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Modelling of Storm-Time Relative Total Electron Content using a Fully Connected Neural Network

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During geomagnetic storms the total electron content (TEC) can dramatically change compared to quiet-time conditions. Therefore, it is still a challenging task for ionospheric models to predict accurately during storm times. In this work, the relative TEC with respect to the preceding 27-day median TEC is predicted, during storm time for the European region (with longitudes 30°W–50°E and latitudes 32.5°N–70°N) using machine learning techniques. A fully connected neural network (NN) is proposed that uses the 27-day median TEC (referred to as median TEC), latitude, longitude, universal time, storm time, solar radio flux index F10.7, global storm index SYM-H and geomagnetic activity index Hp30 as inputs and the output of the network is the relative TEC. The model was trained with storm-time relative TEC data, computed with UQRG global ionosphere maps (GIMs), from the time period of 1998 until 2019 (2015 is excluded) and contains 365 storms. The model was tested with unseen storm data from 33 storm events during 2015 and 2020. The storm-time relative TEC model's predictions showed the seasonal behavior of the storms including positive and negative storm phases during winter and summer, respectively, and a mixture of both phases was seen during equinoxes. The relative TEC was converted to the actual TEC, using the median TEC, and was compared to the Neustrelitz TEC model (NTCM) and a NN-based quiet-time TEC model. The storm model outperforms the NTCM by 1.87 TEC units (TECU) and the quiet-time model by 1.34 TECU during storm time.