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津波が引き起こす電磁場の非一様薄層導体近似を用いた順解問題
Forward calculation of the electromagnetic field induced by tsunamis, using non-uniform thin-sheet approximation.

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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 (Toh et al., 2011). 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 (Ammon et al., 2008).

We tried to simulate the frequency dependence of the observed EM signals, using a three-dimensional (3-D) non-uniform thin-sheet approximation, which can accommodate not only the inducing non-uniform source fields caused by particle motions of conducting seawater at the time of tsunami passage but also the self-induction effect within the ocean and its conductive substrata. Horizontal particle motions were calculated by Fujii and Satake (2008) with two types of hydrodynamic approximation, viz., the Boussinesq approximation and the long-wave approximation. Because the dispersion effect of each tsunami was more remarkable in the 2007 event, the observed EM variations were expected to be more compatible with the simulated EM signals using the Boussinesq approximation than the long-wave approximation.

As a result of the frequency analysis of the observed EM variations at the time of the 2006 event, the frequency of 1.04mHz is most dominant, which is consistent with the result of the frequency analysis of the simulated horizontal particle motions. Also, We confirmed that synthetic plane waves in a flat ocean induced ?-harmonic EM variations. The calculated EM amplitudes for the 2006 event at a period of 960s using the Boussinesq approximation were smaller than those with the long-wave approximation. This can be interpreted as reflecting the dispersive effect.

In this presentation, we will further discuss the advantages and disadvantages of conducting the simulation in the frequency domain for tsunami EM signals and describe the necessity to use the Boussinesq approximation in order to elucidate the observed EM signals at the time of the dispersive tsunami. Furthermore, we will discuss to what extent we can neglect the presence of the horizontal components of the geomagnetic main field in evaluating the source dynamo currents. Also, we will emphasize the usability and importance of the EM observation on the seafloor for tsunami forecast in comparison with the conventional tsunami-height measurements at sea and/or the geomagnetic observations on land.

References

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