



Contribution ID: 13

Type: Oral Presentation

Modelling ground conductivity for computing the electric field associated with geomagnetically induced currents (A mid latitude case study)

Wednesday, 1 July 2015 14:00 (20 minutes)

Abstract content
 (Max 300 words)
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The study of geomagnetically induced currents (GIC) in technological systems connected to the Earth such as power lines and pipelines during adverse space weather conditions requires the computation of the electric field induced in the Earth. These computations can be achieved through solving Maxwell's equations with appropriate boundary conditions. COMSOL Multiphysics, a finite element method (FEM) simulation package is used to compute the electric field induced by measured geomagnetic field in a layered Earth model. The study is based on the calculation of the GIC in a transformer at an electrical substation in South Africa where a ground conductivity profile was derived from GIC and magnetic field measurements. The investigation aims at studying the effects of varying the number, thickness and conductivity of layers when computing the electric field associated with GIC, thus, enhancing the understanding of the distribution of the induced horizontal electric field within the various layers of the Earth during a geomagnetic storm. The measured GIC and the modelled GIC are compared to determine the best representation of the Earth. This kind of study is important in understanding the layers which matter most in the effective modelling of GIC for this particular substation. The results based on this case study indicates that for a layered Earth model where the top layers have a low conductivity compared to the underlying layers the deeper high conductivity layers have a significant influence on the accuracy of the modelled GIC.

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Session Classification: Space

Track Classification: Track D2 - Space Science