On Simulation of Geomagnetically Induced Currents in New Zealand power grids. Challenges, Methodologies, Validation.

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SUMMARY

The Earth's magnetic field disturbances, like geomagnetic storms and magnetospheric substorms, generate geomagnetically induced currents (GICs) in technological systems like power grids. The GICs calculation is of practical interest since, in some cases, they can irreversibly damage the transformers or even cause power grid blackouts.

However, the proper GICs simulations are quite challenging as one should take into account many factors that affect the GICs behaviour such as: a) spatial and temporal behavior of the inducing magnetic field is different for the different events and regions; b) the GICs are induced by geoelectric field, that in turns, depends on the ground conductivity; c) the GICs are strongly dependent on power grid configuration. Another challenge is that the simulations should be validated and, therefore, the observations of GICs are also necessary at least during some events and in some locations.

In this presentation we show how these challenges are overcome or, at least, are tackled by the New Zealand Solar Tsunamis project. Using the newly installed grid of magnetic field observations called MANA (Magnetometer Array for New Zealand Aotearoa), new full three-dimensional conductivity model for the lower part of the South Island, based on the magnetotelluric surveys, multi-site transfer function approach, and the power-grid model, provided by Transpower New Zealand Limited, we performed and validated the simulations of GICs during the strongest geomagnetic events in recent years. The obtained results show the good agreement with observed GICs and confirm that each and every aforementioned "ingredient" is necessary for the accurate simulation.

Keywords: Geomagnetically induced currents, Numerical simulations, 3-D conductivity, Non-uniform source