USS-T

Nagurin

National Aeronautics and Space Administration
Goddard Space Flight Center
Contract No.NAS-5-12487

ST – PF – GM – AI – 10832

BOUNDARY OF TRAPPED ELECTRONS WITH E ⩾ 280 kev AND DISPOSITION OF CURRENT ELECTROJETS IN THE IONOSPHERE

by

R. G. Afonina &
Ya. I. Fel'dshteyn

(USSR)

6 MAY 1969

ST – PF – GM – AI – 10832

BOUNDARY OF TRAPPED ELECTRONS WITH E > 280 KEV AND DISPOSITION OF CURRENT ELECTROJETS IN THE IONOSPHERE

Kosmicheskiye Issledovaniya
Tom 7, vyp.2, 312-314,
Izdatel'stvo "NAUKA", 1969

by R. G. Afonina &
Ya. I. Fel'dshteyn

SUMMARY

This note consists mainly in discussion and interpretation of the results of observations by the 1963 satellite 38-C. The whole paper is principally based upon the previous publications by Dr.D.J.Williams et al, and on the corrected geomagnetic latitudes of the equivalent linear current at ionosphere heights and of the trapping region of electrons with E $\geqslant$ 280 kev.

* *

The results of observations of trapped electrons with energies E $\geqslant$ 280 kev at 1100 km height in the outer radiation zone were discussed in works [1 - 5]. In connection with this it appears to be interesting to consider the mutual disposition of the high-latitude boundary of capture of electrons with E $\geqslant$ 280 kev and of the current electrojets in the ionosphere; this is essential for the understanding of the nature of physical processes responsible for the occurrence and development of DP and of variations in the ionosphere and magnetosphere in the course of magnetic disturbances.

We made use of the observation data of the 1963 AES 38-C, launched on 23 September 1963 into a circular polar orbit. The corrected geomagnetic boundary of the trapping (Φ') was determined for the period from 15 March to 28 April 1964, when the satellite orbit was situated on the night side of the Earth, at midnight hours in the period of appearance of bay-like disturbances on the surface. It was assumed that on the trapping region boundary the counting rate constitutes one percent of the maximum counting rate in the outer radiation zone. This corresponds to trapping boundary determination

../..

according to the decrease in the counting rate of electrons with E > 280 kev by two orders with respect to counting rate latitude distribution maximum.*

The boundary of the region of trapping (Φ') was determined by way of interpolation between the values of latitudes, at which the counting rate was respectively equal to 1 and 10. The position of the electrojet as the equivalent linear current was determined after the magnetograms of a pair of observatories Barroy-College and Tiksi, situated no farther than 15° by longitude from the meridian of the intersection by the satellite of the trapping boundary.

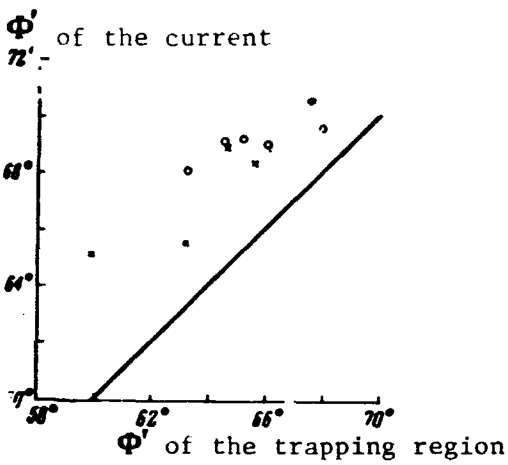

Fig.1

Corrected geomagnetic latitude of the equivalent linear current at ionosphere heights (Φ' of the current) at time of determination by the 1963 38-C satellite of the trapping region's boundary of electrons with E ⩾ 280 kev.

The dots indicate Φ' of current after the Barroy-College observatory data; crosses refer to data of the Tiksi Observatory.

The corrected geomagnetic latitude of the equivalent linear current in a period of negative DP and the boundary of the trapping region of electrons with E ⩾ 280 kev in the period 2300 - 0100 h. LT are shown in Figure 1. It follows from the data of this figure that the shift toward the pole of the western electrojet and of the boundary of trapped electrons' region is synchronous. An analogous conclusion was arrived at in the work [6]. In the near-midnight hours the boundary of the trapping region of electrons with E > 280 kev differs insignificantly from the boundary of the region of steady trapping of electrons with E ⩾ 35 kev according to data from AES "Alouette-2" [7]. Since this boundary is simultaneously the southern boundary of the oval aurora zone at midnight hours [8], it follows that the western electrojet is disposed at aurora zone latitudes.

Only in two cases did we succeed in determining the position of the eastern electrojet with respect to the trapping boundary of electrons with E ⩾ 280 kev, in a period when positive DP were observed on the ground. In other cases we failed, either because of low counting rate at maximum, which was expressed

* Refer to [4, 5].

by a two-digit and by a three-digit number, which is usually the case, or on account of the fact that the current of the positive bay-like disturbance can not always by approximated by a linear current.

According to the data of the pair of observatories Barroy-College in a period of positive DP on 14 May 1964 at 2100 h.LT, the eastern electrojet was located by 3° to the North, on the circumpolar side from the trapping boundary. As to the data from the Tiksi Observatory, the eastern electrojet was located during the positive DP of 17 May 1964 at 2100 h. LT by 2° to the South of the boundary of the trapping region. Obviously, on the basis of two cases, one may not derive the conclusion on the mutual disposition of the eastern electrojet and of the boundary of steady trapping of energetic electrons. However, it is still imperative to note that the eastern electrojet is disposed in the evening hours near the boundary of steady trapping. This is in agreement with the assumption that positive DP are caused by the precipitation of protons, trapped in the near-midnight sector and performing a drift in the geomagnetic field in westerly direction [9]. The limit of closed field lines, along which both the aurora oval and the western electrojet are disposed, is located in a period of positive DP in evening hours at higher latitudes [7, 10].

During magnetic disturbances, the trapping boundary of energetic electrons is shifted toward lower latitudes [2, 4, 5, 11]. The shift of the boundary of trapped electrons with E $\geqslant$ 280 kev is interpreted in [4, 5] as a result of the fact that, originally, the closed field lines are stretched into the tail in the course of a magnetic disturbance.

Fig.2 shows the corrected geomagnetic latitude (Φ') of the boundary of electrons' with E $\geqslant$ 280 kev trapping according to data of the 1963 AES 38-C for the period of its operation from 15 March to 15 April 1964 in the 2300 - 0100 h LT interval, and the AL-indices characterizing the magnetic activity conditioned by the western electrojet [12] (see Fig.2 next page). We may see from it that the mean statistical values of Φ', denoted by crosses through which a straight line is drawn, are found inside four intervals of AL values, namely, $0, -100\gamma$; $-100, -200\gamma$; $-200, -300\gamma$; $-300, -400\gamma$. The observed scattering of the points is explained by the fact that the instantaneous values of Φ' after the satellite data were compared with AL-indices characterizing the

../..

magnetic activity for an hour. Subject to the greatest throw is the point that marks the observation of 17 March 1964 at 1138 h.UT, when the satellite, being over the Barroy meridian, crossed the boundary of the trapping region at $\Phi' = 67.5°$. At that hour AL = -362γ.

However, the horizontal perturbed vector of the geomagnetic field at College, situated at 12° from the Barroy meridian, was at that time small. There is, therefore, reason to believe that the instantaneous value $\Phi' = 67.5°$ must correspond to a lower magnetic disturbance than is shown by the hourly index AL. Besides, the magnitude of Φ' is influenced by the intensity of the magnetic field of the ring current of DP, which was not taken into account on the indicated graph. Nonetheless, Fig.2 shows a a definite tendency to displacement of the boundary of trapped electrons toward the equator as the magnetic disturbance increases.

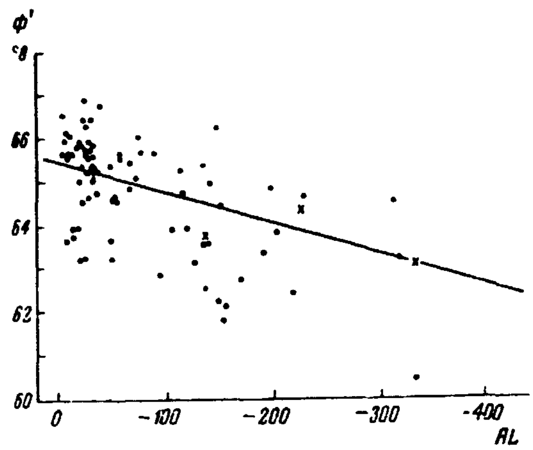

Fig.2

Corrected geomagnetic latitude (Φ') of the boundary of trapped electrons with E ⩾ 280 kev after the data of the 1963 AES 38-C as a function of magnetic activity being expressed by the AL-index

We are grateful to Dr. D. J. Williams for his kindness in presenting us with the observation data of satellite 1963 38-C.

*** T H E E N D ***

Manuscript received on 19 Nov.1968

CONTRACT No.NAS-5-12487
VOLT INFORMATION SCIENCES, INC.
1145 - 19th St.NW
WASHINGTON D.C. 20036.
Telephone: (202)-223-6700 (X-36)

Translated by ANDRE L. BRICHANT
on 5 May 1969

References follow...

R E F E R E N C E S

1. D. J. WILLIAMS, A. M. SMITH. J.G.R., 70, 541, 1965.
2. D. J. WILLIAMS, W. F. PALMER., Ib. 70, 557, 1965.
3. D. J. WILLIAMS, G. D. MEAD. J.G.R., 70, 3017, 1965.
4. N. F. NESS, D. J. WILLIAMS., J.G.R., 71, 322, 1966.
5. D. J. WILLIAMS, N. F. NESS., J.G.R., 71, 5117, 1966.
6. J. D. CRAVON. Trans. Amer. Geophys. Union, 48 (1), 181, 1967.
7. I. B. McDIARMID, J. R. BURROWS. Canad, J. Phys., 46, 1, 49, 1968.
8. Y. I. FELDSTEIN. Rev. Geophys. No.2, 1969 (in press).
9. M. I. PUDOVKIN, N. S. SMIRNOV, Geom. i Aeronomiya, 6, No.1, 166, 1966.
10. R. G. AFONINA, Ya. I. FEL'DSHTEYN. Kosm. Issl. 6, 1, 150, 1968.
11. B. MAEHLUM, B. J. O BRIEN . J.G.R., 68, 997, 1963.
12. T. N. DAVIS, Y. S. WONG. Hourly Values of the Auroral Electrojet Activity Index AE for 1964. Geophys, Inst, Univ. of Alaska. College, Alaska 99701.