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THE F REGION IONOSPHERE RESPONSE ON THE SEVERE MAGNETIC STORM ON SEPTEMBER 25, 1998

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This paper presents the results of observation of ionospheric response to severe magnetic storm on September 25, 1998 (A_p = 121). Storm caused the significant changes in the ionosphere behavior: the increase of the height of the electron density peak h_mF2, the large fall of the peak electron density N_mF2, increase of plasma temperature and significant infringement of plasma exchange processes between low and upper ionosphere.

The study of ionospheric effects of magnetic storms is of great practical importance because the advanced technological systems, especially electric power lines and radio communications are increasingly sensitive to natural variations in the Earth's magnetic field.

In this paper some results of the *F* region observations with the Kharkov incoherent scatter radar during the magnetic disturbances are described. The interpretation of observed ionosphere effects from the point of view of the contemporary understanding of generalt common morphology picture and physical scheme of development of ionosphere disturbance was presented too.

Severe magnetic storm with the planetary index of magnetic activity A_p = 121 was observed on September 25, 1998. This storm was accompanied with the large changes in the Earth's ionosphere behavior. The Kharkov radar measurements have been conducted during the period of September 21-25, 1998. The geomagnetic conditions at this period are shown in Figure 1a in the form of the 3-hour magnetic activity index K_p as a function of Kyiv time (30° E + 1 hour). At the top of this Figure the day number, the daily solar activity $F_{10.7}$ index and the 81-day average $F_{10.7}$ index ($F_{10.7A}$) are shown. It was the period of moderate solar activity.

From this Figure it can be seen that the major storm commenced after local midnight on September 25 reached the peak K_p = 9 near local noon.

The magnetic storm is accompanied with the negative ionosphere disturbance. The height of the electron density peak h_mF2 increases at night by about 70 km and in the daytime by about 50 km in comparison with previous quiet days (Figure 1b). The increase of h_mF2 can be caused by the thermosphere disturbance effects, including the rebuilding of the global thermosphere circulation owing to the high-latitude heating, or by altering the neutral winds and electric fields [1].

The storm caused large fall of the peak of electron density N_mF2 in comparison with the average densities for the previous 56-hours period when the geomagnetic field was quiet (the solid line in Figure 1c). The effect of decrease of N_mF2 occurs at night, almost immediately after the storm commencement, increases gradually, before sunrise the depletion of N_mF2 is near a factor of 4 and before local noon it is near a factor of 4.5. During the morning period the major electron density peak is moving to the *F*1 region below 200 km (Figure 1b). It is *G* condition when $f_0F2 \le f_0F1$.

At night the fall of N_mF2 is explained by the change of neutral atmosphere composition and the increase of plasma temperature that also produced the rise of peak height shown in Figure 1b. The calculation has shown that the observed large decrease of electron density is to some extent accounted for the fall of ratio of the atomic oxygen [O] to molecular [N_2], [O_2] densities and increase of loss rate β of major O^+ ions because of neutral atmosphere composition change. However, vibrationally excited

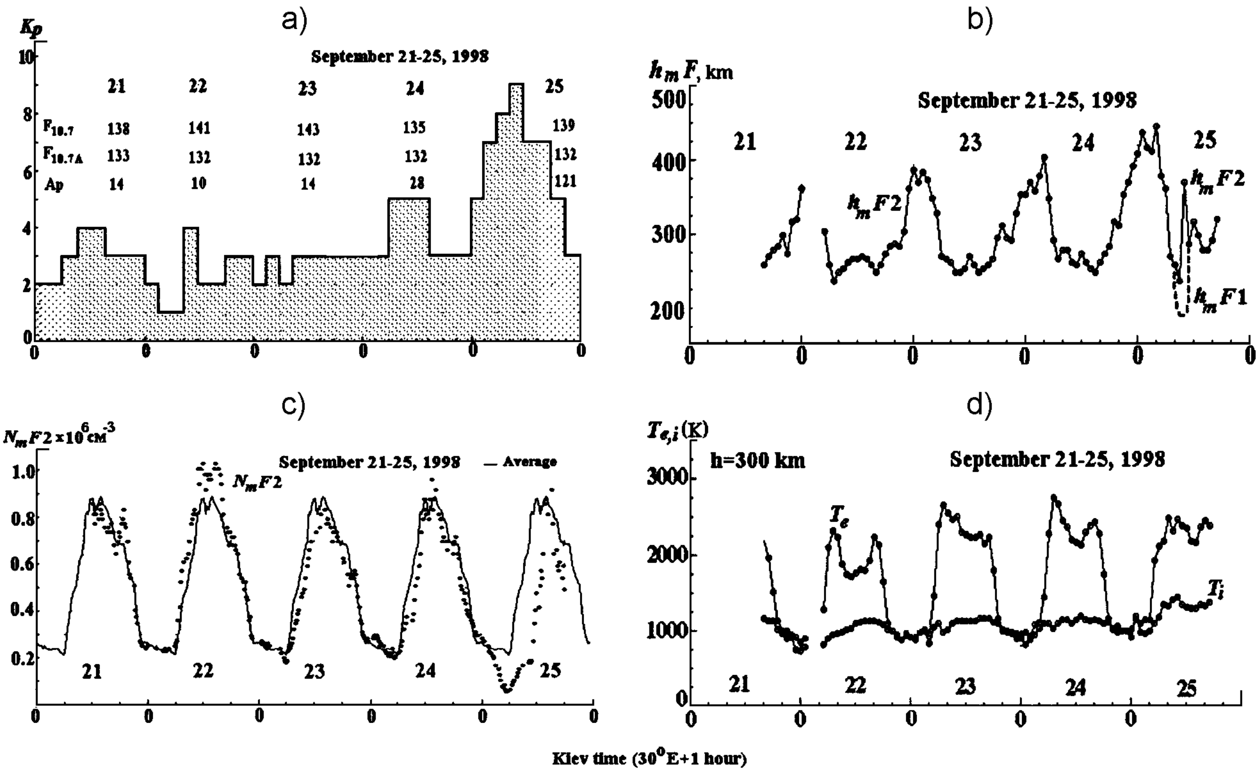

Figure 1. The variations of geomagnetic activity indexes and ionosphere parameters during the period of September 21-25, 1998: a) the 3-hour K_p index as a function of the Kiev time; b) height h_mF of the peak electron density; c) peak electron density N_mF2; the solid line means average values of N_mF2 for previous quiet period (56 hours); d) electron T_e and ion T_i temperatures at 300 km

nitrogen N_2^* could be also important in producing low electron concentrations during this storm [2].

It can be seen from Figure 1d that during the ionospheric disturbance at night, electron temperature T_e at 300 km altitude increases by about 150 K and ion temperature T_i by about 70 K at night and by about 200...300 K in the daytime. The increase of plasma temperature under disturbed conditions could be due to Joule heating associated with penetration of magnetospheric convection electric fields to middle latitudes, particle precipitation and other reasons [1, 2].

Figure 2 illustrates the changes of the vertical velocity of plasma during the severe geomagnetic storm on September 24-25 in comparison with the magnetic quiet days on September 22-23. These data was measured at the height range of 200—500 km.

It can be seen from Figure 2 that in the morning of the quiet day the vertical velocity of plasma was directed practically downward at the all height region from 200 km up to 400 km. During the same morning period (near and after sunrise) of the disturbed day the vertical velocity changed its direction and became the upward one.

Figure 3 illustrates the height profiles of vertical plasma velocity V_z and the plasma flux of O^+ ions, calculated from measured values of N_e and V_z, under undesturbed and disturbed conditions. For the quiet day altitude profile of V_z corresponds to the theoretical representations about the altitude variations of the velocity of F-region plasma parallel to the magnetic field lines [3]. For this period the downward flux observed below 500 km represents that needed for loss (occurring chiefly below 300 km) to balance production.

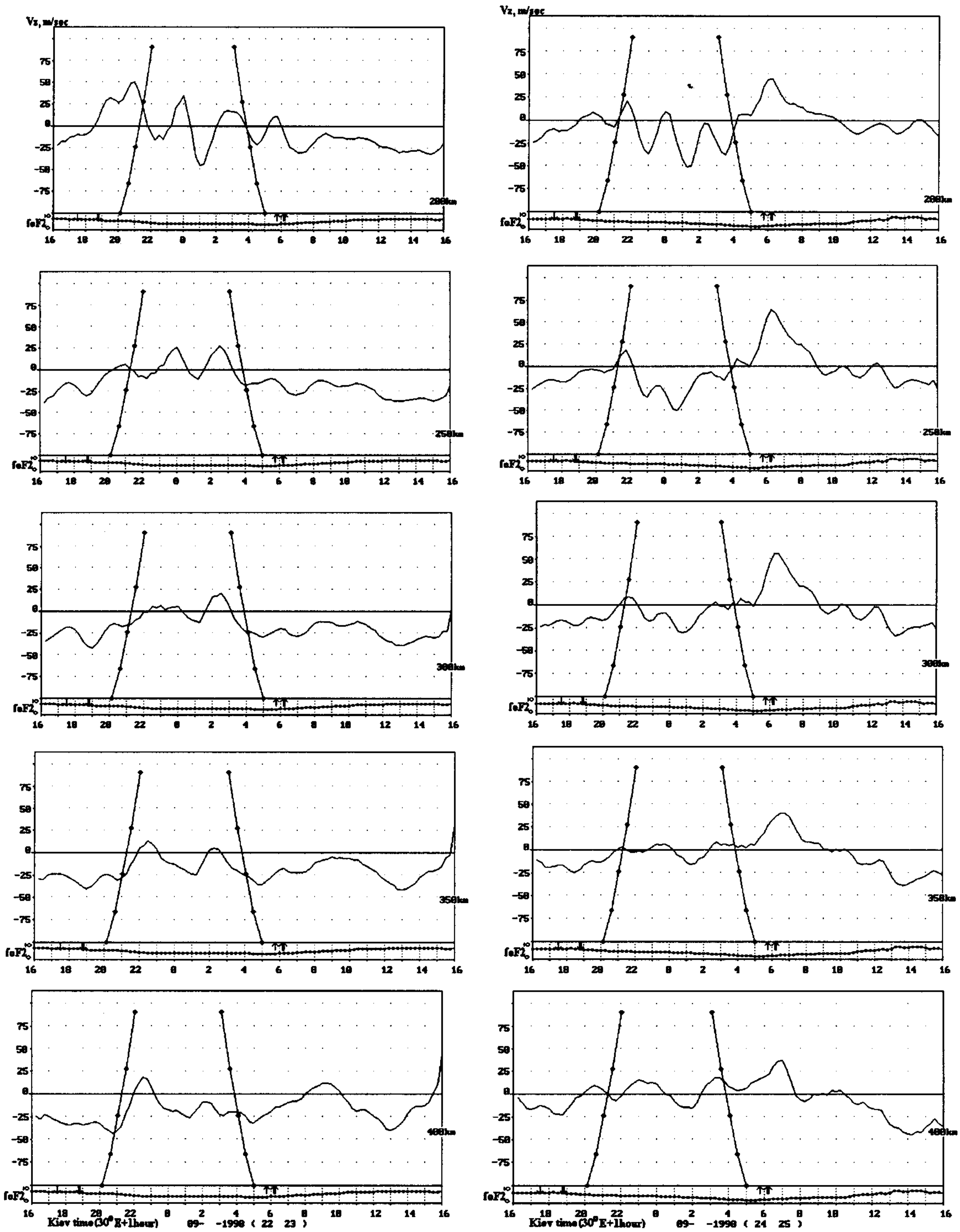

Figure 2. Variations of the vertical velocity of plasma during severe geomagnetic storm (September 24-25, 1998) compared to the magnetic quiet days (September 22-23, 1998)

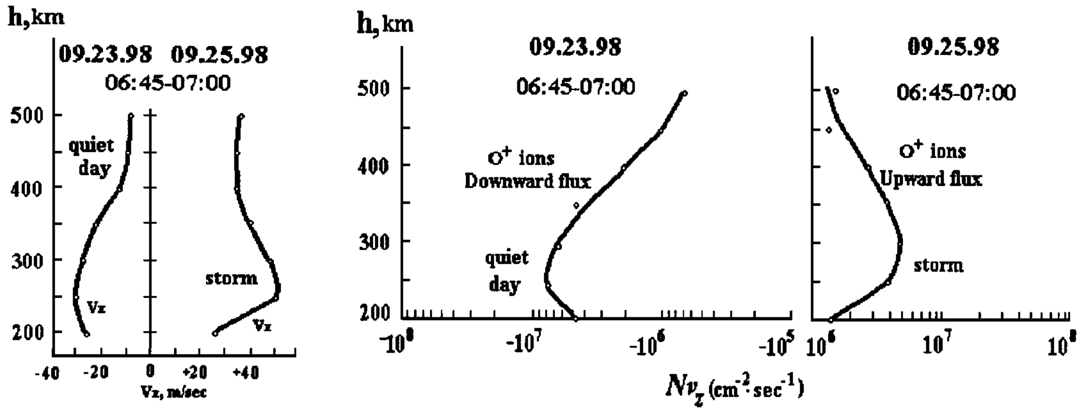

Figure 3. Altitude variations of the vertical plasma velocity and the O^+ flux in the morning on the quiet day (September 23) and during severe magnetic storm (September 25)

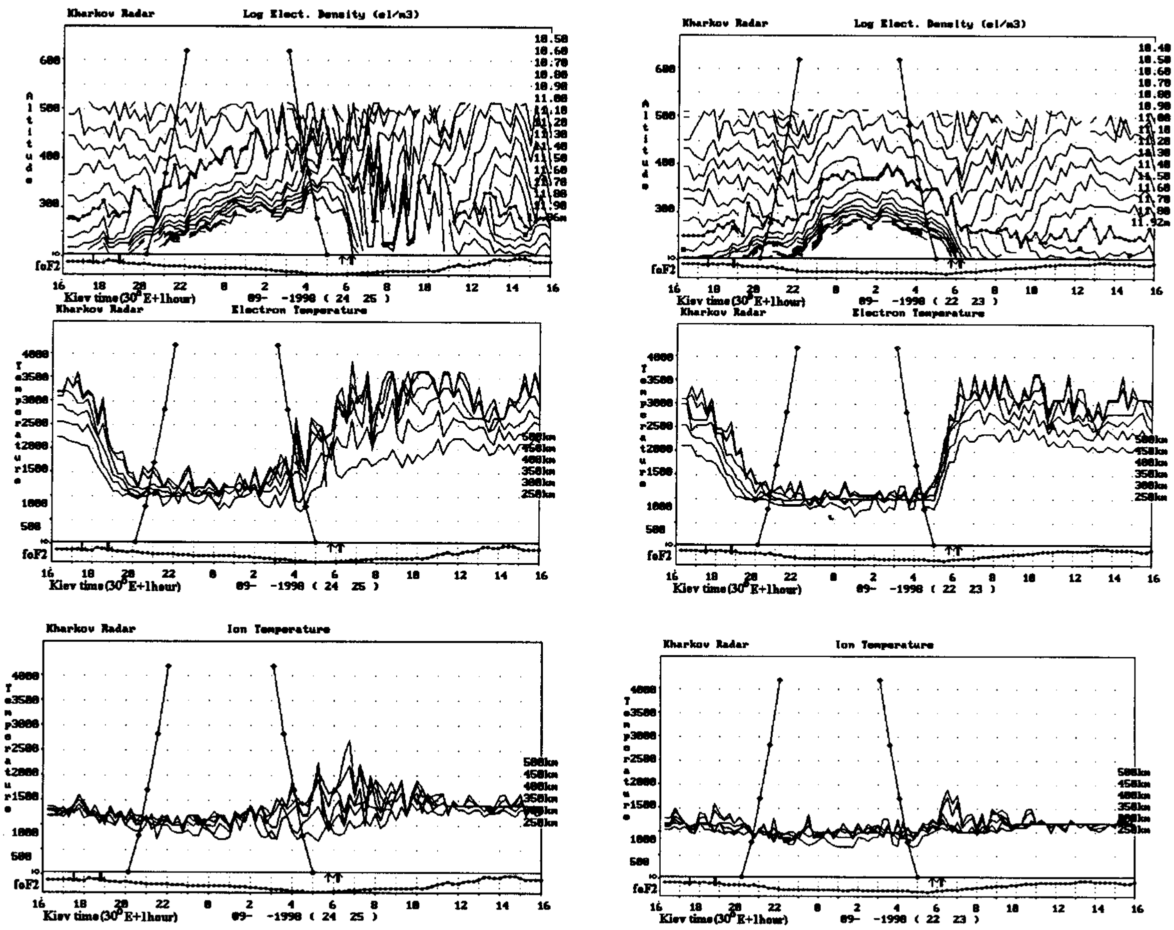

Figure 4. Height-diurnal variations of the electron density N_e (in form of constant plasma frequency lines, MHz), electron T_e and ion T_i temperatures during severe geomagnetic storm (September 24-25, 1998) compared to the magnetic quiet days (September 22-23,1998)

It can be seen that during the disturbed period the vertical plasma velocity V_z and the plasma flux (of O^+ ions) became upward ones at the altitudes from 200 up to 500 km. Such behavior of V_z velocity and the plasma flux is the evidence of the significant change of plasma exchange processes between low and upper ionosphere during this magnetic storm.

Figure 4 shows height-diurnal variations of the electron density N_e (in the form of constant plasma frequency lines, MHz), electron T_e and ion T_i temperatures during severe geomagnetic storm (September 24-25, 1998) compared with the magnetic quiet days (September 22-23,1998).

Obtained results can be used for modeling and prediction of mid-latitude ionosphere parameters under the geomagnetic disturbance conditions.

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