NEDM modelling studies and its potential to improve the IRI model

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The newly developed Neustrelitz Electron Density Model (NEDM2020) [1] describes the ionosphere and plasmasphere up to about 20,000 km altitude. The model can calculate the electron concentration at any given location and time in the ionosphere and can be used for mitigation of propagation errors for trans-ionospheric signals. NEDM2020 is composed of a plasmasphere model and separate models for ionospheric F and E-layer distributions (see Figure 1). The F and E-layer distributions are described by Chapman layer functions whereas a dedicated plasmasphere model namely Neustrelitz Plasmasphere Model (NPSM) [2] is used for describing the topside ionosphere and plasmasphere. The model results were compared with the electron density in-situ data from DMSP and Swarm, Van Allen Probes and ICON missions. The investigation shows that the NEDM2020 performs better than the 3D electron density model NeQuick2 when compared with the in-situ data from Van Allen Probes and ICON satellites. The model results were validated against topside total electron content (TEC) data from COSMIC/FORMOSAT-3 mission, bottom side TEC data from TOPEX/Poseidon mission and ground-based TEC data from International GNSS Service (IGS) covering both high and low solar activity conditions. We found that NEDM2020 performs better than NeQuick2 when compared with the TEC data from COSMIC and TOPEX/Poseidon missions.

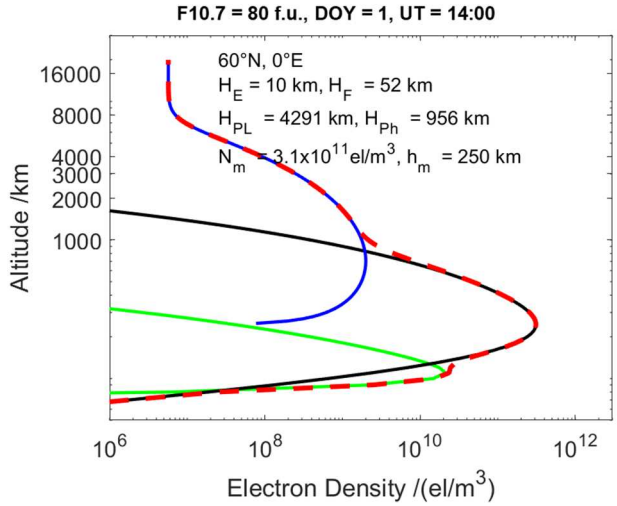

Figure 1. Total electron density distribution superposed by contributions from the NPSM- (blue), F-layer (black) and E-layer (green) computed at (60° N, 0° E) location. The example plot represents for low solar activity (F10.7 = 80) conditions.

Our investigation shows that NEDM2020 provides a better topside ionosphere and plasmasphere description compared to the NeQuick2 model thanks to the inclusion of the NPSM. It is concluded that the topside part of the NEDM2020 has the potential to improve the IRI model up to 20,000 km altitude. Preliminary results will be presented to demonstrate this capability.

References

[1] M. M. Hoque, N. Jakowski, and F. S. Prol"A new climatological electron density model for supporting space weather services," *J. Space Weather Space Clim.*, **12**, 1., 2022, https://doi.org/10.1051/swsc/2021044

[2] N. Jakowski, and M. M. Hoque, "A new electron density model of the plasmasphere for operational applications and services," *J. Space Weather Space Clim.*, **8**, A16, 2018, doi: 10.1051/swsc/2018002