Tsunami signals from the 2006 and 2007 Kuril earthquakes detected at a seafloor geomagnetic observatory

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Abstract: A seafloor geomagnetic observatory in the northwest Pacific detected clear electromagnetic (EM) variations associated with tsunami passage from two earthquakes that occurred along the Kuril Trench. Previous seismological analyses indicated that the M8.3 earthquake on 15 November 2006 was an underthrust type on the landward slope of the trench, while the M8.1 earthquake on 13 January 2007 was a normal fault type on the seaward side. The EM measurements enabled precise monitoring of the tsunami propagation direction as well as particle motion of the seawater. The estimated horizontal water velocity differs significantly for the 2006 and 2007 tsunamis, in terms of initial motion and dispersive characters, being 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 the "electric current wall hypothesis." The dispersion effect is more remarkable in the 2007 event with a smaller source region of its tsunamigenic earthquake. The 2007 tsunamis, therefore, tend to violate the long-wave approximation. The Boussinesq approximation was required to reproduce the dispersive character of the 2007 event in our numerical simulation. In terms of tsunami forecast, an important advantage of EM sensors over conventional tsunami sensors, such as seafloor pressure gauges, is their capability of vector measurements: in addition to their ability to monitor particle motions, the first peak of the downward magnetic component always precedes the tsunami peak, suggesting a significant improvement in global tsunami warning systems if vector EM sensors are integrated into the existing systems.

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