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Global Ionospheric conditions forecasting using Deep Learning: comparative study using LSTM, GRU and CNN

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Being able to predict the global ionospheric conditions of the ionosphere is still challenging, in particular, due to the impact of space weather events. Recently, the scientific community has been implementing data-driven models such as machine learning (ML) based models with considerably good results. The combination of algorithms, computing infrastructure, and the great amount of ionospheric data available makes the ML techniques a suitable approach for ionospheric forecasting.
In this work, we present a comparative study using 3 deep learning (DL) techniques to forecast 24 hs. ahead of the global ionospheric conditions: Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU), and Convolutional Neural Networks (CNN). We use 18 grid points distributed over the globe and covering different latitudes and longitudes, including oceanic regions. The chosen input dataset is Global Ionospheric Map (GIM) with a time resolution of 2 hs. and, as an external variable, we use primarily the Kp index (with 3 hs. resolution) for the geomagnetic forcing (other geomagnetic proxies can be used as well).
Preliminary results show overall acceptable performances in each of the proposed DL-based models. Nevertheless, it can be observed that CNN models have a better performance in comparison with LSTM and GRU. We also observed that each technique has more difficulties to forecast in low latitude stations and oceanic scenarios. In this work, we show the main results and discuss stages of data curation, data resolution management, feature engineering issues, grey box modeling and hyperparameters tunning, and also further steps.