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THIRD PROGRESS REPORT OF INVESTIGATION FROM JAPANESE MAGSAT TEAM*

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TITLES OF JAPANESE MAGSAT INVESTIGATIONS (Statement of Work #M-43)

A. Crustal Structure near Japan and its Antarctic Station
   - A-1. Regional Magnetic Charts
   - A-2. Local Magnetic Anomalies and Their Origin
   - A-3. Crustal Structure in the Antarctic

B. Electric Currents and Hydromagnetic Waves in the Ionosphere and the Magnetosphere
   - B-1. Ionospheric and Magnetospheric Contributions to Geomagnetic Variations
   - B-2. Field-Aligned Currents
   - B-3. Geomagnetic Pulsations and Hydromagnetic Waves

Reporting Date: July 20, 1981

Investigation Period: March 15, 1980 - July 15, 1981

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T. Kamei and T. Iyemori (Geophysical Inst., Kyoto University, Kyoto 606),
T. Nakatsuka and Y. Ono (Geological Survey of Japan, Tsukuba 305).

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1. Introduction

For the past four months, efforts have continued in compiling tapes which contain vector and scalar data decimated at an interval of 0.5 sec, together with time and position data. Regarding the data analysis, progress was seen in the study of magnetic anomalies in the vicinity of Japan and in electric currents in the ionosphere and magnetosphere. Since the supply of CHRONFIN tapes and Investigator-B tapes has become more regular in recent months, the analysis by Japanese colleagues has accelerated, and new results are expected to appear in the coming months.

2. Graphical Display of MAGSAT Data

From the original CHRONINT and CHRONFIN data tapes received from NASA, a compilation of data is being carried out by the National Institute of Polar Research and the Geophysics Research Laboratory of the University of Tokyo, so as to obtain 3-components (X, Y and Z) as well as their residuals from the MGST (4/81) model with the indication of UT, magnetic local time, invariant latitude, geographic longitude and altitude. These are basic materials for analysis. Since only the CHRONFIN tapes are coming in now, all future compilation will be made with these.

3. Ground Magnetic Data

In order to investigate the crustal magnetic structures in the vicinity of Japan, all available surface magnetic data are under compilation. Fig. 1 shows the availability of marine magnetic data accumulated at the National Oceanographic Data Center in the Hydrographic Department, Maritime Safety Agency. This data center also collects the gravity and bathymetric data near Japan. Fig. 2 shows the routes of recent airborne magnetic surveys in Japan. These data will be used fully in the future, for comparison with MAGSAT data.

The world magnetograms for the period of MAGSAT observations are being collected for comparison of satellite and ground data. T. Iijima and R. Fujii are trying to compare the field-aligned signatures with the simultaneous magnetic variations on the ground in high latitudes. Y. Kamide is planning to compare the MAGSAT data with the ground magnetic data of the Alaskan chain stations. H. Maeda and his collaborators are analyzing the Sq variation with the ground magnetic data coming into WDC C2 for Geomagnetism.

4. Preliminary Results of MAGSAT Data Analysis

4-1. Geomagnetic anomalies around Japan

Techniques for modelling the regional magnetic field are now being explored. The first problem to be solved in this modelling is how to reduce the data obtained at various altitudes of MAGSAT orbits to those at a common level of altitude. T. Nakasuka and Y. Ono are making softwares for the upward continuation based on an equivalent source concept. T. Yukutake is considering application of the Fourier analysis technique to the vector data in a restricted area over Japan, by which he expects to obtain the field distribution at any level in a straightforward way.

M. Yanagisawa, M. Kono and T. Yukutake are continuing the analysis of MAGSAT data for the area of latitude 10-70°N and longitude 110-170°E in magnetically quiet periods. They obtained a map of total force anomaly after subtracting the field model of MGST (6/80) and the ring current effect [see Fig. 1 of the Second Progress Report, March 1981]. One of the outstanding features in the map of the magnetic anomaly is a negative magnetic anomaly in the Okhotsk Sea (amounting to -8 nT), which is of geophysical interest because of its possible connection with high heat flow values in that area. M. Yanagisawa is now studing also the magnetic anomalies in the north-western part of the Pacific in comparison with the marine magnetic data of the past years. Although his analysis is still in a preliminary stage, magnetic anomalies obtained from MAGSAT data have been found to be well correlated with the anomalies from the marine data. When this relationship is more firmly established, the depth to the magnetic source will be determined more definitely.

4-2. Field-aligned currents in high latitudes

T. Iijima is examining the vector residuals from MGST (4/81) model in high latitudes with the CHRONFIN data for November-December 1979. Fig. 3 shows some examples of the latitudinal profile of horizontal geomagnetic perturbation vectors observed with MAGSAT in the northern and southern high latitudes. He compared the diagrams obtained with CHRONINT and CHRONFIN data. The occasional deviations in low and middle latitudes, which appeared in the analysis of CHRONINT data, almost vanished in the analysis of CHRONFIN data. This indicates that the effect from the field-aligned currents is very small in middle and low latitudes along the dawn and dusk meridians in comparison with the effect in the polar regions.

As already described in the Second Progress Report (March 1981), the main results of analysis are:

1) $\Delta\vec{B}_\perp$ is thought to be mainly due to the field-aligned sheet currents in the auroral zone (so-called Region 1 and 2 currents); this is concluded after resolving $\Delta\vec{B}_\perp$ into geomagnetic N-S and E-W components. The sheet currents in Regions 1 and 2 vary their intensities, locations and latitudinal widths during substorms.

2) In the polar region, on the other hand, there are some $\Delta\vec{B}_\perp$ perturbations which do not seem to be ascribable to the field-aligned currents; they are directed generally sunward in the northern hemisphere and anti-sunward in the southern hemisphere except for the midday region of the higher - latitude polar cap. The higher-latitude polar cap $\Delta\vec{B}_\perp$ can be explained by counter-clockwise (or clockwise) current flowing in the ionosphere below the MAGSAT altitude.

3) $\Delta B_\parallel$ is inferred to originate primarily from the horizontal electric currents in the ionosphere that are closely connected with the Region 1 and 2 field-aligned currents. The magnitude of $\Delta B_\parallel$ shows a clear seasonal dependence; it is approximately twice in the sunlit southern hemisphere than that in the northern dark hemisphere in November 1979.

4-3. Dawn-dusk asymmetry of daily geomagnetic variations at the MAGSAT level and on the ground

H. Maeda, T. Araki, T. Kamei and T. Iyemori compared the dawn-dusk asymmetry of the observed geomagnetic variations at the MAGSAT level and at 16 stations on the ground, that contained the effect from electric currents flowing in the ionosphere and magnetosphere [see Figs. 5 and 6 in the Second Progress Report, March 1981]. The observed ground values are separated into two parts of ionospheric and magnetospheric origin. They showed the deviations of components (B_H, B_D, and B_Z) from the MGST (6/80) along the dawn and dusk meridians for 16 MAGSAT orbits on 17-18 November 1979. Fig. 4 shows a peculiar systematic variation in B_D in low latitudes (dip latitudes between 20° and -20°), always westward in the northern hemisphere and eastward in the southern hemisphere. Fig. 5 is the average latitude profile of B_H, B_D, and B_Z for the 16 orbits, to show that the peculiar variation can be found only in the B_D component and not at all in both B_H and B_Z components in the dusk meridian. No noticeable variations are observed in all three components in the dawn meridian. The peculiar variation in B_D exists every day, although its amplitude varies from day to day. The existence of this B_D variation will be interpreted in connection with the three-dimensional current closure in the magnetosphere and ionosphere in the dusk meridian, near the eastern end of the daytime equatorial electrojet.

4-4. Electric current across MAGSAT orbit loop

A. Suzuki calculated the total amount of electric current flowing through the plane of MAGSAT orbit loop after integrating the tangential component of the observed magnetic field along a complete satellite orbit loop; this is a direct application of Maxwell's equation. Although he showed earlier that the total electric current was 1-5 million Ampères, his recent more careful analysis indicated $1 - 5 \times 10^{[illegible]}$ Ampères in both sunward and anti-sunward. He will check in the near future whether this is due to the earth's rotation or to the electric current passing through the dawn-dusk meridian.

5. Publications

Only oral presentations have been made on the actual MAGSAT data analysis on the occasion of some domestic meetings. At the 69th Semi-annual Meeting of the Society of Terrestrial Magnetism and Electricity of Japan in May 1981, the following papers were presented:

M. Kono and M. Yanagisawa,
Magnetic anomalies in the vicinity of Japan observed by MAGSAT.

T. Iijima, N. Fukushima, R. Fujii and H. Sakurai,
Characteristics of magnetic field variations observed by MAGSAT satellite.

Y. Kamide, T. Iijima, R. Fujii and N. Fukushima,
Simultaneous magnetic observations by MAGSAT and Alaskan chain stations.

A. Suzuki, T. Kamei and T. Kumamoto,
Calculation of magnetospheric currents by means of MAGSAT data.

S. Tsunomura, T. Iyemori, H. Maeda and T. Araki,
Analysis of SC with MAGSAT data.

H. Maeda, T. Kamei and T. Iyemori,
Analysis of geomagnetic diurnal variation by means of MAGSAT data.

The following papers have been submitted to the Fourth General Scientific Assembly of the International Association of Geomagnetism and Aeronomy in August 1981 in Edinburgh, Scotland, U.K.:

M. Yanagisawa, M. Kono, T. Yukutake and N. Fukushima,
Magnetic Anomalies over Japan and Its Surrounding Area (submitted to the session on "Scientific Results from MAGSAT").

T. Iijima, N. Fukushima and R. Fujii,
Characteristics of Magnetic Field Disturbances Observed by MAGSAT (submitted to the session "General Contributions to IAGA Division III").

T. Iijima, Y. Kamide, R. Fujii and N. Fukushima,
Spatial Relationship between Field-Aligned Currents and the Auroral Electrojets - MAGSAT and Alaskan Chain Observations (submitted to the session "General Contributions to IAGA Division III").

H. Maeda, T. Kamei and T. Iyemori,
Magnetic Effect on Sq Deduced from an Analysis of MAGSAT data (submitted to the session "General Contributions to IAGA Division III").

Conclusions

It is of great benefit to the geophysical community in Japan to carry out extensive analysis of MAGSAT data provided by NASA. The work of the individual members of the Japanese MAGSAT Investigation Team is progressing, and some interesting results are coming out. We hope to be able to report a series of important conclusions in the coming trennial reports, although only some preliminary results are written in this third report.

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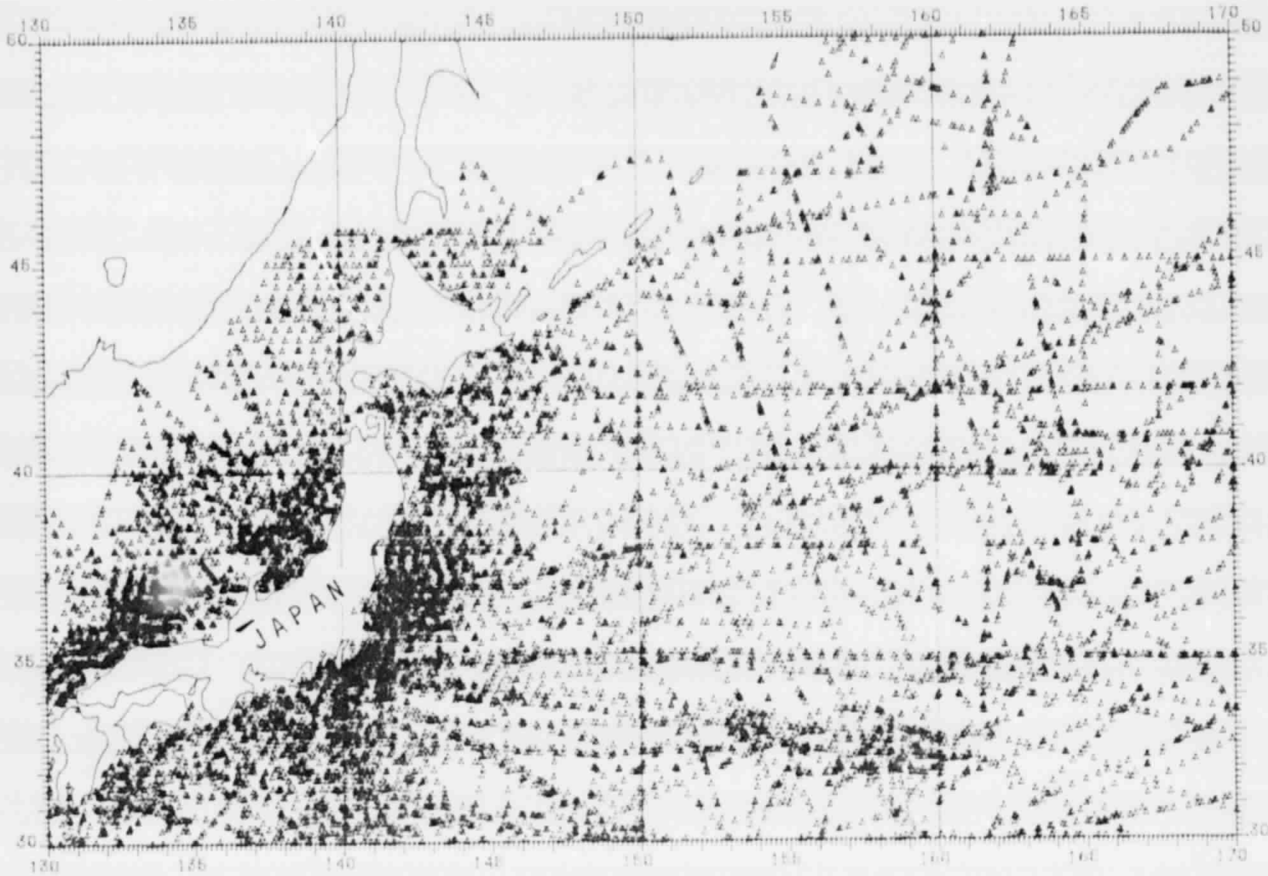

Fig. 1. Marine magnetic measurement sites in the region of 30-50°N and 130-170°E.

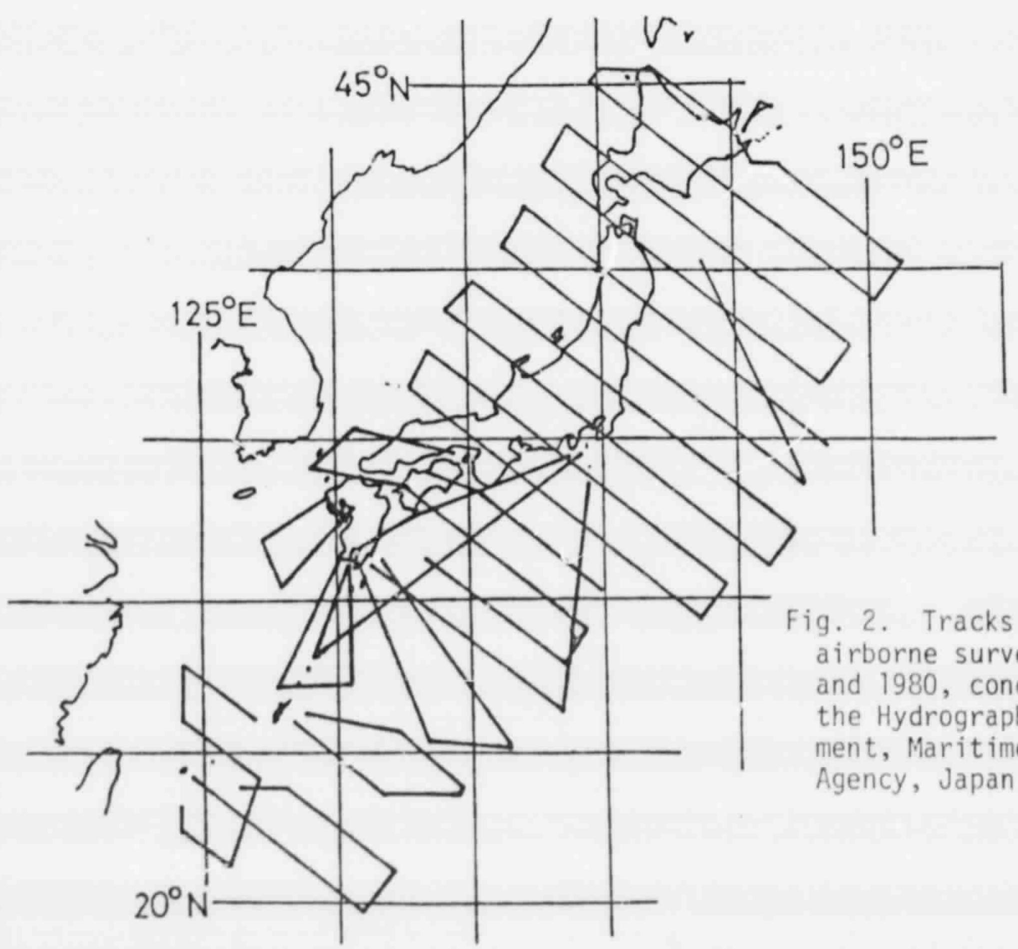

Fig. 2. Tracks of vector airborne surveys in 1979 and 1980, conducted by the Hydrographic Department, Maritime Safety Agency, Japan.

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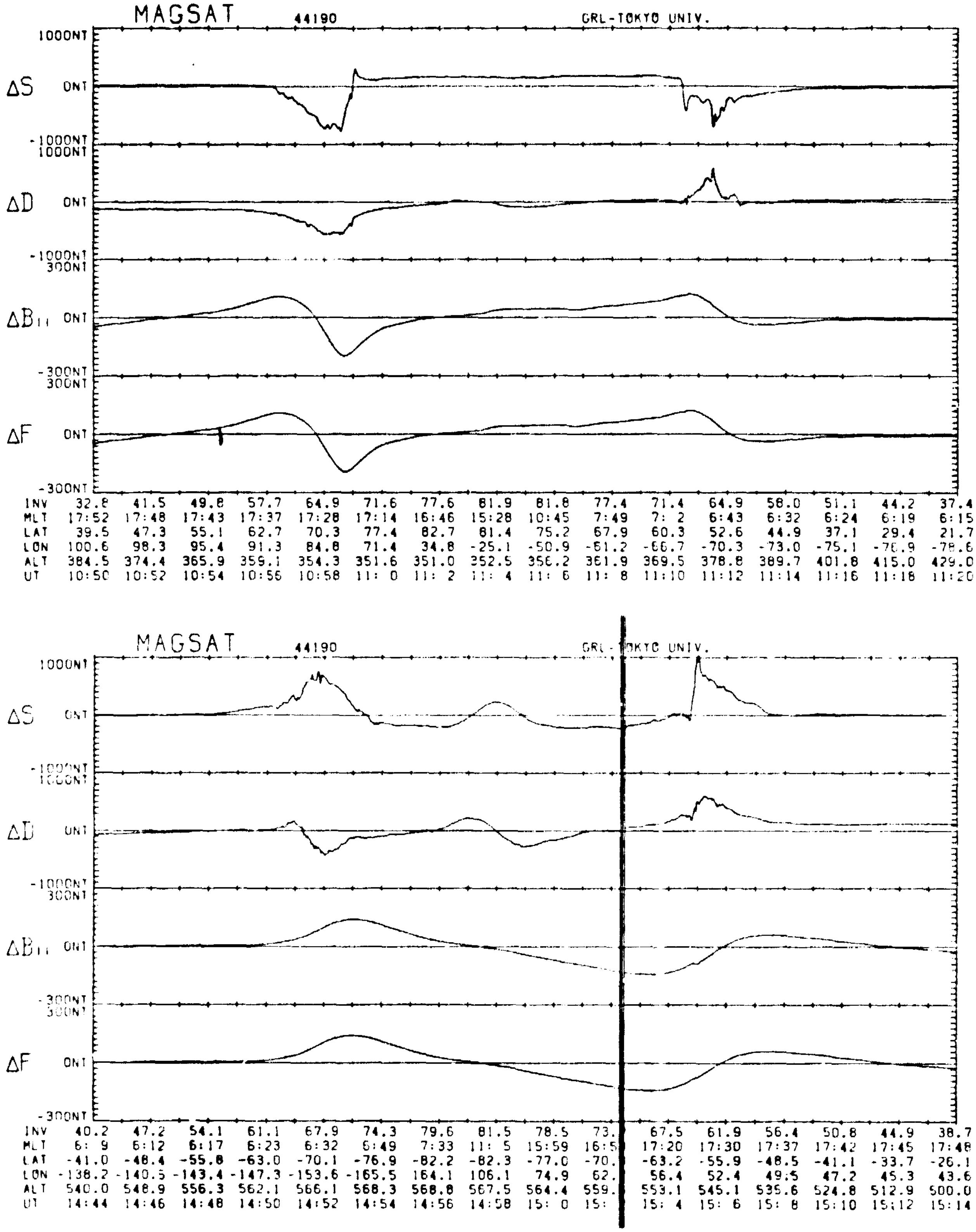

Fig. 3. Geomagnetic vector residuals of MAGSAT CHRONFIN data (1050-1120 UT northern pass and 1444-1514 UT southern pass, November 13, 1979, during severe substorms), separated into ΔS (the perturbation transverse to the main geomagnetic field and directed towards the sun), ΔD (the perturbation transverse to the main field and to the dusk-to-dawn direction), $\Delta B_{\parallel}$ (the perturbation parallel to the main field). ΔF (total force perturbation) is also shown.

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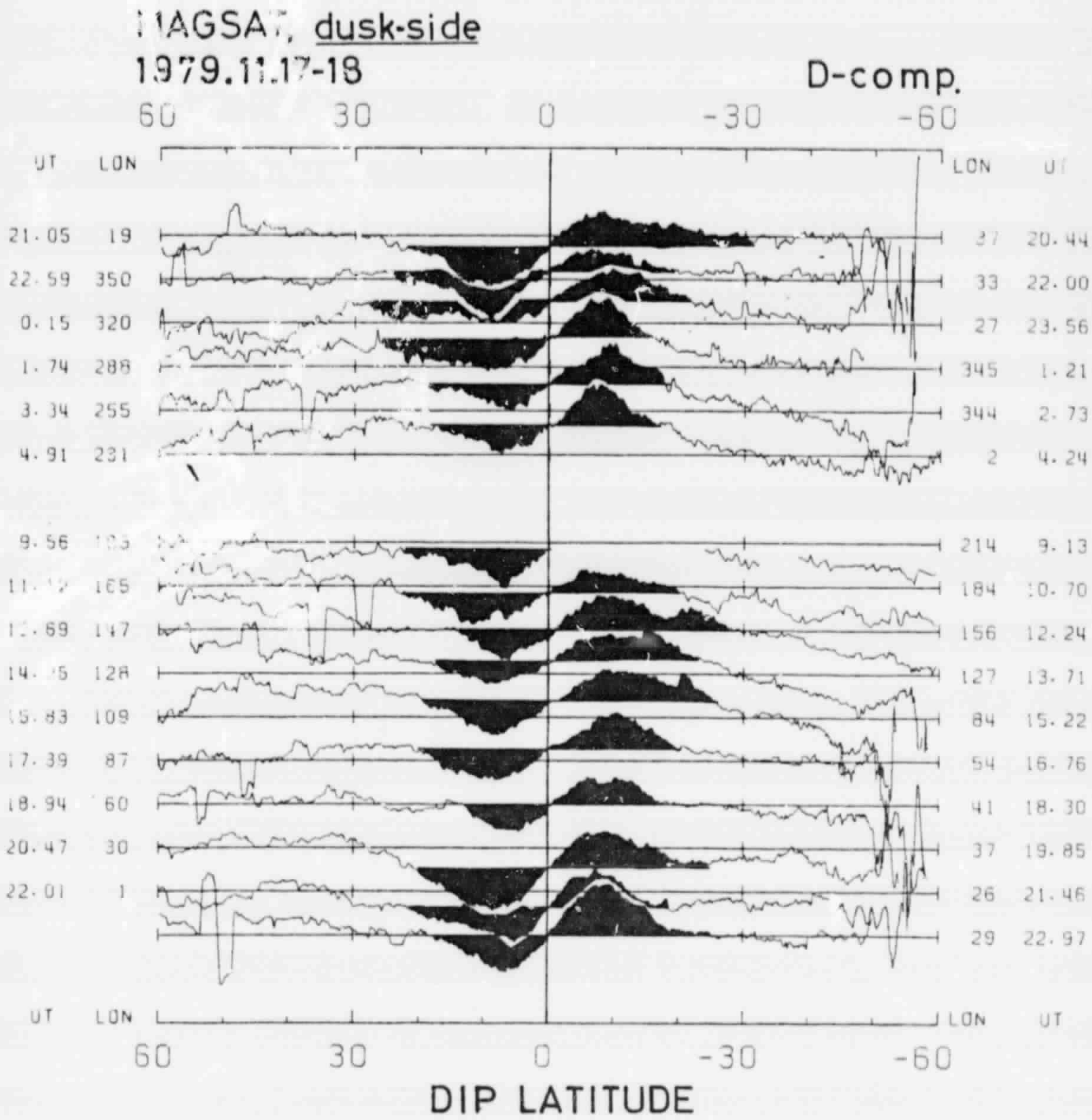

Fig. 4. Latitudinal dependence of D-component, measured by MAGSAT at various longitudes during November 17-18, 1979. A peculiar westward (in the northern hemisphere) and eastward (in the southern hemisphere) deviation in the D-component is observed during every duskside orbit in low latitudes.

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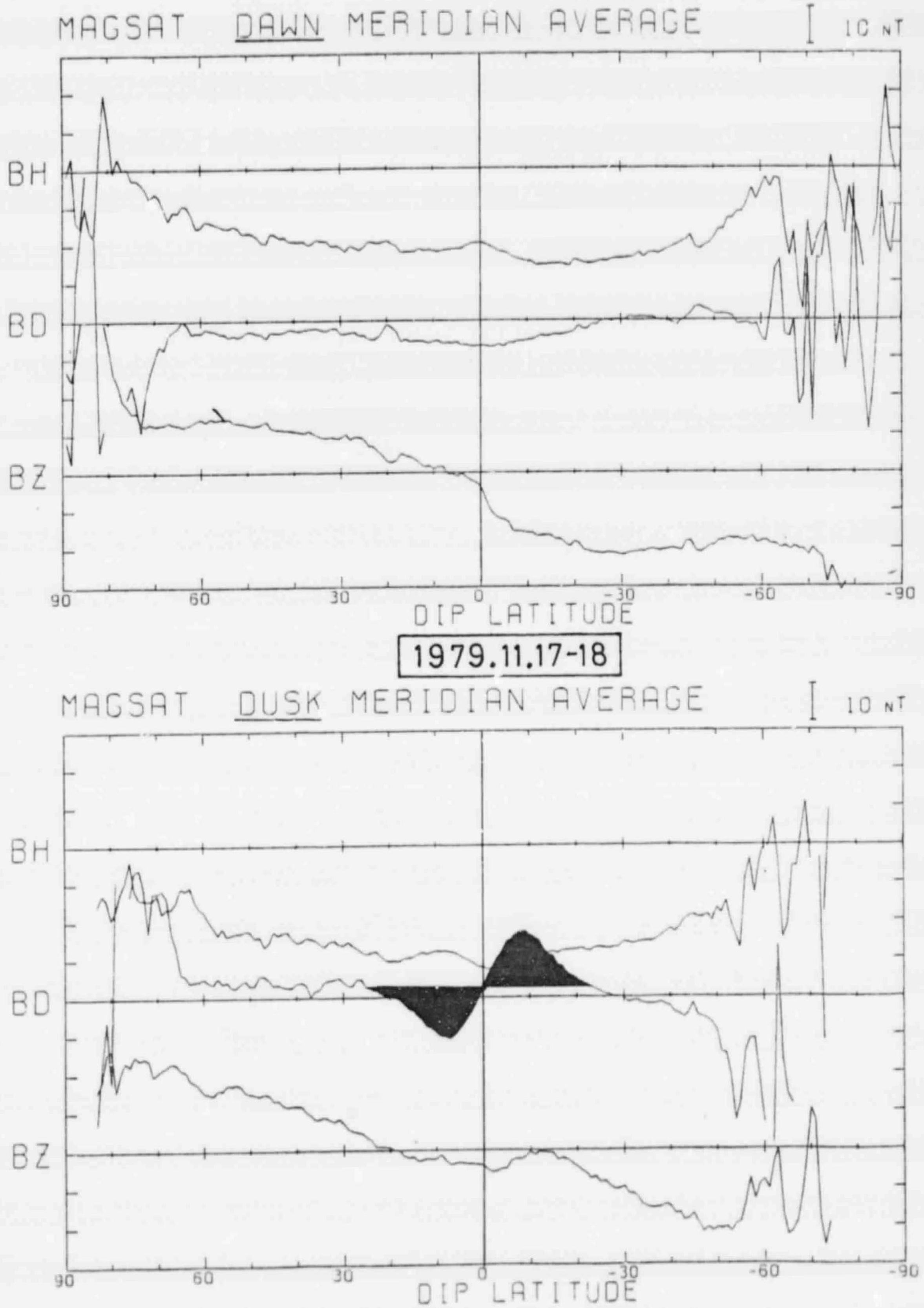

Fig. 5. Average latitudinal profile of the three-components (deviations from model fields; designated as BH, BD, and BZ) for 16 orbits on November 17-18, 1979. The peculiar latitudinal profile is only seen in BD in the dusk meridian.