赤道域海洋島における津波起源磁場

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Tsunami-generated magnetic fields on oceani islands in equatorial regions

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Coupling between horizontal flows and the vertical component of the geomagnetic main field alone has been considered as source electromotive forces (emfs) in arguing motional induction in the ocean including tsunami-generated electromagnetic (EM) fields. Here we report significance of vertical particle motions in EM coupling with horizontal geomagnetic components especially around the sea surface in the equatorial regions.

Vertical velocities of the conductive seawater associated with ocean waves such as tsunamis are usually neglected in motional induction studies (e.g., Minami and Toh, 2013) because of its small magnitudes compared with those of horizontal velocities. On the other hand, horizontal geomagnetic components are also thought to produce negligible emfs since V x F forms a short circuit everywhere within vertical planes in the ocean (Larsen, 1971).

However, it has been found that vertical particle motions can be the only source of emfs in the equatorial regions by the analysis of the analytical solution of EM fields generated by linear dispersive tsunamis (Kawashima, 2015). The vertical velocities can couple with the horizontal geomagnetic component parallel to the direction of tsunami propagation. The coupling creates emfs tangential to tsunami wave fronts with different phases and depth dependence from the emfs by horizontal particle motions and the vertical geomagnetic component. Although they become nil on the seafloor, the emfs by the vertical particle motions can generate vertical magnetic components as large as 1nT for a 1m tsunami and a geomagnetic main field with a horizontal component of 35000nT at the sea surface.

This implies that tsunami-generated poloidal magnetic fields can still be observed on oceanic islands in the equatorial regions even in the absence of coupling of the horizontal particle motions with the vertical component of the geomagnetic main field. It is necessary for effective tsunami detection in the equatorial regions that tsunamis propagate in the north-south direction because the geomagnetic main field tends to be horizontal and along the north-south direction. This situation may be realized in the case of potential tsunami sources in the Solomon Islands and/or the eastern half of the Java Trench. In this presentation, results of data analysis of temporal geomagnetic variations on the Pohnpei Island at the time of significant past tsunami events as well as three-dimensional synthetic numerical simulations will be further discussed.