3rd URSI AT-AP-RASC, Gran Canaria, 29 May – 3 June 2022

Data Driven Physics-Based Ionosphere Models for Operational Services

Tim Fuller-Rowell* and the WAM-IPE Team
CIRES University of Colorado and NOAA Space Weather Prediction Center, Boulder, CO 80302;
email: tim.fuller-rowell@noaa.gov

A physics-based whole atmosphere-ionosphere model (WAM-IPE) was recently transitioned to operations to support the ionospheric products and services provided by the NOAA Space Weather Prediction Center (SWPC). The products include specification and two-day forecasts of the plasma density, total electron content (TEC), and HF maximum useable frequency, and their departure from 10-day running means (see Figure 1). The later represents anomalous ionospheric behavior from the normal quiet day average. The model is driven by the real-time solar wind and interplanetary magnetic field data from the DSCOVR satellite updated every minute, and daily Penticton 10.7 cm radio flux observations, representing geomagnetic and solar activity, respectively. The whole atmosphere neutral model with data assimilation below 60 km implicitly includes the influence of the lower atmosphere variability on the upper atmosphere and ionosphere. The neutral component WAM can also provide neutral density specification and forecast for space traffic management applications.

A data-driven ionospheric data assimilation model, Glo-TEC, using global networks of ground-based data and COSMIC-II radio occultation GNSS measurement is used to remove plasma density biases in the physical model. In addition, GOLD height-integrated O/N_2 ratio observations are compared with WAM values to determine the realism of the neutral composition changes during geomagnetic storms, which are the drivers of ionospheric negative phase and reductions in MUF. The increases in mid-latitude plasma densities during a storm, reflecting the ionospheric positive phase, are well captured and are in reasonable agreement with TEC observations from ground-based networks of GNSS data.

In the future, in addition to the bias correction procedure described above, ensemble Kalman filter data assimilation techniques can be used to fully utilize the increasing number of space weather observations to improve the ionospheric products and services at NOAA-SWPC.

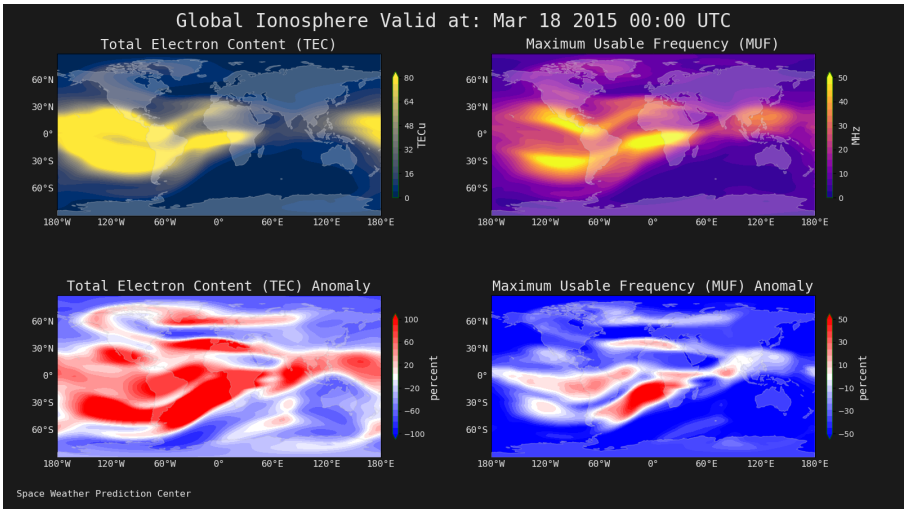

Figure 1. Example of WAM-IPE operational ionospheric products: total electron content and the maximum useable frequency for HF radio wave propagation, and their departures from the ten-day average, representing anomalous ionospheric behavior from the normal quiet day average.