9, respectively; they are consistent with the moment magnitudes derived from the source models. Those results indicate that the tsunami source estimation method developed in this study can be used for near-real time tsunami forecasts.

This method is so simple that we do not need any numerical tsunami simulation or other sophisticated techniques but only need the classification of observed pressure data into three types.