



On the tsunami-induced EM fields at the seafloor: Lessons learned from the 2006-2007 Kuril and 2011 Tohoku tsunamis

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Abstract

A seafloor geomagnetic observatory in the Northwest Pacific Ocean detected clear electromagnetic (EM) signals associated with tsunamis from two earthquakes occurred along the Kuril Trench. Previous seismological analyses indicated that the M8.3 earthquake on November 15, 2006 was an under-thrust type on the landward slope of the trench, while the M8.1 earthquake on January 13, 2007 was a normal-fault type on the seaward side, making this EM case study to be an ideal control experiment for different types of tsunamis. The EM measurements at the time of the two earthquakes enabled estimation of the tsunami propagation direction, as well as particle motion of the seawater. The estimated particle motion differs significantly for the 2006 and 2007 tsunamis in terms of initial motion and dispersive characters. It, however, turned out that the difference is consistent with the hydrodynamic simulation results of the tsunamis. Namely, the tsunami-induced horizontal geomagnetic components showed opposite signs for the rise and retreat waves as expected from our 'electric current wall hypothesis' (Toh et al., 2011). Dispersion effect is more remarkable in the 2007 event with a shorter wavelength that tends to violate the long-wave approximation. The Boussinesq approximation was found necessary to reproduce the stronger dispersion. In terms of tsunami forecast, an important advantage of the vector EM sensors over conventional sensors such as seafloor pressure gauges is: in addition to their ability of continuous monitoring of particle motions, the first peak of the downward magnetic component seems to precede the tsunami peak by $T/4$, where T is the dominant period of the tsunami in concern. Finally, a preliminary report on the seafloor EM variations at the time of the 2011 Tohoku tsunami will conclude the seminar.