

ON THE CONNECTION BETWEEN THE SPATIAL BEHAVIOR OF THE TOTAL ELECTRON CONTENT OF THE IONOSPHERE ON THE GPS SIGNAL PATH AND THE IONOSPHERIC ARTIFICIAL AIRGLOW IN THE 630 nm LINE

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We present the results of simultaneous measurements of the total electron content (TEC) of the ionosphere on the GPS signal path and the ionospheric artificial airglow in the atomic oxygen red line ($\lambda = 630$ nm) during HF pumping of the ionosphere by the Sura facility radiation. It is very likely that when the “navigation satellite — GPS receiver” path of a signal crosses the artificial airglow spot, the maximum brightness of the latter on the line of sight of the optical device at the navigation satellite was observed in the region of the TEC minimum.

1. INTRODUCTION

When the ionosphere is heated by high-power HF radio emission, electron-density irregularities with sizes from tens of centimeters to tens of kilometers [1, 2] are formed in its reflection region. Diagnostics of a large-scale (with sizes $l_{\perp} \gtrsim 0.5$ km across the geomagnetic field) structure of the HF-pumped ionospheric region was performed by means of its transmission by decameter radio emission of space radio sources, as well as ultrashort-wave (VHF) signals from low-orbiting [3] and geostationary satellites, using satellite radio tomography [4], and by *in situ* measurements of the electron density during transit of space vehicles and geophysical rockets through the perturbed region and above it (see reviews [1, 2] and references therein).

Another effective method for studying the large-scale structure of the perturbed ionospheric region is the measurement of its artificial airglow. Optical emission occurs when electrons pass from the excited levels of atoms, molecules, and ions to the lower energy levels. The corresponding levels get excited in collisions of atoms with electrons whose energy exceeds the excitation potential of these levels, and also as a result of ion–molecule reactions, in which an energy sufficient for the excitation of one of the atoms is released, in particular when dissociative recombination of molecules takes place. An increase in the airglow intensity due to the pump wave (artificial airglow) is related to acceleration of electrons by plasma waves arising from the development of various parametric instabilities in the field of a pump wave with ordinary polarization. The lowest excitation potential (1.96 eV) corresponds to the atomic oxygen level $O(^1D)$. Transition of an electron from this level to the ground state $O(^3P)$ corresponds to the atomic oxygen red line ($\lambda = 630$ nm). The radiation lifetime of this level $\tau_r(O(^1D)) = 107$ s [5]. Images of the perturbed ionospheric region in the 630-nm line, which were recorded using a CCD camera, indicate the existence of a large-scale structure of airglow spots with angular sizes of the order of 1° – 10° (this corresponds to sizes of the order of 5–50 km at altitudes of 250–280 km above the Earth’s surface), which sometimes moves (drifts) in space during long-term heating [6, 7, 8, 9, 10, 11, 12].

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