AURORAL DYNAMICS AND MAGNETOSPHERIC DISTURBANCES NEAR THE SYNCHRONOUS ORBIT IN AFTERNOON SECTOR

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ABSTRACT. The signatures of magnetospheric substorms in the afternoon sector (14-18)LT are examined using ground-based data and data obtained on board GEOS-2 by magnetic field and energetic particle measurements. Analysis of the substorm developments allows to make several conclusions. 1. Before the substorm onset the adiabatic decrease of the energetic proton fluxes occurs with the decrease of the magnetic field near the synchronous orbit. 2. After the substorm onset the sharp decrease of the magnetic field and the injection of energetic protons were observed by GEOS-2. 3. The appearance of the discrete auroral arcs poleward of the GEOS-2 footprint is accompanied by the enhancement of energetic proton (E>27 keV) fluxes.

1. INTRODUCTION

Studies of the variations of the fluxes of energetic particles of the outer radiation belt following the availability of satellites at the geostationary orbit have established that the particle variations observed there are closely correlated with the variations of the global auroral electrojet system and the auroral intensifications. Near the local midnight the increases of particle fluxes coincide with the onset of negative bays in the auroral zone and the northward expansion of the substorm auroral bulge. In the early evening sector the sudden large increases of the energetic (>30 keV) proton fluxes are observed during the magnetospheric substorms. The energy and pitch-angle dependent dispersion is consistent with a westward gradient drift of the proton from the nightside acceleration region [1-3]. These protons are responsible for the asymmetric ring current.

The purpose of the present paper is to study the signatures of magnetospheric substorms in the afternoon sector (14-18)LT from ground-based data and data obtained on board GEOS-2 by magnetic field and energetic particle (proton 28-403 keV and electron 16-214 keV) measurements.

2. SUBSTORM ON NOVEMBER 24, 1978

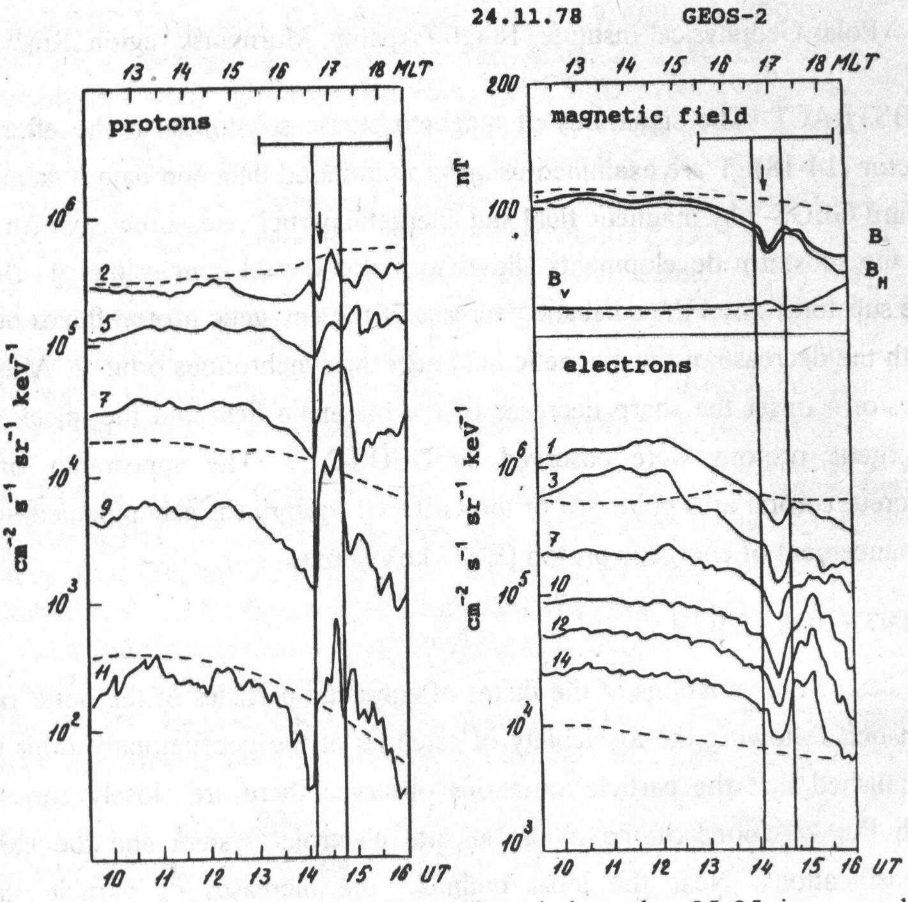

Fig.1. Proton and electron fluxes for pitch-angles 85-95 in several energy channels and local magnetic field (5-min average) on board GEOS-2 for November 24, 1978. GEOS-2 MLT is indicated at the top of the figure. Arrow marks the onset of auroral intensification.

Fig.1 reproduces data from November 24, 1978, showing the effect of magnetospheric substorm on the trapped particle populations near the GEOS2. One can see that at 14.10 UT the proton fluxes have large increases without correspondingly increases in the electrons. Data show the energy dependent dispersion of the proton injection. The behavior of the energetic electrons is similar to that of the magnetic field. The decreases of energetic particle fluxes during the substorm growth phase are characterized by a shift of trapped particle trajectories closer to the Earth following contours of B=const. Observed anticorrelation of proton flux variations and magnetic field changes suggests diamagnetic character of field changes. However from Fig.1 one can see that magnetic field recovered to its previous values long before the higher-energy proton fluxes recovered. The data then draw the conclusion that the field changes were not only diamagnetic but were associated with some phenomena during substorm.

All sky camera data from Kilpisjarvi have been analyzed for the period (13-16)UT. The first auroral arc appeared poleward of the Kilpisjarvi at 14.17 UT. Fig.2 presents the development of the aurora along the Kilpisjarvi meridian close to the GEOS-2 meridian.

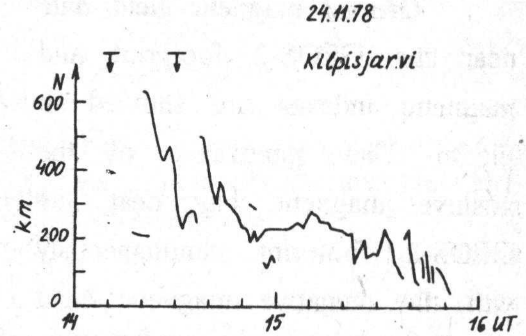

Fig.2. Aurora dynamics along the Kilpisjarvi meridian. Arrows mark the onsets of injections on GEOS-2.

One can see the following:
(1) 5-7 min after the proton injection the auroral arc appears near the GEOS-2 meridian, (2) after intensification onset the auroral arcs move equatorward but never so far as the GEOS-2 footprint.

Fig.3a presents the magnetic data at Kiruna and the AU- and AL-indexes. The proton injection at the GEOS-2 was closely associated with the appearance of the positive magnetic bay seen at Kiruna.

The indexes showed the substorm onset nearly the proton injection, indicating the intensification of the westward and eastward electrojets.

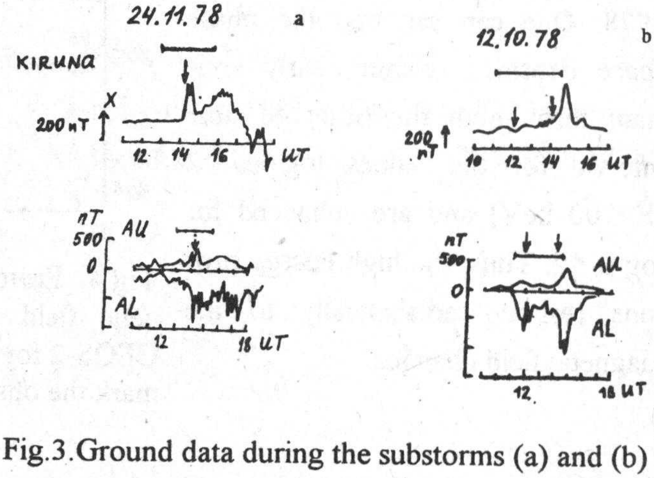

Fig.3.Ground data during the substorms (a) and (b)

3.SUBSTORM ON OCTOBER 12, 1978

Fig. 4 reproduces example of proton injections from October 12, 1978. The 28-98 keV proton injection is observed at near 12.05 UT and second injection of more energetic proton is observed at 14.30 UT. These proton injections are accompanied by simultaneous decrease of energetic electron fluxes (not shown).

Ground magnetic field data near the GEOS-2 footprint and magnetic indexes are showed in Fig.3b. The appearance of the positive magnetic bay near the GEOS-2 footprint simultaneously with the negative magnetic field disturbance and proton injection in the magnetosphere support the model of asymmetric partial ring current.

Fig.5 presents the calculated phase space densities of the protons for several moments before and after the proton injection on October 12, 1978. One can see that the phase space densities remain nearly constant throughout the observed time interval for the values log μ >2 (E>100 keV) and are enhanced for log μ <2. Thus, the high energy protons respond adiabatically to the magnetic field changes.

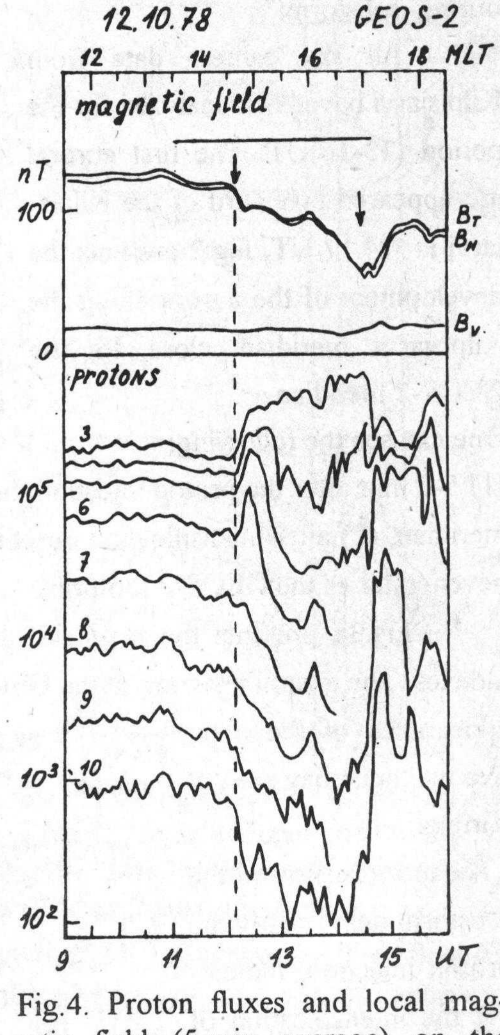

Fig.4. Proton fluxes and local magnetic field (5-min average) on the GEOS-2 for October 12, 1978. Arrows mark the onset of the proton injection.

4. CONCLUSION

Detailed investigation of the energetic particle flux variations in the early evening near the synchronous orbit allows to make the following conclusions.

1. Before the substorm onset the adiabatic decrease of the energetic proton fluxes occurs with the decrease of the magnetic field near the synchronous orbit.

2. After the substorm onset the sharp decrease of the magnetic field and the injection of energetic protons were observed by GEOS-2.

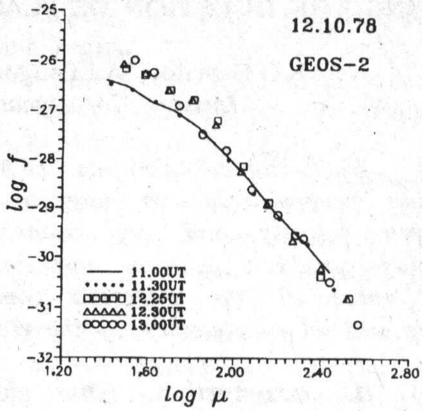

Fig.5. Phase space density f versus first adiabatic invariant for October 12, 1978.

3. The enhancement of energetic proton fluxes is accompanied by the positive magnetic bay on the ground and the appearance of the discrete auroral arcs poleward of the GEOS-2 footprint. After intensification onset the auroral arcs move equatorward but never so far as the GEOS-2 footprint.

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