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Experimental tsunami forecasting of the 2011 off the Pacific coast of Tohoku Earthquake from offshore tsunami data

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We retroactively applied a method of near-field tsunami forecasting to the offshore tsunami data of the 2011 off the Pacific coast of Tohoku Earthquake (Mw 9.0). The tsunami with height of more than 10 m at the coastal tide stations damaged people and infrastructure along the Pacific coasts of Japan Island. The tsunami was observed at many offshore tsunami observatories deployed around Japan, such as cabled ocean bottom pressure gauges (OBPGs) and Real-Time Kinematic GPS (RTK-GPS) buoys, ~10 minutes earlier than at the coastal tide stations nearest the source. In the present study, we carried out an experimental forecasting of the disastrous tsunami using the offshore tsunami data. We applied a method of near-field tsunami forecasting developed by Tsushima et al. (2009). In the method, offshore tsunami waveform data are inverted for distribution of initial sea-surface height within a tsunami source region, and coastal tsunami waveforms are synthesized by using the estimated source and the pre-computed tsunami Green's functions. The successive calculation of tsunami forecasting can be accomplished within one minute. We carried out the calculation of the forecasting using the tsunami data observed at nine offshore stations (four OBPGs and five GPS buoys) from the origin time of the earthquake to 20 minutes; these valuable offshore tsunami data were provided by the University of Tokyo, JAMSTEC, MILT, and PARI. Assuming realistic situation of the earthquake, we used only data that were actually available at the time. As a result, tsunamis with heights of 6-14 m were forecasted at the coastal tide stations Miyako, Kamaishi, and Ofunato nearest to the source where the sea-level elevation due to the tsunami reaches 1 m after elapsed time of 25 minutes. The result suggests a possibility that the method can contribute to issuance of reliable tsunami warning for M9 earthquakes.

Keywords: the 2011 off the Pacific coast of Tohoku Earthquake, real-time tsunami forecasting, ocean bottom pressure gauge, GPS bouy