ABSTRACTS (MASTER THESIS)

Study of geomagnetically induced current using 3D FDTD method

**(Graduate School of Engineering,
Laboratory of Computer Simulation for Humanospheric Sciences,
RISH, Kyoto University)**

Kazuki Kurisu

We performed numerical simulations by using the three-dimensional finite-difference time domain (FDTD) method to study geomagnetically induced currents (GICs) in terms of the atmosphere-ground-power line coupling. We first conducted numerical experiment to estimate the ground distribution of geomagnetically induced electric field (GIE). We introduced two different ground structures to the simulation system, and imposed a uniform electric field at 60 km altitude. We found that GIE is enhanced near the edge of a bay, whereas, the magnetic field decreases near the coastal lines parallel to the incident electric field. When we introduced a mountain model, GIE has local maxima at foots of a ridge, whereas no significant changes of the magnetic field are observed near the mountain. We confirmed that the local enhancement of GIE is caused by the accumulation of electric charges due to inhomogeneous ground conductivity such as the edge of a bay or foots of the ridge. We also found that the large current flowing on the sea surface contributes to the decrease in the magnetic flux near the coastal lines.

Previously, several electromotive force models have been proposed to explain the generation of GIC. To understand the generation of the electromotive force, we next placed a transmission line on the ground and calculated GIC in the system. We first tested the influence of conductance and shapes of the transmission line on GIC, and the influence of conductance of the ground on GIC. Results show different tendency from conventionally known one. We found that the GIC is correlated with time variation of magnetic flux across the surface surrounded by the transmission lines and the underground depth at which magnetic flux is small enough. When we placed a transmission line on two different ground structures, GIC shows a strong influence from the electrical conductivity gradient of the ground especially near the coastal lines.

Global distribution of the GIE and GIC becomes clear in the system including air, ground (sea water) and a transmission line. All these results settle the argument about the generation of GIC. That is, GIC is generated by temporal variation of magnetic flux through a surface deep inside the Earth. The conductivity gradient gives rise to space charge, which also affect the GIC. Regarding influence of the presence of the transmission line on the natural GIE, further studies will be needed.