海底電磁気観測と時間領域の津波電磁場シミュレーションから推定される津波の諸性質ー2011年東北地方太平洋沖地震津波を例にして
Diagnostics of tsunami events by observations and simulations of tsunami-generated magnetic fields: Case study on the 2011 Tohoku earthquake tsunami

*南 拓人[1]、藤 浩明[2]、市原 寛[3]、川嶋 一生[4]
*Takuto Minami[1], Hiroaki Toh[2], Hiroshi Ichihara[3], Issei Kawashima[4]

1. 東京大学地震研究所海半球観測研究センター、2. 京都大学大学院理学研究科地球惑星科学専攻、3. 名古屋大学大学院環境学研究科附属 地震火山研究センター、4. JMSSC
1. Ocean Hemisphere Research Institute, Earthquake Research Institute,The University of Tokyo, 2. Division of Earth and Planetary Science, Graduate School of Science, Kyoto University, 3. Earthquake and Volcano Research Center, Graduate School of Environmental Studies, Nagoya University , 4. Japan Manned Space Systems Corporation

Tsunami propagation is one of significant sources for electromagnetic (EM) variations observed at the seafloor (see review by Minami (2017) for reports on the recent observations of tsunami EM variations). The electromotive force due to the coupling between the ambient geomagnetic field and horizontal components of the tsunami particle velocity generates electric currents in the ocean, parallel to the wavefront of tsunamis. Benefitting from the vector property of magnetic variations, magnetic data can provide information about both the tsunami height and the propagation direction from a single site observation (e.g. Toh et al., 2011; Ichihara et al., 2013), if magnetic data are available at the time of or after tsunami events. However, there have been no time domain EM simulation tools for investigating tsunami EM variations by directly using time domain tsunami simulation results.

We developed a new finite element simulation approach in time domain for tsunami EM variations (Minami et al., 2017). The developed method allows us to conduct three-dimensional simulation with realistic smooth bathymetry and to readily obtain broad structures of tsunami EM fields and their time evolution, benefitting from time domain implementation with efficient unstructured tetrahedral mesh. Highly resolved mesh near observation sites enables us to compare simulation results with observed data and to investigate tsunami properties in terms of EM variations. We applied our simulation approach to the 2011 Tohoku tsunami event using seawater velocity calculated by linear-long and linear-Boussinesq approximations with the source model of Satake et al. (2013). We revealed from the simulations that inclusion of dispersion effect is necessary to explain magnetic variations at a northwest Pacific seafloor site, ~1,500 km away from the epicenter, while linear-long approximation is enough at a seafloor site ~200 km east-northeast of the epicenter. Our simulations provided, for the first time, comprehensive views of spatiotemporal structures of tsunami EM fields for the 2011 Tohoku tsunami, including large-scale electric current circuits in the ocean.

In this presentation, we introduce properties of the tsunami EM variations as well as our new simulation method, and discuss not only the findings from our simulations but also possible future application of tsunami EM observations to tsunami early warning and diagnostics of past tsunami events.

キーワード：津波、有限要素、磁場、シミュレーション、電磁気、海底観測
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