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BEHAVIOUR PECULIARITY OF MF SIGNAL BACKSCATTED BY POLAR IONOSPHERE IN EVENING

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Abstract. The analysis of the MF radar data shows an existence of the repeated phenomenon of a backscattered signal intensity decrease for the period of 0.5 – 4 hrs in evening. A comparison with the fluxes of the particles reveals an intercoupling of the considered processes. One of an assumption explaining the lower ionosphere dynamics peculiarity for the viewed periods is discussed.

Introduction

During the 3 summer seasons between 1999 and 2001 PGI carries out researches of the lower ionosphere with the MF radar near Tumanny (69.0° N, 35.7° E). The MF radar was operated with peak power of ~100 kW, a frequency – 2.72 MHz, a time resolution of 1 s, and a range resolution of 2.25 km. The antenna array consisted of 32 (4×8) extended range cross-vibrators with a rotating field polarization and was suitable for transmission and reception of radiowaves. The beam width – 19° (north-east) and 30° (north-west) [Tereshchenko et al., 2002].

The results of the polar ionosphere MF sounding in Tumanny showed an effect of a drastic decrease of the backscattered signal from the height range 85 –100 km in the summer from 15 till 22 UT and duration 0.5 – 4 hrs. The similar phenomenon was observed many times during the summer experiments of 1999 – 2001. This paper presents the results of MF sounding for Summer 1999.

Experimental results

The examples of the time-altitude diagrams corresponded the effect are depicted in Fig. 1. The figure shows the data averaged over five minute interval by an inverse function. The colour variations from light to dark agree with the signal amplitude range 0 – 2400 mV. Such effect is observed in data of VHF radar [Hoffmann et al., 1999] which are situated in Andenes (69.6° N, 19.2° E).

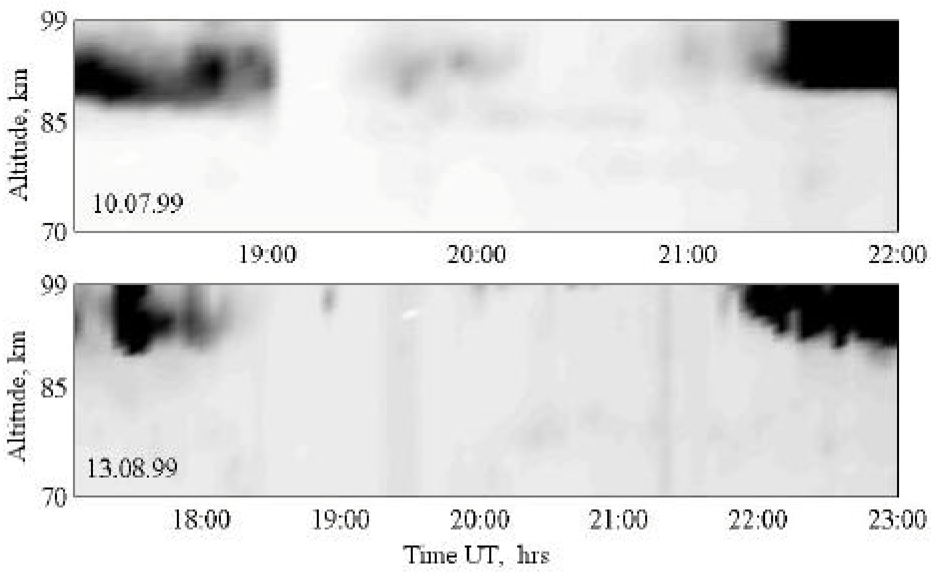

Fig.1. The time-altitude diagrams of the O-wave amplitude variations.

For an examination of a relation between the ionosphere processes causing a decline of the backscattered signals it was considered an event of 99.07.21 (see Fig.2). As shown in the figure it was short-time decline of the signal intensive at 16:55 which continued 35 min. This period is defined by the higher geomagnetic activity (K = 3 – 4), the rise of f_{min} from 1.2 to 1.6 MHz and sporadic E-layer appearance corresponding r type. The decline of the backscattered signal intensity is accompanied by the rise of the electron density at the heights over 85 km.

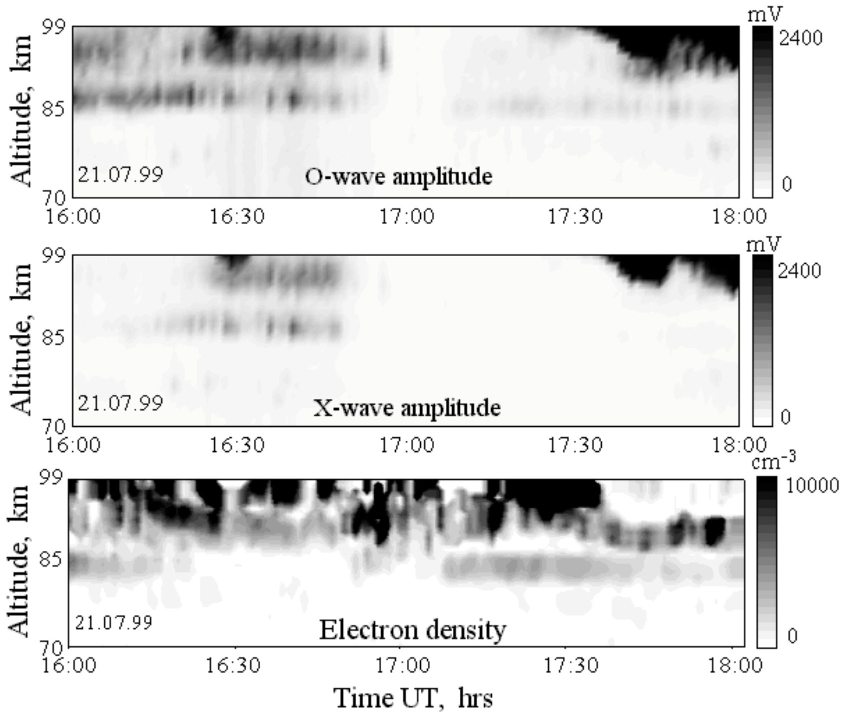

Fig.2. Amplitudes of magneto-ionic components and electron density.

The strong sporadic E-layer appearance after the considerable increase of D-region ionization and the mesospheric echoes intensity rise related with the reduction of the electron density near mesopause come to conclusion about a vertical drift of the ionized gas from D to E region.

The measurements results of the proton and electron fluxes observed by the geo-synchronous spacecraft GOES-8 and GOES-10 are depicted in Fig. 3.

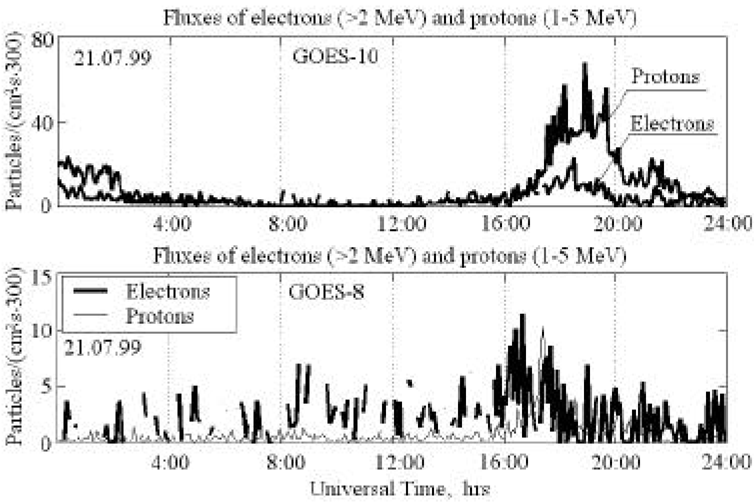

Fig.3. The fluxes measured by GOES-8 and GOES-10

The analysis of GOES-10 data reveals a rise of the proton and electron fluxes during a period from 16 to 20 UT and a maximum for the protons at 19 and the electrons at 18 UT.

A determination of the ionized gas velocity in the lower ionosphere was accomplished by the correlation analysis using spatial spaced measurements (on the ground level and vertical) [Drobgev et al., 1975].

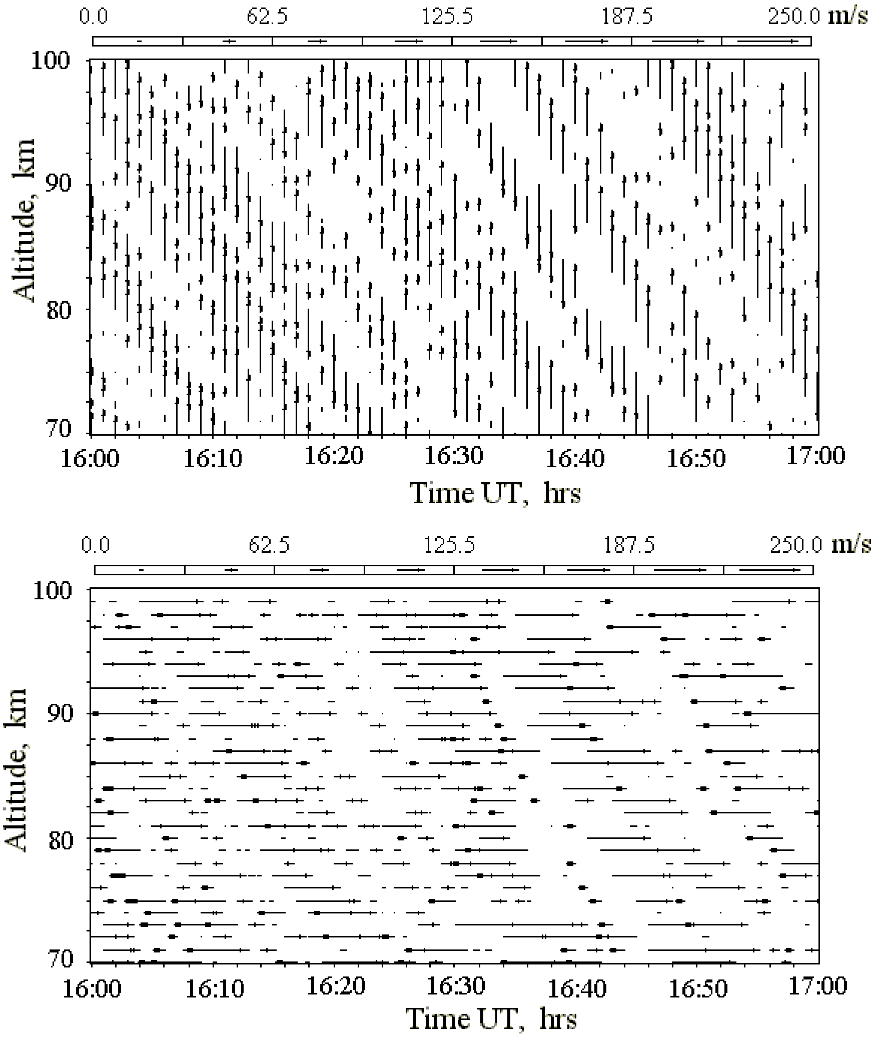

Fig.4. The meridional and zonal velocities of the ionized gas motion

In Fig. 4 it is depicted time-altitude variations of meridional and zonal velocity components of the ionized gas motion at 99.07.21. The calculations are carried out using 10 minutes averaged records with a continuous 1 minute shift. The north is on top of diagram and the east direction on the right. The figure shows undulating variations of the velocity components with different periods and a directions changing.

A vertical velocity determination was calculated by a "method of similar fade" with an assumption about an equality of lower ionosphere irregularities scales. The results for 99.07.21 are plotted in Fig. 5. As shown in the picture the vertical velocity of the irregularities is upward. A possibility of a temporal shift between the similar fades registered on neighbour heights depends on a irregularity type, a value of the transversal velocity, distance between neighbour levels of the backscattering and a width of an antenna pattern. Therefore the determined velocity should be considered as "apparent" velocity of the vertical motion.

Fig. 5 shows a sharp increase of the velocity on the top part of D-region in evening it points out on a quick raise of the backscatter level. As a result the lower Es layer is appeared. The increase of the D-region electron density is displayed with the strong radio waves absorption.

The motion of the irregularities can be explained by a location of an aurora south bound relatively the MF radar and a passing through the ionosphere an inner gravity wave. The particles fluxes cause the brief increase of the ionization in the upper part of D-region and correspondingly the strong radio wave absorption which is developed as the backscattered signal amplitude decrease.

Conclusions

Thus, we present the result of MF echoes observations made during the summer 1999. These observations show a very drastic decrease of the echoes intensity of MF signal backskattered by polar ionosphere in the evening. This effect occurs simultaneously with enhancement of particles precipitation. The MF echoes exhibit similar features as 50 MHz reflections. The nature of the observed phenomena is not clear now and demands of a further research.

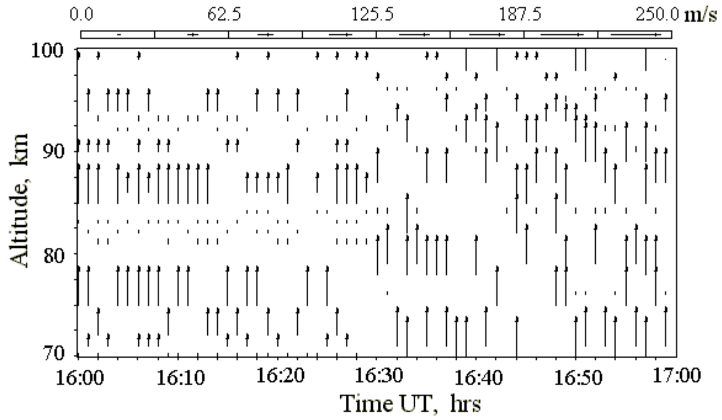

Fig.5. The vertical velocity of the ionized gas motion.

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