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# Three-dimensional simulation of the tsunami-generated magnetic fields: reproduction of seafloor tsunami magnetic signals

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Electrically conductive seawater moving in the geomagnetic main field generates electric currents in the ocean. This is called ”tsunami-generated electromagnetic (TGEM) phenomenon” and there have been many reports on electromagnetic (EM) data associated with this phenomenon since the occurrences of the recent extreme tsunami earthquakes, e.g., the 2011 Tohoku earthquake (e.g., Minami and Toh, 2013). TGEM phenomenon could be applied to the tsunami early warning, diagnoses of tsunamis, and inferences of the conductivity beneath the seafloor. However, each of these applications requires a highly accurate numerical simulation code that takes real bathymetry and arbitrary sub-seafloor conductivity structures into account and can reproduce the transient characteristics of TGEM fields.

For these applications, we developed a three-dimensional simulation code of TGEM fields, adopting the time-domain finite element method (FEM) with unstructured tetrahedral elements. Tetrahedral elements have an advantage in accurate expression of real bathymetry. In this simulation code, we first calculate the oceanic flow associated with tsunami propagation, solving the Laplace equation in terms of the velocity potential of the irrotational and incompressible seawater. Then, we conduct an electromagnetic (EM) simulation using the observed oceanic velocity field as a source. Use of the same tetrahedral mesh between hydrodynamic and EM simulations allows us to obtain the self-consistent results between them.

We conducted a TGEM simulation of the 2011 Tohoku earthquake tsunami with the tsunami source model presented by Satake et al. (2013). We compared the simulation results to the seafloor magnetic data observed on the eastern side of the Japan Trench and found that the amplitude of the calculated vertical magnetic component is less than the observed one, while they are nearly synchronized in phase. This result implies that the tsunami source model of Satake et al. (2013) could be improved by the tsunami magnetic field data.

In the presentation, we will report the comparison between the tsunami-generated magnetic data observed at the seafloor and the three-dimensional simulation results of the 2011 Tohoku earthquake tsunami. Furthermore, we will also report our attempt to infer a new tsunami source model that accounts for not only the existing sea surface elevation data but also TGEM field data.

Keywords: three dimensional simulation, finite element method, tsunami, magnetic field, tetrahedral elements, time domain