URSI AP-RASC 2019, New Delhi, India, 09 - 15 March 2019

Z-wave Occurrence and Propagation Patterns in Topside Sounding of the Earth Ionosphere

Maxim Kolomin, Nadezhda Kotonaeva, and Alexander Karpachev
Fiodorov Institute of Applied Geophysics, Moscow, Russia, e-mail: kongt@yandex.ru;

This work analyzes the occurrence probability of the Z-component trace on topside-sounding ionograms in the experiments aboard the Interkosmos-19 satellite and the space station Mir. The orbit height of Mir was around 350 km, while the perigee and the apogee of Interkosmos-19 were at 500 km and 950 km from the Earth surface.

We have confirmed a conjecture that Z-trace appears on the ionograms over those locations, where the slow extraordinary wave propagates along the geomagnetic field lines and achieves the reflecting condition in plasma layers that are perpendicular to the field lines but inclined to the Earth surface. Such layers arise in ionospheric regions with high horizontal plasma density gradients, for example, in the equatorial anomaly (EA). The vast Interkosmos-19 database allows to analyze statistically the probability of Z-trace occurrence depending on the distance between the satellite and the EA crests. The experimental data were systematized by seasons as well as hemispheres. The hemispheres comparison is important since the morphology of northern and southern anomaly crests is different.

We conjectured that, if sounding is carried out in the middle latitudes, Z-wave propagates equatorward along the magnetic field lines, meets the northern slope of the EA, reflects and comes back to the satellite's receiver. On the space station Mir ionograms in the spring season the maximal probability of the Z-wave registration is found between 36° and 39°N. Same result was derived from the Interkosmos-19 data despite the orbit difference.

The maximal z-trace occurrence probability of 25% is observed at 25°–30° (2800–3300 km) from the northern crest peak. Similarly, for the Southern hemisphere this probability reaches maximal value of 35% at 35°–40° (3900–4400 km) from the southern crest peak. The difference is probably caused by disparities in the structure of the steeper northern and flatter southern crest. The presence of the Z-component trace on topside ionograms is not guaranteed.

If the Z-trace appears in the middle latitudes, it is explained by the influence of the equatorial anomaly. Its occurrence in other regions is a consequence of high gradients caused by ionospheric irregularities of other types.

The reported study was partially funded by RFBR according to the research project № 18-05-80023.