Prediction of geomagnetically induced currents in low-latitude regions using deep learning

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The present study proposes a geomagnetically induced currents (GICs) prediction model for three low-latitude locations, Huancayo, Peru, Addis Ababa, Ethiopia and Guam, United States. It employs the long short-term memory (LSTM) and bidirectional long short-term memory (BiLSTM) neural networks. The model's performance was accessed using the interleaving odd-even data split (IntOE) approach as a benchmark. The geomagnetic field variation (dB/dt) derived from geomagnetic disturbance event on 31 March 2001, is applied as the GICs' proxy. Results showed that employing both models, LSTM and BiLSTM with block division data split markedly enhanced prediction accuracy by up to 66% compared to IntOE. However, IntOE proves to be more effective for event-based validation.

Keywords: Geomagnetic disturbance, geomagnetically induced currents, long short-term memory, low-latitude regions, multiple train-test splits.

in low-latitude regions, prediction on the occurrence of GICs events is crucial for a clear understanding of their behaviour.

Researchers in the fields of Earth and Space Science are becoming more interested in recent advances in deep learning (DL), due to its higher accuracy when trained with large datasets and its track record of outperforming empirical models[6–8]. Long short-term memory (LSTM) is one of the DL methods that can enhance the accuracy of time-series data prediction[9]. Early forecasting of GICs using LSTM was explored by Wintoft *et al.*[8] in the high to mid-latitude region (–30° to –90° and +30° to +90°). Lotz and Cilliers[10] focused on GICs forecasting in the mid-latitude region in 2015. Bailey *et al.*[11] established a GICs and geoelectric field forecasting model in the mid-latitude region of Austria, utilizing real-time solar wind data. Bailey *et al.* used 21 years of predicted geoelectric field values derived from geomagnetic changes. Keesee *et al.*[12] focused on developing a forecast for earth's magnetic perturbation at a