The Prediction of Global TEC with Transformer-based Neural Networks

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Abstract

Ionospheric total electron content (TEC) is a key indicator of the space environment. A full understanding of physical and chemical principles, available and well-representable driving inputs, and capable computational power are required for physical models to reproduce simulations that agree with observations, which may be challenging at times. Recently, data-driven approaches, such as deep learning, have therefore surged as means for TEC prediction. Owing to the fact that the geophysical world possesses a sequential nature in time and space, the Transformer architectures are proposed and evaluated for sequence-to-sequence TEC predictions in this study. We discuss the impacts of time lengths of choice during the training process and analyze what the neural network has learned regarding the data sets. Our results are competitive with other research studies, and the proposed model benefits from the efficiency of the Transformer architecture. In the future, plan to work with the Space Weather Operational Office at, Central Weather Bureau, and build a deep learning model augmented by data assimilation to facilitate more precise global and regional real-time TEC predictions for Taiwan.

Key word: total electron content, Transformer model, artificial intelligence, space weather