COUPLING BETWEEN THE INTERNAL ATMOSPHERIC WAVES AND TILTED SPORADIC E-LAYERS IN THE EARTH'S IONOSPHERE

V.N. Gubenko [1], I.A. Kirillovich [1], Y.-A. Liou [2]

[1] *Kotel'nikov Institute of Radio Engineering and Electronics RAS, Vvedenskii Square 1, Fryazino, Moscow Region, 141190, e-mail: vngubenko@gmail.com;*

[2] *Center for Space and Remote Sensing Research, National Central University, Taoyuan City, 32001, e-mail: yueian@csrsr.ncu.edu.tw*

Keywords:
Earth's ionosphere, radio occultation, inclined plasma layers, internal gravity waves.

Introduction:
We have used the radio occultation (RO) satellite data for studying the ionosphere of the Earth. A method for deriving the parameters of ionospheric structures is based on an analysis of the RO signal variations in the phase path and intensity. This method allows one to estimate the spatial displacement of a plasma layer with respect to the ray perigee, and to determine the layer inclination and height correction values [1, 2]. In this work, we focus on the case study of inclined sporadic (E_s) E-layers in the high-latitude ionosphere based on available CHAMP (Challenging Minisatellite Payload/Global Positioning System) RO data. Assuming that the internal gravity waves (IGWs) with the phase-fronts parallel to the ionization layer surfaces are responsible for the tilt angles of sporadic plasma layers, we have developed a new technique for determining the parameters of IGWs linked with the inclined E_s-structures [3]. A small-scale internal wave may be modulating initially horizontal E_s-layer in height and causing a direction of the plasma density gradient to be rotated and aligned with that of the wave propagation vector **k**. We have shown that the magnitudes of intrinsic frequency and period can be directly determined based on the values of Brunt-Vaisala frequency and angle between the local vertical and wave propagation vector, only. It was found that the analyzed internal waves have the intrinsic periods from 35 to 46 min and intrinsic vertical phase speeds from 1.4 to 2.0 m/s. These values correspond to a period of 30 min in the ground-based frame and downward wind speed of 2.0 m/s at a height of 100 km found for a model of the Polar cap Sporadic-E layers [4]. The developed technique extends capabilities of the RO method for studying the atmospheres and ionospheres of the Earth and planets. The results of determination of the intrinsic wave frequency and period, vertical and horizontal wavelengths, intrinsic vertical and horizontal phase speeds, angle between the local vertical and wave propagation vector, and other characteristics of IGWs under study are presented and discussed.

This work was partially supported by the RAS Presidium Program 28.

References:

[1] Pavelyev, A.G., Liou, Y.A., Zhang, K., Wang, C.S., Wickert, J., Schmidt, T., Gubenko, V.N., Pavelyev, A.A., Kuleshov, Y. Identification and localization of layers in the ionosphere using the eikonal and amplitude of radio occultation signals // Atmos. Meas. Tech. 2012. V. 5. No. 1. P. 1–16. DOI: 10.5194/amt-5-1-2012.

[2] Pavelyev, A.G., Liou, Y.A., Matyugov, S.S., Pavelyev, A.A., Gubenko, V.N., Zhang, K., Kuleshov, Y. Application of the locality principle to radio occultation studies of the Earth's atmosphere and ionosphere // Atmos. Meas. Tech. 2015. V. 8. No. 7. P. 2885–2899. DOI: 10.5194/amt-8-2885-2015.

[3] Gubenko, V.N., Pavelyev, A.G., Kirillovich, I.A., Liou, Y.-A. Case study of inclined sporadic E layers in the Earth's ionosphere observed by CHAMP/GPS radio occultations: Coupling between the tilted plasma layers and internal waves // Advances in Space Research. 2018. V. 61. No. 7. P. 1702–1716. DOI: 10.1016/j.asr.2017.10.001.
[4] MacDougall, J.W., Plane, J.M.C., Jayachandran, P.T. Polar cap Sporadic-E: part 2, modeling // J. Atmos. Sol.-Terr. Phys. 2000. V. 62. P. 1169–1176.