Modeling geomagnetically induced currents (GIC) in the 500 kV power grid in Japan

Satoko Nakamura[1]; Yusuke Ebihara[2]; Shigeru Fujita[3]; Tada-nori Goto[4]
[1] RISH, Kyoto Univ.; [2] RISH, Kyoto Univ.; [3] Meteorological College; [4] Kyoto Univ.

A realistic model of GIC in the Japanese 500 kV power system is developed for the first time to estimate the influence of the geomagnetically induced currents (GIC) on the Japanese electrical distribution grid. Previously, it is believed that there is no threat in Japanese power grid because of the Japanese location at mid-latitude far from auroral- or equatorial- electrojet. Then, scarce research has been done to assess detailly the GIC influence in Japan.

We develop the 500 kV power grid model in Japan and calculate GIC assuming uniform electric fields on Earth's surface and more realistic electric fields. Geomagnetically induced electric field (GIE) is obtained by Finite-difference time-domain (FDTD) method, given a uniform sheet current changing with a period of 100 s at the upper air as a source. A three-dimensional electrical conductivity is derived from a global relief model (NOAA) and a global map of sediment Thickness (Gabi Laske and Guy Masters). The Japanese GIE exhibit strong coastal effects and some anomaly spots resulting from underground structures of the conductivity. Due to the shape of a thin bow, Japanese lands can play a role like a capacitor according to the direction of the source current. Basically, a largest magnitude of GIC is obtained at Kashiwazaki with a North-South electric field. Using our model, we can compare factors of resistance parameters of the power grid, the positional relationship, the direction of source currents, underground structures in GIC distributions in the Japanese high-voltage power grid.