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DETERMINING THE POSITION AND PROPERTIES OF THE REGION OF ARTIFICIAL IONOSPHERIC IRREGULARITIES ABOVE THE SURA FACILITY RESPONSIBLE FOR GENERATION OF ASPECT SCATTERING SIGNALS ON A SHORT PATH

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The data obtained in the experiments on aspect scattering on a short path of Kazan — Vasilsursk — Kazan performed at the Sura facility in 2010 at frequencies of 2–7 MHz are compared with the results of ray-tracing calculations of the sounding and scattered signals. Positions and sizes of the region above Sura responsible for generation of the aspect scattering signals are determined. Characteristic scales of artificial decameter scattering irregularities and their dynamic properties as functions of the generation altitude and the time of the day are found.

1. INTRODUCTION

It is well known that when the Earth's ionosphere is affected by high-power HF radio waves, electron-density irregularities stretched along the geomagnetic field $\mathbf{B}_0$ occur in the region of their reflection. Transverse (with respect to the geomagnetic field) scales of these irregularities range from a few centimeters to hundreds of meters [1–5]. Such irregularities cause aspect scattering, including backscattering, of radio waves propagating through the perturbed ionospheric region. Using aspect scattering, it is possible to study the spatial spectrum of artificial irregularities, as well as the structure of the perturbed ionospheric region. A large volume of data on studying the perturbed ionospheric region with the help of aspect scattering was accumulated for the probing radiation of the UHF and HF waves in the frequency range 10–30 MHz [1–8]. In the HF wavelength range, for calculation of the wave trajectories it is important to allow for their refraction in the inhomogeneous ionosphere and the geomagnetic field effect. The path lengths of the sounding/scattered signals in such experiments exceed several hundred kilometers.

In this paper, based on the ray-tracing calculations for aspect scattering of radio waves of the lower frequencies (2–7 MHz) by the artificially created irregularities above Sura, we study the structure of the perturbed ionospheric region, including the localization and sizes of the region responsible for the generation of aspect scattering signals, typical scales of the artificial irregularities responsible for the scattering and their dynamic characteristics as functions of the altitude of the generation region and the time of the day. Strong refraction of radio waves of such frequencies in the ionosphere permits research on short paths, while ionospheric conditions along the path can approximately be considered unchanged. In addition, the geomagnetic field has a more significant effect on propagation of radio waves in this frequency range.

Calculations were carried out for the conditions of the experiments performed on May 14-15 and September 6, 2010 for the Kazan — Vasilsursk — Kazan propagation path. Sounding of the perturbed ionospheric region and recording of the scattered signals were performed using the Tsyklon ionosonde located

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