2020 Systems of Signals Generating and Processing in the Field of on Board Communications, 2020

Calculation of Total Electron Content for Simulation of Meteor-Scatter Radio Links

Politaeva A.S., Sulimov A.I., Karpov A.V.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

© 2020 IEEE. Channel nonreciprocity is one of understudied features of meteor-scatter radio propagation that is caused mainly by polarization phenomena in the channel. For correct estimation of the nonreciprocity level, accurate values of the Faraday polarization twist are required that leads to problem of calculation of Total Electron Content of the ionosphere (TEC) along the signal propagation path. In this paper, the TEC is calculated by direct numerical integration of the ionosphere electron density throughout uplink to a meteor trail. The calculation method is based on division of the uplink path into several segments, each characterized by its own electron density height profile. Our computations made for 10000 various meteor trails simulated for a typical meteor radio link of 720-km length showed quite unambiguously that precise integration along the propagation path can be replaced with high accuracy by simple integration over the single electron height profile containing the signal reflection point. Estimates of the difference between the TEC values calculated for the opposite propagation uplink paths to meteor trail from both link ends are presented. It is shown that these differences are tiny and can be neglected at modeling meteor-scatter links.

http://dx.doi.org/10.1109/IEEECONF48371.2020.9078559

Keywords

ionosphere, Meteor burst communication, nonreciprocal wave propagation, polarization, total electron content

References

[1] V. A. Korneyev, "Time & Frequency coordination using unsteady, variable-precision measurements in meteor-burst channel, " Proc. 2003 IEEE Int. Freq. Cont. Symp. and PDA Exhibition Jointly with the 17th EFTF, pp. 285-289, Tampa (USA), May 2003.

[2] A. I. Sulimov, "Secure key distribution based on meteor burst communications, " Proc. 11th Int. Conf. on Security and Cryptography (SECRYPT-2014), pp. 445-450, Vienna (Austria), 28-30 Aug. 2014.

[3] A. I. Sulimov, "Analysis and simulation of channel nonreciprocity in meteor burst communications, " IEEE Trans. Ant. and Prop., vol. 65, no. 4, pp. 2009-2019, Apr. 2017.

[4] D. W. R. McKinley, Meteor science and engineering. New York, NY, USA: McGraw-Hill, 1961.

[5] P. S. Cannon, "Polarization rotation in meteor burst communication systems, " Radio Science, vol. 21, no. 3, pp. 501-510, May-June 1986.

[6] V. A. Premyakov, V. V. Sidorov, R. G. Khuzyashev, "Comparison of experimental data with numerical modeling of polarization effects on backscattering of waves from a meteor trail, " Radiophysics and Quantum Electronics, vol. 31, iss. 12, pp. 1026-1031, Dec. 1988.

[7] E. R. Billam and I. C. Browne, "Characteristics of Radio Echoes from Meteor Trails IV: Polarization Effects, " Proc. of the Phys. Soc. Section B, vol. 69, no. 1, pp. 98-113, 1956.

[8] P. S. P. Wei, C. R. Miller, C. K. Martin, "Polarization effects in radio wave scattering from meteor bursts, " Proc. of the IEEE Military Communications Conference (MILCOM-89), pp. 433-439, Oct. 1989.

[9] K. C. Yeh, "Note on the geometry of the earth magnetic field useful to Faraday effect expirements, " J. of Geophys. Res., vol.65, no.10, p.3209, 1960.

[10] A.V. Karpov "The computer model "KAMET": The new generation version, " Proc. Meteroids 2001 Conf., Kiruna (Sweden), pp.367-370, Aug. 2001.

[11] D. Bilitza, "IRI the International Standard for the Ionosphere, " Adv. Radio Sci., 16, 1-11, 2018.