

## **Modelling geomagnetically induced currents in the Alberta power network: Comparison and validation using Hall probe measurements during a magnetic storm**

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### **SUMMARY**

During space weather events, geomagnetic disturbances (GMDs) induce geoelectric fields which drive geomagnetically induced currents (GICs) through electrically-grounded power transmission lines. Alberta, Canada—located near the auroral zone and thus prone to large GMDs—has a dense network of magnetometer stations and surface impedance measurements to better characterize the GMD and ground conductivity, respectively. GIC monitoring devices were recently installed at five substation transformer neutrals, providing a unique opportunity to compare data to modelled GICs. GICs are modelled across the >240 kV provincial power transmission network during a moderate GMD event on April 24, 2023. GIC monitoring devices measured larger neutral-to-ground currents than expected up to 117 Amps during peak storm time, providing unequivocal evidence linking network GICs with GMDs. The model performs reasonably well (correlation coefficients >0.5; performance parameter >0.15) at four of five substations, but generally underestimates peak GIC values (often by a factor >2), suggesting that the present model underrepresents overall network risk. The model performs poorly at one of the five substations (correlation = 0.46; performance parameter = 0.10), the reasons for which may be due to simplifications and/or unknowns in network parameters. Despite these underestimates, during this GMD, the model predicts the largest GIC at substations located in the northeastern part of the province (240 kV) or around Edmonton (500 kV)—regions which have significant electrical and industrial infrastructure. Further refinement of the network model with transformer resistances, more line and earthing resistances, and/or including lower voltage levels is necessary to improve data fit.

**Keywords:** magnetotellurics, geomagnetically induced currents, space weather, monitoring, geoelectric fields