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Inversion of Geomagnetic Fields to Derive Ionospheric Currents that Drive Geomagnetically Induced Currents.

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Geomagnetically induced currents in powerlines of South Africa and Namibia are explored. Generated by geomagnetic storms, these currents cause damage to transformers. The future aim is to develop a system for predicting these currents from solar events and provide advance warning to power utilities. Ionospheric and magnetopheric currents (amperes) are modelled by inverting Fourier integrals of both electric (millivolt per kilometer) and magnetic (nano-Tesla) field solutions of the diffusion equation. Conductivity structures (Sievert per meter) from any one location, based on the layered-earth model, are used to obtain the complex impedance (Ohms) and skin depth (kilometer) at a given angular frequency (Hertz) of the alternating currents placed a certain height above the Earth's surface. Either line currents or those with a North-South Cauchy distribution were implemented, running East-West along a given latitude. The image-current method in the plane-earth geometry was used to represent induced electromagnetic fields on the earth's surface. Preliminary field-plots show reasonable results, but differ considerably from different locations with different resistivity structures.

Abstract content
   (Max 300 words)

This research focusses on the inversion of geomagnetic field measurement to obtain source currents in the ionosphere. The ionospheric currents during a geomagnetic storm induce geo-electric fields, which in turn create geomagnetically induced currents (GICs) in power lines. These GICs may cause damage to grounded power transformers. The ultimate aim is to develop a system for predicting the ionospheric source currents from solar event data and use the link between the source currents and GICs to provide advance warning to power utilities. Line currents running East-West along given latitude are postulated to exist at a certain height above the Earth's surface. This physical arrangement expresses the fields on the ground in terms of the magnetic north and down component, and the electric east component. Ionospheric currents are modelled by inverting Fourier integrals of elementary geomagnetic fields using the Levenberg-Marquardt technique. The output parameters of the model are the current strength, period, height and latitude of the ionospheric current system. A conductivity structure with five layers from Quebec, Canada, based on the Layered-Earth model, is used to obtain the complex skin depth at a given angular frequency. The paper will present inversion results based on the Quebec structure and simulated geomagnetic fields. Model parameters can be obtained to within 2% of published values. This technique has applications for modelling the currents of electrojets at the equator and auroral regions, as well as currents in the magnetosphere.

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