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Impact of heliogeophysical disturbances on ionospheric HF channels

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Abstract

The article presents the results of the observation of a strong magnetic storm and two X-ray flares during the summer solstice in 2015, and their impact on the HF signals characteristics in ionospheric oblique sounding. It was found that the negative phase of the magnetic storm led to a strong degradation of the ionospheric channel, ultimately causing a long blackout on paths adjacent to subauroral latitudes. On mid-latitude paths, the decrease in 1FMOF reached ~50% relative to the average values for the quiet ionosphere. It is shown that the propagation conditions via the sporadic Es layer during the magnetic storm on a subauroral path are substantially better than those for F-mode propagation via the upper ionosphere. The delay of the sharp decrease in 1FMOF during the main phase of the magnetic storm allowed us to determine the propagation velocity of the negative phase disturbances (~100 m/s) from subauroral to mid-latitude ionosphere along two paths: Lovozero – Yoshkar-Ola and Cyprus – Nizhny Novgorod. It is shown that both the LOF and the signal/noise ratio averaged over the frequency band corresponding to the propagation mode via the sporadic Es layer correlate well with the auroral AE index. Using an over-the-horizon chirp radar with a bistatic configuration on the Cyprus – Rostov-on-Don path, we located small-scale scattering irregularities responsible for abnormal signals in the region of the equatorial boundary of the auroral oval.

Keywords: Storm and substorms; X-ray flare; Ionospheric propagation; Ionospheric disturbances; Ionospheric irregularities

1. Introduction

Despite the development of satellite and fiber communication, HF radio communication continues playing an important role in the solution of applied problems of ionospheric radio waves propagation. Its advantages consist in a long coverage range, high mobility, persistence and low cost compared with other types of communication.

The main problem of HF radio is the ionospheric channel susceptibility to different kinds of disturbances of both natural and artificial origin (solar flares, coronal mass ejections, magnetic storms, the passage of the terminator, eclipses, industrial explosions, missile launches, ionosphere heating, etc.). Magnetic ionospheric disturbances lead to changes in the regular distribution of electron density, cause an absorption increase, produce a strengthening of ionospheric irregularities, and induce the occurrence of abnormal signals. All this together with a change in noise

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