有限要素法を用いた二次元津波ダイナモシミュレーション

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2-D tsunami dynamo simulations using the finite element method

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Tsunami dynamo effect is a phenomenon that tsunamis induce electric currents in sea water by coupling with the geomagnetic main fields. It was first reported by Toh et al. (2011) using their electromagnetic (EM) data observed on the seafloor. In addition, we obtained EM data including signals of the 2011 off the Tohoku earthquake tsunami in the northwest Pacific Basin. However, the relation between the tsunami dynamo effect and the EM variations on the seafloor is still unknown, especially when there are strong bathymetric changes, inhomogeneous conductivity structures beneath the seafloor, and when the tsunami cannot be approximated by long waves. There are no studies on oceanic dynamo effects taking all above factors into account.

In order to investigate the tsunami dynamo effect in more detail, we developed a two-dimensional (2-D) finite element method (FEM) tsunami dynamo EM simulation code. Provided that oceanic flows are non-rotational and incompressible, we can calculate time evolution of the oceanic flows using appropriate bathymetry at the beginning of the simulation, and use them as current sources of the EM simulations. In this manner, we were able to appreciate effects of electrical conductivity structures beneath the seafloor, arbitrary bathymetry, and dispersion of the tsunamis on EM variations, taking the vertical structure of the oceanic flow into account.

In our simulation, we first assigned the period of water waves to 10 minutes, the wavelength to 132km, the uniform water depth of 5km, the uniform conductivity of 0.01 S/m beneath the seafloor, and the amplitude of the tsunami wave height to 1m. We also buried 20km square conductive (1S/m) anomaly 5km beneath the observatory on the seafloor. As a result, it was found that amplitudes of vertical components of the magnetic field are reduced by about 13 percent compared to the case without conductive anomalies.

In the presentation, we will further report our results of the 2-D tsunami dynamo EM simulations and compare the results with the 2011 Tohoku tsunami signals obtained in the northwest Pacific Ocean.