Abrupt water temperature increases near seafloor during the 2011 Tohoku earthquake

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Ocean bottom pressure observations at eight stations recorded the Mw9.0 2011 Tohoku earthquake just above its epicenter. We carefully investigated the temperature records for the thermal compensation in the pressure transducer using a quartz crystal oscillator. Using a heat conduction equation, we proposed a method to estimate ambient temperature (i.e., seafloor water temperature) from the temperature inside the pressure sensor (i.e., Bourdon tube). The estimated seafloor water temperature showed that there was a temperature increase of 0.2 degC at a station at a 1.1 km sea depth 3.2 hours after the occurrence of the Tohoku earthquake, which was persistent for several hours. At two stations at depths of 3.3 km and 5.8 km, there were temperature increases of 0.2 degC and 0.1 degC occurred 4.5 hours and 3.5 hours after the earthquake, respectively. Both temperature anomalies similarly decayed to respective usual temperature levels over 10-20 days. The pressure gauge at the 5.8 km depth was recovered two weeks after the earthquake. During the rising to sea surface of the pressure gauge, water temperature anomalies of less than +0.03 degC were found up to 500 m above the seafloor. No significant water temperature anomaly was found related the Tohoku earthquake at other five stations at depths of 1.0-1.6 km. The water temperature anomalies were carefully discussed with results of several geophysical, geochemical, and geological field surveys near the epicenter that were conducted before and after the Tohoku earthquake. The temperature anomaly at the 1.1 km depth was probably caused by the tsunami-generated turbidity current, as was pointed out by previous study. On the other hand, the temperature anomalies at the 3.3 km and 5.8 km depths were most likely due to warm water seepages below seafloor after the Tohoku earthquake, which is mostly consistent with the results of other field surveys mentioned above.

Keywords: Seafloor pressure, Water temperature, Earthquake

