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THE EFFECT OF THE MAGNETOSPHERE PROCESSES ON THE IONOSPHERE DURING THE MAGNETIC STORM OF 1.XII.77 BASED ON THE COSMOS-900 DATA

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ABSTRACT

The effect of the magnetospheric disturbances on the high-latitude ionospheric plasma during the magnetic storm of 1.XII.77 is investigated using the data of measurements on-board Cosmos-900 satellite (the circular orbit is at the height of about 500 km, its inclination is 83°, the orbit period is 94.4 min). The measurements made it possible to correlate the regions of energetic electron precipitation with aurorae and the intensity of protons forming the storm ring current and to study the dynamics of the main ionospheric trough and polar peaks of the density and the temperature of the ionospheric plasma.

Electrons and protons with energies of tens of keV were measured by differential semiconductor spectrometers. The aurorae were recorded in the line of 3914Å by an on-board spectrophotometer. The instrument field of view is the cone with the full angle 9°; the axis of the field of view was directed to nadir. The thermal plasma density measurements were carried out by the three-electrode ion trap with a "floating" potential of the outer grid, and the electron temperature - by the radio-frequency probe.

There are the electron temperature and the atmospheric glow in the line of 3914Å data only for the shadowed parts of the orbits crossing the North hemisphere morning sector ($3\div6^h$ MLT).

Fig. 1 gives an indication of the parameters described above under the moderate and strong magnetic disturbance conditions. Fig. 1 presents: 1) the atmospheric glow intensity (in kiloRayleighs) in the 3914Å line; 2) the counting rate of the channel of E_e = 30 to 50 keV (geom. factor G 4x10^{-3} cm^2 ster) for electrons precipitating along the field lines; 3) the counting rate of the channel of E_p = 50 to 80 keV (G~8x10^{-3} cm^2 ster) for protons precipitating from the ring current, the reflection points of those protons being situated at the Cosmos-900 trajectory height; 4) the ionospheric plasma density; 5) the electron temperature.

The Cosmos-900 pass given in Fig. 1a corresponds to the initial phase of the storm (the geomagnetic data are shown in Fig. 2). There are seen two glow maxima at the latitudes 67° and 73°. Two electron precipitation regions match them. The intensive precipitations and the glow appear near the internal edge of the ring current protons. The profile of the electron density is typical of the winter ionosphere during moderately disturbed period; Fig. 1a shows the main electron density trough (1) the density of which increases more steeply on the polar side of the trough; then the auroral peak and the auroral trough (2), the polar peak and the polar trough (3) of the density. In the region of the minimum electron density there is observed the electron temperature maximum which is associated with the heat flow from above [1] and with the thermal plasma density decrease. The electron temperature increase at polar latitudes begins in the intensive precipitation regions.

The pass given in Fig. 1b occurred at the main storm phase during intensive geomagnetic bay disturbances.

The great glow peak displaced down to the latitude of about 64.5° is observed. The precipitating electron intensity increased strongly (by the order of magnitude in the maximum), the precipitation region extended to low latitudes. Proton fluxes with E_p = 50 to 80 keV also increased greatly and the internal edge of their profile shifted to lower latitudes. As in the previous case, the glow (and the most intensive precipitations) appears near the decay beginning in the proton profile. The picture of the ionospheric irregularities distribution significantly changes: the main density trough becomes less pronounced and shifts to low latitudes, the auroral trough

disappears, the irregularities become less and their zone extends.

Fig. 2 gives time variations of magnetospheric and ionospheric parameters during the storm :

1) the glow maximum position λ = 3914Å (black rectangles); half-width of the maximum is designated by vertical bars; 2) the precipitating electron intensity position (white rectangles); the precipitation region size is designated by vertical bars; its boundaries were determined by the counting rate decrease to the level of 10 sec^{-1}; 3) the internal edge profile position of protons with E_p = 50 to 80 keV (crosses) determined by the moment of the counting rate decrease by the order of magnitude relative to its maximum value; 4) the position of the main ionospheric trough (white circles); 5) the counting rate at the intensity maximum of protons with E_p = 50 to 80 keV (black circles); 6) D_{st} - variation; 7) AL-index.

The position of the main ionospheric trough highly correlates with the magnetic disturbance variation. The minimum latitude up to which the trough displaced during the main phase of the storm was 51.5°. At the initial storm phase when D_{st} -variation level was about 50γ, the effect of the trough shift to 57° due to the moderate substorm is clearly seen. The intensity of protons with E_p = 50 to 80 keV increased by a factor of several tens and was the highest in the main storm phase maximum. The internal edge of the profile of these protons as well as the ionospheric trough closely follows the storm variation. The regions of the maximum electron precipitation and the maximum glow adjoin the internal edge of protons from the high latitude side. The discrepancy between the maxima of the glow and the electron precipitation does not exceed 1^{o}. The half-width of the glow maximum is less than 3.5^{o}, excluding the passes at $\sim 21^{h}$ and at $\sim 08^{h}$ UT when the large region of low intensity glow ($<$ 10 kR) was observed. Under the conditions of moderate magnetic disturbances the low-latitude boundary of the electron precipitation practically coincides with the internal edge of the proton profile whereas during the main storm phase it is $\sim 3^{o}$ closer to the equator.

The main trough displacement to low latitudes demonstrates the magnetospheric electrostatic field increase during the storm development. The penetration of protons and electrons with the above energies into the magnetosphere seems to be explained by the amplification of the magnetospheric convection. As mentioned above, electrons in the increased electric field penetrate into the morning sector more deeply than protons. This effect agrees well with the picture of the combined drift in the convection electric field and the inhomogeneous magnetic field (for energies with tens of keV and even more the magnetic drift is more essential than the corotation). As known [2] in this case if the convection is from the night side positive particles will penetrate into the magnetosphere more deeply in the night sector and negative ones in the morning sector.

As seen in Figs 1 and 2 the intensive glow at λ = 3914Å appears near the ring current internal edge. According to theoretical ideas [3] bright aurorae are associated with the currents flowing along field lines from the Earth (in this case electrons are going to the Earth). These currents appear at the ring current boundaries and in the case of the low-latitude boundary are directed from the Earth on its morning side.

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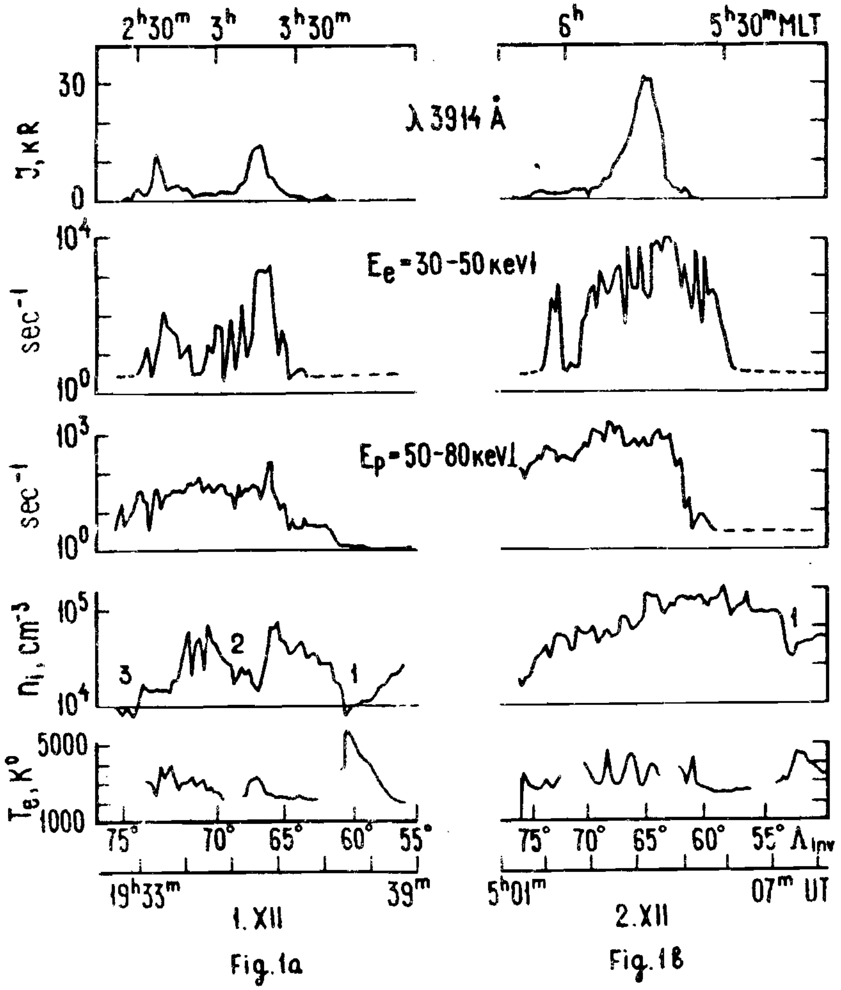

Fig. 1 Examples of the latitudinal profiles of the ionospheric and magnetospheric parameters observed during moderate (a) and strong (b) magnetic disturbances.

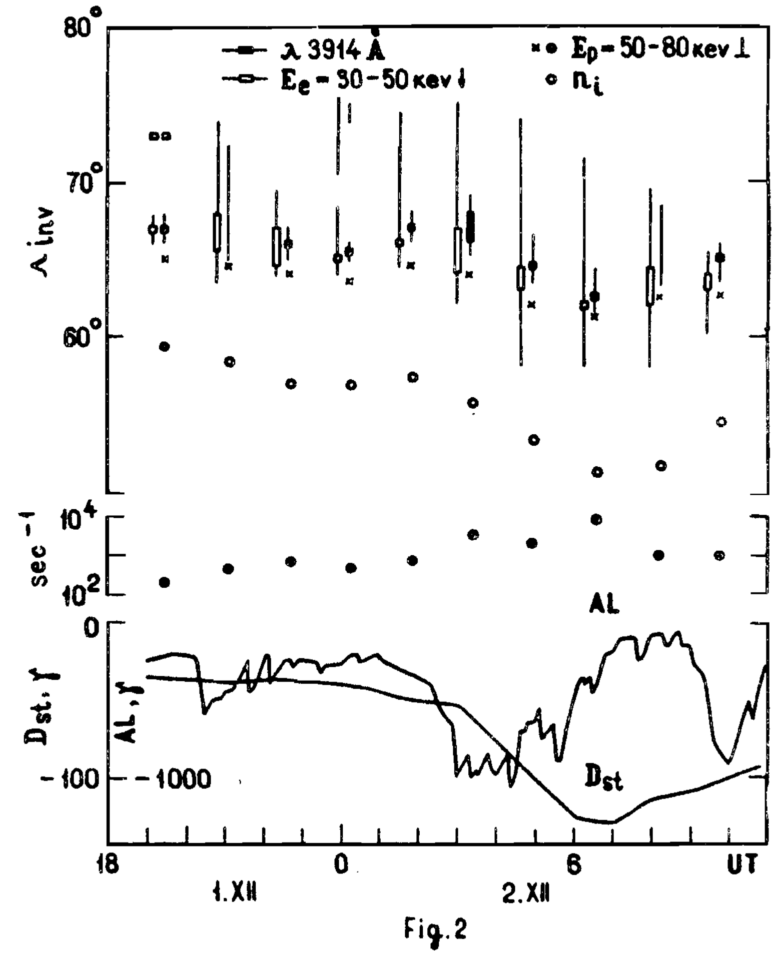

Fig. 2 Time variation of ionospheric and magnetospheric parameters observed during the storm of 1.XII.77.

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