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[Abstract]

Using Machine Learning to Predict Geomagnetic Variations for GIC Applications

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Abstract: Extreme space weather events can perturb Earth's magnetic field and generate enhanced geo-electric fields that result in the flow of large Geomagnetically Induced Currents (GICs) through infrastructures such as transmission lines (Gaunt 2016). These disturbances underscore the vulnerabilities and interdependencies of critical infrastructure and key resources. For example, the loss of power could also affect water, food, transportation, communication, banking, and finance. Thus, predicting geomagnetic variations is paramount to better understanding GICs to safeguard critical infrastructure. Research on GICs is starting to benefit from comprehensive data-intensive approaches such as machine Learning (ML) neural networks that are both computationally efficient and inexpensive (Baily et al. 2022). In this study, we train the multi-variate Long-Short Term Memory (LSTM) neural networks for time series analysis to ingest solar wind and interplanetary magnetic field from the OMNI dataset and geomagnetic field observations obtained from ground magnetometer recordings, with a future goal of predicting geomagnetic field disturbances for GIC applications. Neural Networks are best trained with clean and validated data sets. However, both OMNI and ground station data have

unexpected values (spikes) and/or data gaps. To address those, we present preliminary results using the LSTM model for the following: 1) Data validation - to know how much data is missing, as well as size of data; 2) Interpolation - to reduce large data gaps. Additionally, we will also implement other neural network models, including a multi-layer perception such as the feed-forward artificial neural network (ANN) or a convolutional neural network (CNN). The results will inform the decision as to the best neural network model to use to predict geomagnetic variations for GIC applications.

Keywords: GICs, AI/Machine Learning, Extreme space weather

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