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An abrupt seafloor water-temperature increase in the epicentral region of the 2011 Tohoku earthquake

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We reported in the previous JpGU meeting that an abrupt seawater temperature increase observed just after the 2011 Tohoku earthquake (Inazu et al. 2014 JpGU). The temperature anomaly started several hours after the earthquake, reaching up to 0.1 deg.C above background temperature with another hours, and last for a few weeks. The temperature anomaly was observed at the sea depth of 3000-6000 m, and not observed at shallower sea depth. In the present meeting, we suggest a sequence of a couple of geophysical models to explain the temperature anomaly. We first estimate a heat content required for the temperature increase, being 4∗10ˆ16J. Since the heat content was loaded with several hours, the estimated heat flux is to be 2∗10ˆ12J/s. These heat properties are comparable to those of ”mega plumes” at hydrothermal vent systems typically found at plate spreading axes. We consider that a similar explosive event occurred during the Tohoku earthquake, and adopt a hydrothermal plume model (Wilcock 1997 JGR) for the temperature anomaly. The branch normal fault (Tsuji et al. 2013 EPSL) is assumed as a heat (fluid) path. The heat temperature is estimated to be about 200 deg.C at the seafloor. We next adopt a two-dimensional (vertical and east-west direction) advection-diffusion model. The temperature of 200 deg.C is successfully modeled if the heat source in the model (Kano et al. 2006 GRL) is given by the coseismic frictional heat at the plate boundary during the Tohoku earthquake. A portion (˜10 %) of the frictional heat probably migrated through the branch normal fault, and was released in the seawater, referring the JFAST temperature observation in the plate boundary (Fulton et al. 2013 Science).

Keywords: Tohoku earthquake, seafloor, water temperature