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IONOSPHERIC DRIFT VELOCITY MEASUREMENTS AT JICAMARCA, PERU (JULY 1967 - MARCH 1970)

by

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Introduction

This report is a collection of measurements of electron drift velocity in the E and F regions of the equatorial ionosphere, made at the Jicamarca Radar Observatory (dip latitude ≃1°N). The data consist of about eighty days of observations during the period July 1967 to March 1970. The measurements consist of (1) the vertical component of the electron drift velocity in the F region, and (2) the east-west component of the electron drift velocity in the E region. Other components of the drifts have been measured but the data are sparse and have not been included here. The horizontal component (H trace) of the magnetic field strength records of Huancayo, Peru, has also been included for reference.

The purpose of this report is to make these data available to the scientific community. Comparison between these measurements and other geophysical phenomena should aid in the understanding of a variety of ionospheric and magnetospheric processes. This type of data continues to be taken at JRO from time to time. For information regarding the more recent data, we suggest contacting either of the authors of this report. The data included in this report are also available in digital form on magnetic tape and punched cards. Inquiries should be directed to the World Data Center A, Upper Atmosphere Geophysics, NOAA, Boulder, Colorado 80302.

Data Description

I. F-region measurements

The F-region drift-measurement technique has been described by Woodman and Hagfors [1968]. The method involves the determination of the Doppler shift of incoherently-scattered signals from the F-region ionization when the propagation vector is directed normal to the earth's magnetic field. (When "looking" normal to the magnetic field, the Doppler shifts can be accurately determined because of the narrowness of the signal spectrum.) A presentation and discussion of the F-region data is given in a paper by Woodman [1970].

The data presented here are five-minute-average values of the average drift velocity between 300–400 km. This is achieved by averaging together the five simultaneous drift measurements (each one representing a five-minute-average value) obtained in the five separate height ranges between 300–400 km.

The accuracy of the drift measurement is determined primarily by signal-to-noise levels of the F-region echoes. This is affected by a variety of factors (transmitted power, antenna size, F-region electron density, etc.). Under typical conditions, the drift measurements are accurate to within about ±2 m/sec.

One major obstacle in obtaining continuous (diurnal) drift velocity measurements is the occurrence of equatorial spread F (field-aligned irregularities in the F region that produce anomalously strong echo returns). Spread F [Farley, et al. 1970] is a frequent nighttime phenomenon, typically beginning after F-region sunset and usually lasting until about local midnight. The presence of strong spread-F irregularities in a given region effectively precludes drift measurements in that region by standard techniques. (Doppler measurements during spread-F conditions can be made, but the results do not describe the average behavior of the ambient ionization.) If the irregularities do not occur within the 300-400 km height interval, then the drift measurements can be made; if they do occur within the interval, it is sometimes still possible to obtain a representative value of the true drift velocity by hand-scaling non-affected points at other heights. The reason that this technique is useful is that the F-region drift velocity is roughly height independent under normal conditions [Woodman 1970].

These vertical drift velocities may be used to obtain a value for the (east-west) electric field in the F region. At F-region heights, collision frequencies are so low that ions and electrons gyrate several times before they are affected by collisions. Thus, motions perpendicular to the magnetic field are effectively Hall drifts of ions and electrons produced by the cross product of the electric and magnetic fields. At Jicamarca the magnetic dip is only 2°, so measurements of (nominally) vertical drift velocities can be taken as a measurement of the horizontal electric field. The relationship between the drift velocity and the electric field is given by:

$$V = 10\ E/B \qquad (1)$$

where V is the vertical drift velocity in m/sec, E is the electric field strength in mV/m, and B is the magnetic field strength expressed in gauss.

II. E-region measurements

The measurement technique for the E-region drifts has been covered in a series of reports [Balsley, 1969a,b; 1970a,b]. Briefly, the data are obtained by determining the mean Doppler shift of oblique radar returns from a type of electron density irregularity embedded in the equatorial electrojet. These irregularities drift with the electrons so that a measurement of the irregularity drift velocity is equivalent to a measurement of the electron motion itself. The method is limited to periods when the drift velocity is between about 50 m/sec and 360 m/sec (the ion-acoustic velocity): for velocities below 50 m/sec, the irregularities are too weak to be reliably observed with the existing radar system; for velocities greater than the ion-acoustic velocity, the presence of another type of irregularity (generated by the two-stream instability [Farley, 1963]) makes determination of the drift velocity somewhat difficult. It is possible to infer drift velocities up to about 500 m/sec by making reasonable assumptions, and this has been done in the data presented here. The above limitations are not too restrictive, since the observed drift velocities are less than 50 m/sec usually only for a short period when the electrojet current is reversing and exceed the ion-acoustic velocity only for relatively short periods.

The possibility cannot be completely discounted that the E-region (as well as the F-region) measurements are contaminated during periods of intense spread F. For the E-region measurements, the spread-F echoes could be received via a vertically-directed antenna sidelobe, so that the resulting data might contain vertical motion of the spread-F irregularities. Although statistical studies (unpublished three-year averages of E- and F-region drift comparisons) show that this effect is not important on the average, the reader should be aware of this possibility.

The E-region drift velocities which appear in this report represent time-average (2½ minutes) values of the average (over all heights) drift velocity in the electrojet region. The height averaging arises because the mean Doppler shifts obtained from the oblique-echo spectra are a composite of the shifts from irregularities over the complete height range of the echoing region (95-110 km). Therefore, although the electron drift velocity is strongly height dependent within the region [Sugiura and Cain, 1963], the resulting drifts represent a weighted average value for all heights.

The accuracy of the E-region drift measurements may be conveniently classified into three divisions: (1) for velocities below about ±50 m/sec the accuracy is probably no better than ±20 m/sec; (2) for velocities in the range 50-360 m/sec, the accuracy is better than ±15% of the value shown; (3) for velocities in excess of the ion-acoustic velocity (360 m/sec), the plotted values should be considered only as indicative of the probable velocities (the only quantitative statement that can be made for values in this category is that the drift velocity is equal to or greater than the ion-acoustic velocity).

The electron drift velocity may be used to estimate a value for the horizontal electric field responsible for the drift: Sugiura and Cain [1966] show that the electric field is related to the drift velocity by:

$$V_e \simeq E_y(\sigma_2 \cos I)/B(\sigma_0 \sin^2 I + \sigma_1 \cos^2 I) \qquad (2)$$

where V_e is the electron drift velocity (assumed to be equal to the irregularity drift velocity) expressed in m/sec; σ_1 and σ_2 are the Pedersen and Hall conductivities, respectively; B is the geomagnetic field expressed in Weber/m^2; and E_y is the imposed (east-west) electric field expressed in V/m. For values pertinent to Jicamarca ($B \cong 27 \times 10^{-6}$ Weber/m^2, and magnetic dip = 2°), and for the most recent values of the conductivities [Tarpley, 1969], (2) may be written as:

$$E_y \simeq -5.9 \times 10^{-6}\ V_e \quad \text{V/m} \qquad (3)$$

Data Format

All of the data presented in this report are displayed in one format: the curves representing (1) the F-region (vertical) drift velocity, (2) the E-region (east-west) drift velocity, and (3) the magnetic field strength (H trace) are shown in the time interval 0800 on a given day until 0800 on the following day (75°W. time). This format is adhered to even when only portions of a data day are available, or when only one of the two drift measurements are made.

The vertical axis for the F-region data is scaled between ±50 m/sec; the positive values correspond to upward drifts while the negative values represent downward drifts. The horizontal-dashed lines that appear occasionally at the -50 m/sec level of the F-region curves indicate times of system outage. The shaded horizontal strips that appear on the zero m/sec line indicate periods of occurrence of equatorial spread F at some height over the observatory. When these irregularities occurred outside of the 300-400 km region (where the average F-region drifts are obtained), both types of data (F-region drift velocities and spread-F occurrence) are shown. When the irregularities occurred within this height range, the normal drift measurements were not possible. In these instances, if it was possible to obtain a representative drift velocity value from a higher region, these results are plotted as dashed lines. If the irregularities were very strong and/or occurred throughout the entire F region, then no data are plotted.

The E-region curves are scaled between ± 500 m/sec; positive for westward drift velocities. As in the F-region curves, the horizontal-dashed lines at the -500 m/sec level indicate periods of system outage. The horizontal-dashed lines that appear occasionally at the ±360 m/sec levels show the nominal critical drift velocity (V_{i-a}) for the generation of the two-stream irregularities. Finally, the small circles that replace the E-region curves when the drift velocity approaches ±500 m/sec indicate that determination of the drift velocity is precluded by the presence of strong two-stream echoes.

The vertical-dashed lines indicated by SR, SS, SR', SS' indicate the approximate times of local ground sunrise (SR) and sunset (SS), and sunrise (SR') and sunset (SS') at a height of 100 km (the approximate height of the equatorial electrojet). These data were obtained from Colin and Myers [1966].

The horizontal component of the Huancayo magnetogram has been plotted assuming a baseline of 27,750 γ for all records. This baseline value was taken from the 1967 Huancayo magnetic records. The actual baseline values during the 1967-1970 observation period increased gradually by about 13 γ (the pronounced decrease in the nighttime level apparent during the period is much larger than this and is due to secular variations in the earth's magnetic field [Campbell, 1971]). Reference should be made to the original records if accuracies comparable to variations of this magnitude are desired, particularly since the magnetic field strength curves shown here are merely handsmoothed rescalings of the actual data, and are meant mainly for visual comparison with the other data.

For further convenience, the three-hour averaged values of the Huancayo K indices are shown at the bottom of each figure. These values were obtained from the actual scalings made at the Huancayo Observatory, which were included in the standard magnetic records.

Acknowledgements

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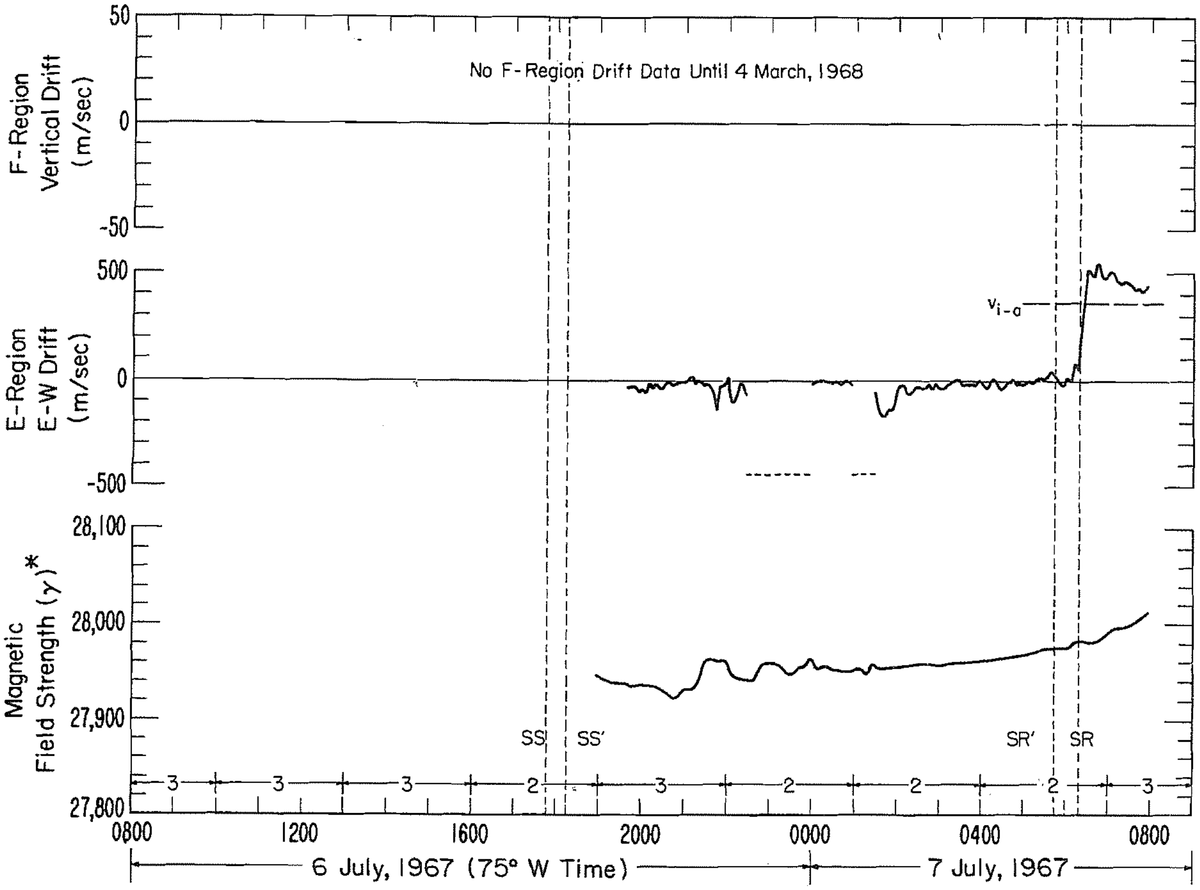
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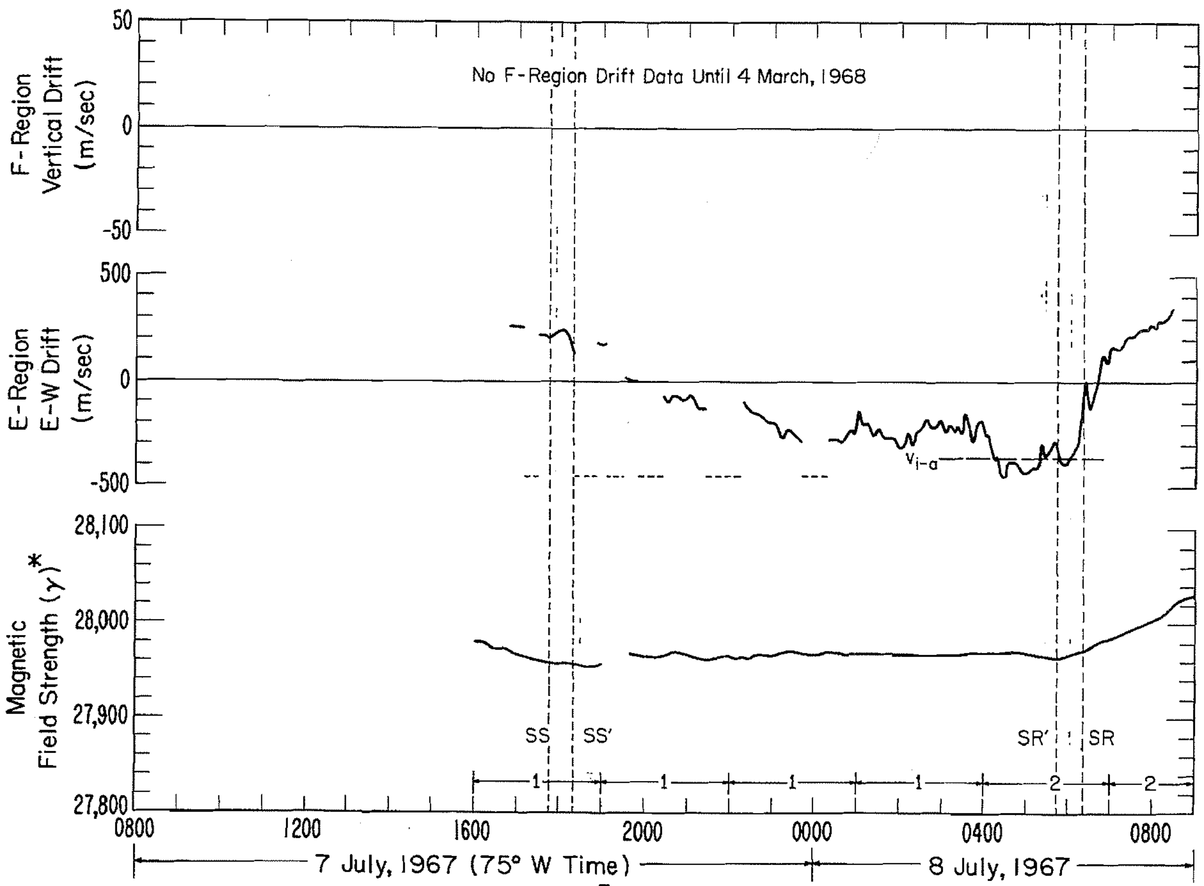
F-Region Vertical Drift (m/sec)
E-Region E-W Drift (m/sec)
v_{i-a}
Magnetic Field Strength (γ)*
SS
SS'
SR'
SR
0800
1200
1600
2000
0000
0400
0800
6 July, 1967 (75° W Time)
7 July, 1967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E-Region E-W Drift (m/sec)
v_{i-a}
Magnetic Field Strength (γ)*
SS
SS'
SR'
SR
0800
1200
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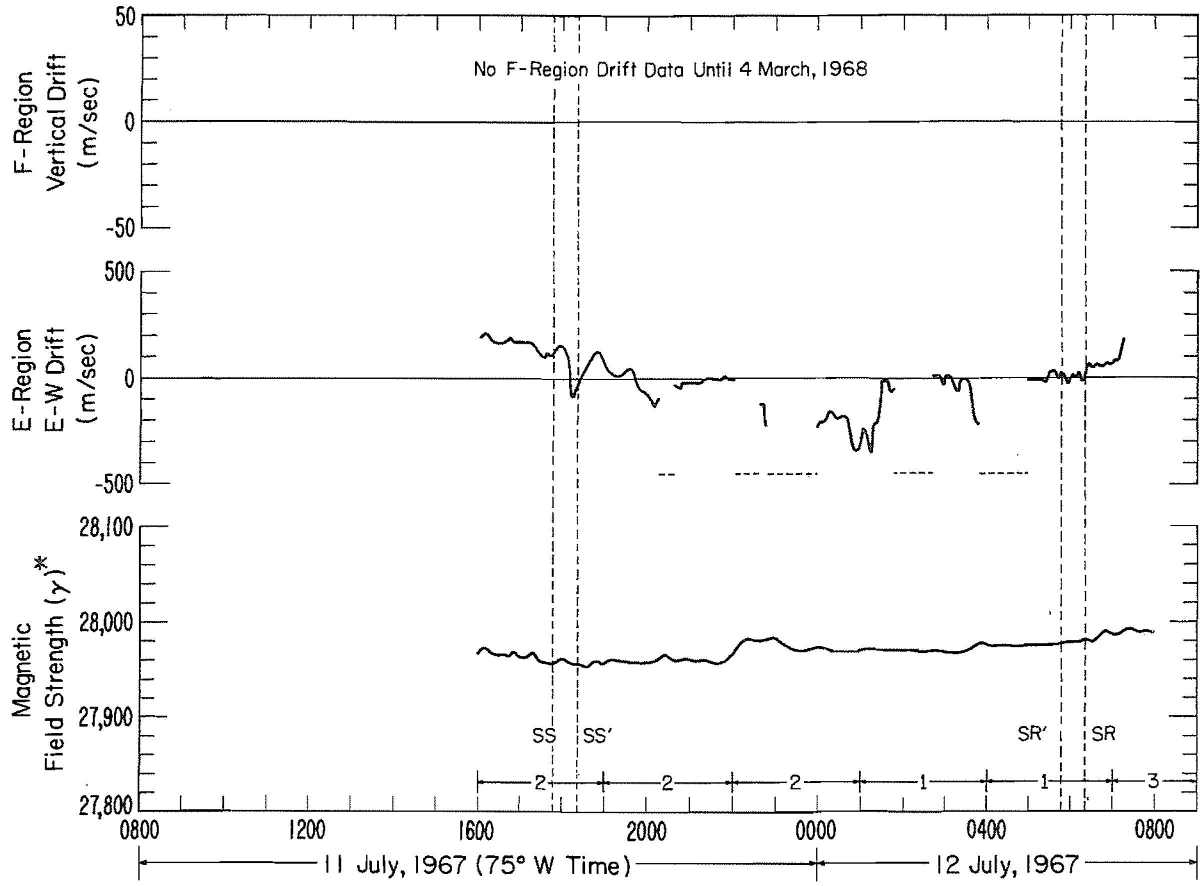
0400
0800
7 July, 1967 (75° W Time)
8 July, 1967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F-Region Vertical Drift (m/sec)
E-Region E-W Drift (m/sec)
Magnetic Field Strength (γ)*
SS
SS'
SR'
SR
0800
1200
1600
2000
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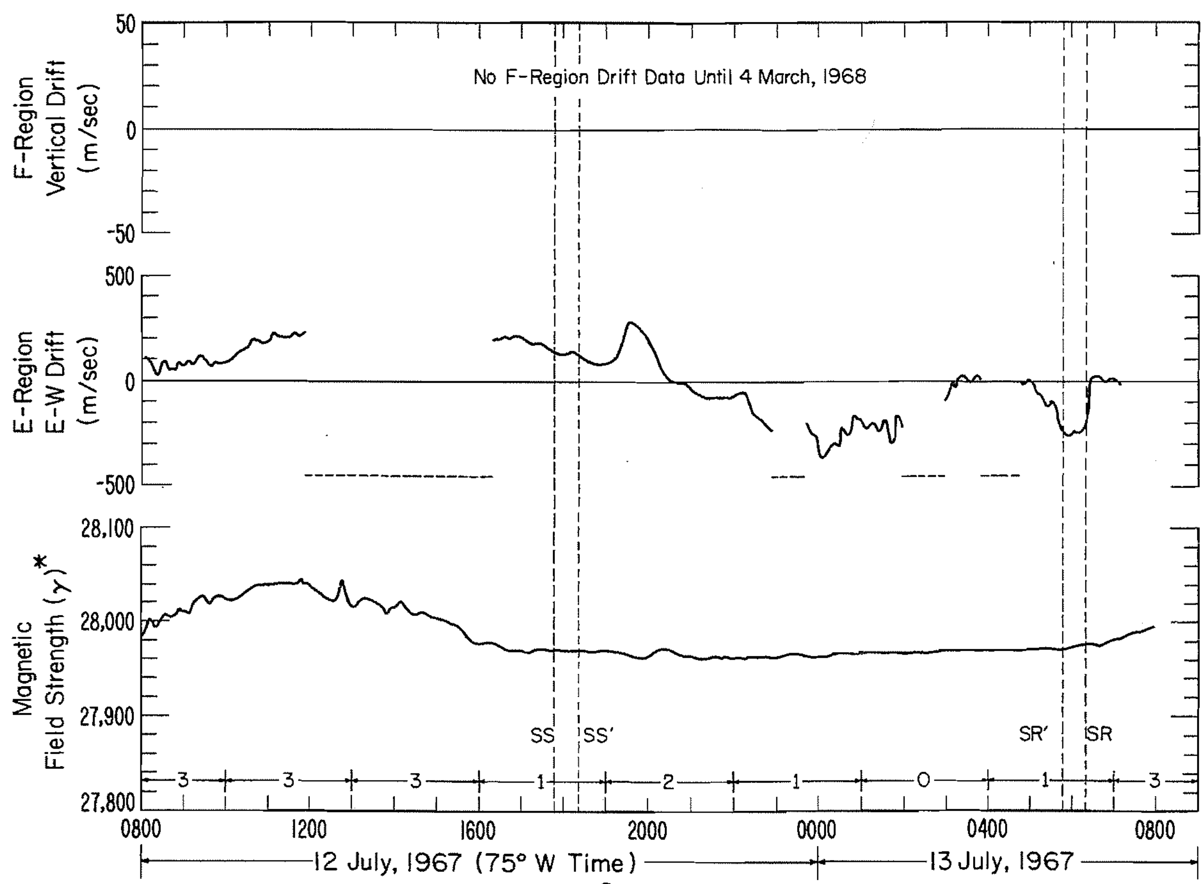
0400
0800
11 July, 1967 (75° W Time)
12 July, 1967


No F-Region Drift Data Until 4 March, 1968
F-Region Vertical Drift (m/sec)
E-Region E-W Drift (m/sec)
Magnetic Field Strength (γ)*
SS
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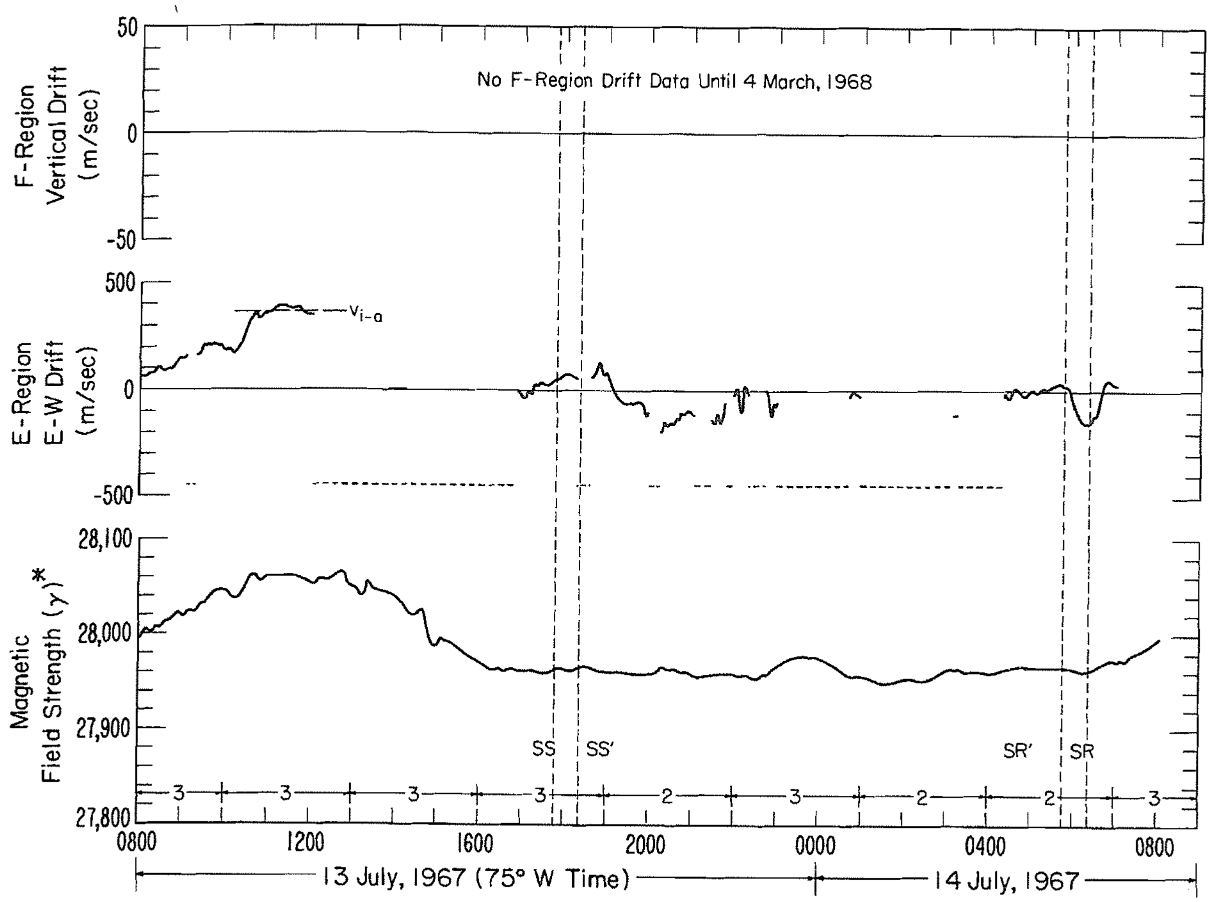
SR'
SR
0800
1200
1600
2000
0000
0400
0800
12 July, 1967 (75° W Time)
13 July, 1967



F-Region Vertical Drift (m/sec)
50
0
-50
No F-Region Drift Data Until 4 March, 1968
E-Region E-W Drift (m/sec)
500
0
-500
v_{i-a}
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
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SS′
SR′
SR
3
3
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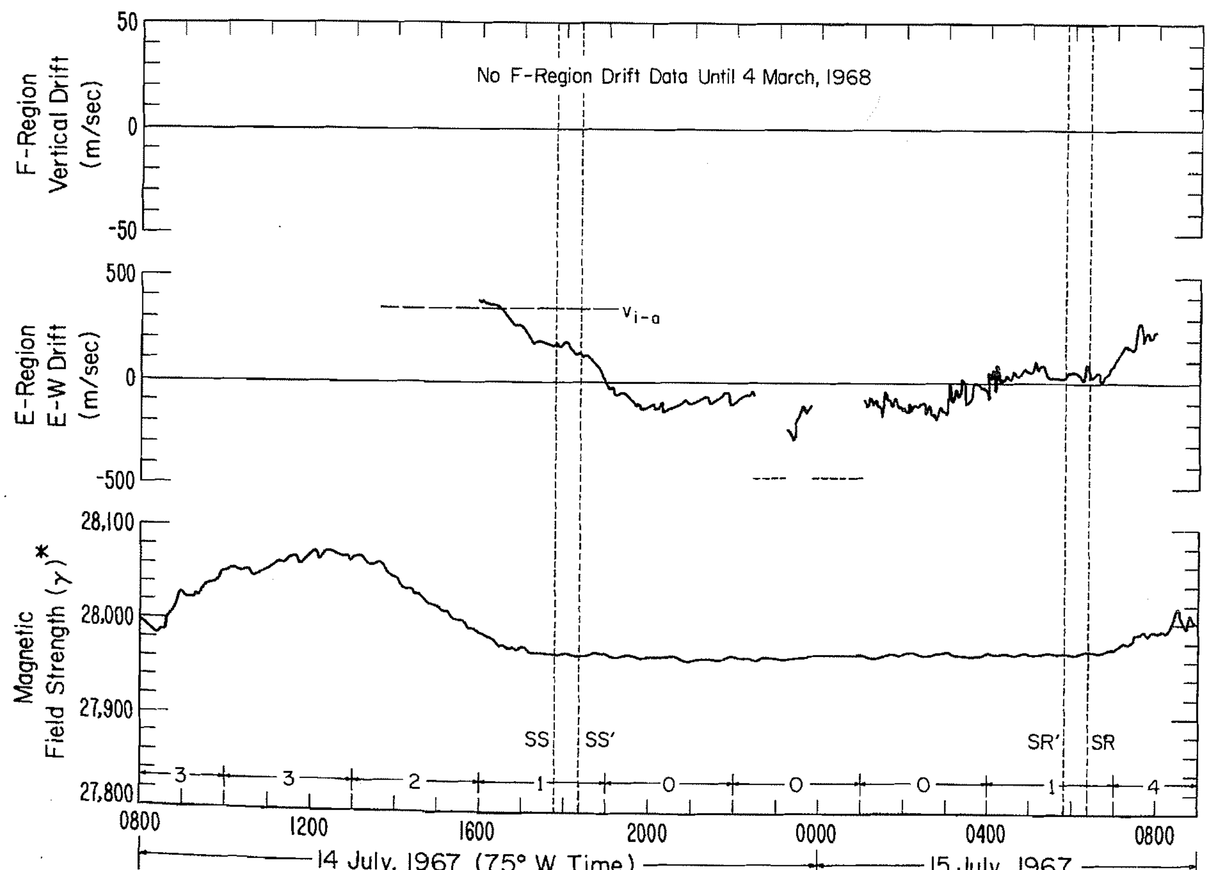
13 July, 1967 (75° W Time)
14 July, 1967



F-Region Vertical Drift (m/sec)
50
0
-50
No F-Region Drift Data Until 4 March, 1968
E-Region E-W Drift (m/sec)
500
0
-500
v_{i-a}
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
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SS′
SR′
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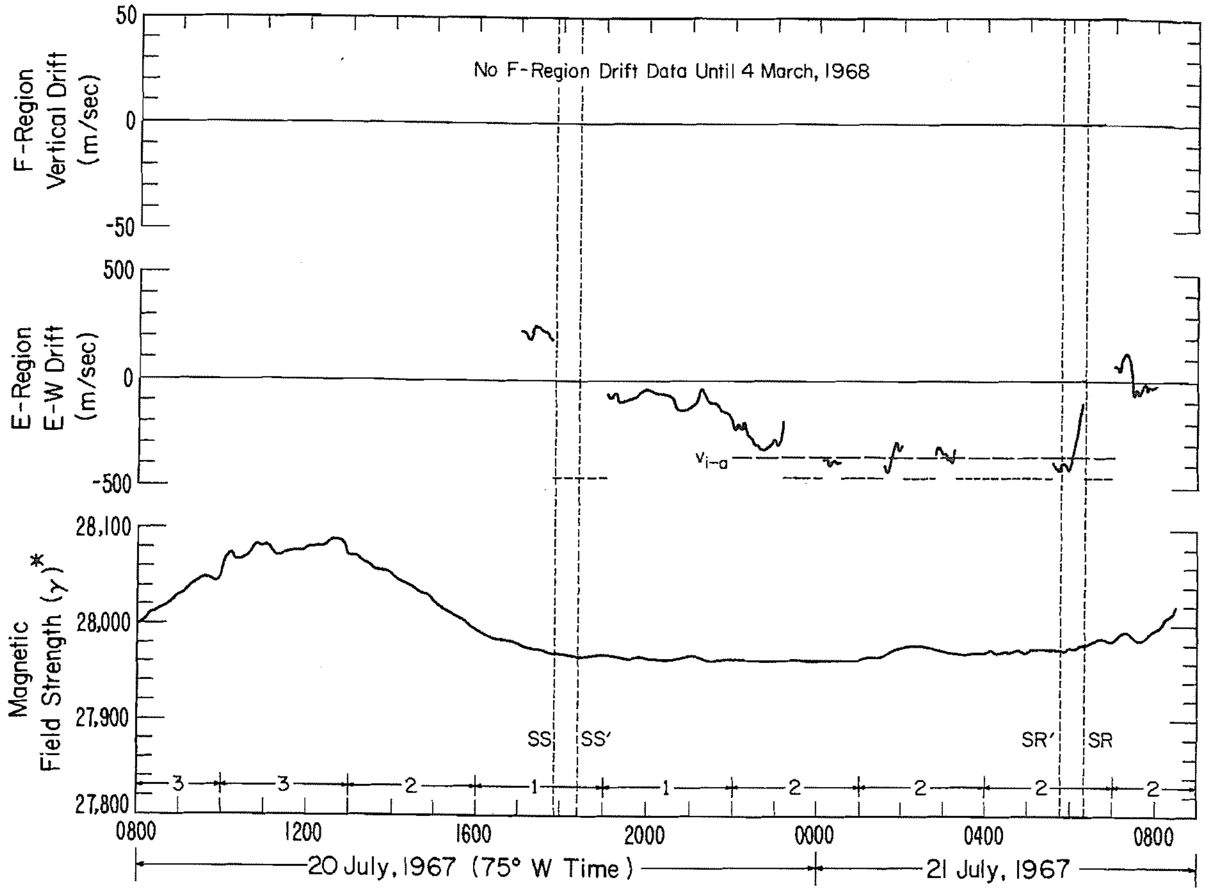
14 July, 1967 (75° W Time)
15 July, 1967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E-Region E-W Drift (m/sec)
Magnetic Field Strength (γ)*
No F-Region Drift Data Until 4 March, 1968
v_{i-a}
SS
SS′
SR′
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-500
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28,000
27,900
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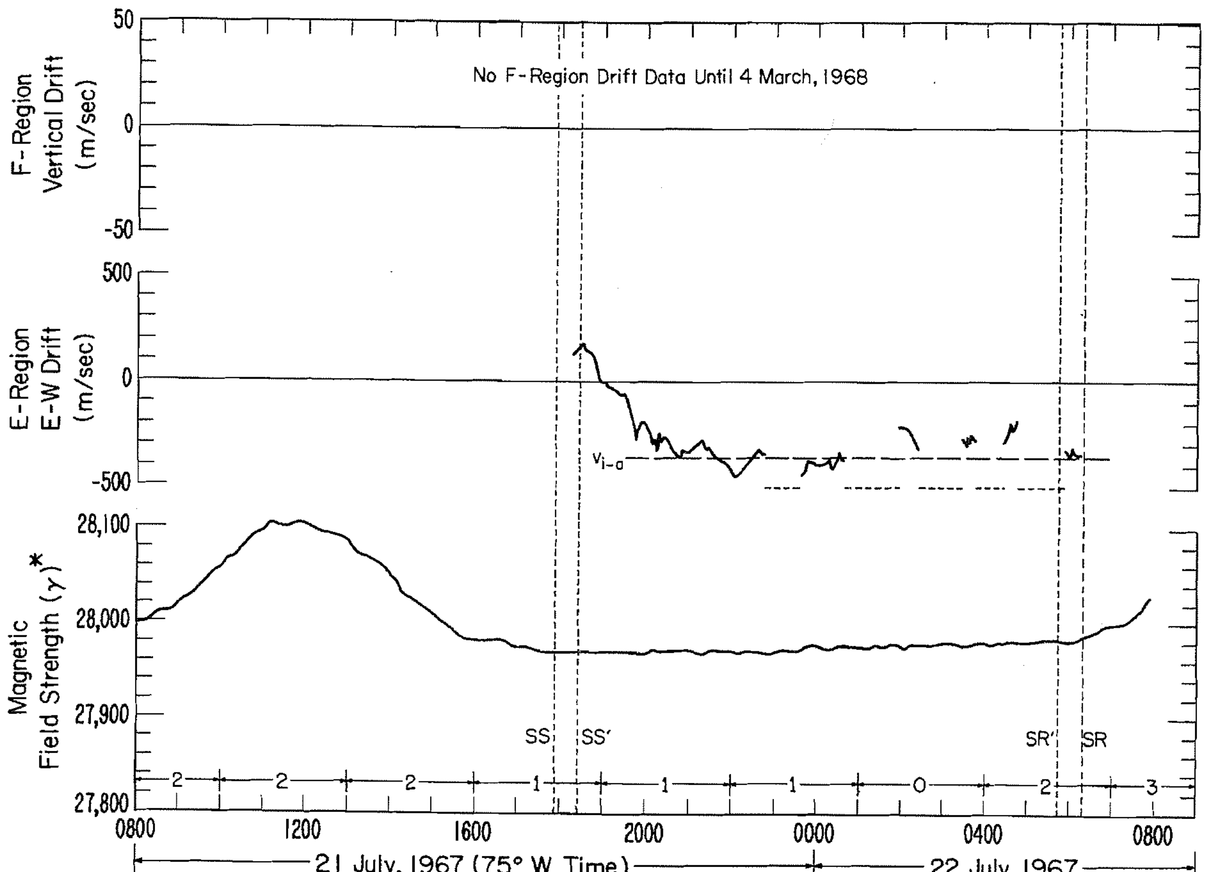
20 July, 1967 (75° W Time)
21 July, 1967


F-Region Vertical Drift (m/sec)
E-Region E-W Drift (m/sec)
Magnetic Field Strength (γ)*
No F-Region Drift Data Until 4 March, 1968
v_{i-a}
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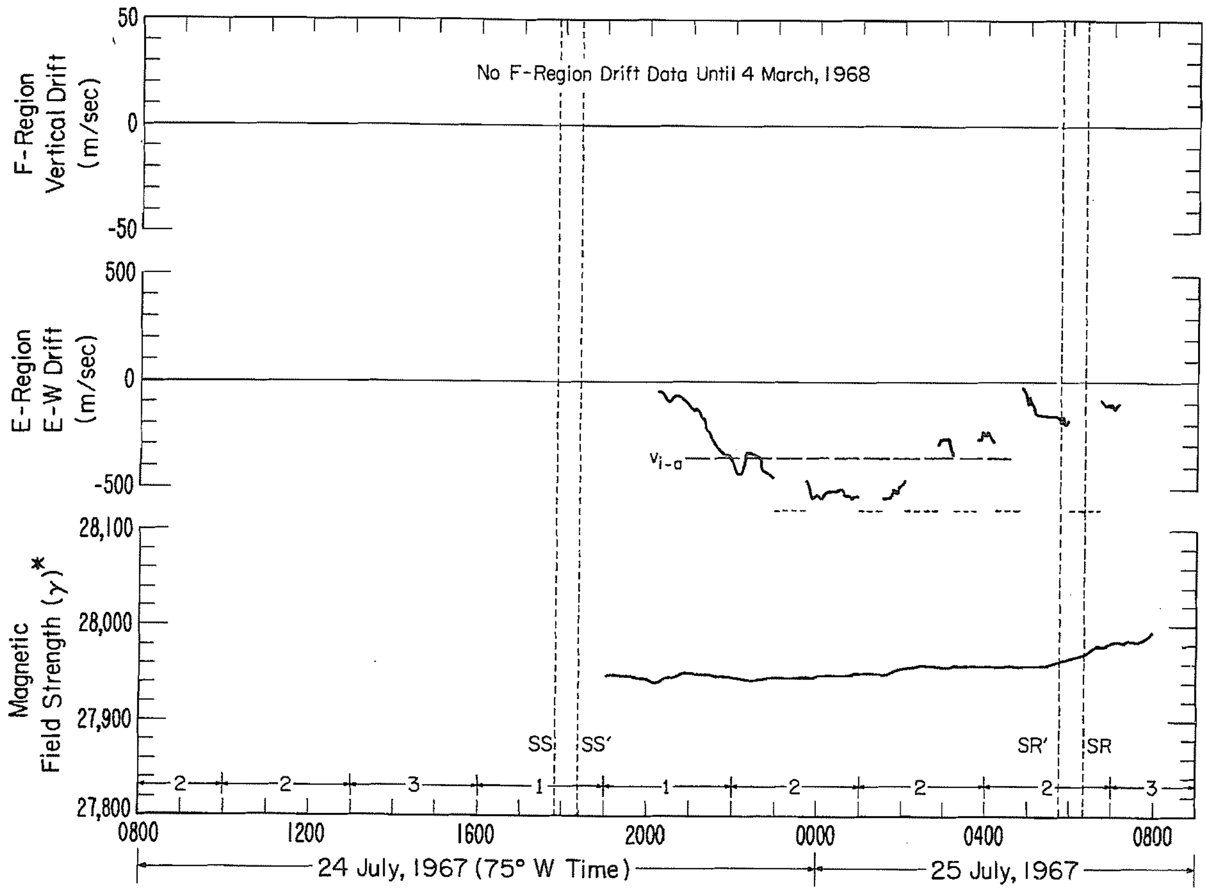
21 July, 1967 (75° W Time)
22 July, 1967



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No F-Region Drift Data Until 4 March, 1968
E-Region E-W Drift (m/sec)
v_{i-a}
Magnetic Field Strength (γ)*
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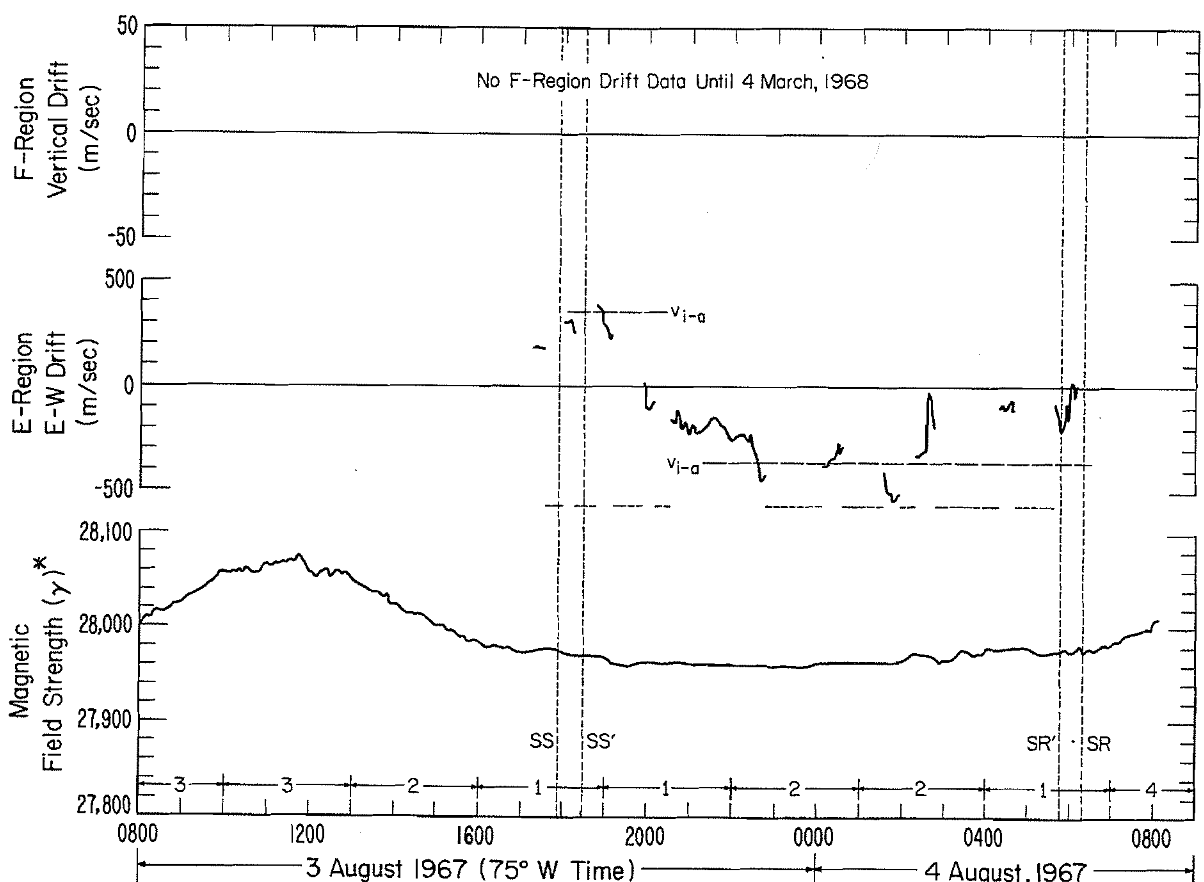
24 July, 1967 (75° W Time)
25 July, 1967



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No F-Region Drift Data Until 4 March, 1968
E-Region E-W Drift (m/sec)
v_{i-a}
Magnetic Field Strength (γ)*
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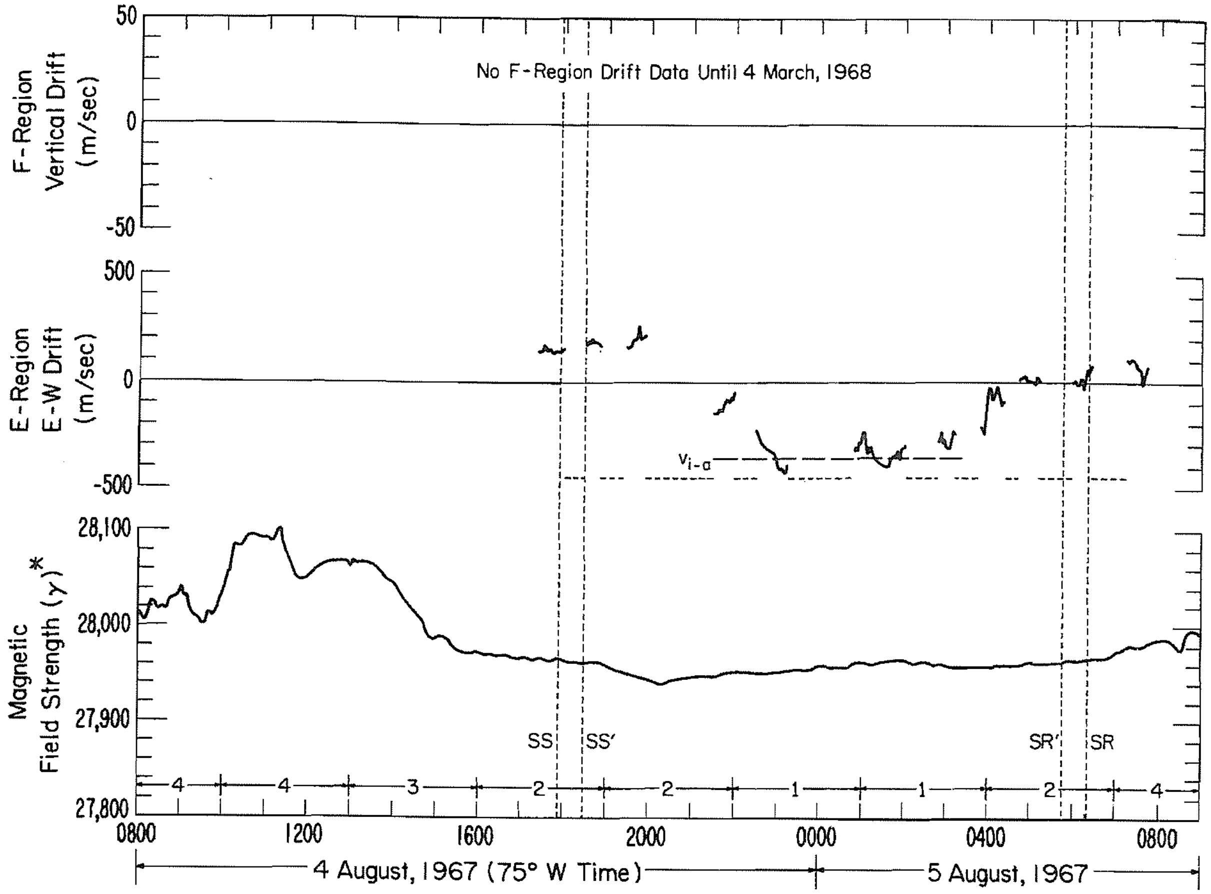
3 August 1967 (75° W Time)
4 August, 1967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50
0
-50
No F-Region Drift Data Until 4 March, 1968
E-Region E-W Drift (m/sec)
500
0
-500
v_{i-a}
Magnetic Field Strength (γ)*
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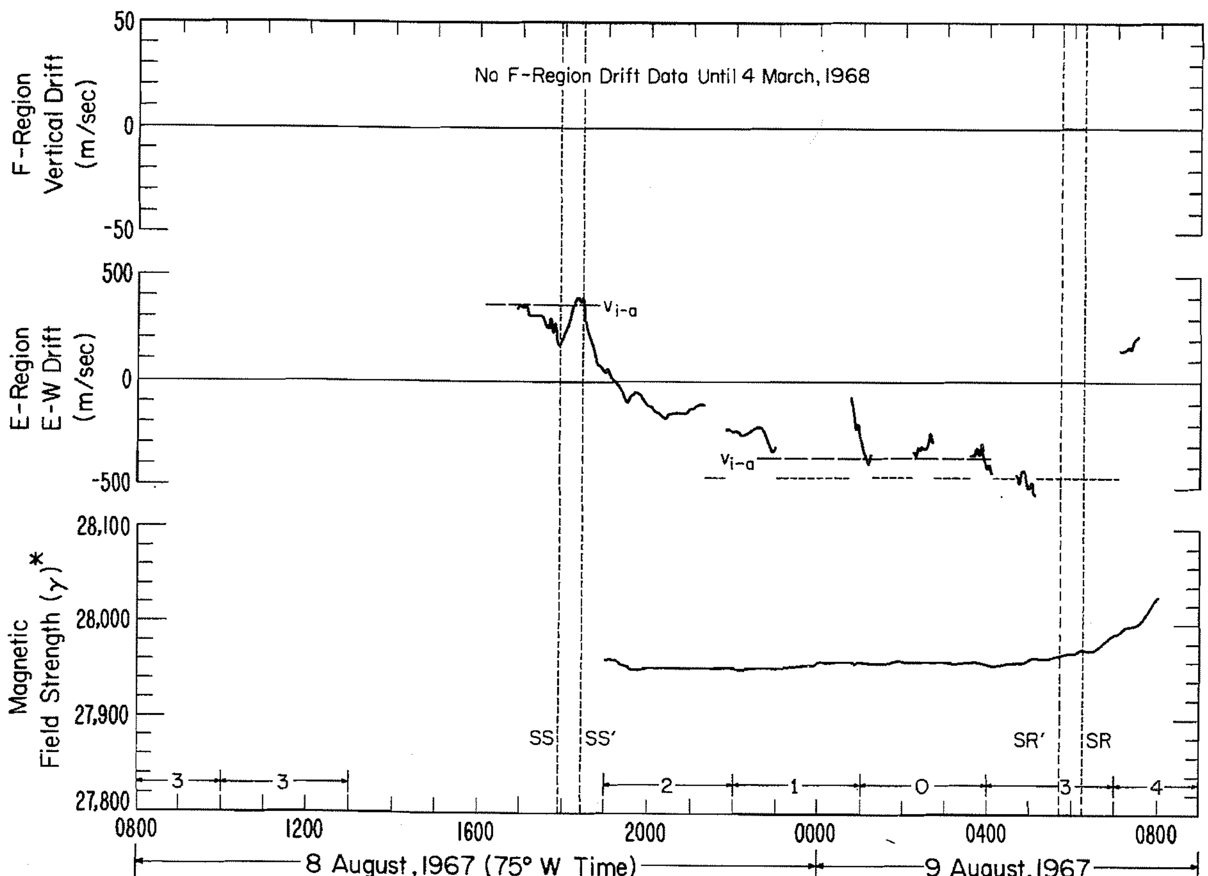
4 August, 1967 (75° W Time)
5 August, 1967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0
-50
No F-Region Drift Data Until 4 March, 1968
E-Region E-W Drift (m/sec)
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-500
v_{i-a}
v_{i-a}
Magnetic Field Strength (γ)*
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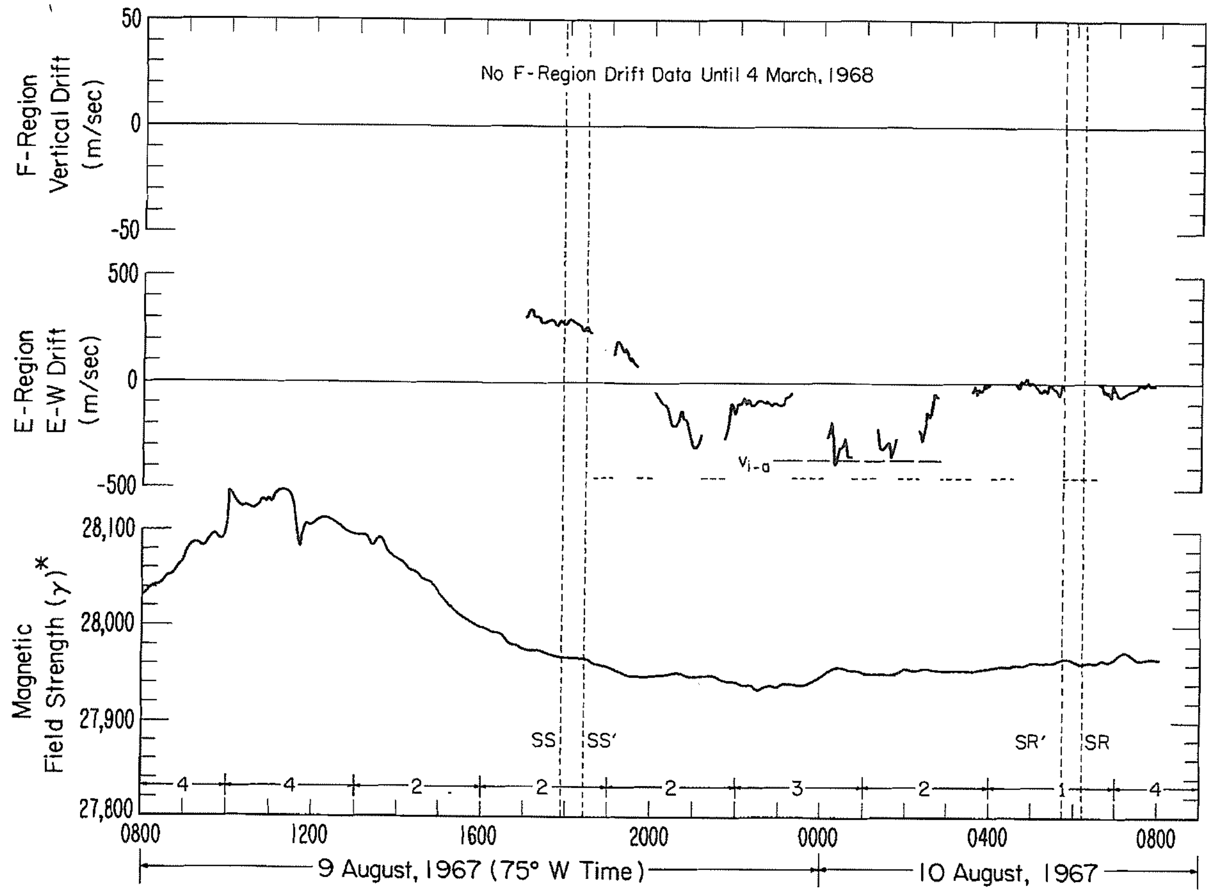
8 August, 1967 (75° W Time)
9 August, 1967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E-Region E-W Drift (m/sec)
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-500
v_{i-a}
Magnetic Field Strength (γ)*
28,100
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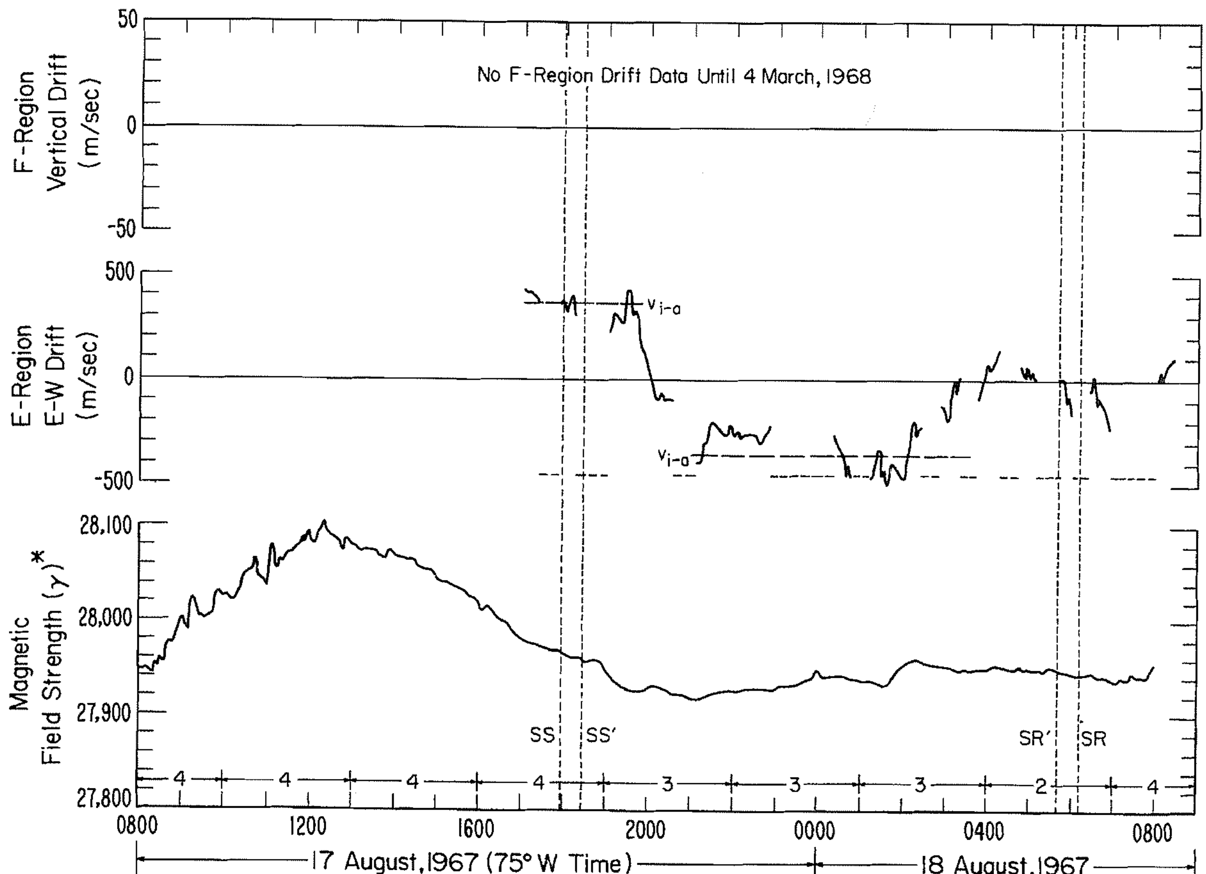
9 August, 1967 (75° W Time)
10 August, 1967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E-Region E-W Drift (m/sec)
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Magnetic Field Strength (γ)*
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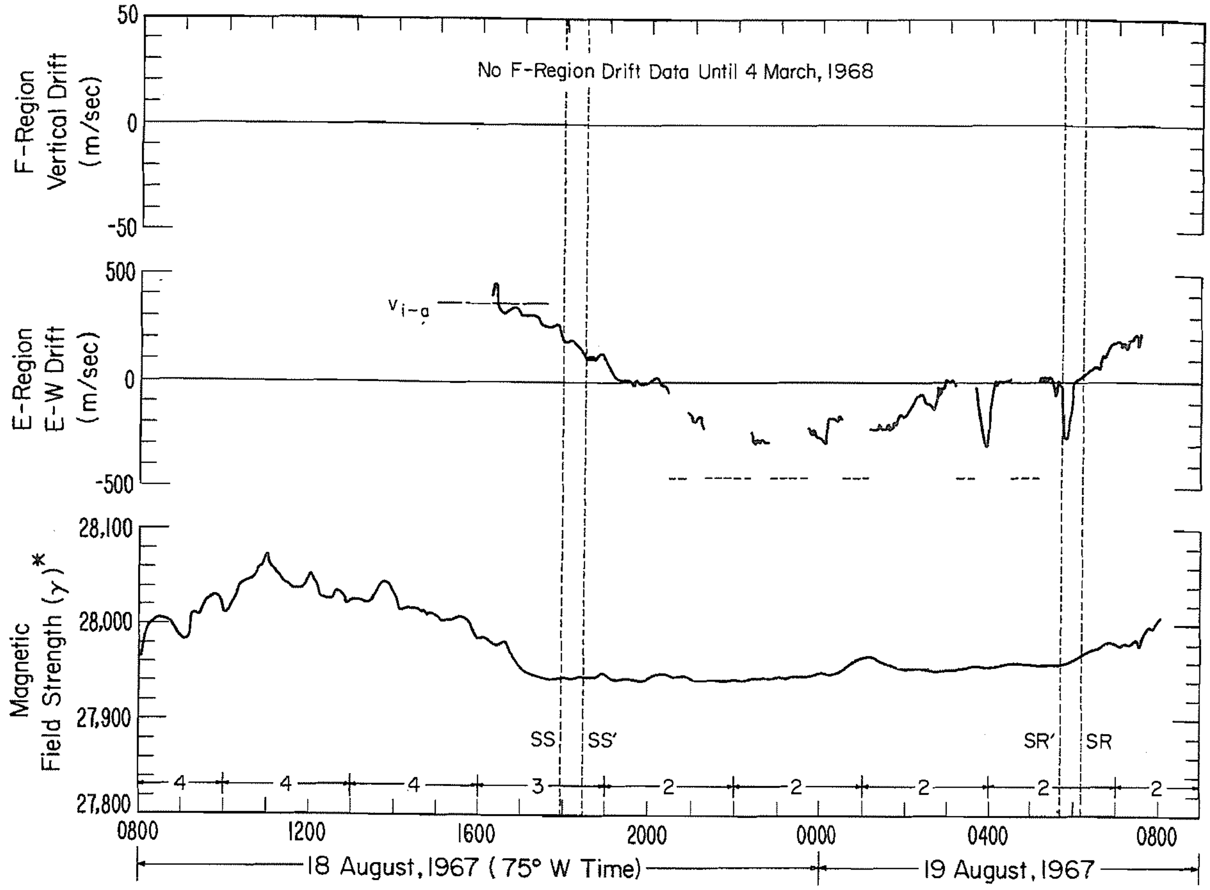
17 August, 1967 (75° W Time)
18 August, 1967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50
0
-50
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E-Region
E-W Drift
(m/sec)
500
0
-500
v_{i-a}
Magnetic
Field Strength (γ)*
28,100
28,000
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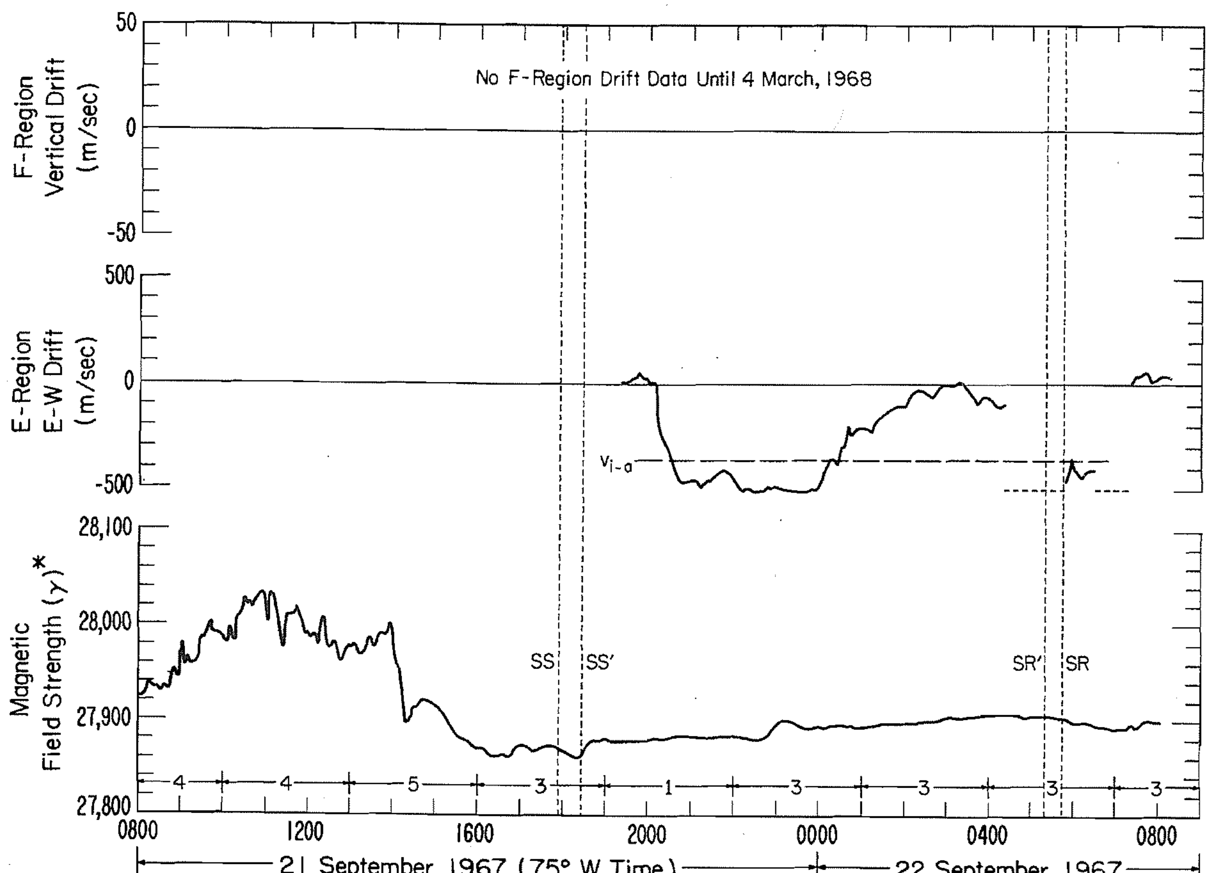
19 August, 1967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Vertical Drift
(m/sec)
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0
-50
No F-Region Drift Data Until 4 March, 1968
E-Region
E-W Drift
(m/sec)
500
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v_{i-a}
Magnetic
Field Strength (γ)*
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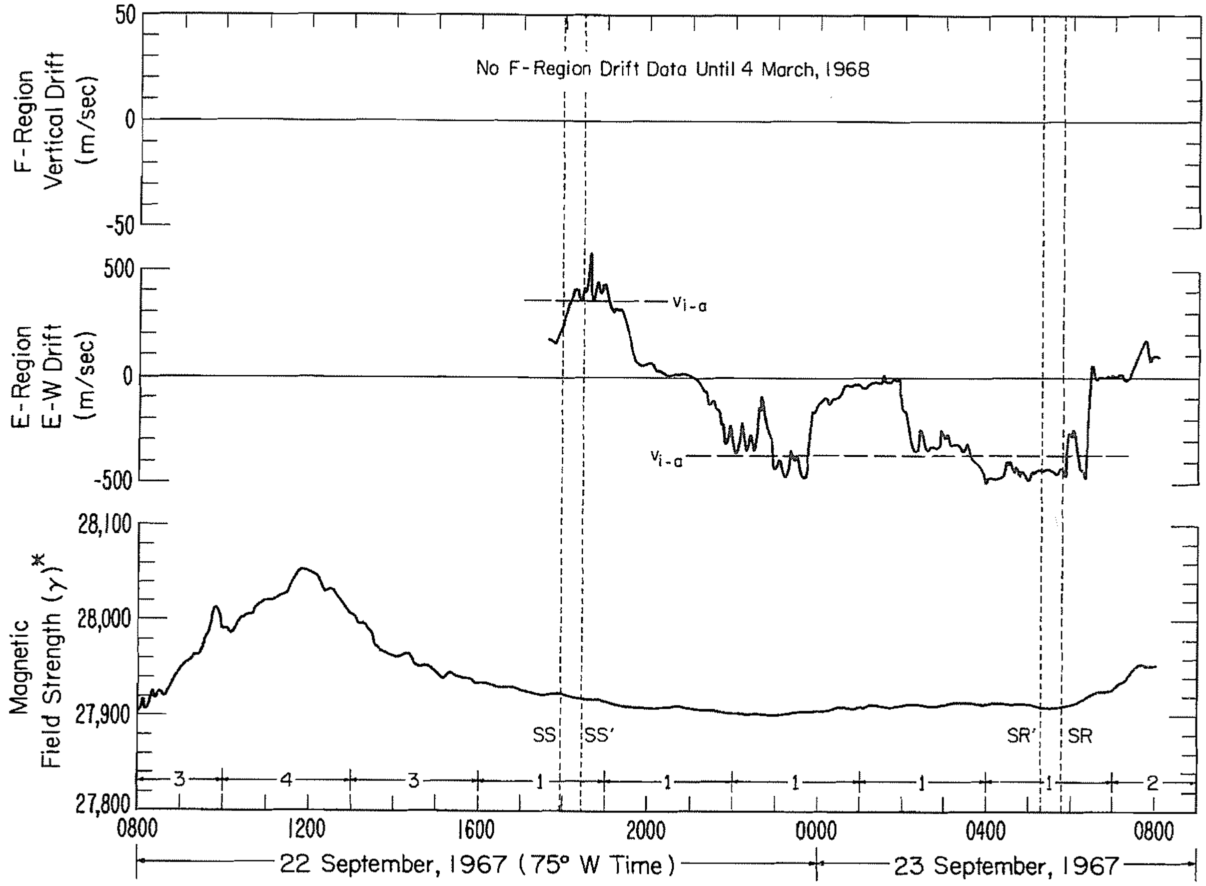
21 September, 1967 (75° W Time)
22 September, 1967



No F-Region Drift Data Until 4 March, 1968
F-Region Vertical Drift (m/sec)
E-Region E-W Drift (m/sec)
Magnetic Field Strength (γ)*
v_{i-a}
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SR'
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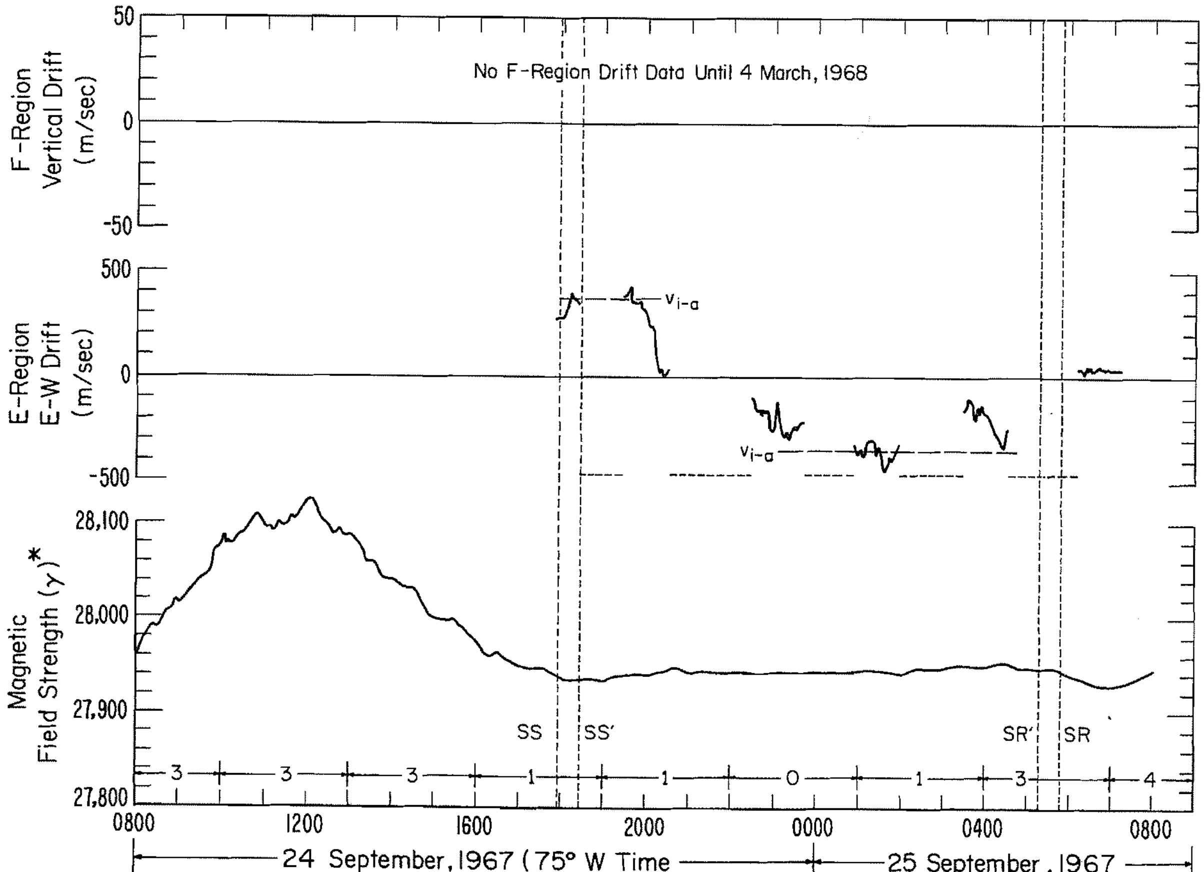
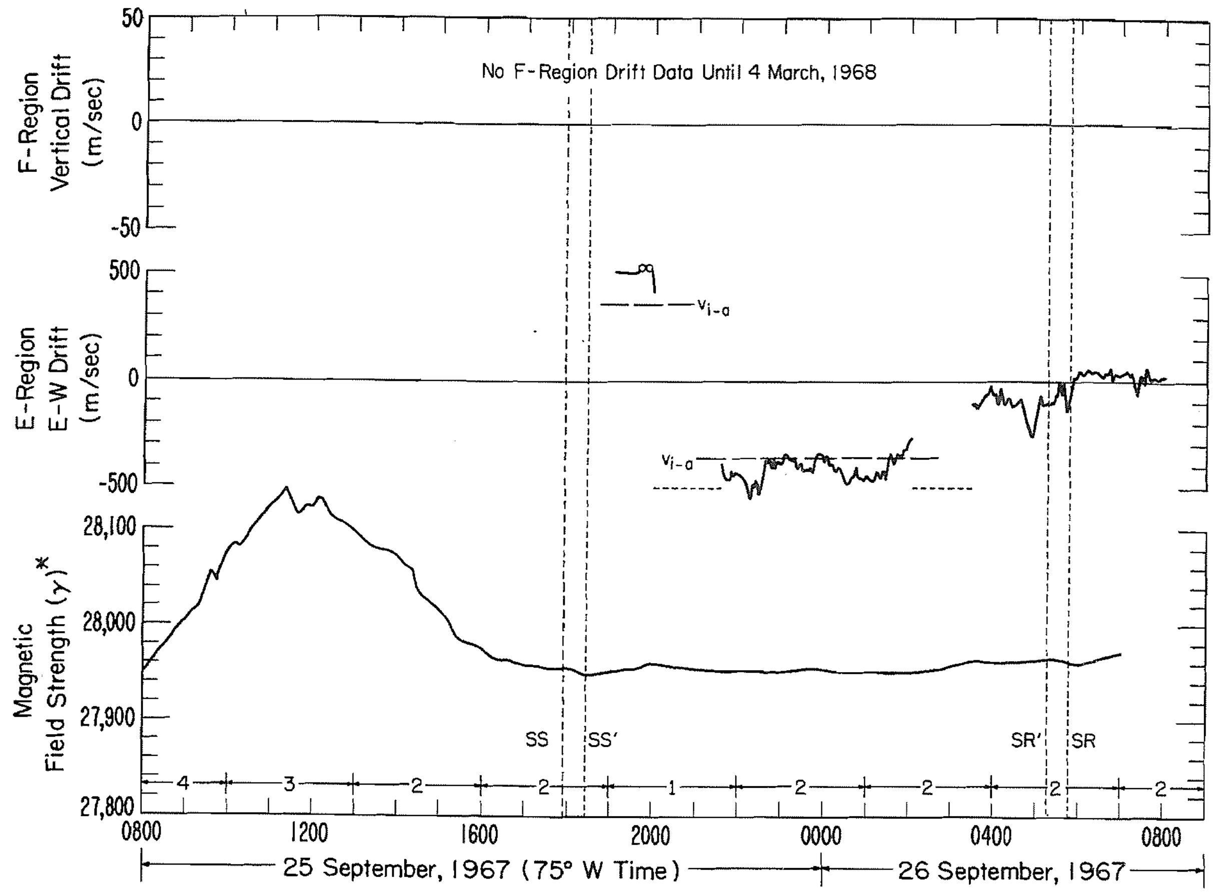
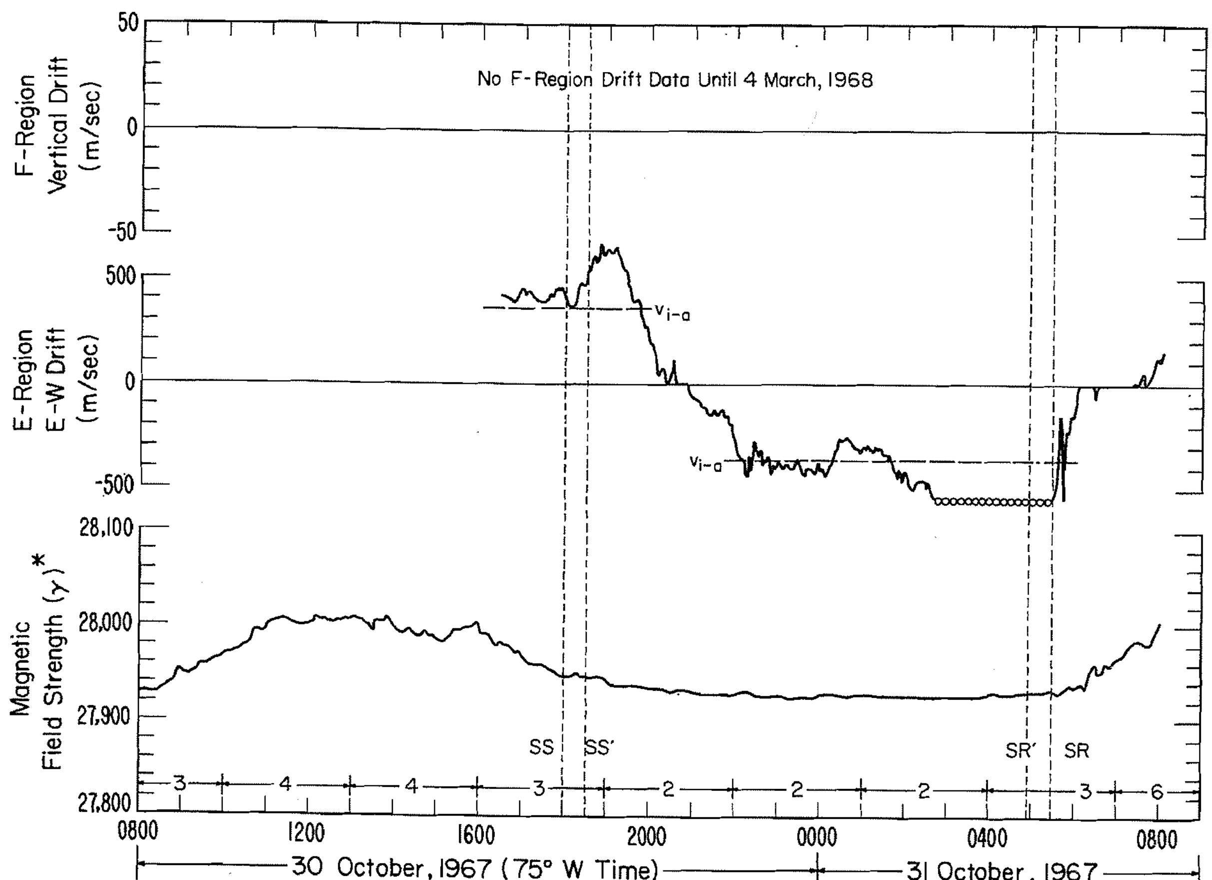
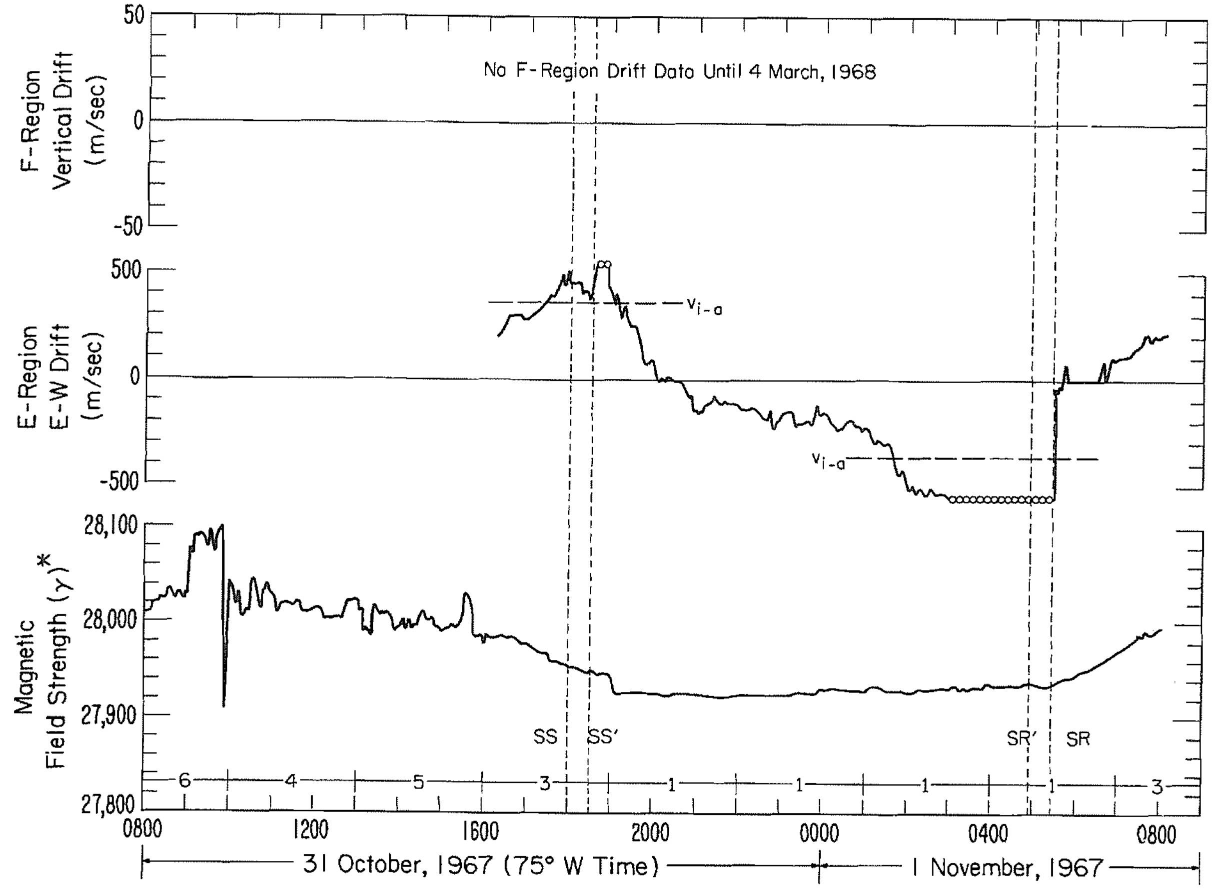
22 September, 1967 (75° W Time)
23 September, 1967

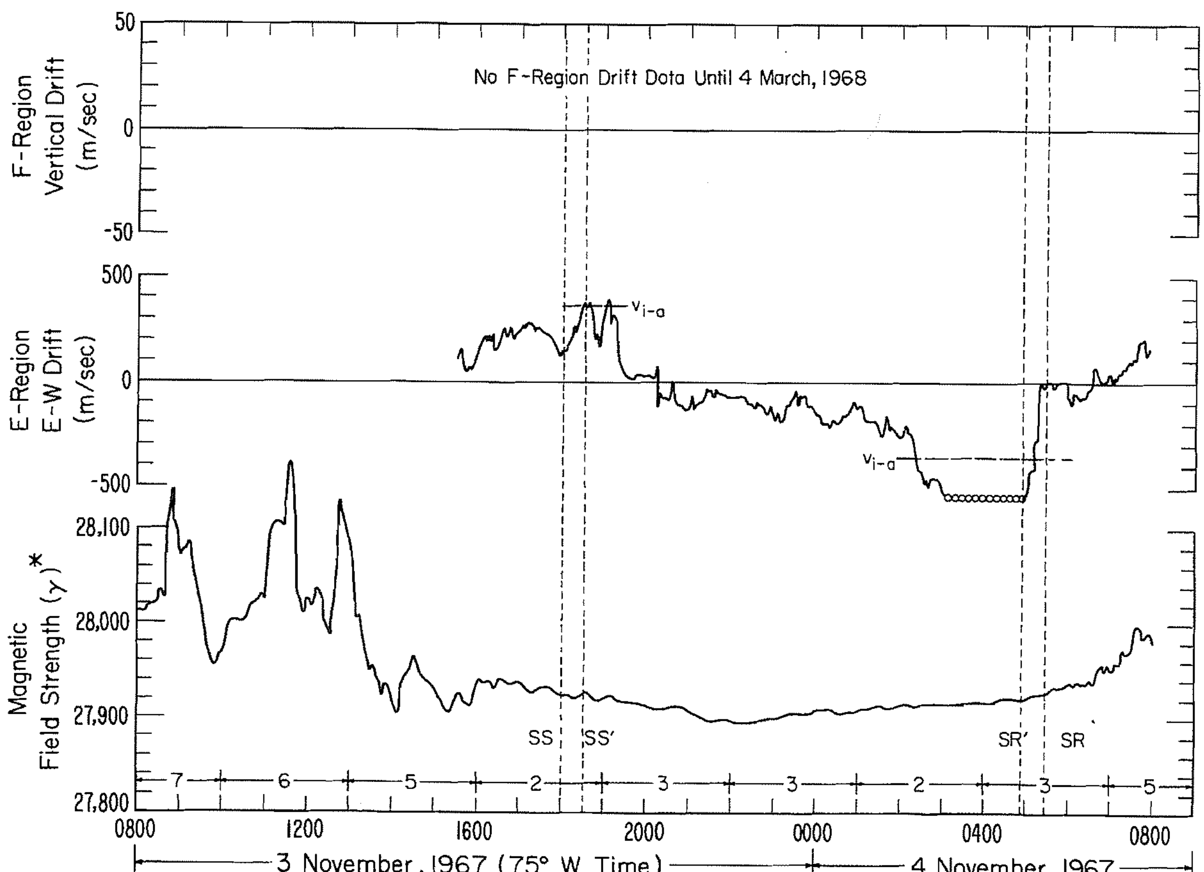


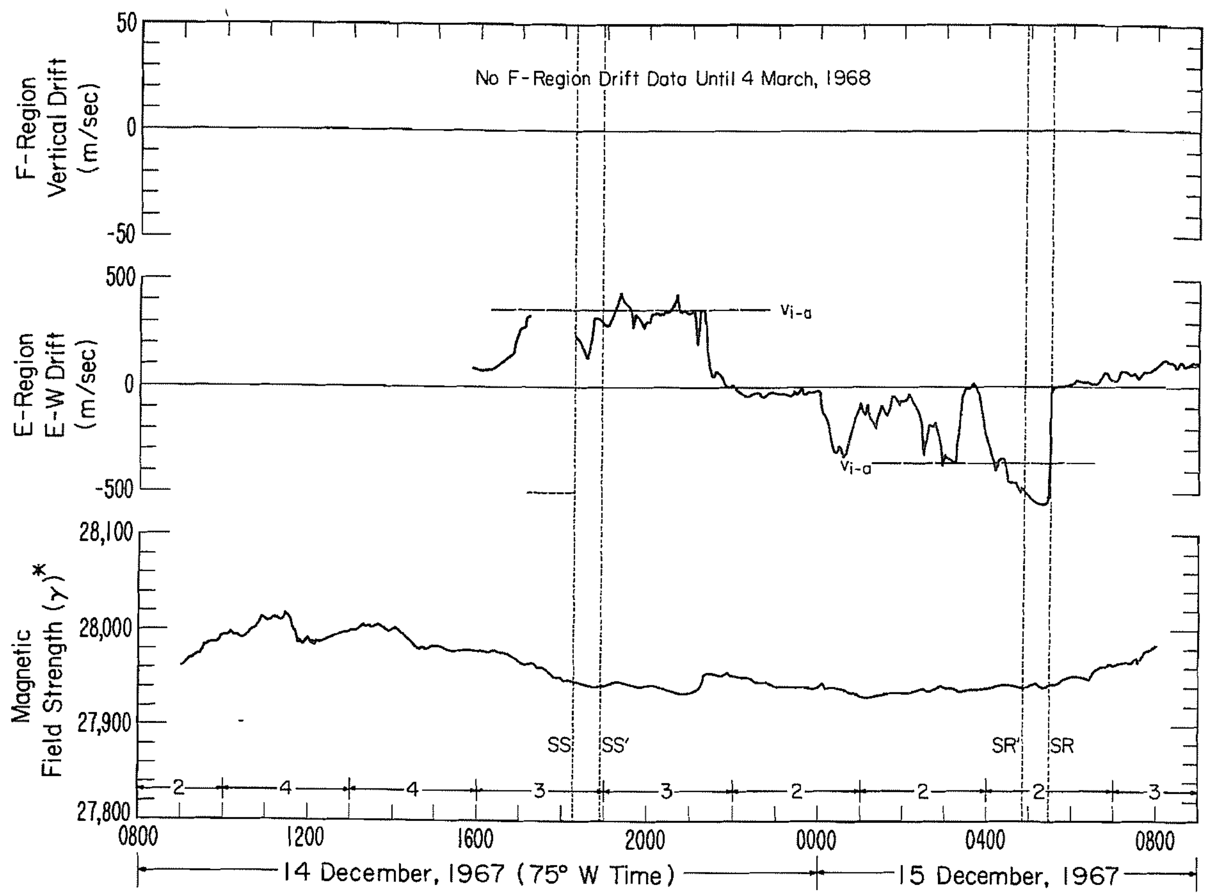
No F-Region Drift Data Until 4 March, 1968
F-Region Vertical Drift (m/sec)
E-Region E-W Drift (m/sec)
Magnetic Field Strength (γ)*
v_{i-a}
SS
SS'
SR'
SR
0800
1200
1600
2000
0000
0400
0800
24 September, 1967 (75° W Time
25 September, 1967

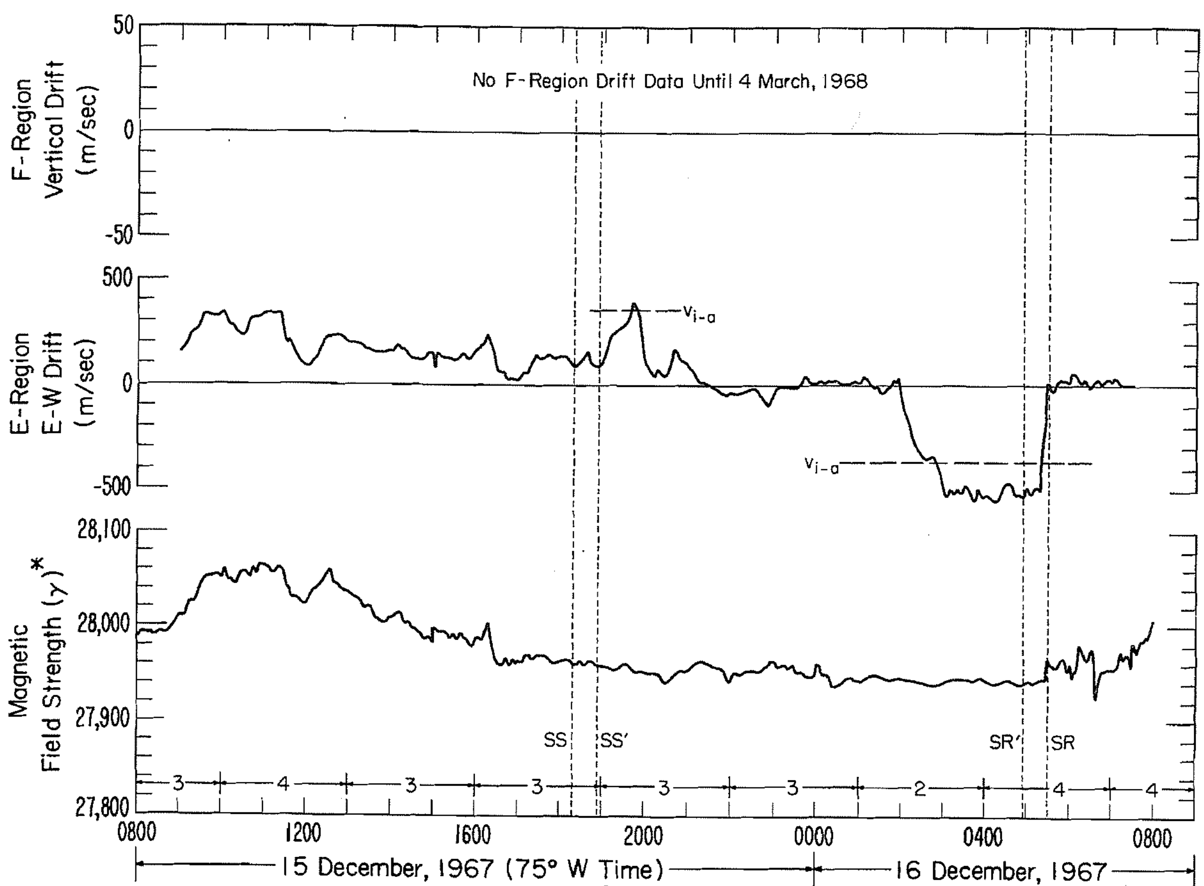

No F-Region Drift Data Until 4 March, 1968
F-Region Vertical Drift (m/sec)
E-Region E-W Drift (m/sec)
Magnetic Field Strength (γ)*
v_{i-a}
SS
SS'
SR'
SR
0800
1200
1600
2000
0000
0400
0800
25 September, 1967 (75° W Time)
26 September, 1967

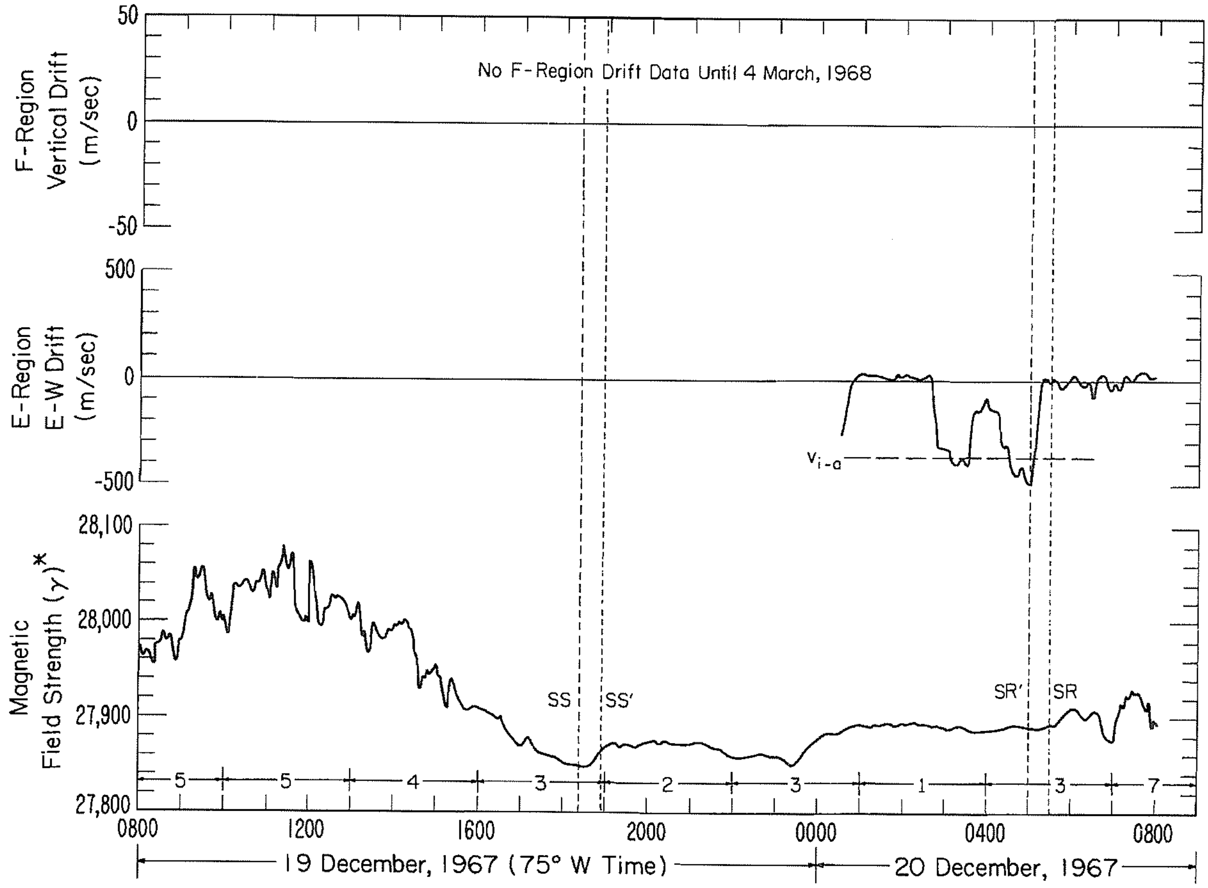

No F-Region Drift Data Until 4 March, 1968
F-Region Vertical Drift (m/sec)
E-Region E-W Drift (m/sec)
Magnetic Field Strength (γ)*
v_{i-a}
SS
SS'
SR'
SR
0800
1200
1600
2000
0000
0400
0800
30 October, 1967 (75° W Time)
31 October, 1967

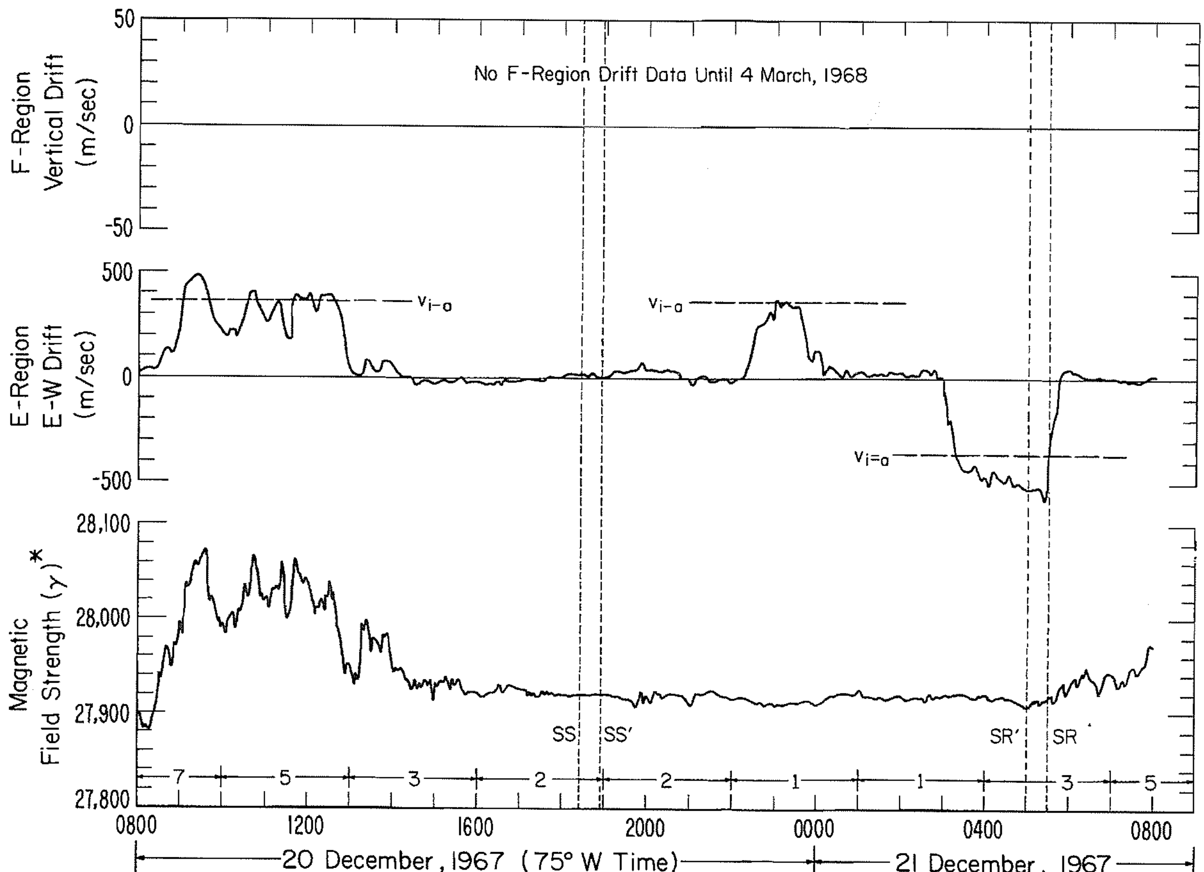

F-Region Vertical Drift (m/sec)
No F-Region Drift Data Until 4 March, 1968
E-Region E-W Drift (m/sec)
v_{i-a}
Magnetic Field Strength (γ)*
SS
SS′
SR′
SR
31 October, 1967 (75° W Time)
1 November, 1967

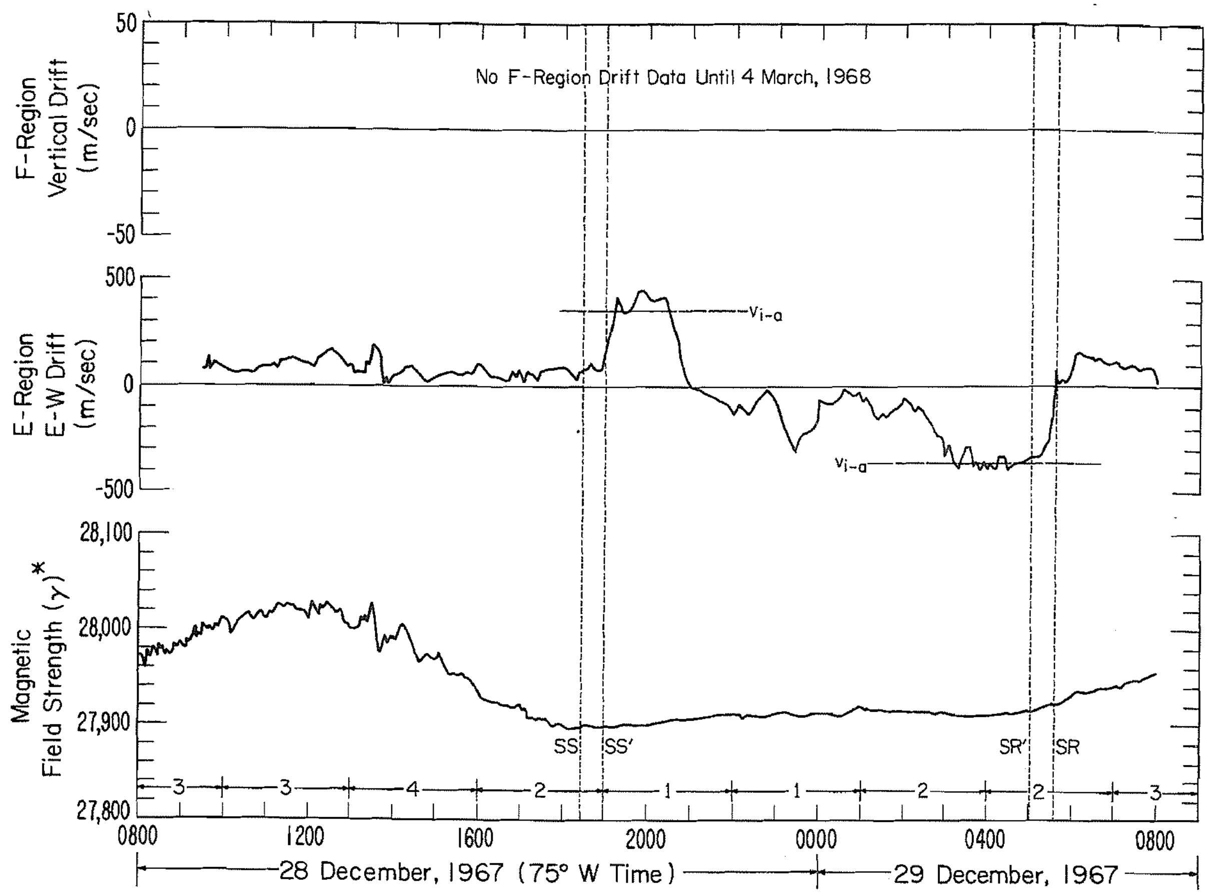

F-Region Vertical Drift (m/sec)
No F-Region Drift Data Until 4 March, 1968
E-Region E-W Drift (m/sec)
v_{i-a}
Magnetic Field Strength (γ)*
SS
SS′
SR′
SR
3 November, 1967 (75° W Time)
4 November, 1967


No F-Region Drift Data Until 4 March, 1968
F-Region Vertical Drift (m/sec)
E-Region E-W Drift (m/sec)
Magnetic Field Strength (γ)*
SS
SS'
SR'
SR
14 December, 1967 (75° W Time)
15 December, 1967

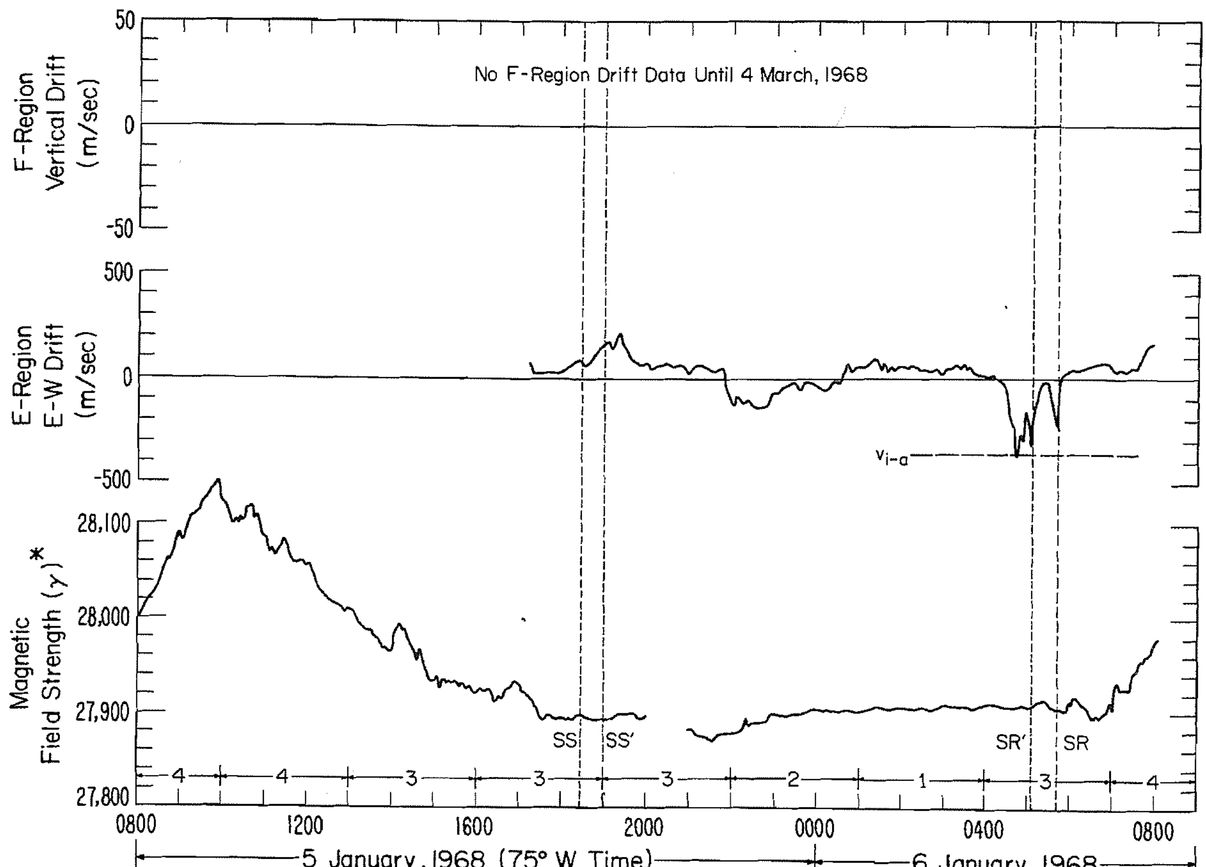

No F-Region Drift Data Until 4 March, 1968
F-Region Vertical Drift (m/sec)
E-Region E-W Drift (m/sec)
Magnetic Field Strength (γ)*
SS
SS'
SR'
SR
15 December, 1967 (75° W Time)
16 December, 1967


F-Region Vertical Drift (m/sec)
No F-Region Drift Data Until 4 March, 1968
E-Region E-W Drift (m/sec)
Magnetic Field Strength (γ)*
SS
SS'
SR'
SR
19 December, 1967 (75° W Time)
20 December, 1967

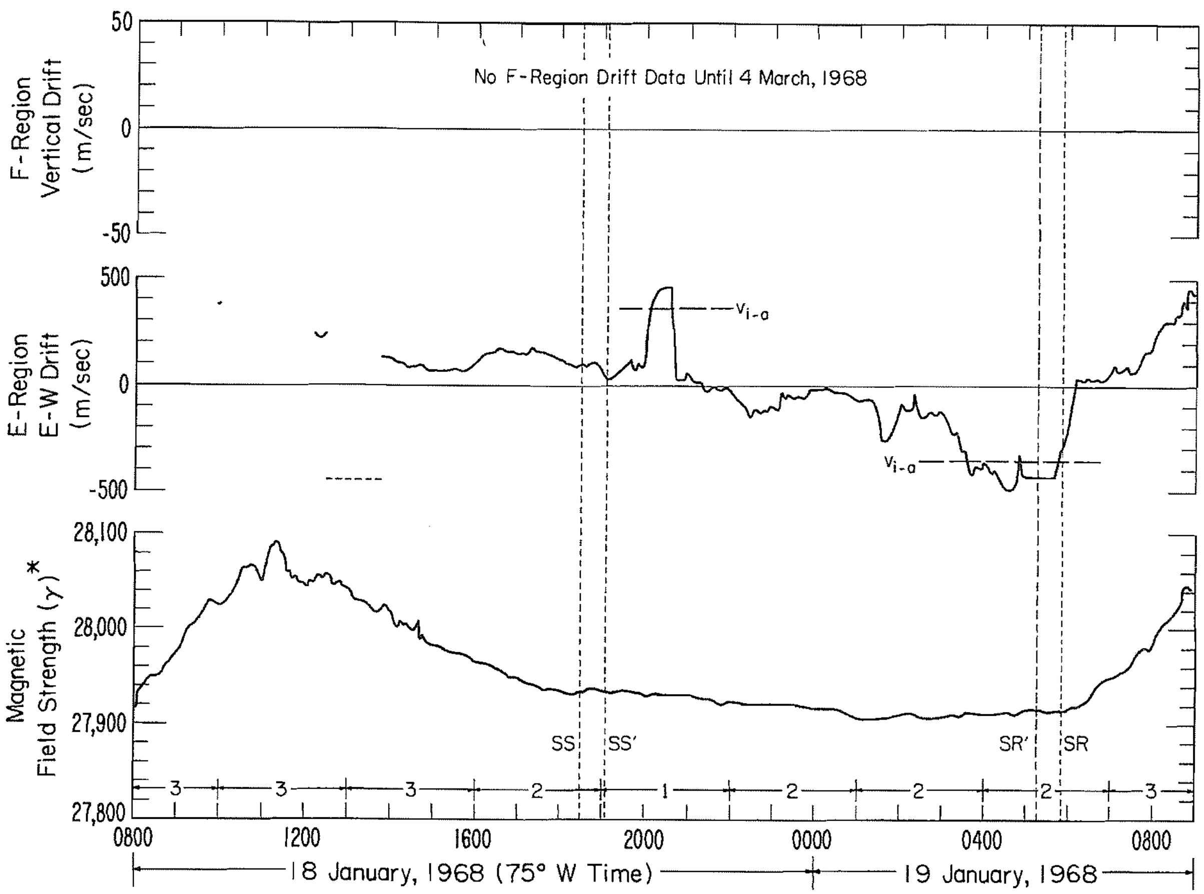

F-Region Vertical Drift (m/sec)
No F-Region Drift Data Until 4 March, 1968
E-Region E-W Drift (m/sec)
Magnetic Field Strength (γ)*
SS
SS'
SR'
SR
20 December, 1967 (75° W Time)
21 December, 1967

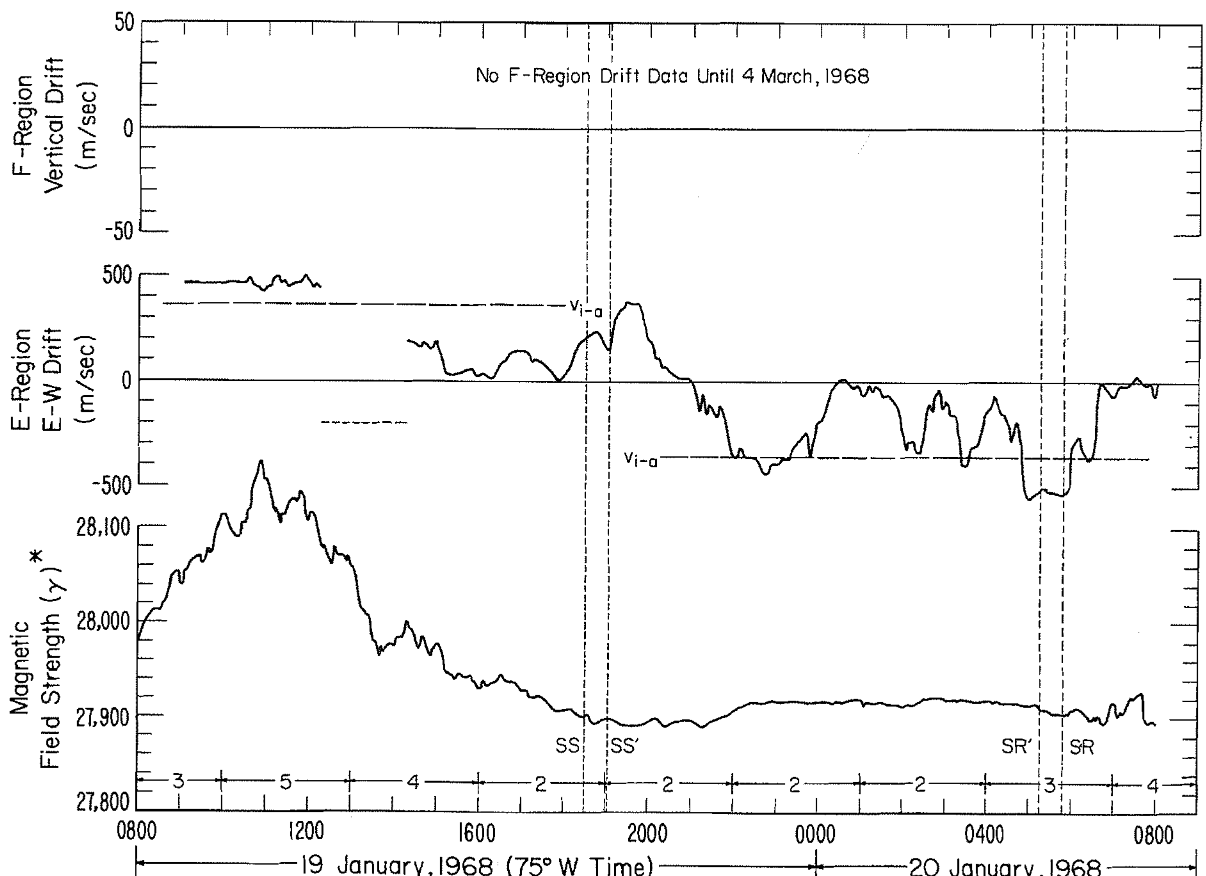


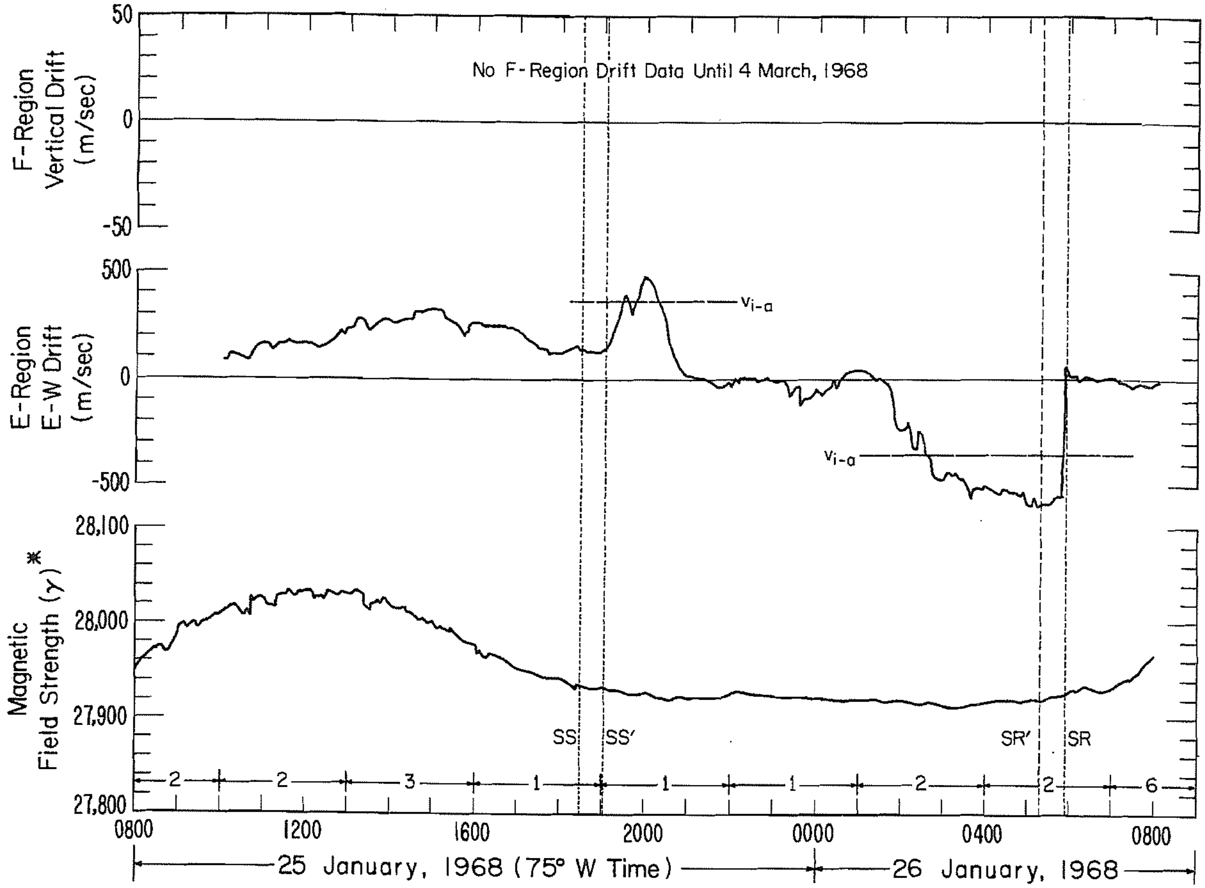
F-Region Vertical Drift (m/sec)
No F-Region Drift Data Until 4 March, 1968
E-Region E-W Drift (m/sec)
vi-a
Magnetic Field Strength (γ)*
SS
SS'
SR'
SR
28 December, 1967 (75° W Time)
29 December, 1967

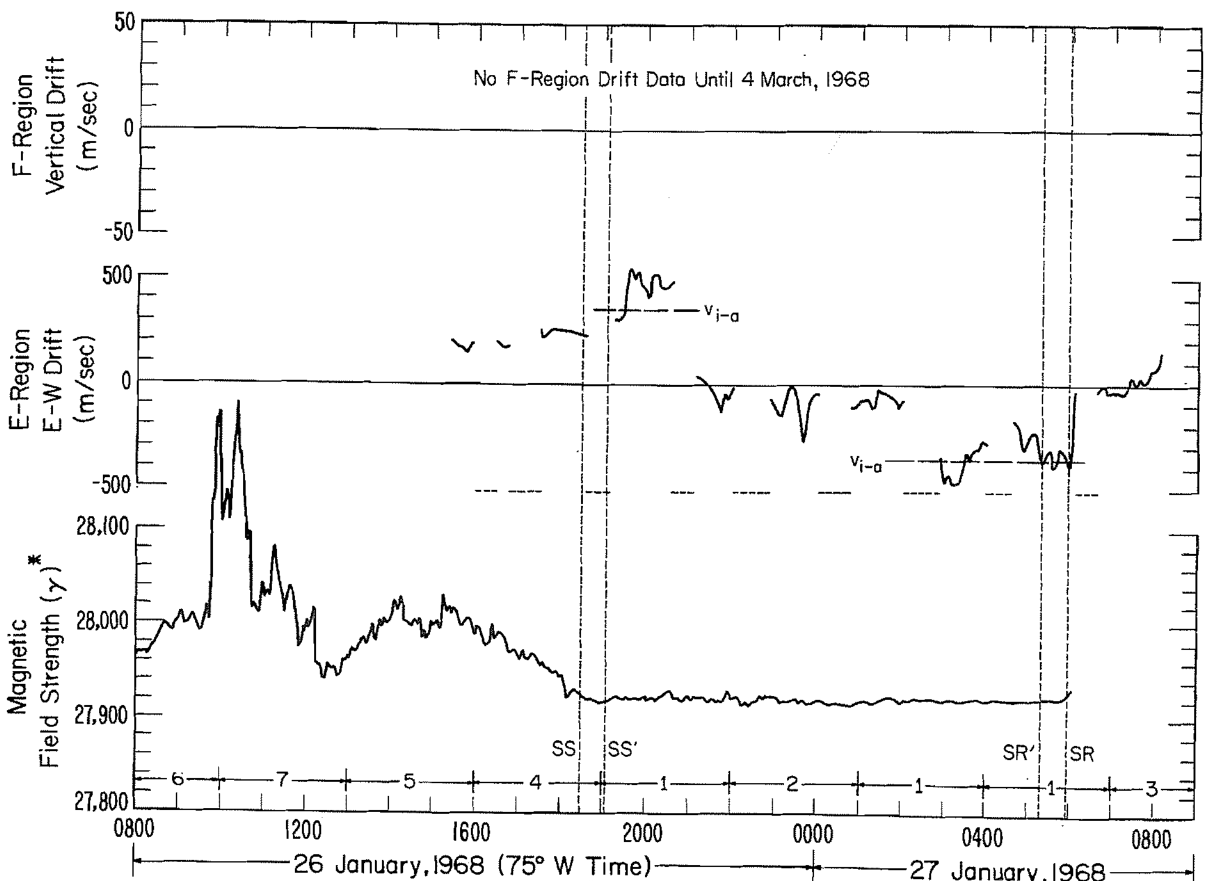


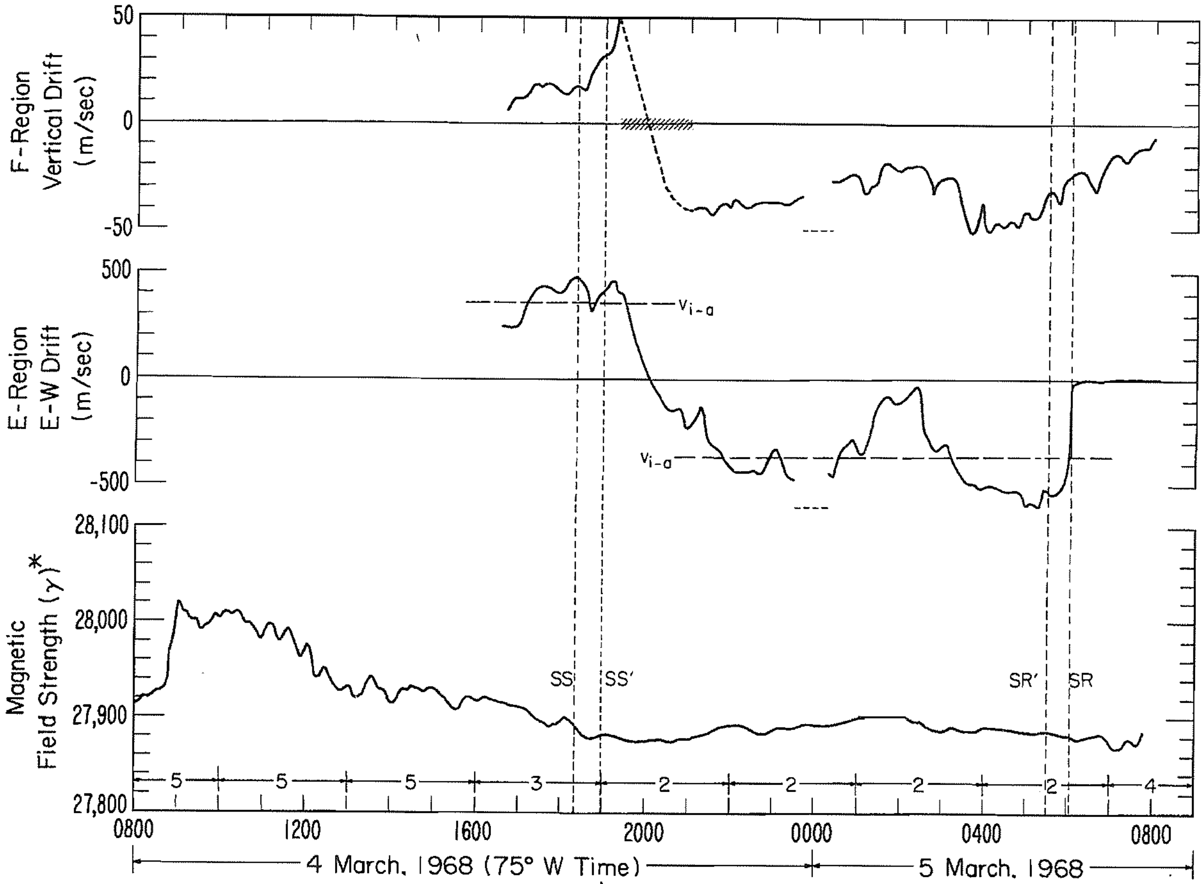
F-Region Vertical Drift (m/sec)
No F-Region Drift Data Until 4 March, 1968
E-Region E-W Drift (m/sec)
vi-a
Magnetic Field Strength (γ)*
SS
SS'
SR'
SR
5 January, 1968 (75° W Time)
6 January, 1968

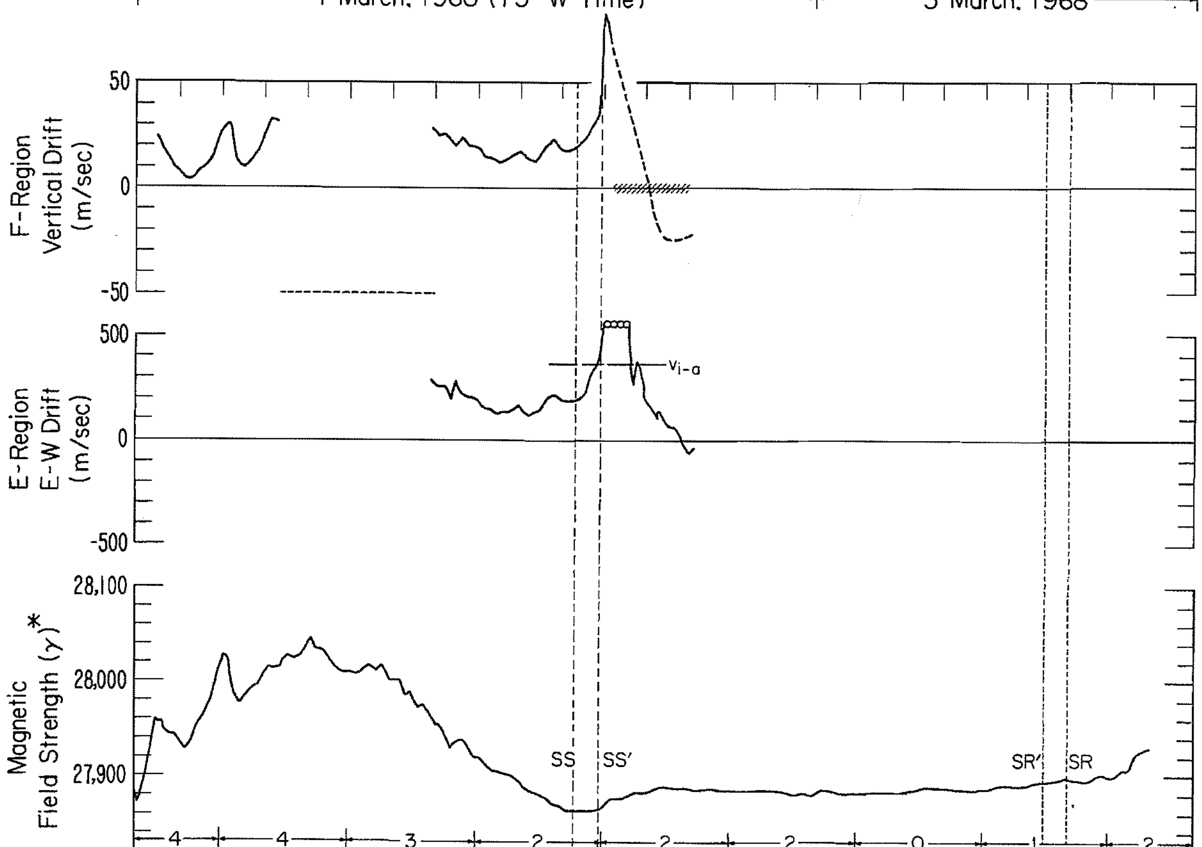

F-Region Vertical Drift (m/sec)
No F-Region Drift Data Until 4 March, 1968
E-Region E-W Drift (m/sec)
v_{i-a}
Magnetic Field Strength (γ)*
SS SS' SR' SR
3 3 3 2 1 2 2 2 3
0800 1200 1600 2000 0000 0400 0800
18 January, 1968 (75° W Time)
19 January, 1968

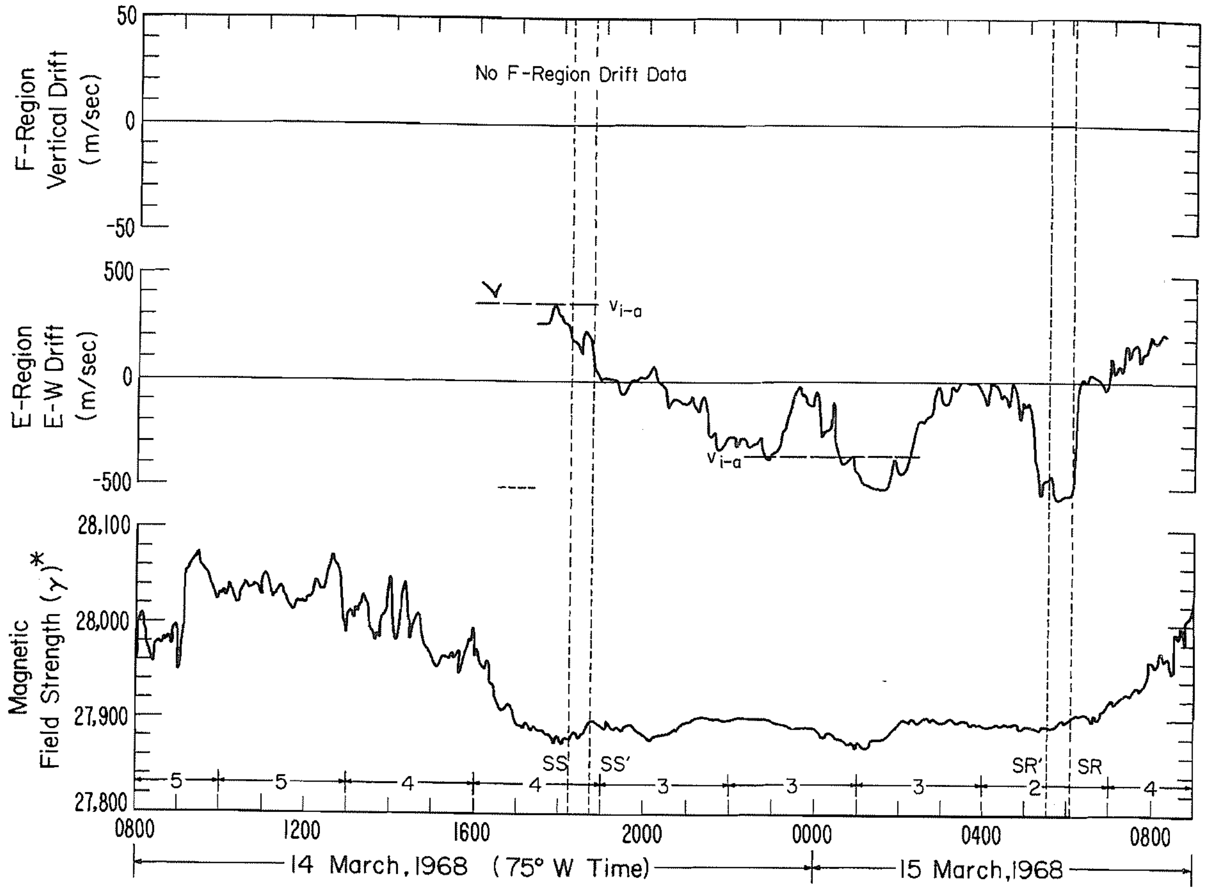

F-Region Vertical Drift (m/sec)
No F-Region Drift Data Until 4 March, 1968
E-Region E-W Drift (m/sec)
v_{i-a}
Magnetic Field Strength (γ)*
SS SS' SR' SR
3 5 4 2 2 2 2 3 4
0800 1200 1600 2000 0000 0400 0800
19 January, 1968 (75° W Time)
20 January, 1968

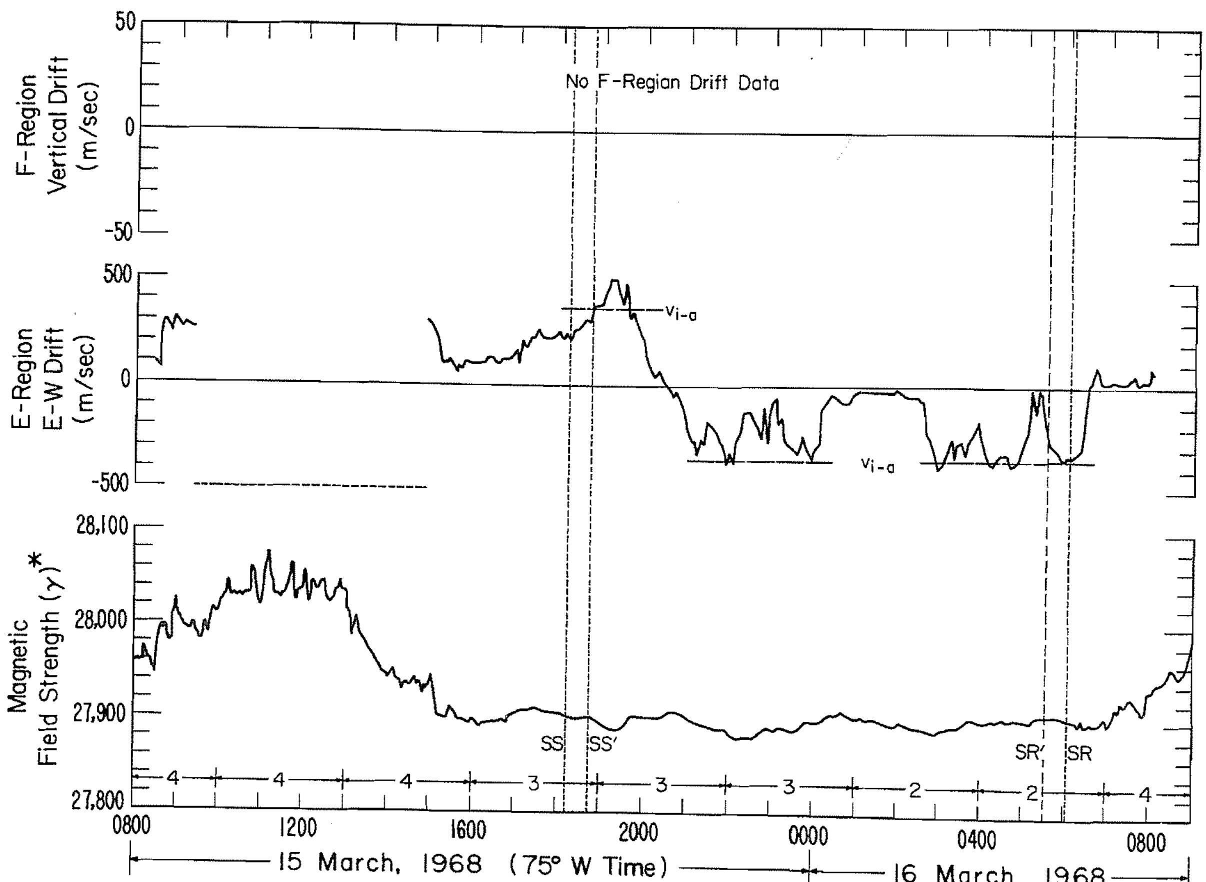

50
0
-50
F-Region
Vertical Drift
(m/sec)
No F-Region Drift Data Until 4 March, 1968
500
-500
E-Region
E-W Drift
(m/sec)
v_{i-a}
28,100
28,000
27,900
27,800
Magnetic
Field Strength (γ)*
SS
SS'
SR'
SR
0800
1200
1600
2000
0000
0400
25 January, 1968 (75° W Time)
26 January, 1968

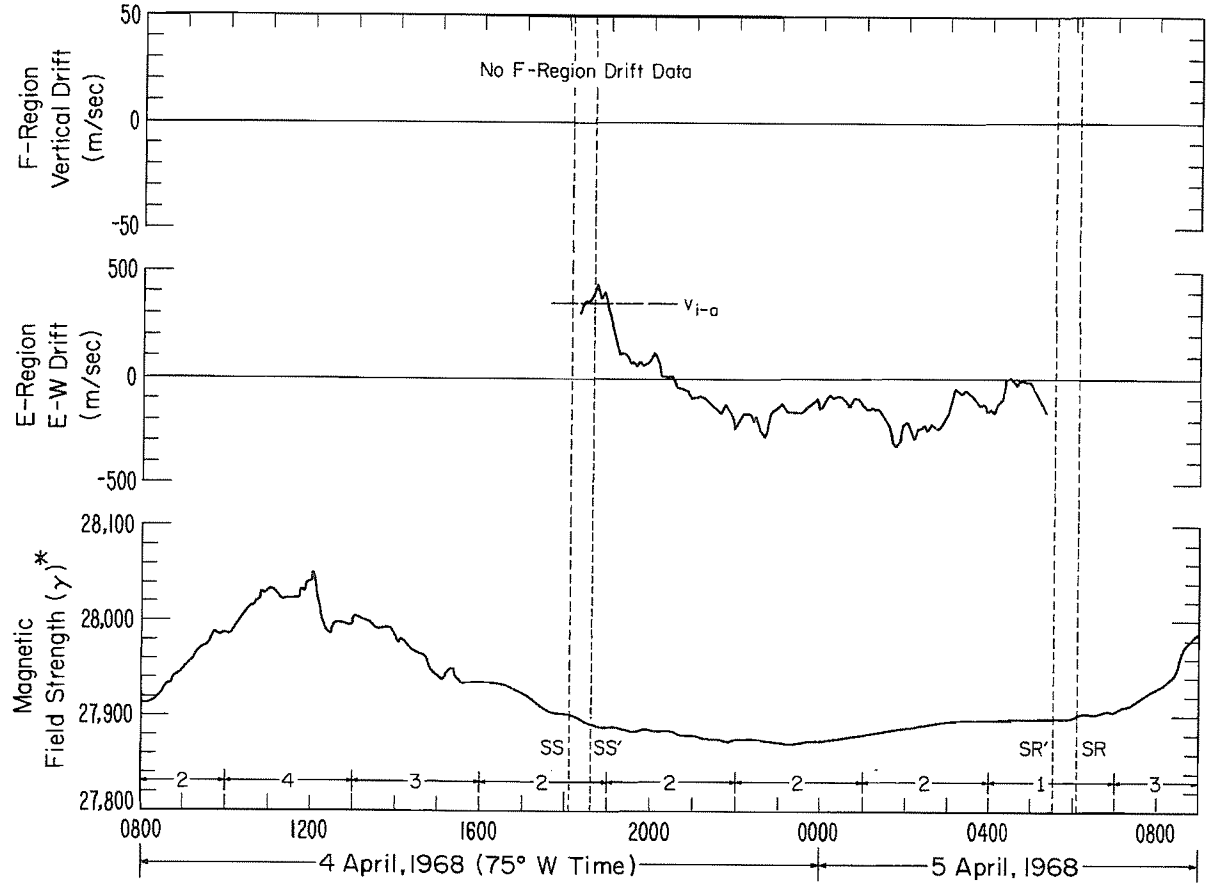

50
0
-50
F-Region
Vertical Drift
(m/sec)
No F-Region Drift Data Until 4 March, 1968
500
-500
E-Region
E-W Drift
(m/sec)
v_{i-a}
28,100
28,000
27,900
27,800
Magnetic
Field Strength (γ)*
SS
SS'
SR'
SR
0800
1200
1600
2000
0000
0400
26 January, 1968 (75° W Time)
27 January, 1968


F-Region Vertical Drift (m/sec)
50
0
-50
E-Region E-W Drift (m/sec)
500
0
-500
v_{i-a}
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS′
SR′
SR
5
5
5
3
2
2
2
2
4
0800
1200
1600
2000
0000
0400
0800
4 March, 1968 (75° W Time)
5 March, 1968

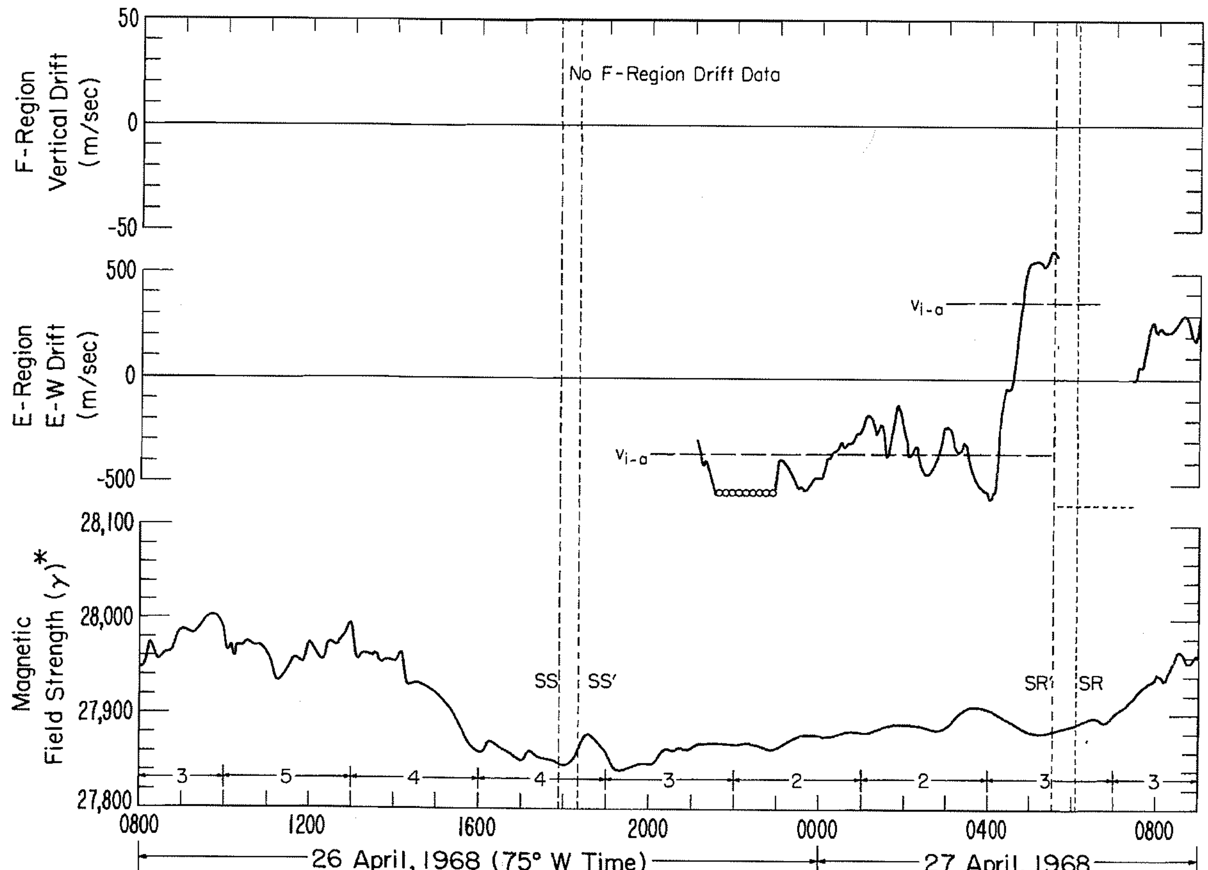

F-Region Vertical Drift (m/sec)
50
0
-50
E-Region E-W Drift (m/sec)
500
0
-500
v_{i-a}
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS′
SR′
SR
4
4
3
2
2
2
0
1
2
0800
1200
1600
2000
0000
0400
0800
5 March, 1968 (75° W Time)
6 March, 1968


50
0
-50
F-Region Vertical Drift (m/sec)
No F-Region Drift Data
500
0
-500
E-Region E-W Drift (m/sec)
v_{i-a}
v_{i-a}
28,100
28,000
27,900
27,800
Magnetic Field Strength (γ)*
SS
SS'
SR'
SR
5
5
4
4
3
3
3
2
4
0800
1200
1600
2000
0000
0400
0800
14 March, 1968 (75° W Time)
15 March, 1968

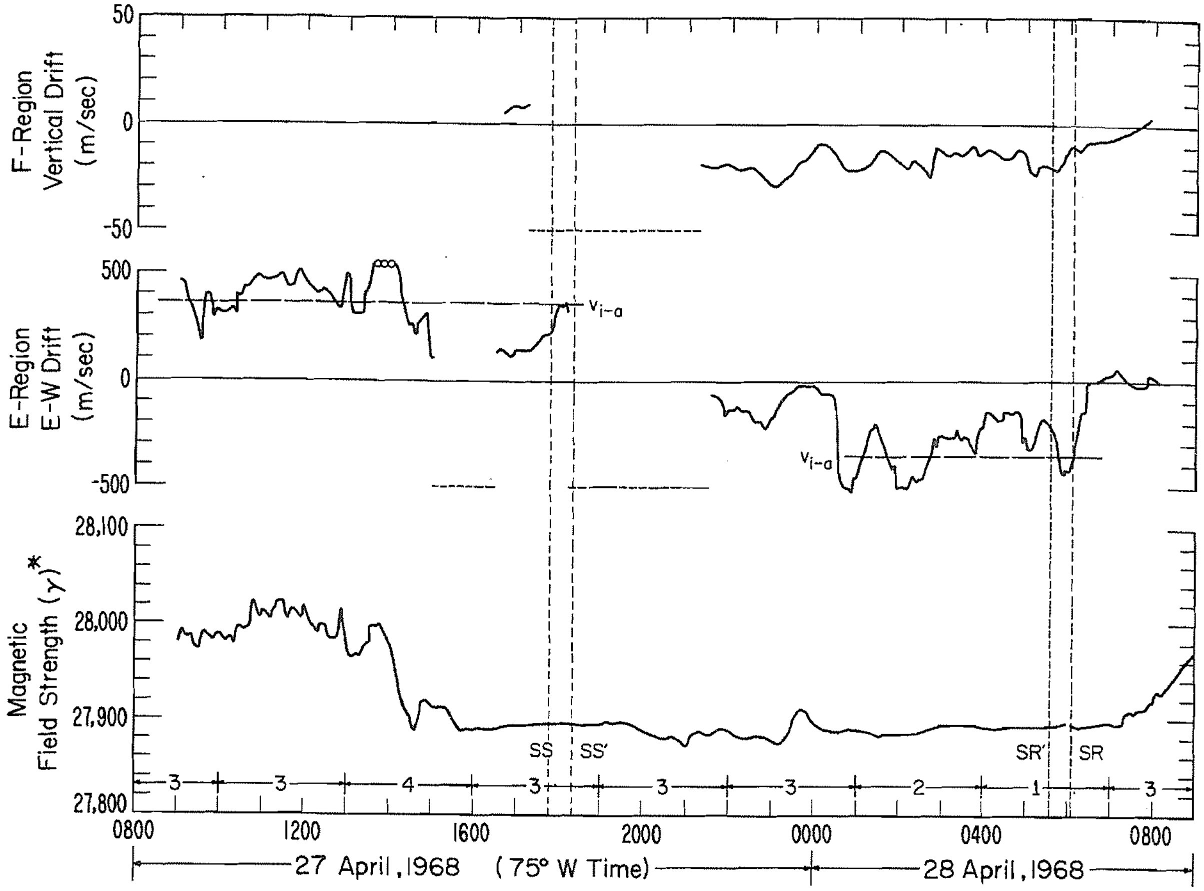

50
0
-50
F-Region Vertical Drift (m/sec)
No F-Region Drift Data
500
0
-500
E-Region E-W Drift (m/sec)
v_{i-a}
v_{i-a}
28,100
28,000
27,900
27,800
Magnetic Field Strength (γ)*
SS
SS'
SR'
SR
4
4
4
3
3
3
2
2
4
0800
1200
1600
2000
0000
0400
0800
15 March, 1968 (75° W Time)
16 March, 1968



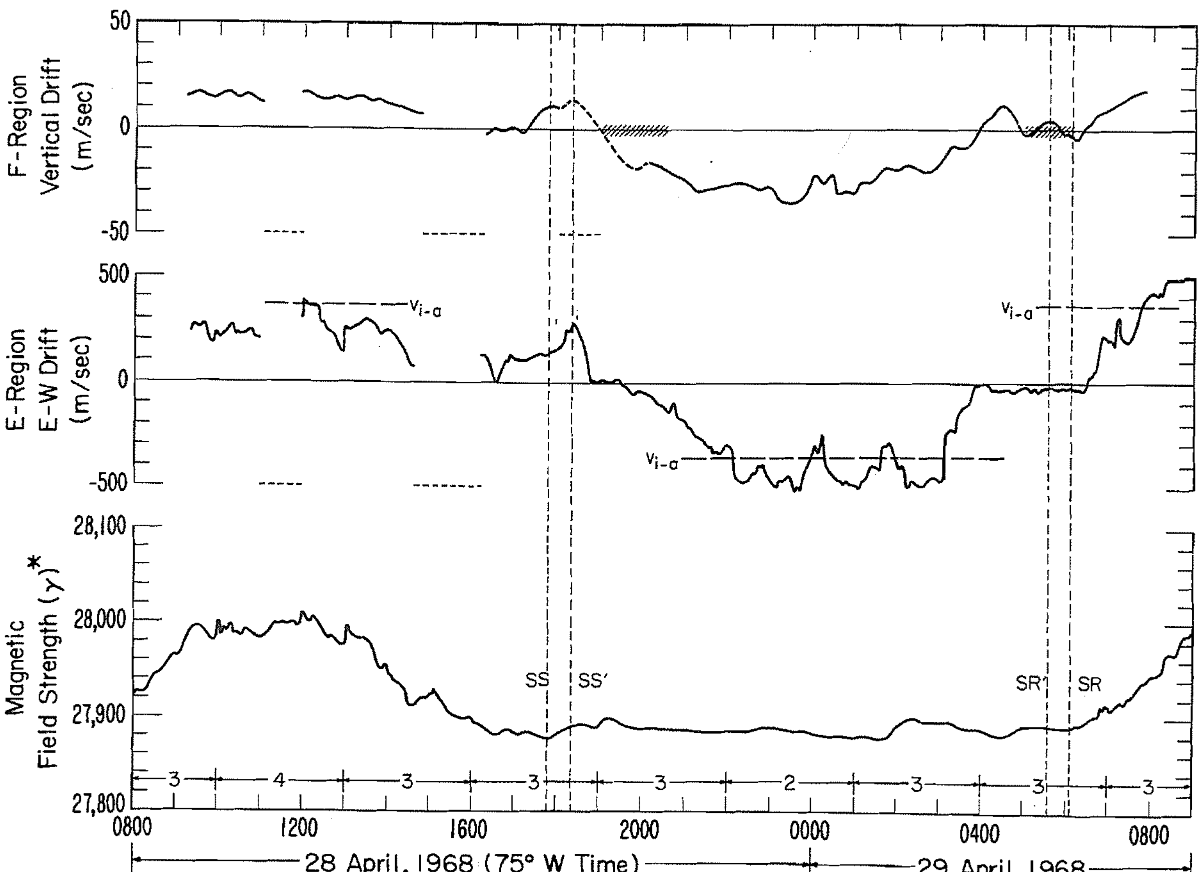
F-Region Vertical Drift (m/sec)
50
0
-50
No F-Region Drift Data
E-Region E-W Drift (m/sec)
500
0
-500
v_{i-a}
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS′
SR′
SR
2
4
3
2
2
2
2
1
3
0800
1200
1600
2000
0000
0400
0800
4 April, 1968 (75° W Time)
5 April, 1968



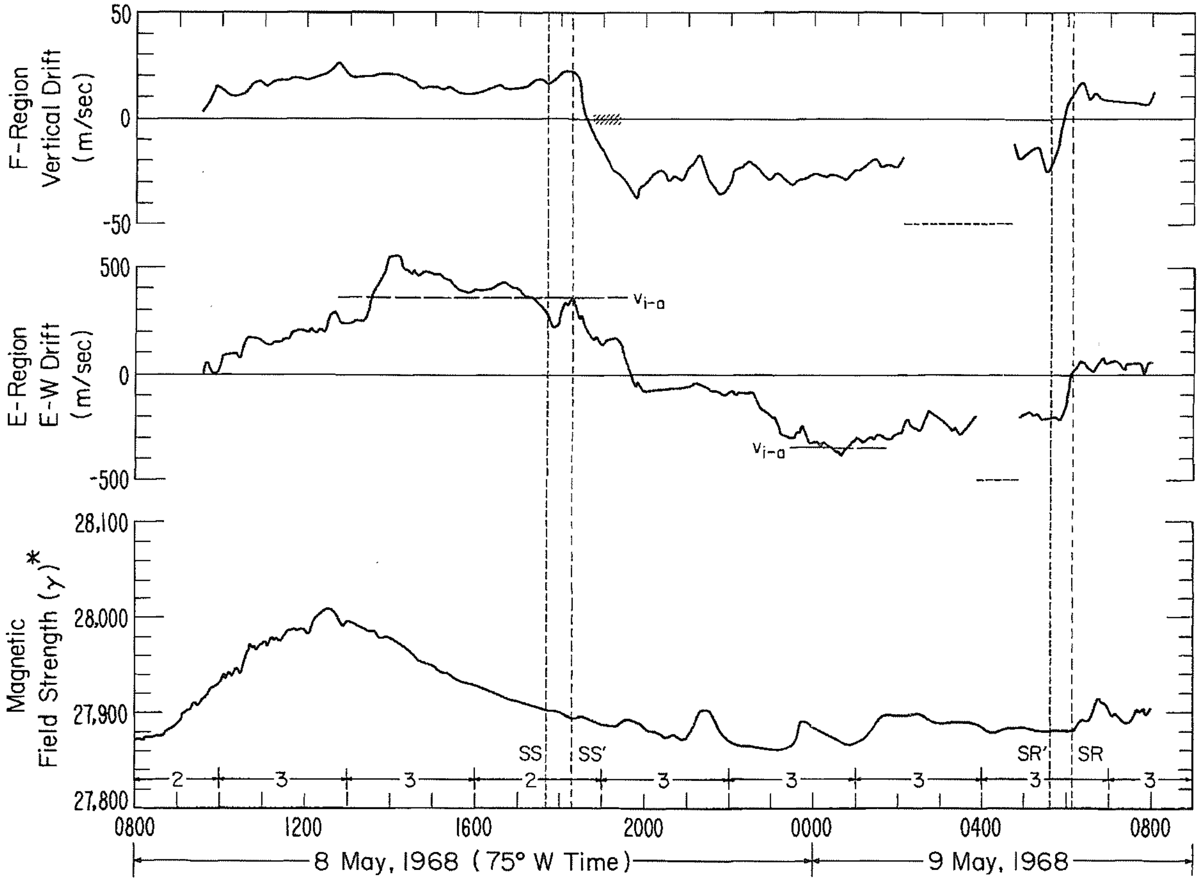
F-Region Vertical Drift (m/sec)
50
0
-50
No F-Region Drift Data
E-Region E-W Drift (m/sec)
500
0
-500
v_{i-a}
v_{i-a}
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS′
SR′
SR
3
5
4
4
3
2
2
3
3
0800
1200
1600
2000
0000
0400
0800
26 April, 1968 (75° W Time)
27 April, 1968



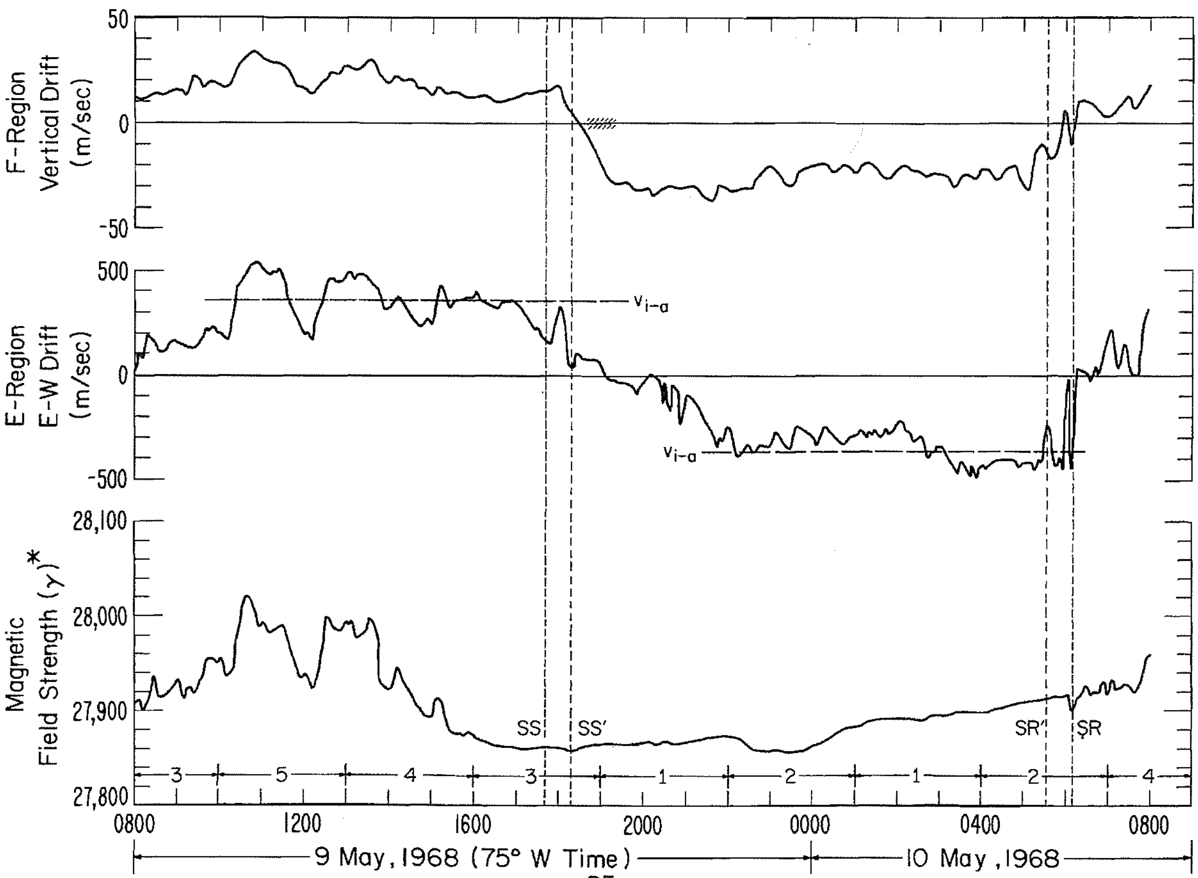
F-Region Vertical Drift (m/sec)
E-Region E-W Drift (m/sec)
Magnetic Field Strength (γ)*
SS
SS'
SR'
SR
27 April, 1968 (75° W Time)
28 April, 1968



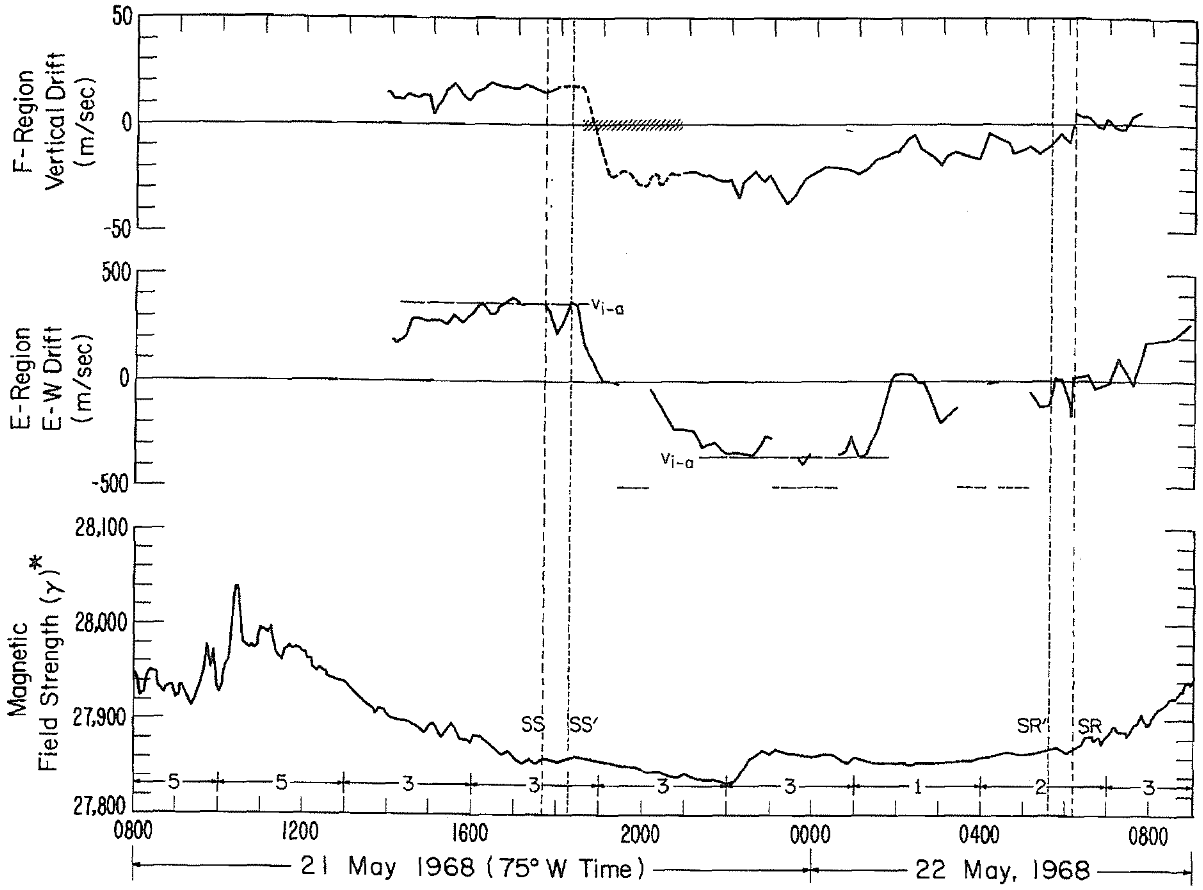
F-Region Vertical Drift (m/sec)
E-Region E-W Drift (m/sec)
Magnetic Field Strength (γ)*
SS
SS'
SR'
SR
28 April, 1968 (75° W Time)
29 April, 1968

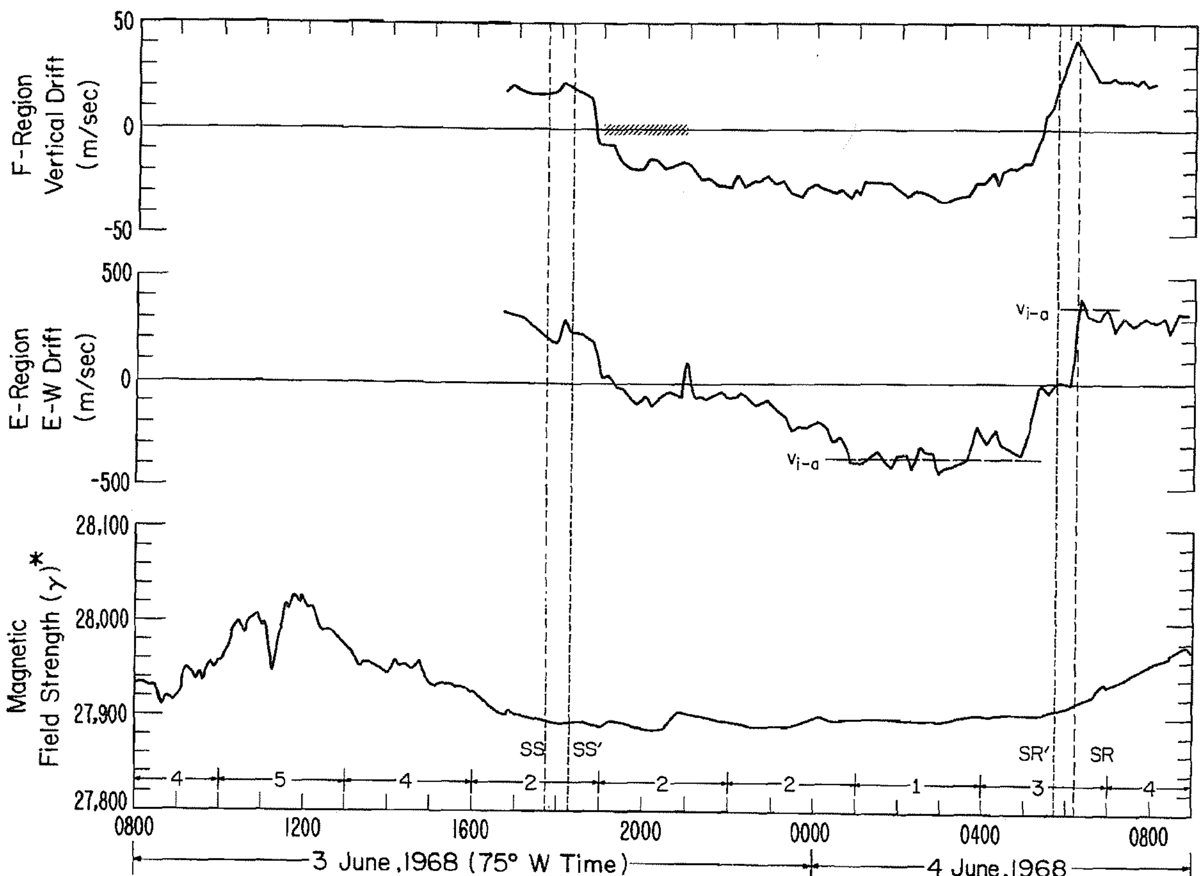


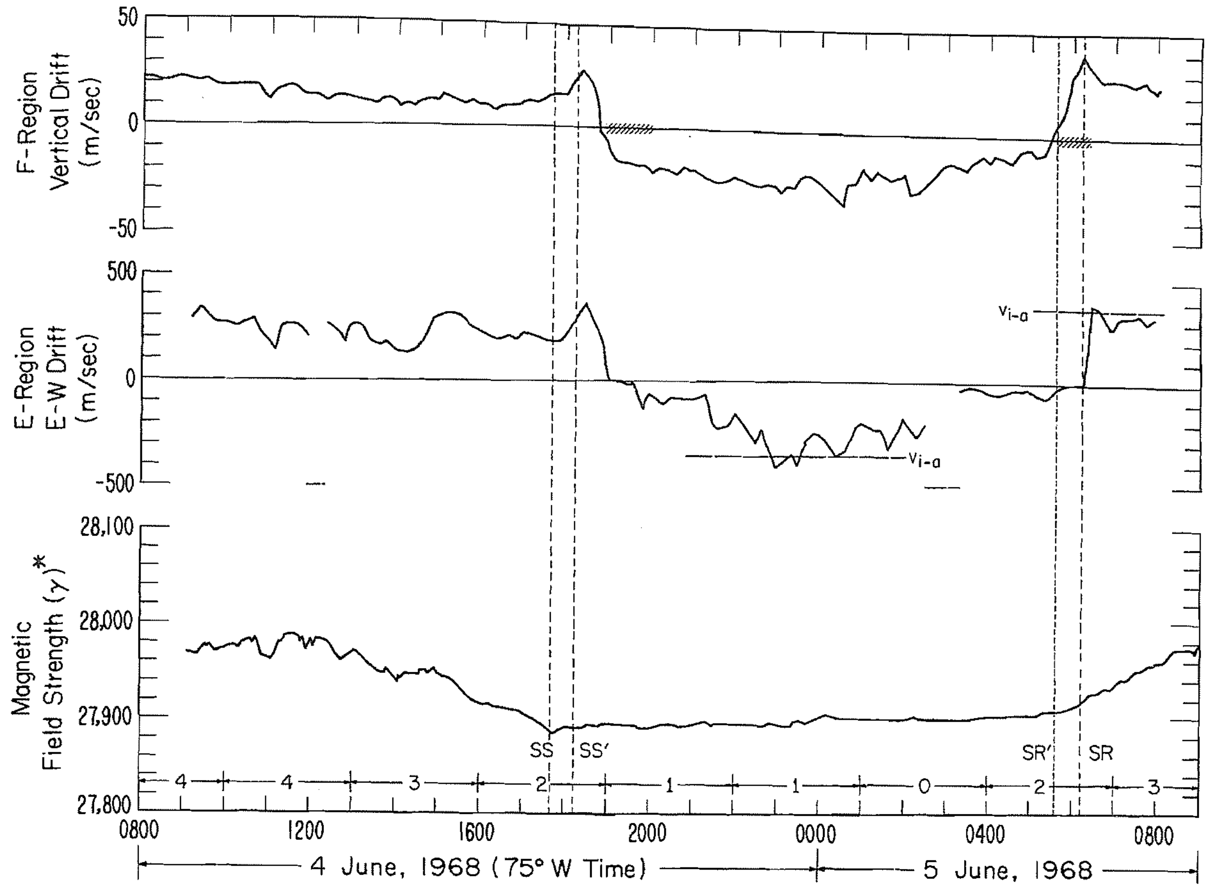
50
0
-50
F-Region
Vertical Drift
(m/sec)
500
0
-500
E-Region
E-W Drift
(m/sec)
v_{i-a}
v_{i-a}
28,100
28,000
27,900
27,800
Magnetic
Field Strength (γ)*
SS
SS'
SR'
SR
2
3
3
2
3
3
3
3
3
0800
1200
1600
2000
0000
0400
0800
8 May, 1968 (75° W Time)
9 May, 1968

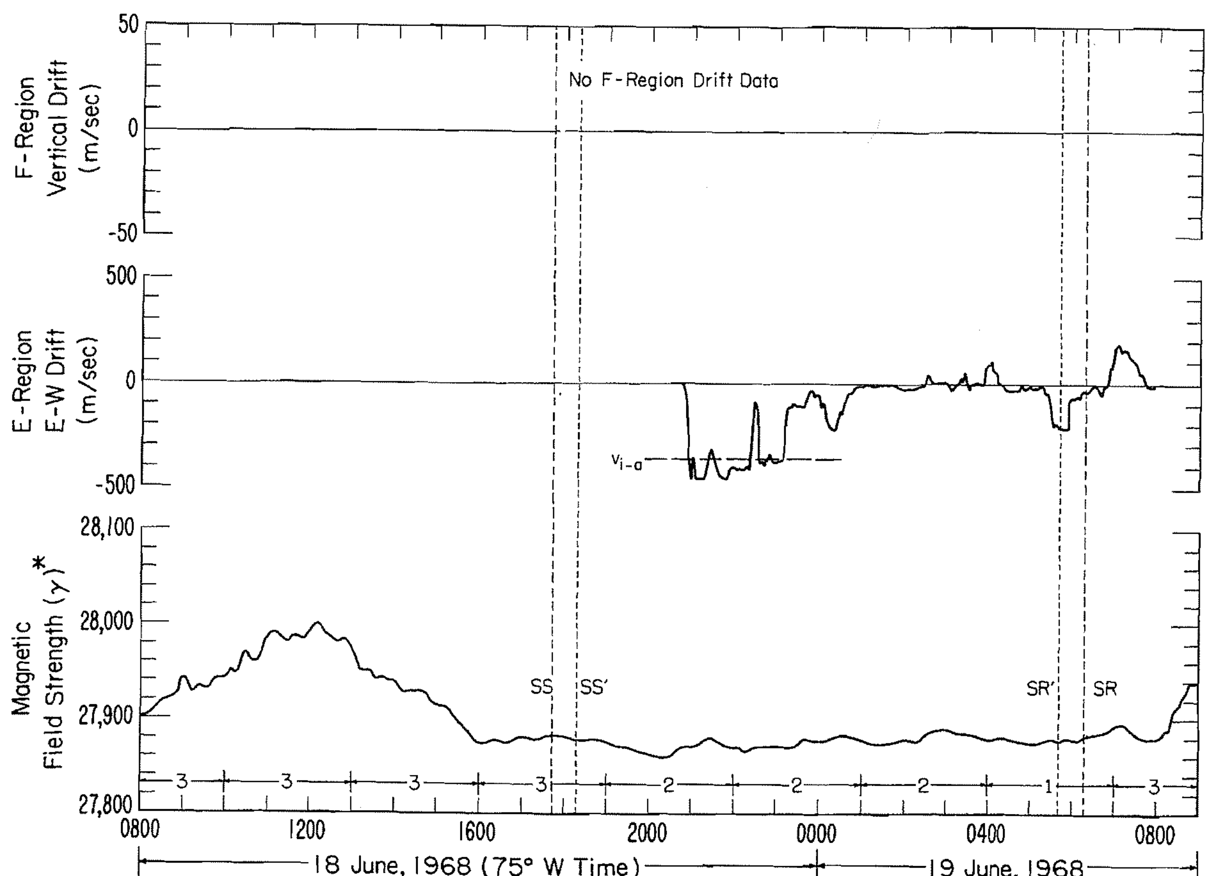


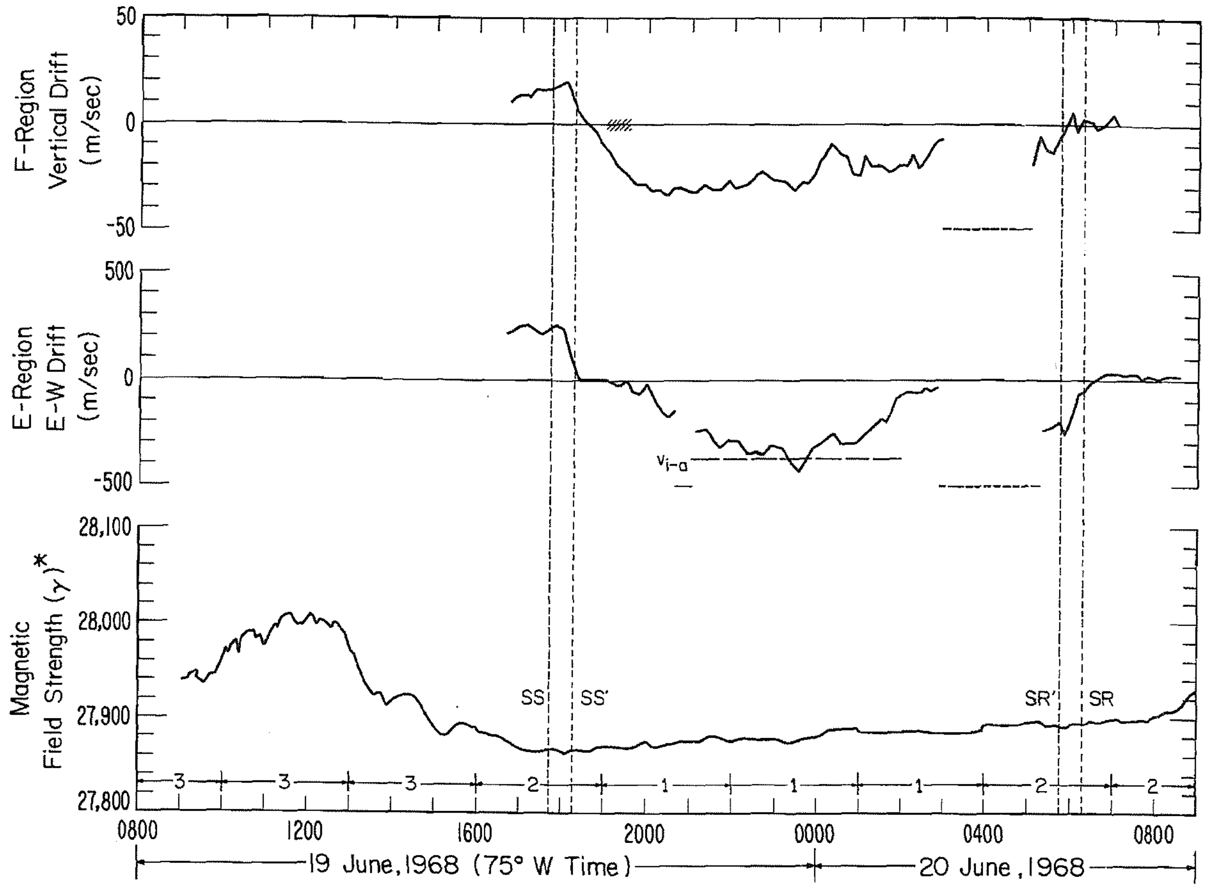
50
0
-50
F-Region
Vertical Drift
(m/sec)
500
0
-500
E-Region
E-W Drift
(m/sec)
v_{i-a}
v_{i-a}
28,100
28,000
27,900
27,800
Magnetic
Field Strength (γ)*
SS
SS'
SR'
SR
3
5
4
3
1
2
1
2
4
0800
1200
1600
2000
0000
0400
0800
9 May, 1968 (75° W Time)
10 May, 1968

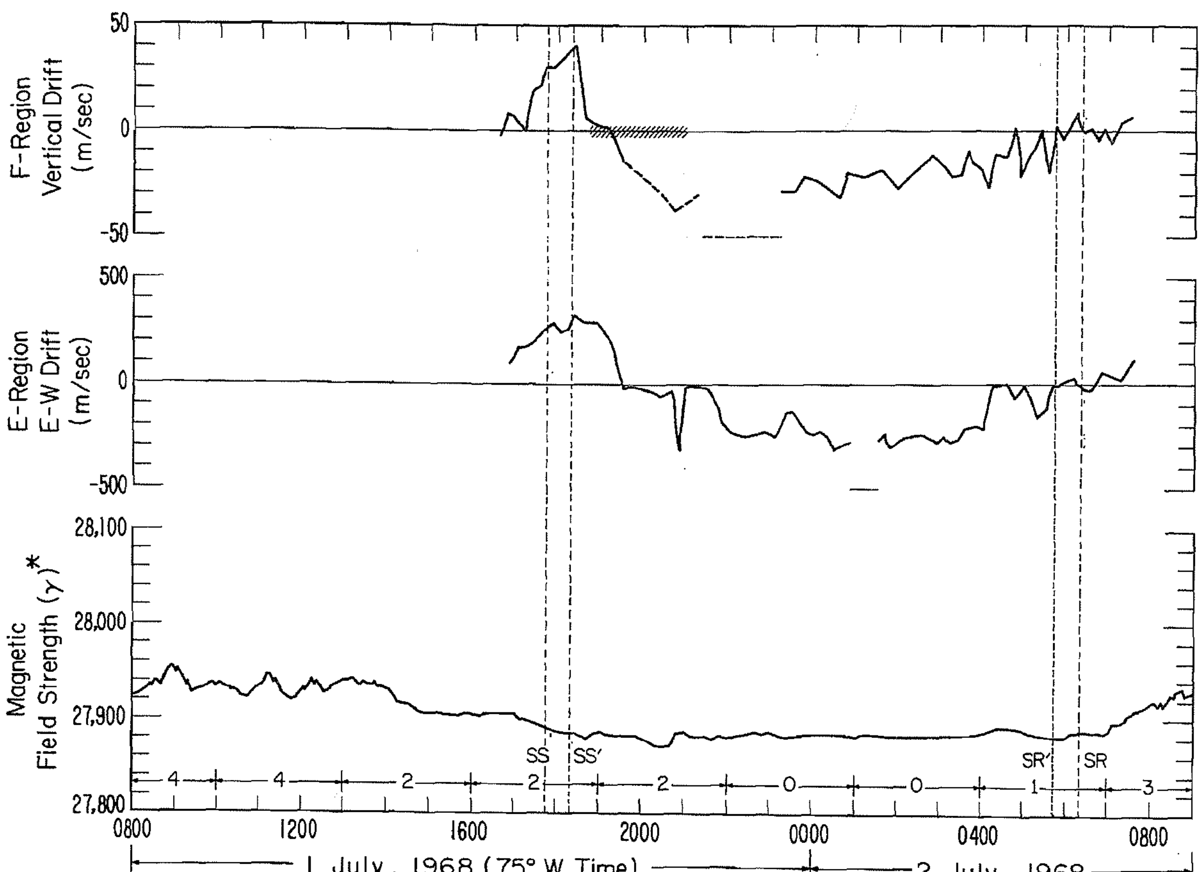

F-Region Vertical Drift (m/sec)
50
0
-50
E-Region E-W Drift (m/sec)
500
0
-500
v_{i-a}
v_{i-a}
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS′
SR′
SR
5
5
3
3
3
3
1
2
3
0800
1200
1600
2000
0000
0400
0800
21 May 1968 (75° W Time)
22 May, 1968

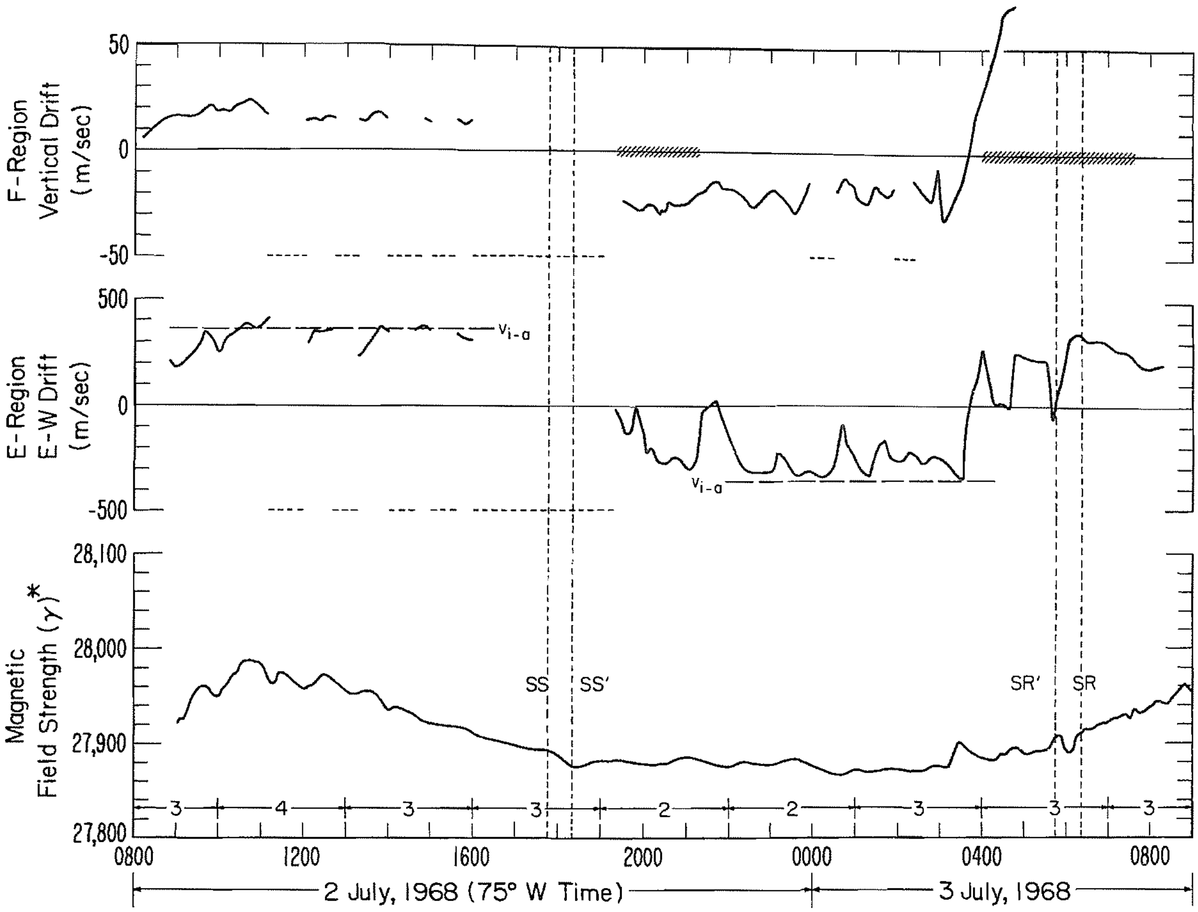

F-Region Vertical Drift (m/sec)
50
0
-50
E-Region E-W Drift (m/sec)
500
0
-500
v_{i-a}
v_{i-a}
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS′
SR′
SR
4
5
4
2
2
2
1
3
4
0800
1200
1600
2000
0000
0400
0800
3 June, 1968 (75° W Time)
4 June, 1968

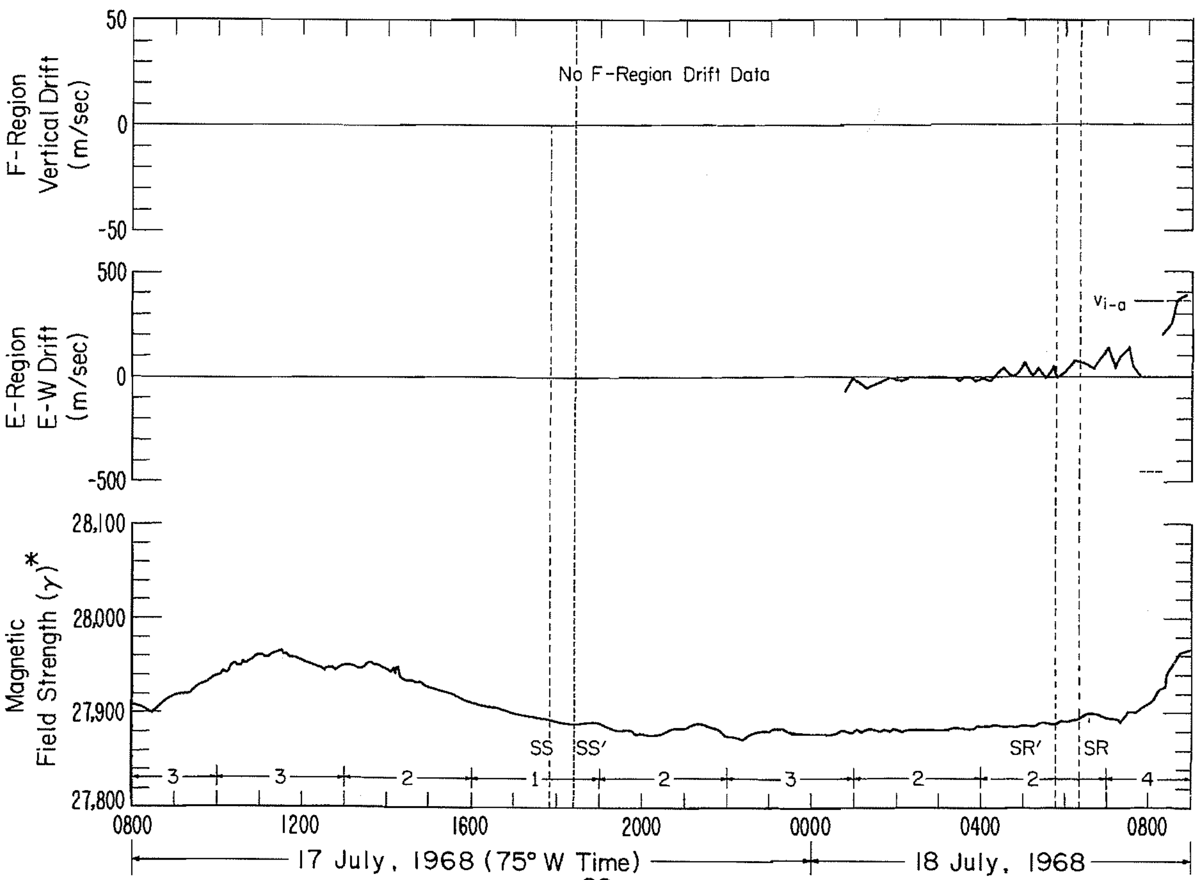

F-Region Vertical Drift (m/sec)
E-Region E-W Drift (m/sec)
Magnetic Field Strength (γ)*
v_{i-a}
SS
SS'
SR'
SR
0800
1200
1600
2000
0000
0400
0800
4 June, 1968 (75° W Time)
5 June, 1968

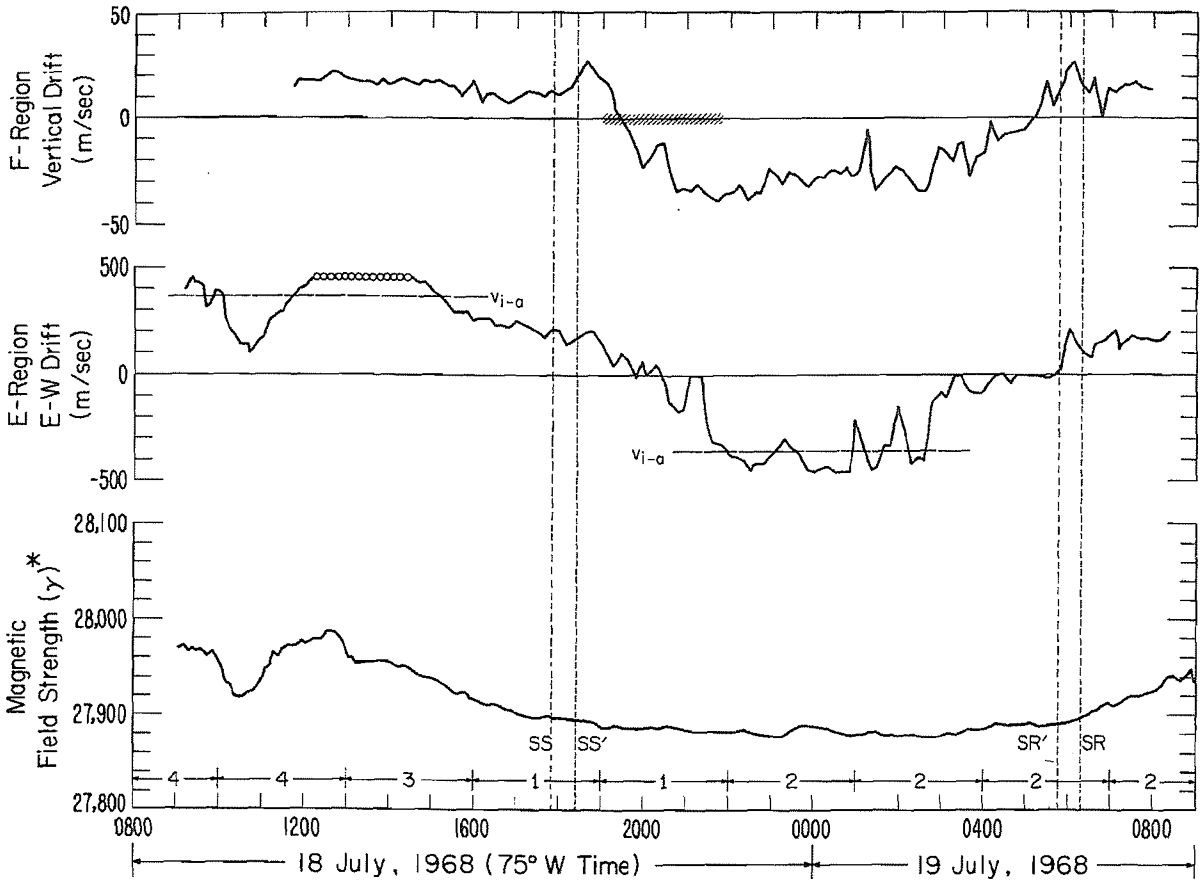

F-Region Vertical Drift (m/sec)
No F-Region Drift Data
E-Region E-W Drift (m/sec)
Magnetic Field Strength (γ)*
v_{i-a}
SS
SS'
SR'
SR
0800
1200
1600
2000
0000
0400
0800
18 June, 1968 (75° W Time)
19 June, 1968


F-Region Vertical Drift (m/sec)
50
0
-50
E-Region E-W Drift (m/sec)
500
0
-500
v_{i-a}
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS'
SR'
SR
3
3
3
2
1
1
1
2
2
0800
1200
1600
2000
0000
0400
0800
19 June, 1968 (75° W Time)
20 June, 1968

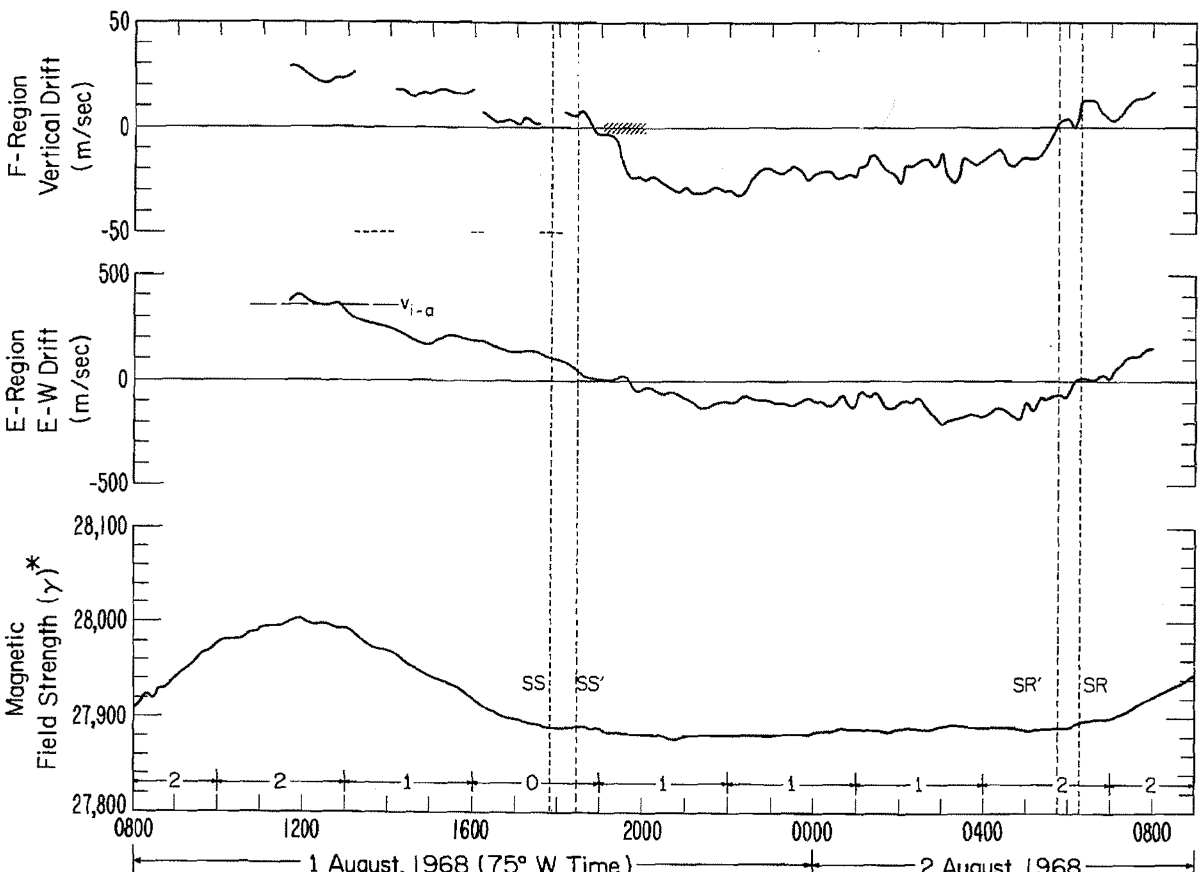

F-Region Vertical Drift (m/sec)
50
0
-50
E-Region E-W Drift (m/sec)
500
0
-500
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS'
SR'
SR
4
4
2
2
2
0
0
1
3
0800
1200
1600
2000
0000
0400
0800
1 July, 1968 (75° W Time)
2 July, 1968


F-Region
Vertical Drift
(m/sec)
50
0
-50
E-Region
E-W Drift
(m/sec)
500
0
-500
v_{i-a}
Magnetic
Field Strength $(\gamma)^*$
28,100
28,000
27,900
27,800
SS
SS'
SR'
SR
3
4
3
3
2
2
3
3
3
0800
1200
1600
2000
0000
0400
0800
2 July, 1968 (75° W Time)
3 July, 1968

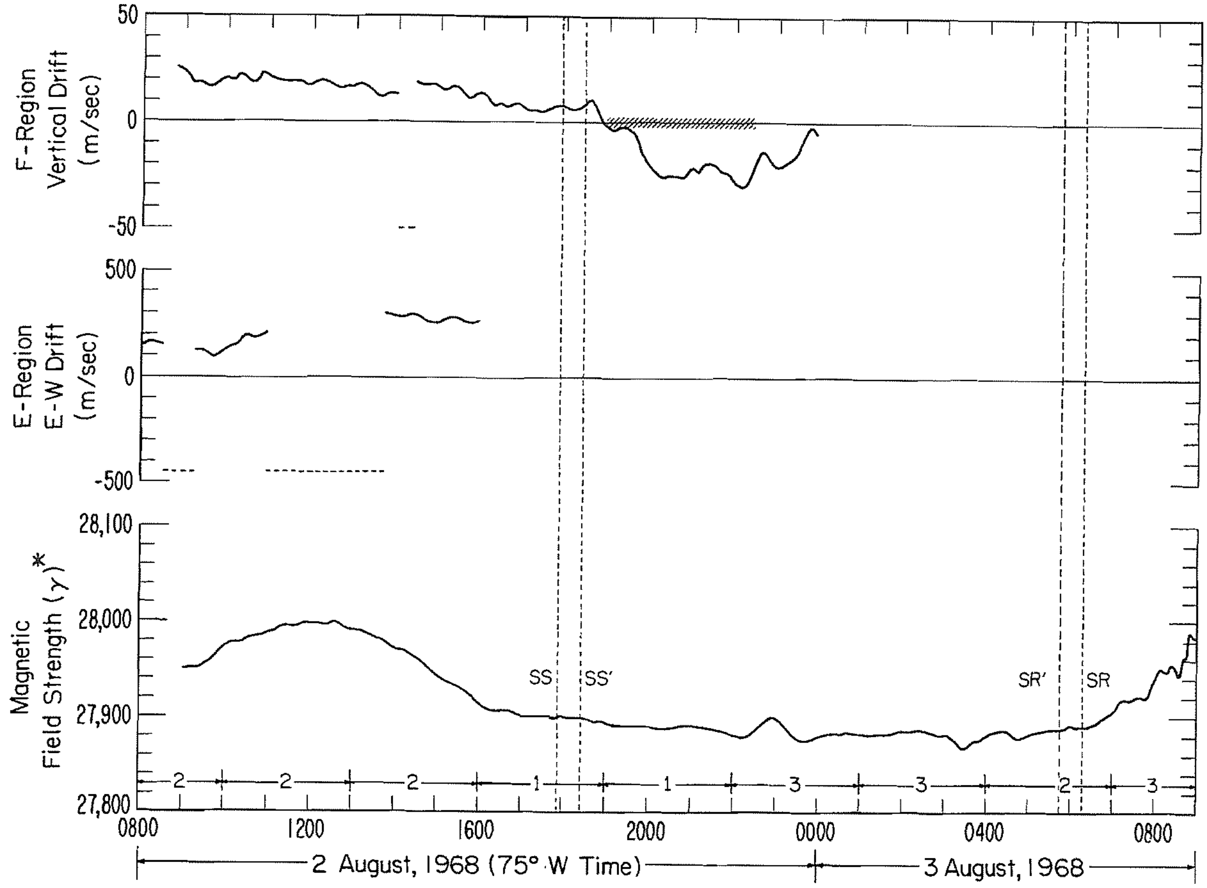

F-Region
Vertical Drift
(m/sec)
50
0
-50
No F-Region Drift Data
E-Region
E-W Drift
(m/sec)
500
0
-500
v_{i-a}
Magnetic
Field Strength $(\gamma)^*$
28,100
28,000
27,900
27,800
SS
SS'
SR'
SR
3
3
2
1
2
3
2
2
4
0800
1200
1600
2000
0000
0400
0800
17 July, 1968 (75° W Time)
18 July, 1968

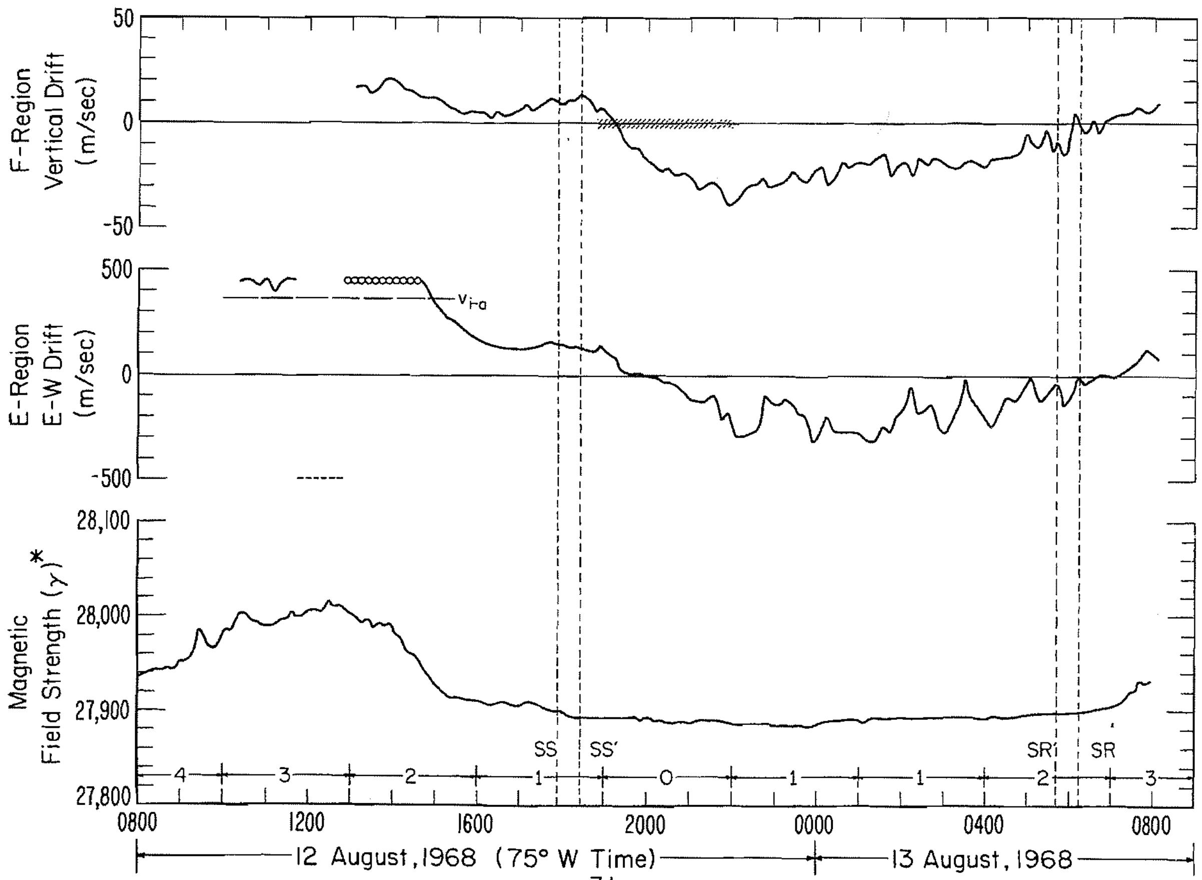


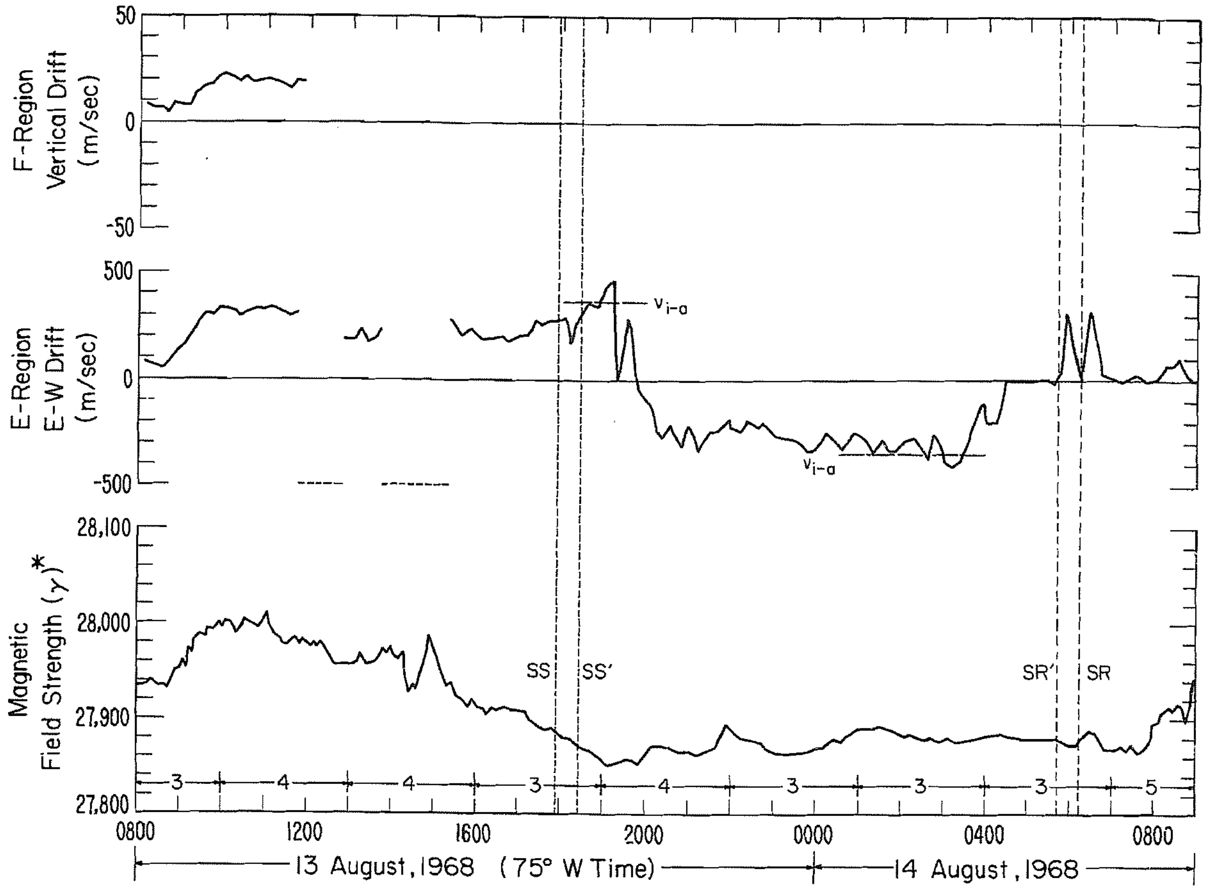
F-Region Vertical Drift (m/sec)
E-Region E-W Drift (m/sec)
v_{i-a}
Magnetic Field Strength (γ)*
SS
SS'
SR'
SR
18 July, 1968 (75° W Time)
19 July, 1968

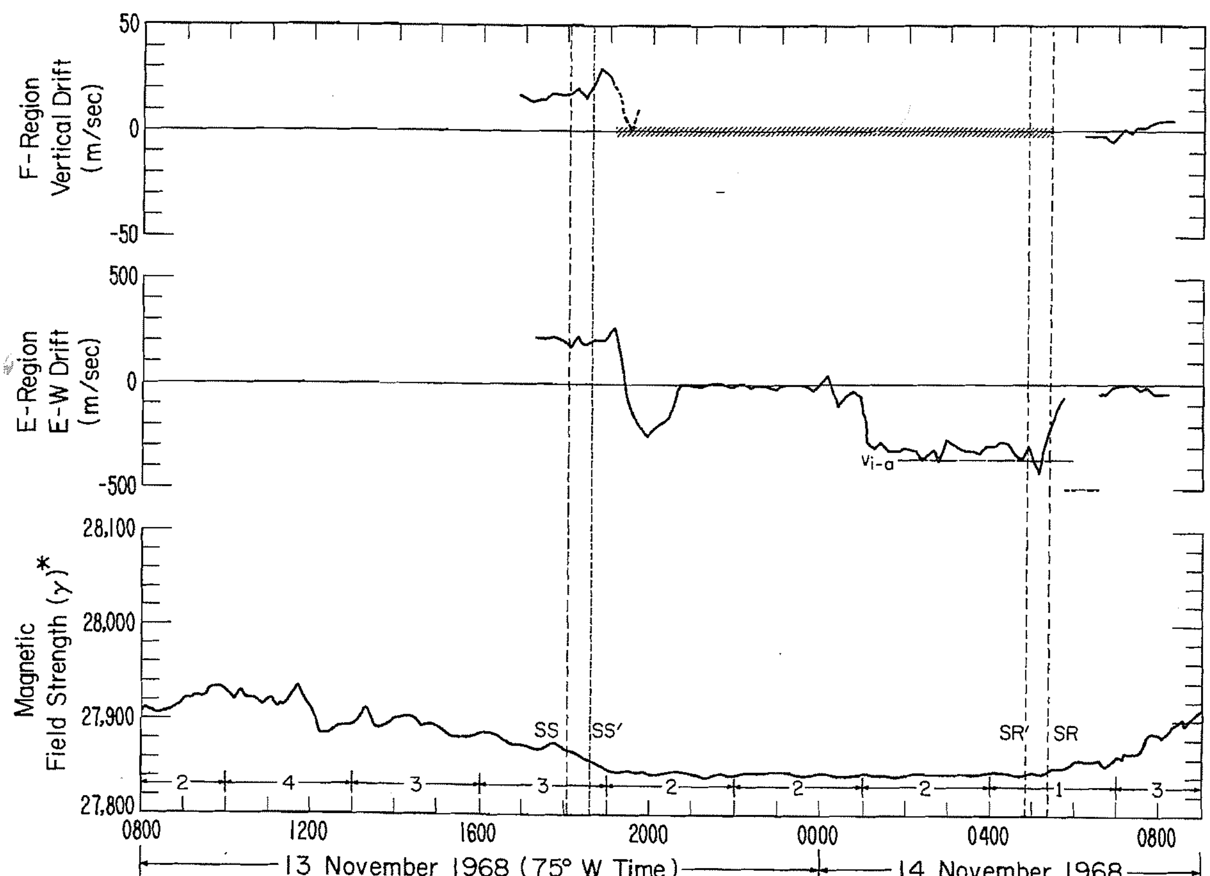


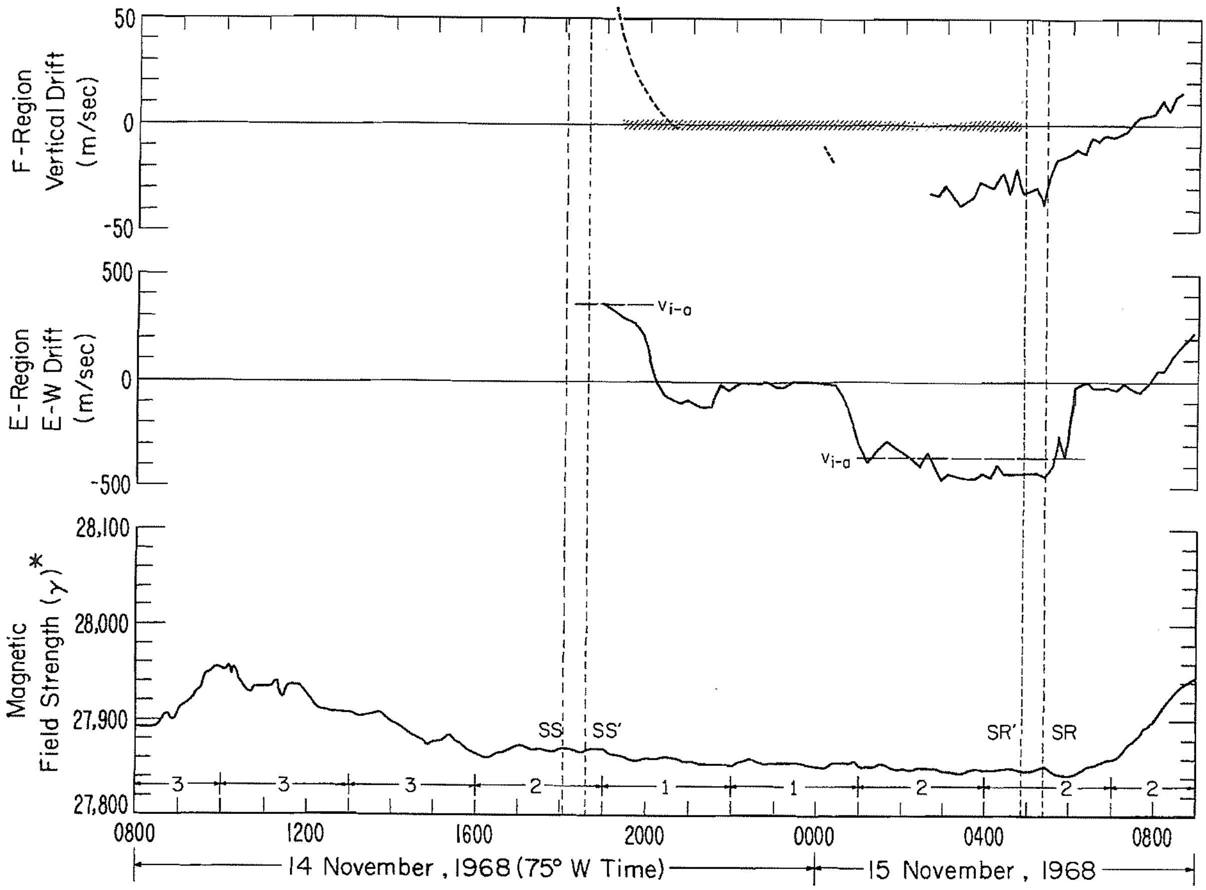
F-Region Vertical Drift (m/sec)
E-Region E-W Drift (m/sec)
v_{i-a}
Magnetic Field Strength (γ)*
SS
SS'
SR'
SR
1 August, 1968 (75° W Time)
2 August, 1968


F-Region
Vertical Drift
(m/sec)
50
0
-50
E-Region
E-W Drift
(m/sec)
500
0
-500
Magnetic
Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS'
SR'
SR
2
2
2
1
1
3
3
2
3
0800
1200
1600
2000
0000
0400
0800
2 August, 1968 (75° W Time)
3 August, 1968

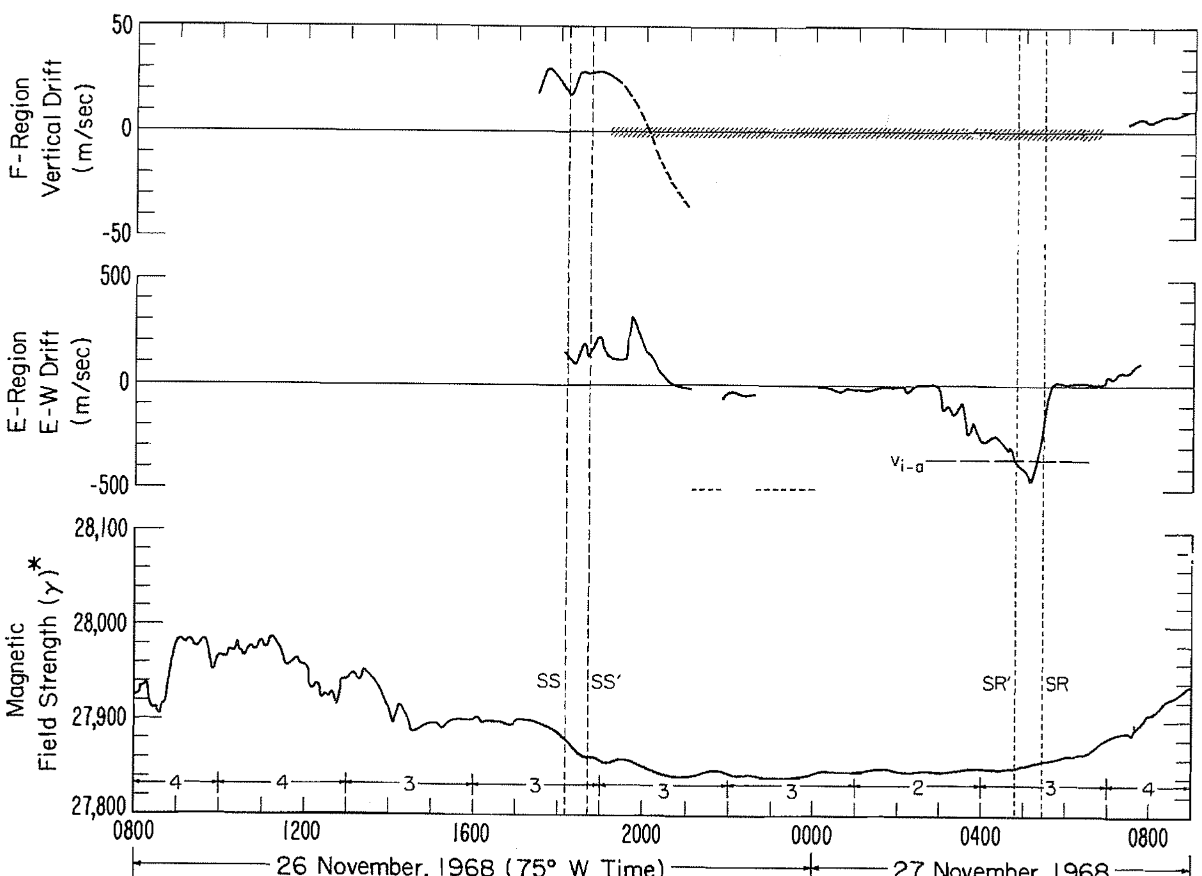

F-Region
Vertical Drift
(m/sec)
50
0
-50
E-Region
E-W Drift
(m/sec)
500
0
-500
v_{i-a}
Magnetic
Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS'
SR
SR
4
3
2
1
0
1
1
2
3
0800
1200
1600
2000
0000
0400
0800
12 August, 1968 (75° W Time)
13 August, 1968


F-Region Vertical Drift (m/sec)
E-Region E-W Drift (m/sec)
Magnetic Field Strength (γ)*
SS
SS'
SR'
SR
v_{i-a}
13 August, 1968 (75° W Time)
14 August, 1968

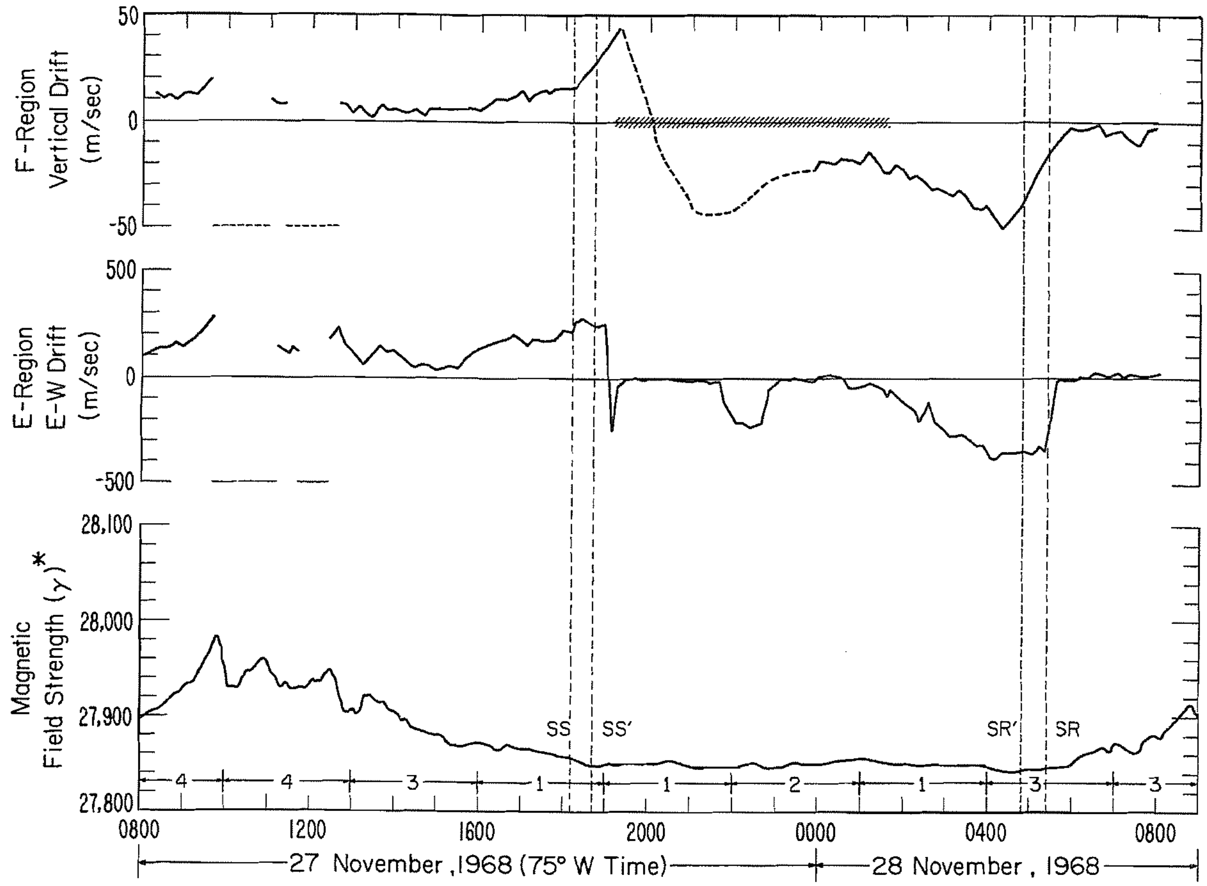

F-Region Vertical Drift (m/sec)
E-Region E-W Drift (m/sec)
Magnetic Field Strength (γ)*
SS
SS'
SR'
SR
v_{i-a}
13 November 1968 (75° W Time)
14 November 1968



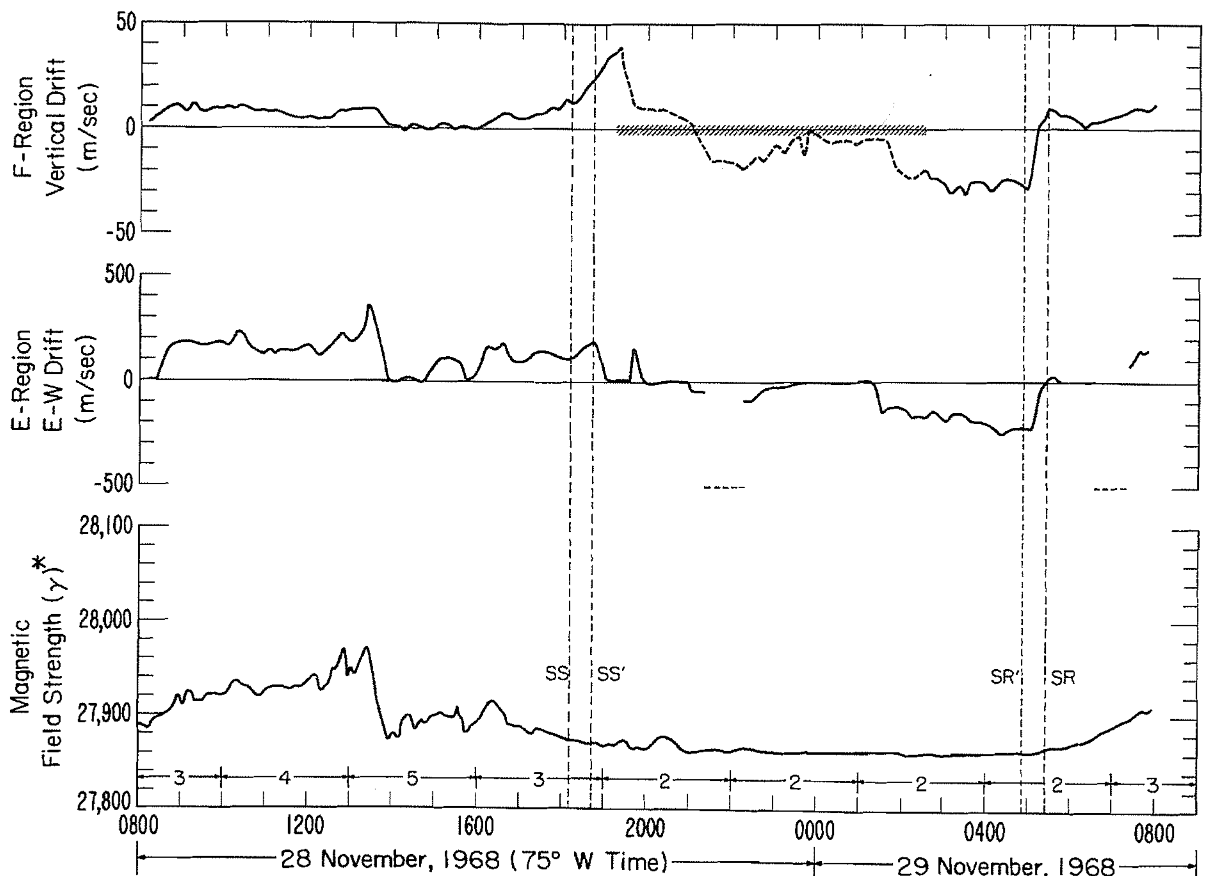
F-Region Vertical Drift (m/sec)
50
0
-50
E-Region E-W Drift (m/sec)
500
0
-500
v_{i-a}
v_{i-a}
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS'
SR'
SR
3
3
3
2
1
1
2
2
2
0800
1200
1600
2000
0000
0400
0800
14 November, 1968 (75° W Time)
15 November, 1968



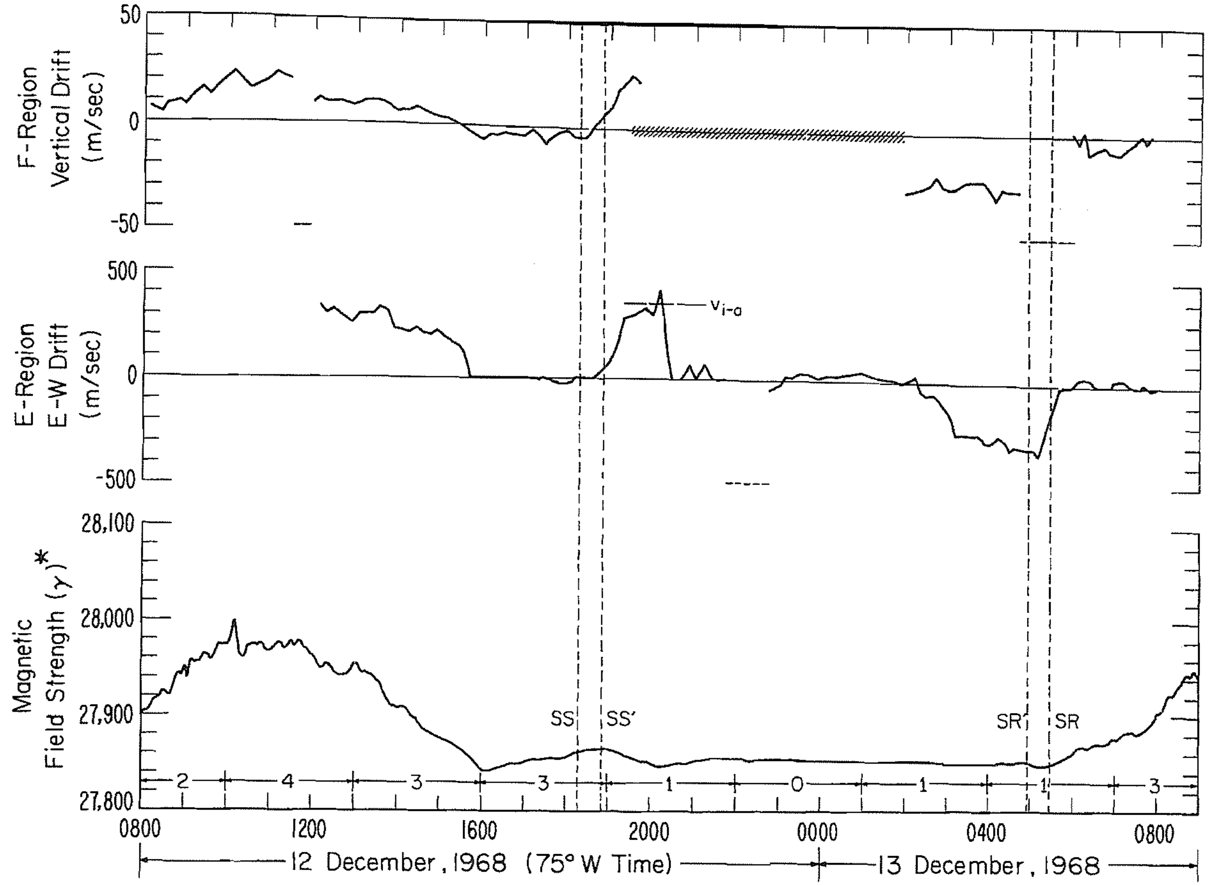
F-Region Vertical Drift (m/sec)
50
0
-50
E-Region E-W Drift (m/sec)
500
0
-500
v_{i-a}
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS'
SR'
SR
4
4
3
3
3
3
2
3
4
0800
1200
1600
2000
0000
0400
0800
26 November, 1968 (75° W Time)
27 November, 1968

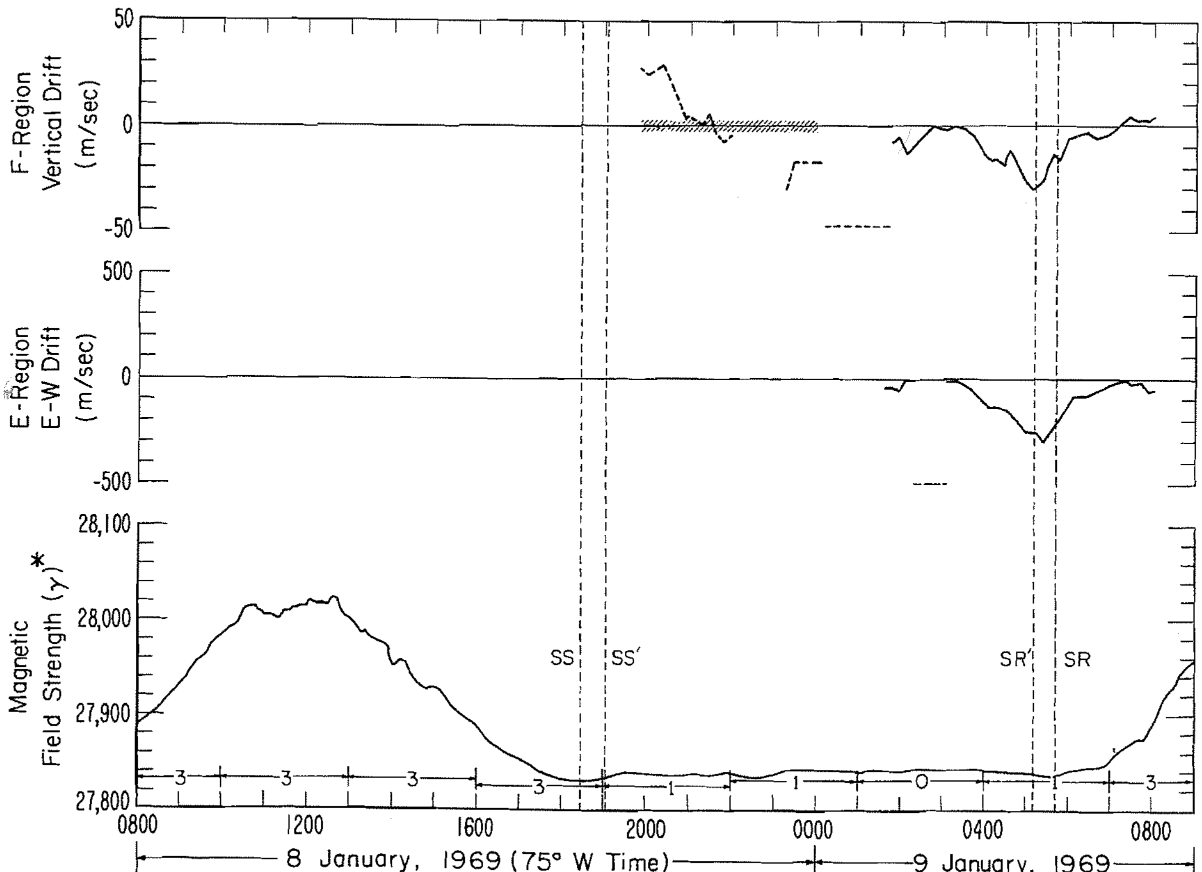


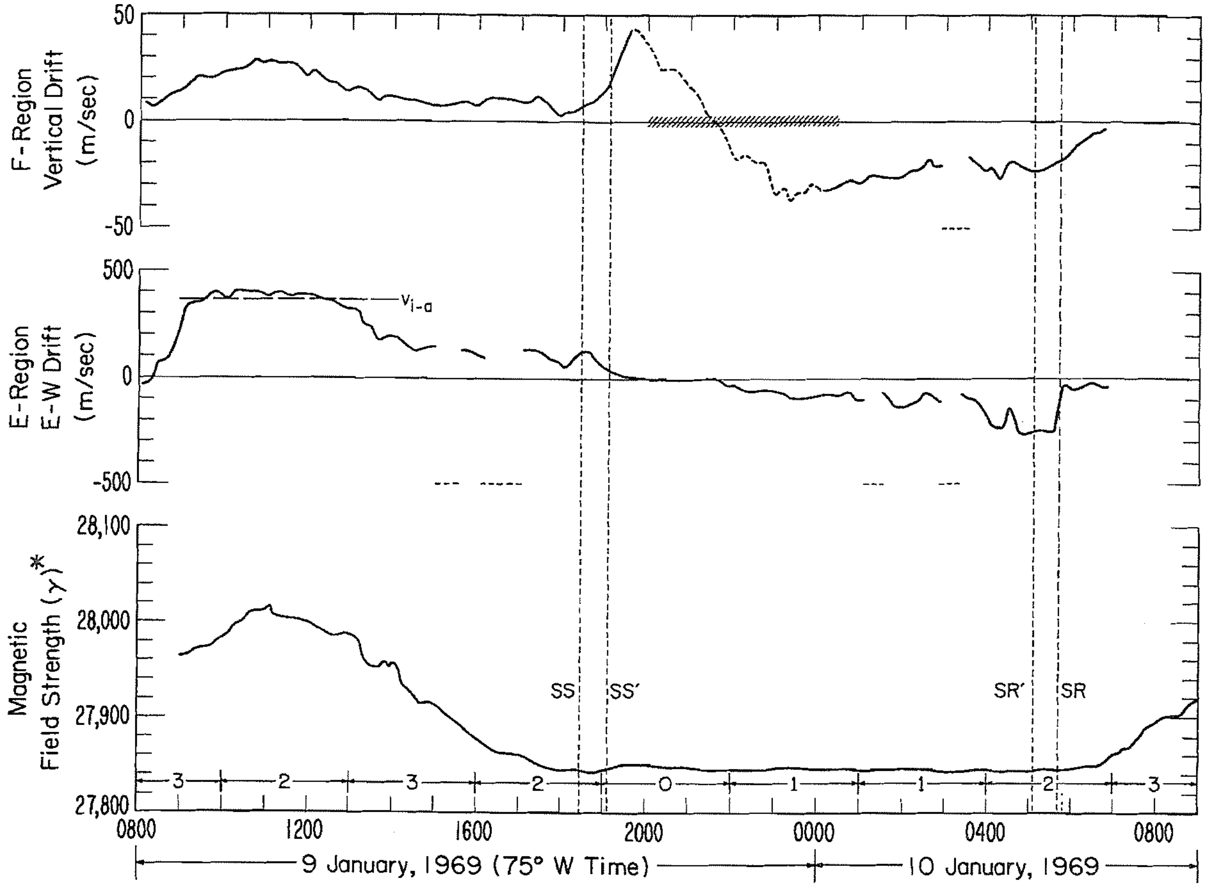
F-Region Vertical Drift (m/sec)
50
0
-50
E-Region E-W Drift (m/sec)
500
0
-500
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS'
SR'
SR
4
4
3
1
1
2
1
3
3
0800
1200
1600
2000
0000
0400
0800
27 November ,1968 (75° W Time)
28 November , 1968



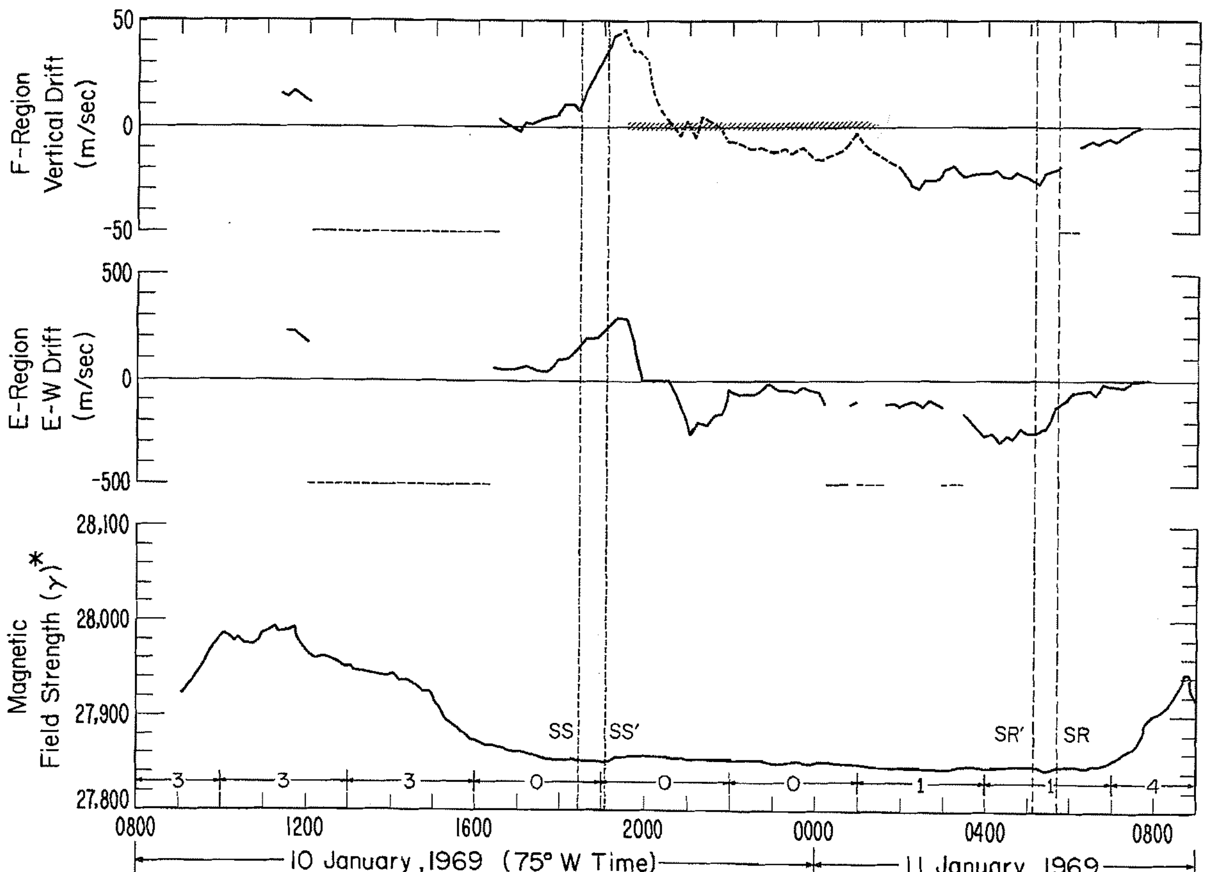
F-Region Vertical Drift (m/sec)
50
0
-50
E-Region E-W Drift (m/sec)
500
0
-500
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS'
SR'
SR
3
4
5
3
2
2
2
2
3
0800
1200
1600
2000
0000
0400
0800
28 November, 1968 (75° W Time)
29 November, 1968


F-Region
Vertical Drift
(m/sec)
50
0
-50
E-Region
E-W Drift
(m/sec)
500
0
-500
v_{i-a}
Magnetic
Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS'
SR'
SR
2
4
3
3
1
0
1
1
3
0800
1200
1600
2000
0000
0400
0800
12 December, 1968 (75° W Time)
13 December, 1968

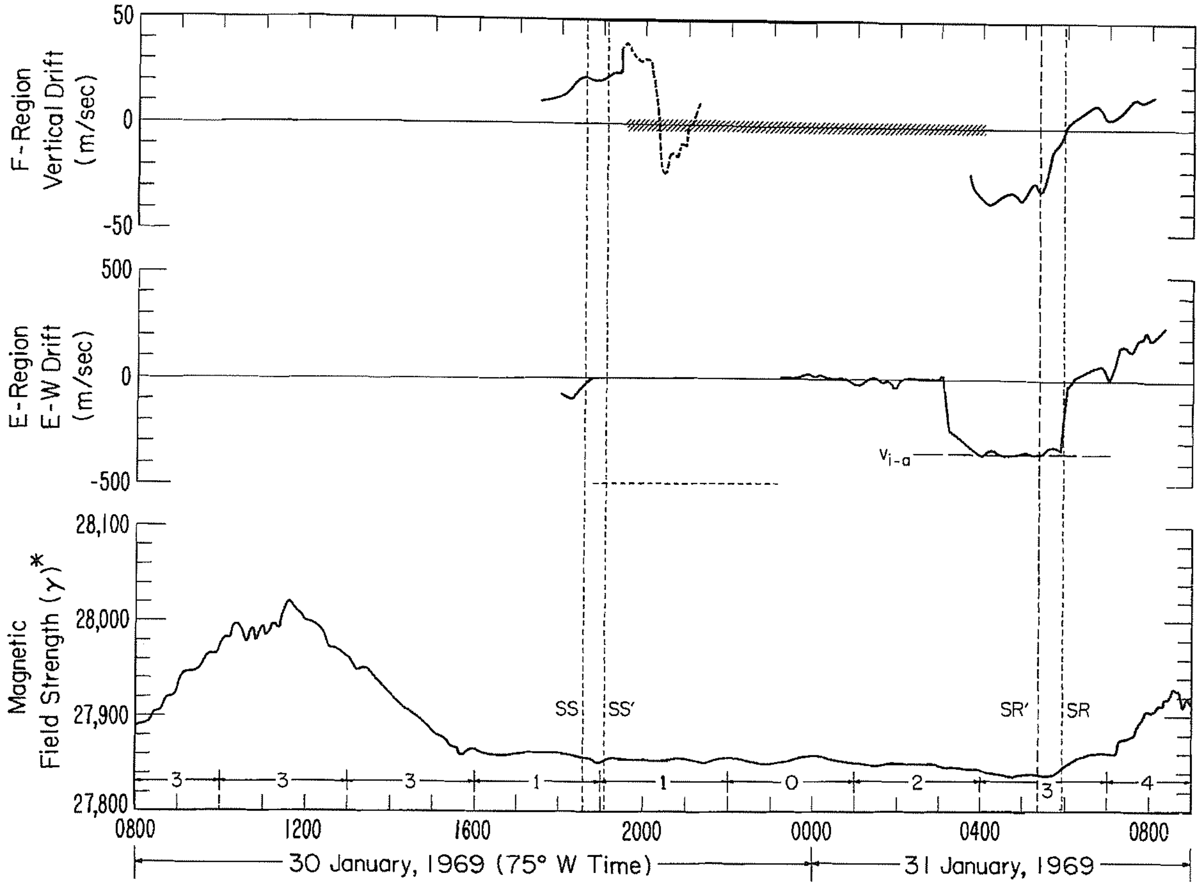

F-Region
Vertical Drift
(m/sec)
50
0
-50
E-Region
E-W Drift
(m/sec)
500
0
-500
Magnetic
Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS'
SR'
SR
3
3
3
3
1
1
0
1
3
0800
1200
1600
2000
0000
0400
0800
8 January, 1969 (75° W Time)
9 January, 1969

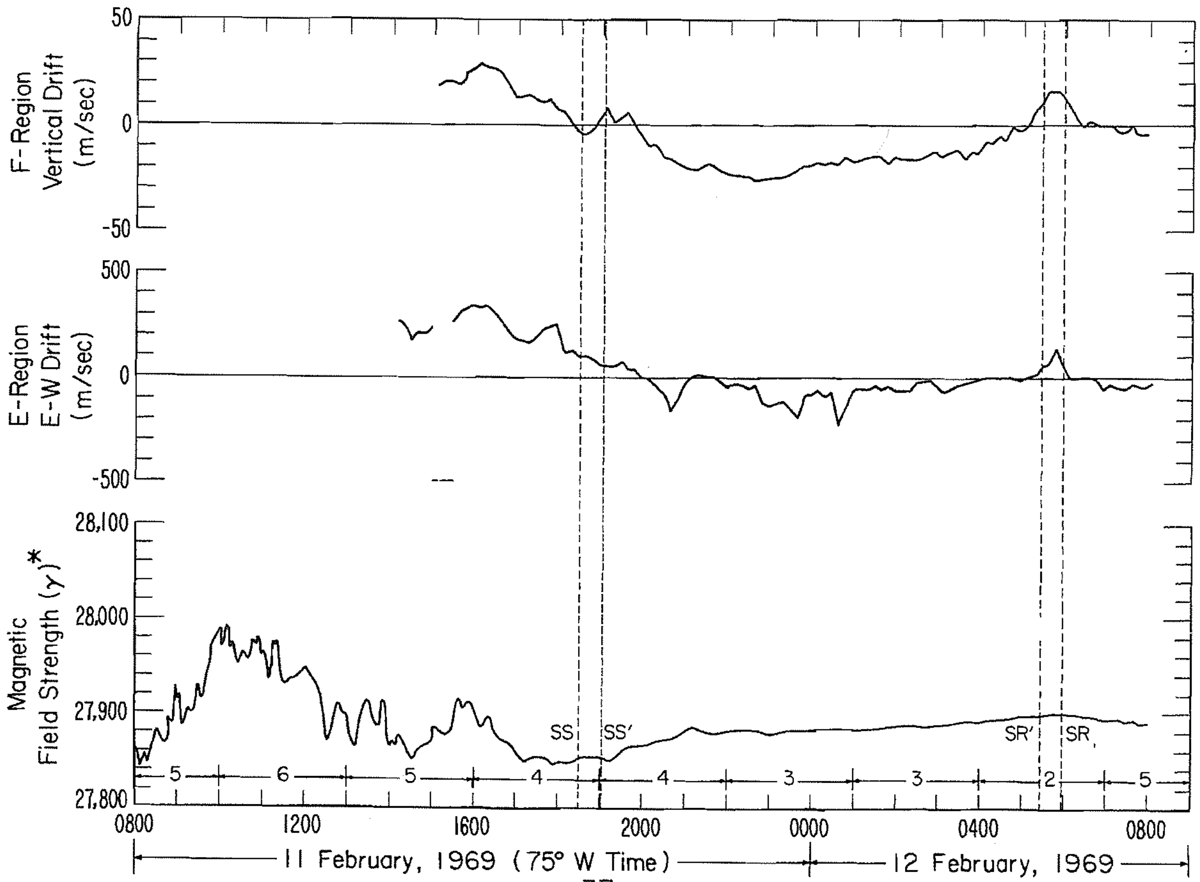


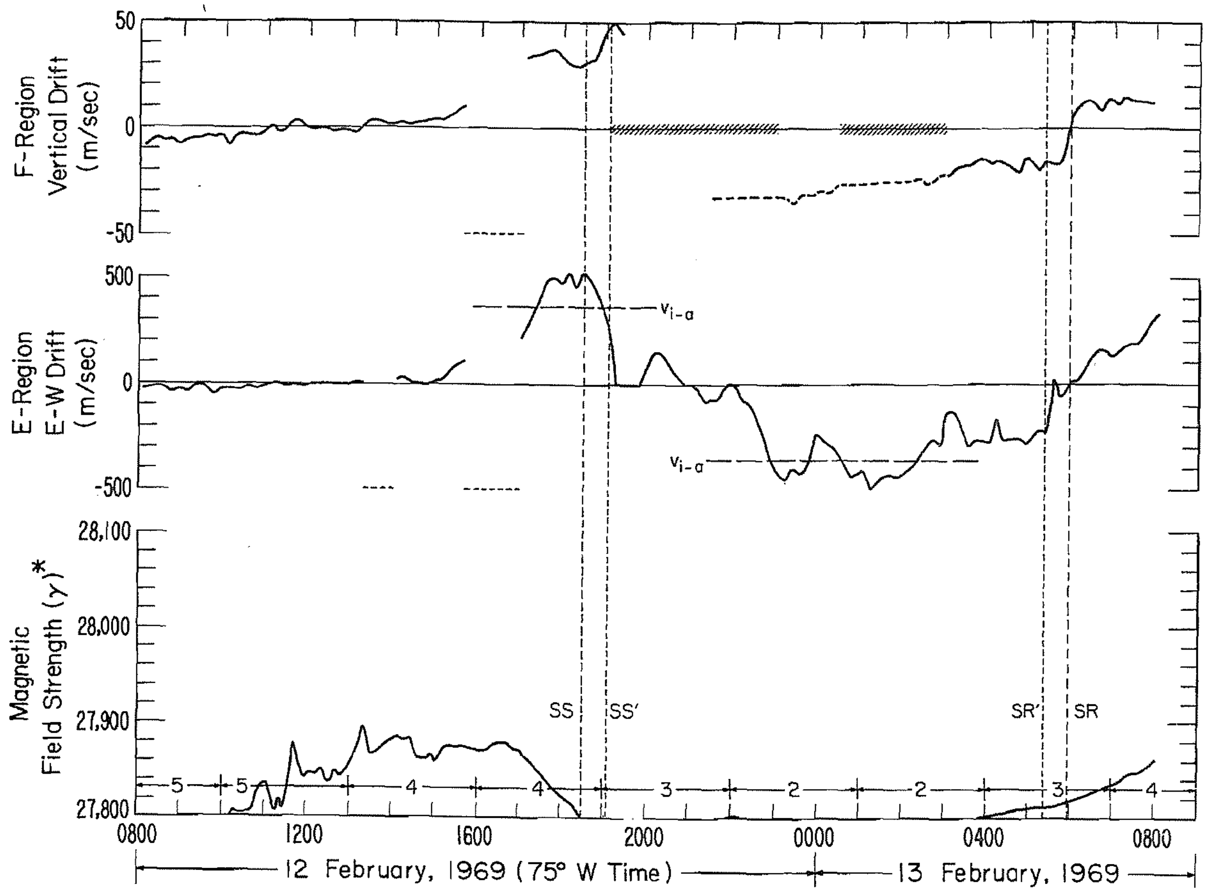
F-Region Vertical Drift (m/sec)
E-Region E-W Drift (m/sec)
Magnetic Field Strength (γ)*
v_{i-a}
SS
SS′
SR′
SR
9 January, 1969 (75° W Time)
10 January, 1969

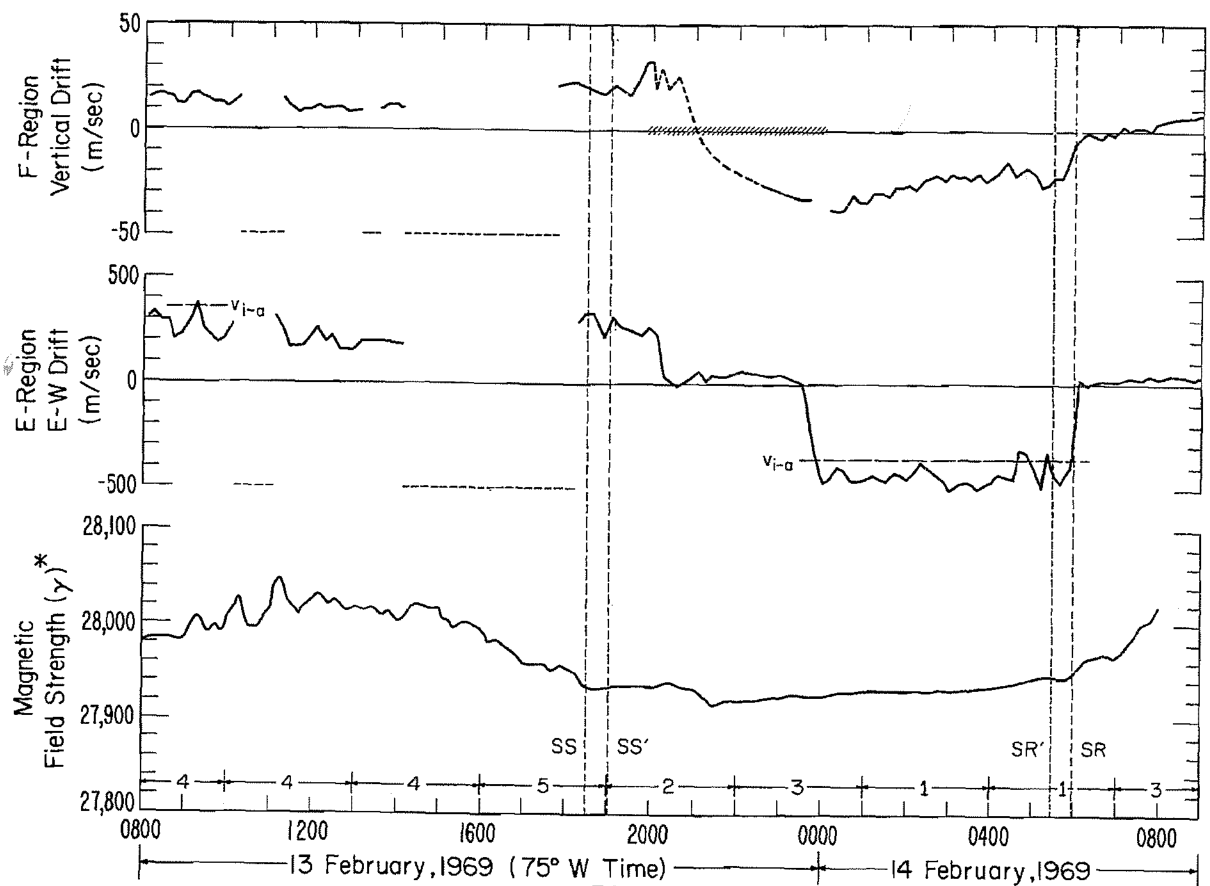


F-Region Vertical Drift (m/sec)
E-Region E-W Drift (m/sec)
Magnetic Field Strength (γ)*
SS
SS′
SR′
SR
10 January, 1969 (75° W Time)
11 January, 1969


F-Region
Vertical Drift
(m/sec)
50
0
-50
E-Region
E-W Drift
(m/sec)
500
0
-500
v_{i-a}
Magnetic
Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS′
SR′
SR
3
3
3
1
1
0
2
3
4
0800
1200
1600
2000
0000
0400
0800
30 January, 1969 (75° W Time)
31 January, 1969


F-Region
Vertical Drift
(m/sec)
50
0
-50
E-Region
E-W Drift
(m/sec)
500
0
-500
Magnetic
Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS′
SR′
SR
5
6
5
4
4
3
3
2
5
0800
1200
1600
2000
0000
0400
0800
11 February, 1969 (75° W Time)
12 February, 1969


F-Region Vertical Drift (m/sec)
50
0
-50
E-Region E-W Drift (m/sec)
500
0
-500
v_{i-a}
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS′
SR′
SR
5
5
4
4
3
2
2
3
4
0800
1200
1600
2000
0000
0400
0800
12 February, 1969 (75° W Time)
13 February, 1969


F-Region Vertical Drift (m/sec)
50
0
-50
E-Region E-W Drift (m/sec)
500
0
-500
v_{i-a}
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS′
SR′
SR
4
4
4
5
2
3
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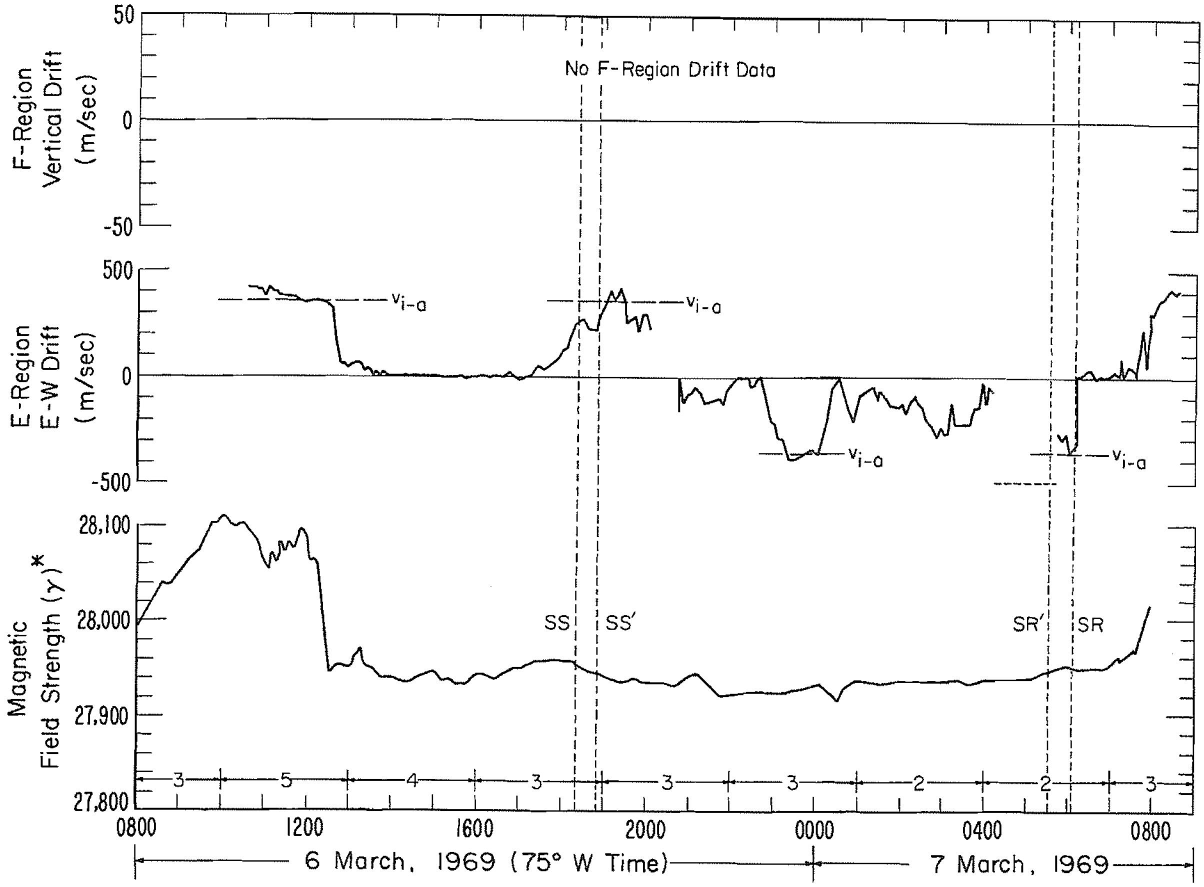
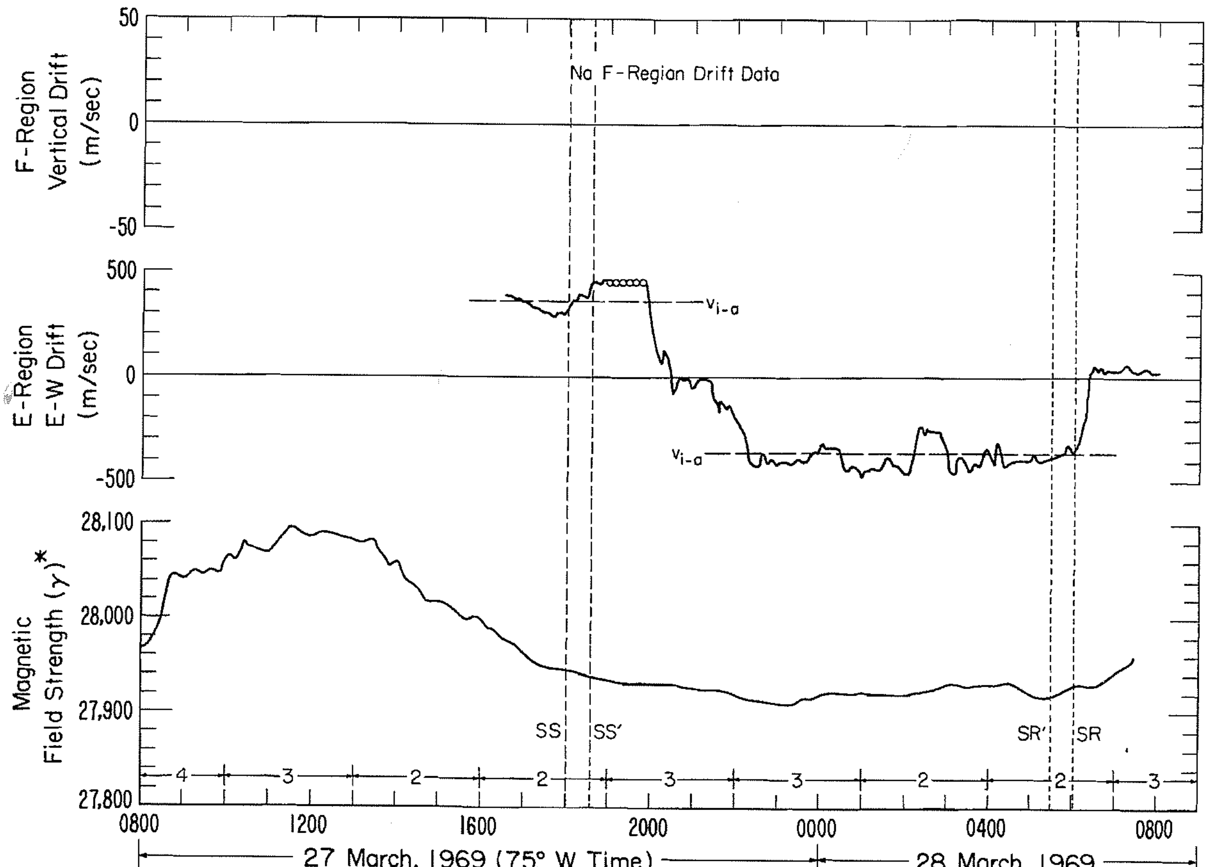
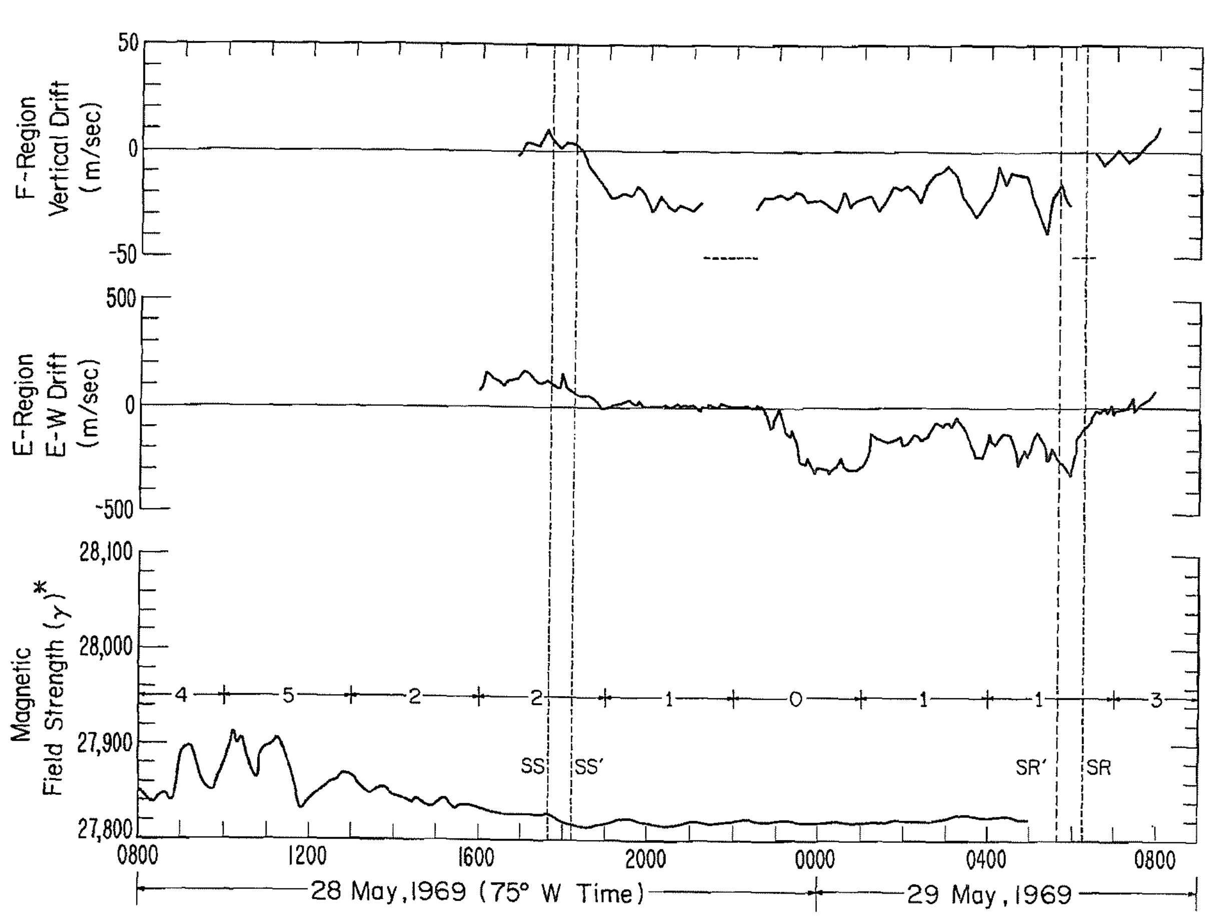
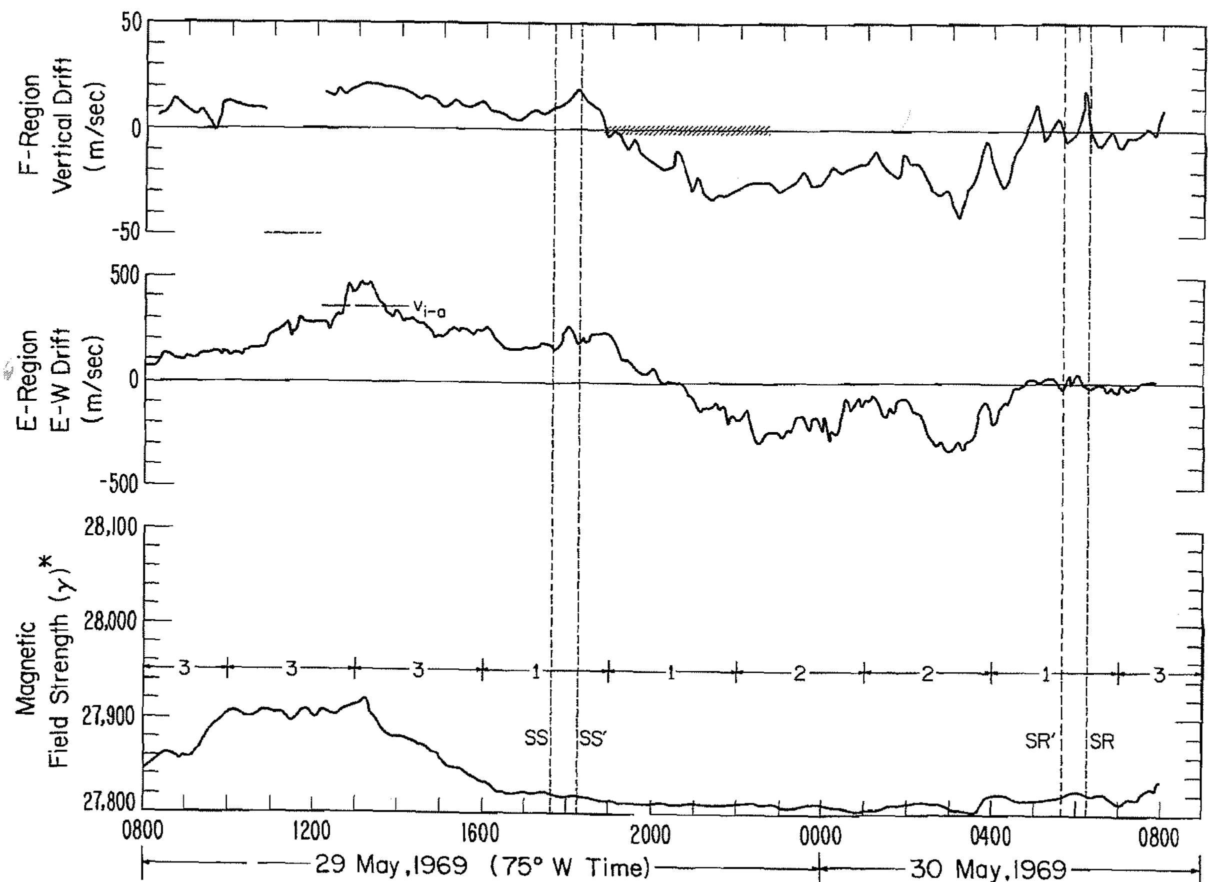
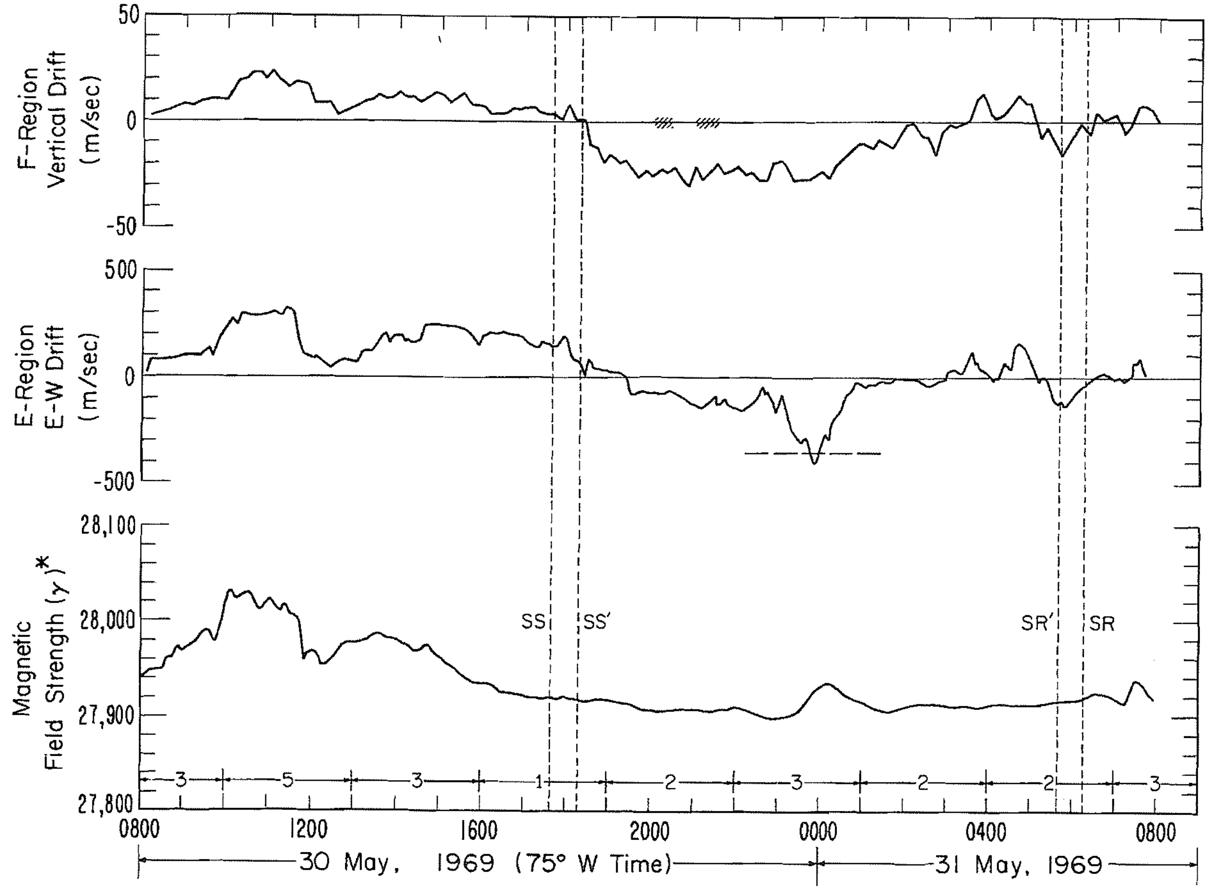
1
3
0800
1200
1600
2000
0000
0400
0800
13 February, 1969 (75° W Time)
14 February, 1969


F-Region Vertical Drift (m/sec)
No F-Region Drift Data
E-Region E-W Drift (m/sec)
v_{i-a}
Magnetic Field Strength (γ)*
SS
SS′
SR′
SR
0800
1200
1600
2000
0000
0400
0800
6 March, 1969 (75° W Time)
7 March, 1969

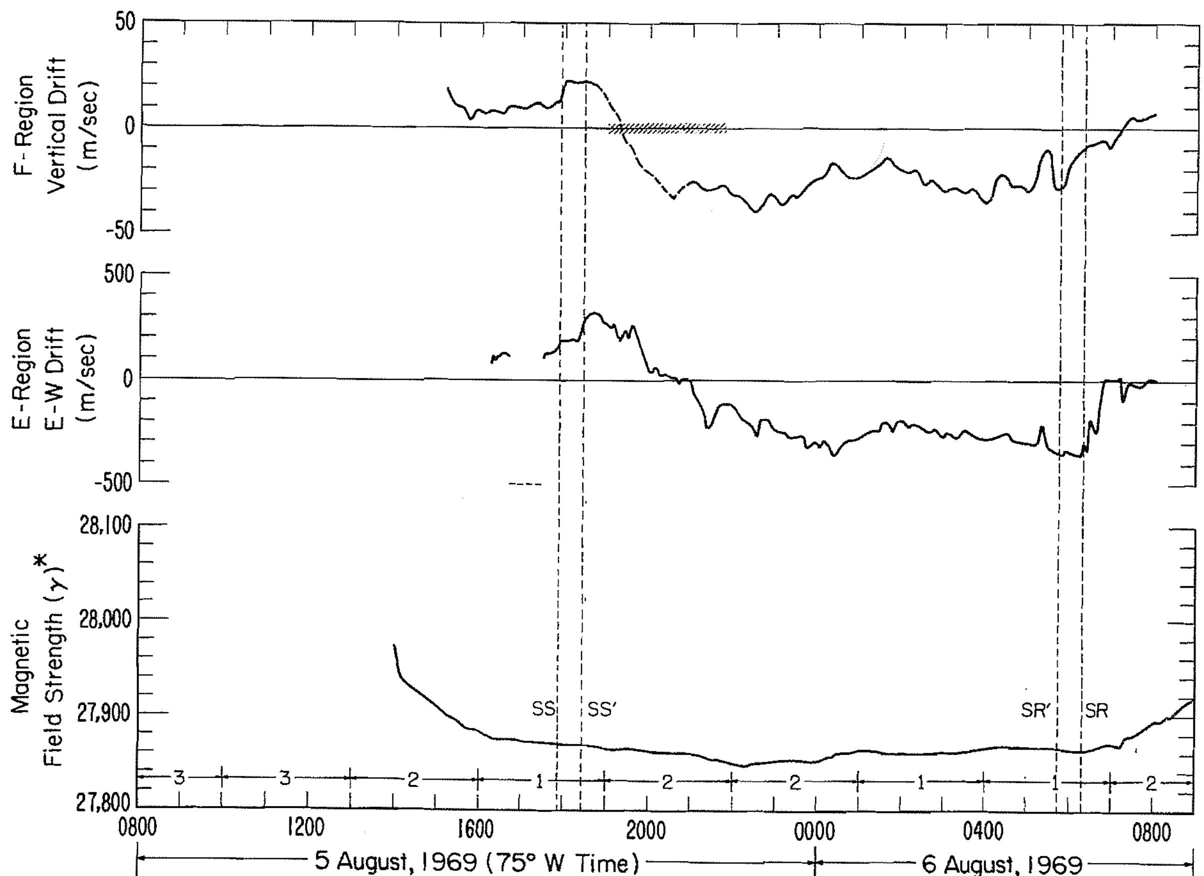

F-Region Vertical Drift (m/sec)
No F-Region Drift Data
E-Region E-W Drift (m/sec)
v_{i-a}
Magnetic Field Strength (γ)*
SS
SS′
SR′
SR
0800
1200
1600
2000
0000
0400
0800
27 March, 1969 (75° W Time)
28 March, 1969


F-Region
Vertical Drift
(m/sec)
E-Region
E-W Drift
(m/sec)
Magnetic
Field Strength (γ)*
50
0
-50
500
0
-500
28,100
28,000
27,900
27,800
4
5
2
2
1
0
1
1
3
SS
SS′
SR′
SR
0800
1200
1600
2000
0000
0400
0800
28 May, 1969 (75° W Time)
29 May, 1969

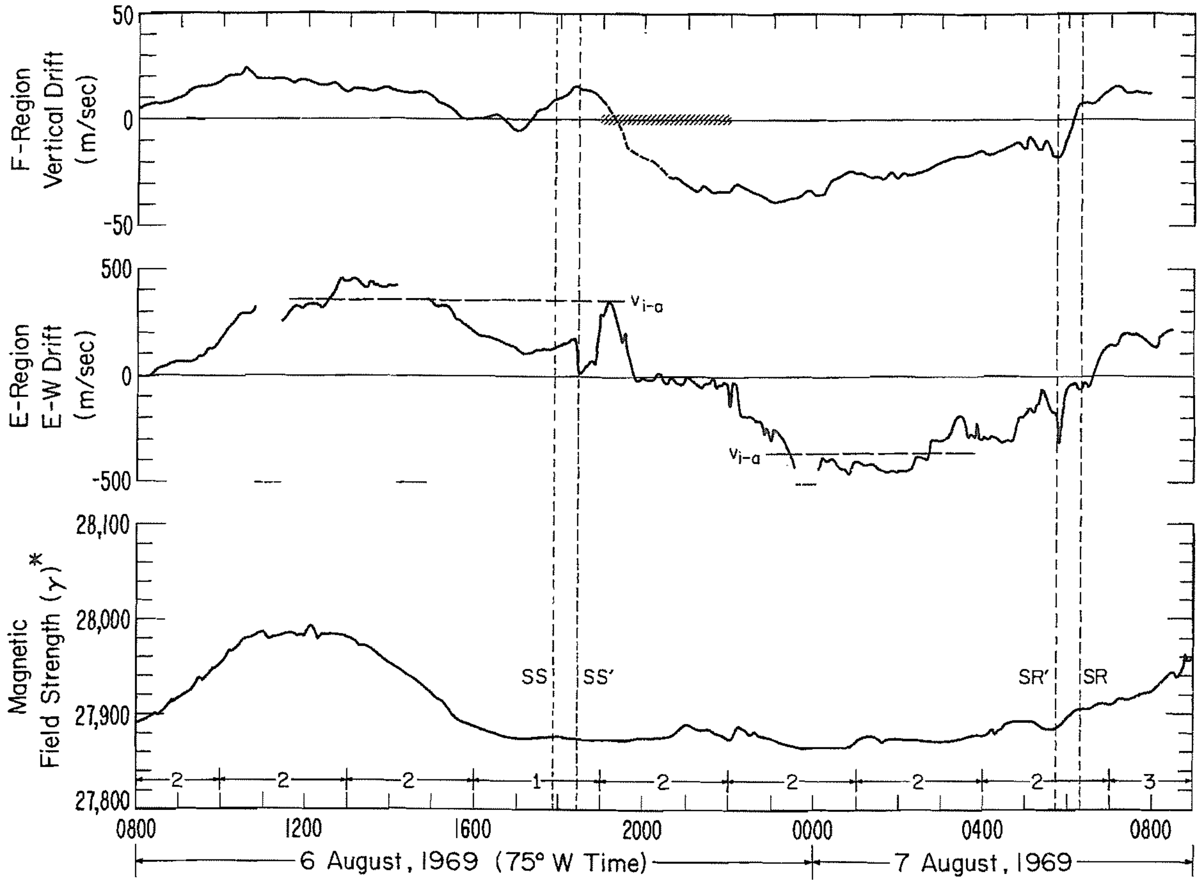

F-Region
Vertical Drift
(m/sec)
E-Region
E-W Drift
(m/sec)
Magnetic
Field Strength (γ)*
50
0
-50
500
0
-500
v_{i-a}
28,100
28,000
27,900
27,800
3
3
3
1
1
2
2
1
3
SS
SS′
SR′
SR
0800
1200
1600
2000
0000
0400
0800
29 May, 1969 (75° W Time)
30 May, 1969



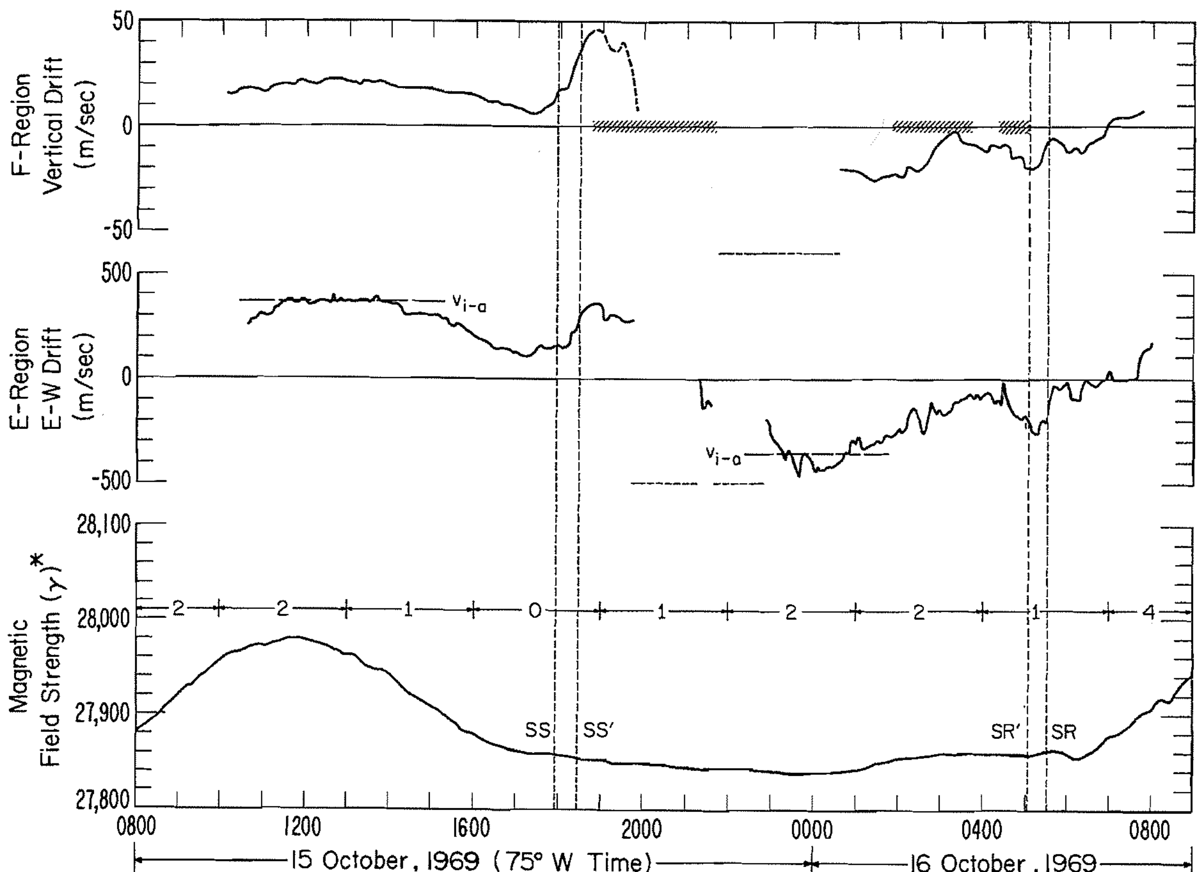
F-Region Vertical Drift (m/sec)
50
0
-50
E-Region E-W Drift (m/sec)
500
0
-500
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS′
SR′
SR
3
5
3
1
2
3
2
2
3
0800
1200
1600
2000
0000
0400
0800
30 May, 1969 (75° W Time)
31 May, 1969



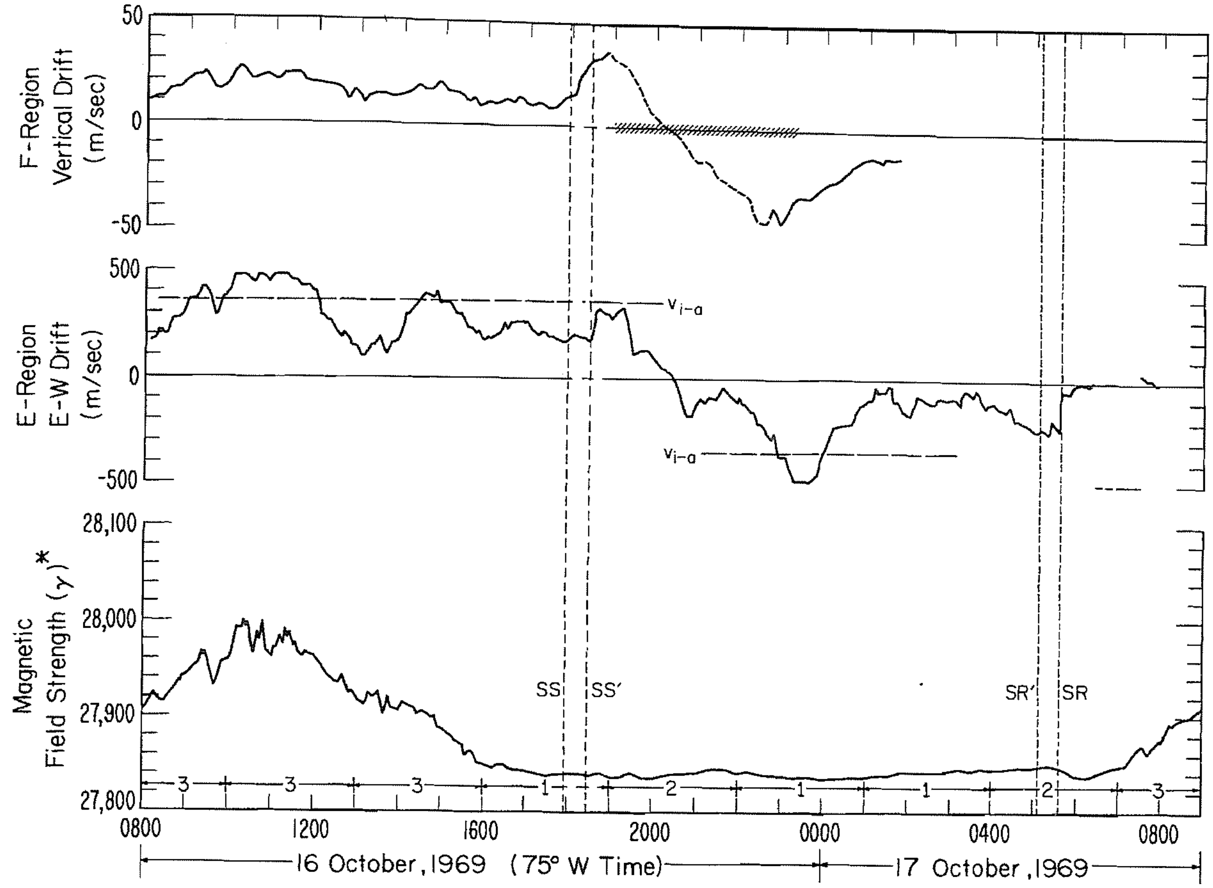
F-Region Vertical Drift (m/sec)
50
0
-50
E-Region E-W Drift (m/sec)
500
0
-500
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS′
SR′
SR
3
3
2
1
2
2
1
1
2
0800
1200
1600
2000
0000
0400
0800
5 August, 1969 (75° W Time)
6 August, 1969



50
0
-50
F-Region Vertical Drift (m/sec)
500
0
-500
E-Region E-W Drift (m/sec)
v_{i-a}
v_{i-a}
28,100
28,000
27,900
27,800
Magnetic Field Strength $(\gamma)^*$
SS
SS′
SR′
SR
2
2
2
1
2
2
2
2
3
0800
1200
1600
2000
0000
0400
0800
6 August, 1969 (75° W Time)
7 August, 1969



50
0
-50
F-Region Vertical Drift (m/sec)
500
0
-500
E-Region E-W Drift (m/sec)
v_{i-a}
v_{i-a}
28,100
28,000
27,900
27,800
Magnetic Field Strength $(\gamma)^*$
2
2
1
0
1
2
2
1
4
SS
SS′
SR′
SR
0800
1200
1600
2000
0000
0400
0800
15 October, 1969 (75° W Time)
16 October, 1969


F-Region Vertical Drift (m/sec)
50
0
-50
E-Region E-W Drift (m/sec)
500
0
-500
v_{i-a}
v_{i-a}
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS′
SR′
SR
3
3
3
1
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2
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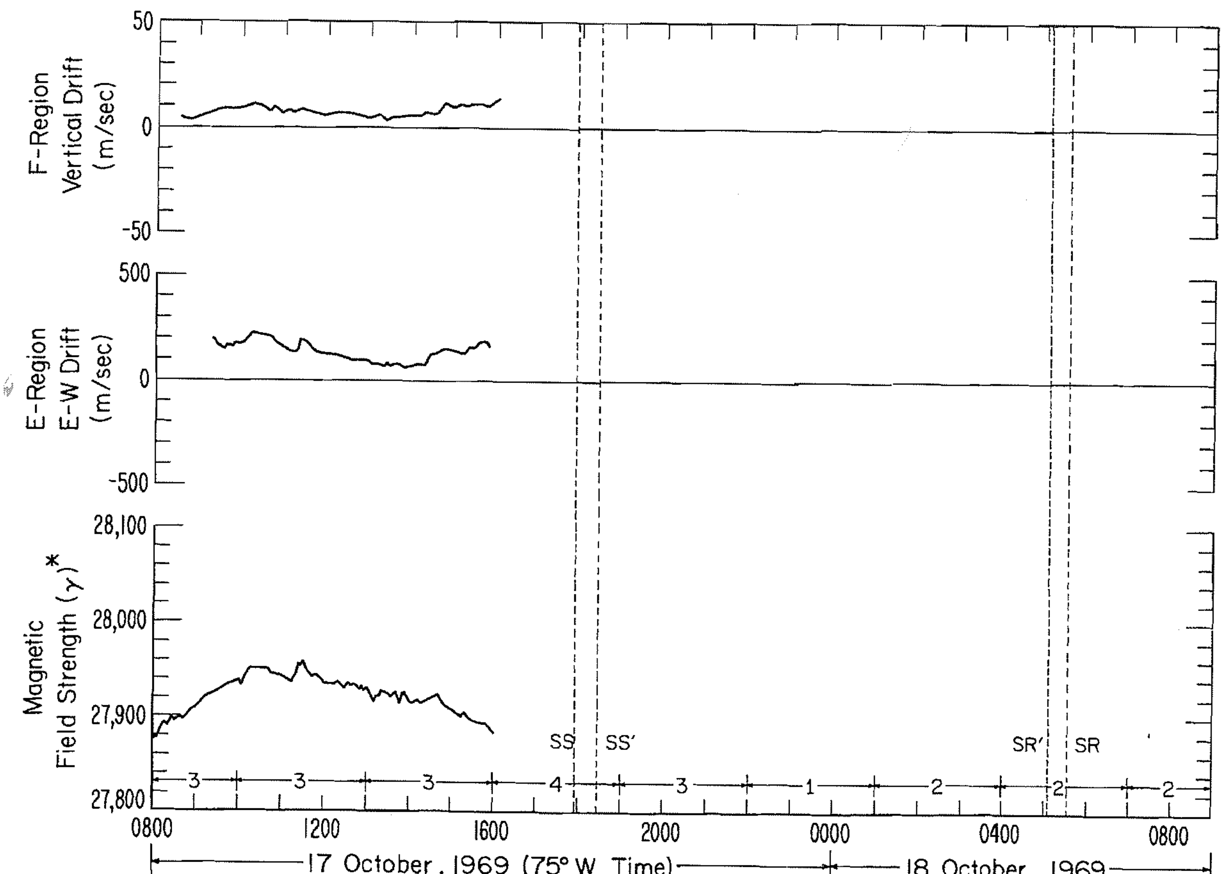
0800
1200
1600
2000
0000
0400
0800
16 October, 1969 (75° W Time)
17 October, 1969


F-Region Vertical Drift (m/sec)
50
0
-50
E-Region E-W Drift (m/sec)
500
0
-500
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
SS
SS′
SR′
SR
3
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3
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3
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2
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0800
1200
1600
2000
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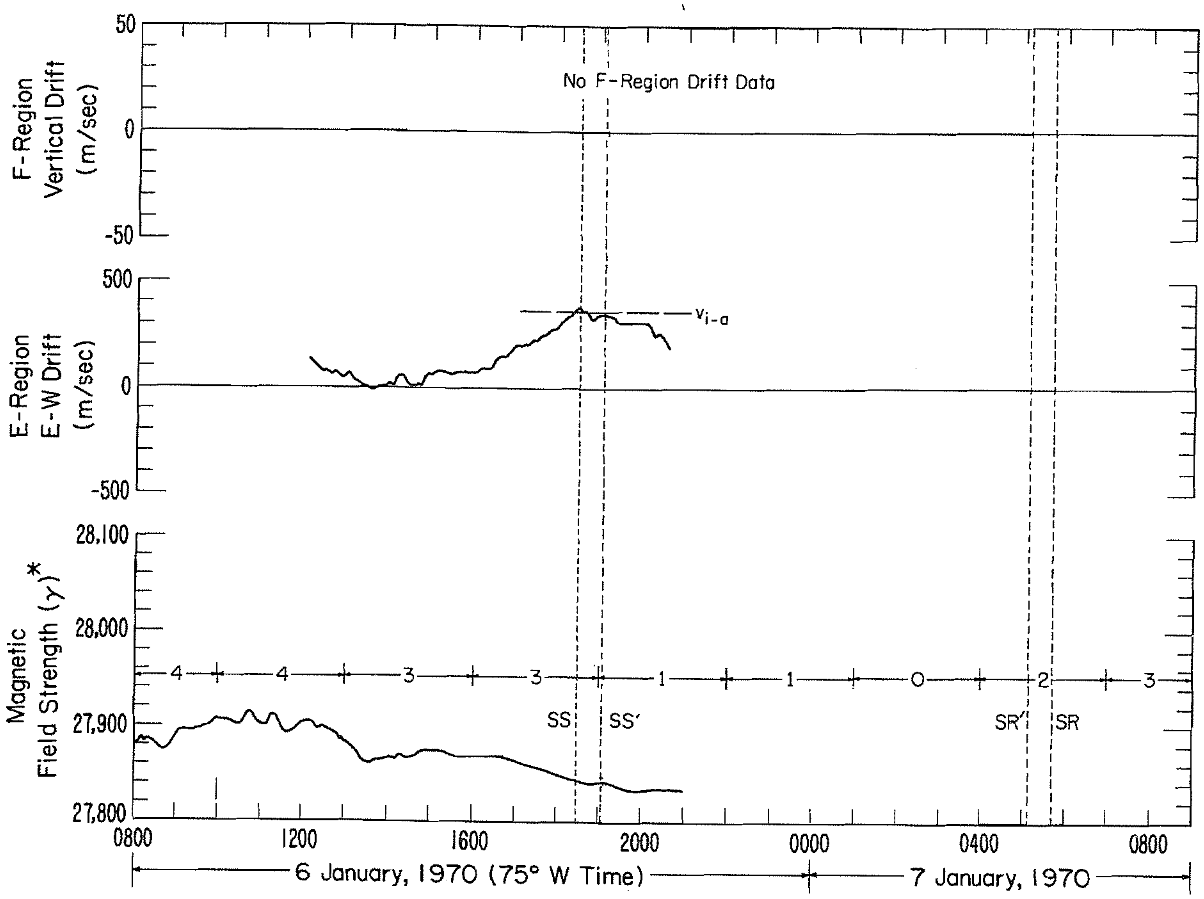
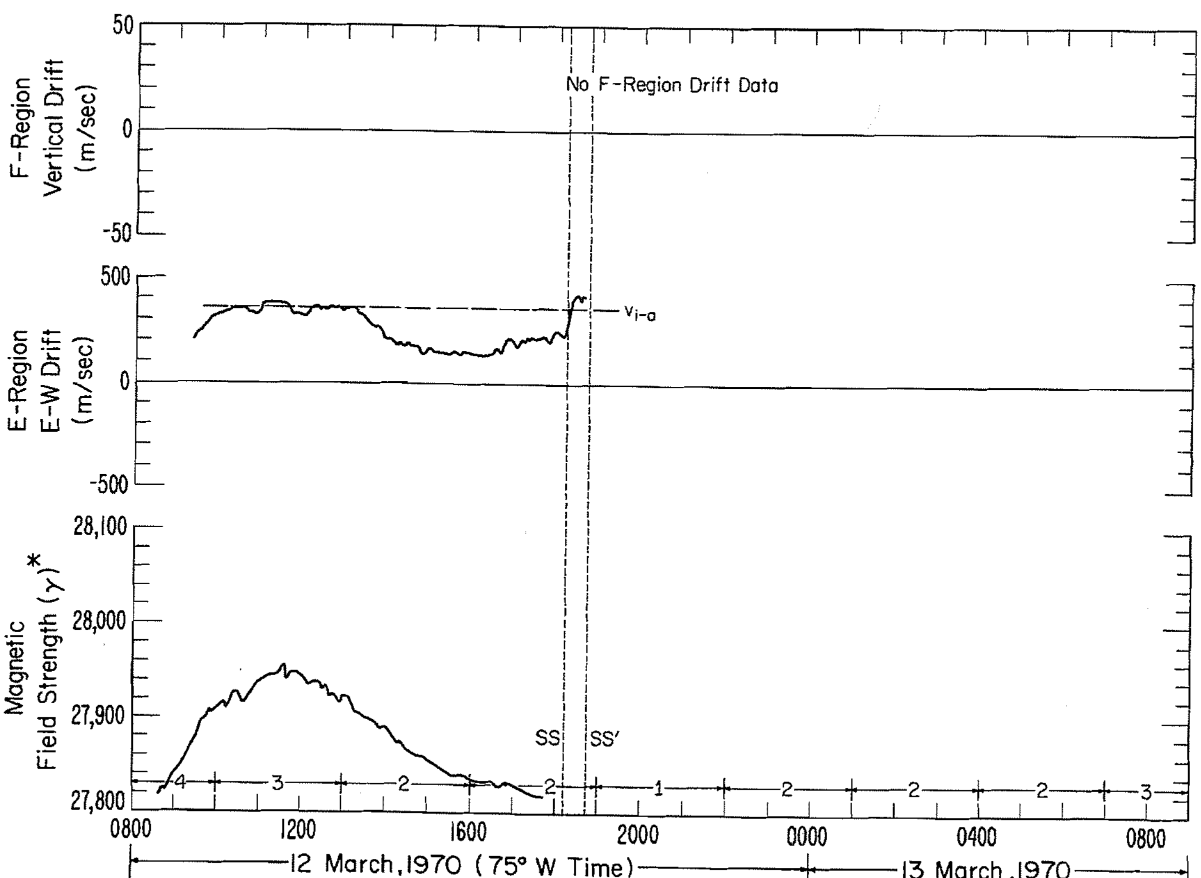
0400
0800
17 October, 1969 (75° W Time)
18 October, 1969


F-Region Vertical Drift (m/sec)
50
0
-50
No F-Region Drift Data
E-Region E-W Drift (m/sec)
500
0
-500
v_{i-a}
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
4
4
3
3
1
1
0
2
3
SS
SS′
SR′
SR
0800
1200
1600
2000
0000
0400
0800
6 January, 1970 (75° W Time)
7 January, 1970


F-Region Vertical Drift (m/sec)
50
0
-50
No F-Region Drift Data
E-Region E-W Drift (m/sec)
500
0
-500
v_{i-a}
Magnetic Field Strength (γ)*
28,100
28,000
27,900
27,800
4
3
2
2
1
2
2
2
3
SS
SS′
0800
1200
1600
2000
0000
0400
0800
12 March, 1970 (75° W Time)
13 March, 1970

Publication Notice

WORLD DATA CENTER A - UPPER ATMOSPHERE GEOPHYSICS REPORT UAG
(Prepared by World Data Center A, Upper Atmosphere Geophysics, NOAA, Boulder, Colorado)

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Upper Atmosphere Geophysics Report UAG-8, "Data on Solar Geophysical Activity October 24-November 6, 1968", Parts 1 and 2, compiled by J. Virginia Lincoln, World Data Center A, Upper Atmosphere Geophysics, ESSA, March 1970, single copy price (includes Parts 1 and 2) $1.75. Part 1 [Catalog No. C52.16/2:8/1], Part 2 [Catalog No. C52.16/2:8/2]

Upper Atmosphere Geophysics Report UAG-9, "Data on Cosmic Ray Event of November 18, 1968 and Associated Phenomena" compiled by J. Virginia Lincoln, World Data Center A, Upper Atmosphere Geophysics, ESSA, April 1970, single copy price 55 cents. [Catalog No. C52.16/2:9]

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