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AVERAGE DAILY VARIATIONS IN THE MAGNETIC FIELD AS OBSERVED BY ATS-5

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16. Abstract

Hourly averages of the magnetic field components are determined and analyzed using the measurements of the magnetic field monitor aboard the ATS-5. The data covering the time period of September 1969 through September 1971 are sorted and analyzed for various Kp values, geomagnetic latitude of the subsolar point, and local time. Local time variations are harmonically analyzed, and amplitudes and phases are given up to the fourth harmonic.

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AVERAGE DAILY VARIATIONS IN THE MAGNETIC FIELD AS OBSERVED BY ATS-5

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INTRODUCTION

Applications Technology Satellite-5 (ATS-5), launched on August 12, 1969, was the fifth in a series of satellites conceived and designed by NASA/Goddard Space Flight Center with the program objective of furthering the state-of-the-art in applications technology, placing emphasis on satellite communications and meteorology. Due to excessive onboard damping during an interim spin-stabilized phase of flight, spin about an unstable axis deteriorated to an anomalously flat spin shortly after the spacecraft was positioned in the synchronous orbit. The spin axis was rotated to the position of the original spacecraft axis by ejecting the apogee motor casing on September 5, but it was spinning in the opposite direction The momentum removal systems were unable to reduce the spacecraft spin. Consequently, all experiments depending on the planned gravity-gradient stabilization became inoperative, and the mission was declared a failure.

Two systems capable of operating in the spinning condition were the magnetic field monitor (MFM) and portions of the environmental measurements experiment (EME). The EME was a scientific experiment package consisting of six experiments, four of which have operated continuously since turn-on. Specifics of these experiments are listed in Table 1.

The MFM was not onboard as a scientific experiment, but was to be used along with three-axis torquing coils as a backup attitude-control system during launch and maneuvering to the on-station position. The magnetometer sensor is mounted on the antenna boom approximately 1.37 meters (4.5 ft) from the center of the spacecraft. Figure 1 shows the instrument perched midway on the boom at the top of the photograph. It is covered by an aluminized Mylar thermal blanket to passively control the temperature range of the sensor. The temperature encountered by the sensor was nominally near 273.15 K (0° C) varying from 268.15 to 278.15 K (±5°C) with the sun's position. However, the temperature dropped when the spacecraft was shadowed by the earth; for instance, during an eclipse of maximum duration (approximately 80 minutes), the temperature dropped to 248.15 K (−25°C) (see Figure 2). Figure 3 is a diagram showing the positions of the MFM sensor and electronics. The output of the magnetometer is fed into the EME telemetry system (pulse frequency modulation (PFM)) for inclusion on each experimenter's data tapes. The prime output is on the spacecraft telemetry system (pulse code modulation (PCM)) and has been recorded approximately 60 percent of the time since launch. Information about the magnetometer and the telemetry systems may be found in Skillman.[1]

ATS-5 was spin-stabilized at 77 rpm about the spacecraft z-axis, which is approximately parallel to the earth's rotational axis, and has been on-station at $105° \pm 1°$ W longitude since September 11, 1969. The inclination of the spacecraft changed with time from its initial value of 2.5° to a value of 0.5° in September 1971. Changes in the orbit inclination and right ascension of the ascending node are shown in Figures 4 and 5. Figure 6 illustrates the ATS-5 orbit and spin geometry. It shows the satellite in the synchronous orbit (ω = 1 rev/24 hours) at the fixed earth longitude of 105° W. The spacecraft is spinning about the $-z$ body axis and the spin vector is pointing north. The angle θ, defined as the angle between the $-x$ axis and the plane containing the spin axis and the spacecraft sun vector, is used in the description related to the despinning of the PCM data. The coordinate system is that used by General Electric, the subcontractor responsible for attitude determination of the spacecraft.

MAGNETIC FIELD MEASUREMENTS

The MFM is a triaxial fluxgate magnetometer with a range of approximately $\pm 500\ \gamma$ and a sensitivity of 1 γ. The field is measured along each axis by combining a fine reading within a range of $\pm 25\ \gamma$ with a coarse reading indicating the necessary number of steps to be fed into a compensating coil to keep the instrument within the range of the fine scale. There are 32 steps of approximately 33 γ for each axis, thereby providing a nominal range of -495 to 525 γ.

Along each axis of the fluxgate coordinate system the magnetic field component is thus determined from the following formula:

$$B = A(N - 15) + D(V - C) \qquad (1)$$

where

B = magnetic field along the sensor axis in gammas

A = constant gamma field increment for each digital compensating field (N)

N = digital number telemetered back giving the status of current steps applied to the sensor compensating coils

D = constant number of gammas per volt for fluxgate axis over the linear portion of its response curve

V = output voltage from the fluxgate (nominally 0.75 to 4.25V)

C = voltage (a constant) for zero magnetic field along sensor axis

Constants A, D, and C vary for different sensor axes. A calibration field of 10 γ per axis is internally generated once every 12.02 hours for a duration of 5.63 minutes as a means of checking the magnetometer sensitivity.

The constants used for the ATS-5 magnetometer in Equation 1 are as follows:

$A_x = 32.804\ \gamma$	$D_x = 13.49\ \gamma/V$	$C_x = 2.49V$
$A_y = 32.942\ \gamma$	$D_y = 13.85\ \gamma/V$	$C_y = 2.52V$
$A_z = 32.775\ \gamma$	$D_z = 13.63\ \gamma/V$	$C_z = 2.55V$

For the fine output the frequency responses of the magnetometer (sensor and electronics combined) are:

PCM: approximately 100 Hz at 3 dB
PFM: approximately 0.115 Hz at 3 dB

The data sampling intervals for each axis are:

PCM:	
Fine	2.97 s/sample
Coarse	95 s/sample
PFM: fine and coarse	5.12 s/sample

DATA REDUCTION

Some general comments should be made about the accuracy of the measurements used in this report. First, the magnetometer was onboard the spacecraft as a monitor, not as an experiment. Second, the spacecraft was not magnetically clean; and, as a result, it encountered large disturbances from both ac and dc fields. The dc fields as measured at the GSFC Magnetic Test Facility were compensated by six auxiliary magnets with the following field modifications at the magnetometer:

Magnetometer coordinate	Initial perm field	Compensated
x	$119.7\ \gamma$	$21\ \gamma$
y	$-\ 80.8\ \gamma$	$31\ \gamma$
z	$-164.0\ \gamma$	$109\ \gamma$

The large field remaining in z was purposely set at 109 γ to ensure maximum range when on-station in synchronous orbit.

Prior to flight, dc offsets resulting from various spacecraft functions being turned on and off were recorded. These corrections, some of which changed after launch, have been used to correct the data. This was accomplished by observing sudden field shifts of the spin axis (z) output on the plotted data and correcting the field value accordingly. Where sudden jumps in the dc level were observed, the command log from the ATS-5 control center was checked to see whether a command had been sent to the spacecraft. If a command had been sent, the resulting shift was compared to the preflight test to see if the observed shift was consistent with the test. Typically these corrections varied from 1 to 20 γ.

Corrections observed during ground testing for ac fields and later verified in flight were also applied to the data to eliminate the effects of the solar array modulation due to the spacecraft spin. These corrections were always less than 10 γ.

The data used in the hourly value data set for the spin axis (z) component were supplemented with data from the PFM telemetry system when not available on the PCM telemetry output.

The PCM telemetry output in the spin plane (x, y plane) was despun by a program developed by General Electric Valley Forge Space Center. This investigation was performed under contract by GE, the spacecraft attitude control subcontractor, who was completely familiar with the spacecraft, specifically with the various sensors onboard. For a report of this study contract and the details of the despinning technique, see Mueller and Coyne.[2]

The despun data were transformed to the *DHV* components of the magnetic field using the sun sensor output and the following assumptions:

(a) The ATS-5 spacecraft is located at synchronous altitude at 105° W longitude and 0° latitude and is stationary in a geocentric reference frame corotating with the earth.

(b) The vehicle is spinning about its $-z$ (GE body frame) axis, which is aligned with the earth's spin axis, with no nutation.

This *DHV* system is the same as that used by Coleman and Cummings[3] for the analysis of the ATS-1 magnetic field data and is illustrated in Figure 7.

The north (H) component is obtained directly from the $+z$ magnetometer measurements. The east and outward components (D and V, respectively), are obtained from the x and y components by the despinning technique previously mentioned. It should be noted here that the east component, D, is a force unit and not an angular measure such as declination in the conventional usage of the notation D. Also note that H is the north component and not the total horizontal intensity.

ANALYSIS

After the geomagnetic latitude of the subsolar point θ^s_{gm} was computed for each hourly value observed, the data were sorted into three categories: $\theta^s_{gm} > 10°$, $-10° < \theta^s_{gm} \leq 10°$, and $\theta^s_{gm} \leq -10°$. This division was made to investigate the dependence of the daily variations on the tilt angle of the dipole axis relative to the sun-to-earth direction. The data were further sorted by geomagnetic activity, Kp, into three classes: Kp = 0,1, Kp = 2, 3, and Kp $\geq$ 4.

For each magnetic field component and for each (Kp, θ^s_{gm}) group, hourly averages (each centered at the half-hour) and standard deviations were computed for each local time hour (see Appendix). To indicate the statistical significance of these averages, the maximum and minimum numbers of hourly data points (used in averaging) and the maximum and minimum standard deviations are given in Tables 2 through 4 for each (Kp, θ^s_{gm}) group. It should be noted that the number of data points for very disturbed conditions of Kp $\geq$ 4 is unavoidably small for some local hours.

Figure 8 presents the daily variations in the magnitude, F, and H, D, and V components of the magnetic field at the ATS-5 position. To facilitate comparison of the daily variations for different θ^s_{gm} groups, classification is made first with respect to Kp, and for each Kp group, three curves are drawn for the three θ^s_{gm} groups.

In Figure 9 the same data are presented in a different form; namely, division is made first according to θ^s_{gm}, and for each θ^s_{gm} group, three curves are prepared for the three Kp groups to show the dependence of the daily variations on magnetic activity.

A separate diagram, Figure 10, is presented to give the daily variations in the dip angle I, where I is computed from the formula $\tan I = -V/\sqrt{D^2 + H^2}$. The maximum and minimum values of I and the local hours at which these maxima and minima occur are listed in Table 5 together with the ranges of I. Figures 11 and 12 contain plots of angle variations determined from hourly average values for tilts in the HV and HD planes.

Each average daily variation $f(t)$ is then expressed in a Fourier series as

$$f(t) = \sum_{m=0}^{9} a_m \cos mt + b_m \sin mt$$

$$= \sum_{m=0}^{9} C_m \cos (mt - \alpha_m)$$

where

$$C_m = \sqrt{a_m{}^2 + b_m{}^2} \quad m = 0, 1, 2, \ldots,$$

$$\alpha_m = \tan^{-1} \frac{b_m}{a_m}$$

Tables 6 through 8 give the amplitudes C_m and phases α_m for F, H, V, and D. Table 9 lists the time of the maximum for the diurnal (24-hr) component of each of these elements.

In Figure 8 the daily variations for difference θ^s_{gm} groups are presented for each Kp group. The seasonal classification therefore is made using the geometric parameter θ^s_{gm}; that is, the geomagnetic latitude of the subsolar point. This classification is more precise and convenient for the study of the distortions of the magnetospheric field due to the solar wind than a classification according to the calendar season. However, the seasonal changes in the daily variations by use of the ordinary season classification are of value in certain types of statistical studies. Figure 13 contains plots of the average daily variations for the four seasons defined as follows:

Season	Day of Year	Dates
Spring	36 to 127	February 5 to May 7
Summer	128 to 218	May 8 to August 6
Fall	219 to 309	August 7 to November 5
Winter	310 to 35	November 6 to February 4

DISCUSSION

The plots in Figures 8 and 9 clearly show the effects of increased magnetic activity on the daily variations. The largest variations occur near local midnight because of the diamagnetic effects of increased plasma intensity.

The sorting of the data by geomagnetic latitude of the subsolar point emphasizes two points. First, there is an apparent change in phase in the *y (D)* and *-z (V)* directions as shown in Figure 9. Second, there is a significant difference in the $\leqslant -10°$ trace in Figure 10 when compared with the other two θ^s_{gm} traces in the same plots. This difference is also evident in the *D* and *V* plots in Figure 13. The position of ATS-5 is 7° to 10° north of the geomagnetic equator. Therefore, during the winter ($\theta^s_{gm} \leqslant -10°$), ATS-5 is closest to the equatorial current sheet. The existence of this current sheet has been established by the Orbiting Geophysical Observatory-3 and -5 (OGO-3 and -5) magnetic field observations.[4]

Figure 13 shows appreciable differences between spring and fall. In Figures 8 to 10 these differences are masked because the geomagnetic latitude of the sun was used for the classification of the data, thereby combining two equinoctial seasons. The presence of the annual variation seen in Figure 13 was quite unexpected, because such a variation calls for an explanation that goes beyond the geometrical configuration of the current sources relative to the sun's geomagnetic latitude. This implies that there is either a true annual variation in the solar-wind conditions or a hysteresis effect in the response of the magnetosphere to the seasonal variations in the solar wind.

To study the apparent phase changes in *D (y)* and *V (-z)*, the data were subdivided into the calendar seasons. This breakdown resolves the $-10° < \theta^s_{gm} \leqslant 10°$ in Figure 8 into spring and fall in Figure 13. The difference in these two seasonal traces is most prominent in the *V (-z)* plots of Figure 13. Figure 14 is a further subdivision of the data for Kp = 0, 1 for each calendar month. Gradual phase changes are apparent in both *D* and *V*. There seems to be a reversal in phase in these components near February to March. Corresponding to this phase reversal, a slight, but noticeable, phase shift is observed in *H*.

The data were next compared with calculated field values taken from the ATS-5 ephemeris data. The ephemeris data include component field values for the ATS-5 position at 10-minute intervals for a "regular" (geomagnetic reference field) and a "distorted" field model. The model for the regular field is determined from the GSFC/65 epoch 1965.0 of Hendricks and Cain[5] and represents the internal field of the earth. The distorted field takes into account the additional effects of the solar wind and geomagnetic tail. These calculations are from the Mead-Williams model[6] using a 40-γ tail field. Figure 15 displays the computed values for four days: day 172, 1970; day 264, 1970; day 355, 1970; and day 80, 1971. These days are the equinoxes and solstices and are compared here with the observed hourly averages compiled monthly which include these dates. The observed *H* trace follows the shape of the Mead Williams model fairly well, but has a more or less constant higher field value of 5 to 25 γ.

The D and V plots in Figure 15 show both amplitude and phase differences when compared with either of the calculated fields. These differences between the measured and calculated field values are assumed to be due to the equatorial current sheet. It should be noted that the phase changes in the calculated fields for the various days are probably due to changes in the geomagnetic latitude of the satellite because of the orbit inclination.

Figure 16 shows the variation of geomagnetic latitude of ATS-5 with season and local time. The importance of geomagnetic latitude variations on satellite measurements, even when the satellite is in a nominal synchronous equatorial orbit such as the ATS satellites are, is again stressed.

In summary, the present study of the daily variations in the magnetic field as observed by ATS-5 suggests a need for an improved magnetospheric field model that takes into account the recent finding of the equatorial current sheet. The existence of the annual change in the daily variation of the magnetic field at the synchronous orbit, as indicated in the spring-fall asymmetry, should be studied further. Comparison of the present results with the OGO-3 and -5 observations will be made in a separate report.

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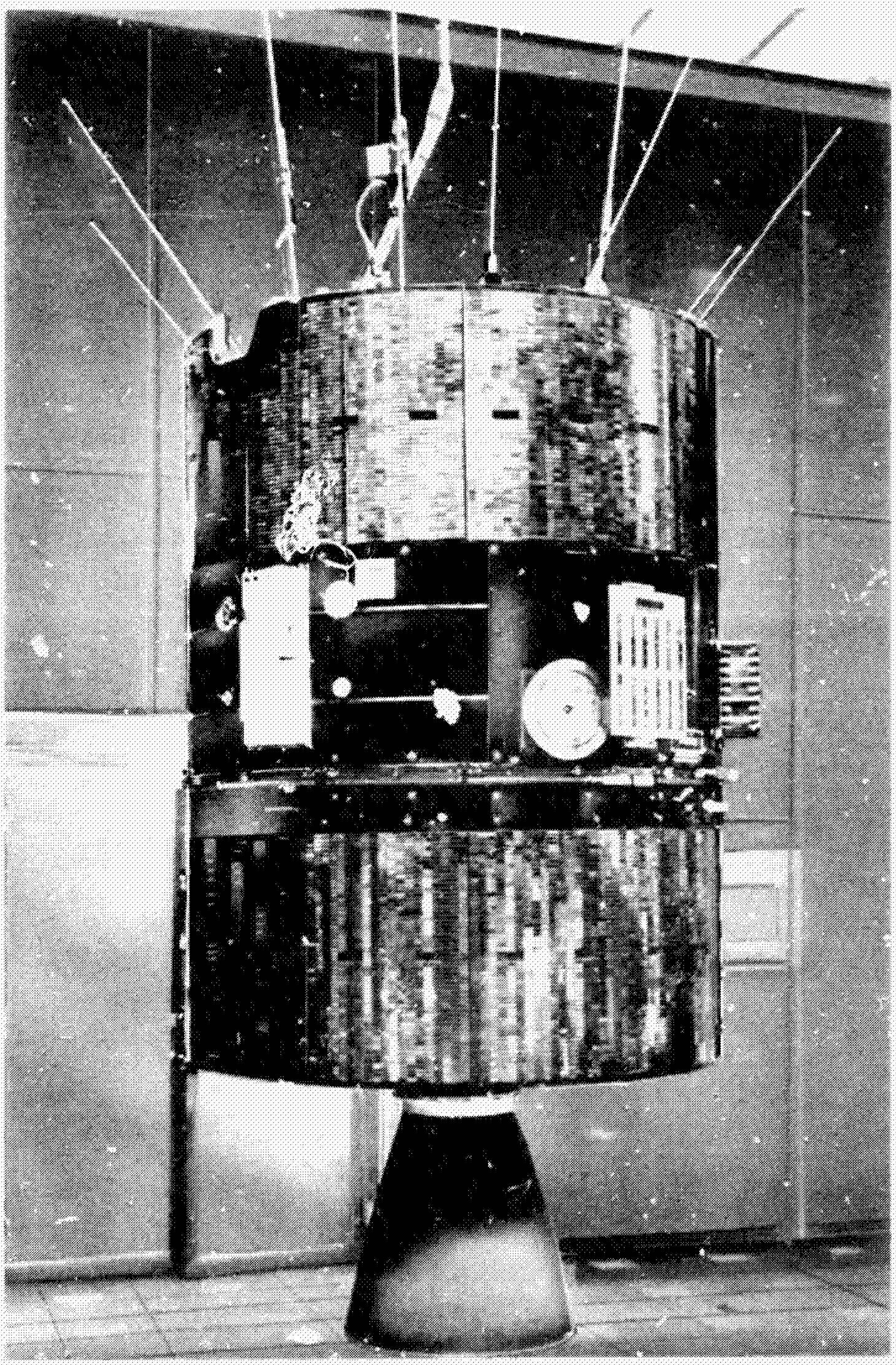

Figure 1. ATS-5 showing magnetometer sensor mounted on boom.

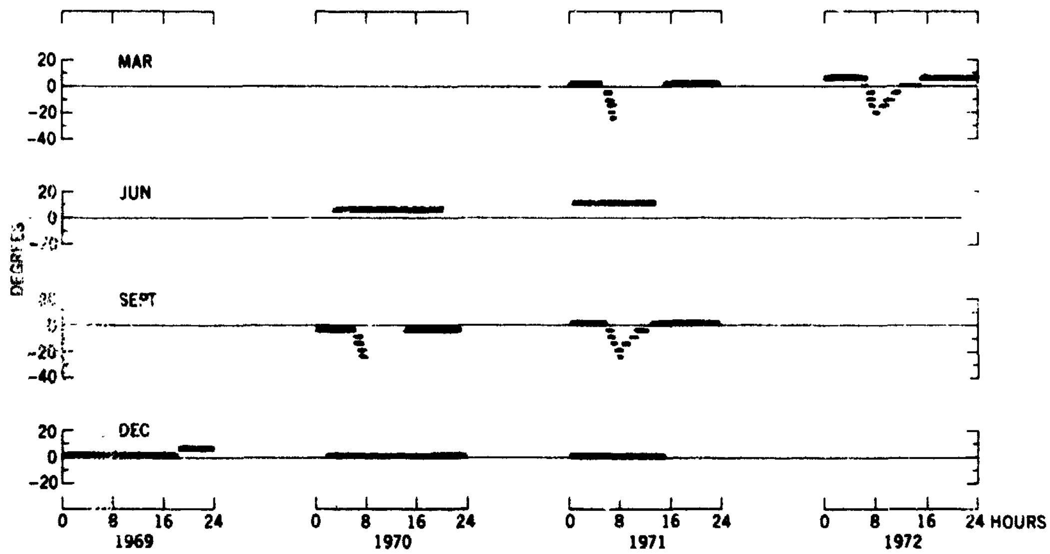

Figure 2. ATS-5 magnetometer sensor temperature.

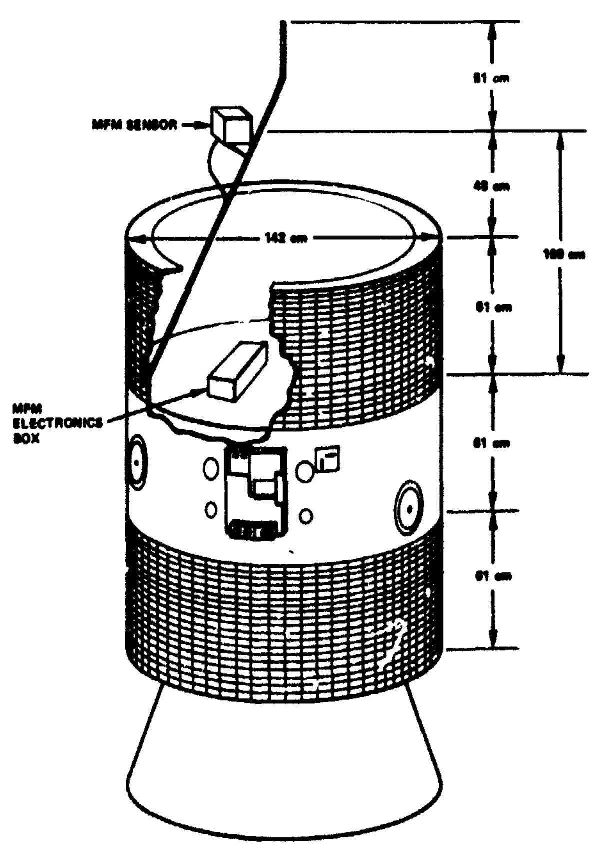

Figure 3. Diagram of the relative positions of the MFM sensor and electronics on ATS-5.

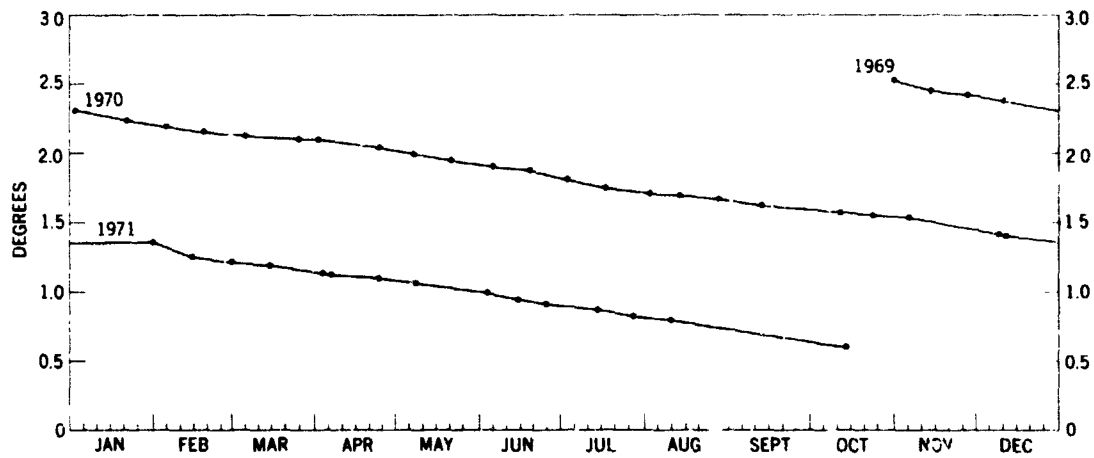

Figure 4. Orbit inclination.

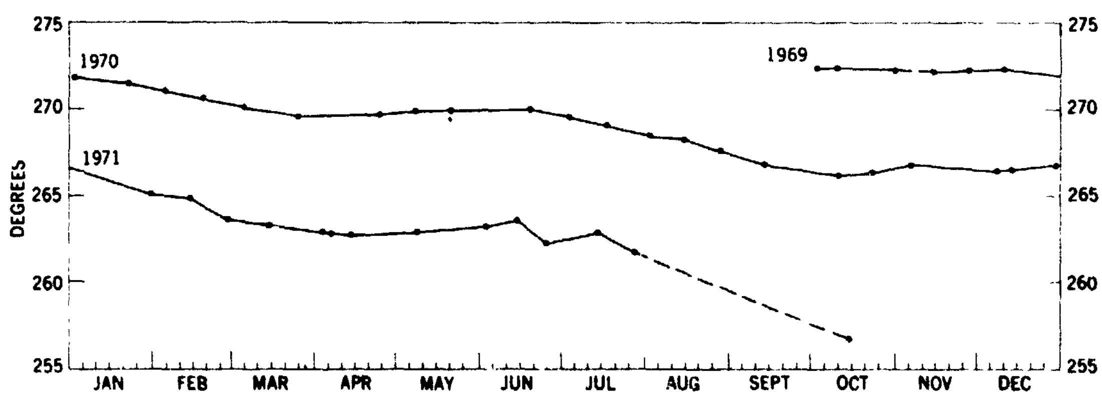

Figure 5. Right ascension of ascending node.

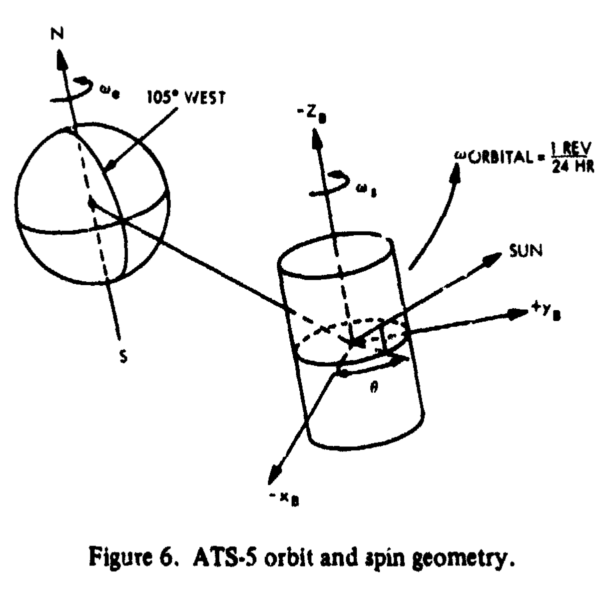

Figure 6. ATS-5 orbit and spin geometry.

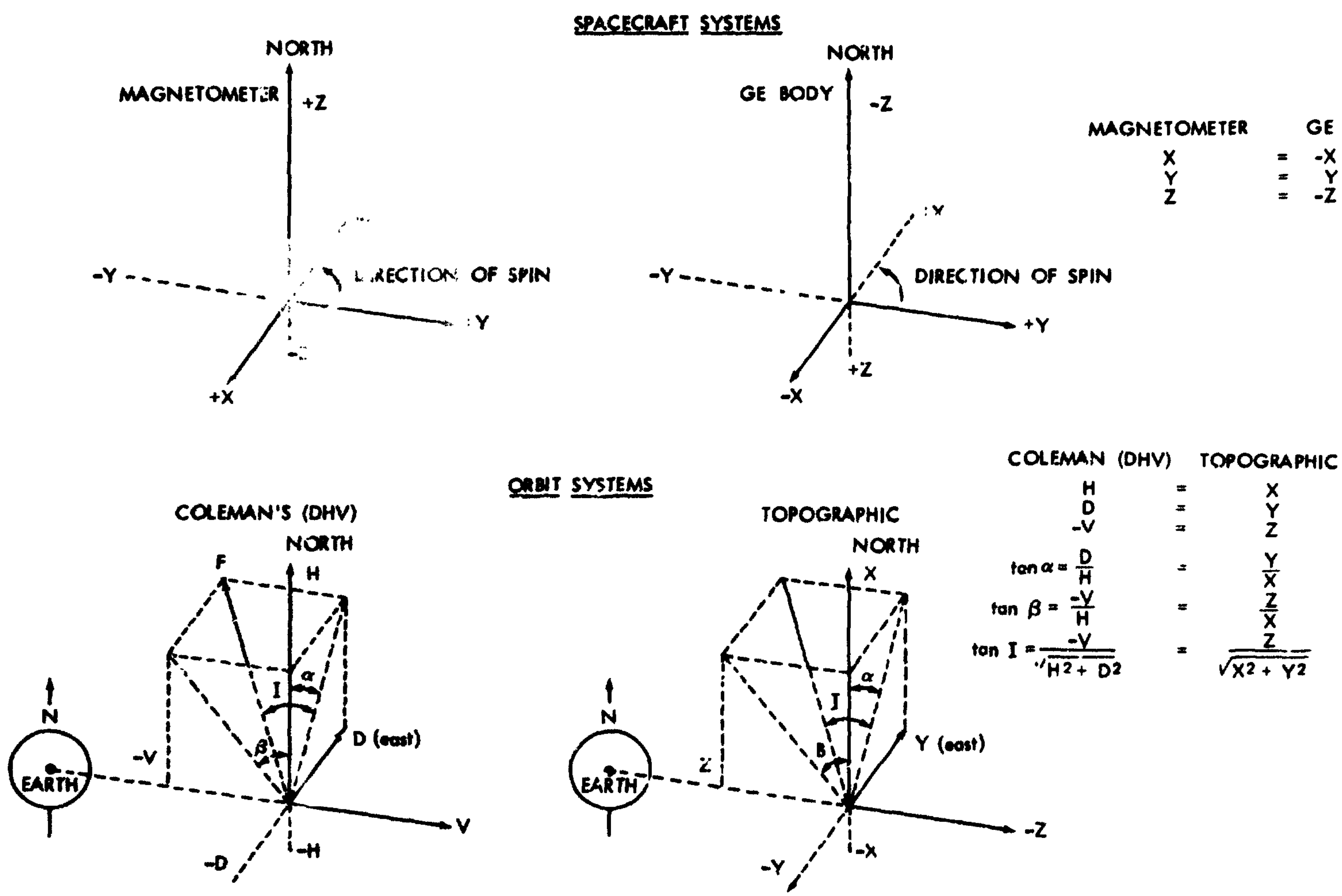

Figure 7. Various ATS-5 coordinate systems.

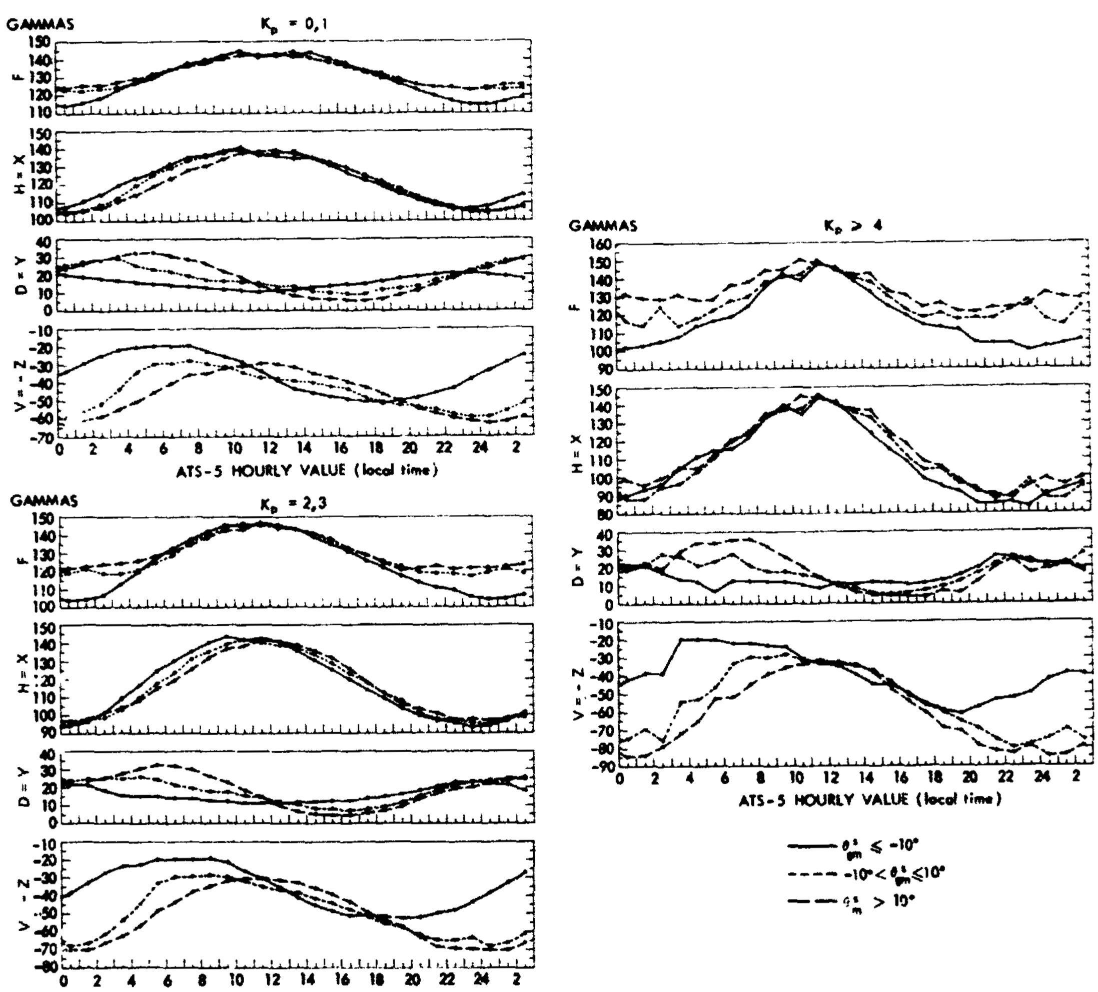

Figure 8. Daily variations in the magnitude F and H, D, and V components of the magnetic field at ATS-5.

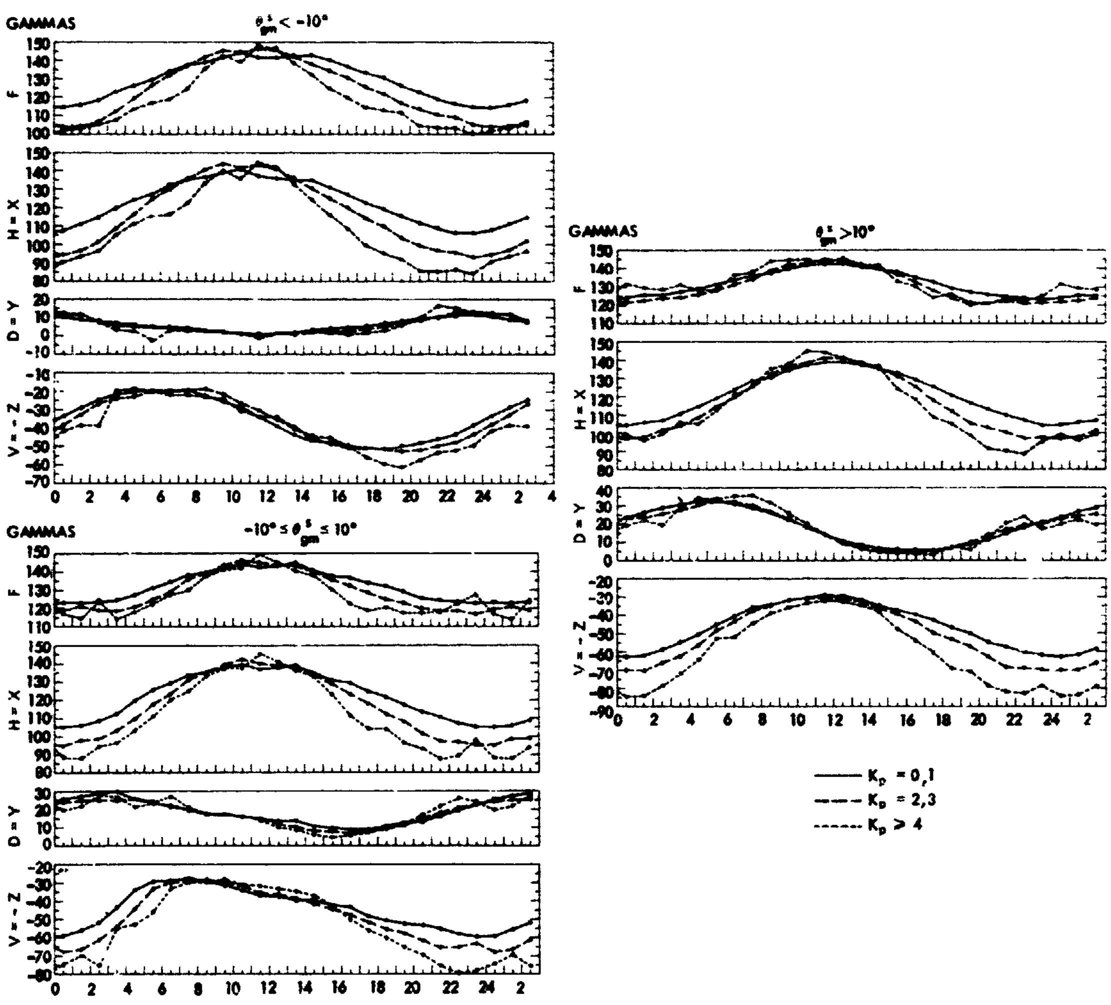

Figure 9. Daily variations in the magnitude *F* and *H, D,* and *V* components of the magnetic field at ATS-5.

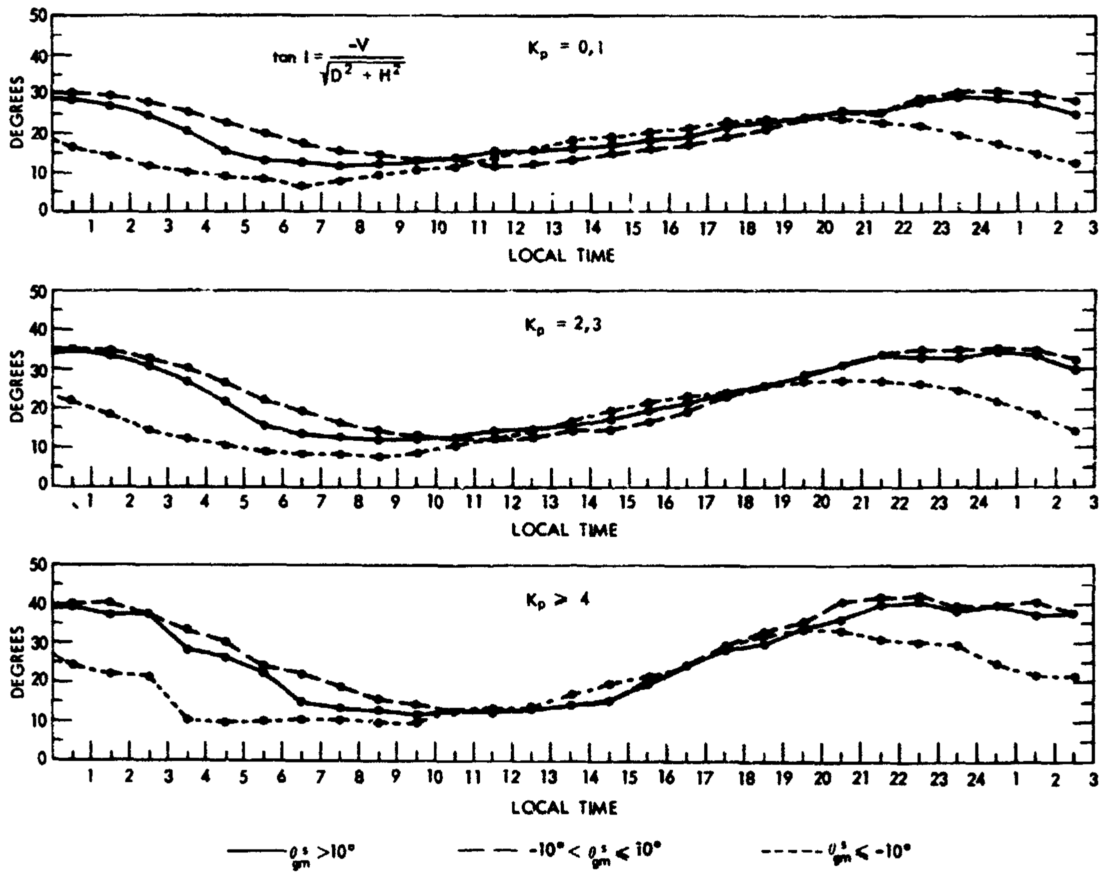

Figure 10. Daily variations in the dip angle *I* of the magnetic field at ATS-5.

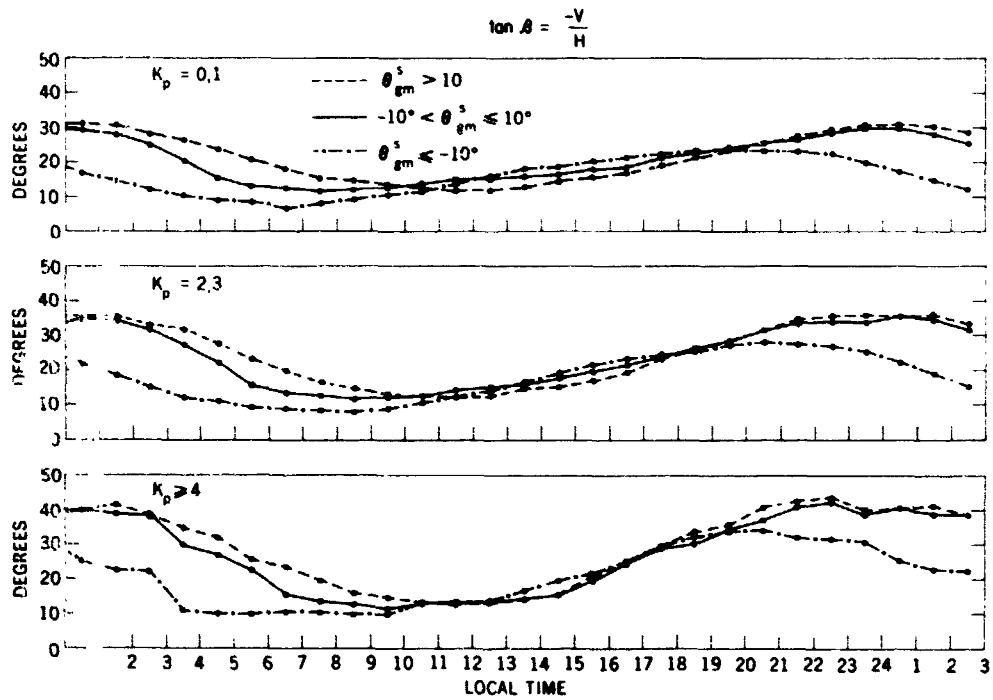

Figure 11. ATS-5 tilt angle β as a function of time.

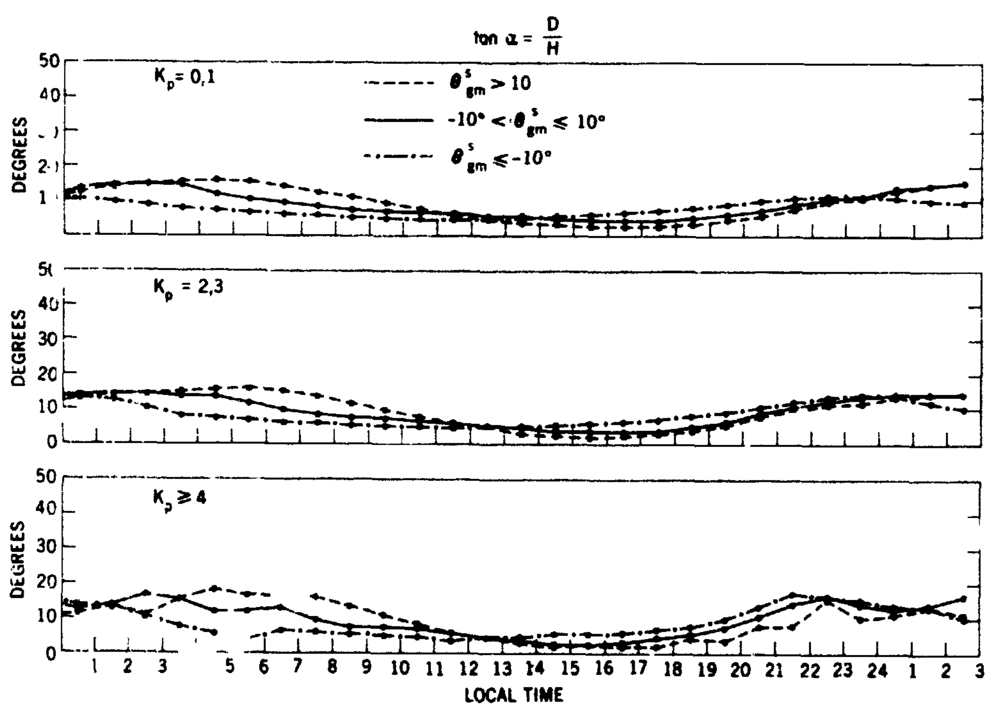

Figure 12. ATS-5 tilt angle α as a function of time.

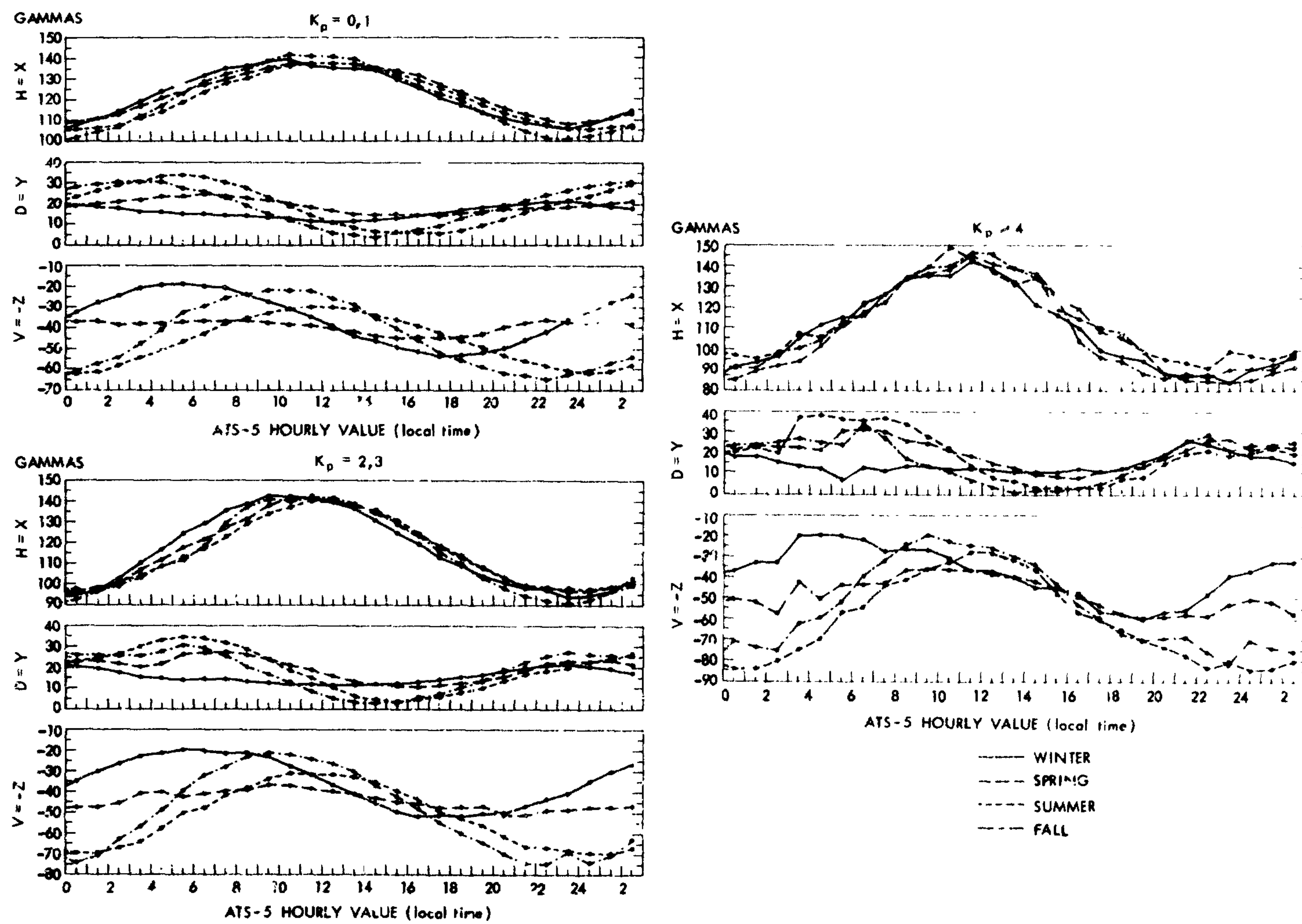

Figure 13. Daily variations relative to seasons of the year.

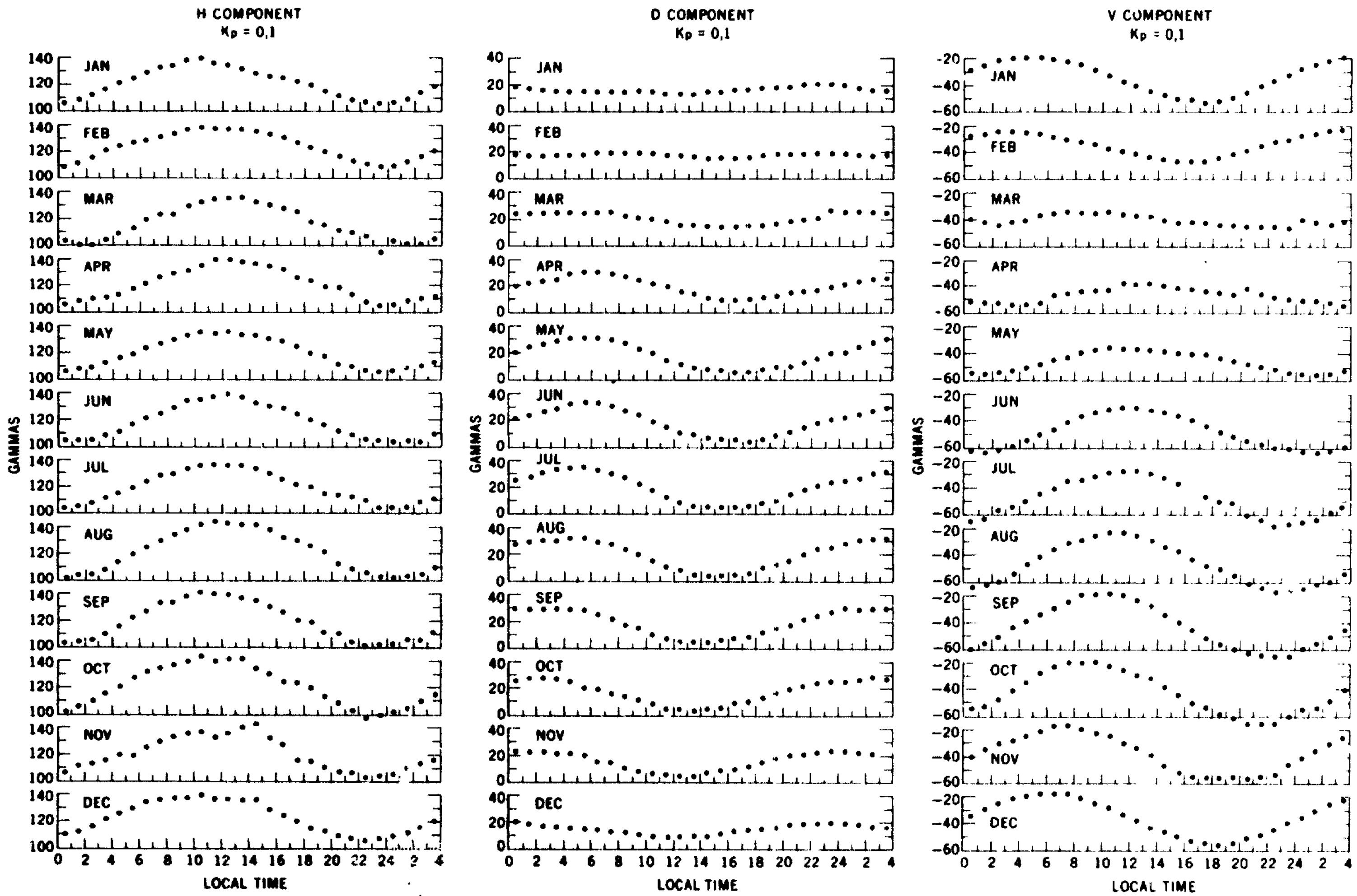

Figure 14. Daily variations (*H*, *D*, and *V*) separated by calendar months.

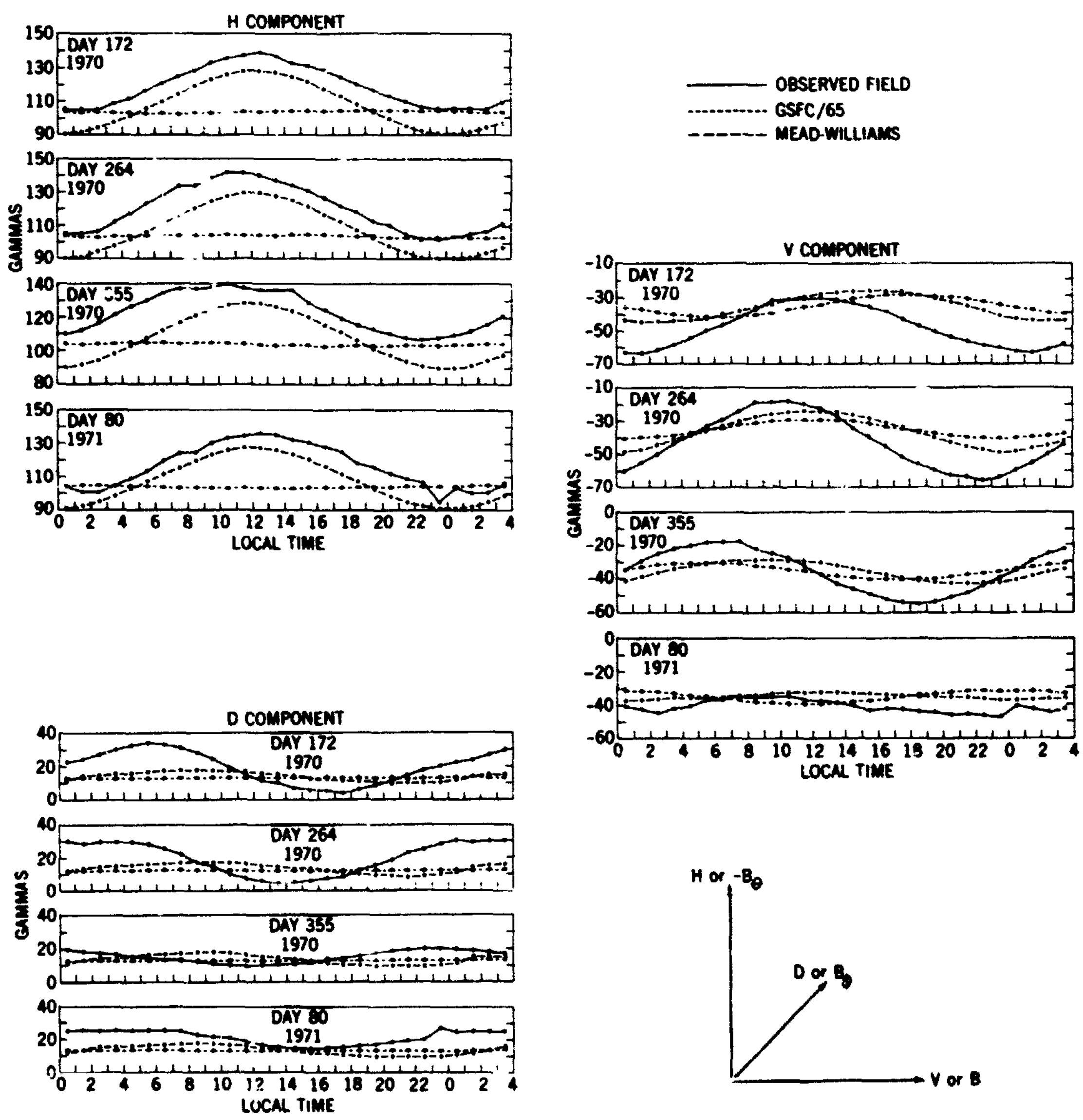

Figure 15. Comparisons of ATS magnetic fields and computed theoretical fields.

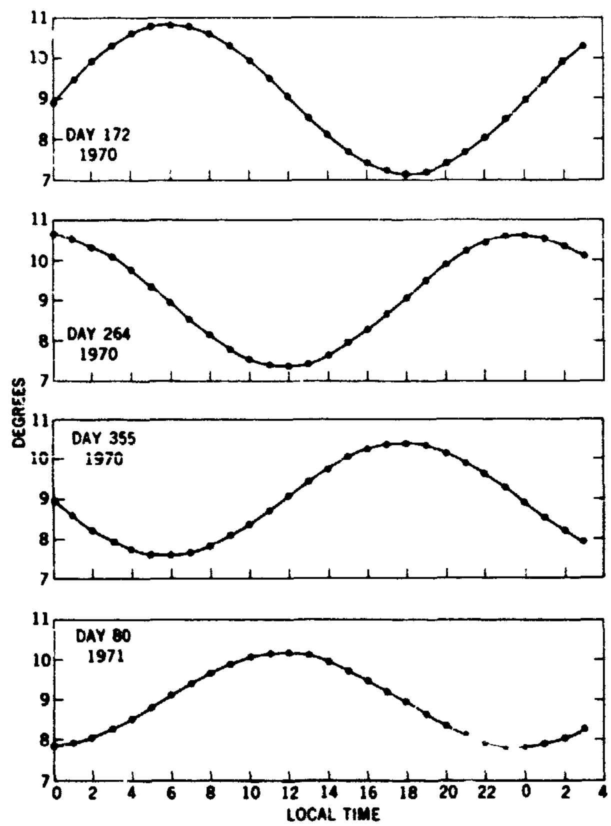

Figure 16. ATS-5 geomagnetic latitude.

Table 1
ATS-5 Environmental Monitor Experiments.

Instrumentation	Status	Purpose	Principal Investigator
Tridirectional medium-energy particle detector	Operational	To extend the description of auroral zone phenomena involving energetic trapped radiation (protons: 30 to 250 keV; electrons: above 30 keV)	F. Mozer, University of California Berkeley
Omnidirectional high-energy particle detector	Operational	To study the electric and magnetic fields responsible for the acceleration of outer zone electrons (0.5 to 5 MeV)	C. McIlwain, University of California San Diego
Bidirectional low-energy particle detector	Operational	To map the distribution of low-energy electrons and and protons on a constant line of force (electrons and protons: 0.5 to 20 keV)	C. McIlwain, University of California San Diego
Total power radiometer	Booms not extended	To measure the effects of solar radio burst at 32 discrete frequencies from 60 kHz to 3.8 MHz	R. G. Stone, NASA/GSFC
High-impedance voltmeter (dc/ac)	Booms not extended	To measure the electric field in the magnetosphere by using the spacecraft gravity-gradient booms as Langmuir probes	T. L. Aggson, NASA/GSFC
Unidirectional low-energy particle detector	Operational	To study (long term) auroral particle fluxes in the vicinity of the loss cone (electrons: 0.5 to 50 keV; protons: 1, 5, 20, 60, and 1000 keV)	R. D. Sharp, Lockheed Palo Alto Research Laboratory

Table 2
Numbers of Samples and Standard Deviation for $\theta^s_{gm} \leq -10°$

Component		Number of Samples		Standard Deviation γ	
	Kp	Maximum	Minimum	Maximum	Minimum
H	0, 1	92	32	9.80	6.46
	2, 3	102	23	15.95	6.83
	≥ 4	25	1	17.58	.0
V	0, 1	86	33	11.73	3.56
	2, 3	95	21	15.42	3.14
	≥ 4	21	1	18.98	.0
D	0, 1	86	33	3.69	.87
	2, 3	95	21	5.46	1.76
	≥ 4	20	1	8.28	.0

Table 3
Numbers of Samples and Standard Deviation for $-10° < \theta^s_{gm} \leq 10°$.

Component		Number of Samples		Standard Deviation γ	
	Kp	Maximum	Minimum	Maximum	Minimum
H	0, 1	64	35	9.62	6.59
	2, 3	80	38	14.49	7.90
	≥ 4	25	8	22.24	7.40
V	0, 1	52	20	10.68	3.92
	2, 3	71	24	23.40	5.36
	≥ 4	23	4	16.77	6.21
D	0, 1	52	20	6.01	2.40
	2, 3	71	24	7.09	2.29
	≥ 4	23	4	9.97	2 70

Table 4
Numbers of Samples and Standard Deviation for $\theta^s_{gm} > 10°$.

Component	Kp	Number of Samples		Standard Deviation γ	
		Maximum	Minimum	Maximum	Minimum
H	0, 1	99	27	8.46	4.87
	2, 3	119	33	17.95	6.34
	≥ 4	29	6	20.18	4.31
V	0, 1	88	24	8.10	3.98
	2, 3	108	26	10.64	5.12
	≥ 4	30	2	12.51	1.00
D	0, 1	88	24	4.72	1.55
	2, 3	108	27	7.50	1.99
	≥ 4	30	2	9.28	1.50

Table 5
Maximum and Minimum Values of the Angle of Dip *(I)*.

Kp	θ^s_{gm} (deg)	Maximum		Minimum		Total Range (deg)
		I (deg)	Local Time	I (deg)	Local Time	
0, 1	≤ -10	23.3	19.5	6.8	06.5	16.5
	$-10 < \theta^s_{gm} \leq 10$	28.9	23.5	11.5	07.5	17.4
	> 10	30.5	00.5	11.7	11.5	18.8
2, 3	≤ -10	27.2	20.5	7.6	08.5	19.6
	$-10 < \theta^s_{gm} \leq 10$	34.8	00.5	11.8	08.5	23.0
	> 10	35.1	00.5	12.1	11.5	23.0
≥ 4	≤ -10	33.3	20.5	9.7	09.5	23.6
	$-10 < \theta^s_{gm} \leq 10$	40.6	22.5	11.5	09.5	29.1
	> 10	42.2	22.5	12.5	11.5	29.7

Table 6
Values of C_m and α_m for $\theta^{s}_{gm} \leqslant -10°$

Component	Kp	Parameter	m				
			0	1	2	3	4
F	0, 1	C_m, γ	129.6	14.5	0.8	0.8	1.0
		a_m, deg	–	17	−1	−36	85
	2, 3	C_m, γ	124.8	21.1	2.5	.8	.3
		a_m, deg	–	20	−57	−66	73
	≥ 4	C_m, γ	118.8	20.8	4.5	2.1	.5
		a_m, deg	–	22	49	63	50
H	0, 1	C_m, γ	123.0	16.5	.6	0.5	0.9
		a_m, deg	–	33	9	−46	75
	2, 3	C_m, γ	117.3	25.2	2.1	.5	.5
		a_m, deg	–	31	−54	−52	85
	≥ 4	C_m, γ	109.5	27.1	4.5	1.7	.9
		a_m, deg	–	35	28	48	−86
D	0, 1	C_m, γ	15.7	4.6	.5	.4	.3
		a_m, deg	–	23	−83	−80	79
	2, 3	C_m, γ	15.7	5.4	1.5	.7	.3
		a_m, deg	–	18	55	68	−16
	≥ 4	C_m, γ	14.9	6.3	3.1	.7	1.8
		a_m, deg	–	28	64	90	83
−V	0, 1	C_m, γ	35.3	15.8	.9	.7	.8
		a_m, deg	–	−75	−12	5	−51
	2, 3	C_m, γ	36.3	17.1	1.1	.7	.4
		a_m, deg	–	−87	−41	−57	−52
	≥ 4	C_m, γ	39.1	18.5	1.0	2.0	1.6
		a_m, deg	–	86	86	−51	−29

Table 7
Values of C_m and α_m for $-10° < \theta^s_{gm} \leqslant 10°$.

Component	Kp	Parameter	m = 0	1	2	3	4
F	0, 1	C_m, γ	132.5	11.0	1.1	0.6	0.6
		a_m, deg	–	14	70	25	
	2, 3	C_m, γ	129.1	1.0	3.3	1.3	6
		a_m, deg	–	17	44	-12	-67
	⩾ 4	C_m, γ	128.3	10.5	8.5	3.9	2.6
		a_m, deg	–	14	66	−12	43
H	0, 1	C_m, γ	122.6	17.3	1.9	.7	.5
		a_m, deg	–	19	−14	−80	27
	2, 3	C_m, γ	116.8	23.7	1.8	1.0	.2
		a_m, deg	–	21	−90	33	11
	⩾ 4	C_m, γ	113.1	24.0	7.1	[illegible]	2.4
		a_m, deg	–	20	78	−21	51
D	0, 1	C_m, γ	18.1	8.7	2.0	.7	.1
		a_m, deg	–	−36	−11	46	5
	2, 3	C_m, γ	17.1	8.9	1.3	.8	.5
		a_m, deg	–	−36	57	−5	−48
	⩾ 4	C_m, γ	17.2	9.1	2.7	1.8	1.0
		a_m, deg	–	−34	−67	−2	6
−V	0, 1	C_m, γ	44.1	14.2	4.8	2.1	.4
		a_m, deg	–	50	13	−50	−45
	2, 3	C_m, γ	48.2	18.9	4.8	2.5	1.2
		a_m, deg	–	40	−9	−72	77
	⩾ 4	C_m, γ	52.6	25.1	2.5	1.8	1.5
		a_m, deg	–	34	−2	78	−14

Table 8
Values of C_m and α_m for $\theta^s_{gm} > 10°$.

Component	Kp	Parameter	m				
			0	1	2	3	4
F	0, 1	C_m, γ	132.1	9.5	1.0	.1	.1
		α_m, deg	–	18	15	78	-59
	2, 3	C_m, γ	130.4	11.8	3.2	.4	.7
		α_m, deg	–	23	25	-81	28
	≥ 4	C_m, γ	133.2	10.7	5.4	1.3	.5
		α_m, deg	–	40	33	-18	-35
H	0, 1	C_m, γ	121.2	17.3	0.4	.1	.2
		α_m, deg	–	11	82	-50	48
	2, 3	C_m, γ	116.8	22.6	2.3	.6	.4
		α_m, deg	–	16	26	72	17
	≥ 4	C_m, γ	114.5	25.4	5.3	1.6	.9
		α_m, deg	–	27	23	10	43
D	0, 1	C_m, γ	18.5	13.2	1.4	.8	.5
		α_m, deg	–	-54	-20	-75	-22
	2, 3	C_m, γ	8.2	12.7	3.2	.9	.3
		α_m, deg	–	-53	-36	-75	-73
	≥ 4	C_m, γ	18.6	13.7	5.3	2.4	1.1
		α_m, deg	–	-62	-37	-65	7
-V	0, 1	C_m, γ	45.8	16.6	1.4	.2	.5
		α_m, deg	–	17	-27	-29	51
	2,3	C_m, γ	50.6	20.9	1.2	.8	.7
		α_m, deg	–	20	-42	59	30
	≥ 4	C_m, γ	59.5	26.9	1.5	1.9	.9
		α_m, deg	–	23	63	-58	82

Table 9
Local Time (hours) of Maximum Field Value for First Harmonic.

θ^s_{gm} deg	Kp	*H*	*V*	*D*	*F*
$\leqslant -10$	0, 1	14.2	7.0	1.5	13.1
	2, 3	14.1	6.2	1.2	13.3
	$\geqslant 4$	14.4	5.8	1.8	13.5
$-10 < \theta^s_{gm} \leqslant 10$	0, 1	13.3	15.3	9.6	12.9
	2, 3	13.4	14.7	9.6	13.1
	$\geqslant 4$	13.3	14.2	9.8	12.9
> 10	0, 1	12.7	13.2	8.4	13.2
	2, 3	13.1	13.3	8.4	13.5
	$\geqslant 4$	13.8	13.6	7.9	14.7

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APPENDIX

MAGNETIC FIELD DATA

GEOMAGNETIC SUN LATITUDE LESS THAN OR EQUAL -10 DEG
H COMPONENT

K_p IS 0 OR 1

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	87	107.5	9.23
1.5	41	110.8	8.57
2.5	77	114.4	7.61
3.5	60	119.8	6.90
4.5	48	123.9	6.46
5.5	44	127.0	7.45
6.5	39	131.9	7.62
7.5	34	133.5	7.92
8.5	34	136.5	8.34
9.5	32	138.9	8.52
10.5	32	140.7	8.87
11.5	34	137.0	9.31
12.5	39	135.9	9.80
13.5	35	134.6	8.46
14.5	48	134.9	8.62
15.5	70	130.9	8.85
16.5	85	126.8	8.15
17.5	90	122.3	7.50
18.5	79	119.1	7.22
19.5	94	115.0	8.00
20.5	97	111.3	7.98
21.5	92	103.4	9.99
22.5	91	106.0	9.43
23.5	49	105.2	9.23

K_p IS 2 OR 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	77	94.2	13.44
1.5	66	96.7	11.98
2.5	59	101.6	12.97
3.5	41	108.9	7.35
4.5	32	116.6	6.83
5.5	27	124.3	11.77
6.5	25	130.0	15.95
7.5	23	135.5	9.62
8.5	26	140.3	10.82
9.5	23	143.4	12.15
10.5	23	141.5	13.16
11.5	31	142.8	12.36
12.5	37	140.8	12.46
13.5	40	135.9	12.37
14.5	37	133.1	10.61
15.5	50	124.9	10.06
16.5	67	[illegible]	10.21
17.5	84	113.9	9.27
18.5	91	109.6	9.67
19.5	102	103.3	10.58
20.5	97	99.5	9.84
21.5	95	96.7	9.94
22.5	97	95.5	15.63
23.5	31	92.8	[illegible]

K_p IS GREATER THAN 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	16	90.3	8.09
1.5	14	93.2	12.92
2.5	9	96.2	11.52
3.5	3	105.0	[illegible]
4.5	3	111.3	5.44
5.5	1	115.0	0.0
6.5	2	116.0	7.00
7.5	2	122.0	9.00
8.5	4	133.3	9.78
9.5	3	140.0	7.79
10.5	4	135.0	[illegible]
11.5	2	144.0	4.00
12.5	3	141.7	5.44
13.5	4	132.3	2.77
14.5	7	124.0	11.20
15.5	10	115.4	[illegible]
16.5	13	108.2	14.26
17.5	21	99.1	17.58
18.5	21	94.9	[illegible]
19.5	25	92.1	15.27
20.5	24	85.1	14.36
21.5	21	84.8	[illegible]
22.5	22	85.8	11.15
23.5	14	83.7	10.05

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GEOMAGNETIC SUN LATITUDE LESS THAN OR EQUAL -10 DEG
V COMPONENT

K_p IS 0 OR 1

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	91	-33.3	9.16
1.5	75	-28.9	7.59
2.5	64	-24.7	4.69
3.5	50	-21.8	4.05
4.5	41	-20.1	3.99
5.5	41	-19.4	3.88
6.5	35	-19.8	4.35
7.5	34	-19.3	4.39
8.5	34	-22.4	4.07
9.5	33	-25.7	4.21
10.5	33	-28.8	4.08
11.5	35	-33.6	3.77
12.5	40	-39.0	4.13
13.5	39	-44.0	3.61
14.5	46	-45.9	3.56
15.5	62	-48.0	4.06
16.5	74	-49.5	4.54
17.5	70	-50.9	5.39
18.5	69	-51.5	6.28
19.5	74	-50.1	7.45
20.5	79	-48.5	8.78
21.5	85	-46.1	10.32
22.5	85	-43.3	11.73
23.5	86	-38.4	10.43

K_p IS 2 OR 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	68	-38.1	12.61
1.5	55	-32.8	10.51
2.5	47	-27.1	5.08
3.5	31	-23.4	3.17
4.5	30	-22.5	3.86
5.5	26	-19.8	4.68
6.5	24	-19.5	5.11
7.5	21	-19.9	4.81
8.5	25	-18.9	3.14
9.5	23	-21.7	4.49
10.5	24	-26.3	4.87
11.5	33	-30.4	5.15
12.5	36	-35.4	5.04
13.5	37	-40.7	6.25
14.5	40	-45.3	4.65
15.5	49	-48.8	4.21
16.5	65	-51.0	4.78
17.5	76	-50.8	6.55
18.5	80	-51.5	8.37
19.5	95	-52.5	10.91
20.5	84	-51.9	12.83
21.5	85	-49.9	14.20
22.5	91	-48.0	15.42
23.5	75	-43.6	13.87

K_p IS GREATER THAN 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	11	-41.9	13.10
1.5	9	-33.7	13.71
2.5	9	-39.0	18.98
3.5	2	-20.0	0.0
4.5	2	-19.5	0.50
5.5	1	-20.0	0.0
6.5	2	-22.0	4.00
7.5	2	-22.0	5.00
8.5	3	-23.0	3.56
9.5	2	-24.0	1.00
10.5	3	-30.7	5.44
11.5	2	-33.5	1.50
12.5	4	-34.3	5.63
13.5	5	-39.8	6.62
14.5	6	-44.5	2.99
15.5	10	-45.4	4.96
16.5	12	-50.0	6.15
17.5	17	-55.9	9.33
18.5	18	-59.3	8.85
19.5	21	-61.2	10.68
20.5	19	-57.4	14.39
21.5	18	-53.3	17.24
22.5	19	-52.2	13.91
23.5	11	-49.7	18.70

GEOMAGNETIC SUN LATITUDE LESS THAN OR EQUAL -10 DEG
D COMPONENT

K_p IS 0 OR 1

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	91	20.2	3.61
1.5	75	18.8	3.69
2.5	64	17.9	2.86
3.5	50	16.9	2.12
4.5	41	16.1	1.34
5.5	41	15.1	1.20
6.5	35	14.5	0.87
7.5	34	13.8	1.26
8.5	34	12.9	1.92
9.5	33	12.1	1.81
10.5	33	11.2	2.30
11.5	35	10.6	2.29
12.5	40	11.3	2.70
13.5	39	11.4	2.57
14.5	46	12.9	2.85
15.5	62	13.5	2.89
16.5	74	14.4	2.73
17.5	70	15.0	2.60
18.5	69	16.4	2.32
19.5	74	17.8	2.24
20.5	79	19.0	2.21
21.5	85	20.2	2.73
22.5	85	21.0	3.21
23.5	86	21.0	3.56

K_p IS 2 OR 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	69	22.2	5.37
1.5	55	21.3	5.37
2.5	47	18.1	1.99
3.5	31	15.5	2.43
4.5	30	15.1	2.65
5.5	26	14.9	2.56
6.5	24	14.1	1.76
7.5	21	13.8	1.92
8.5	25	12.6	2.30
9.5	23	11.9	2.07
10.5	24	11.2	2.08
11.5	33	11.1	2.54
12.5	36	11.2	3.09
13.5	39	11.4	3.01
14.5	49	11.8	3.14
15.5	47	12.2	2.92
16.5	65	12.4	2.75
17.5	75	13.6	2.97
18.5	91	15.0	2.83
19.5	95	16.2	2.71
20.5	84	18.2	3.00
21.5	85	20.2	3.59
22.5	91	22.5	4.91
23.5	75	22.9	5.46

K_p IS GREATER THAN 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	11	21.8	6.87
1.5	9	21.7	6.43
2.5	8	17.4	4.53
3.5	2	13.5	1.50
4.5	2	[illegible]	1.50
5.5	1	7.0	0.0
6.5	2	13.0	1.00
7.5	2	12.5	0.50
8.5	3	12.3	1.25
9.5	2	12.0	1.00
10.5	3	10.7	0.47
11.5	2	8.5	1.50
12.5	4	11.3	3.42
13.5	5	10.6	3.50
14.5	6	12.0	2.00
15.5	10	11.3	2.41
16.5	12	10.5	3.66
17.5	18	11.3	2.77
18.5	18	12.8	2.65
19.5	20	15.8	3.17
20.5	19	19.7	5.54
21.5	18	26.2	5.63
22.5	20	25.1	6.09
23.5	11	22.3	8.28

GEOMAGNETIC SUN LATITUDE GREATER THAN -10 DEG BUT LESS THAN OR EQUAL 10 DEG
H COMPONENT

K_p IS 0 OR 1

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	52	105.1	7.41
1.5	53	105.8	7.90
2.5	43	108.4	6.59
3.5	3[illegible]	112.4	7.18
4.5	41	119.8	7.40
5.5	48	125.7	7.49
6.5	52	129.4	7.35
7.5	56	133.8	8.18
8.5	57	135.4	7.58
9.5	63	138.0	8.64
10.5	64	139.3	9.53
11.5	52	136.9	9.33
12.5	56	137.4	9.23
13.5	50	138.5	9.62
14.5	52	134.3	9.06
15.5	44	130.7	7.66
16.5	35	129.1	6.95
17.5	38	124.3	7.70
18.5	42	121.6	7.20
19.5	39	117.6	7.04
20.5	49	113.1	8.22
21.5	48	110.3	7.71
22.5	51	107.1	7.63
23.5	49	105.2	7.52

K_p IS 2 OR 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	68	[illegible]4.9	9.27
1.5	70	98.0	9.12
2.5	62	98.9	9.27
3.5	47	103.0	10.05
4.5	50	109.4	9.42
5.5	40	117.7	8.96
6.5	38	123.1	8.80
7.5	43	131.3	13.95
8.5	40	135.3	12.09
9.5	4[illegible]	139.4	14.22
10.5	51	142.0	14.49
11.5	52	140.1	10.81
12.5	5[illegible]	138.7	8.85
13.5	55	137.5	8.12
14.5	54	133.8	7.90
15.5	57	128.3	8.68
16.5	58	123.2	11.05
17.5	68	117.6	9.69
18.5	74	112.0	10.24
19.5	80	108.0	10.99
20.5	72	101.4	10.18
21.5	76	97.5	9.47
22.5	76	97.1	10.21
23.5	5[illegible]	95.6	10.63

K_p IS GREATER THAN 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	14	88.2	11.10
1.5	16	87.8	7.40
2.5	8	94.5	9.99
3.5	10	96.5	7.93
4.5	9	103.1	9.85
5.5	14	110.9	8.55
6.5	12	120.3	10.18
7.5	12	124.7	10.73
8.5	20	133.4	9.42
9.5	25	137.2	11.30
10.5	20	137.6	11.53
11.5	19	145.7	11.32
12.5	18	140.5	9.53
13.5	13	136.0	9.98
14.5	15	132.8	11.35
15.5	16	122.5	17.71
16.5	15	111.5	18.26
17.5	24	103.8	22.24
18.5	25	104.1	15.0[illegible]
19.5	24	96.5	13.88
20.5	21	93.3	12.10
21.5	20	92.6	12.96
22.5	25	89.4	9.73
23.5	1[illegible]	98.3	13.40

GEOMAGNETIC SUN LATITUDE GREATER THAN -10 DEG BUT LESS THAN OR EQUAL 10 DEG
V COMPONENT

K_p IS 0 OR 1

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.3	52	-59.2	9.07
1.5	48	-56.0	6.58
2.5	31	-51.8	4.78
3.5	29	-43.6	3.92
4.5	22	-33.5	6.16
5.5	25	-29.2	5.07
6.5	35	-29.1	6.93
7.5	38	-27.6	6.37
8.5	44	-29.3	9.20
9.5	50	-31.2	9.37
10.5	49	-34.1	9.08
11.5	45	-37.0	7.45
12.5	48	-37.5	8.12
13.5	38	-39.7	7.80
14.5	37	-40.1	6.65
15.5	33	-42.3	6.36
16.5	26	-43.7	4.35
17.5	30	-48.6	5.09
18.5	36	-50.6	7.05
19.5	34	-52.4	8.09
20.5	43	-53.6	9.60
21.5	41	-55.2	9.95
22.5	49	-58.2	10.68
23.5	50	-59.4	9.04

K_p IS 2 OR 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	53	-68.0	12.82
1.5	57	-66.5	12.02
2.5	41	-61.1	12.45
3.5	26	-51.4	13.69
4.5	24	-44.0	11.26
5.5	25	-32.9	6.57
6.5	24	-29.3	5.43
7.5	34	-29.5	10.26
8.5	29	-28.4	7.82
9.5	40	-29.9	8.11
10.5	42	-31.6	4.34
11.5	43	-35.1	9.53
12.5	47	-36.6	7.54
13.5	38	-38.5	6.93
14.5	48	-41.5	5.95
15.5	51	-44.7	5.75
16.5	49	-47.8	5.36
17.5	61	-51.6	5.82
18.5	66	-55.2	8.79
19.5	71	-57.4	9.61
20.5	60	-61.8	11.94
21.5	64	-65.0	12.54
22.5	63	-65.0	12.05
23.5	51	-63.2	23.40

K_p IS GREATER THAN 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	5	-74.4	8.31
1.5	4	-69.5	4.38
2.5	4	-75.5	13.74
3.5	6	-54.3	13.12
4.5	6	-52.8	16.77
5.5	9	-46.4	13.51
6.5	7	-32.9	6.98
7.5	11	-29.7	10.88
8.5	18	-29.8	9.41
9.5	23	-28.2	9.10
10.5	18	-31.5	8.87
11.5	15	-31.8	9.25
12.5	15	-33.4	8.31
13.5	12	-34.8	7.55
14.5	17	-37.2	6.23
15.5	16	-43.5	6.21
16.5	17	-50.5	6.84
17.5	19	-56.5	8.27
18.5	19	-60.2	11.16
19.5	17	-65.4	11.28
20.5	12	-69.4	14.29
21.5	12	-75.4	8.12
22.5	13	-79.9	6.96
23.5	5	-78.2	12.35

GEOMAGNETIC SUN LATITUDE GREATER THAN -10 DEG BUT LESS THAN OR EQUAL 10 DEG
D COMPONENT

K_p IS 0 OR 1

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	52	25.7	5.04
1.5	47	27.2	5.02
2.5	31	28.8	3.61
3.5	20	29.8	3.82
4.5	22	23.2	5.18
5.5	26	23.1	4.80
6.5	35	22.0	4.36
7.5	38	19.3	3.62
8.5	44	17.4	2.97
9.5	50	16.9	4.12
10.5	49	16.1	4.32
11.5	45	15.2	4.93
12.5	48	13.3	6.01
13.5	39	13.7	5.49
14.5	37	10.9	5.51
15.5	33	9.9	4.90
16.5	26	9.0	2.56
17.5	30	9.0	2.40
18.5	36	10.8	2.45
19.5	34	12.4	2.64
20.5	43	13.7	2.96
21.5	41	16.8	3.78
22.5	48	19.6	4.44
23.5	49	22.1	4.35

K_p IS 2 OR 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	53	23.8	5.58
1.5	56	24.7	6.61
2.5	12	25.0	7.07
3.5	26	24.8	7.09
4.5	24	26.0	5.97
5.5	25	24.5	4.55
6.5	24	21.4	4.12
7.5	34	19.7	8.53
8.5	29	17.8	8.20
9.5	40	17.5	4.77
10.5	42	15.8	4.91
11.5	43	14.4	5.71
12.5	47	11.9	6.25
13.5	38	10.2	6.19
14.5	48	9.1	5.35
15.5	51	7.8	4.59
16.5	48	6.9	3.60
17.5	61	7.5	2.29
18.5	65	9.2	2.51
19.5	71	11.3	3.28
20.5	60	14.9	4.55
21.5	64	18.1	5.42
22.5	62	20.8	5.98
23.5	50	22.7	5.64

K_p IS GREATER THAN 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	5	19.6	9.97
1.5	5	21.6	8.33
2.5	4	27.8	5.12
3.5	6	26.5	6.63
4.5	6	21.5	6.42
5.5	9	23.7	6.77
6.5	7	27.6	5.10
7.5	11	20.9	6.14
8.5	18	17.9	4.46
9.5	23	17.7	5.13
10.5	18	16.1	5.17
11.5	15	14.9	6.06
12.5	15	10.7	5.99
13.5	12	8.7	5.89
14.5	17	6.1	4.84
15.5	17	4.9	3.98
16.5	18	6.1	3.59
17.5	19	7.3	2.83
18.5	19	9.8	2.70
19.5	17	12.5	2.97
20.5	12	17.0	5.34
21.5	12	22.0	6.08
22.5	13	26.2	5.83
23.5	5	24.2	3.92

GEOMAGNETIC SUN LATITUDE GREATER THAN 10 DEG
H COMPONENT

K_p IS 0 OR 1

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	50	104.3	7.48
1.5	61	106.0	6.57
2.5	80	106.8	7.04
3.5	85	110.8	5.87
4.5	99	114.2	5.71
5.5	66	119.1	5.67
6.5	96	123.7	6.02
7.5	99	128.3	6.77
8.5	86	130.6	7.16
9.5	89	134.8	7.46
10.5	85	137.4	7.92
11.5	31	138.7	8.32
12.5	75	139.1	8.46
13.5	72	137.3	7.35
14.5	59	135.3	7.56
15.5	56	132.8	7.96
16.5	46	129.1	7.02
17.5	44	125.6	7.13
18.5	39	120.6	5.78
19.5	36	116.5	6.54
20.5	27	113.1	5.39
21.5	28	109.8	4.87
22.5	30	107.2	5.64
23.5	40	104.3	8.41

K_p IS 2 OR 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	53	97.0	7.90
1.5	61	97.7	7.70
2.5	74	101.6	8.12
3.5	71	104.1	7.98
4.5	80	108.4	7.97
5.5	106	114.3	7.87
6.5	116	119.6	7.87
7.5	119	125.4	8.83
8.5	108	132.0	10.32
9.5	109	136.9	11.14
10.5	109	138.4	17.95
11.5	107	141.2	11.27
12.5	102	141.0	12.30
13.5	93	138.5	11.39
14.5	94	135.8	11.43
15.5	91	131.4	11.11
16.5	74	125.4	11.18
17.5	56	117.8	11.25
18.5	53	112.1	9.70
19.5	41	105.6	7.86
20.5	38	103.2	9.25
21.5	43	100.5	[illegible]
22.5	38	97.3	9.80
23.5	40	97.7	6.34

K_p IS GREATER THAN 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	15	99.1	9.02
1.5	19	95.9	7.73
2.5	20	99.6	8.68
3.5	16	105.6	8.37
4.5	15	104.9	6.01
5.5	25	112.2	9.81
6.5	27	121.0	11.92
7.5	28	125.6	10.92
8.5	19	135.2	15.96
9.5	21	138.0	18.30
10.5	20	145.0	20.18
11.5	22	144.1	15.62
12.5	27	141.4	14.28
13.5	17	137.4	14.35
14.5	25	136.8	14.27
15.5	26	124.2	15.45
16.5	20	118.5	12.14
17.5	15	108.4	14.58
18.5	13	105.2	11.96
19.5	10	98.7	10.47
20.5	6	91.5	9.91
21.5	6	90.2	7.60
22.5	6	88.3	4.31
23.5	12	95.3	8.13

GEOMAGNETIC SUN LATITUDE GREATER THAN 10 DEG
V COMPONENT

K_p IS 0 OR 1

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	46	-62.9	6.14
1.5	55	-61.8	6.88
2.5	57	-58.8	6.22
3.5	56	-54.8	5.41
4.5	71	-50.3	6.68
5.5	59	-45.1	7.03
6.5	78	-40.3	7.43
7.5	88	-35.6	7.75
8.5	74	-34.3	8.04
9.5	78	-31.8	8.10
10.5	76	-30.4	7.87
11.5	75	-28.9	7.16
12.5	7[illegible]	-29.8	6.06
13.5	74	-31.7	5.18
14.5	54	-35.0	3.98
15.5	53	-37.5	4.05
16.5	43	-39.8	4.09
17.5	36	-42.8	5.10
18.5	31	-46.6	6.03
19.5	29	-50.0	5.49
20.5	24	-54.7	5.98
21.5	25	-57.4	5.74
22.5	25	-60.1	6.47
23.5	36	-61.8	7.07

K_p IS 2 OR 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	41	-70.1	8.94
1.5	46	-70.1	9.32
2.5	46	-66.2	9.69
3.5	40	-62.3	9.33
4.5	47	-55.4	8.24
5.5	74	-48.2	9.39
6.5	100	-43.5	10.01
7.5	10[illegible]	-37.5	9.82
8.5	96	-34.9	9.65
9.5	97	-31.8	9.18
10.5	93	-30.5	7.78
11.5	88	-30.4	7.47
12.5	96	-31.2	6.60
13.5	92	-32.8	6.19
14.5	81	-36.0	5.12
15.5	76	-39.3	5.53
16.5	69	-43.3	6.00
17.5	46	-49.9	7.13
18.5	43	-53.0	7.89
19.5	36	-57.1	9.05
20.5	34	-62.5	8.00
21.5	26	-68.6	10.47
22.5	29	-69.3	10.64
23.5	27	-69.7	9.82

K_p IS GREATER THAN 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	5	-84.6	6.47
1.5	5	-84.0	2.97
2.5	4	-79.0	11.94
3.5	2	-72.0	3.00
4.5	4	-64.8	12.46
5.5	13	-52.6	10.89
6.5	21	-51.9	12.51
7.5	21	-44.7	11.48
8.5	16	-38.9	11.02
9.5	20	-35.7	10.12
10.5	21	-33.3	9.19
11.5	30	-32.0	7.94
12.5	27	-32.5	8.95
13.5	17	-34.4	7.01
14.5	21	-39.0	7.19
15.5	23	-47.4	8.85
16.5	18	-54.0	9.04
17.5	13	-60.4	13.34
18.5	10	-69.2	8.86
19.5	8	-70.6	10.83
20.5	2	-78.5	7.50
21.5	2	-82.0	1.00
22.5	2	-83.0	1.00
23.5	5	-78.8	8.42

GEOMAGNETIC SUN LATITUDE GREATER THAN 10 DEG
D COMPONENT

K_p IS 0 OR 1

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	45	21.3	3.23
1.5	54	26.5	4.72
2.5	57	28.8	3.93
3.5	56	30.5	4.01
4.5	71	32.4	3.41
5.5	59	32.7	3.04
6.5	78	31.2	3.43
7.5	88	28.7	3.71
8.5	73	26.3	3.57
9.5	78	22.3	3.72
10.5	76	18.5	3.62
11.5	75	13.9	3.75
12.5	71	10.7	3.35
13.5	73	8.2	4.57
14.5	54	6.7	4.65
15.5	51	6.1	4.36
16.5	43	5.9	4.43
17.5	36	5.4	2.15
18.5	31	6.7	1.77
19.5	29	8.9	1.55
20.5	24	11.3	1.76
21.5	25	14.9	1.55
22.5	25	18.1	2.23
23.5	36	21.1	2.72

K_p IS 2 OR 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	41	22.9	5.85
1.5	46	24.0	5.19
2.5	45	25.5	6.37
3.5	40	27.9	7.10
4.5	48	30.6	[illegible].31
5.5	74	32.6	4.10
6.5	100	32.2	4.05
7.5	108	30.1	4.08
8.5	96	26.7	4.58
9.5	97	23.0	4.71
10.5	93	18.5	4.59
11.5	88	14.3	5.01
12.5	95	9.7	4.19
13.5	81	6.3	3.29
14.5	80	5.0	2.94
15.5	76	4.1	2.36
16.5	69	4.6	1.99
17.5	46	5.8	2.43
18.5	42	7.5	2.28
19.5	34	9.7	2.71
20.5	34	13.9	4.10
21.5	27	16.9	5.03
22.5	30	19.4	7.50
23.5	29	20.0	5.14

K_p IS GREATER THAN 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	6	19.7	7.67
1.5	6	23.7	7.65
2.5	4	19.3	9.28
3.5	2	29.0	8.00
4.5	3	34.3	3.86
5.5	14	33.8	6.67
6.5	21	35.7	5.25
7.5	21	35.9	4.94
8.5	16	32.0	6.45
9.5	20	26.1	6.01
10.5	21	20.3	6.15
11.5	30	14.5	5.99
12.5	27	10.2	5.33
13.5	17	6.4	5.38
14.5	21	4.9	3.74
15.5	23	4.6	3.52
16.5	17	3.9	4.34
17.5	13	3.5	8.46
18.5	10	7.4	7.45
19.5	8	5.9	5.25
20.5	2	12.5	2.50
21.5	2	20.5	2.50
22.5	2	24.5	1.50
23.5	4	17.0	4.30

DATA NOT SEPARATED ACCORDING TO GEOMAGNETIC SUN LATITUDE
H COMPONENT

K_p IS 0 OR 1

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE (GM)	STANDARD DEVIATION
0.5	189	106.0	8.44
1.5	195	107.9	8.17
2.5	200	110.1	7.98
3.5	132	114.1	7.66
4.5	188	117.9	7.56
5.5	178	122.8	7.60
6.5	137	127.0	7.62
7.5	199	131.2	8.05
8.5	177	133.3	7.98
9.5	154	136.6	8.27
10.5	141	138.7	8.78
11.5	167	137.8	8.89
12.5	170	137.8	9.13
13.5	157	137.1	8.50
14.5	159	134.9	8.40
15.5	170	131.5	8.32
16.5	166	127.9	7.70
17.5	162	123.7	7.54
18.5	160	120.1	6.97
19.5	159	116.0	7.54
20.5	163	112.[illegible]	7.74
21.5	168	109.2	8.12
22.5	172	106.6	8.38
23.5	177	105.5	8.64

K_p IS 2 OR 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE (GM)	STANDARD DEVIATION
0.5	198	95.2	10.86
1.5	[illegible]	97.4	10.66
2.5	195	100.7	9.50
3.5	159	105.0	8.81
4.5	162	110.3	8.77
5.5	173	116.7	9.53
6.5	179	121.8	10.25
7.5	185	128.0	10.99
8.5	174	134.0	11.22
9.5	141	138.4	12.37
10.5	[illegible]	139.8	10.59
11.5	190	141.1	11.37
12.5	179	140.3	11.46
13.5	188	137.7	10.77
14.5	185	134.1	10.58
15.5	[illegible]	128.8	10.53
16.5	199	122.9	10.80
17.5	208	116.2	9.84
18.5	218	111.0	9.95
19.5	223	105.4	10.65
20.5	207	100.8	9.79
21.5	204	97.6	9.59
22.5	211	96.4	2.36
23.5	190	93.8	11.27

K_p IS GREATER THAN 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE (GM)	STANDARD DEVIATION
0.5	45	92.6	10.53
1.5	49	92.5	10.04
2.5	37	97.7	9.96
3.5	29	102.4	9.17
4.5	27	105.0	7.83
5.5	40	111.8	8.54
6.5	41	120.5	11.29
7.5	42	125.1	10.91
8.5	43	134.2	12.79
9.5	49	137.7	14.59
10.5	46	140.8	16.81
11.5	50	144.7	13.84
12.5	48	141.1	12.28
13.5	34	136.3	12.02
14.5	47	130.6	13.69
15.5	52	122.0	15.57
16.5	48	113.5	15.50
17.5	60	103.3	19.28
18.5	59	101.1	15.28
19.5	[illegible]	95.0	14.23
20.5	51	89.2	13.58
21.5	[illegible]	88.8	14.21
22.5	53	87.6	10.07
23.5	41	92.[illegible]	12.66

DATA NOT SEPARATED ACCORDING TO GEOMAGNETIC SUN LATITUDE
V COMPONENT

K_p IS 0 OR 1

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	179	-46.5	16.19
1.5	178	-46.4	16.69
2.5	152	-43.0	16.69
3.5	126	-39.9	15.90
4.5	134	-38.3	14.70
5.5	126	-33.5	12.84
6.5	148	-32.9	10.86
7.5	160	-33.2	9.48
8.5	152	-30.2	9.05
9.5	151	-30.4	8.27
10.5	158	-31.2	7.93
11.5	155	-32.3	7.53
12.5	159	-34.5	7.62
13.5	151	-36.9	7.76
14.5	137	-40.0	6.63
15.5	148	-43.0	6.59
16.5	143	-45.5	6.14
17.5	136	-48.3	6.24
18.5	136	-50.1	6.72
19.5	137	-50.7	7.32
20.5	146	-51.0	9.08
21.5	151	-50.6	10.82
22.5	158	-50.5	13.26
23.5	172	-49.4	14.52

K_p IS 2 OR 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	152	-56.0	19.27
1.5	158	-55.8	20.02
2.5	134	-50.9	20.00
3.5	97	-47.5	19.17
4.5	101	-43.4	16.58
5.5	125	-39.2	13.73
6.5	148	-37.3	12.85
7.5	173	-33.5	11.21
8.5	150	-31.0	10.41
9.5	160	-29.9	9.08
10.5	159	-30.2	7.76
11.5	174	-31.6	7.95
12.5	179	-33.5	7.03
13.5	159	-36.1	7.30
14.5	169	-39.7	6.51
15.5	176	-43.5	6.59
16.5	182	-47.2	6.36
17.5	183	-50.8	6.50
18.5	189	-53.1	8.57
19.5	200	-55.0	10.30
20.5	178	-57.2	12.79
21.5	175	-58.2	15.43
22.5	183	-57.2	16.51
23.5	153	-54.7	20.45

K_p IS GREATER THAN 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	21	-59.8	21.91
1.5	18	-58.1	22.72
2.5	16	-59.1	25.10
3.5	10	-51.0	19.80
4.5	12	-51.3	20.55
5.5	23	-48.8	13.60
6.5	30	-45.5	14.99
7.5	34	-39.5	13.62
8.5	37	-33.2	11.18
9.5	45	-31.4	10.18
10.5	42	-32.3	8.39
11.5	47	-32.0	8.23
12.5	46	-33.0	8.52
13.5	34	-35.3	7.39
14.5	44	-38.5	6.83
15.5	49	-45.7	7.57
16.5	47	-51.7	7.82
17.5	49	-57.3	10.36
18.5	47	-61.8	10.58
19.5	46	-64.4	11.45
20.5	33	-63.1	15.63
21.5	32	-63.4	18.02
22.5	34	-64.6	17.95
23.5	21	-63.4	21.05

DATA NOT SEPARATED ACCORDING TO GEOMAGNETIC SUN LATITUDE
D COMPONENT

K_p IS 0 OR 1

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	179	22.6	4.63
1.5	176	23.4	5.92
2.5	152	24.2	6.39
3.5	126	25.0	7.36
4.5	134	26.2	7.92
5.5	126	25.0	8.34
6.5	146	25.1	7.73
7.	160	23.3	7.08
8	151	20.7	6.42
9.5	161	18.5	5.36
10.5	158	16.2	4.57
11.5	155	13.5	4.22
12.5	159	11.6	4.36
13.5	150	10.4	4.99
14.5	137	9.9	5.16
15.5	148	10.0	5.10
16.5	143	10.8	5.14
17.5	136	11.1	4.81
18.5	136	12.7	4.61
19.5	137	14.6	4.31
20.5	146	16.2	3.98
21.5	151	18.4	3.61
22.5	158	20.1	3.67
23.5	171	21.3	3.69

K_p IS 2 OR 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	162	22.9	5.61
1.5	157	23.3	5.99
2.5	134	22.7	6.82
3.5	97	23.1	8.06
4.5	102	24.9	8.53
5.5	125	27.3	8.10
6.5	148	27.5	8.03
7.5	163	25.8	7.37
8.5	150	22.6	7.07
9.5	160	20.0	[illegible].04
10.5	159	16.7	5.10
11.5	164	13.7	5.00
12.5	178	10.6	4.75
13.5	158	8.5	4.73
14.5	168	7.5	4.7[illegible]
15.5	176	7.4	4.70
16.5	182	8.0	4.41
17.5	183	9.6	4.32
18.5	188	11.3	4.20
19.5	200	13.4	4.03
20.5	178	16.2	4.23
21.5	176	18.9	4.75
22.5	183	21.4	5.88
23.5	154	22.3	5.57

K_p IS GREATER THAN 3

LOCAL TIME	NUMBER OF SAMPLES	AVERAGE(GM)	STANDARD DEVIATION
0.5	2[illegible]	20.7	7.97
1.5	2[illegible]	21.9	7.33
2.5	16	20.4	7.53
3.5	10	24.4	8.38
4.5	11	23.4	9.12
5.5	24	28.9	9.34
6.5	30	32.3	8.30
7.5	34	29.7	9.67
8.5	37	23.5	9.19
9.5	45	21.2	7.08
10.5	42	17.8	6.21
11.5	47	14.4	6.02
12.5	46	10.4	5.43
13.5	34	7.8	5.56
14.5	44	6.3	4.66
15.5	50	6.0	4.38
16.5	47	6.4	4.66
17.5	50	7.7	5.82
18.5	47	10.5	4.66
19.5	45	12.8	5.03
20.5	33	18.3	5.67
21.5	32	24.3	6.08
22.5	35	25.5	5.85
23.5	20	21.7	7.17

NASA-Langley, 1974