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The daily variations of Doppler frequency shift of ionospheric signal on middle-latitude radio lines

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Abstract

Doppler frequency shift (DFS) analyses of middle-latitude radio line signals during different seasons and for different geomagnetic conditions are presented in this work. It is shown; that during quiet geomagnetic conditions the range of DFS variations is the order of 0.1 Hz in the day time and 1–2 Hz during sunset and sunrise. The range of DFS variations during autumn and winter seasons is larger than during summer. The results of simultaneous measurements on two radio lines have been analyzed. One of them is N-S oriented, the other is E-W oriented. The range of DFS variations increases for N-S oriented radio line. The periods of variations with the maximal amplitude has been estimated. These periods are 10–80 min. Such periods are typical for internal gravity waves at ionospheric heights. The DFS variations during geomagnetic storm have been analyzed. Increase of variation range, especially on N-S oriented radio line is observed. The correlation analysis of DFS and indices of geomagnetic activity has been carried out. The correlation coefficient for average values of DFS and Kp indices is −0.55, the correlation coefficient for DFS variations and Kp indices is 0.65. Features of DFS variations during solar eclipse on March, 29th 2006 have been analyzed. On a radio line which crosses a track of total solar eclipse the increase of DFS variations range during an eclipse has been observed.

Keywords: Ionosphere; Traveling ionospheric disturbances; Solar eclipse

1. Introduction

The method of measurement of DFS of ionospheric signal – a Doppler method – is one of well known and widely used methods of ionosphere research. The interrelation of observable frequency shifts of ionospheric radio signals with changes of ionosphere parameters has been shown in works by Bennett, 1976; Davies and Baker, 1966; Namazov et al., 1975.

Advantages of Doppler method are the high sensitivity to small frequency disturbances and the high time resolution. One more advantage of Doppler method is capability of long continuous observations (Namazov et al., 1975; Namazov and Novikov, 1980). Nowadays Doppler method is widely used by various Russian research groups (Blagoveshchenskaya, 2001; Bochkarev et al., 2004a; Egorov et al., 2003; Vertogradov et al., 2004).

Doppler method allows to research various disturbances in the ionosphere. There are some sources of disturbances in the ionosphere. These are geomagnetic storms, solar flashes, metero effects, atmospheric waves. By means of Doppler method the influence of solar flashes on the ionosphere (Mitra, 1974; Blagoveshchenskiy and Borodkin, 1991) and effects of geomagnetic storms (Uryadov et al., 2004) are researched. Disturbances in the ionosphere during the severe geomagnetic storm on October, 29–30th 2003 have been studied by Bochkarev et al. (2004b). The Doppler method allows to find out the influence of earthquakes, explosions and other processes on the ionosphere, which occur near to the Earth. In works by Nagorsky,

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