URSI GASS 2021, Rome, Italy, 28 August - 4 September 2021

Further development of the GISM: Perspectives and prospective

D. Vasylyev(1), Y. Bèniguel(2), V. Wilken(1), M. Kriegel(1), and J. Berdermann(1)
(1) German Aerospace Center, Neustrelitz, Germany, 17235, e-mail: dmytro.vasylyev@dlr.de; volker.wilken@dlr.de; martin.kriegel@dlr.de; jens.berdermann@dlr.de
(2) Informatique Electromagnétisme Electronique Analyse Numérique, Promenade Paul Doumer, Courbevoie/Paris, 92400 France, e-mail: beniguel@ieea.fr

In the digital transformation era new and evolving technologies (such as autonomous driving, smart logistics, precision agriculture) high-precision and robust satellite-mediated positioning services are of immense importance. The accuracy, availability, and continuity of Global Navigation Satellite Systems (GNSS) providing such services can strongly be affected by spatial and temporal variations of electron density in the ionosphere. Such fluctuations of electron density introduce random variations of phase of the propagating electromagnetic signal wave and results in intensity and phase fluctuations of the received signal, a phenomena known as scintillation. In the periods of strong solar-terrestrial interactions ionospheric variations are especially large and the resulting strong scintillations could severely affect reliability of GNSS systems.

Within the framework of space weather forecasting activities at the DLR Institute for Solar-Terrestrial Physics we plan to revisit the Global Ionospheric Scintillation Model (GISM) [1, 2] (see also Figure 1 for an example of the GISM output) and extend its applicability to the parameter region characteristic for high solar activity. Moreover, the integration of machine learning regression and/or anomaly detection algorithms in the GISM framework would allow short-term forecast of radio wave disturbances on a global scale. We present the first results of our works and discuss strategies for further development, extension, and validation of the GISM.

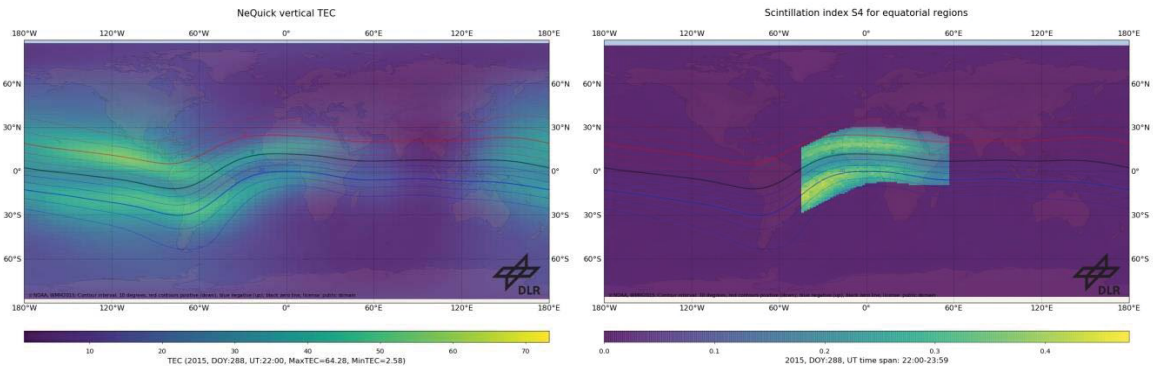

Figure 1. Shown are vertical TEC (left panel) for 15.10.2015, 22:00 UT and an excerpt of the corresponding scintillation map for the equatorial region (right panel). The scintillation map is obtained from the GISM modelling.

References

[1] Béniguel Y., P. Hamel, "A Global Ionosphere Scintillation Propagation Model for Equatorial Regions", Journal of Space Weather Space Climate, 1, (2011), doi: 10.1051/swsc/2011004

[1] IEEA, "Global Ionospheric Scintillation Model. User Manual. Version 6.9," January 2020.