

UPPER ATMOSPHERE PHYSICS (UAP) DATA OBTAINED
AT SYOWA AND ASUKA STATIONS IN 1991

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1. Introduction

This data book summarizes upper atmosphere physics data acquired by the 32nd Japanese Antarctic Research Expedition (JARE-32) with the "Upper Atmosphere Physics Monitoring Systems" at Syowa Station and Asuka Station in 1991. The observations at the two stations are as follows:

At Syowa Station:

1) Geomagnetism : The H-, D- and Z-components of the geomagnetic field.

Total force of the geomagnetic field.

The H-, D- and Z-components of magnetic pulsations.

2) ELF-VLF wave : Intensities of ELF/VLF waves at frequencies 0.35, 0.75,

1.2, 2, 4, 8, 30, 60 and 95 kHz.

Wide-band (0-10 kHz) ELF-VLF emissions.

3) Ionosphere: Cosmic noise absorption at 30 MHz.

4) Aurora : All sky camera.

Panchromatic auroral images recorded on black and white film.

Scanning photometers.

Meridian scanning record at the following three wavelengths.

427.8 nm (N_2^+ 1NG), 630.0 nm (OI) and 486.1 nm (Hg)

Fixed directional photometers

Auroral intensity of 427.8 nm (N_2^+ 1NG) in three directions,

30° poleward, zenith and 30° equatorward.

All sky TV camera.

Panchromatic TV images of auroras.

At Asuka Station:

1) Geomagnetism: The H-, D-, and Z-components of the magnetic fields.

The H-, D-, and Z-components of magnetic pulsations.

2) VLF waves : Intensities at frequencies 0.65, 2.0, 8.0 kHz

Wide-band (0-10 kHz) ELF-VLF emissions

3) Ionosphere : Cosmic noise absorption at 30 MHz.

Differential doppler measurement of NNSS telemetry signals.

4) Aurora : All sky camera

Panchromatic auroral images recorded on black and white film

Scanning photometers

Meridian scanning record at the following wavelengths

557.7 nm(OI), 630.0nm(OI), 486.1nm(Hg)

Zenith photometer for 427.8 nm (N_2^+ 1NG).

All sky TV camera

Panchromatic TV images of auroras

Monochromatic CCD TV

Monochromatic TV images of auroras

Outlines of the observation systems at Syowa and Asuka are given in Section 2. Section 3 describes specifications of the observation instruments and the data acquisition systems. The recording periods are also listed in Section 3. The format of the compiled digital data is shown in Section 4. Magnetograms in the period January 1-December 31, 1991 observed at Syowa Station and in the period January 1- November 15, 1991 at Asuka Station are given in Appendix 1.

All sky camera film data, magnetograms and summary plots of monitoring data are available to researchers upon request. The request should be addressed to:

World Data Center C2 for Aurora
National Institute of Polar Research
9-10, Kaga 1-chome, Itabashi-ku,
Tokyo 173, Japan.

Digital and analog data described here are available to researchers who want to conduct joint studies with personnel of the upper atmosphere physics branch of NIPR. The request should be addressed to:

Upper Atmosphere Research Division
National Institute of Polar Research
9-10, Kaga 1-chome, Itabashi-ku,
Tokyo 173, Japan.

2. Upper Atmosphere Physics Monitoring System

2.1. Syowa Station

The real-time digital data acquisition system for upper atmosphere physics observations was constructed at Syowa Station in January 1981 (Sato *et al.*, 1984). Data obtained from the system have been collected and published annually in the JARE Data Reports (Upper Atmosphere Physics) (Sato *et al.*, 1984 ; Fujii *et al.*, 1985; Sakurai *et al.*, 1985 ; Ono *et al.*, 1986; Yamagishi *et al.*, 1987; Kikuchi *et al.*, 1988; Miyaoka *et al.*, 1990; Sato *et al.*, 1991 ; Kadokura *et al.*, 1992, Ono *et al.*, 1993). This report is the 11th of this series.

A block diagram of the system is shown in Fig. 1. The sensors for measuring weak natural electromagnetic waves such as ELF-VLF emissions, the three components of ULF magnetic pulsations and cosmic radio noise absorption (CNA) have been placed at the remote station on West Ongul Island, located about 5 km from Syowa Station in order to avoid man-made electromagnetic interference, since 1981.. Data of the magnetic pulsations and CNA are transmitted continuously to Syowa Station by PCM telemeter in the VHF band. Wide-band signals of ELF-VLF emissions are transmitted to Syowa Station through the FM telemeter in the UHF band.

At the remote station, the electric power which drives all the instruments has been supplied by a solar battery system with maximum output power of 530 W since February 1985. An additional solar battery system with maximum power of 365 W was constructed in January 1987 to reinforce the original battery system. The solar battery system consists of eighteen rechargeable car batteries (200 Ah each), five solar panels and three controllers in total. During winter when no sunlight is available, the batteries are charged manually about once a month by using the 16 kVA diesel-engine dynamo.

The fluxgate magnetometer and proton magnetometer sensors are placed at Syowa Station on East Ongul Island, about 150 m from the Data Processing Building. All the auroral photometric instruments such as photometers and a TV camera are placed on the roof of the data processing building. The data acquisition facilities are installed inside the Data Processing Building. All output obtained from the observation instruments are transferred to the matrix terminal board and then recorded with pen recorders, analog data recorders and a computer system. These data have been recorded simultaneously with two sets of the TEAC DR-200 digital data logger systems since January 1987. An 8 mm video tape recorder is used to record wide-band VLF emissions, and 24-hour data can be stored on one volume of 8 mm video tape.

Universal time (UT) is supplied from a precise time-keeping system. This system consists of an NNSS satellite timing receiver, a quartz frequency standard with a stability of 2×10^{-11} /day, and time code generators. The time code generators supply the IRIG-A, -B and slow codes for analog data recorders and the 36-bit BCD code for the digital recording systems, respectively. The absolute accuracy of this system is estimated to be about 1 ms.

2.2. Asuka Station

A block diagram of the upper atmosphere physics monitoring system at Asuka Station is shown in Fig. 2. Sensors of the induction and fluxgate magnetometers, and the 30 MHz riometer, are located under snow, approximately 150 m southeast of the old observation building. The meridian scanning photometer and zenith photometer are placed on the roof of the optical building newly installed by JARE 32. The all-sky camera and all sky TV camera were installed inside the optical building. A loop antenna (1 m x 1 m square) to receive Omega signals for a time-code generator was also set up about 50 m southeast of the old observation building. A VLF antenna was constructed 500m away from the optical building.

Observation signals from the induction, the fluxgate magnetometers and the riometer were put into a digital data logger system (TEAC DR-200/MT800GP), a long-term analog data recorder R-950L and an 8-channel chart recorder. During the auroral observation season, photometer data were recorded by the digital data logger system and chart recorders. All-sky TV data were recorded by using VHS and U-matic video recorder. The time-code generator (ECHO AQ-9000), which was automatically corrected within ± 10 ms using Omega signals, supplied analog data recorders with IRIG-B and slow code, and also the digital data logger system with BCD time-code, 0.5 pps sampling pulses and 1 pps external clocks, continuously.

3. Specifications of Instruments

3.1. Syowa Station

3.1.1. Geomagnetism

(1) Magnetogram

Magnetic variations were measured by a three-axis fluxgate magnetometer. The full-scale range of the H-component has been changed since February 8, 1990 to avoid saturation due to big storms. The full scale ranges were +1250 to -3750 nT for the H-component and ± 2500 nT for D- and Z-components, respectively, with the frequency response of DC-2 Hz and with noise levels less than

0.5 nT. The data obtained from the magnetometer were recorded in digital form at the sampling rate of 1 Hz. The H-component data were also recorded on a chart recorder and an R-950L long-term analog data recorder.

Continuous computer plots of the magnetograms from January 1, 1991 to December 31, 1991 are given in Appendix 1, where positive signs of the H-, D-, and Z-components indicate northward, westward and downward, respectively, with one division of the vertical axis corresponding to 100 nT.

(2) Total force of the geomagnetic field

Due to unexpected trouble with the proton magnetometer in January, 1991, the total force observations were made only about once a month until January, 1992, using the other proton magnetometer, which was unable to be linked with the UAP system. The results are listed in Table 1.

(3) ULF magnetic pulsations

The H-, D-, and Z-components of ULF magnetic pulsations are detected by three sets of search coil magnetometers. The search coil sensors have copper wires (0.4 mm ϕ , 40000 turns each) wound around permalloy cores (1cm in diameter x 100 cm in length). The measurable intensity range of the magnetometer is 0.001-5 nT/s and the frequency response is 0.001-3 Hz. The search coil magnetometers are located at the remote station on West Ongul Island. The output signals transmitted by the PCM telemeter are recorded on an R-950L long-term analog data recorder, a chart recorder and a digital data recorder. The sampling frequency of the digital data is 1 Hz for each component.

(4) Base line of the magnetic field and K-index

The K-indices are calculated for every 3-hour interval measuring the maximum deviations of the H- and D-component magnetic fields from quiet-day baselines. The definition of the K-indices at Syowa Station is as follows.

0	:	0 - 25 nT	5	:	350 - 600 nT
1	:	25 - 50	6	:	600 - 1000
2	:	50 - 100	7	:	1000 - 1660
3	:	100 - 200	8	:	1660 - 2500
4	:	200 - 350	9	:	2500 and more

Table 2 gives K-indices at Syowa Station in 1991. Inquiries or requests for data copies of the magnetic field measurements should be addressed to World Data Center C2 for Aurora, NIPR.

3.1.2. ELF-VLF waves

The natural ELF-VLF wave receiving system at the remote station has consisted of a triangle-shaped three turn loop antenna (10 m in height, 20 m in the bottom side), a pre-amplifier and a main amplifier with gains of 60 and 40 dB, respectively. The ELF-VLF wave intensities at the frequency bands of 0.35, 0.75, 1.2, 2, 4, 8, 30, 60, 95 kHz were obtained from wide band waveforms using a 9-channel filter bank and a detector. The ELF-VLF emissions within the intensity range of 10^{-17} to 10^{-13} W/m² Hz were detectable with this system. These data were recorded continuously with the sampling rate of 1 Hz. Some of the wide-band ELF-VLF signals up to 10 kHz were recorded on 8 mm video tape recorders.

3.1.3. Ionosphere

Cosmic noise absorption at 30 MHz was measured with a riometer made by La Jolla Science. The bandwidth and time constant of the receiver were 150 kHz and 0.25 s, respectively.

Observations of the ionospheric vertical soundings, the cosmic noise absorption (20, 30 and 45 MHz), the CW field strength (8 and 10 MHz) and the VHF auroral radar (112 MHz) were carried out continuously by other observation systems at Syowa Station, and the observational results have been published in another JARE Data Report (Ionosphere). Inquiries and requests for data copies are to be addressed to:

World Data Center C2 for Ionosphere
Communications Research Laboratory
Ministry of Posts and Telecommunications
2-1, Nukui-Kitamachi 4-chome, Koganei-shi, Tokyo 184, Japan.

3.1.4. Aurora

(1) All-sky camera

Black and white all sky auroral images were observed using a 35 mm cine-pulse camera with a fish-eye lens of f/1.4 and an exposure time of 7 s. The observations were carried out during clear nights in early 1991, as given in Table 3, but were then stopped due to trouble with the film feed motor. The SIT all-sky TV camera observations described below were made on almost all clear sky nights at the sampling rates of 30 Hz for VTR and 10 s for optical video disc recordings. Inquiries or

requests for the all sky data copies should be addressed to World Data Center C2 for Aurora in NIPR.

(2) Meridian scanning photometer

Auroral emissions at the wavelengths of 427.8 nm (N_2^+ 1NG), 630.0 nm (OI) and 486.1 nm (Hg) were observed by a meridian scanning photometer installed in 1987. The interference filter for Hg was tilted with 1 s period, measuring the doppler effect of the auroral Hg emission. The field of view of the photometer was 3° for 427.8 nm and 630.0 nm, and 5° for Hg emissions. The scanning from the poleward horizon to the equatorward horizon required 30 s. The meridian scanning photometer data were recorded with a sampling frequency of 10 or 25 Hz.

(3) Fixed directional photometer

A three-direction photometer detected 427.8 nm emissions at three zenith angles (zenith, 30° poleward and 30° equatorward), with the field of view 5°. The detectable auroral range was from 7 R to 28 kR.

(4) All sky TV

Auroral images were obtained from the SIT all sky TV camera. Observed images were recorded using VTRs in NTSC format, and images every 10 s were also recorded on an Optical Video Disk (OVD) which can store 108,000 pictures on one disk.

3.2. Asuka Station

3.2.1. Magnetogram

Magnetic variations were measured by a three-axis fluxgate magnetometer (SHIMAZU MB162), the same type as used at Syowa Station. The full-scale ranges were +1250 -3750 nT for H-component and ± 2500 nT for D- and Z- components; the frequency response was DC-2 Hz. The noise level was less than 0.5 nT. The fluxgate magnetometer was set in the sensor area about 150 m southeast of the observation building. The H-, D-, and Z-components of the magnetometer were simultaneously supplied to a R-950L long-term data recorder, an 8-channel chart recorder and a DR-200 digital data logger with a sampling rate of 1 Hz.

Continuous computer plots of magnetograms in the period January 1 to November 15, 1991 are given in Appendix 1 along with the magnetograms at Syowa Station. In these plots, positive signs of

the H-, D-, and Z-components indicate northward, westward and downward, respectively. One division of the vertical axis corresponds to 100 nT.

3.2.2. ULF magnetic pulsations

The H-, D-, and Z-components of ULF magnetic pulsations were detected by the search coil (induction) magnetometers of the same type as those used at Syowa Station. The search coil magnetometers were also set in the sensor area about 150 m southeast of the observation building. The output signals from the induction magnetometer were supplied to the R-950L data recorder, the 8-channel chart recorder and the DR-200 digital data logger. The sampling frequency of the digital data was 1 Hz.

3.2.3. VLF waves

The natural VLF wave receiving system consisted of a square antenna (30m in length and 2 m in height) and pre-main amplifier with a gain of about 100 dB. A counter poise was constructed under the snow in order to obtain a proper signal ground. Wide band VLF signals up to 10kHz were recorded on an 8mm video tape recorder, and band-limited VLF wave intensities (0.65, 2.0, 8.0kHz) were recorded on an FM recorder.

3.2.4. Ionosphere

Cosmic noise absorption at 30 MHz was measured with a riometer made by La Jolla Science, the same type as used at Syowa Station. The bandwidth and time constant of the receiver were 150 kHz and 0.25 s, respectively. The riometer was also set in the sensor area about 150 m southeast of the observation building in December 1988. The riometer data were also supplied to the R-950L data logger. The sampling frequency of the digital data was 1 Hz.

Differential doppler frequency of the NNSS telemetry signals (150 and 400 MHz) was measured by using an NNSS receiver during 1991. The differential doppler frequency gives variation of the total electron content along the telemetry signal path. The measured frequency was recorded on a floppy disk every 1 s by using a personal computer.

3.2.5. Aurora

(1) Zenith photometer

A zenith photometer for detecting 427.8 nm (N_2^+ 1NG) emission was installed on the optical building . The data were recorded by an 8-channel chart recorder and a DR-200 digital data logger with the sampling frequency of 1 Hz.

(2) Meridian scanning photometer

Auroral emissions at wave lengths of 557.7nm(OI),630.0nm(OI) and 486.1nm(H β) were observed by a meridian scanning photometer. The interference filter for H β was tilted with 1 sec period measuring a doppler effect of the auroral H β emission. The field of view of the photometer was 3 degrees for these three waves lengths. The scanning period from the poleward to the equatorward horizon is 30 sec.

(3) All sky camera

Black and white all sky aurora images were observed by using a 35 mm cine-pulse camera with an f/2.8 fish-eye lens of. A picture was taken every 30 s with an exposure time of 20 s using KODAK 4-X (ISO 400) film. The observations were carried out during clear nights in 1991, as given in Table 4.

(4) All-sky TV

Auroral images were obtained from the SIT all-sky TV camera. The data were recorded by using VTR in NTSC format. The observation periods are listed in Table 4.

(5) Monochromatic CCD TV

Monochromatic imaging of aurora was done by using intensified CCD imagery. Observation wavelengths were selected from 630.0nm, 557.7nm and 486.1nm. The data were recorded on VTR. The observation periods are listed in Table 4.

4. Compiled Digital Tape Format

4.1. Syowa Station

Data have been digitally recorded continuously since 1981. A similar recording system has been used in Iceland for the geomagnetic conjugate observations. The specifications of the compiled digital tapes are as follows:

Tracks	: 9
Record density	: 6250 BPI
Record format	: FB
Block length	: 28848 bytes

Logical record length : 48 bytes

Label : Non-label

Filing : Multi-file (1 file/day)

24 kinds of upper atmospheric data are recorded every 1 s in the following sequence.

Word No.	Observation item	Word No.	Observation item
1	H-component of magn. field	13	VLF 8 kHz
2	D-component of magn. field	14	VLF 30 kHz
3	Z-component of magn. field	15	VLF 60 kHz
4	H-component of ULF waves	16	VLF 95 kHz
5	D-component of ULF waves	17	Total magn. force
6	Z-component of ULF waves	18	MBR angle
7	CNA (30 MHz)	19	MBR N-S sweep
8	VLF 350 Hz	20	MBR E-W sweep
9	VLF 750 Hz	21	MBR E30°
10	VLF 1.2 kHz	22	MBR S30°
11	VLF 2 kHz	23	MBR Zenith
12	VLF 4 kHz	24	MBR N30°

Each datum is recorded in the 2 byte binary form of signed 2's complement. A set of these 24 data makes a logical record of 48 bytes; the 10-min data make a block of 28848 bytes. A file contains one day of data (144 blocks) and a volume contains one month of data (28-31 files), as shown in Figure 3. At the beginning of each block, the starting time of the observation period is written in the following format (48 bytes):

Sequence	Item
1	Year (2 bytes)
2	Total day (2 bytes)
3	Hour (2 bytes)
4	Minute (2 bytes)
5	Station code (4 bytes)
6	Space (36 bytes)

The magnetic field data recorded on a compiled tape can be transformed to physical quantities by the following relations:

$$H, D, Z\text{-component of the geomagn. field (nT)} = \text{DATA} \times 2500/2048$$

$$H\text{-component of ULF waves (nT/s)} = \text{DATA}/141$$

$$D\text{-component of ULF waves (nT/s)} = \text{DATA}/158$$

$$Z\text{-component of ULF waves (nT/s)} = \text{DATA}/316$$

For CNA, VLF and MBR data, individual calibration values are required to transform MT data. Inquiries on these data should be addressed to the Upper Atmosphere Research Division of NIPR. For more detailed information on the compiled data, see Uchida *et al.* (1988).

4.2. Asuka Station

Digital data recording with a TEAC DR-200/MT-800GP system was started on February 19, 1987 at Asuka Station. These data have been compiled in the same format as the DR-200 data from Syowa and Iceland Stations. The specification of the compiled digital tapes are as follows:

Tracks	: 9
Record density	: 6250 BPI
Record format	: FB
Block length	: 9616 bytes
Logical record length	: 16 bytes
Label	: Non-label
Filing	: Multi-file (1 file/day)

On these tapes, 8 kinds of upper atmospheric data are recorded every 2 s in the following sequence.

Word No.	Observation item
1	H-component of magnetic field
2	D-component of magnetic field
3	Z-component of magnetic field
4	H-component of ULF waves
5	D-component of ULF waves
6	Z-component of ULF waves
7	CNA (30 MHz)

H, D, Z-components of the geomagnetic field in nT are obtained by DATA*2500/2048. Figure 4 illustrates the structure of the compiled digital tape for Asuka Station. The sampling frequency of the digital data was 1 Hz. Ten minutes of data, consisting of 601 logical records (600 points of 1 s data and a time header), form one data block of 9616 bytes. For further information on these data, contact Upper Atmosphere Research Division of NIPR.

4.3 Available facilities and utilities

The HITAC M-680D computer system of the Information Science Center is available for collaborative researchers of NIPR. The center has also been providing various kinds of software such as tape-to-tape copy, displays and spectrum analysis program to the researchers.

Acknowledgments

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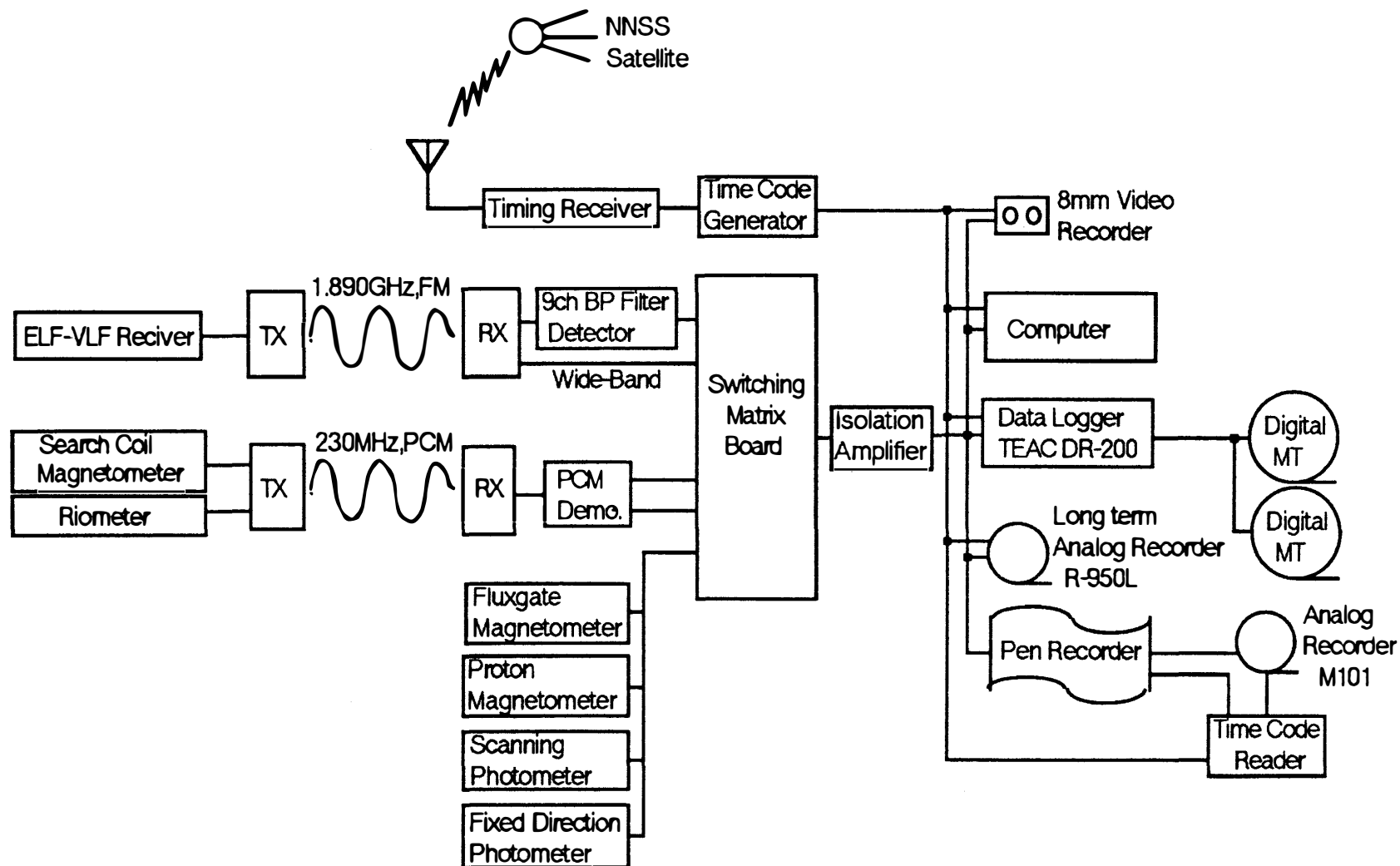


Fig. 1. Block diagram of the "Upper Atmosphere Physics" monitoring system at Syowa Station.

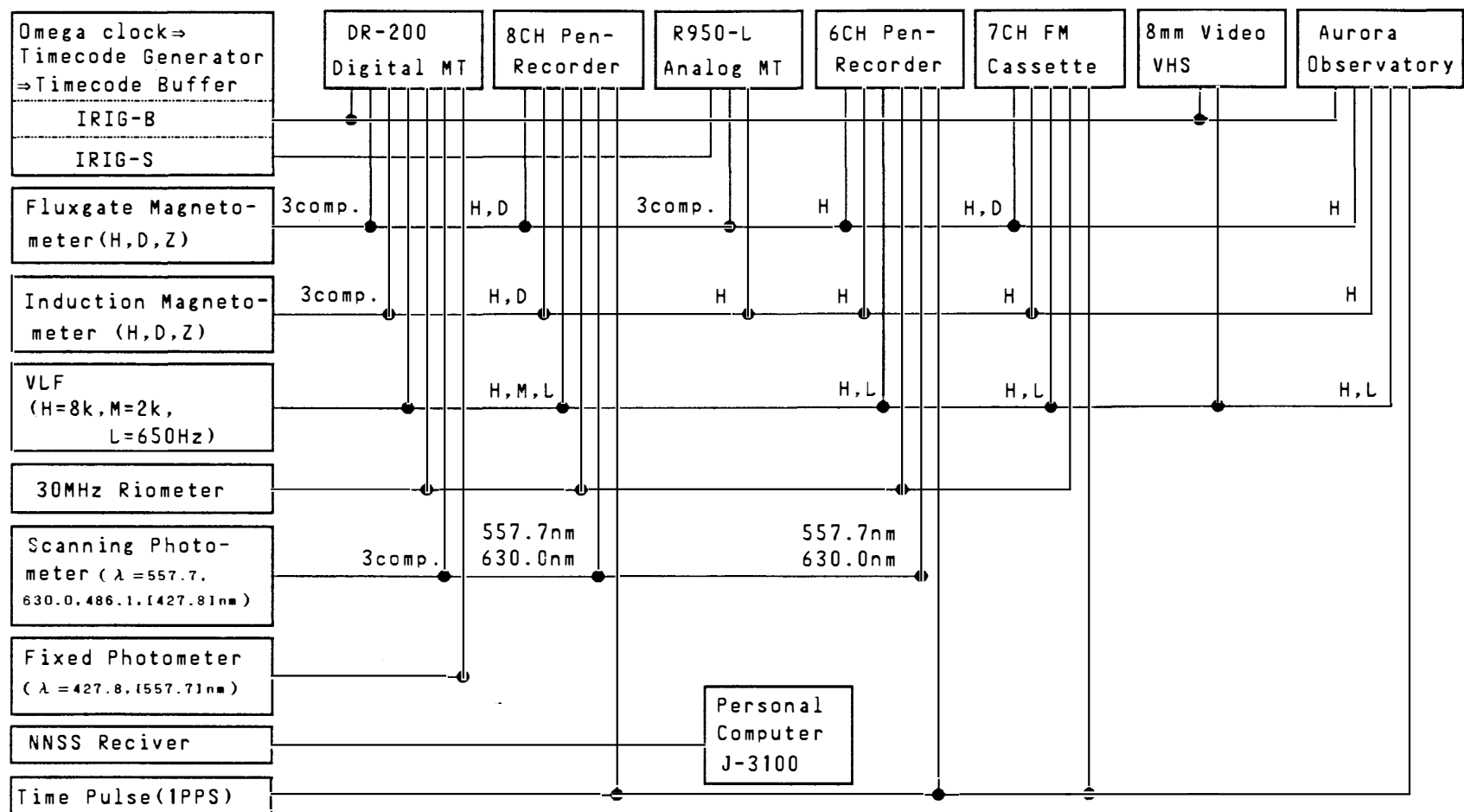


Fig. 2. Block diagram of the "Upper Atmosphere Physics" monitoring system at Asuka Station.

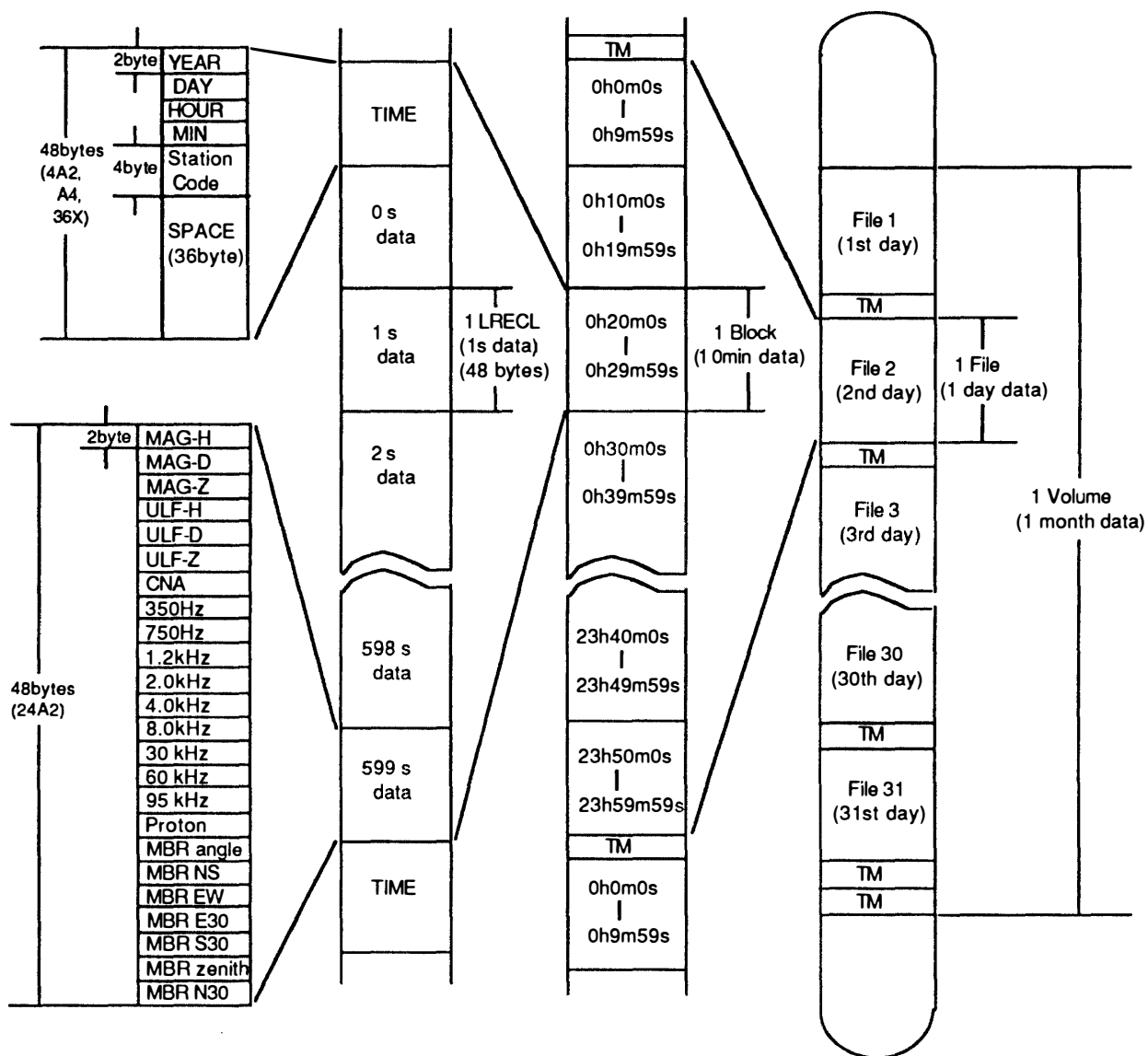


Fig. 3. The structure of the compiled digital tape format for Syowa Station.

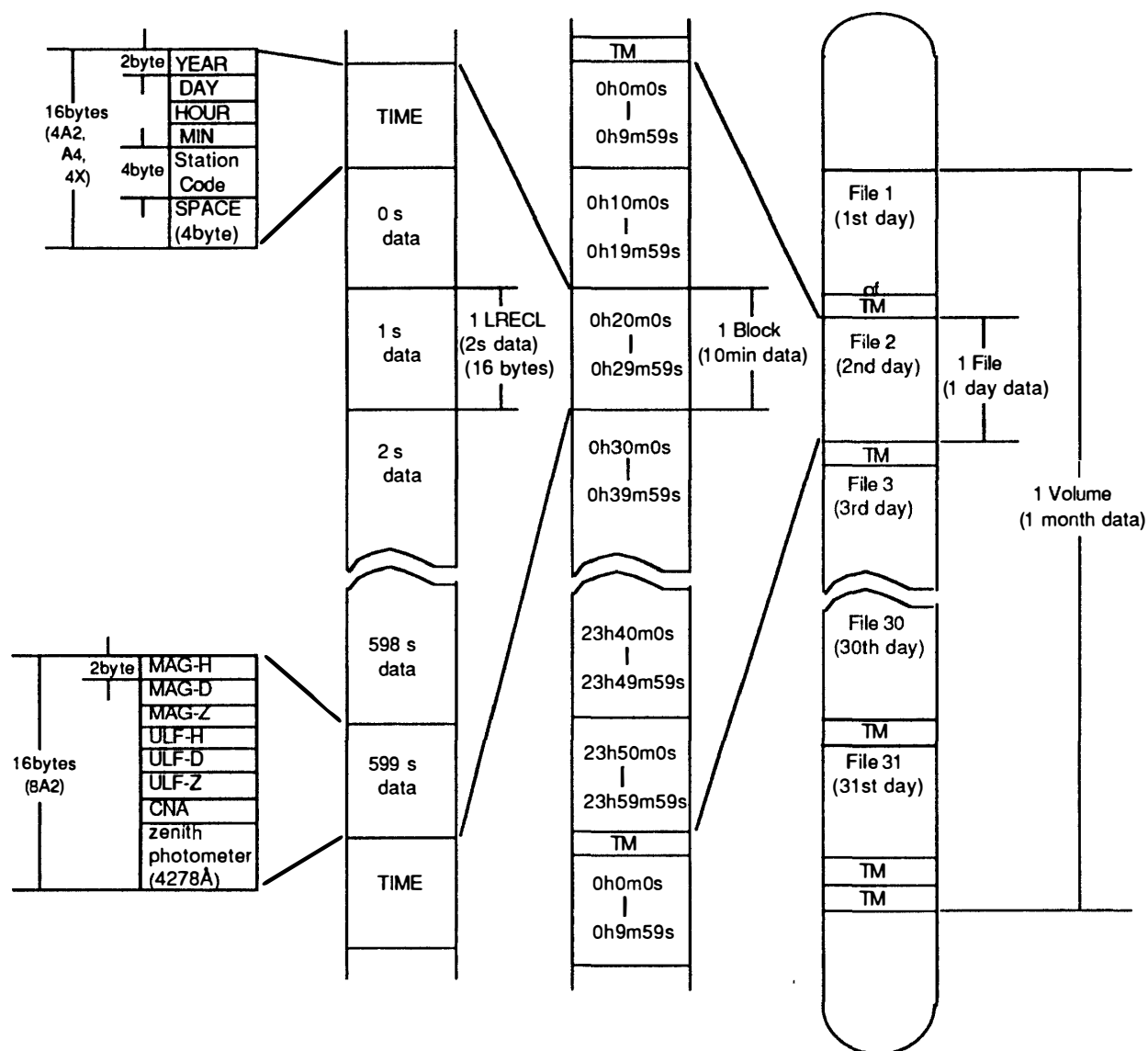


Fig. 4. The structure of the compiled digital tape format for Asuka Station.

Table 1. Absolute values of total force of the geomagnetic field at Syowa Station in 1991.

DATA	TIME (UT)	TOTAL INT. (nT)	HORI- ZONAL INT. (nT)	VERTICAL INT. (nT)	DECLINATION	DIP ANGLE
FEB. 20	11h 59m	43894.8	19031.7	-39554.3	-47° 19.1'	-64° 18.3'
MAR. 16	13h 03m	43905.4	19013.7	-39574.7	-47° 22.9'	-64° 20.3'
APR. 9	11h 24m	43917.3	19040.8	-39574.9	-47° 22.1'	-64° 18.4'
MAY 21	11h 53m	43904.8	19069.2	-39547.4	-47° 24.9'	-64° 15.4'
JUN. 16	11h 19m	43906.7	19044.4	-39561.4	-47° 25.6'	-64° 17.7'
JUL. 25	12h 47m	43907.5	19058.7	-39555.4	-47° 24.1'	-64° 16.4'
AUG. 14	13h 22m	43898.8	19058.5	-39545.9	-47° 24.5'	-64° 16.1'
SEP. 21	11h 11m	43868.0	19052.5	-39514.6	-47° 24.5'	-64° 15.5'
OCT. 14	12h 52m	43877.4	19048.4	-39527.0	-47° 23.1'	-64° 16.2'
DEC. 31	13h 55m	43855.0	19055.4	-39498.7	-47° 23.0'	-64° 14.8'
JAN. 9	11h 12m	43870.5	19065.5	-39511.0	-47° 23.5'	-64° 14.5'
JAN. 23	13h 54m	43882.2	19074.7	-39519.6	-47° 23.0'	-64° 14.1'

Table 2. K-indices at Syowa Station in 1991.

	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	JANUARY
1	4343 3566	3342 2255	6653 3226	6333 3354	4566 4325	3421 1123	6231 2444	6563 3455	4443 3366	5445 6775	4332 2346	3332 3423
2	5332 2112	4422 2233	5544 2336	5545 5655	6753 2658	1442 2345	3576 3536	5575 2323	6554 4644	5532 3344	5334 4334	6554 2332
3	1322 2723	2221 1123	5566 4355	4542 2235	4352 2255	5553 3344	5564 4336	2532 3246	4432 2245	4333 3344	3433 3445	5543 3245
4	3212 2112	4322 2234	4335 6555	5232 1123	3121 4775	6332 1112	6553 3356	5452 1335	5652 3376	4543 2365	5432 4345	3553 2344
5	4422 2223	4553 3335	5543 2322	5311 1113	5886 5565	2111 0101	6654 3326	6662 2344	6432 1021	4543 3334	3422 2232	4432 3444
6	2221 2222	3553 2576	5531 1244	3221 0003	6545 3225	3311 0223	6545 3234	4531 1335	3212 2456	4552 3335	3332 1124	3432 3345
7	3422 2235	5432 3355	4532 1224	3121 1001	4564 3335	2310 0024	4651 1124	5432 1213	6643 3233	4432 2232	3331 2233	4422 2343
8	3433 3444	5333 2356	4411 1233	4231 0121	5432 2444	5554 4776	5522 2114	4542 2454	5554 3474	4343 6687	2432 3212	3554 4443
9	4332 3554	5533 3336	4531 2344	2321 0233	7433 3553	3584 5567	4522 3333	5444 3377	5534 3323	6775 5554	2222 2444	3331 1112
10	3322 2223	6643 2111	3333 2100	2221 1213	5475 4665	6542 3323	2222 1213	5562 3345	5662 3444	4433 4455	4342 3445	5432 3433
11	4432 1344	1112 2212	0111 1112	2011 0000	7665 4567	4444 3223	4432 4333	3323 3343	3232 2325	4322 2456	4432 3355	4444 5544
12	4532 2314	4332 2455	1232 2111	0111 0022	6646 5655	4546 3334	5554 4565	4333 1123	4321 1124	5332 1224	5522 2444	4443 3335
13	3522 3223	7553 2320	1111 1012	3444 3563	5675 6685	5567 3766	5212 0024	5322 1136	3221 1123	3222 3333	5433 3445	4654 4545
14	3212 2335	4532 1110	1122 1112	2464 3445	4423 1212	6667 4366	3121 1347	5543 3344	3321 1233	5442 3233	3442 4445	4332 4545
15	6332 2134	1112 2100	2122 1100	2222 1000	3433 2322	5533 1112	5664 4357	5421 1022	3322 1111	4344 5435	5431 3221	4333 4232
16	3322 1113	0112 1242	0111 1121	0000 1044	2012 1112	3311 0555	6744 3325	4412 1024	1222 1111	4554 4444	2233 3555	4433 4454
17	3222 2113	4542 1124	2322 1242	5665 2111	4524 5576	6763 3366	3543 3245	4121 1123	3121 1124	4335 4443	6644 4564	4322 2334
18	2222 2113	5522 1000	1232 1123	1000 0000	4543 2345	5331 2356	5432 1253	2121 1124	4221 3123	4444 4445	4553 3321	3332 1111
19	1112 2442	1422 2354	3543 1112	0000 0010	5653 3245	6553 3476	5664 3321	4321 1125	4322 1233	4774 4755	1333 4443	2322 2312
20	1222 2443	3532 2111	1011 1110	0000 0000	6432 2224	5555 3334	2245 5245	4431 0013	3444 3331	3443 3446	1432 4533	4443 3434
21	3333 2121	2132 3213	0112 0100	0001 1111	6452 2234	6753 3355	5564 4324	3321 1022	4643 4364	3565 4754	4544 4445	2220 3334
22	2343 2223	3333 2125	3122 2110	3332 1233	6552 3335	5554 3325	7773 2236	3222 1003	4443 3433	5665 5323	3332 1112	3332 3320
23	4452 4333	5522 2221	1211 0135	5533 3335	5554 4456	5432 2342	6543 1111	3111 0022	4432 2346	4554 5343	5533 4434	2321 2122
24	3421 1212	4975 3469	5421 0045	5452 3355	6653 3344	2221 0123	4331 1214	4421 1133	5562 3354	4432 3335	4433 3432	3222 0012
25	2122 2222	7664 4666	6653 1012	7564 3355	5544 3336	2222 1234	5521 0123	4543 3465	5534 4455	3331 2334	2222 2333	4521 1212
26	4332 1211	7675 6466	3540 0035	5443 2354	6453 3345	2220 0111	3421 1023	4563 3355	5663 4546	3433 2227	3421 1333	1221 2423
27	1222 2234	5554 5456	6752 2345	6654 3325	5322 2225	2201 0025	5531 1565	5664 5565	6654 4455	3322 2443	4535 3555	6632 1245
28	5553 2335	6754 3231	5652 4445	6653 2467	4542 1213	3411 0001	4432 2345	6644 4466	6556 5745	3222 2133	4333 4564	5532 2334
29		1111 1113	7564 5557	6533 3346	3000 1013	2211 0014	2121 3355	4222 2346	6766 4655	5432 3335	3553 3456	4332 3264
30		4564 4554	6664 4345	5442 1335	3532 3336	4432 0122	4433 3455	4543 3465	3323 5756	4542 2236	6432 3333	5552 3443
31		4333 1115		5445 5443		3010 1023	3455 4446		6465 4555		3232 3443	4453 3332

Table 3. Observation periods of a 35 mm all-sky camera at Syowa Station in 1991.

Date	Hours (Universal Time)									K-Index	
	h	m	s	h	m	s	h	m	s		
Feb. 24				19	06	00	-19	56	07	3421	1212
25				19	00	00	-22	43	37	2122	2222
26				19	01	00	-22	59	37	4332	1211
28				19	01	00	-22	57	37	5553	2335
Mar. 5							20	03	00	4553	3335
6	-02	15	07				19	01	00	3553	2576
7	-01	05	47							5432	3355
8							18	17	00	5333	2356
9	-00	59	57				18	17	00	5533	3336
10	-00	43	27				18	18	00	6643	2111
11	-00	59	47	19	03	00	-20	59	47	1112	2212
16				18	28	00	20	06	07	0112	1242
17							18	46	00	4542	1124
18	-00	59	47				18	46	00	5522	1000
19	-00	59	47	18	01	00	-23	54	47	1422	2354
20	00	30	00	-01	19	47	18	01	00	3532	2111
21	-01	19	47				18	01	00	2132	3213
22	-01	19	47				19	47	00	3333	2125
23	-01	19	57				18	31	00	5522	2221
24	-01	20	07				17	27	00	4975	3469
25	-01	39	57	17	26	00	-21	44	57	7664	4666
28							18	00	00	6754	3231
29	-00	51	07							1111	1113
31							18	01	00	4333	1115
Apr. 1	-00	36	07				19	19	00	6653	3226
2	-01	26	47	19	16	00	-22	06	47	5544	2336
3				18	00	00	19	29	37	5566	4355
5				17	31	00	23	46	07	5543	2322
6							18	05	00	5531	1244
7	-01	26	07				18	11	00	4532	1224
8	-01	26	07				17	01	00	4411	1233
9	-01	26	47				17	00	00	4531	2344
10	-02	49	37				16	01	00	3333	2100
11	-02	59	37				16	01	00	0111	1112
12	-03	00	07				16	00	00	1232	2111
13	-02	59	07				16	01	00	1111	1012
14	-01	59	07							1122	1112
20				18	06	00	-21	14	07	1011	1110
21							18	01	00	0112	0100
22	-01	59	07	17	01	00	23	32	07	3122	2110
23							17	30	00	1211	0135
24	-02	59	57	17	01	00	-19	17	07	5421	0045

Table 4. Observation periods of a 35 mm all-sky camera at Asuka Station in 1991.

1991 Asuka All-sky data

Vol.	Start time				End time				Opr. (Sec)	Exp. (Sec)	Pictures Number
	Month	Day	Hour	Min.	Month	Day	Hour	Min.			
1	3	8	21	30	3	9	0	30	30	20	360
1	3	9	20	35	3	10	1	35	60	28	300
1	3	10	20	23	3	11	1	23	30	20	600
1	3	11	20	10	3	12	1	10	30	20	600
1	3	16	19	21	3	17	0	48	30	24	655
1	3	18	19	30	3	19	1	30	30	24	720
1	3	19	19	32	3	20	1	32	30	24	720
1	3	20	19	36	3	21	1	26	30	24	700
1	3	21	19	25	3	22	1	25	30	24	720
1	3	22	19	32	3	23	1	32	30	24	720
1	3	23	19	25	3	24	1	35	30	24	740
1	3	24	19	25	3	25	1	35	30	24	740
1	4	1	19	0	4	2	2	0	30	24	840
1	4	2	19	15	4	3	2	20	30	24	849
1	4	3	19	30	4	4	2	30	30	24	840
1	4	4	19	37	4	5	2	17	30	24	800
1	4	5	19	0	4	6	2	0	30	24	840
1	4	8	18	44	4	9	2	14	30	24	900
2	4	9	18	32	4	10	2	2	30	24	900
2	4	10	18	30	4	11	2	0	30	24	900
2	4	11	18	30	4	12	2	30	30	24	960
3	4	12	18	55	4	13	2	55	30	24	960
3	4	13	18	30	4	14	2	30	60	28	960
3	4	16	18	37	4	17	2	37	60	28	480
3	4	17	19	47	4	18	2	47	60	28	420
4	4	18	22	33	4	19	2	18	60	28	233
4	4	19	19	50	4	20	2	50	60	28	420
4	4	20	19	33	4	21	2	33	60	28	420
4	4	22	22	14	4	23	3	14	60	28	300
4	4	23	22	19	4	24	3	19	60	28	300
4	4	24	23	22	4	25	2	40	60	28	199
4	4	26	1	40	4	26	4	18	60	28	165
5	5	2	17	50	5	3	3	50	60	28	600
5	5	3	18	6	5	4	4	6	60	28	600
5	5	4	18	0	5	5	4	0	60	28	600
5	5	9	17	30	5	10	3	30	60	28	600
5	5	10	17	47	5	11	3	47	60	28	600
5	5	11	3	49	5	?	?	?	?	?	?
5	5	11	18	2	5	12	6	2	60	28	720
6	5	12	15	44	5	13	4	44	60	28	780
6	5	13	16	31	5	14	5	31	60	28	780
6	5	14	15	34	5	15	4	34	60	28	780
7	5	15	15	18	5	16	4	18	60	28	780
7	5	16	15	9	5	17	4	9	60	28	780
7	5	17	15	0	5	18	4	0	60	28	780
7	5	19	18	3	5	?	?	?	60	28	?
7	5	23	1	7	5	23	6	7	60	28	300
7	5	24	1	21	5	24	6	21	60	28	300
8	6	3	16	30	6	4	6	30	60	28	840
8	6	4	15	48	6	5	5	48	60	28	840
8	6	7	1	30	6	7	6	30	60	28	300
8	6	7	17	5	6	8	0	45	60	28	462
9	6	10	14	45	6	11	5	45	60	28	900
9	6	11	15	27	6	12	6	27	60	28	900
9	6	12	15	0	6	13	2	32	60	28	752
10	6	13	4	21	6	14	6	31	60	28	130

10	6	13	16	30	6	14	3	0	60	28	630
10	6	14	22	53	6	15	4	53	60	28	480
10	6	15	15	47	6	16	6	47	60	28	900
10	6	17	17	50	6	17	22	20	60	28	268
11	6	19	23	38	6	20	6	8	60	28	450
11	6	21	1	9	6	21	9	40	60	28	510
11	7	3	15	5	7	4	6	35	60	28	930
11	7	4	14	50	7	5	1	0	60	28	930
12	7	8	0	57	7	8	6	57	60	28	300
12	7	9	16	11	7	10	7	11	60	28	900
12	7	11	17	23	7	12	6	53	60	28	810
12	7	15	16	38	7	16	6	8	60	28	810
12	7	16	22	15	7	17	10	5	60	28	710
13	7	18	0	30	7	18	6	30	60	28	360
13	7	18	23	33	7	19	6	3	60	28	390
13	7	22	16	50	7	23	5	50	60	28	780
13	7	23	18	5	7	24	6	5	60	28	720
13	7	25	20	50	7	26	9	50	60	28	780
14	7	30	16	46	7	31	5	46	60	28	780
14	7	31	17	15	8	1	5	45	60	28	750
14	8	1	15	35	8	2	5	35	60	28	840
14	8	2	16	50	8	3	5	20	60	28	750
14	8	3	15	58	8	3	21	3	60	28	305
15	8	3	21	30	8	3	5	30	60	28	480
15	8	4	16	12	8	5	5	42	60	28	810
15	8	5	15	47	8	6	5	47	60	28	840
15	8	8	17	23	8	9	5	23	60	28	720
16	8	9	17	19	8	10	5	39	60	28	740
16	8	10	16	52	8	11	5	22	60	28	750
16	8	11	17	6	8	12	5	36	60	28	750
16	8	12	16	33	8	13	5	33	60	28	780
17	8	13	18	40	8	14	4	52	60	28	612
17	8	14	20	19	8	15	4	49	60	28	510
17	8	28	17	26	8	29	4	56	60	28	690
17	8	29	17	21	8	30	4	21	60	28	660
17	8	30	18	25	8	31	3	55	60	28	570
17	8	31	17	52	8	1	3	22	60	28	570
17	9	1	17	51	9	2	3	21	60	28	570
17	9	2	18	4	9	3	3	34	60	28	570
18	9	3	18	24	9	4	3	34	60	28	550
18	9	4	17	51	9	5	3	1	60	28	570
18	9	5	17	50	9	6	3	30	60	28	570
18	9	6	17	50	9	7	3	30	60	28	570
18	9	7	17	52	9	8	3	22	60	28	570
19	9	8	19	18	9	9	3	38	60	28	500
19	9	9	17	49	9	10	2	59	60	28	550
19	9	10	17	50	9	11	3	0	60	28	550
19	9	11	17	48	9	12	2	58	60	28	550
19	9	12	17	50	9	13	1	20	60	28	450
19	9	13	20	17	9	14	2	57	60	28	400
20	9	14	21	21	9	15	3	1	60	28	400

* Opr : Operation time for sending out every picture.
Exp : Exposure time of 1 picture.

1991 ASUKA CCD Data

VOL.	Start time				End time				Comments
	Month	Day	Hour	Min.	Month	Day	Hour	Min.	
1	5	8	20	35	5	9	0	0	VHS tape
1	5	9	17	41	5	9	22	27	VHS
2	5	9	22	47	5	10	2	31	SVHS tape
2	5	10	18	10	5	10	20	21	
3	5	10	20	23	5	11	2	34	
4	5	11	2	34	5	11	4	34	
4	5	11	18	12	5	11	22	23	
5	5	11	22	23	5	11	23	54	Cloudy(21UT). quiet
5	5	12	0	20	5	12	4	59	Light at high lat. quiet
6	5	12	15	55	5	12	21	59	
7	5	12	22	20	5	13	4	10	Faint→Active arc
8	5	13	4	10	5	13	5	43	Pulsating patch
8	5	13	16	29	5	13	21	6	Active arc. B-Up?
9	5	13	21	7	5	14	3	18	quiet
10	5	14	3	18	5	14	5	47	quiet
10	5	14	15	23	5	14	19	5	Stable arc & Pulsation
11	5	14	19	6	5	15	1	17	B-Up & Pulsation
12	5	15	1	17	5	15	5	5	Stable pulsation
12	5	15	18	3	5	15	20	25	
13	5	15	21	24	5	16	5	55	
14	5	16	15	0	5	16	20	0	
15	5	16	21	28	5	17	4	55	
16	5	17	15	0	5	17	21	7	
17	5	17	21	0	5	18	2	30	
18	5	18	2	30	5	18	4	55	
18	5	18	18	33	5	18	22	2	
19	5	18	22	3	5	19	4	13	
20	5	19	17	50	5	20	0	1	
21	5	20	0	1	5	20	5	26	
22	5	20	22	52	5	21	5	0	Bad SN. High temp? quiet
22	5	23	0	58	5	23	4	30	Post B-Up
23	5	23	4	30	5	23	6	0	Torch. Patch. cloudy. moon
23	5	24	2	42	5	24	6	10	Torch. Patch. moon
24	6	3	14	51	6	3	16	58	Patch?. fine
25	6	3	17	0	6	3	19	30	W-Surge?
25	6	4	14	50	6	4	22	2	*Red aurora. B-Up. moon
27	6	7	20	28	6	8	2	39	Surge. Torch. HB
28	6	8	2	40	6	8	5	40	Patch
28	6	10	16	6	6	11	19	15	Arc. B-Up
29	6	10	19	16	6	11	1	25	*Red aurora. B-Up
30	6	11	1	30	6	11	6	46	Arc
30	6	11	15	30	6	11	16	24	
31	6	11	17	1	6	11	23	10	
32	6	11	23	12	6	12	5	23	
33	6	12	5	24	6	12	6	42	Pulsating aurora
33	6	12	14	38	6	12	19	30	N-S pulsating arc. Patch
34	6	12	20	44	6	13	2	54	B-Up
35	6	13	3	0	6	13	6	45	Stable
35	6	13	16	15	6	13	18	20	
36	6	13	18	22	6	14	1	10	B-Up
37	6	14	1	10	6	14	4	20	Blizzard
37	6	14	22	46	6	15	1	46	blizz. fine

38	6	15	1	54	6	15	6	50	Pulsating
38	6	15	15	38	6	15	16	47	quiet.fine
39	6	15	17	0	6	16	1	17	quiet.fine
40	6	16	23	1	6	16	23	25	
40	6	16	2	18	6	16	6	25	
40	6	16	19	30	6	16	22	34	
41	6	17	0	0	6	17	6	10	Pulsation
42	6	17	6	11	6	17	6	45	
42	6	17	20	0	6	17	23	20	stop for cloudy
42	6	20	1	26	6	20	3	42	No SIT data
43	6	20	4	8	6	20	6	46	
43	6	21	3	10	6	21	6	40	
44	7	3	14	50	7	3	22	25	-2014UT miss.7/2→7/3
44	7	4	16	8	7	4	17	0	fine. quiet
45	7	4	17	59	7	5	0	10	quiet
46	7	5	0	10	7	5	1	2	quiet
46	7	8	0	41	7	8	6	0	Torch
47	7	8	6	0	7	8	7	0	Torch
47	7	9	15	59	7	9	20	5	Blizz. Flare
48	7	9	20	5	7	9	23	35	cloudy
48	7	12	1	16	7	12	4	0	
49	7	12	4	0	7	12	5	20	
49	7	12	5	21	7	12	6	40	
49	7	15	21	55	7	15	2	19	
50	7	16	2	20	7	16	6	30	
50	7	16	21	35	7	16	23	40	
51	7	16	23	42	7	17	5	53	
52	7	17	5	53	7	17	6	50	
52	7	17	23	45	7	17	23	53	
52	8	2	19	48	8	3	0	53	B-Up
53	8	3	0	53	8	3	6	0	Pulsating
53	8	3	16	25	8	3	17	29	Blizzard
54	8	3	17	29	8	3	23	30	
55	8	3	23	30	8	4	5	37	Torch.*Red aurora
56	8	4	16	35	8	4	23	37	Blizzard.stop2321UT~
56	8	5	15	59	8	5	17	40	
57	8	5	17	46	8	5	21	35	Blizzard
57	8	8	20	2	8	8	22	30	Arc at high lat
58	8	8	22	30	8	9	4	50	Bad0438-0440.04-05h Stop
58	8	10	3	21	8	10	4	9	wholly quiet
59	8	10	4	10	8	10	4	46	quiet
59	8	10	16	56	8	10	22	30	quiet
60	8	10	23	36	8	11	5	3	arc
61	8	11	17	11	8	11	23	22	quiet
62	8	11	23	23	8	12	5	22	active(morning). stereo
63	8	12	16	59	8	12	23	8	stereo
64	8	12	23	9	8	13	4	36	stereo
64	8	13	21	21	8	13	22	5	Error.8/3→8/13.stereo
65	8	13	22	6	8	14	3	57	Error.8/3→8/13.stereo
66	8	15	0	1	8	15	5	13	Bad.5577(CK=3)adjust
66	8	29	17	46	8	29	18	46	Temp-40.Noise(CK4.6)
67	8	29	19	36	8	30	1	46	
68	8	30	1	47	8	30	3	50	
68	8	30	21	31	8	31	1	40	
69	8	31	1	41	8	31	3	42	
69	8	31	17	55	8	31	22	4	quiet

70	8	31	22	4	9	1	3	58	
71	9	1	17	56	9	2	0	7	
72	9	2	0	7	9	2	3	45	
73	9	2	18	11	9	3	0	21	quiet
74	9	3	0	46	9	3	3	30	quiet
74	9	3	17	47	9	3	21	14	
75	9	3	21	15	9	4	3	26	
76	9	4	17	55	9	4	0	7	
77	9	5	0	7	9	5	3	30	windy
77	9	5	17	26	9	5	20	15	
78	9	5	20	15	9	6	2	25	
79	9	6	3	1	9	6	3	45	Torch
79	9	6	18	8	9	6	23	34	quiet
80	9	6	23	35	9	7	3	16	
80	9	7	19	30	9	7	21	50	quiet. Error 9/2→9/6
81	9	7	21	50	9	8	3	10	quiet
81	9	8	18	38	9	8	19	29	Error(Day). Blizz
82	9	8	19	25	9	8	19	45	Blizz. Stop
82	9	9	0	23	9	9	3	20	Blizz. Stop
83	9	9	18	33	9	9	21	31	Blizzard
83	9	9	21	32	9	10	3	6	
84	9	10	19	51	9	11	2	1	
85	9	11	2	26	9	11	2	50	
86	9	11	20	15	9	12	1	58	
86	9	11	1	59	9	12	2	30	
86	9	12	18	36	9	13	0	3	
87	9	13	0	4	9	13	2	10	
87	9	13	20	5	9	13	23	50	
88	9	13	23	51	9	14	2	0	Torch Aurora(morning)?

1991 ASUKA SIT Data

Vol.	Start time				End time				Comments
	Month	Day	Hour	Min.	Month	Day	Hour	Min.	
1	3	5	22	23	3	6	1	6	moon
2	3	7	21	39	3	8	1	41	moon
3	3	8	20	30	3	9	1	30	moon, W-Surge, active
3	3	9	20	40	3	9	23	44	moon, quiet
4	3	9	23	45	3	10	1	31	moon, Faint arc
4	3	10	20	17	3	11	1	25	moon, quiet
5	3	11	20	20	3	12	1	21	cloudy, W-Surge, quiet
6	3	12	20	29	3	12	22	41	N-S arc, cloudy
6	3	16	19	35	3	17	0	49	cloudy(0000), bliz, quiet
7	3	18	19	36	3	19	1	30	Error!1951-1952UT, +2sec
7	3	19	19	21	3	19	21	35	active, Flare
8	3	19	21	35	3	20	1	38	active, Flare
8	3	20	19	40	3	21	0	9	
9	3	21	0	9	3	21	1	45	active
9	3	21	19	30	3	22	1	50	Active arc
10	3	22	19	40	3	23	1	50	Active aurora
10	3	23	19	29	3	23	21	22	
11	3	23	23	19	3	24	2	0	
12	3	24	18	45	3	25	2	32	
13	3	27	19	25	3	27	20	0	moon, bliz, cloudy, quiet
13	4	8	18	37	4	9	2	15	quiet
14	4	9	2	15	4	9	3	8	quiet
14	4	9	18	38	4	10	1	58	TV Gain, Level adjust
15	4	10	18	39	4	11	2	0	quiet
16	4	11	18	38	4	12	2	40	quiet, Stereo
17	4	12	18	15	4	13	2	27	quiet, Stereo
18	4	13	18	32	4	13	20	41	Stereo, Data loss
18	4	13	22	59	4	14	2	35	quiet arc
19	4	16	18	56	4	17	3	34	B-up(0130UT)
20	4	17	19	0	4	18	3	11	
21	4	18	0	17	4	19	2	7	Cloudy
21	4	19	19	47	4	20	2	8	the second half, Cloudy
22	0	0	0	0	0	0	0	0	No data
23	4	20	19	31	4	?	?	?	quiet, Bad data
24	4	22	22	6	4	23	3	58	moon, quiet
25	4	23	22	34	4	24	4	3	Moon, Pulsating
25	4	24	23	27	4	25	1	59	Torch, Active
26	5	8	19	1	5	9	2	5	TV adjust, quiet
27	5	9	17	20	5	?	?	?	quiet
28	5	10	1	4	5	10	3	9	
28	5	10	18	3	5	11	0	10	quiet
29	5	11	0	12	5	11	4	35	quiet
29	5	11	18	0	5	11	21	50	quiet
30	5	11	21	50	5	11	23	54	quiet, cloudy(2100UT)
30	5	12	0	15	5	12	5	0	quiet, cloudy
31	5	12	17	6	5	13	1	19	cloudy(No blizzard)
32	5	12	1	20	5	13	5	25	Arc, Patch, Torch
32	5	13	16	29	5	13	20	35	
33	5	13	20	35	5	14	4	49	active
34	5	14	4	50	5	14	5	47	quiet
34	5	14	18	9	5	15	1	23	B-Up
35	5	15	1	23	5	15	5	5	No Aurora, stereo

35	5	15	15	33	5	15	20	1	stereo
36	5	15	21	45	5	16	5	53	stereo
37	5	16	15	0	5	16	23	11	stereo
38	5	16	23	12	5	17	4	55	stereo
38	5	17	15	0	5	17	16	49	stereo
39	5	17	16	50	5	18	1	0	No aurora.stereo
40	5	18	1	0	5	18	4	55	No aurora.stereo
40	5	18	18	33	5	18	22	3	No aurora.stereo
41	5	18	22	4	5	19	5	36	No aurora.stereo
42	5	19	17	51	5	20	2	0	the 1st half.moon
43	5	20	2	1	5	20	5	26	Bad data->Auto Gain mode
43	5	20	23	23	5	21	4	12	post B-Up
44	5	23	1	0	5	23	5	45	moon
44	5	24	2	34	5	24	5	41	fine.no wind.moon
45	6	3	16	31	6	3	20	6	active
45	6	4	14	49	6	4	19	27	TV adjust
46	6	7	16	55	6	8	1	9	
47	6	8	1	9	6	8	4	30	
47	6	8	23	5	6	9	3	45	Blizzard.bad data.B-Up
48	6	10	14	40	6	10	22	54	B-Up.active.*Red aurora
49	6	10	22	55	6	11	6	41	B-Up.*Red Aurora
50	6	11	15	25	6	11	23	38	Arc
51	6	11	23	38	6	12	6	30	Auroral Buldge?
51	6	12	14	35	6	12	15	55	
52	6	12	16	1	6	13	0	14	
53	6	13	0	15	6	13	6	30	Pulsating aurora
53	6	13	16	15	6	13	18	14	
54	6	13	18	18	6	14	3	22	
55	6	14	3	33	6	14	4	20	cloudy.blizzard
55	6	14	22	48	6	15	5	5	quiet.snow.fine(zenith)
56	6	15	15	37	6	15	23	50	quiet.no wind.fine
57	6	15	23	52	6	16	6	30	quiet
57	6	16	16	8	6	16	17	40	quiet.wind.bli.moon
58	6	16	19	46	6	17	4	0	quiet
59	6	17	4	2	6	17	6	30	Pulsating aurora
59	6	17	17	40	6	17	23	26	B-Up(2024).cloudy(2300)
60	6	17	23	28	6	18	0	10	cloudy.stop
60	6	20	4	15	6	20	6	45	
60	6	21	1	6	6	21	6	8	N-S Arc(post B-UP)
61	6	21	6	10	6	21	6	40	Faint diffuse(no pulsat)
61	7	3	14	51	7	3	22	26	~ 2012UT miss 7/2→7/3
62	7	3	22	26	7	3	22	48	moon
62	7	4	14	51	7	4	22	41	
63	7	4	22	42	7	5	1	11	quiet
63	7	8	0	37	7	8	6	22	Torch
64	7	8	6	22	7	8	6	35	Torch
64	7	8	14	40	7	8	16	0	
64	7	8	19	10	7	8	19	15	Cloudy.B-Up?
64	7	9	14	33	7	9	21	9	cloudy.stars.blizzard
65	7	9	21	11	7	10	5	24	cloudy.0524UTstop
66	7	11	17	14	7	12	1	24	cloudy.bliz.quiet
67	7	12	1	24	7	12	6	30	cloudy.B-Up?
67	7	13	3	35	7	13	6	36	cloudy.blizzard
68	7	15	16	47	7	16	0	57	wind.fine.quiet
69	7	16	4	56	7	16	6	30	wind.fine.quiet
69	7	16	18	9	7	17	0	49	cloudy.wind

70	7	17	0	49	7	17	6	19	torch. corona
70	7	17	23	30	7	18	2	15	
71	7	18	2	16	7	18	6	10	active. wind
71	7	18	23	39	7	19	3	58	cloudy. Day miss(3/2?)
72	7	19	4	0	7	19	6	6	cloudy
72	7	20	2	52	7	20	6	15	moon
72	7	31	17	27	7	31	21	47	1728UTstop.1907UTstart
73	7	31	22	38	8	1	1	38	Stable arc.0030UTB-Up
73	8	1	15	28	8	1	18	28	cloudy
74	8	1	23	38	8	2	3	55	fine & cloudy
74	8	2	16	44	8	2	20	36	snowy. active
75	8	2	23	10	8	3	5	30	
75	8	3	15	52	8	3	17	42	
76	8	3	18	41	8	4	2	54	
77	8	4	2	55	8	4	5	27	Pulsating aurora
77	8	4	16	8	8	4	21	30	
78	8	4	21	30	8	5	5	43	
79	8	5	15	37	8	5	23	50	2303→blizzard
80	8	5	23	50	8	6	2	25	0051~0054stop
80	8	8	17	18	8	8	22	58	blizzard
81	8	8	22	58	8	9	5	25	fine
81	8	9	15	50	8	9	17	30	quiet
82	8	10	4	37	8	10	4	45	
82	8	10	16	31	8	11	0	32	stereo
83	8	11	0	32	8	11	5	3	stereo
83	8	11	17	2	8	11	20	34	stereo
84	8	11	20	34	8	12	4	45	stereo
85	8	12	16	26	8	13	0	36	stereo
86	8	13	1	0	8	13	4	51	stereo
86	8	13	18	12	8	13	22	30	stereo
87	8	13	22	30	8	?	?	?	stereo
87	8	14	20	10	8	14	21	40	stereo
88	8	14	21	41	8	15	5	10	stereo
89	8	28	17	16	8	28	22	35	moon
89	8	29	17	18	8	29	20	12	early time aurora
90	8	29	20	12	8	30	3	49	cloudy
91	8	30	18	17	8	31	2	30	cloudy
92	8	31	2	30	8	31	3	34	
92	8	31	17	44	9	1	0	50	cloudy
93	9	1	20	34	9	2	3	45	
93	9	2	17	30	9	2	18	23	
94	9	2	18	23	9	3	2	36	quiet
95	9	3	17	42	9	4	1	31	
96	9	4	1	32	9	4	3	30	
96	9	4	17	46	9	4	23	58	
97	9	5	0	7	9	5	3	20	
97	9	5	17	16	9	5	22	14	cloudy
98	9	5	22	27	9	6	3	30	
98	9	6	17	49	9	6	21	0	quiet
99	9	6	21	0	9	7	3	10	
99	9	7	17	41	9	7	19	42	quiet
100	9	7	19	42	9	8	3	1	
101	9	8	18	30	9	9	2	44	Bliz. fine(zenith)
102	9	9	17	43	9	10	1	56	
103	9	10	1	56	9	10	3	5	
103	9	10	17	45	9	11	0	55	

104	9	11	0	58	9	11	2	50	
104	9	11	20	11	9	12	2	30	stereo.moon
105	9	12	18	31	9	13	2	10	stereo.snowy
106	9	13	23	42	9	14	2	25	stereo.moon.cloudy

Appendix 1

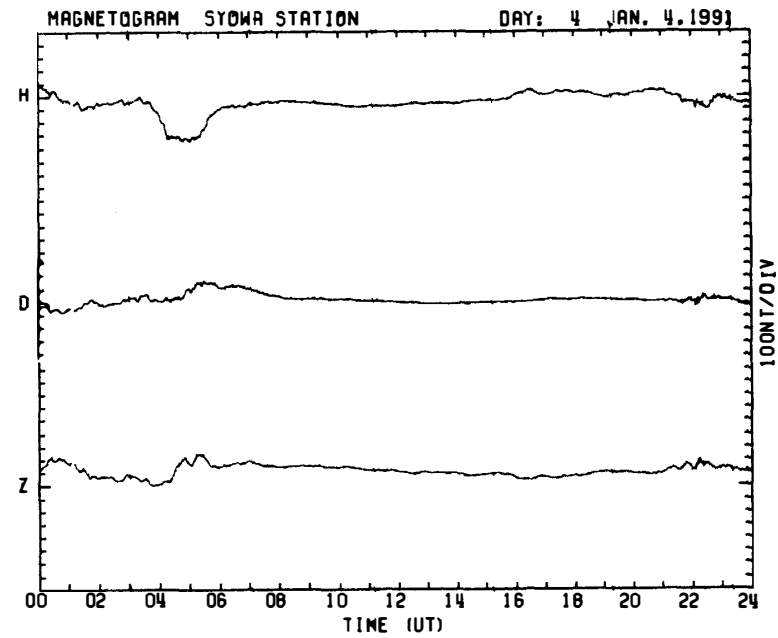
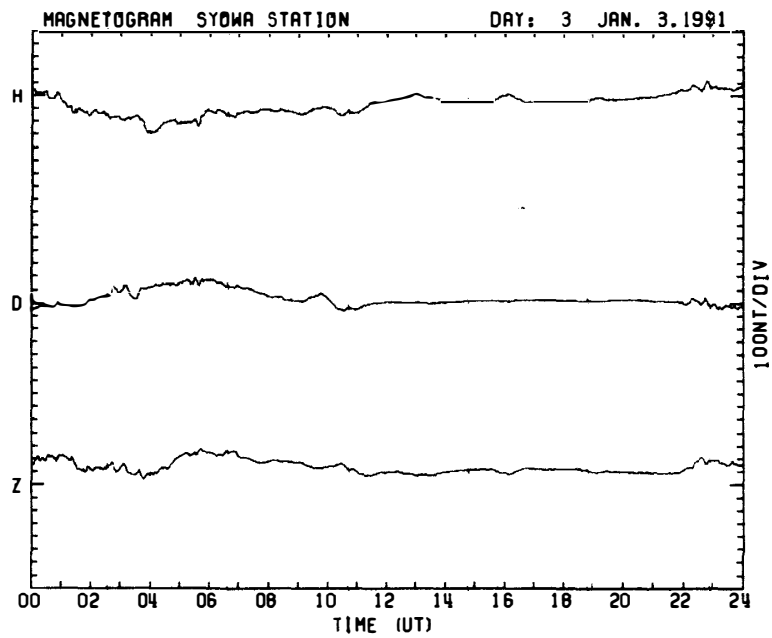
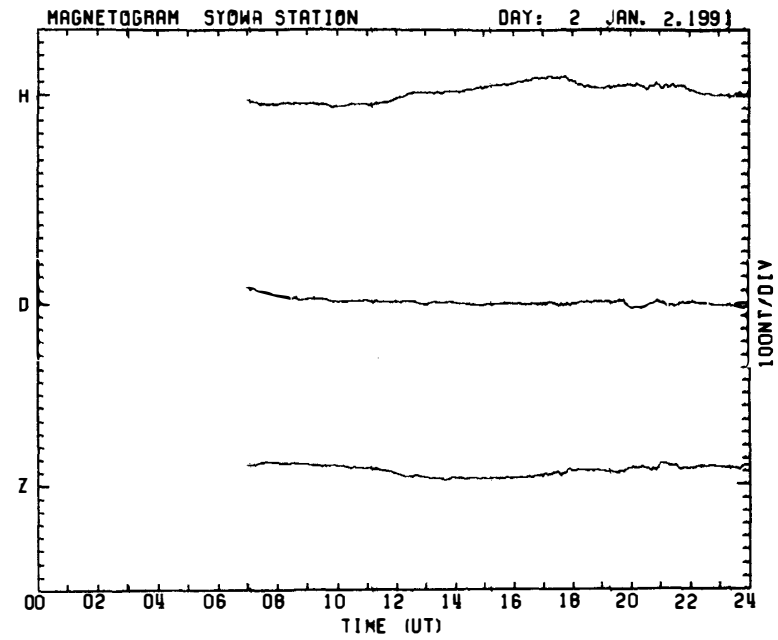
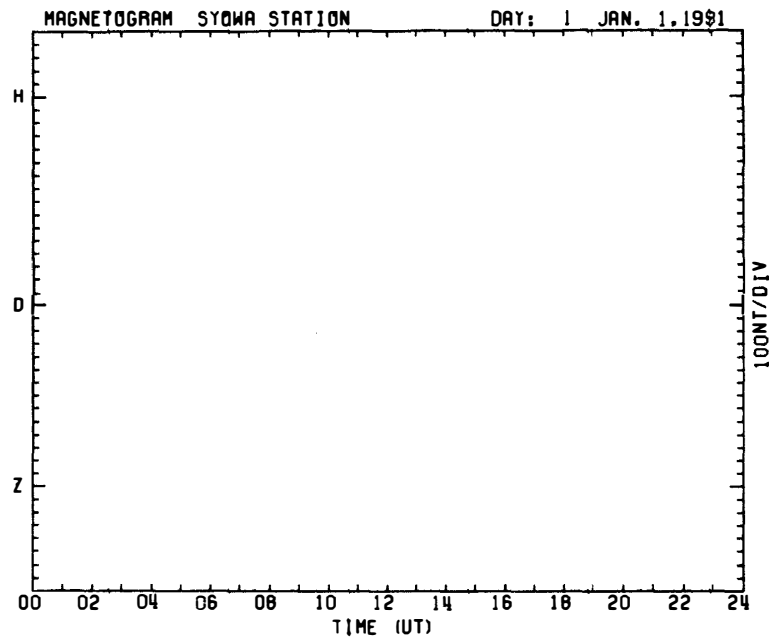
Continuous computer plots of magnetogram in 1991

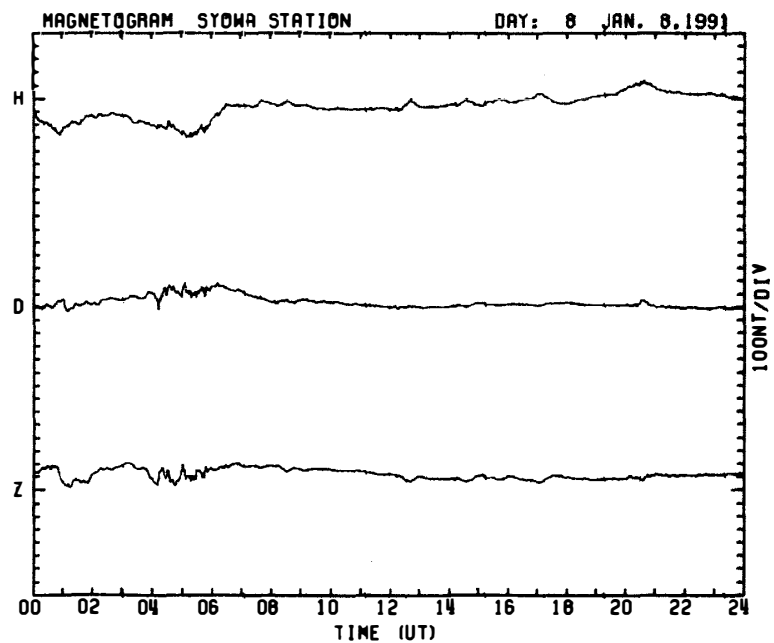
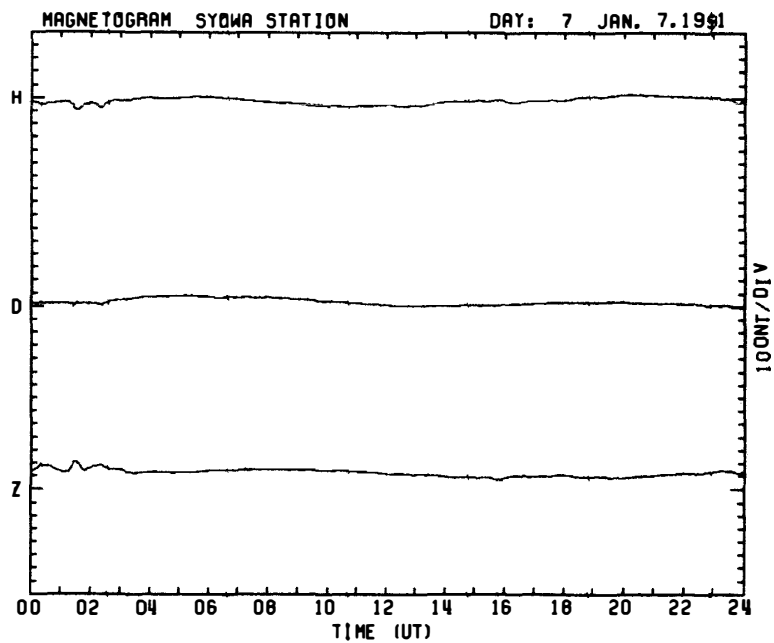
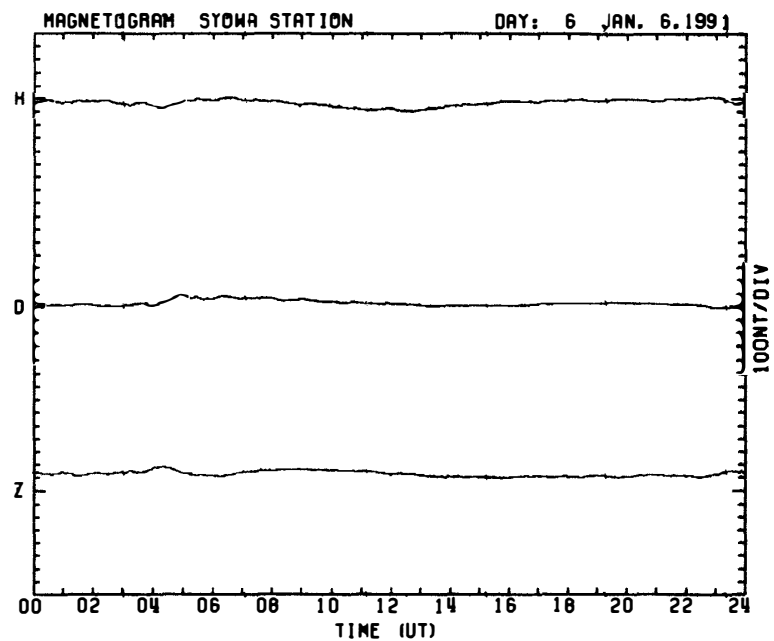
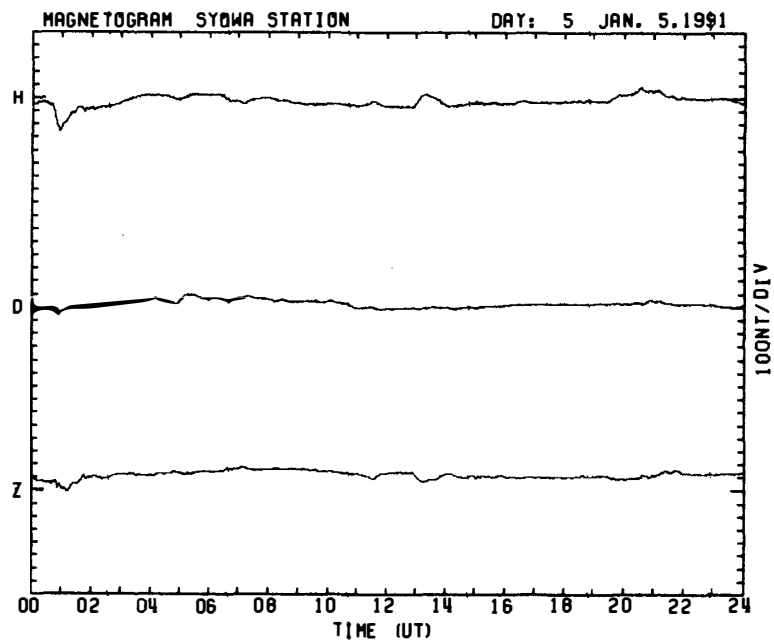
Displacement of magnetogram trace toward the top of records indicates;

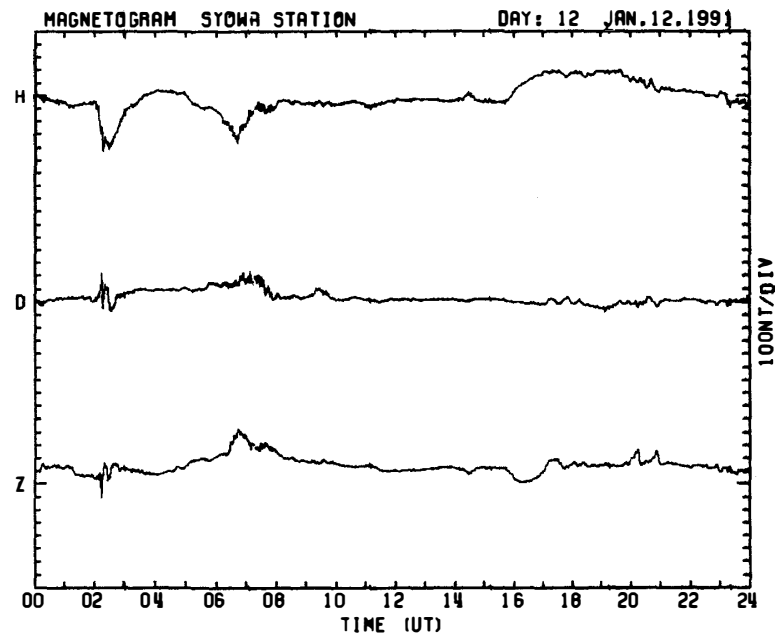
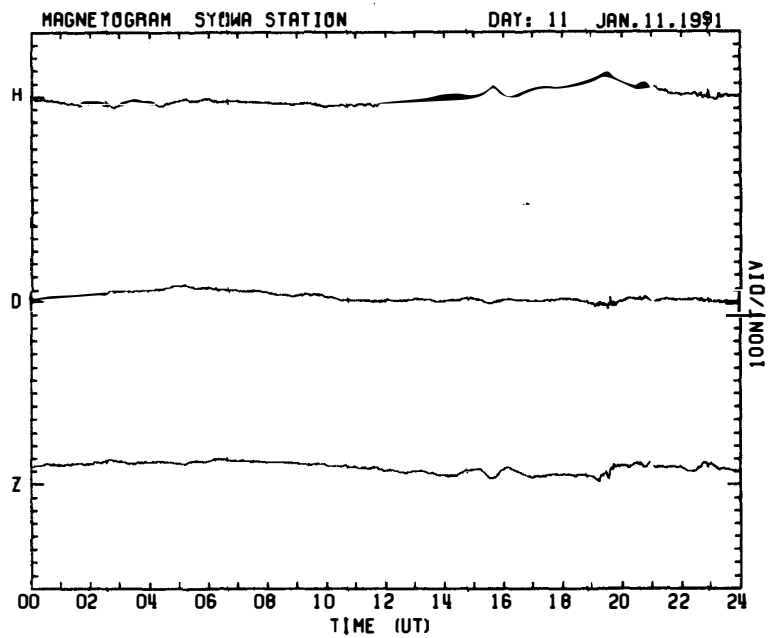
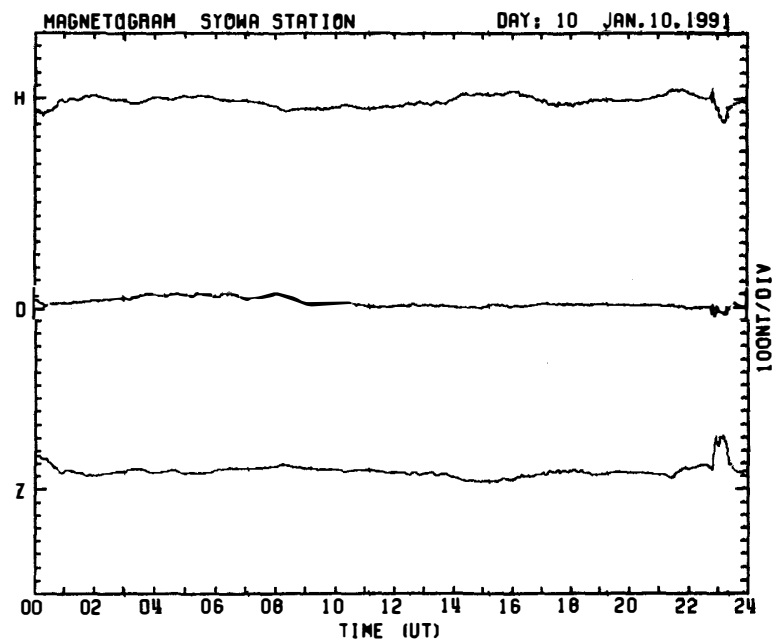
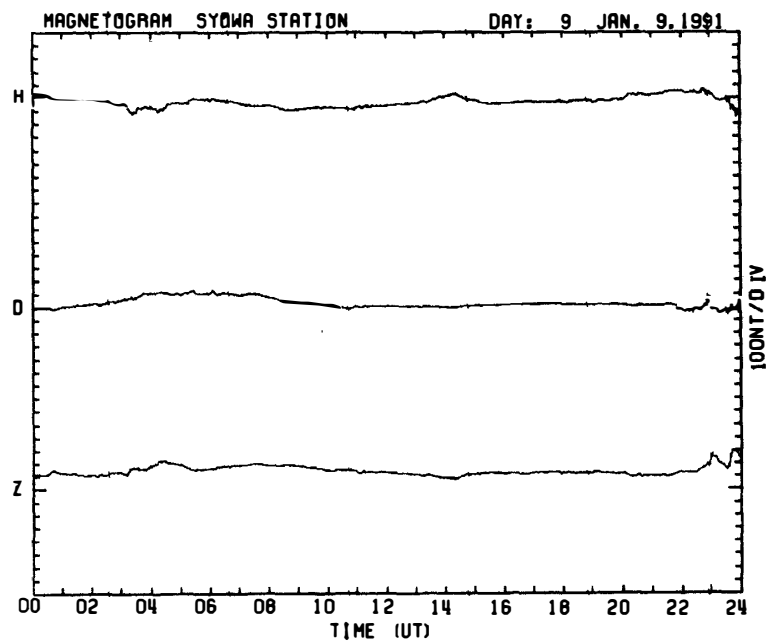
H : northward,

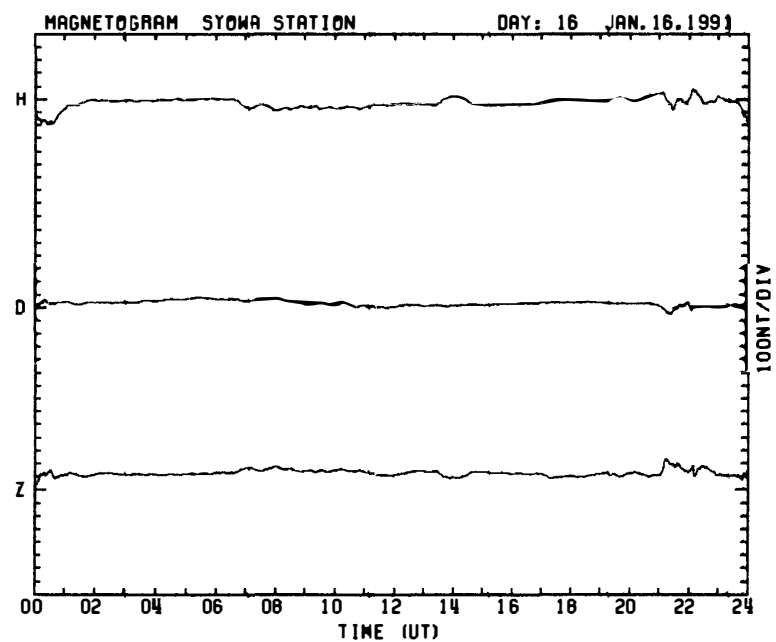
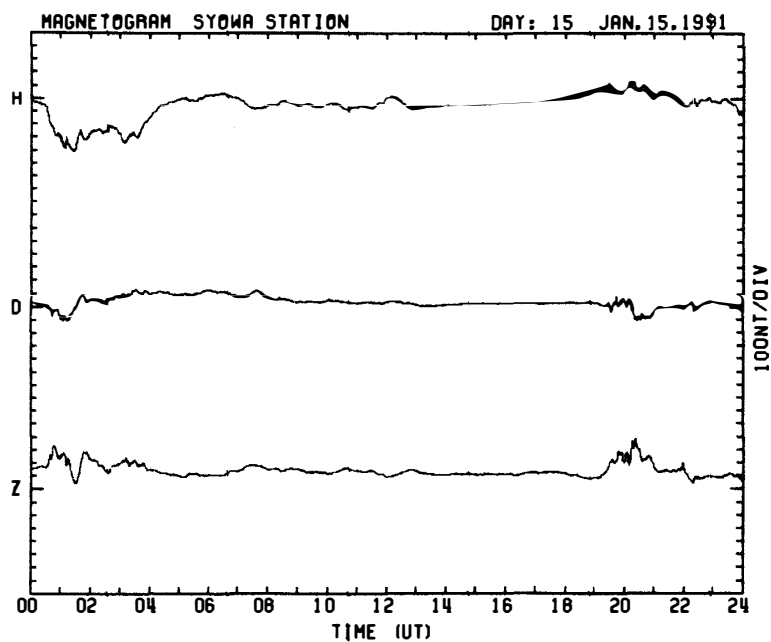
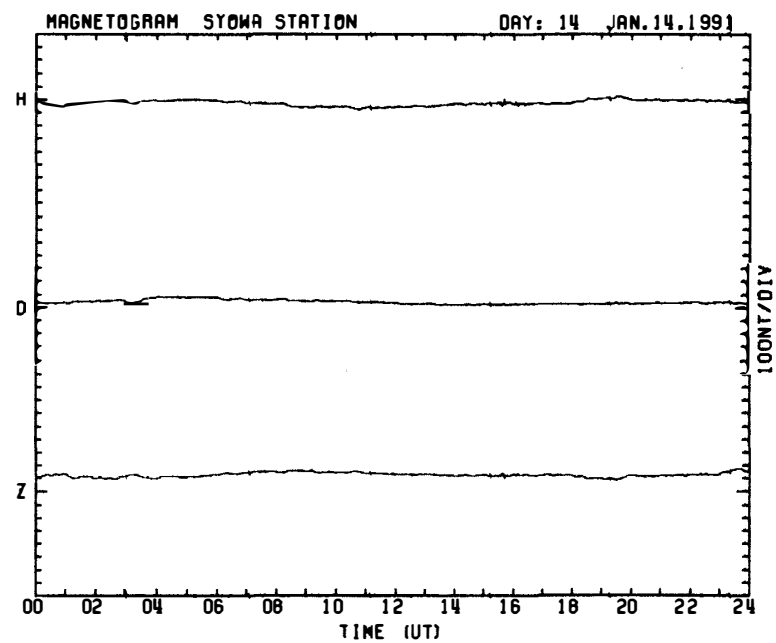
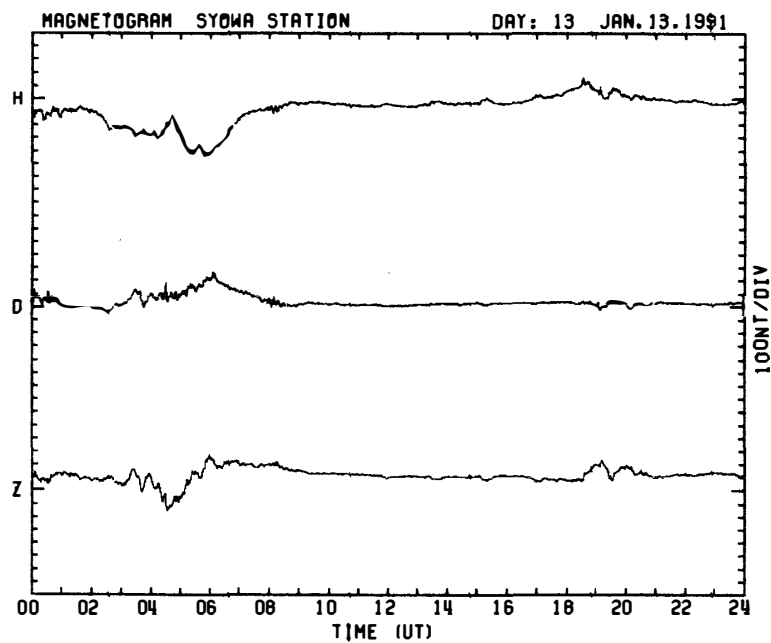
D : westward,

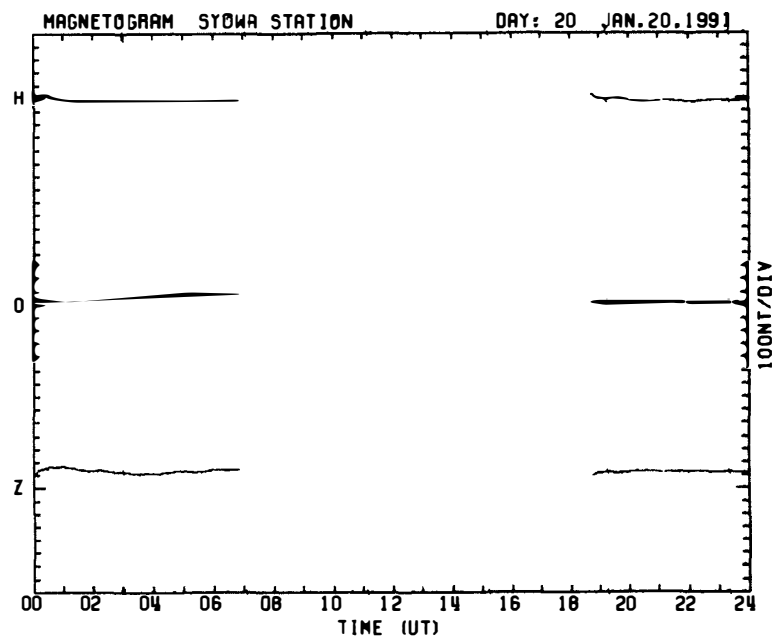
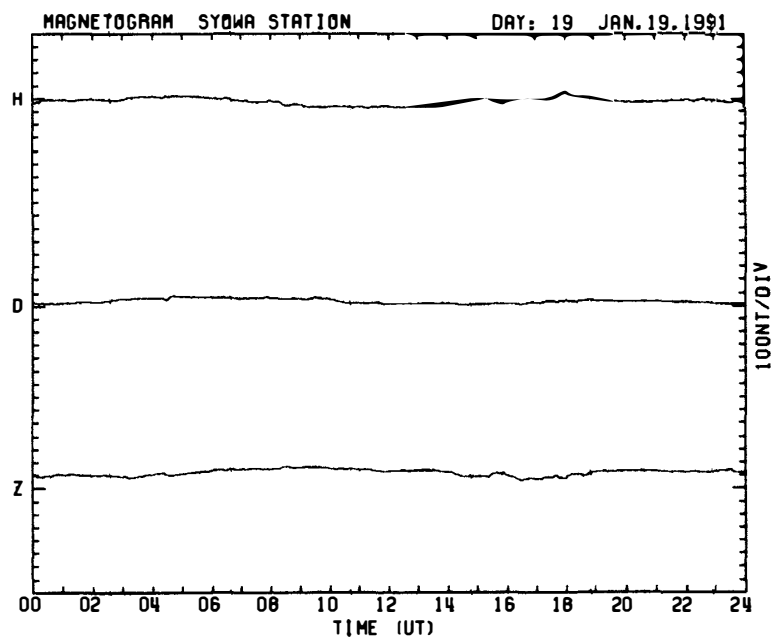
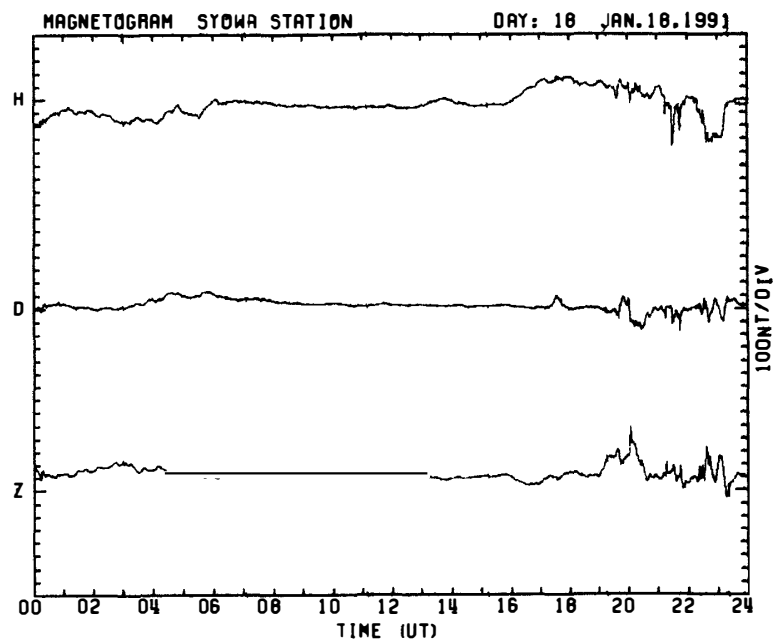
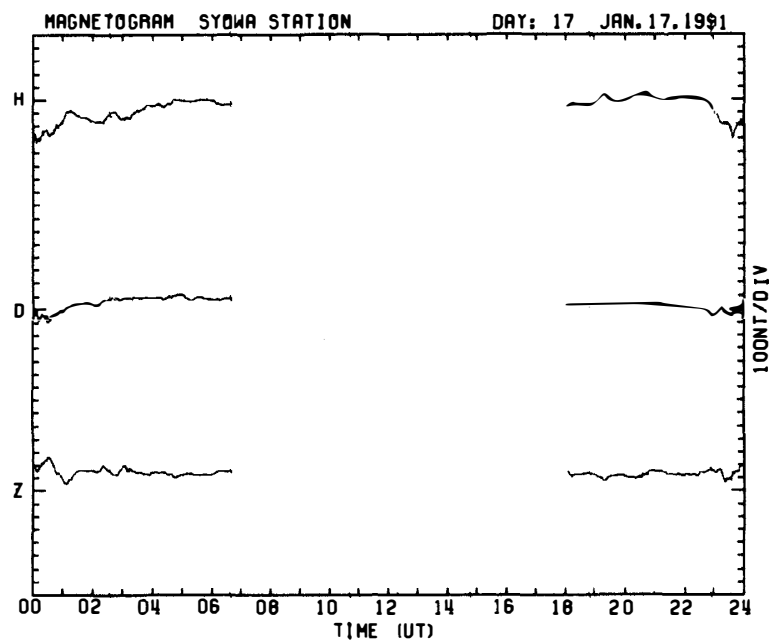
Z : downward.

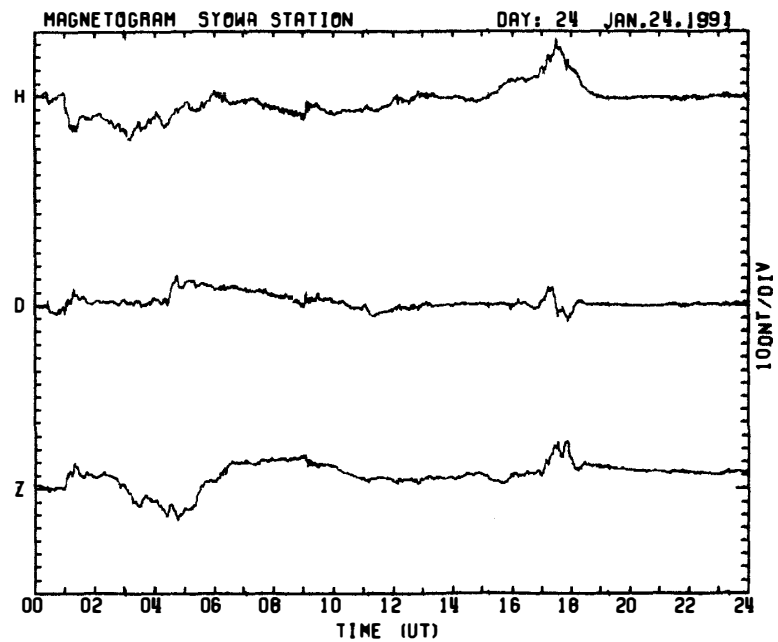
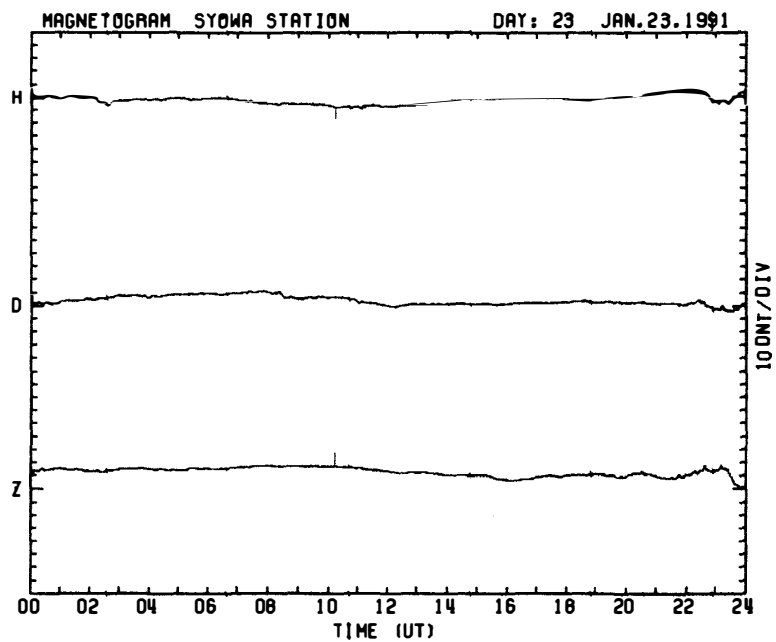
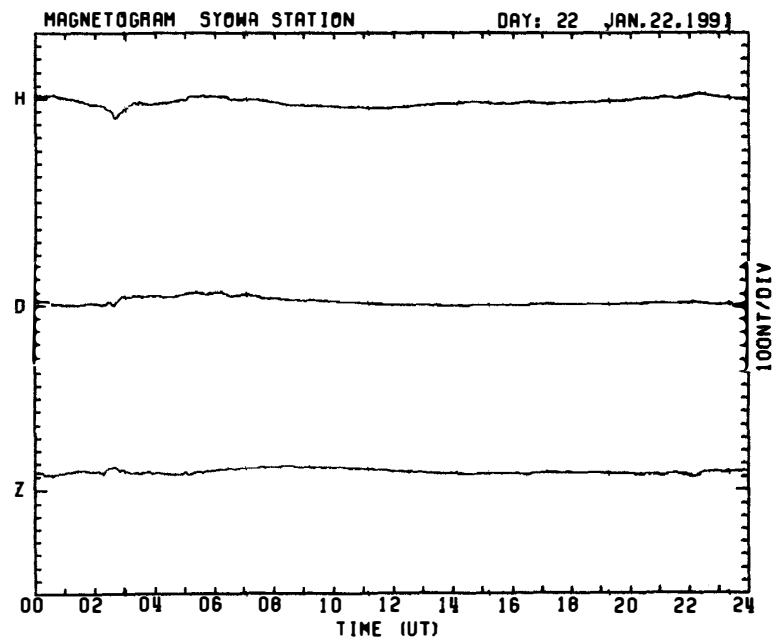
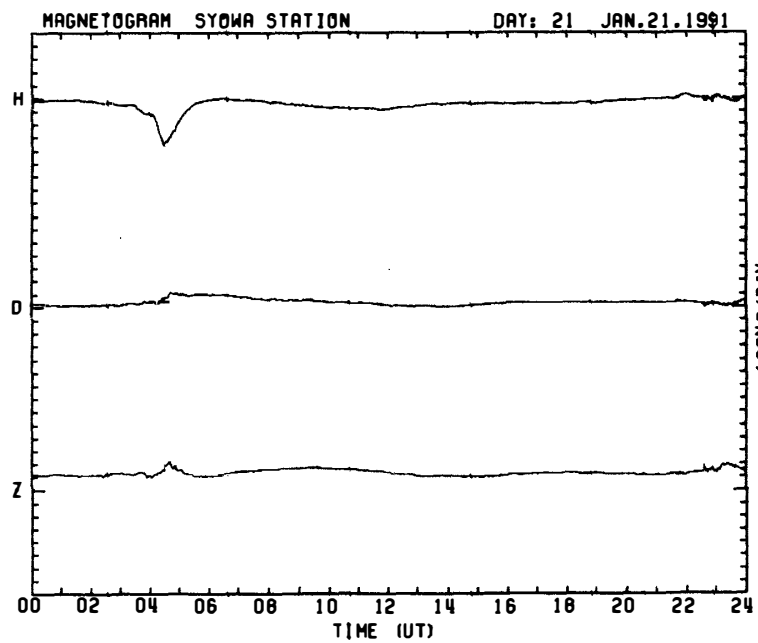


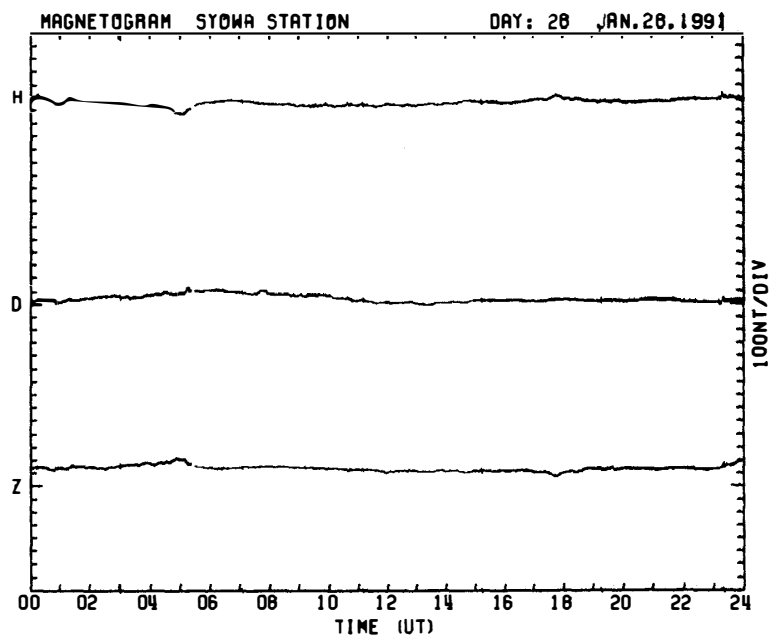
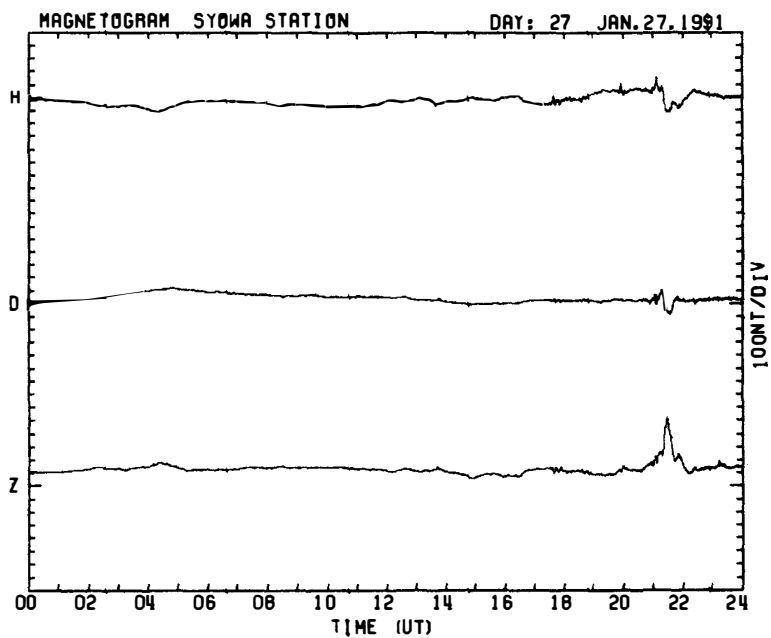
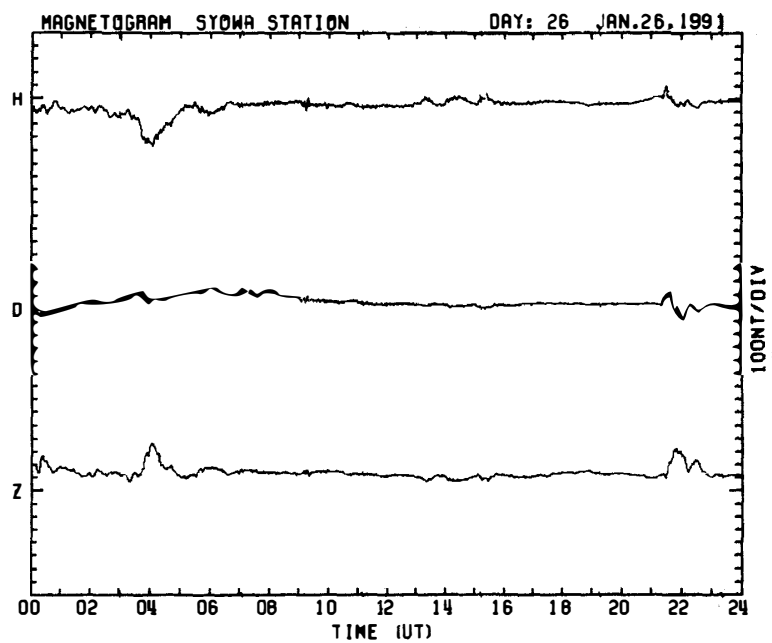
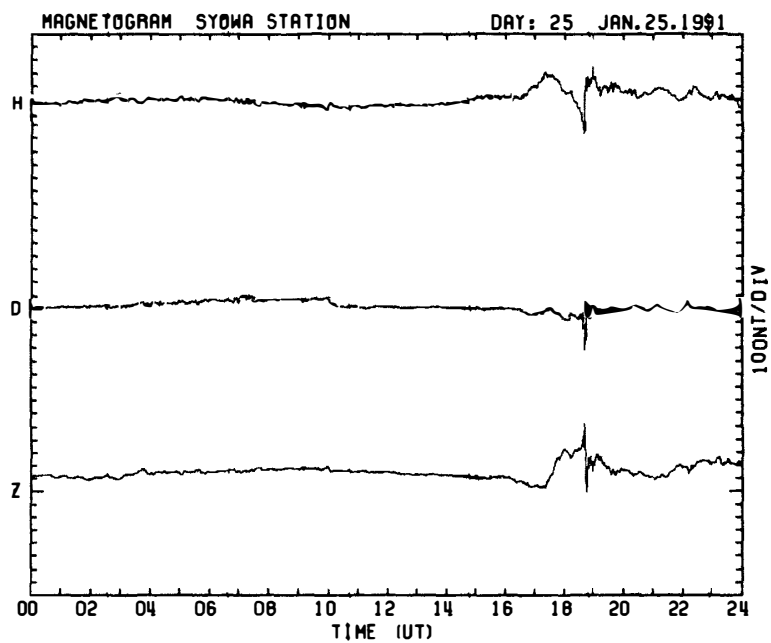


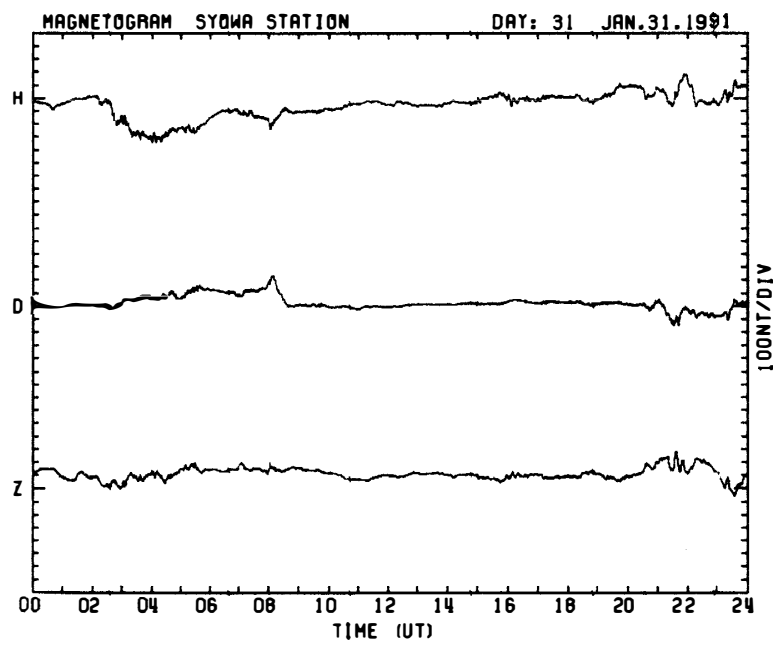
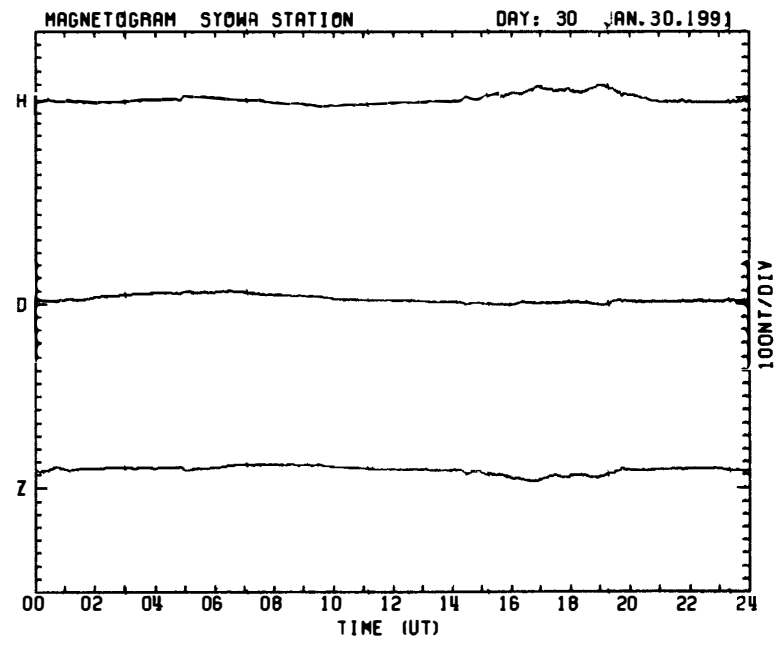
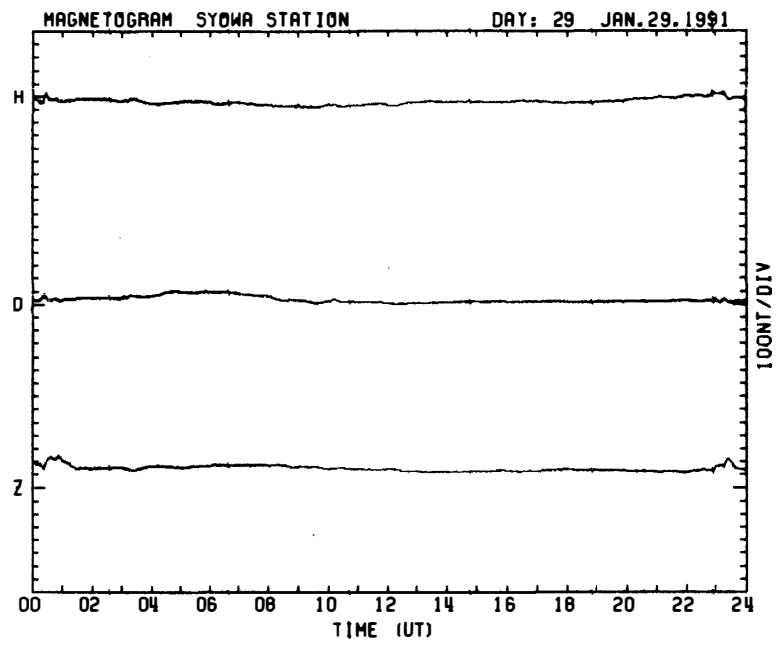


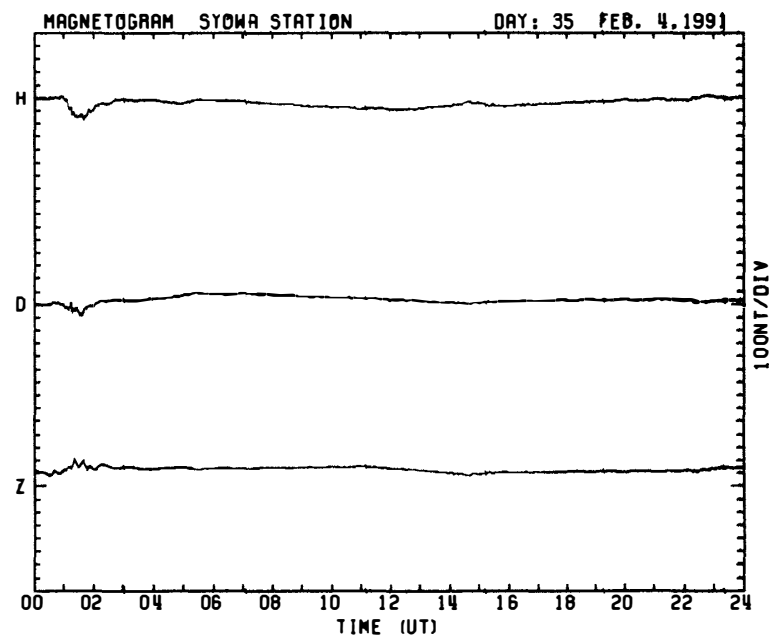
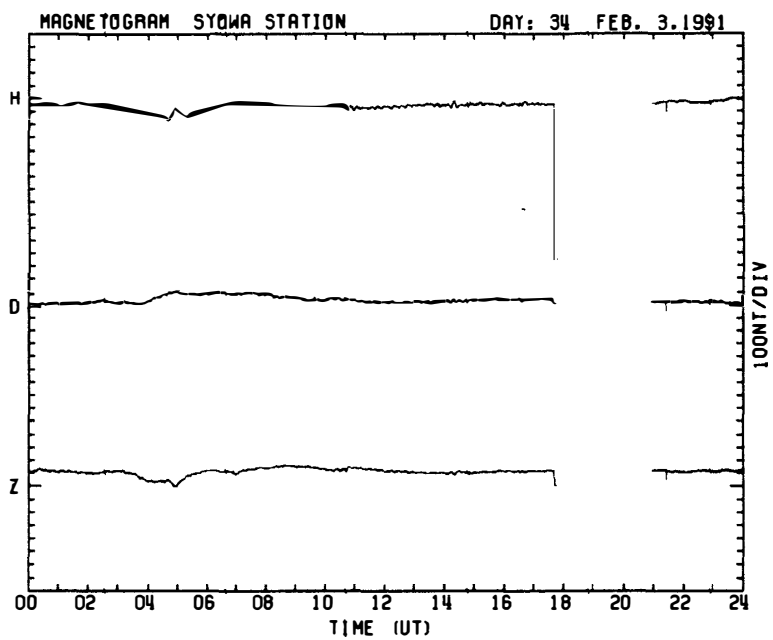
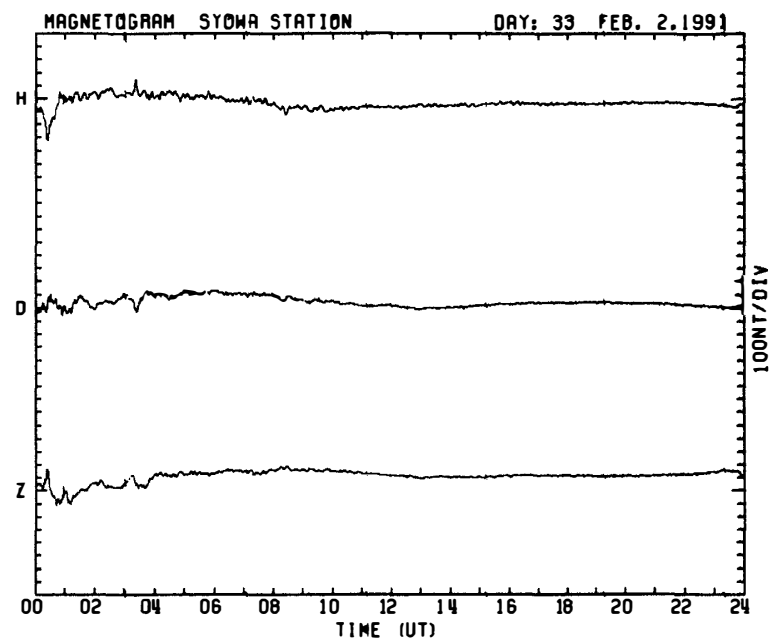
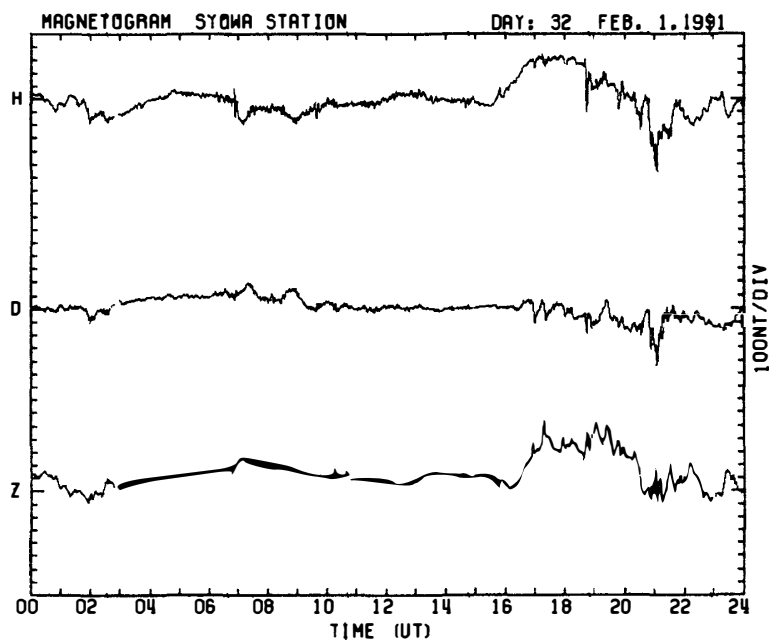


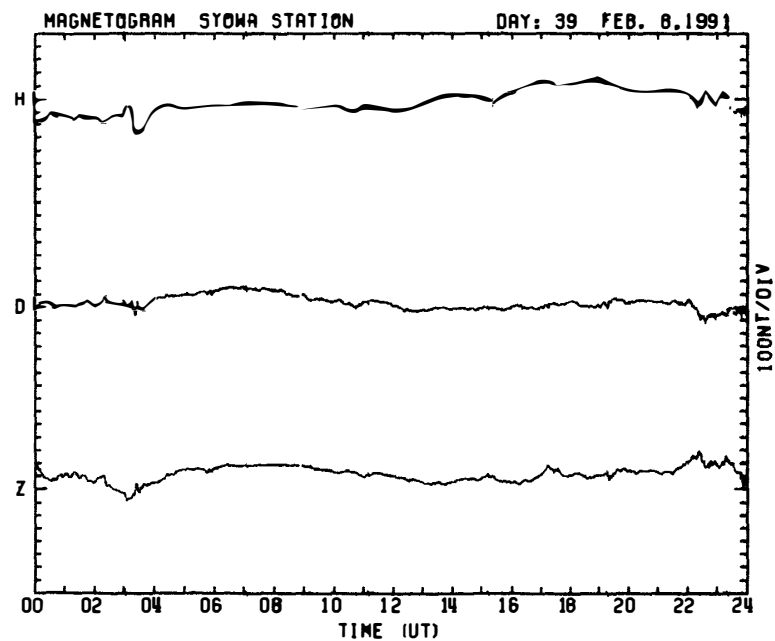
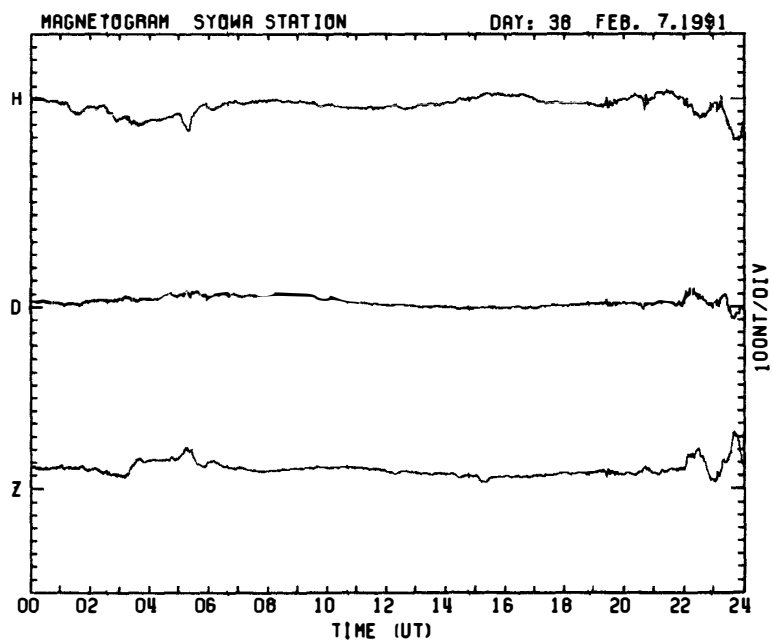
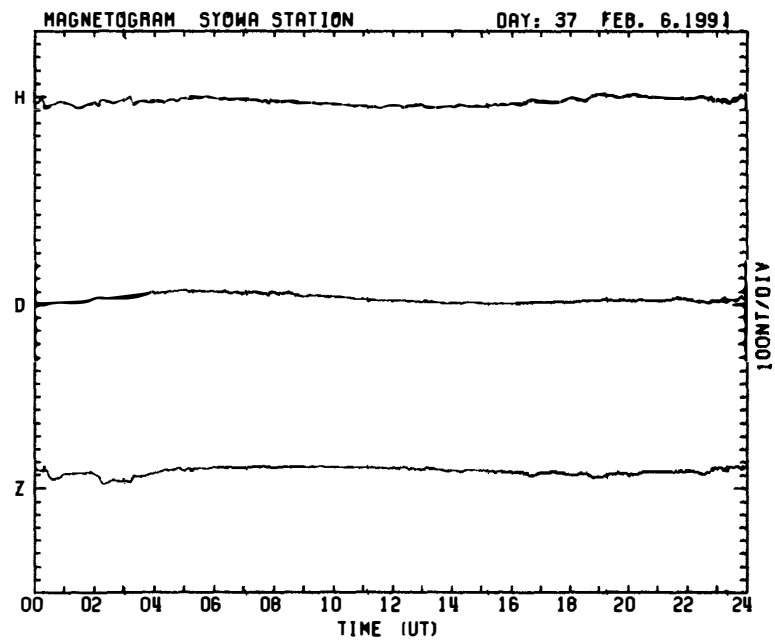
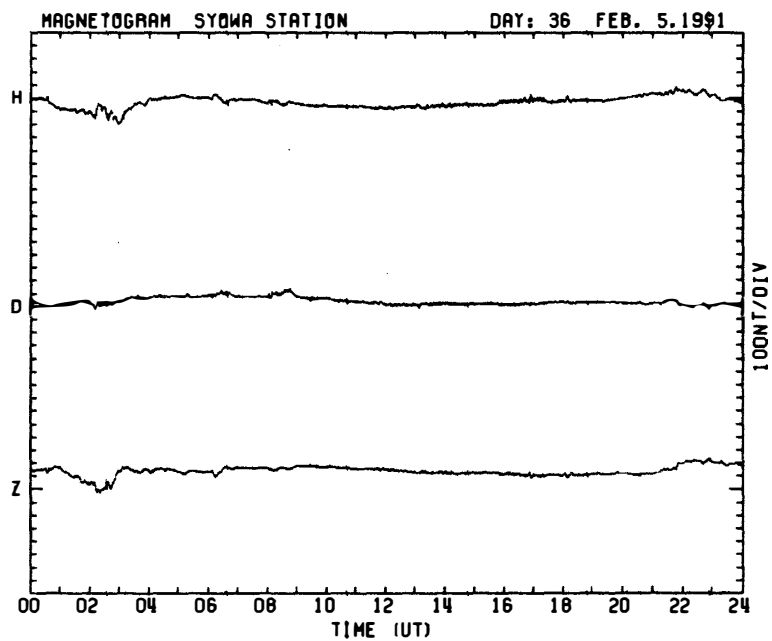


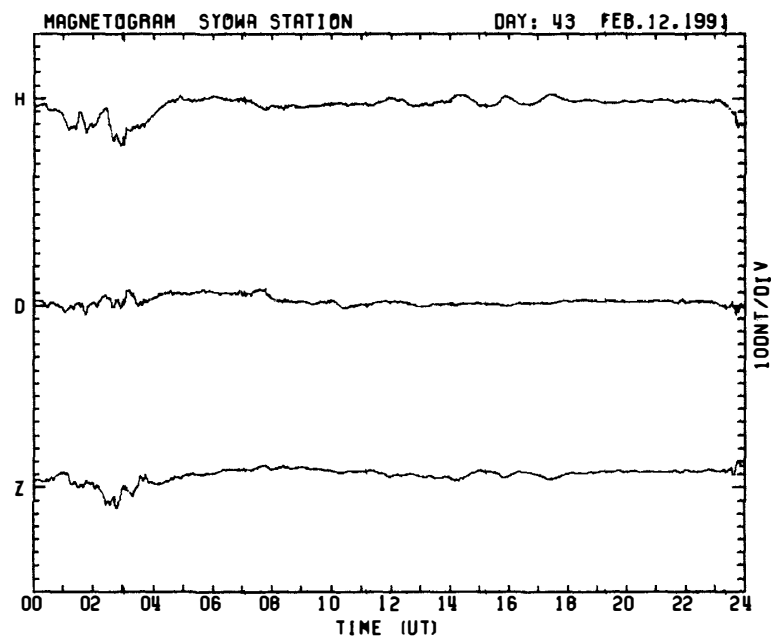
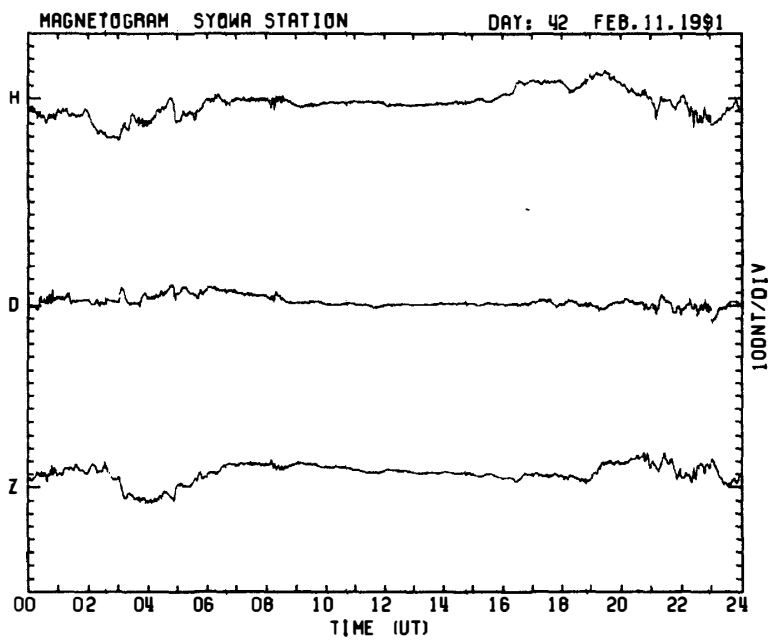
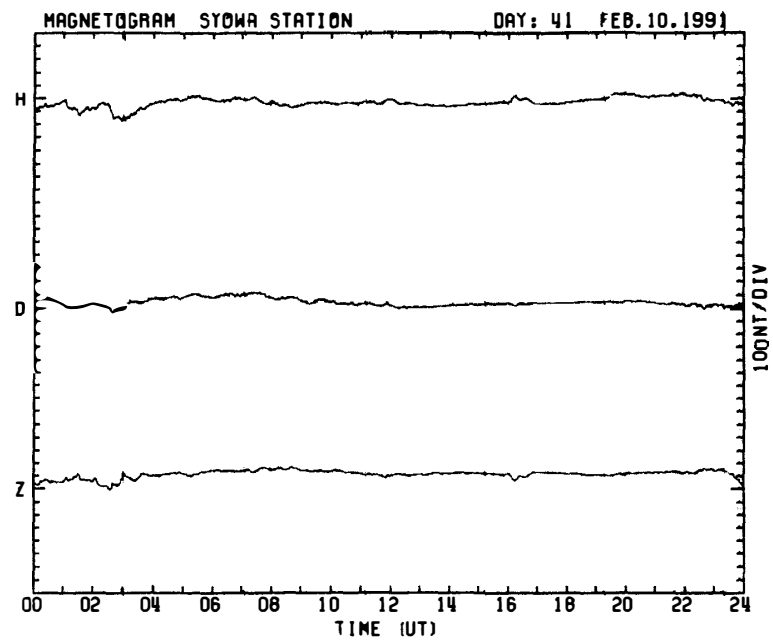
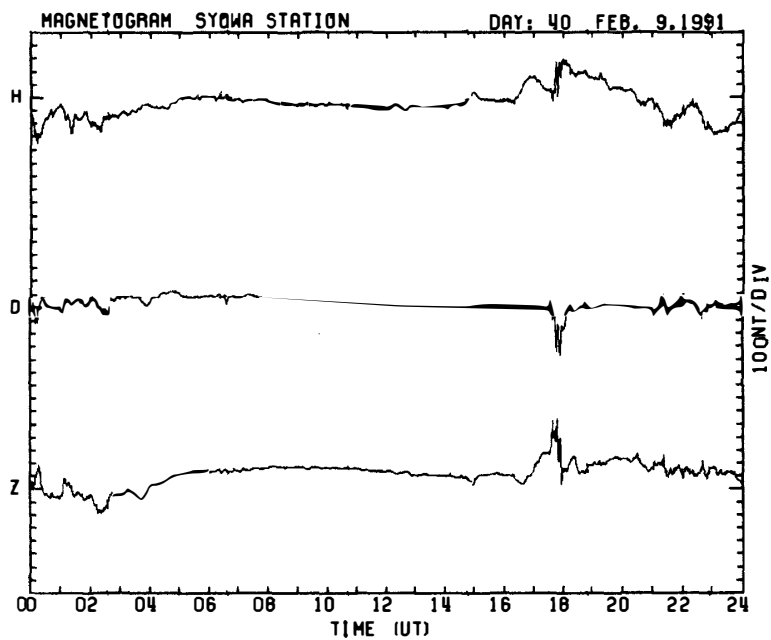


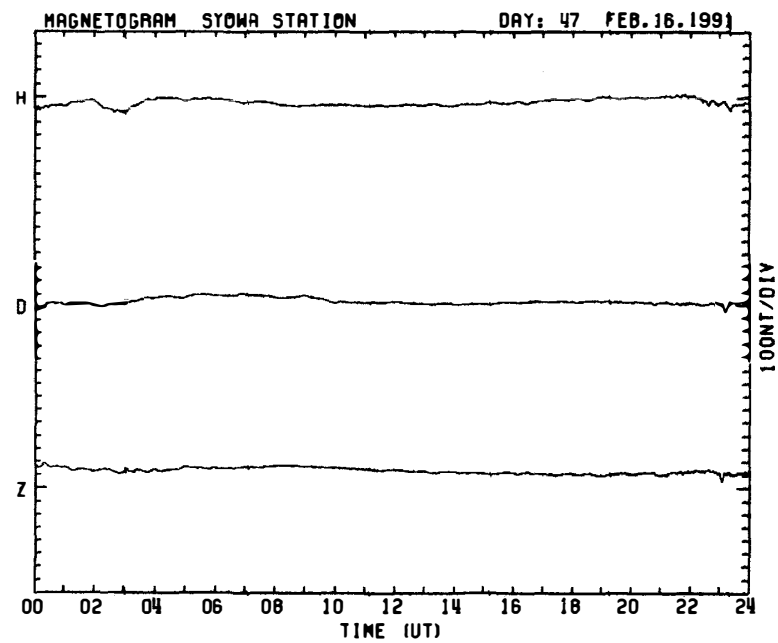
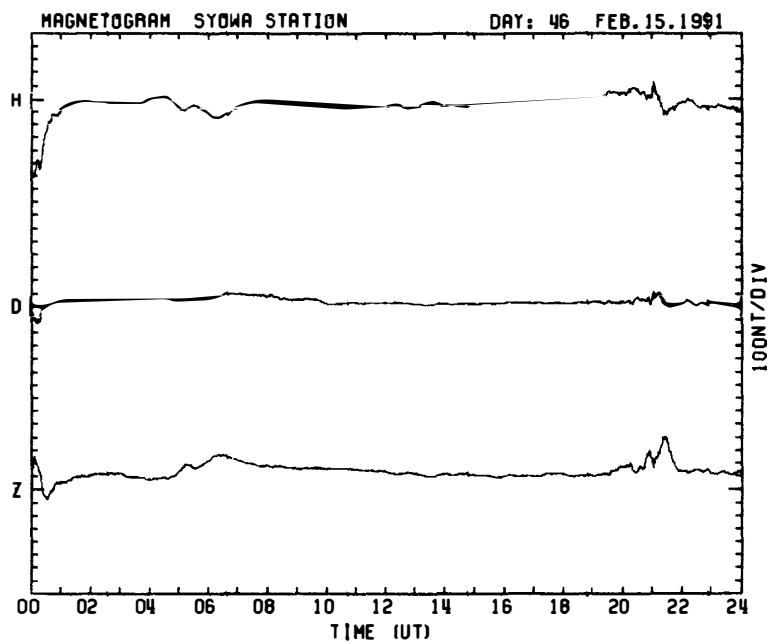
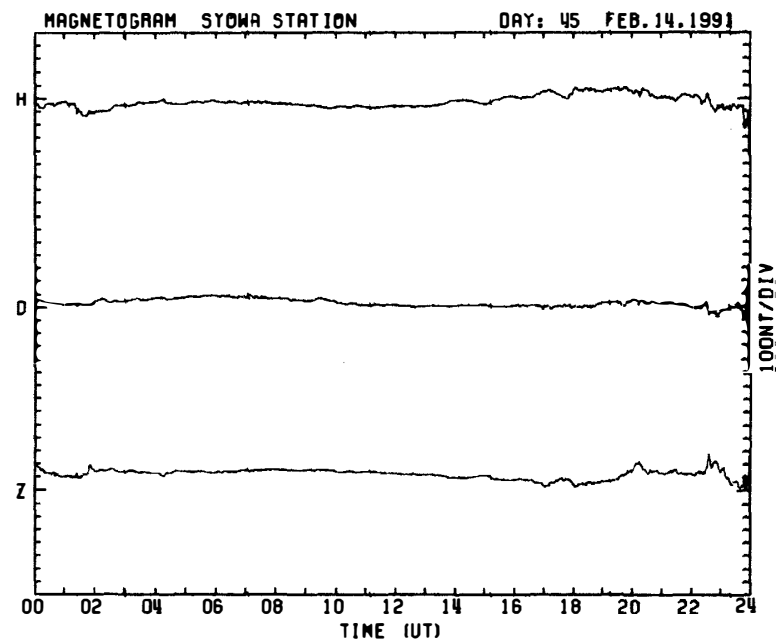
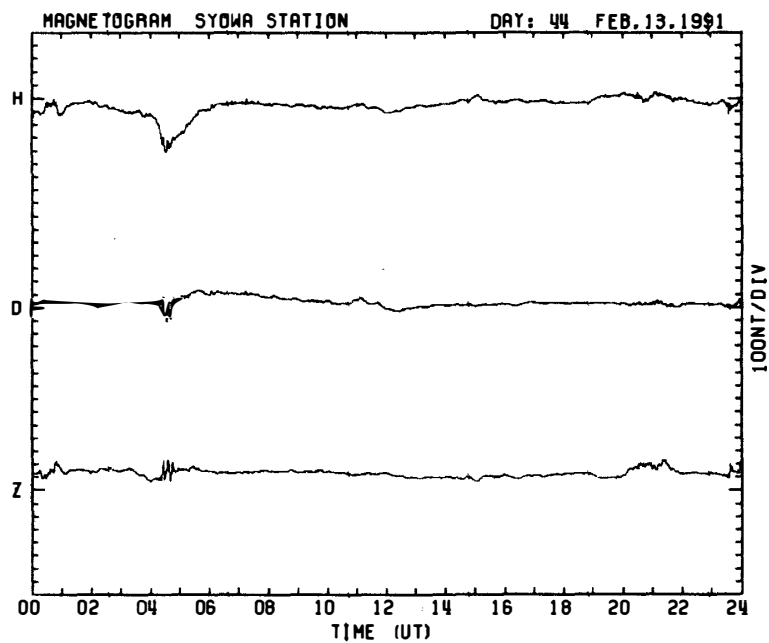


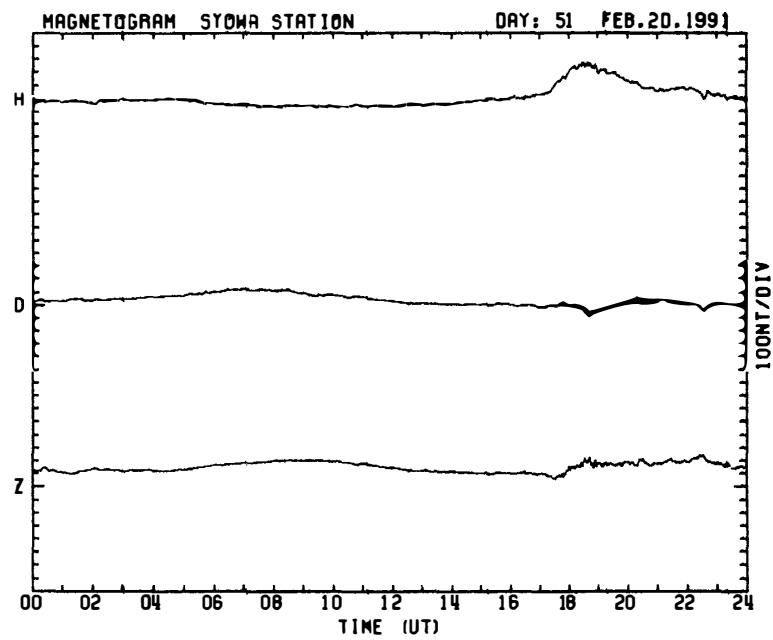
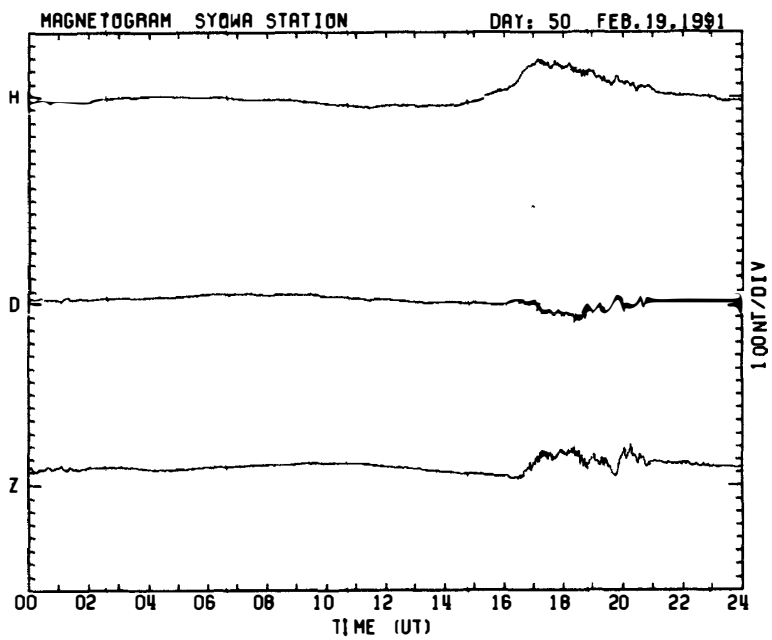
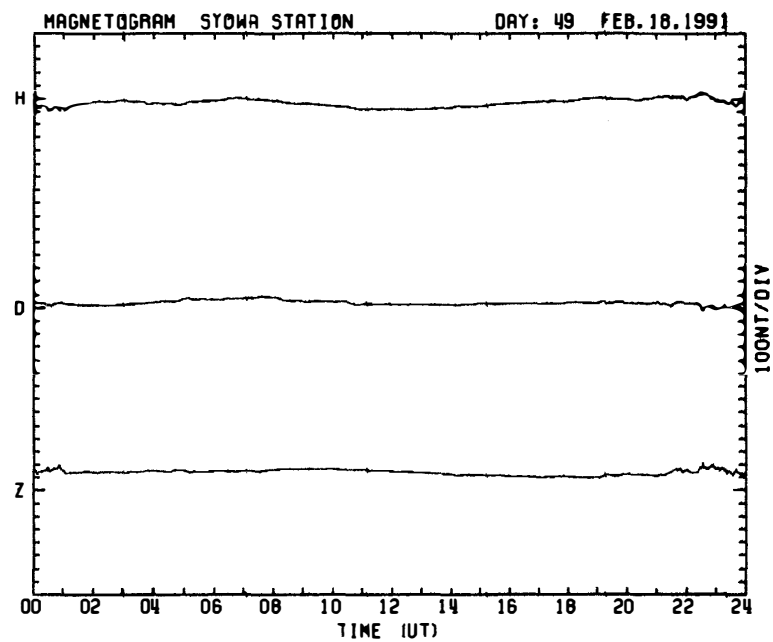
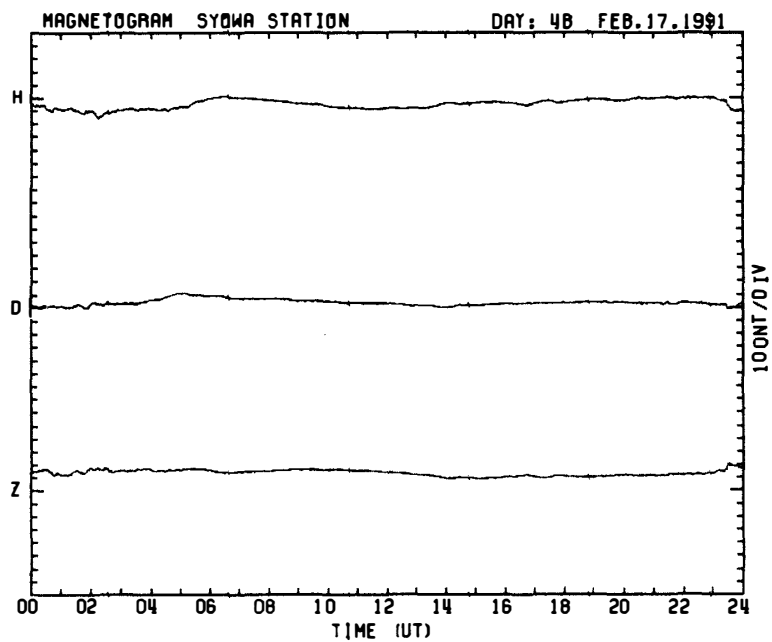


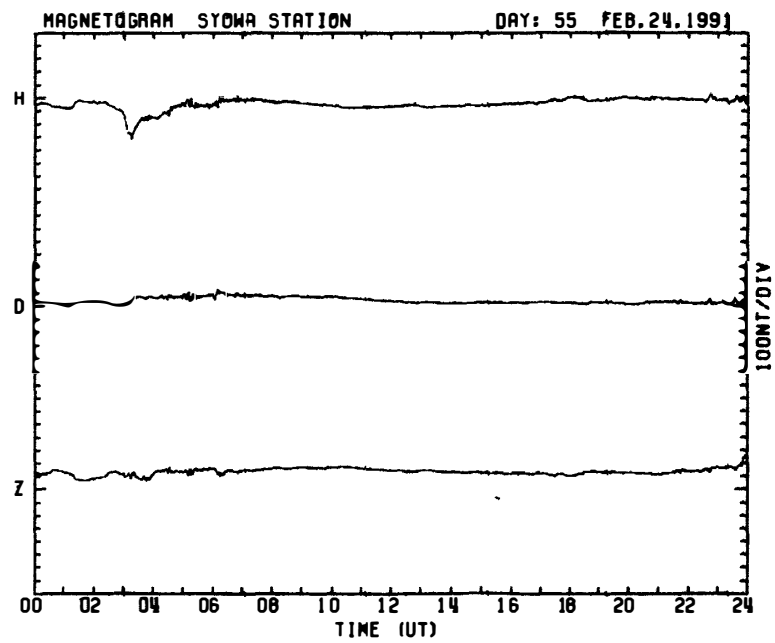
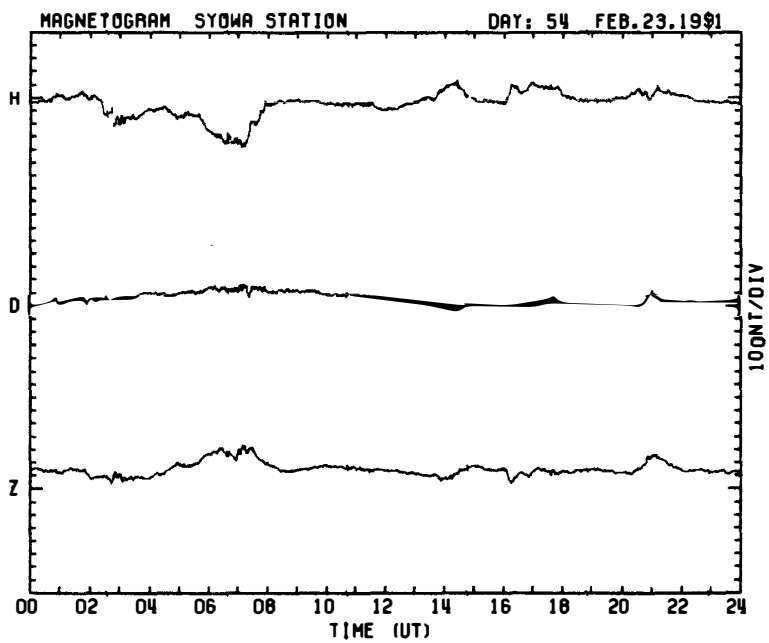
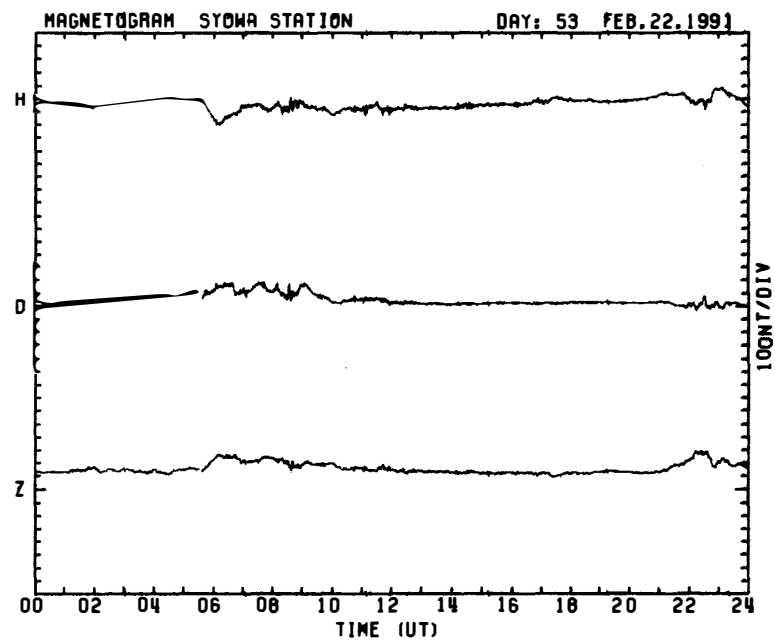
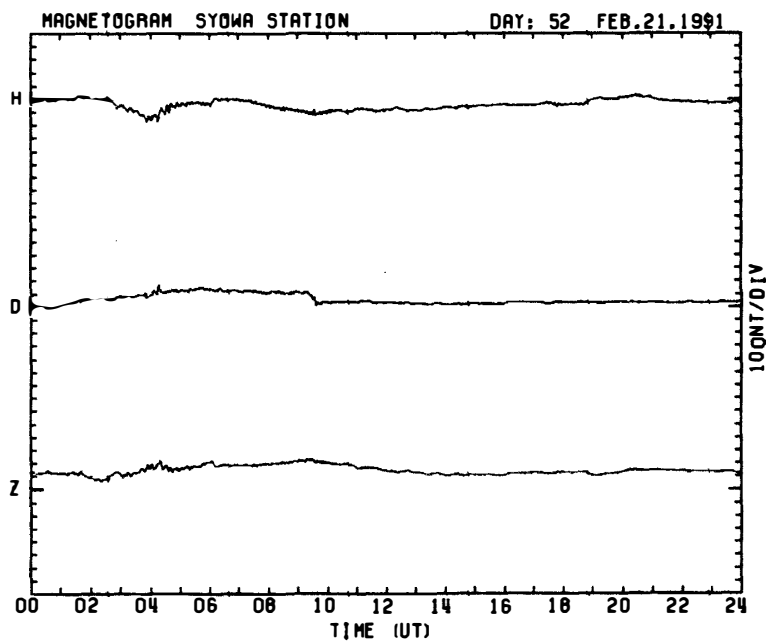


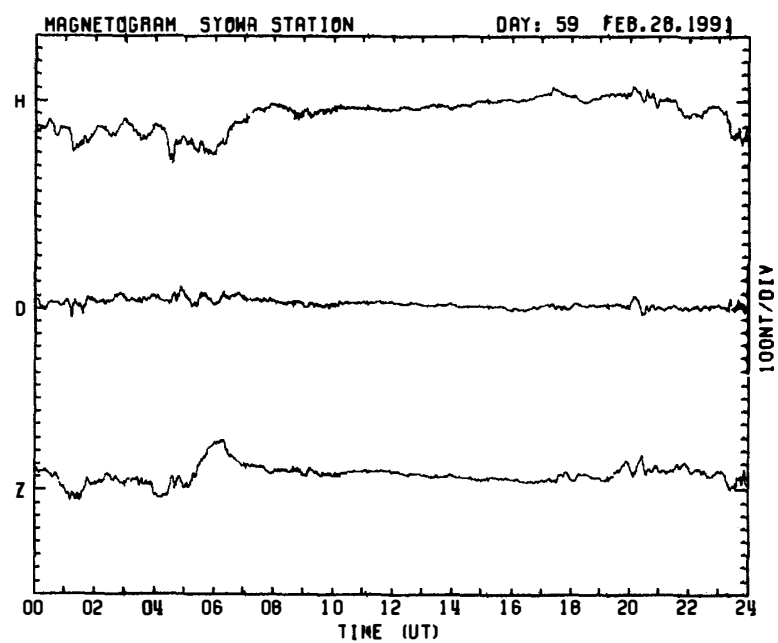
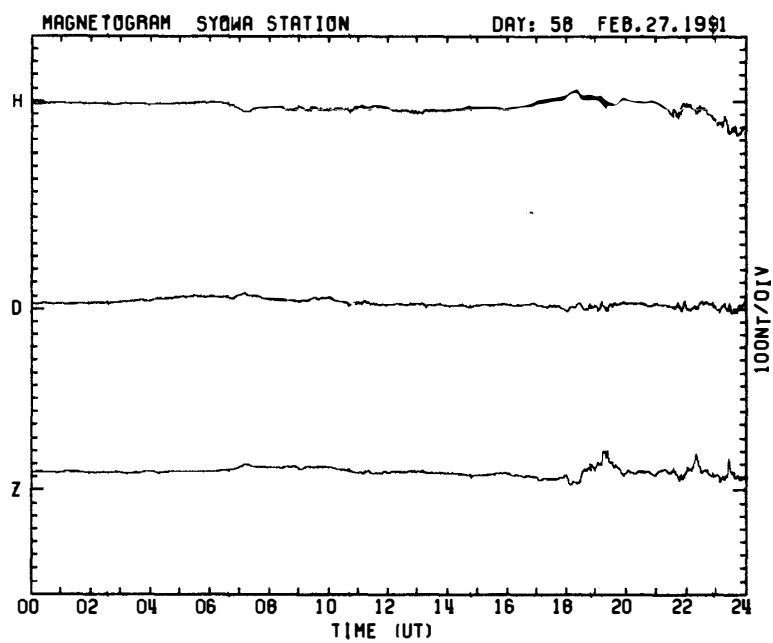
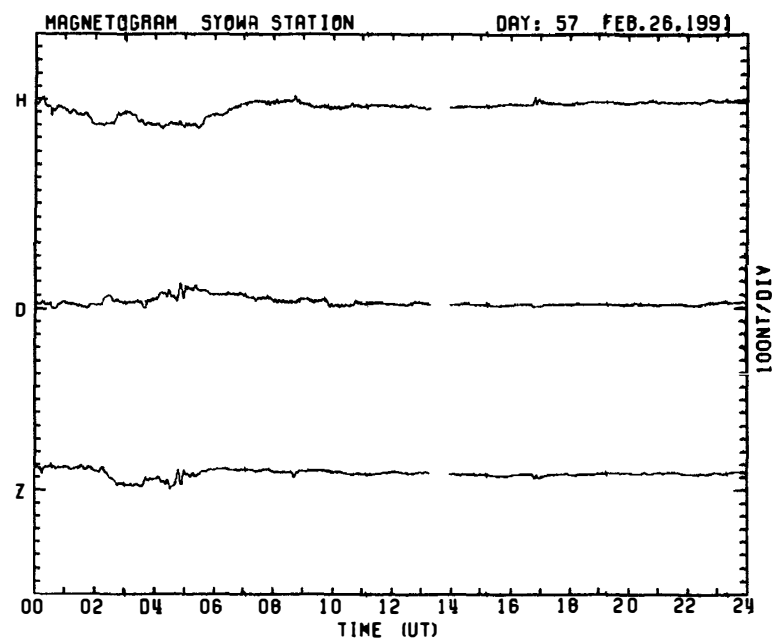
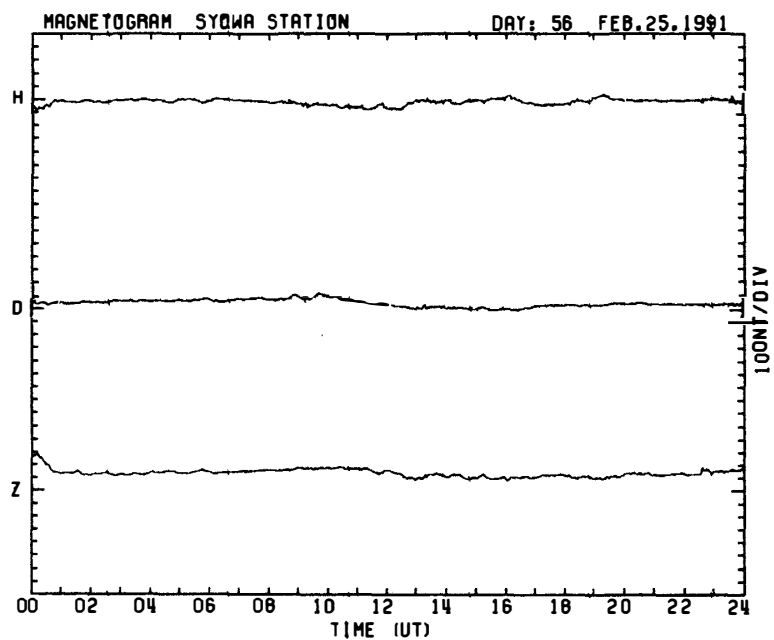


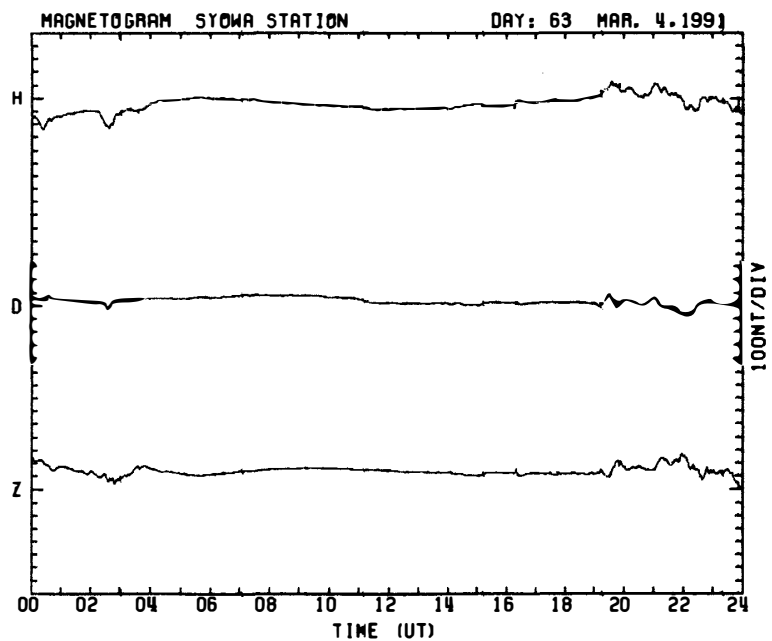
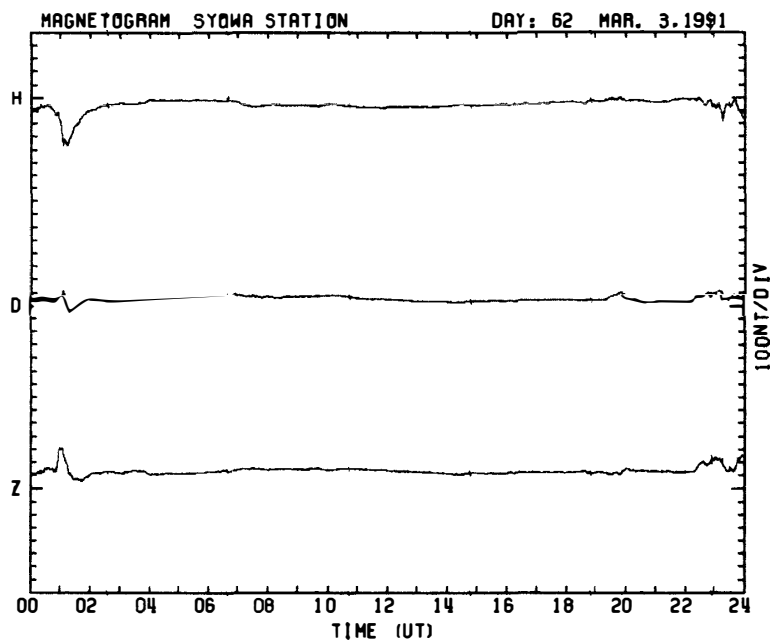
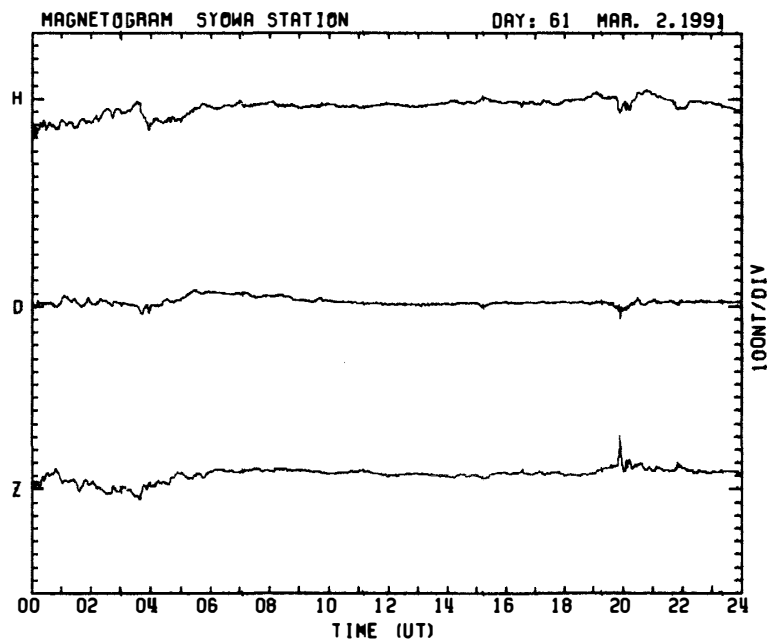
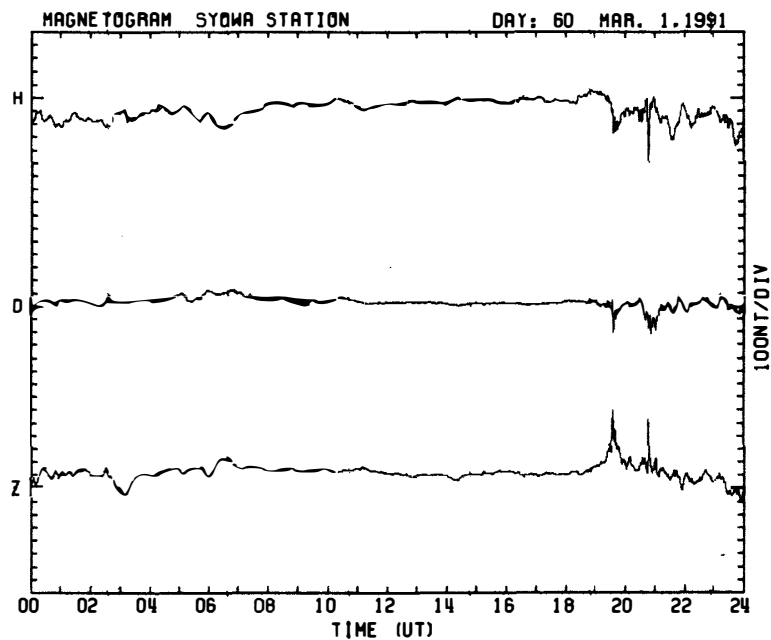


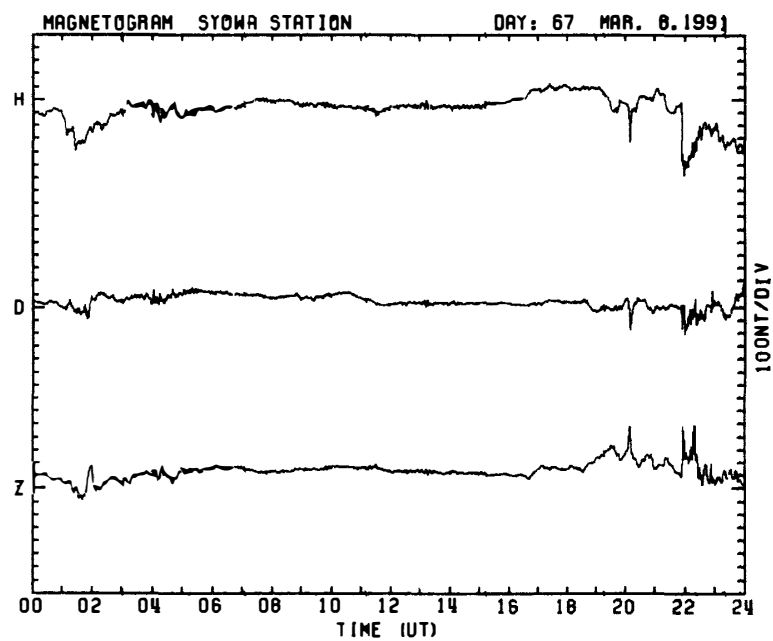
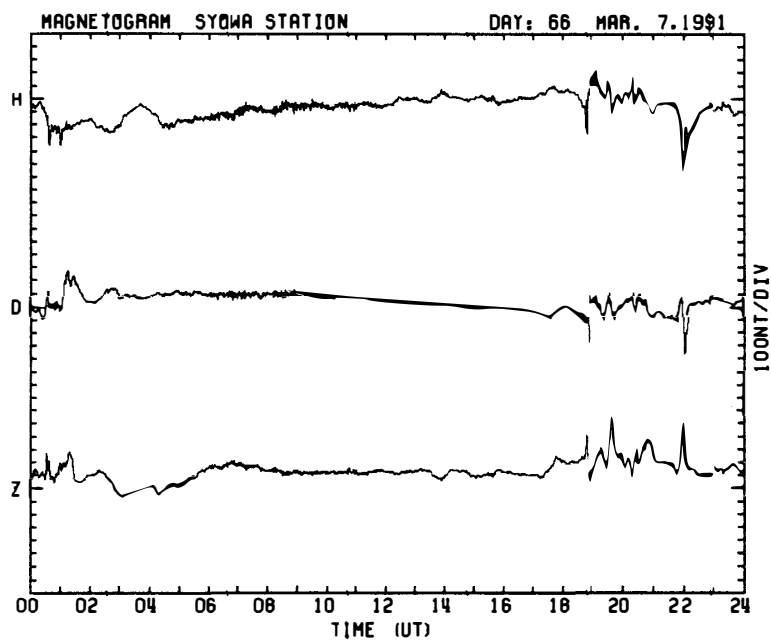
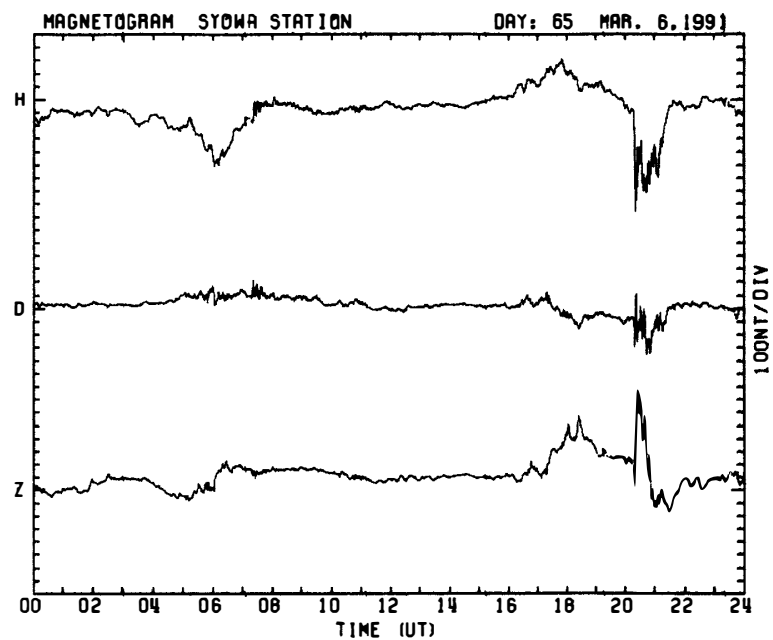
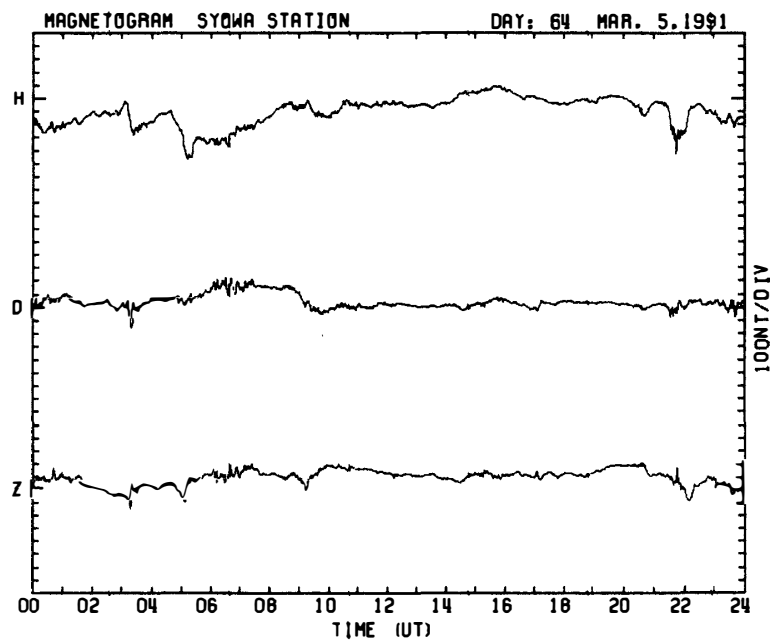


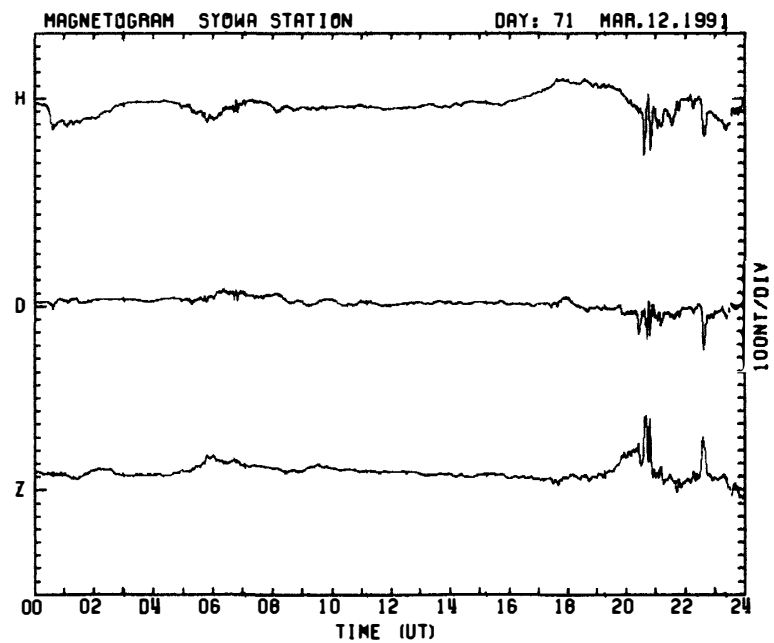
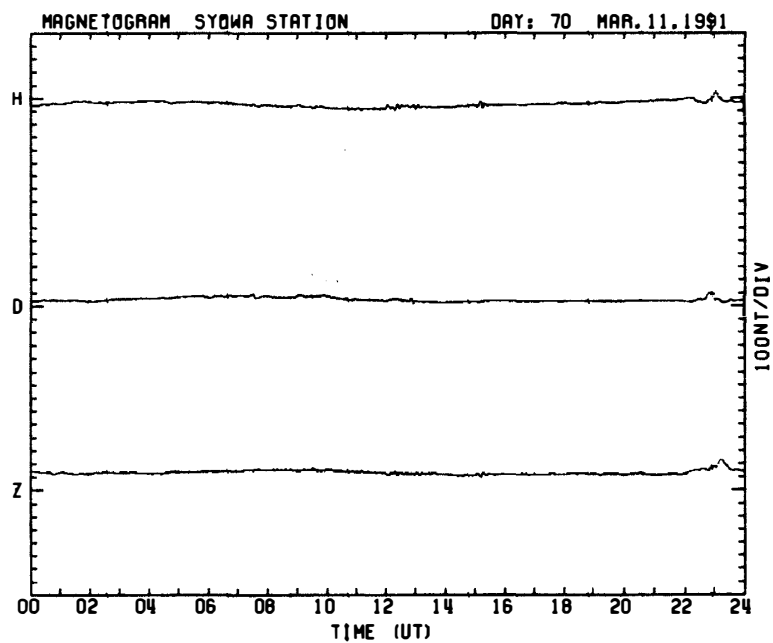
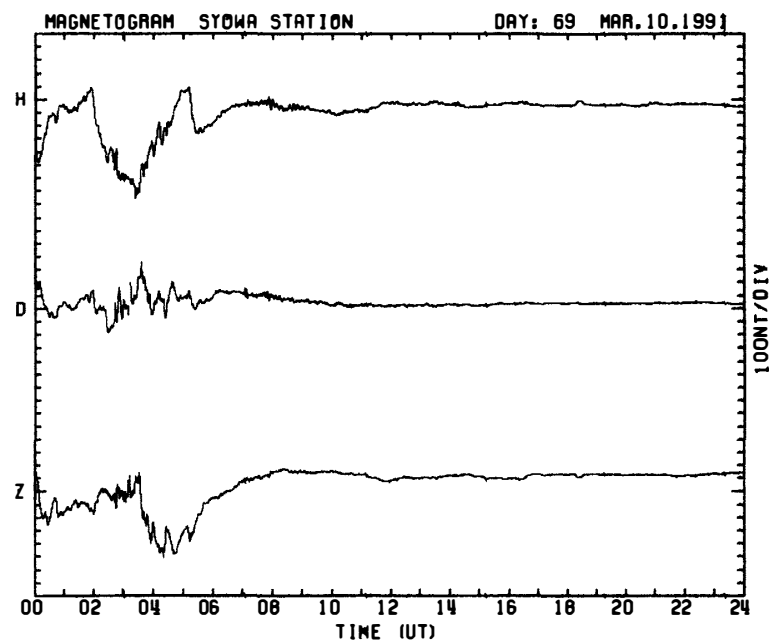
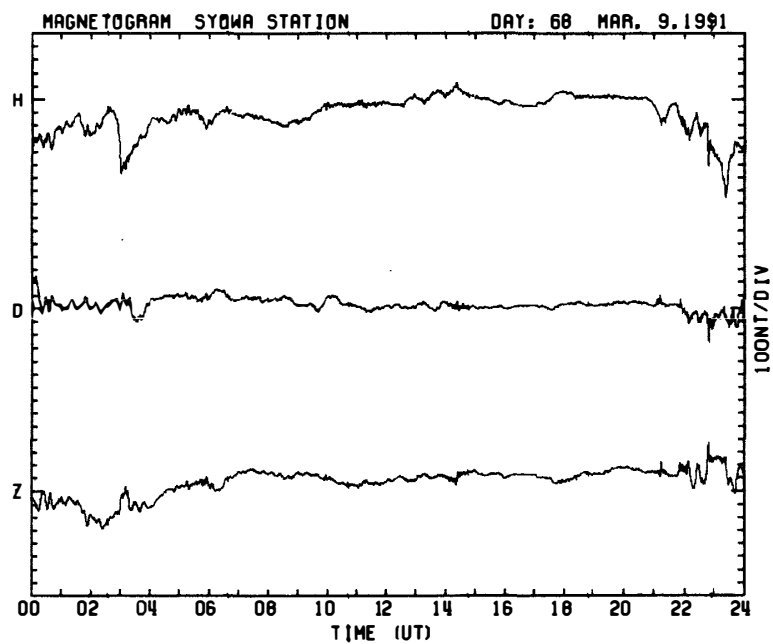


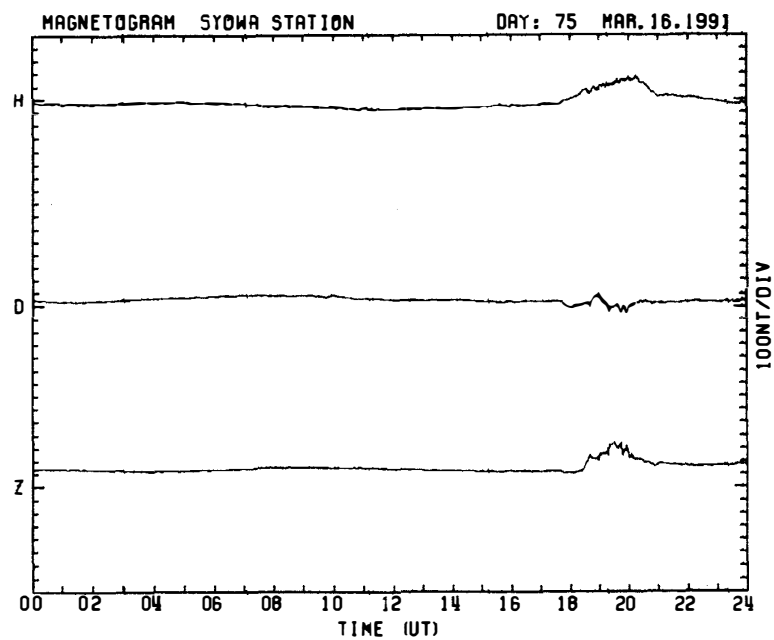
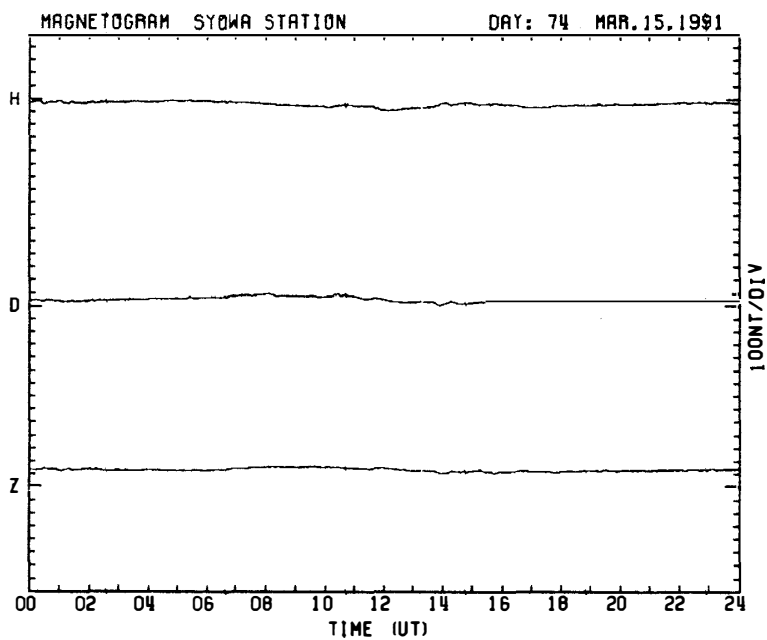
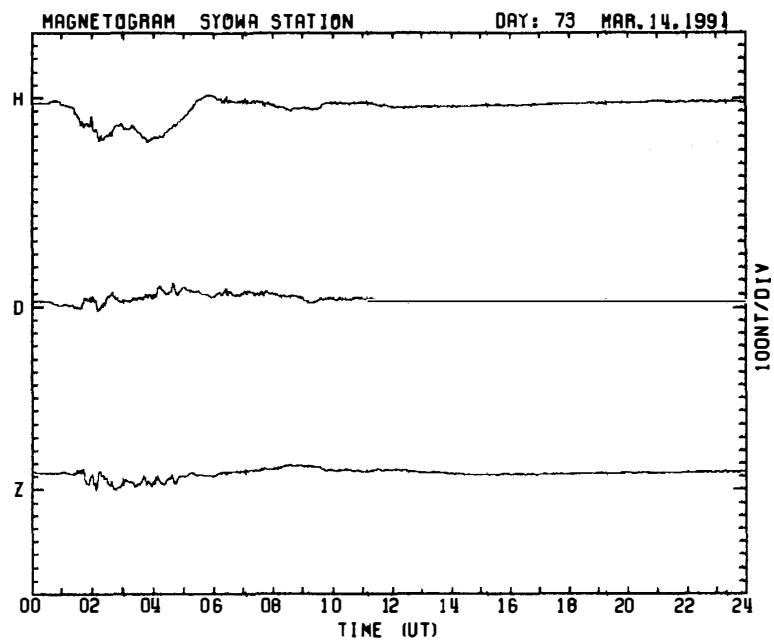
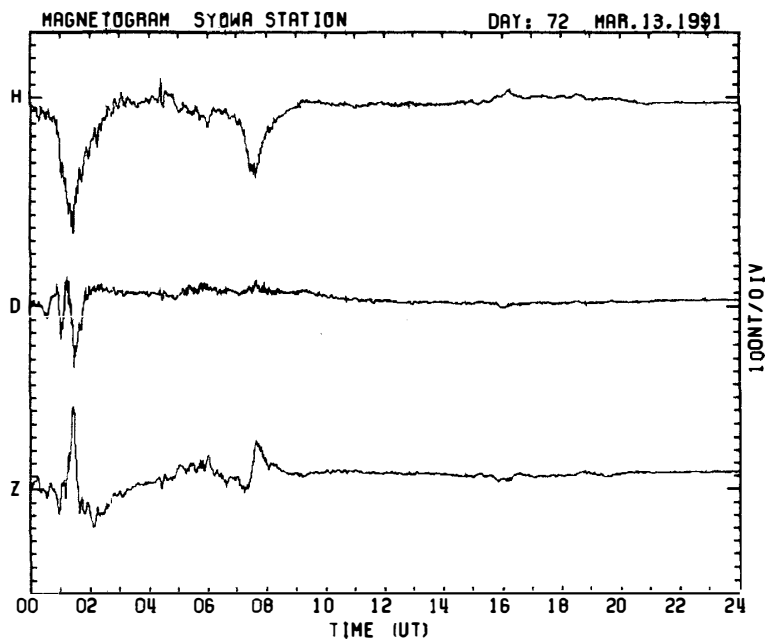


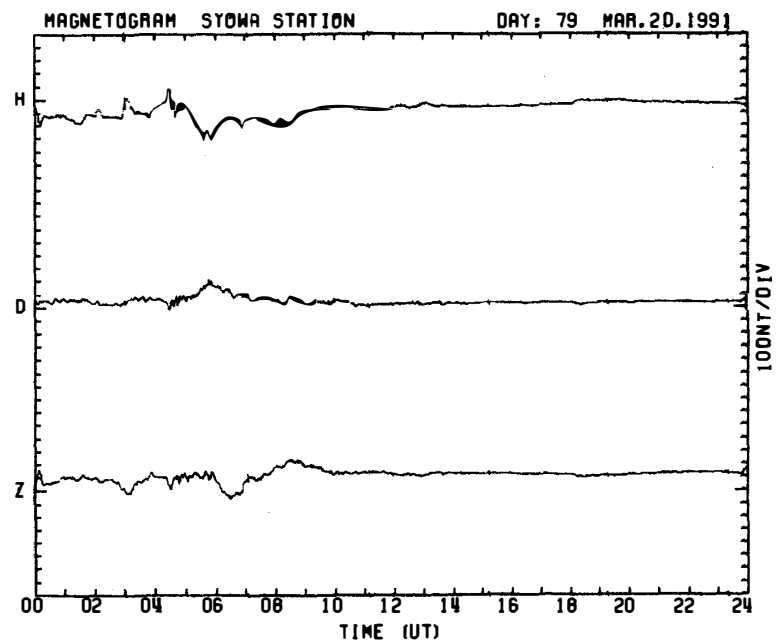
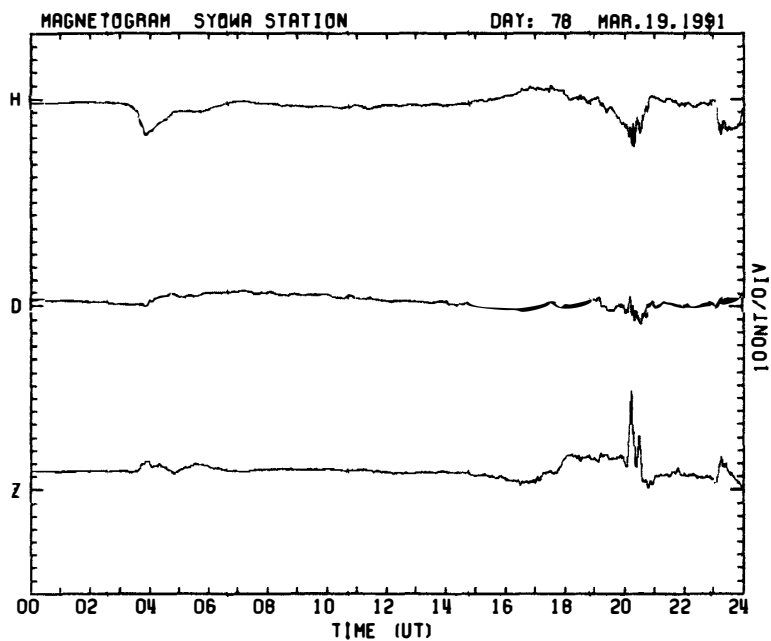
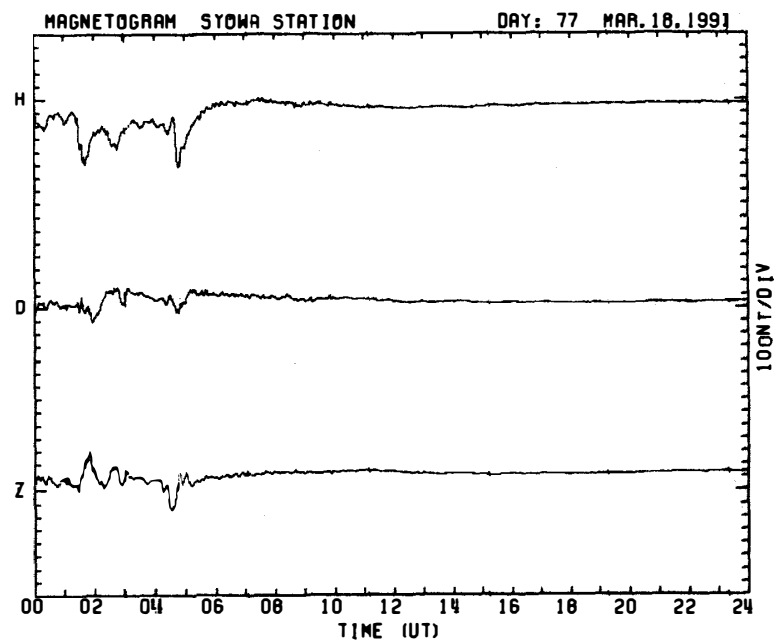
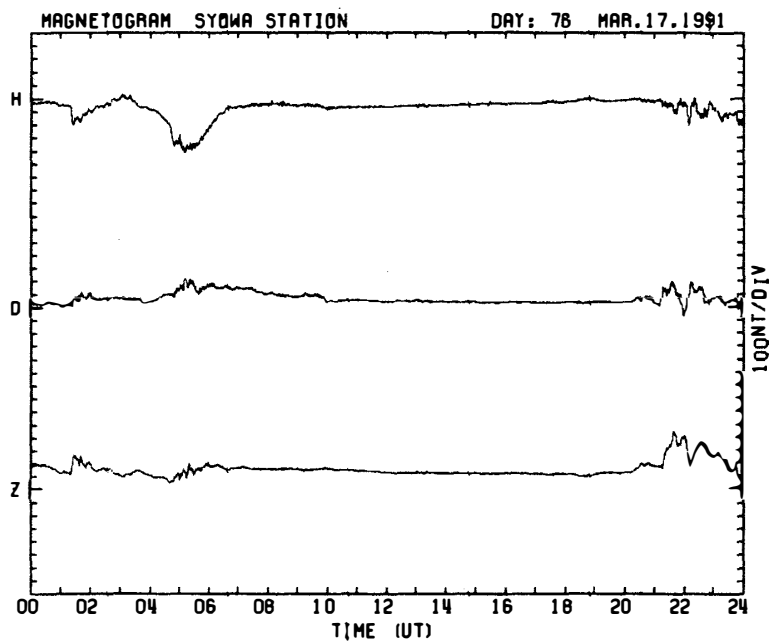


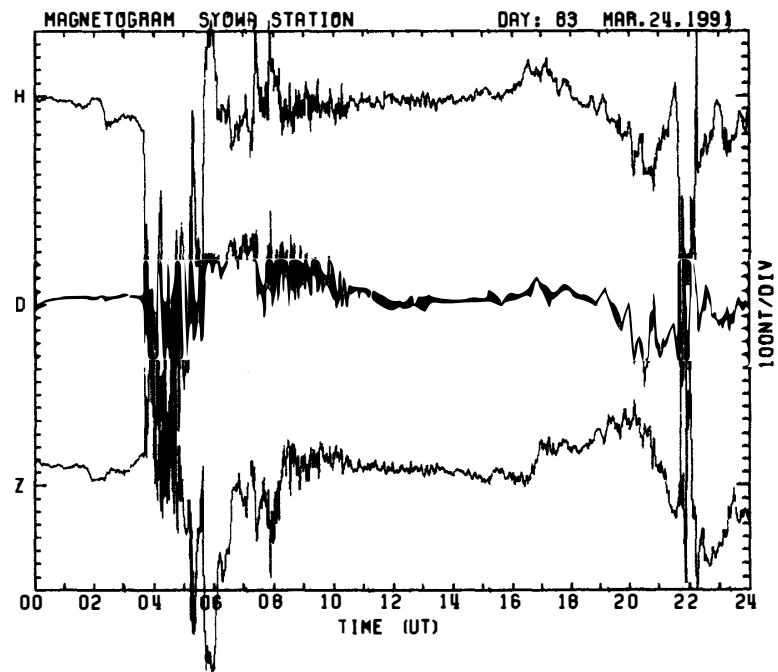
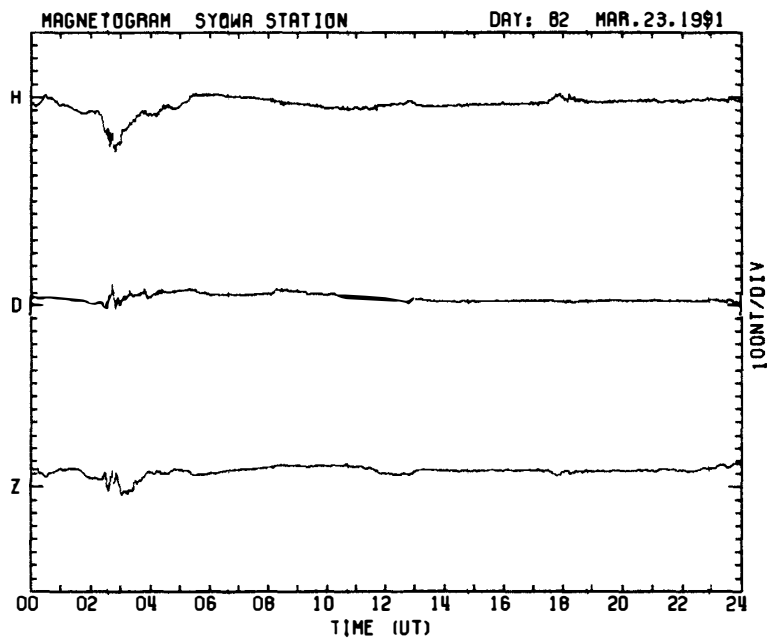
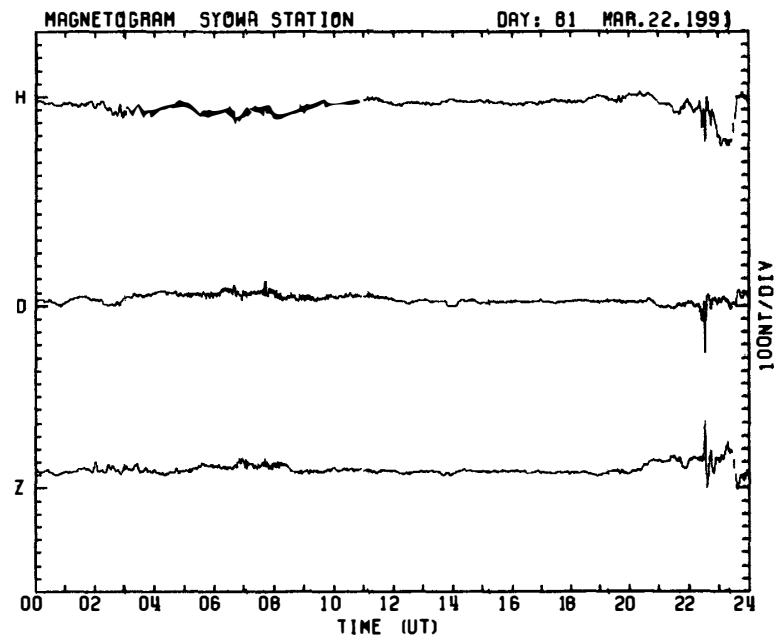
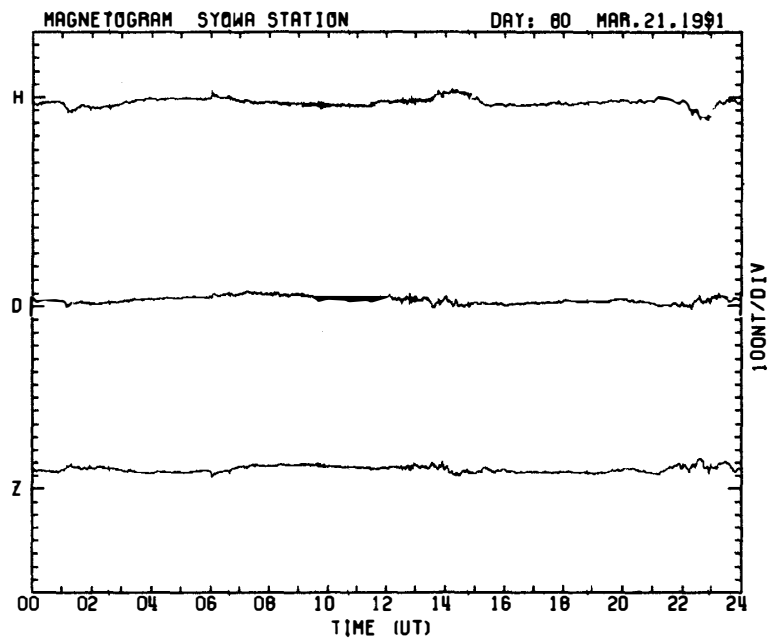


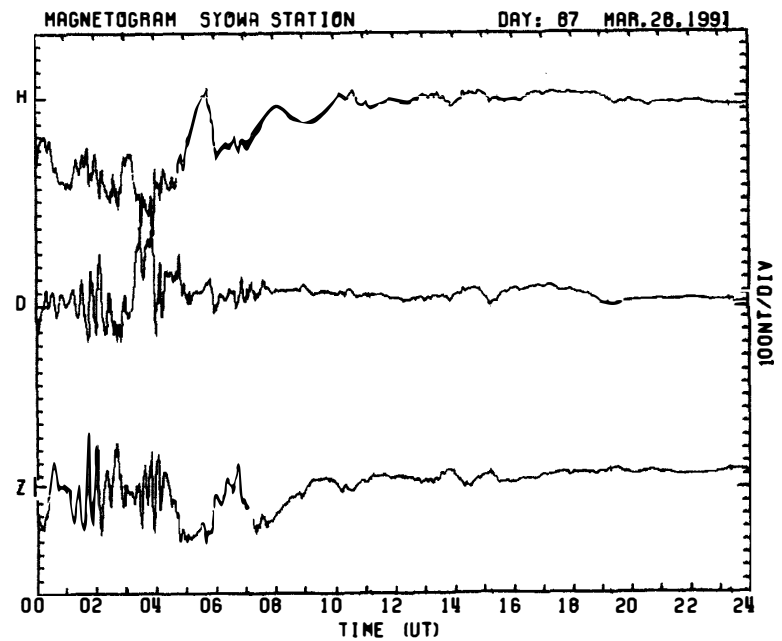
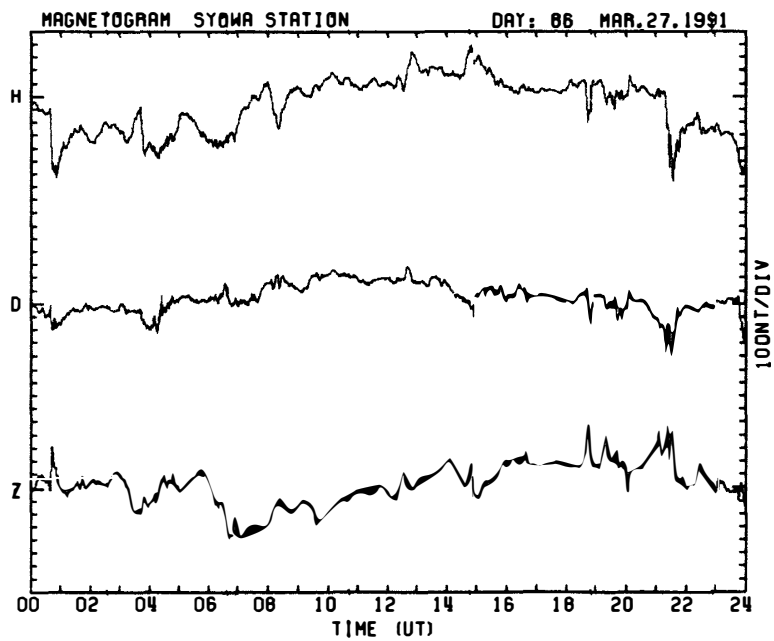
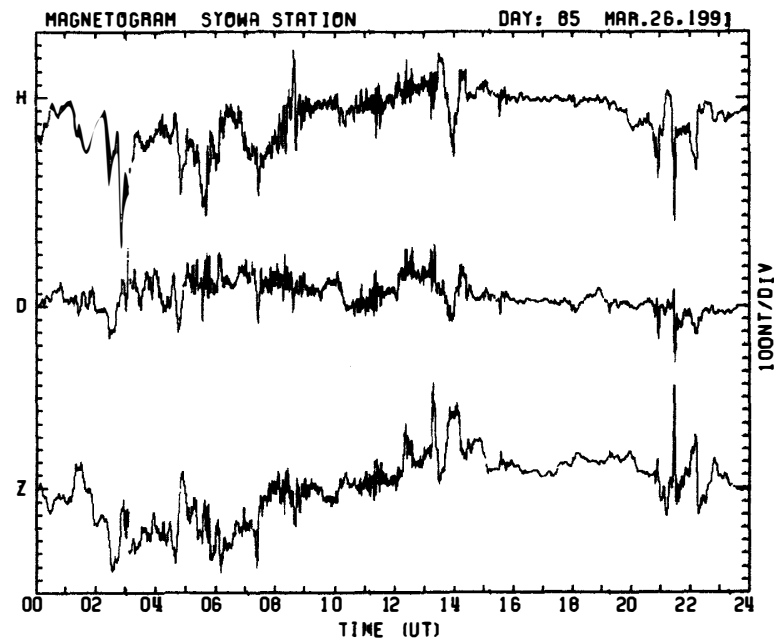
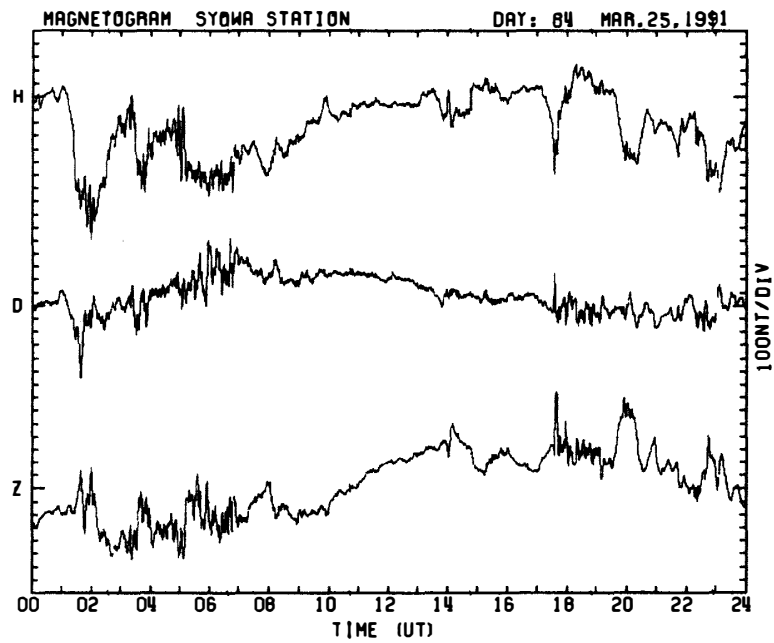


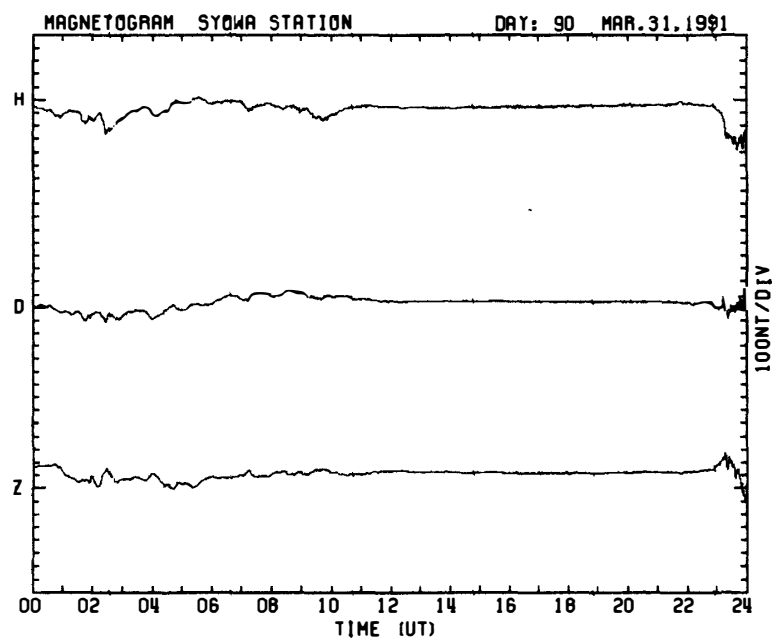
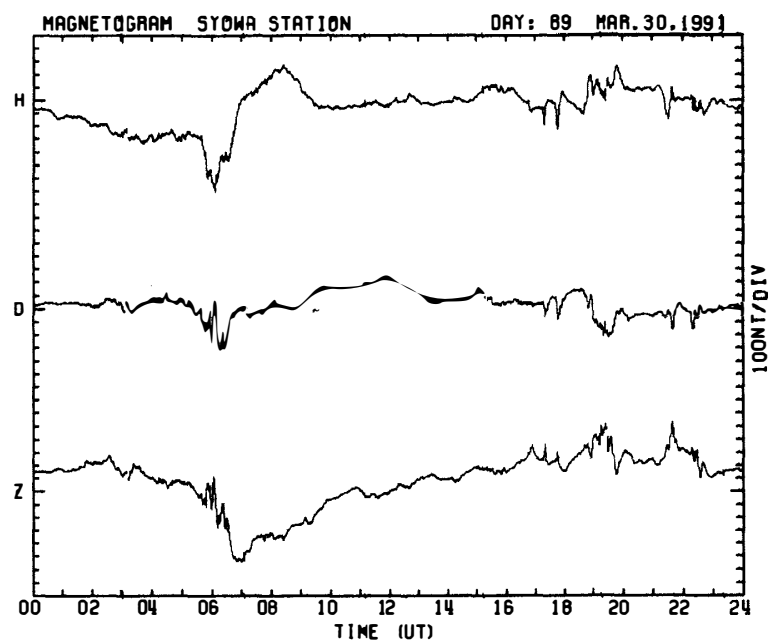
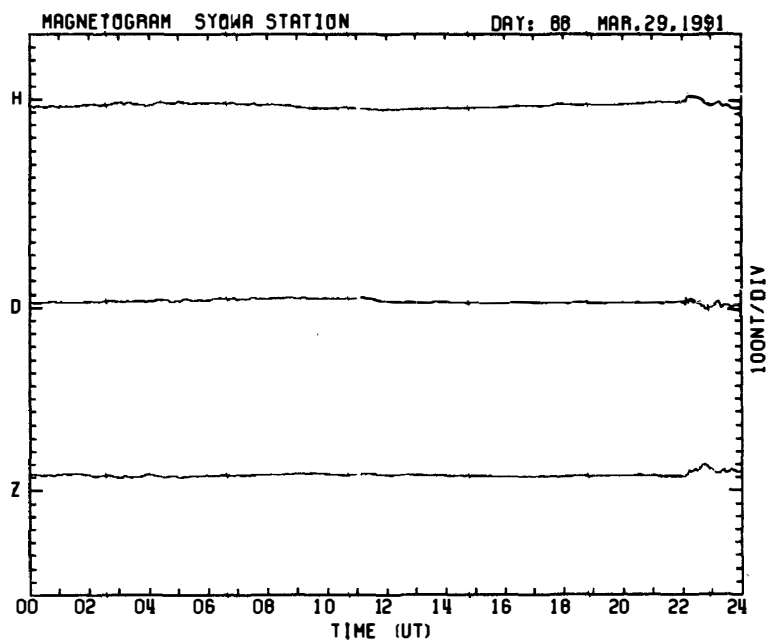


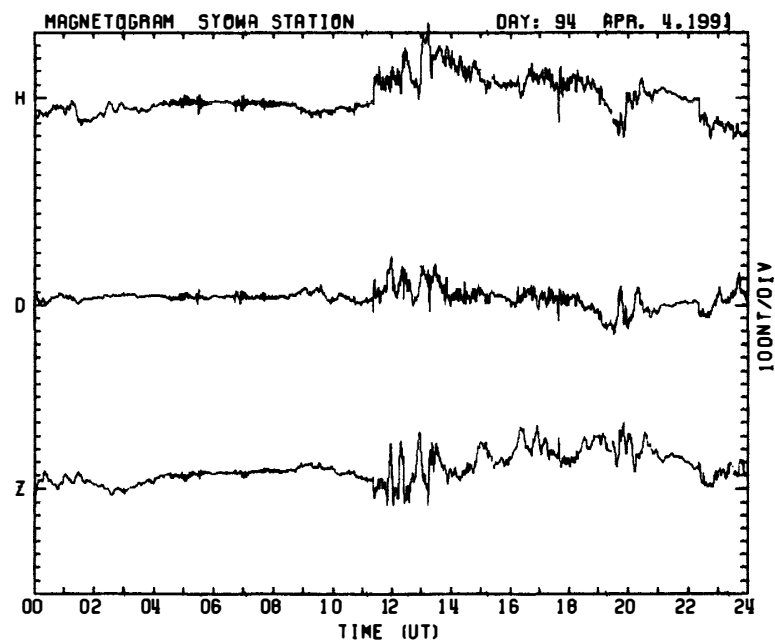
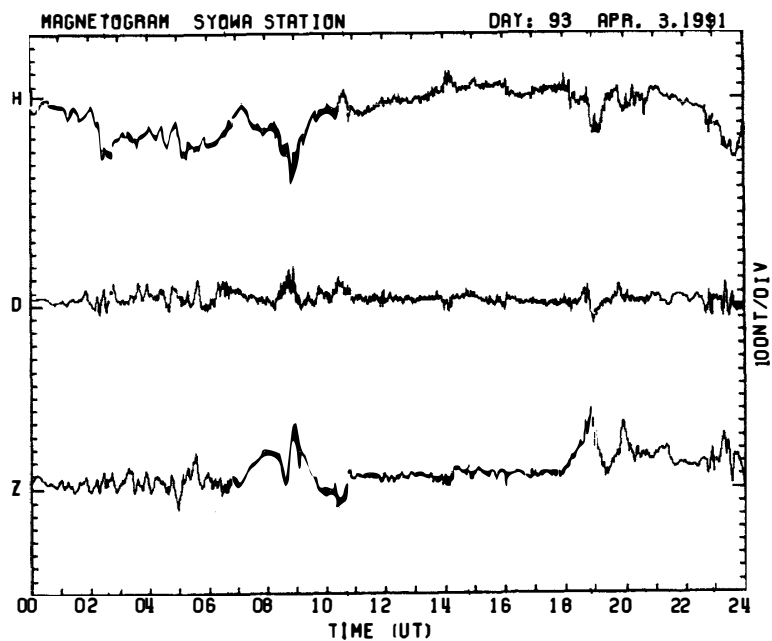
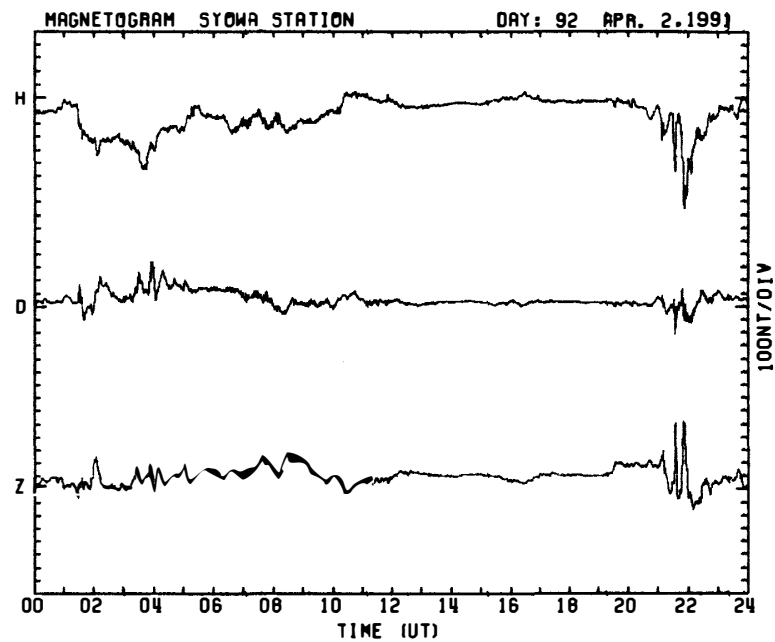
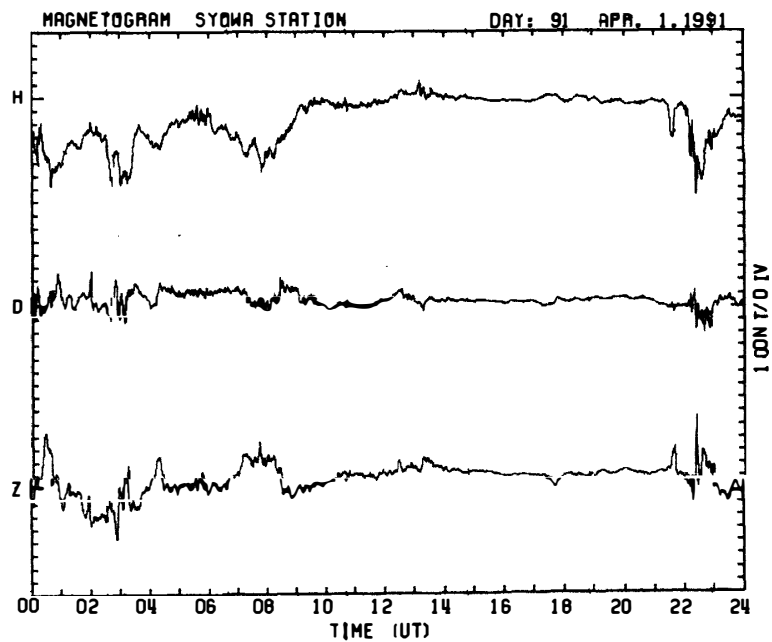


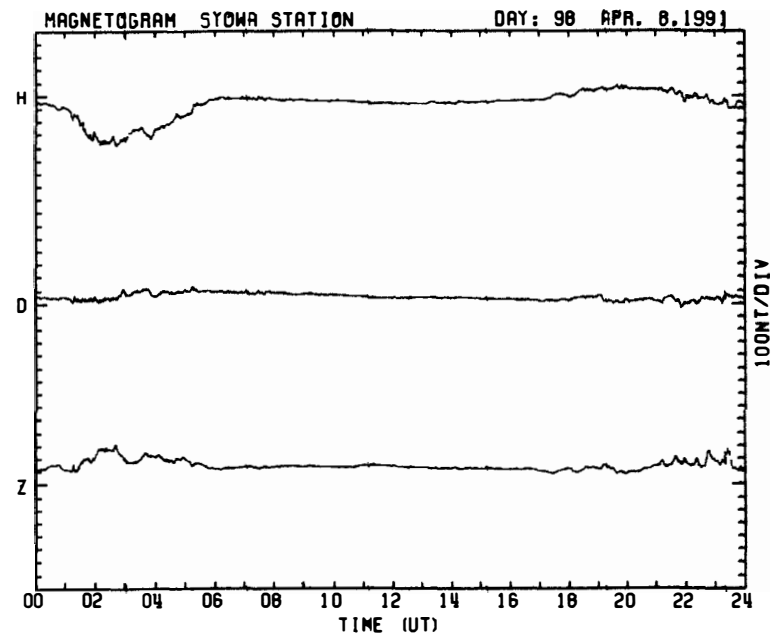
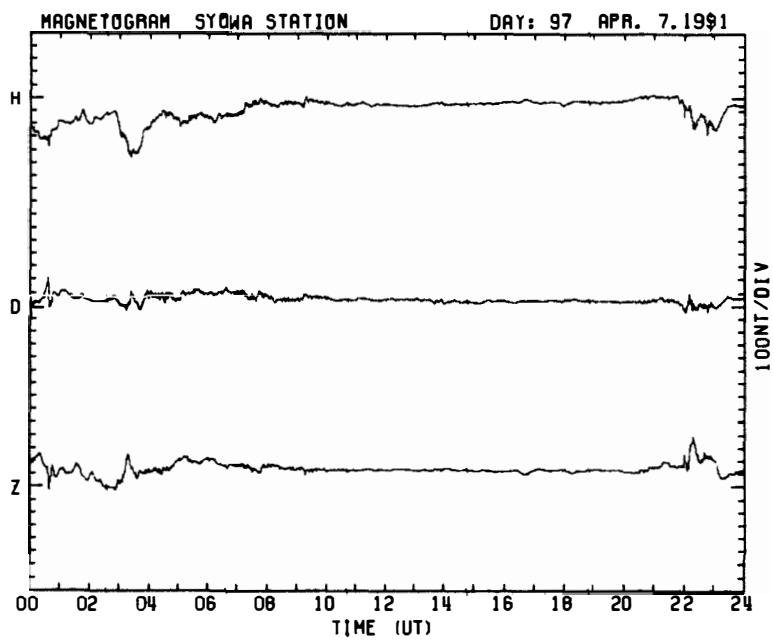
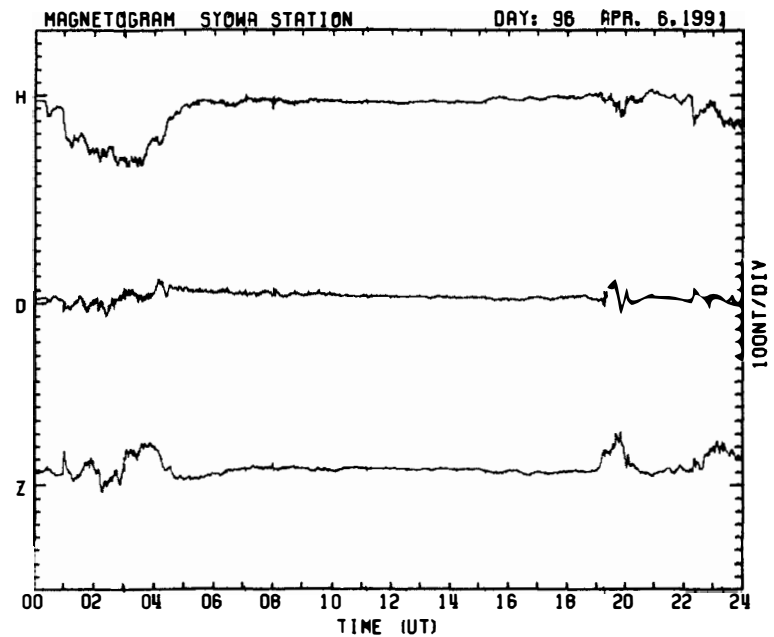
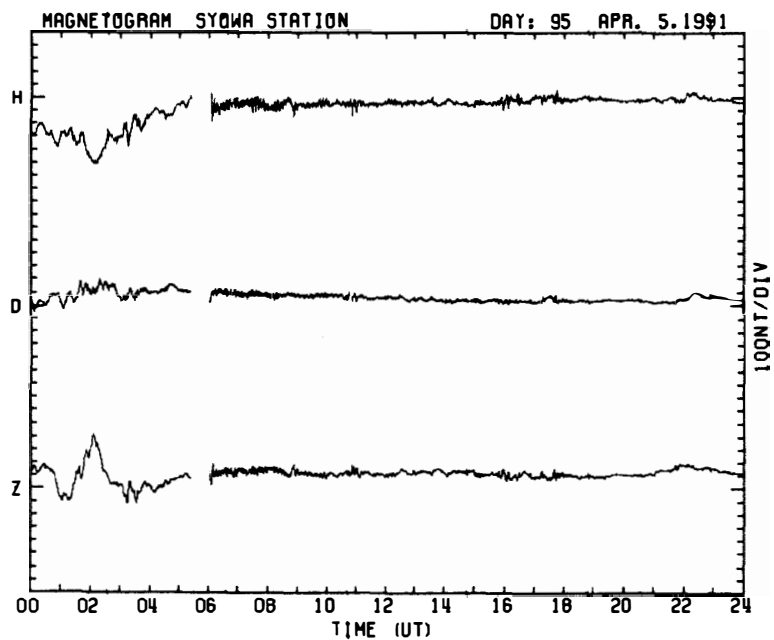


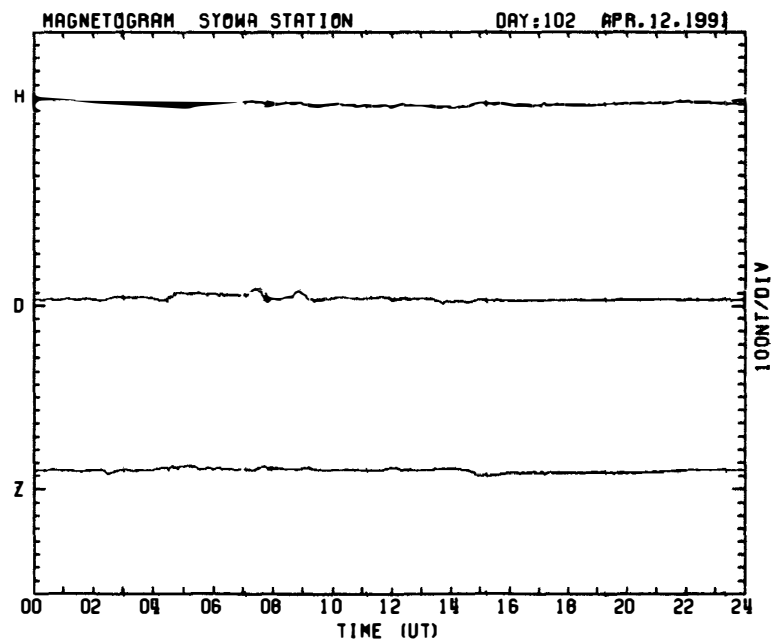
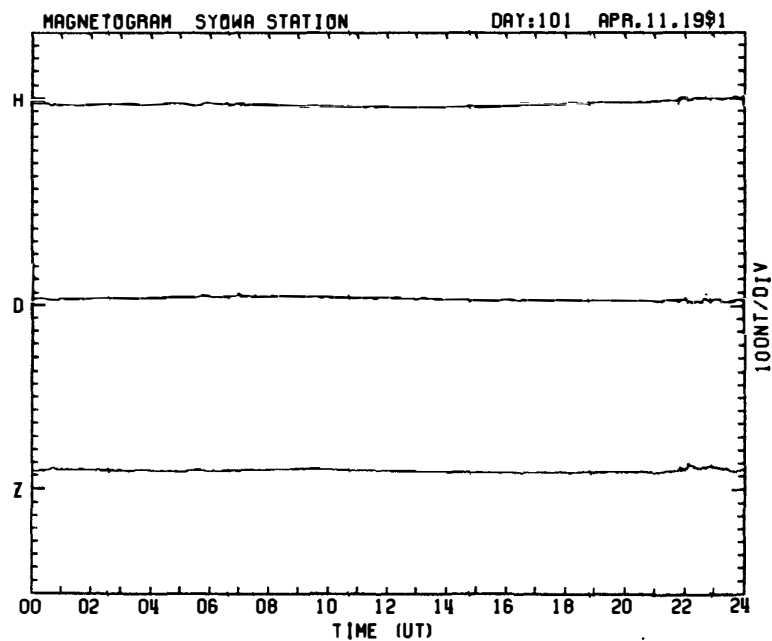
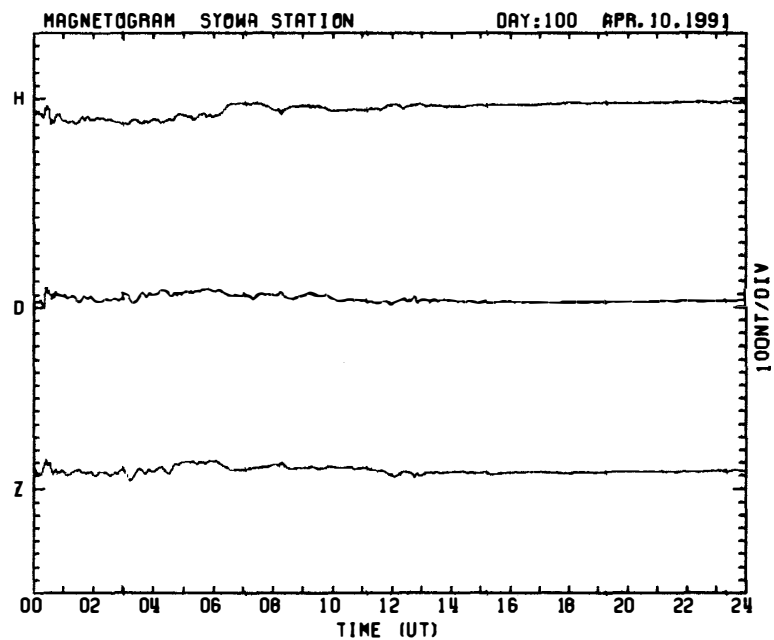
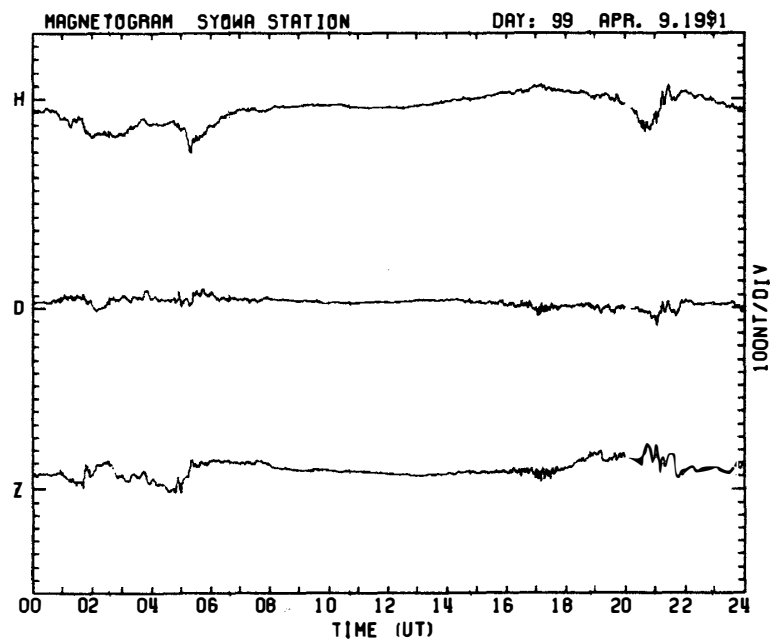


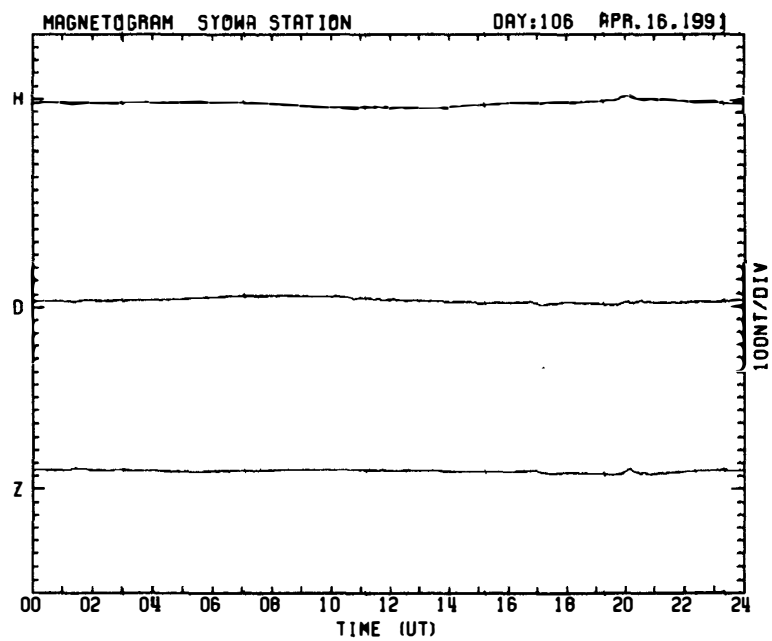
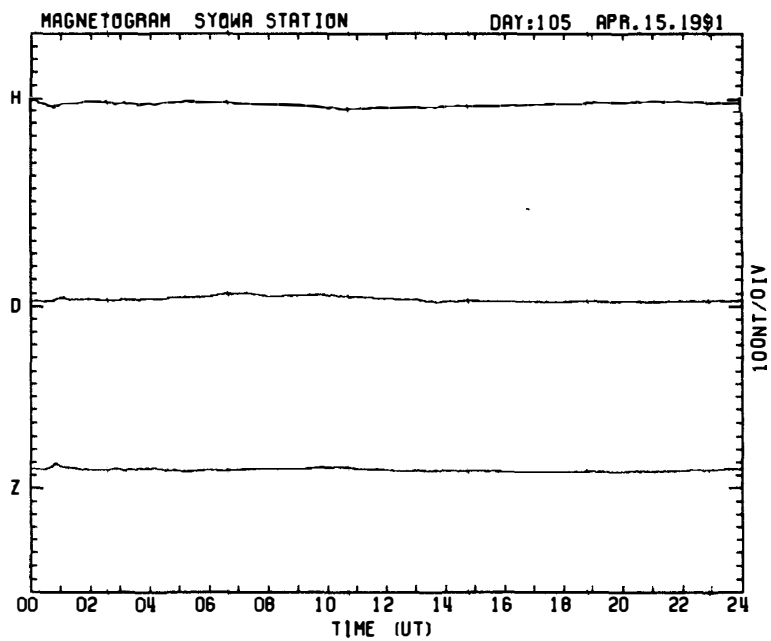
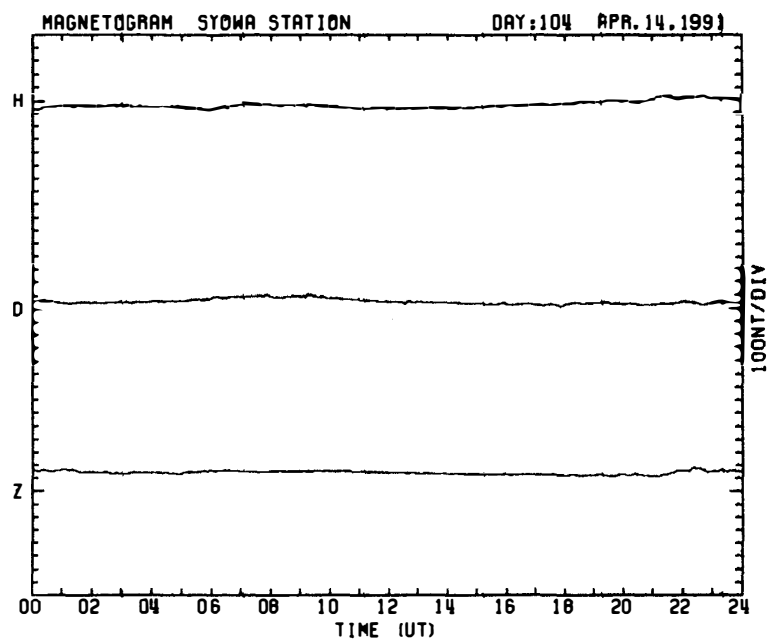
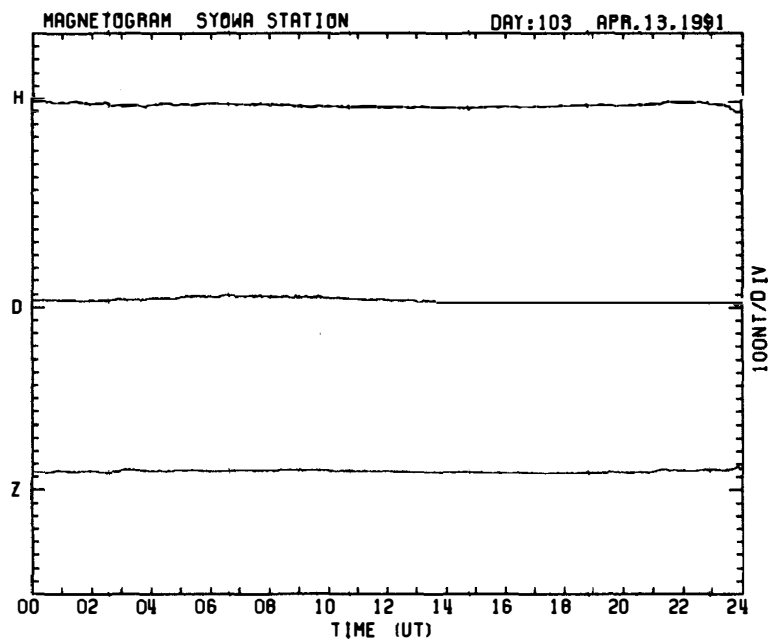


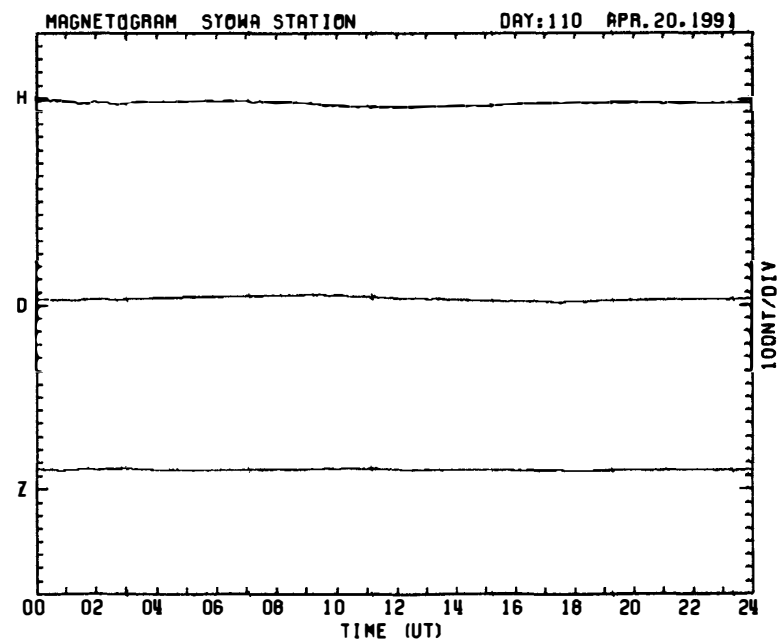
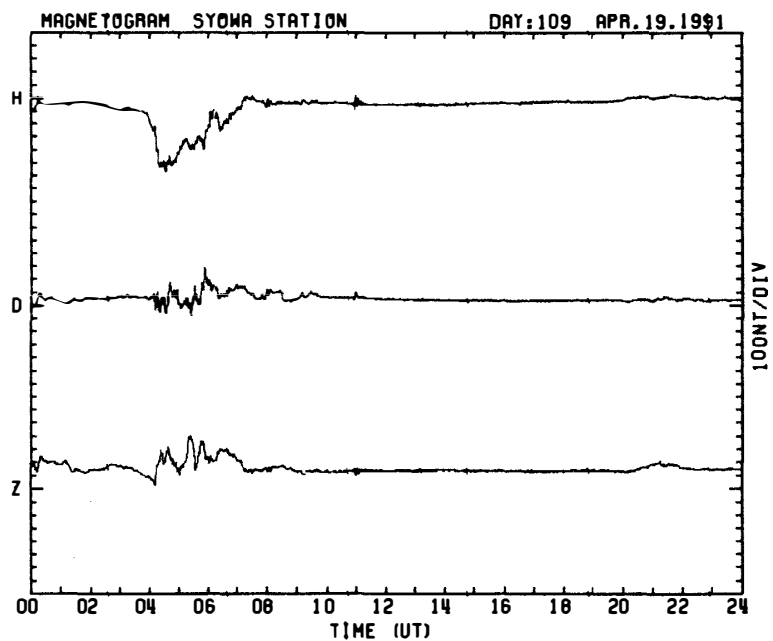
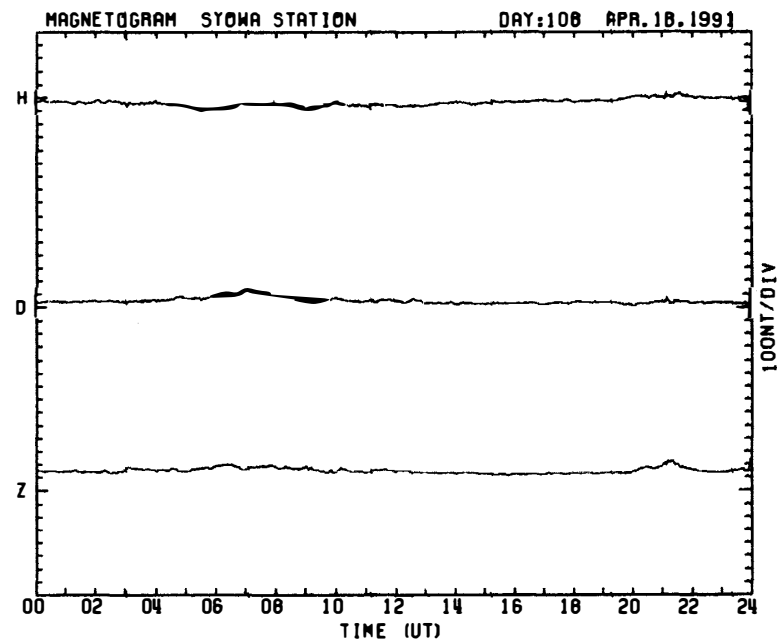
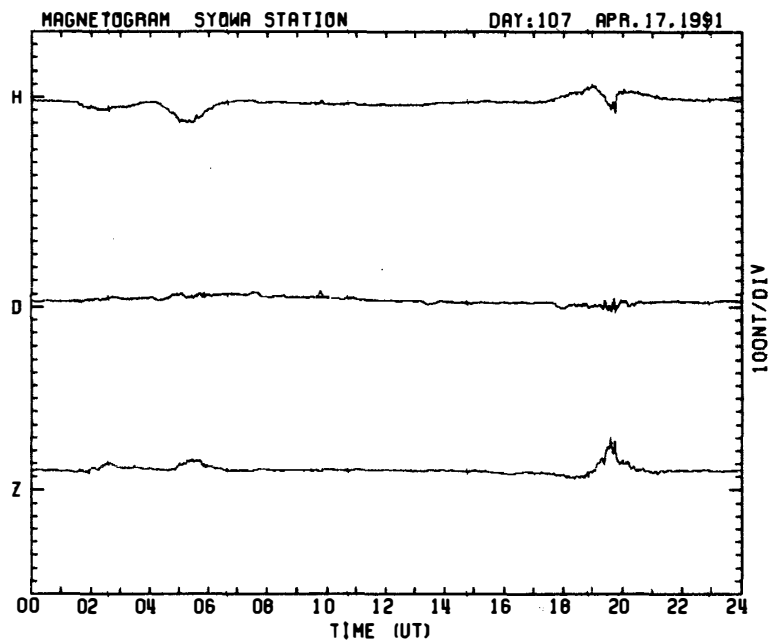


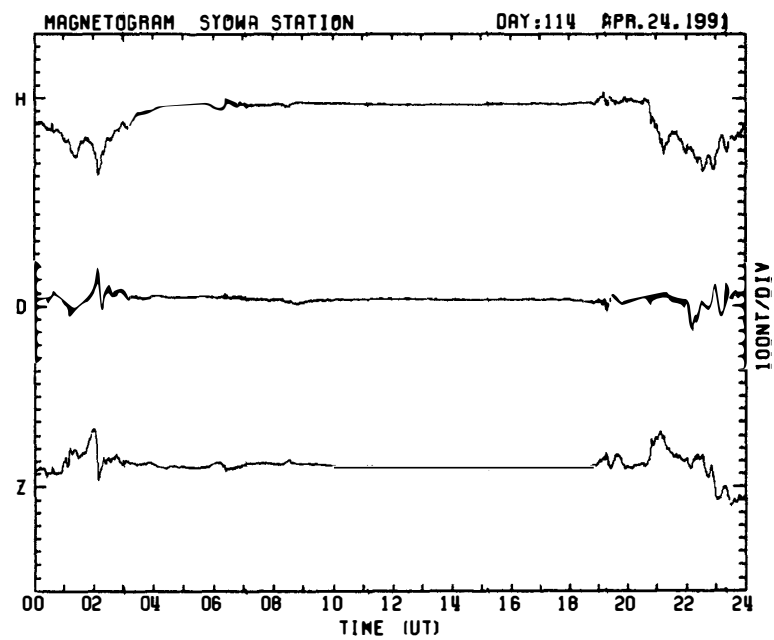
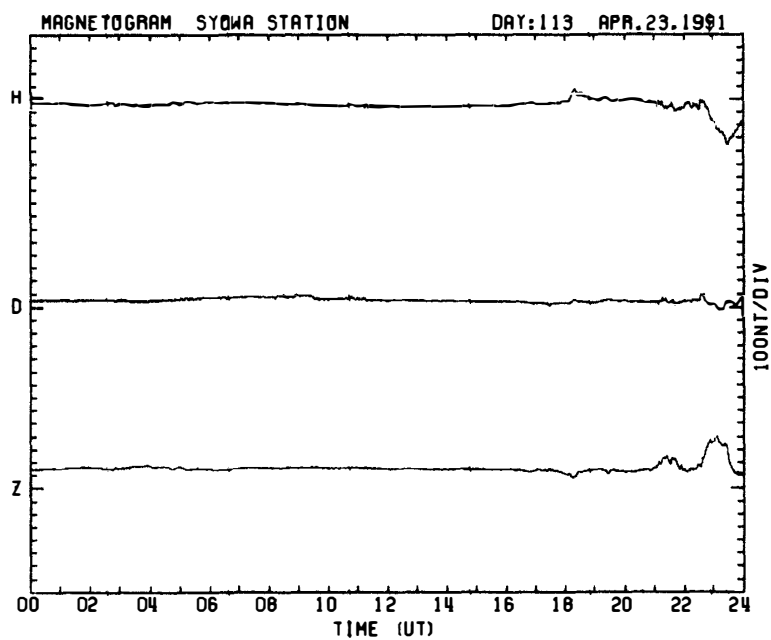
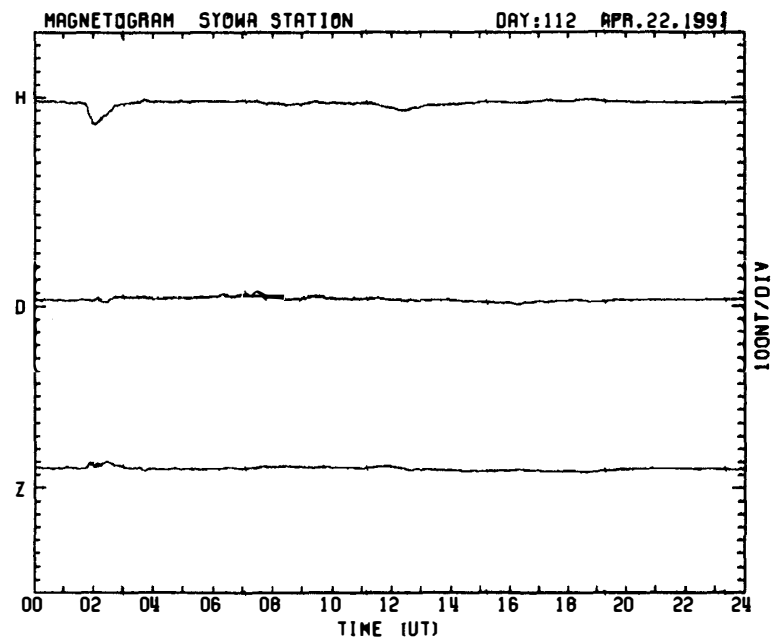
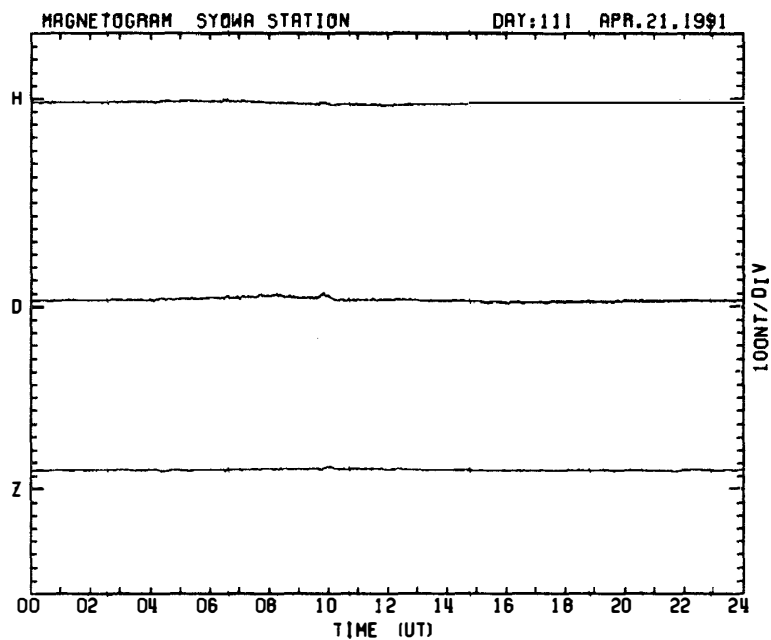


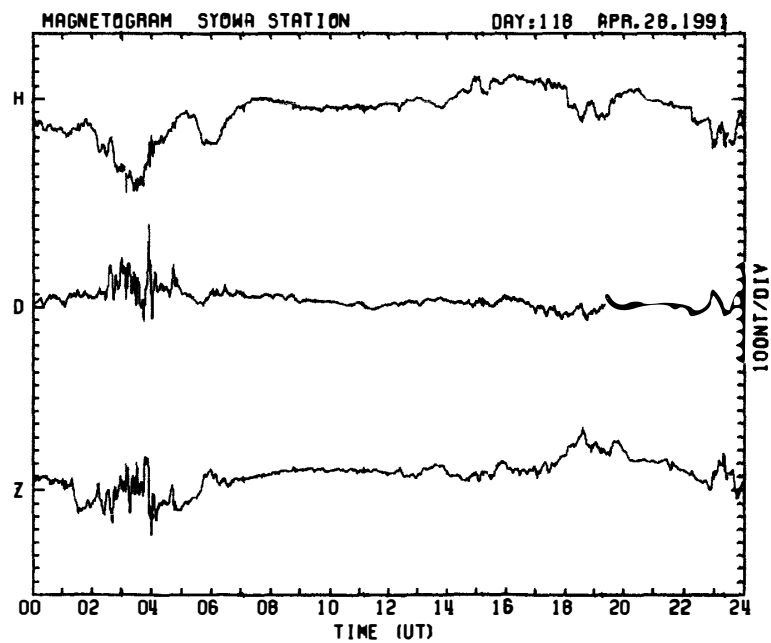
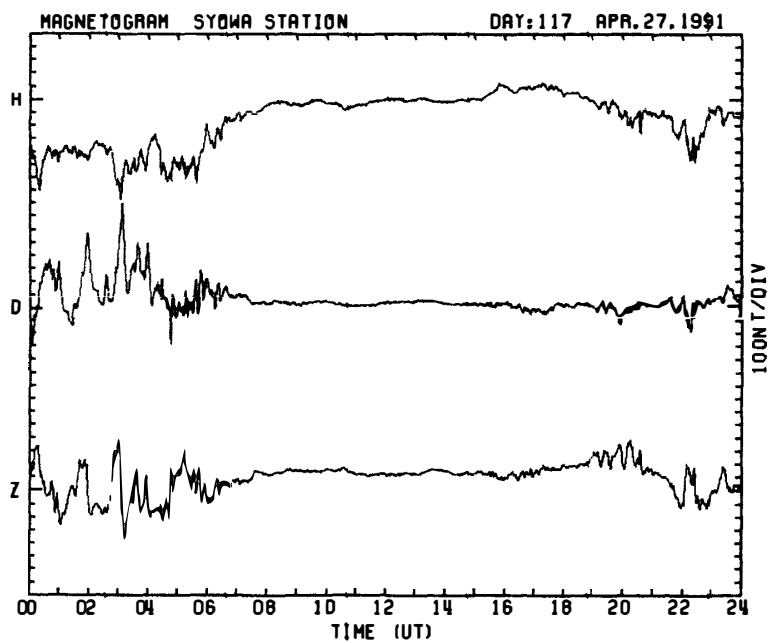
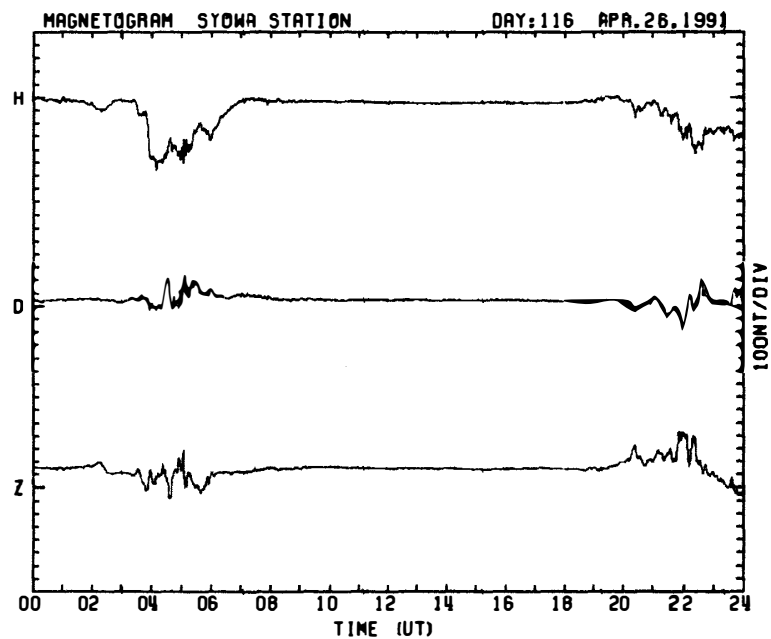
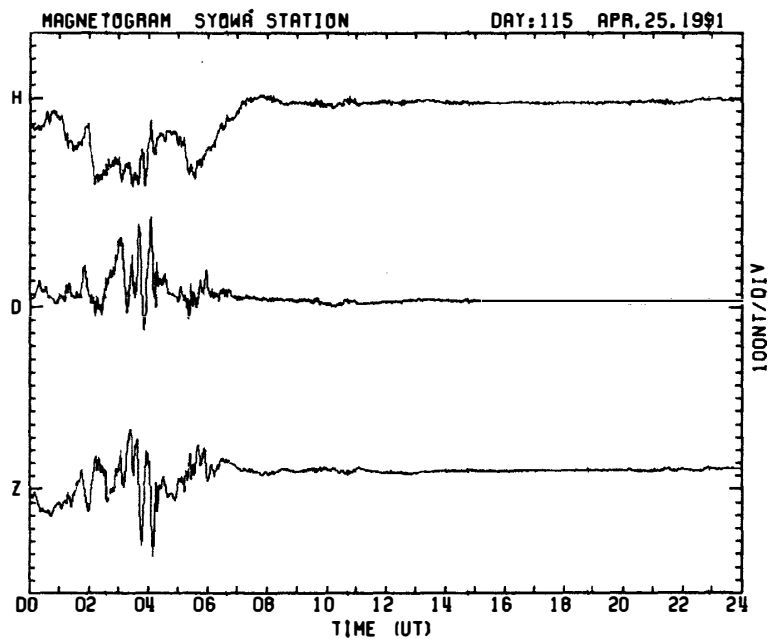


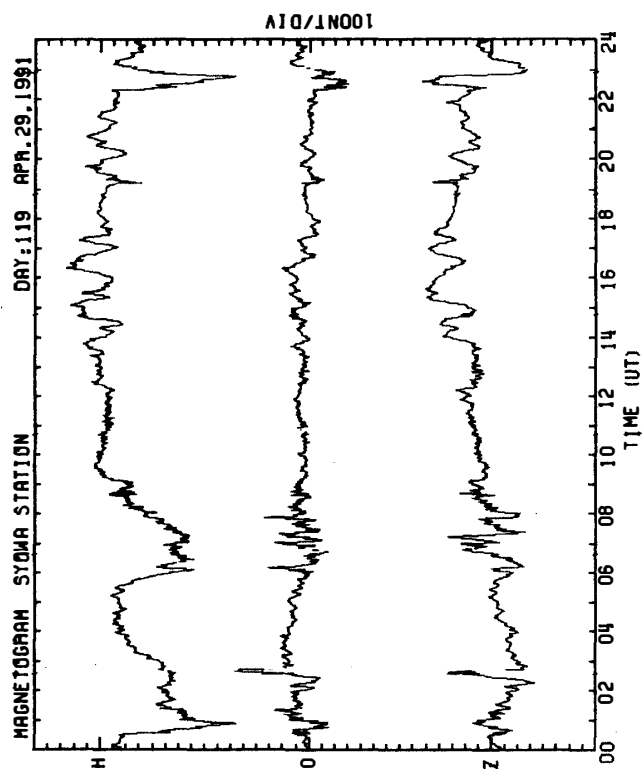
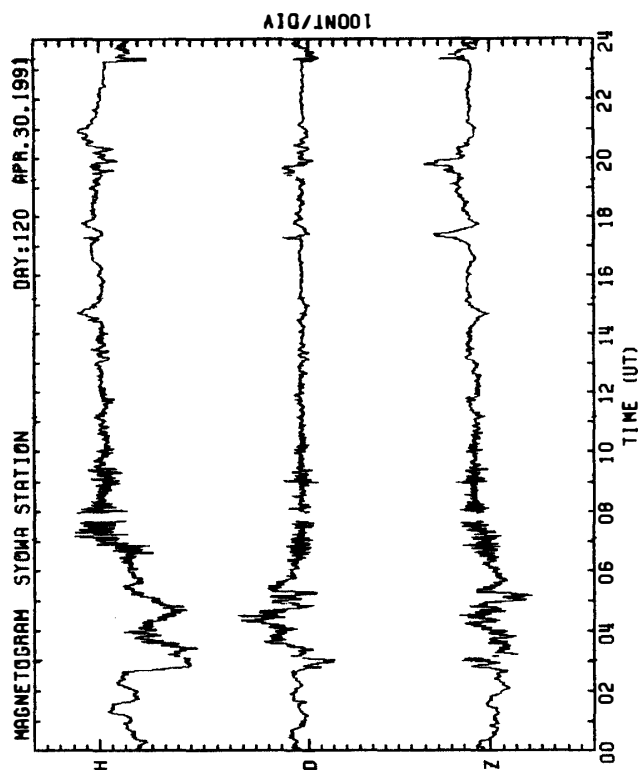


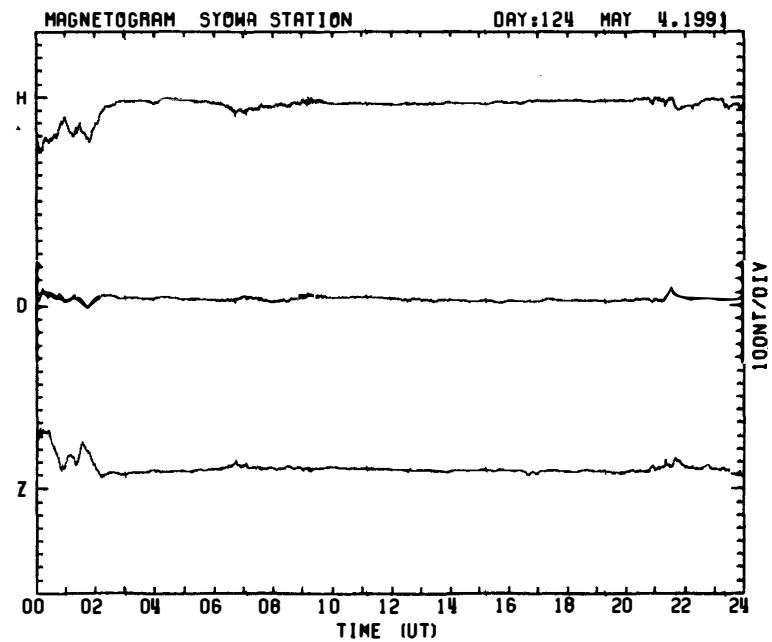
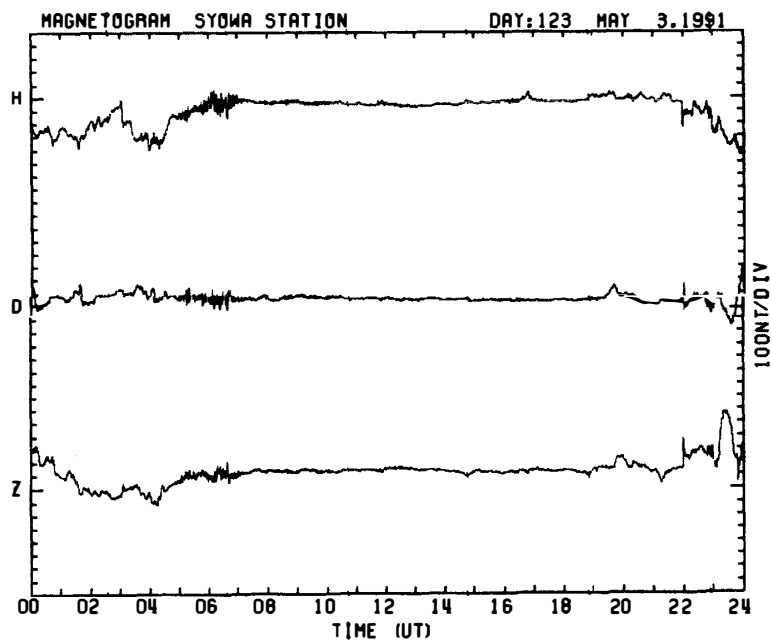
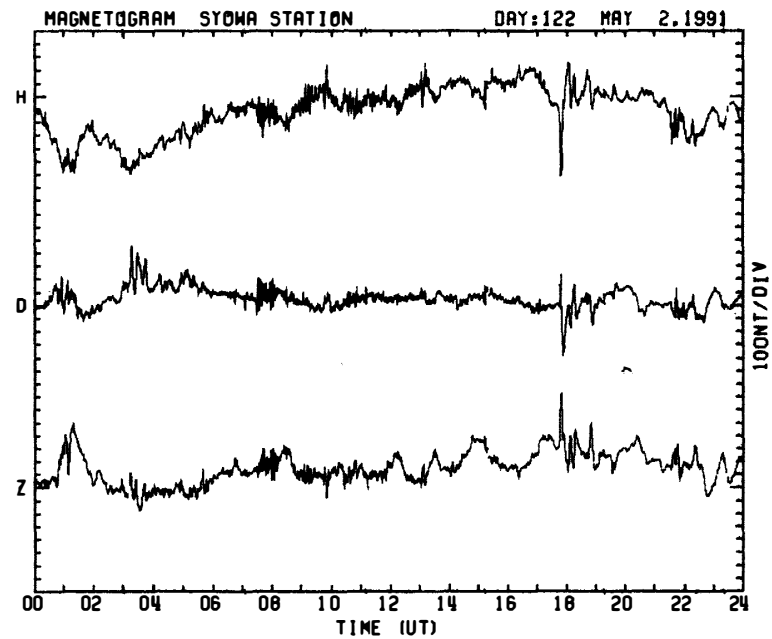
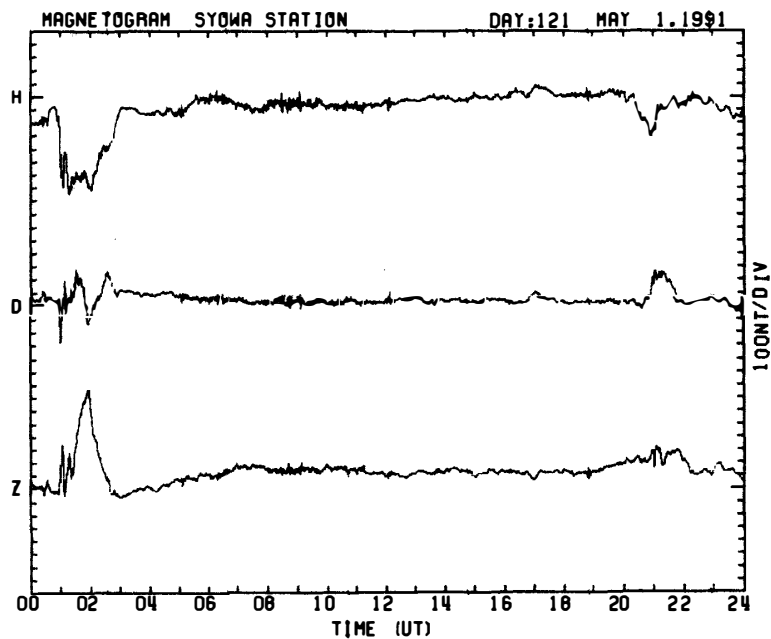


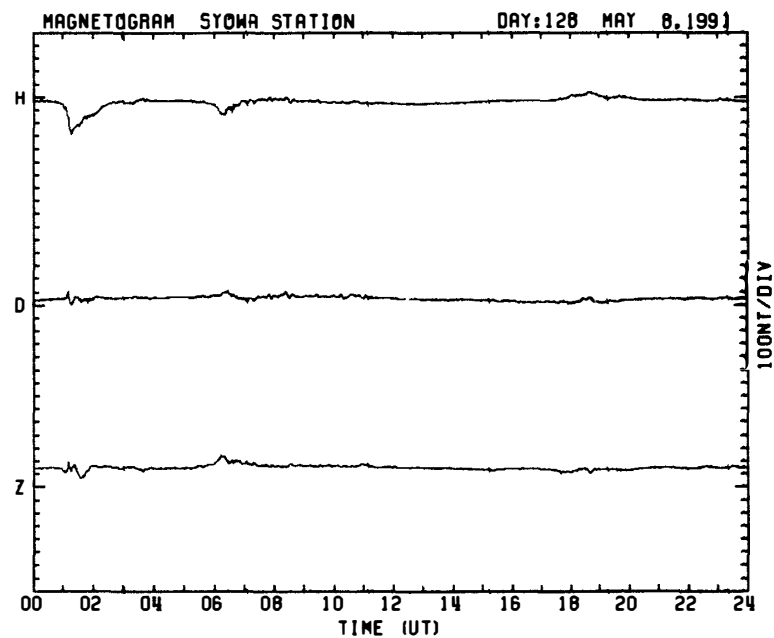
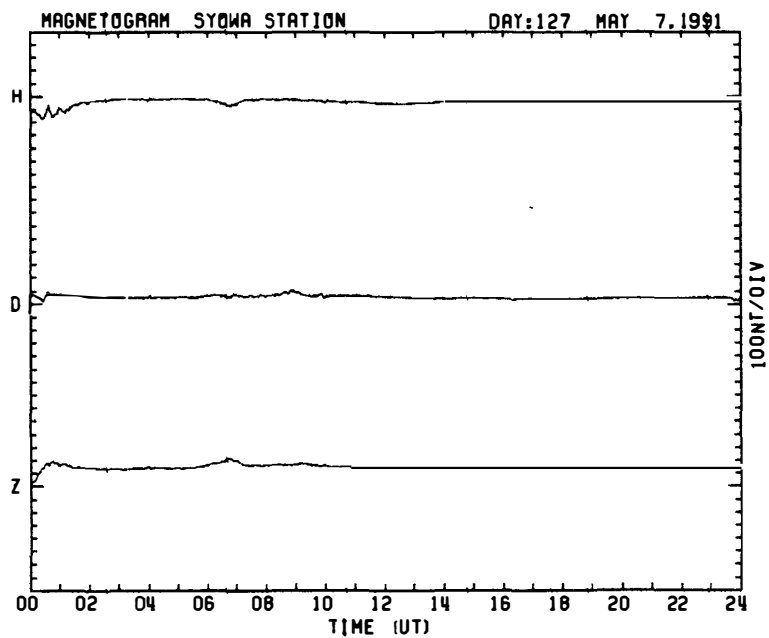
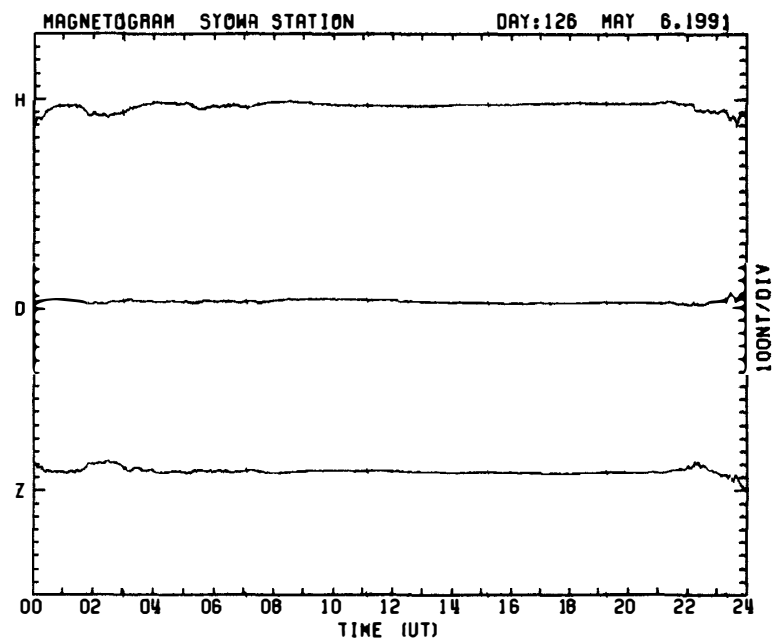
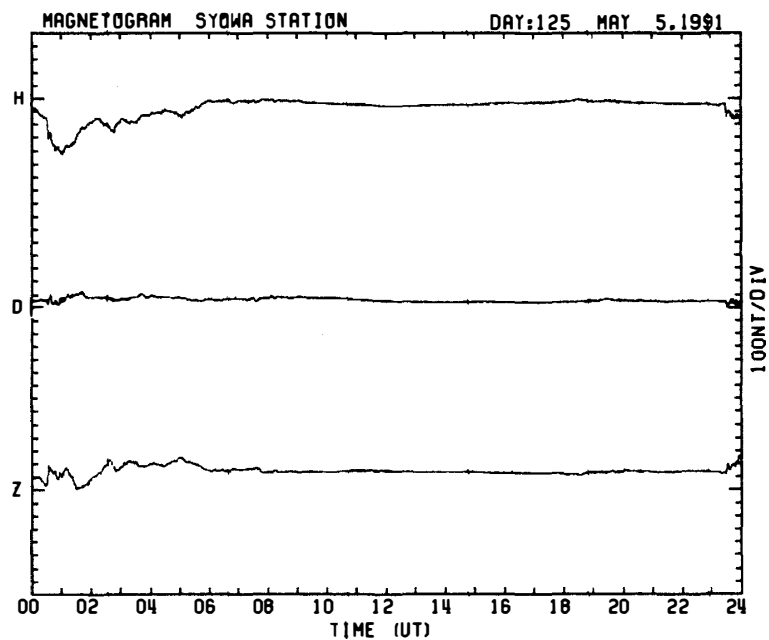


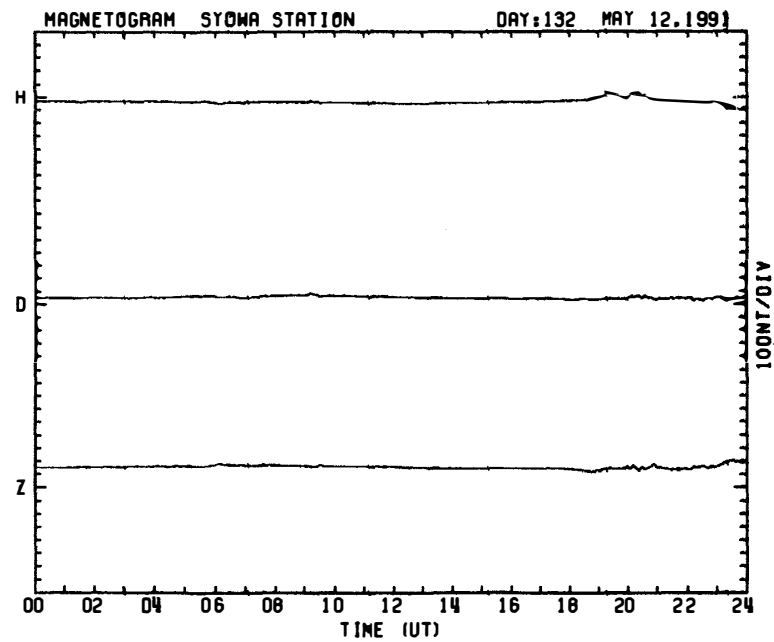
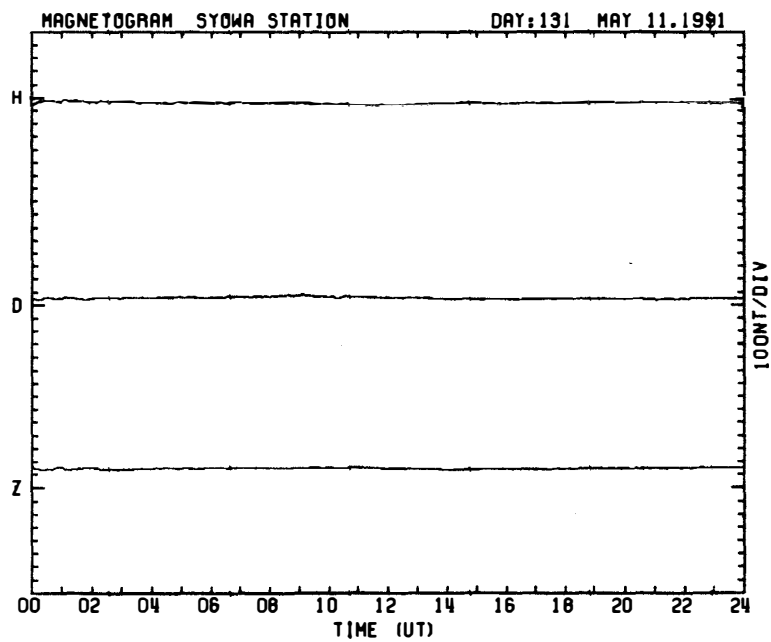
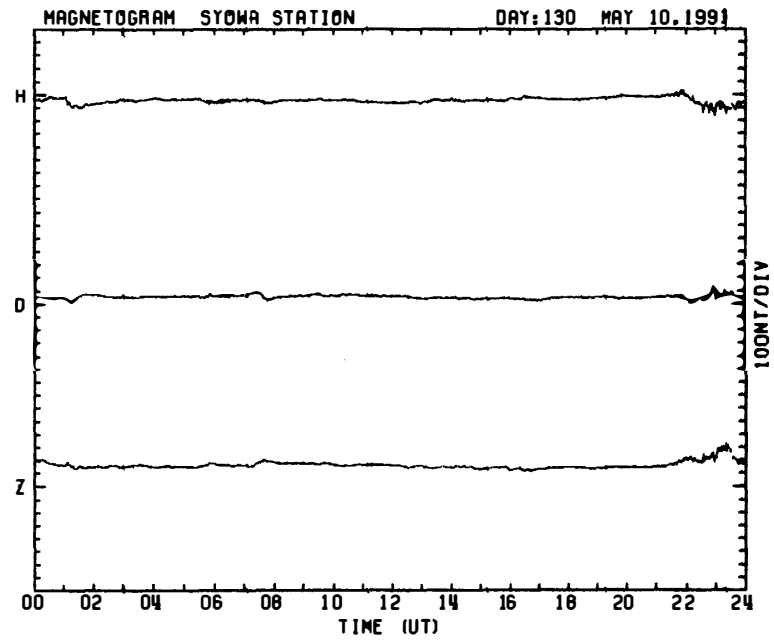
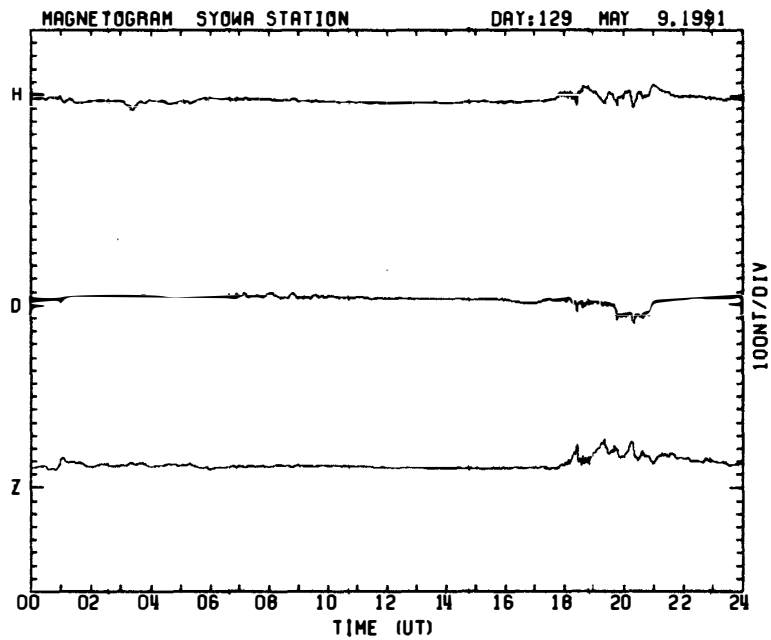


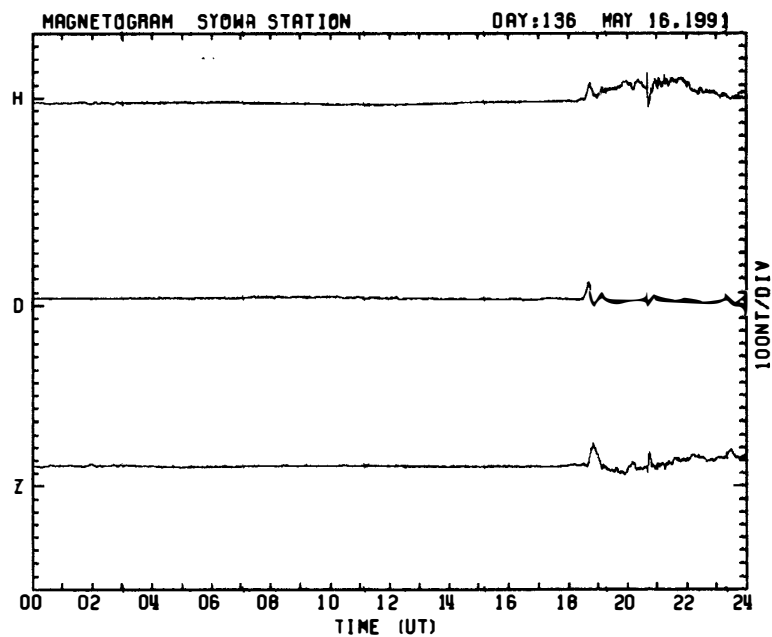
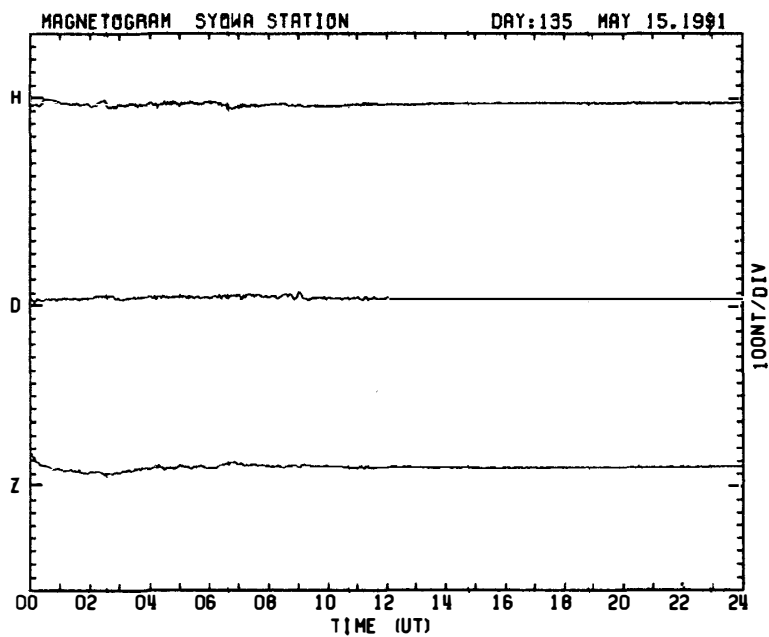
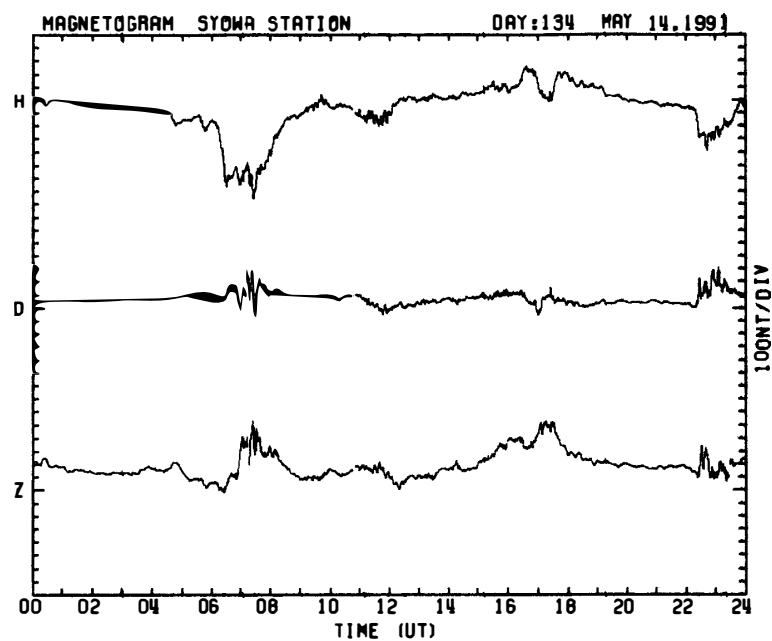
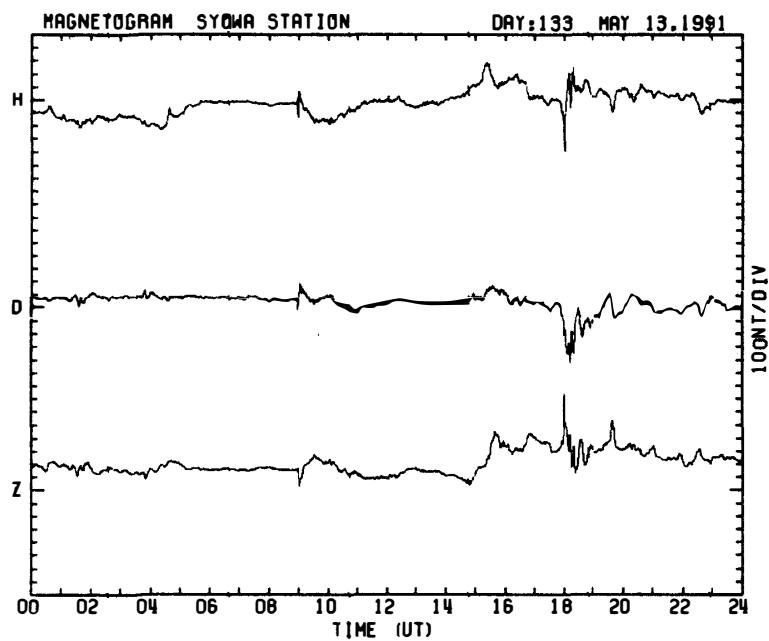


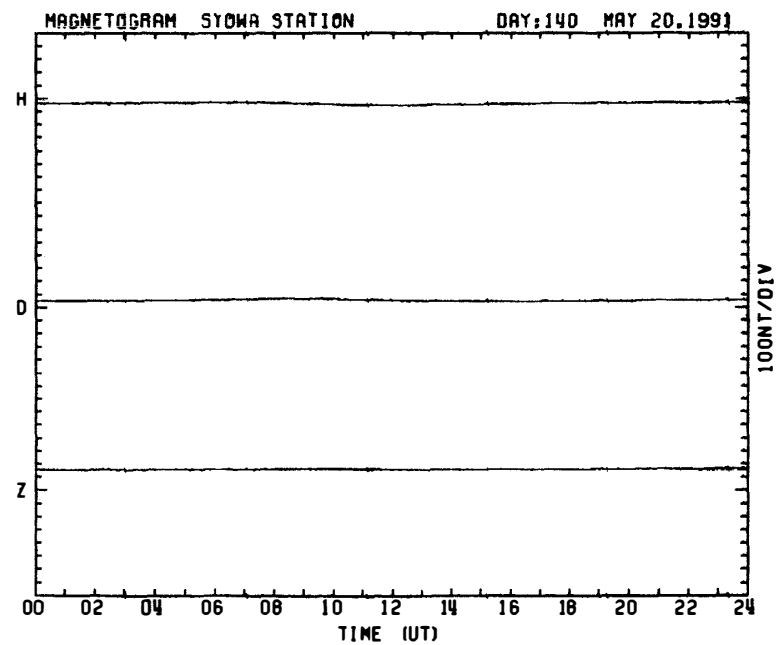
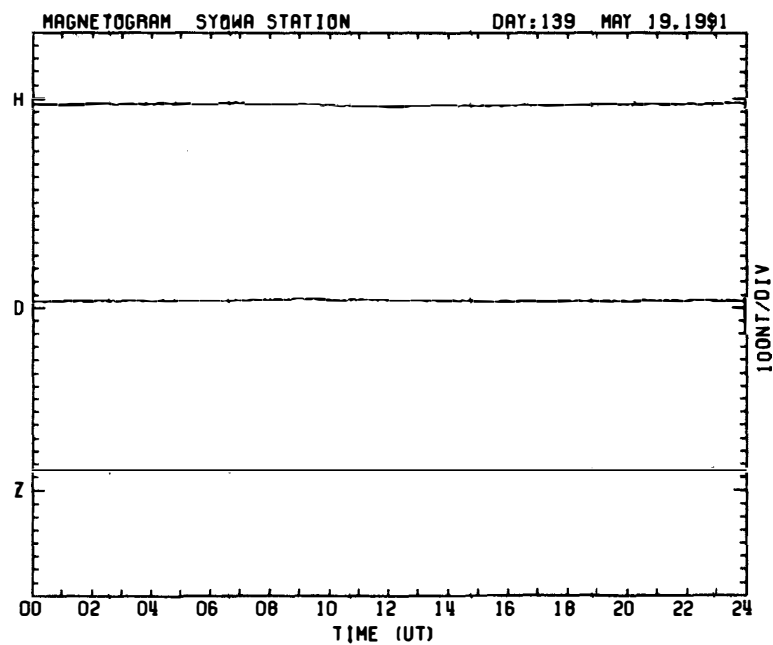
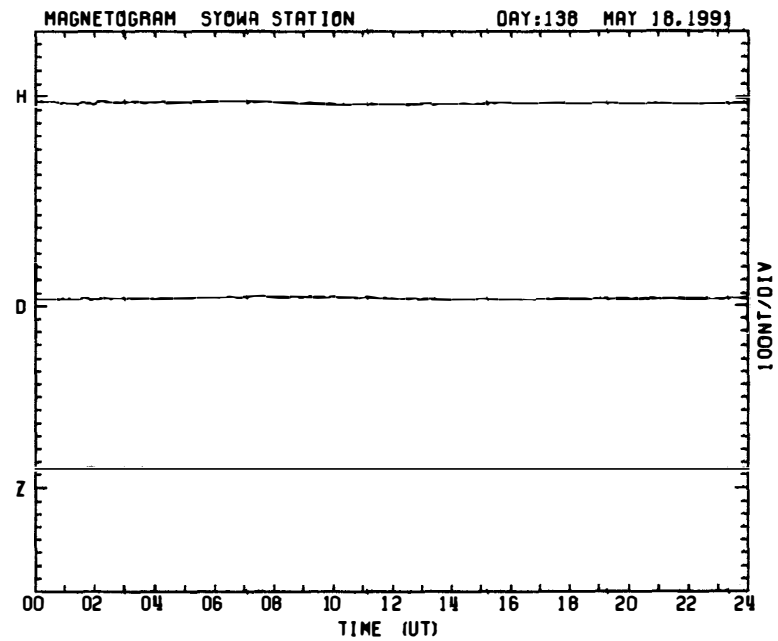
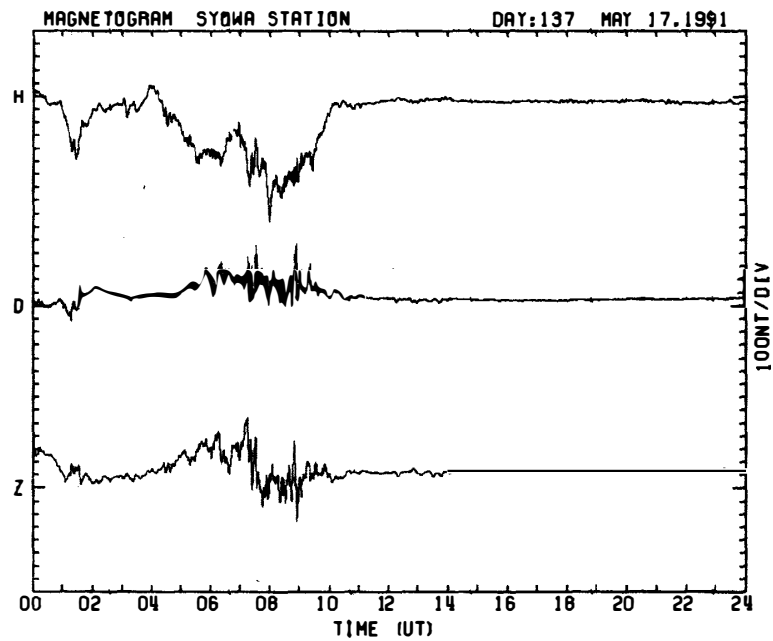


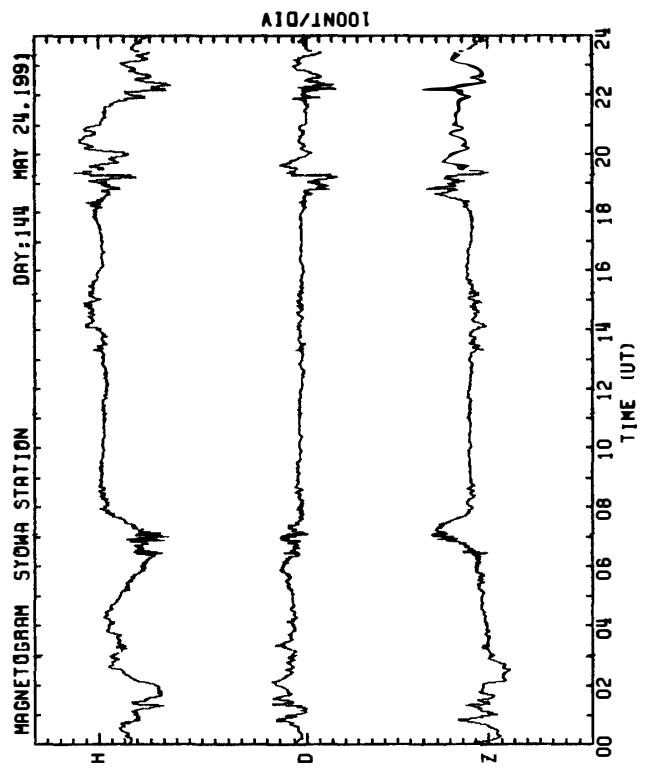
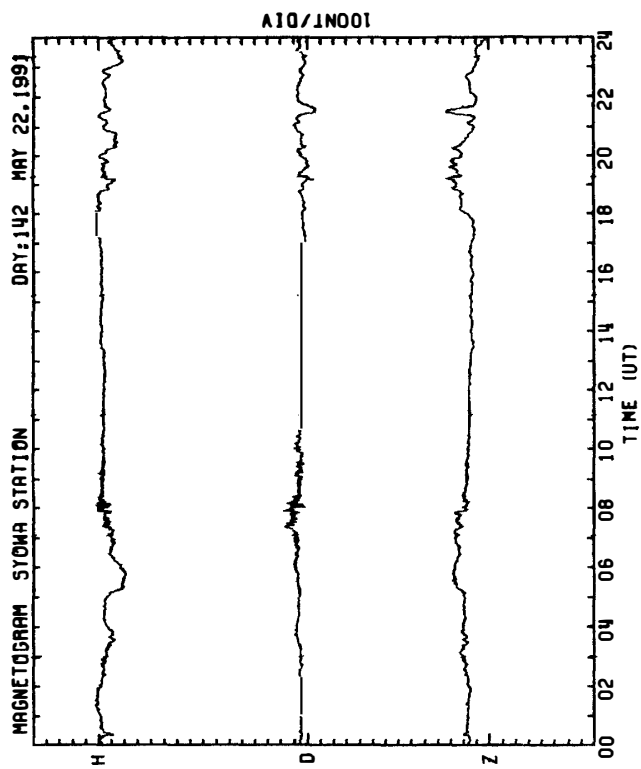
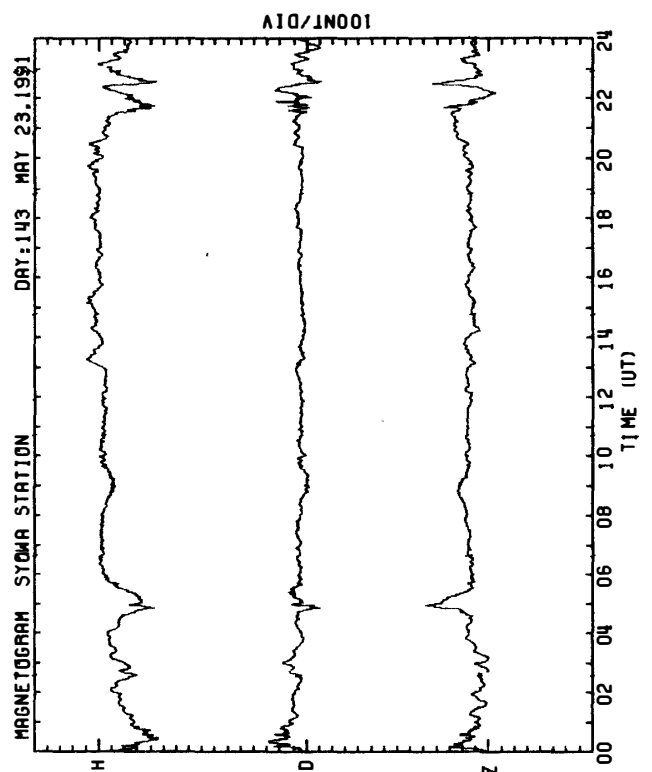
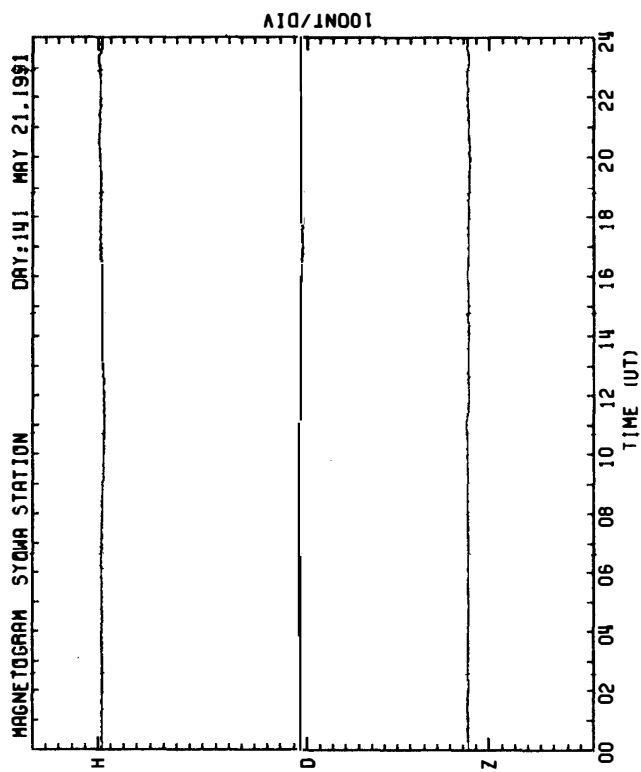


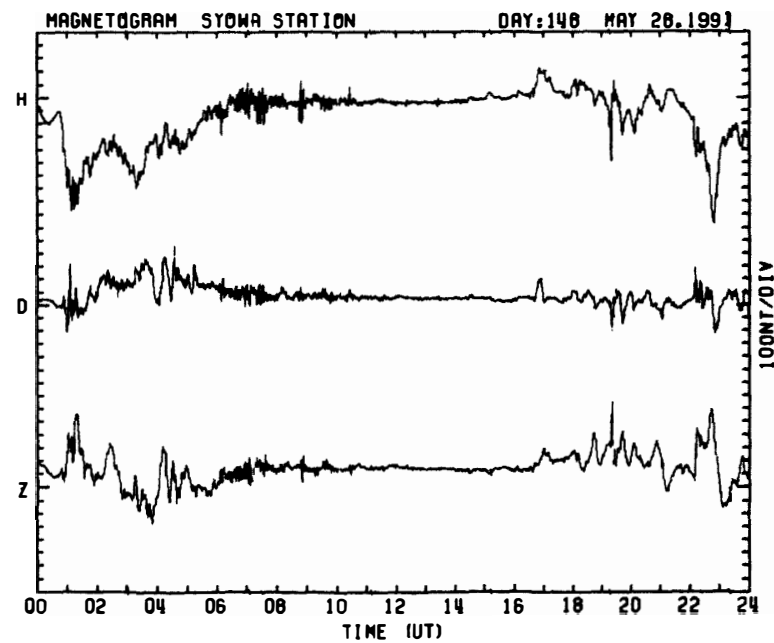
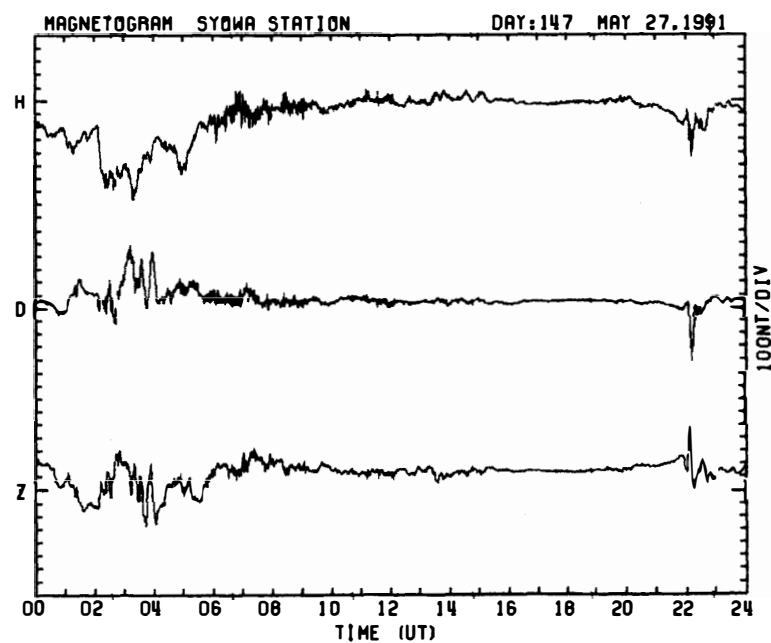
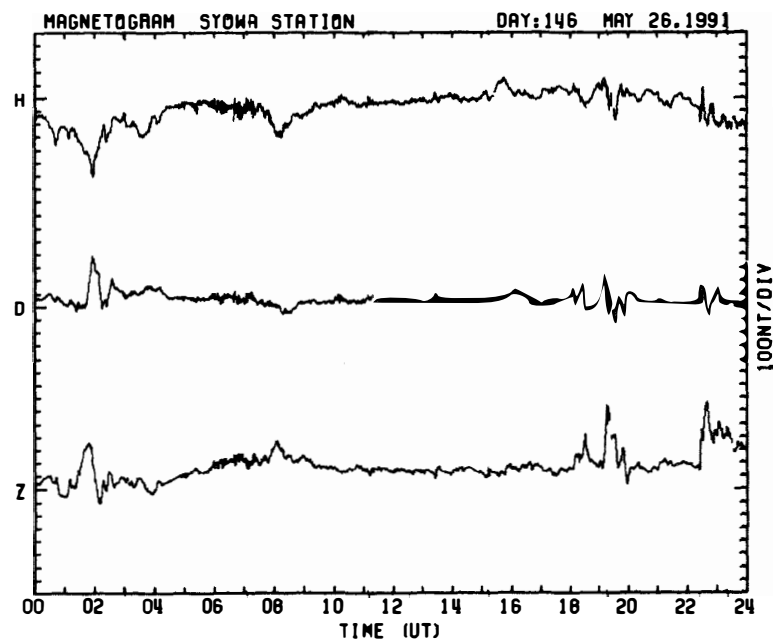
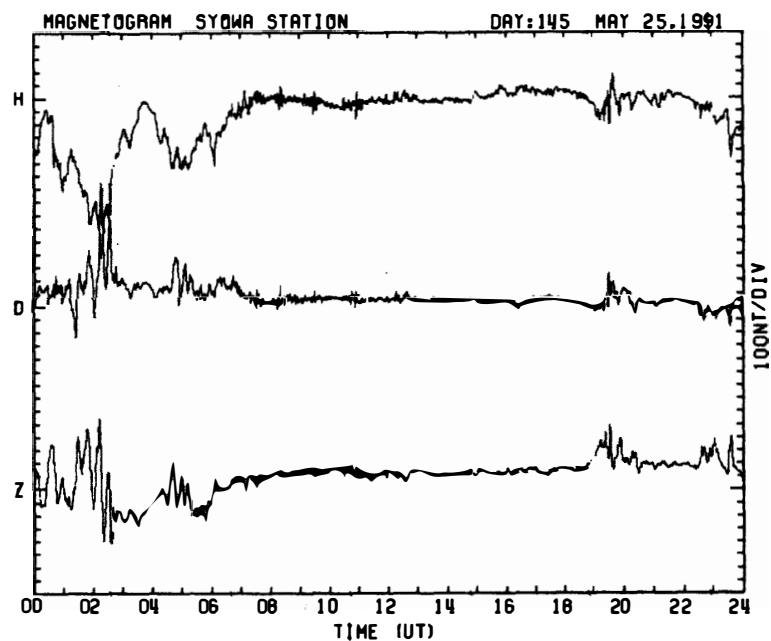


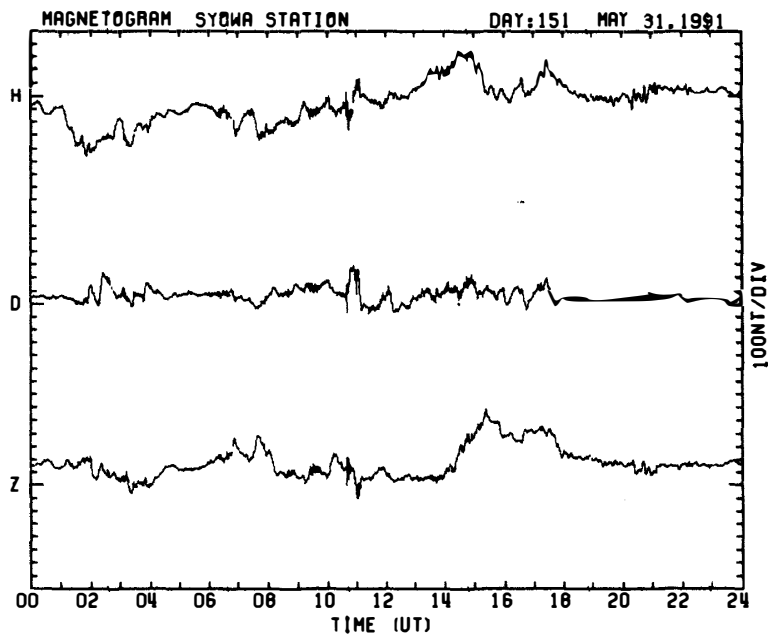
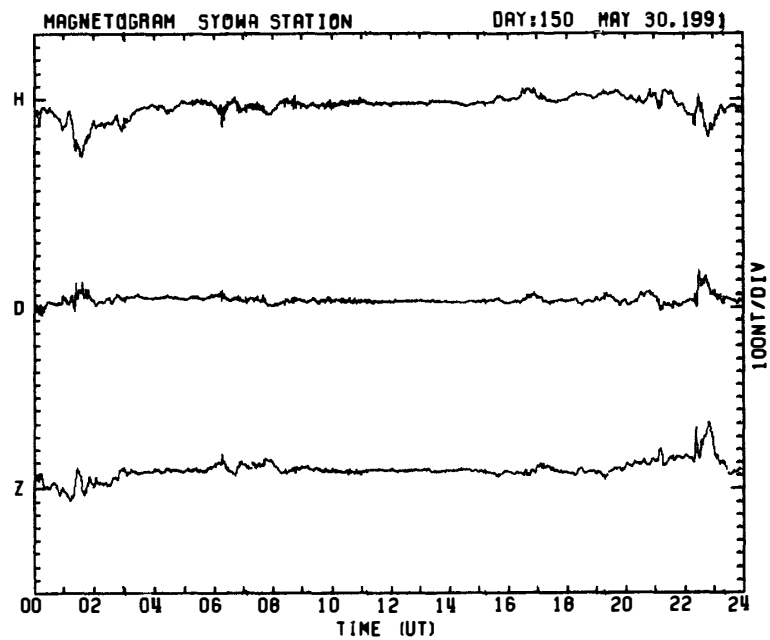
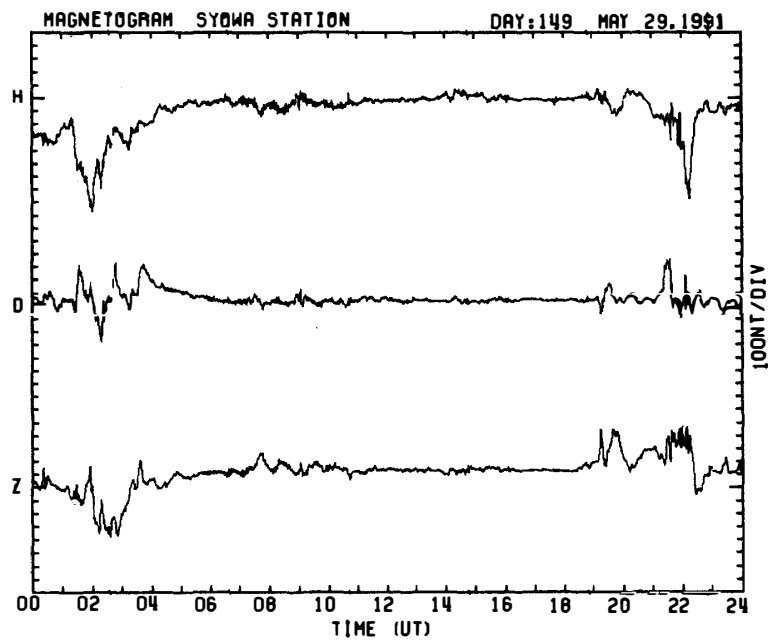


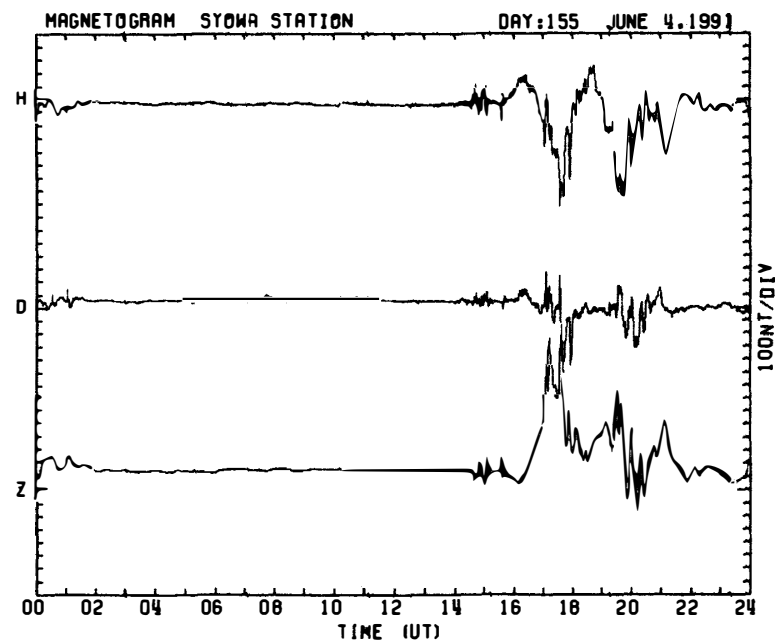
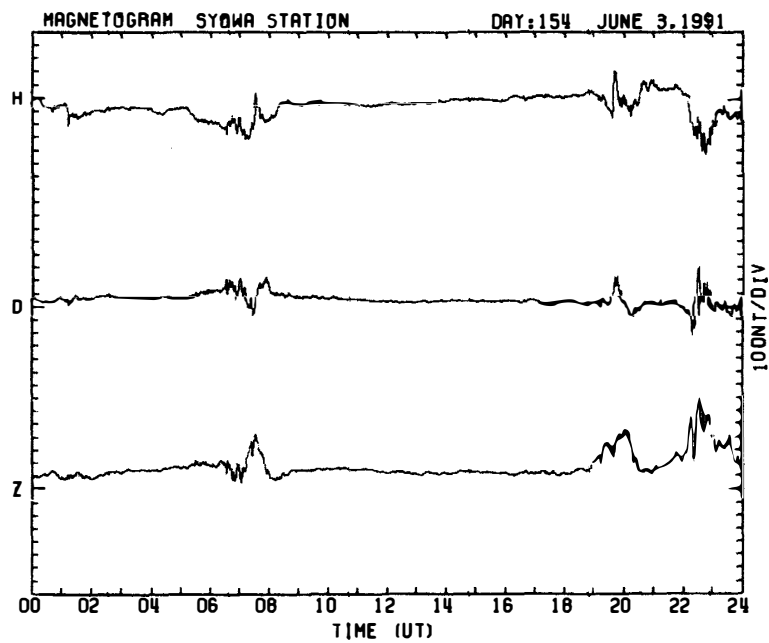
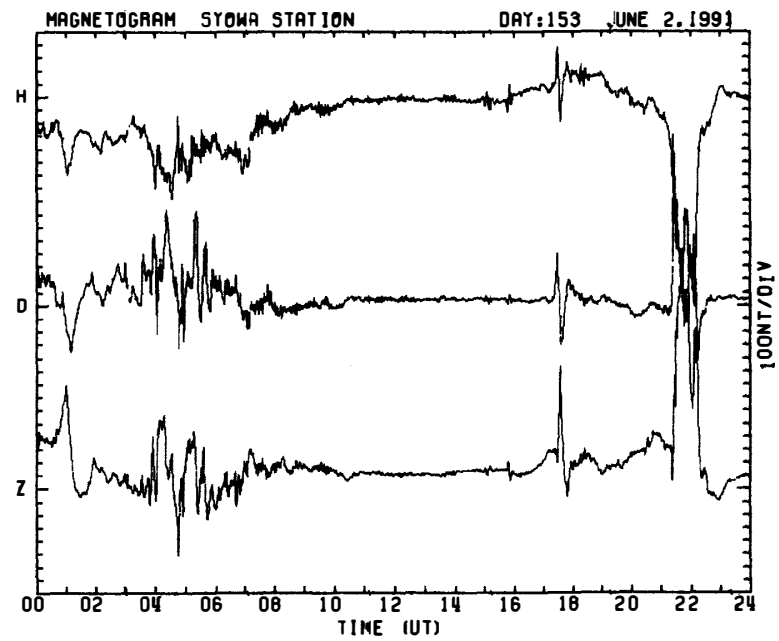
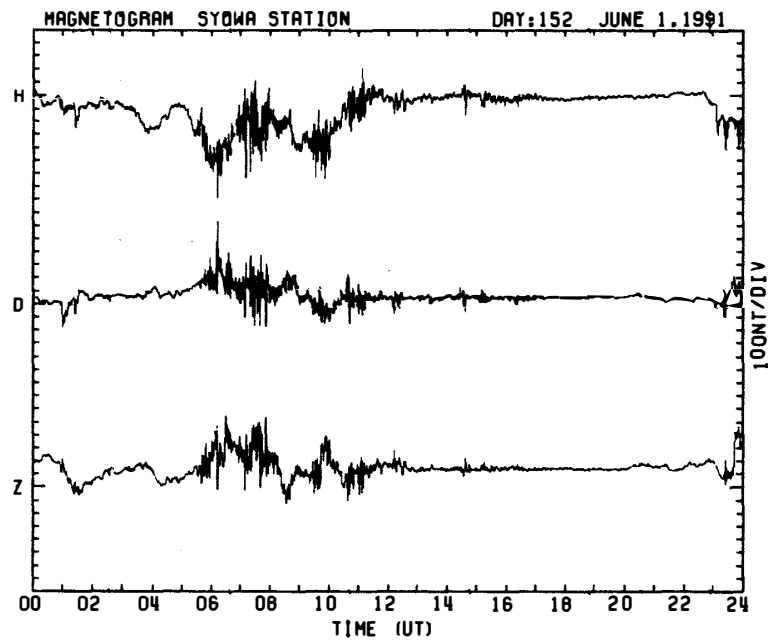


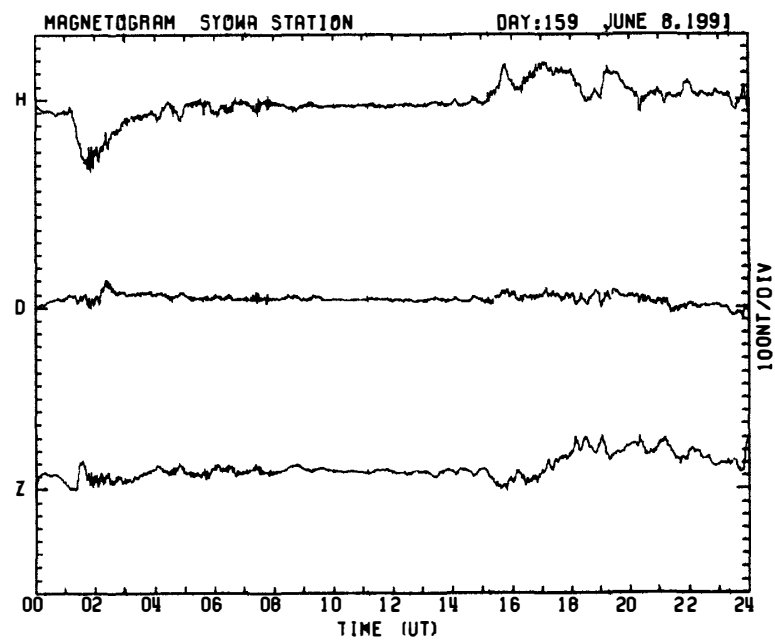
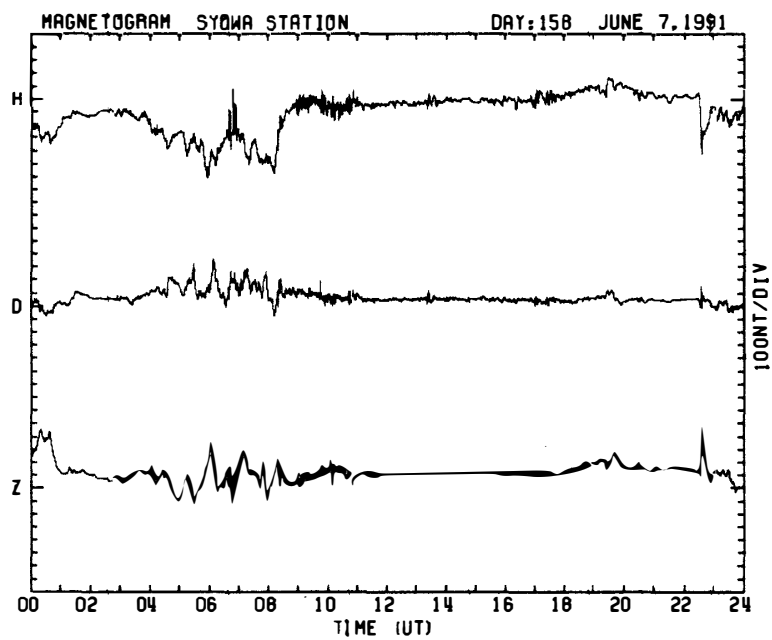
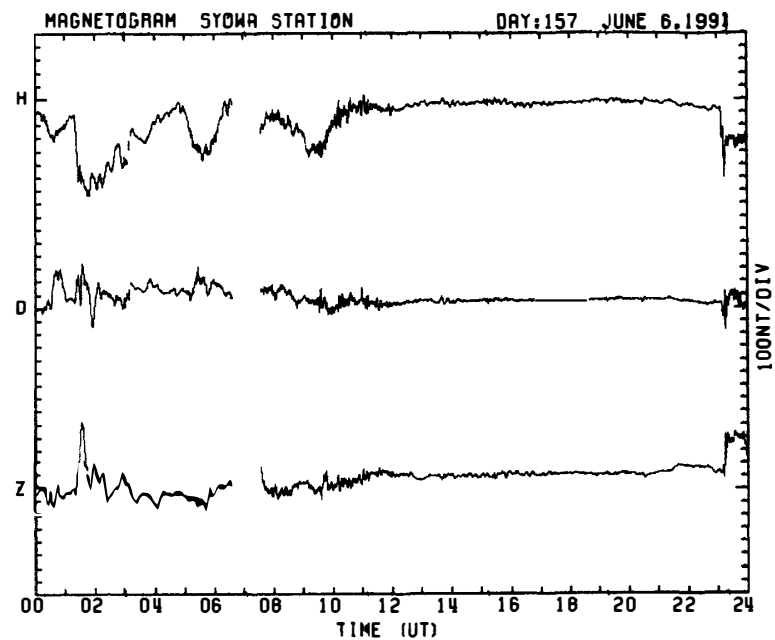
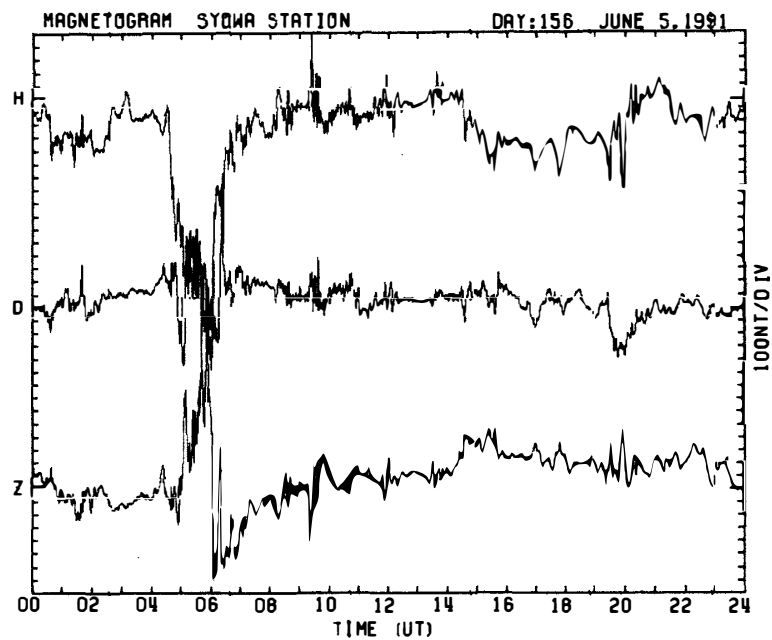


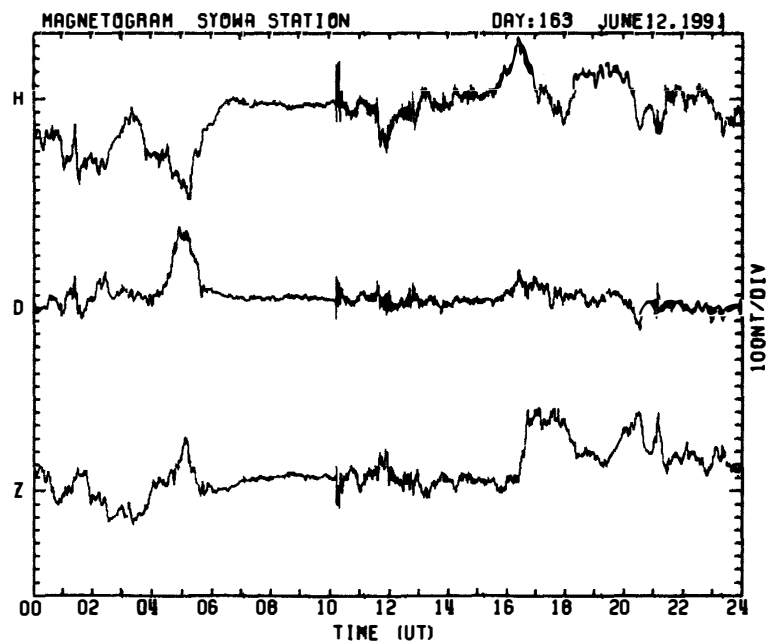
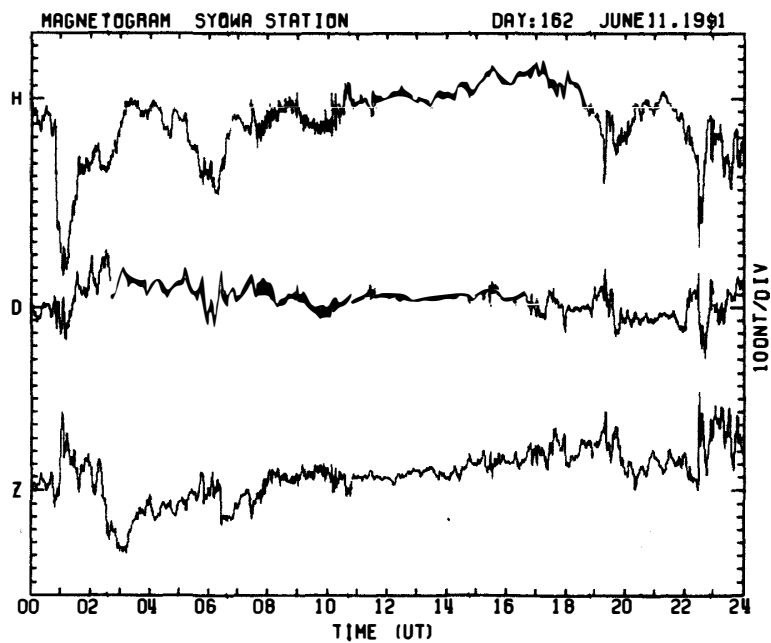
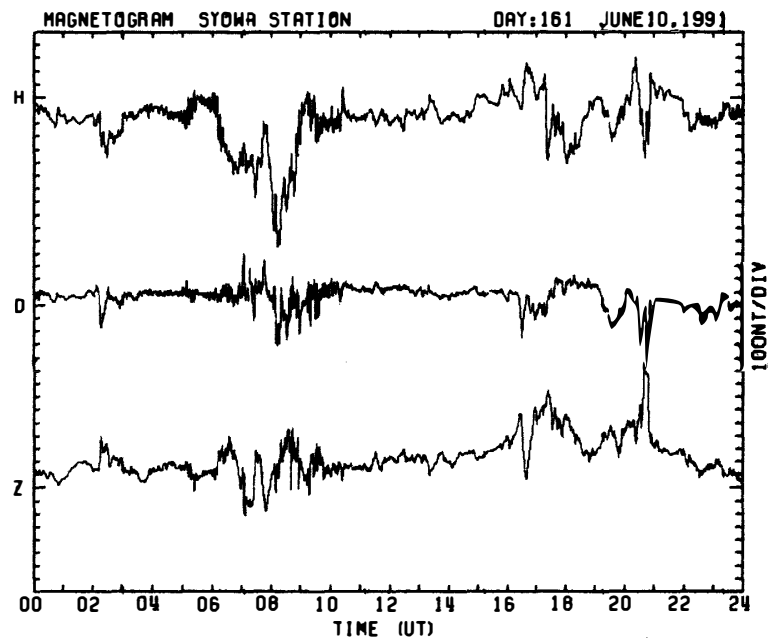
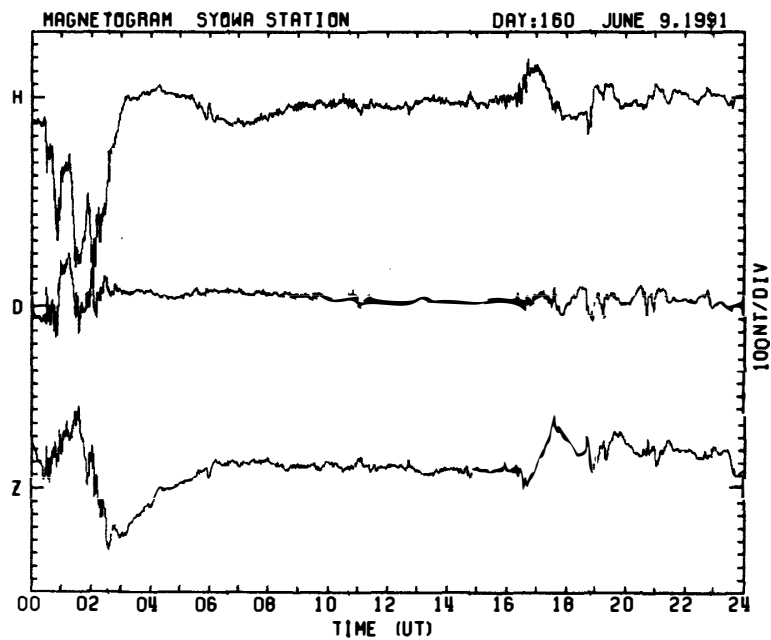


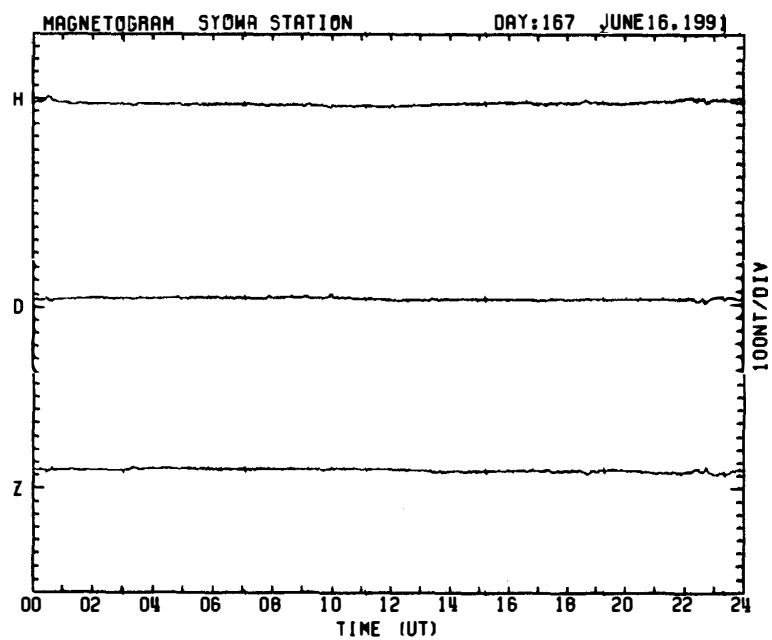
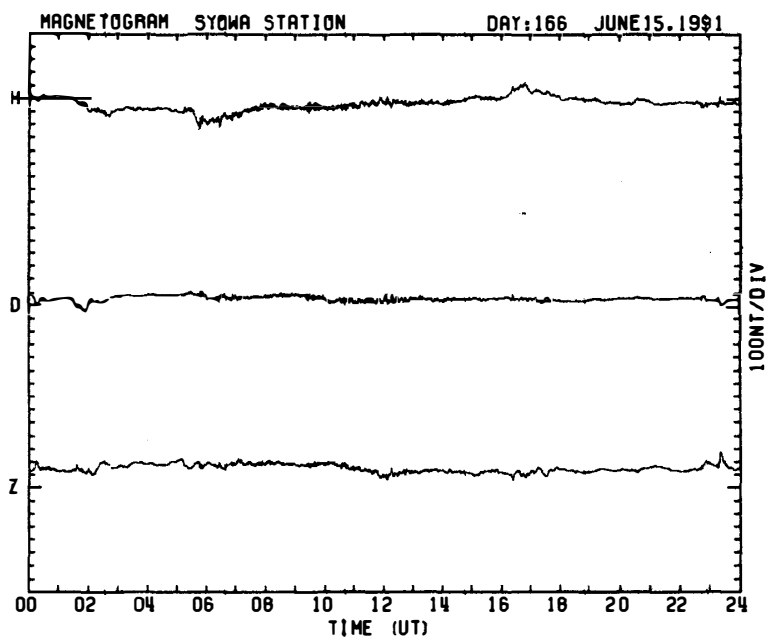
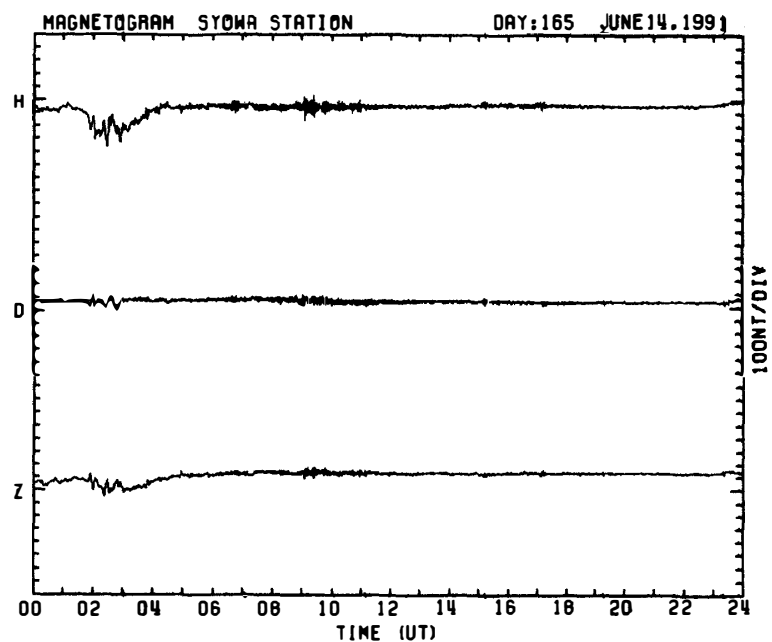
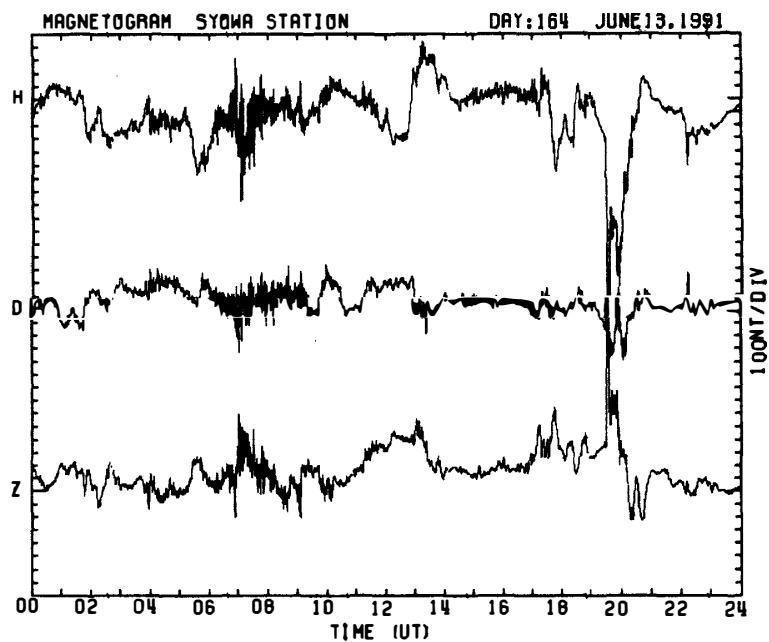


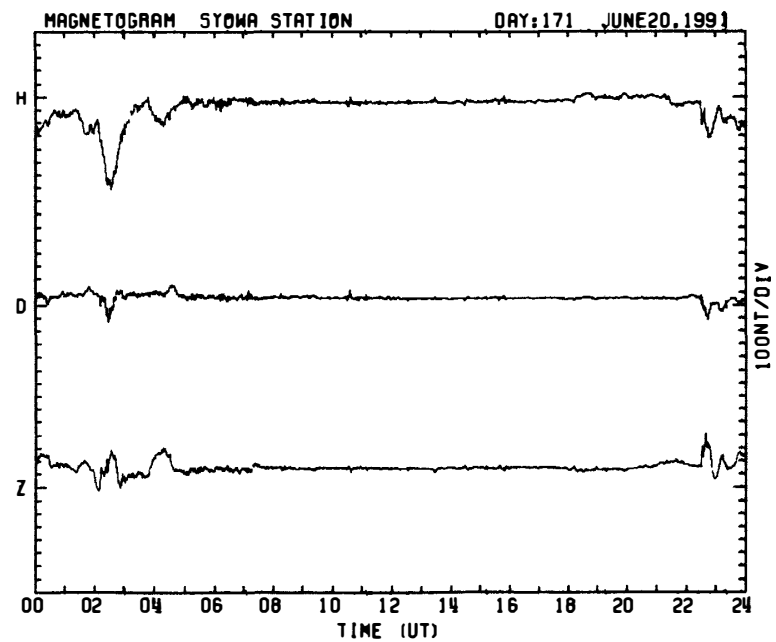
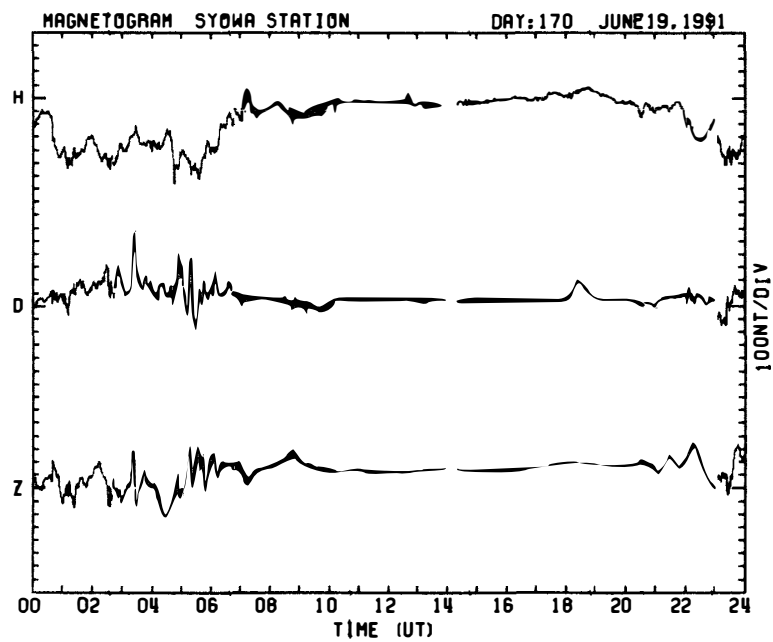
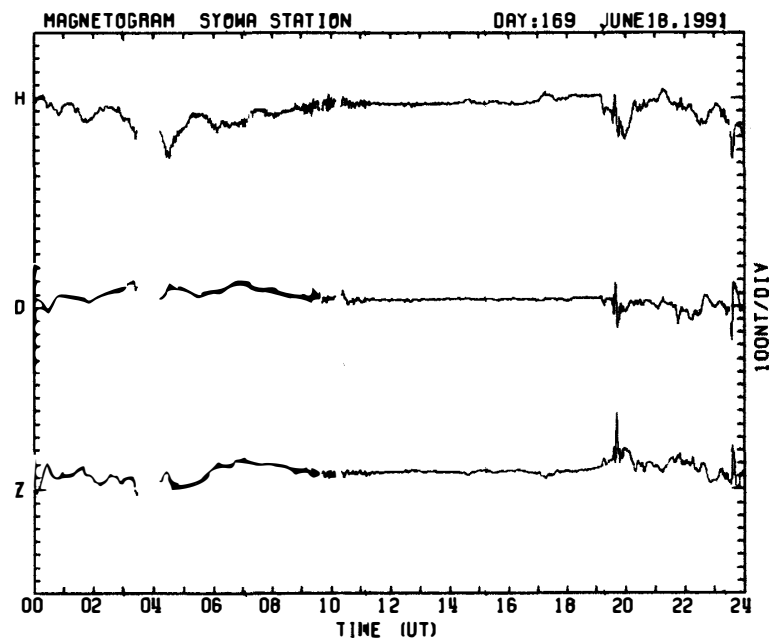
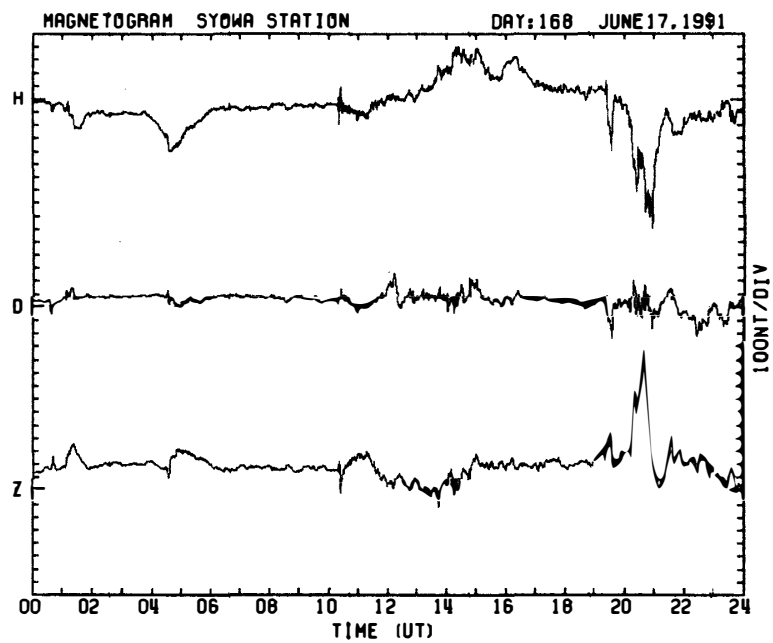


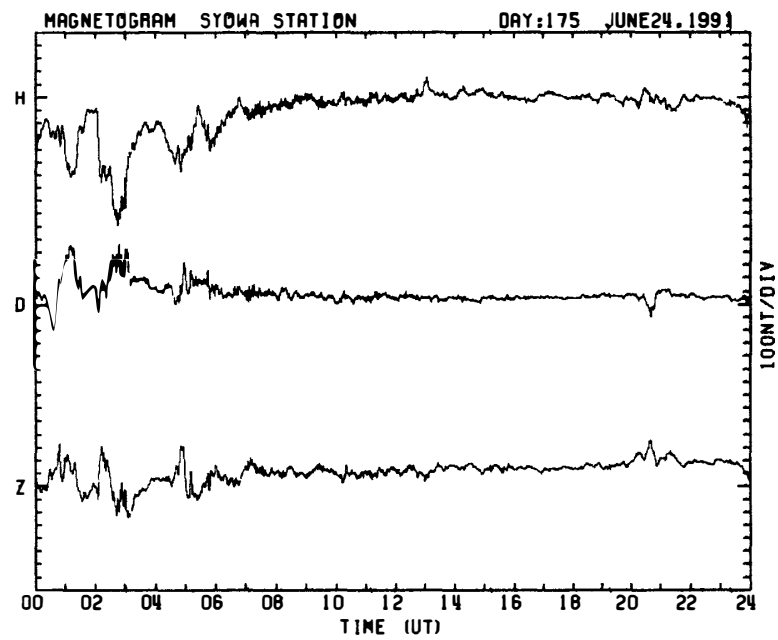
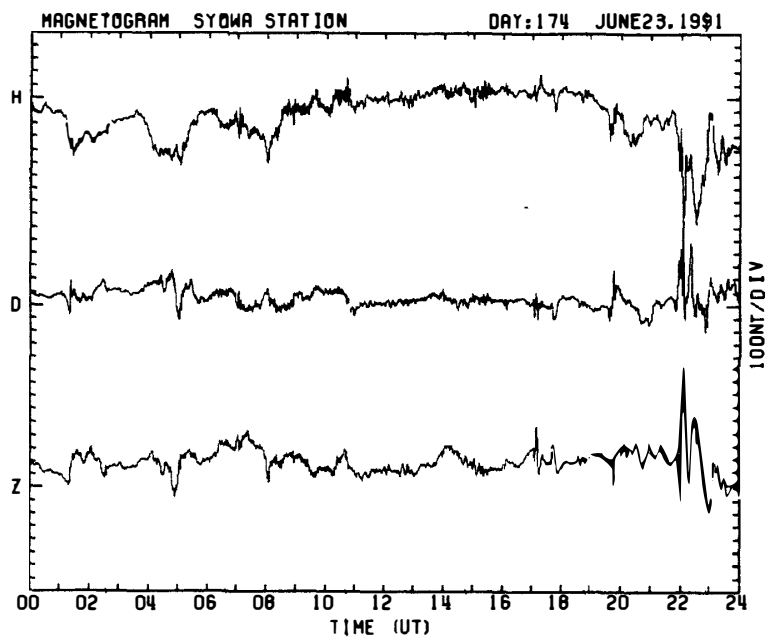
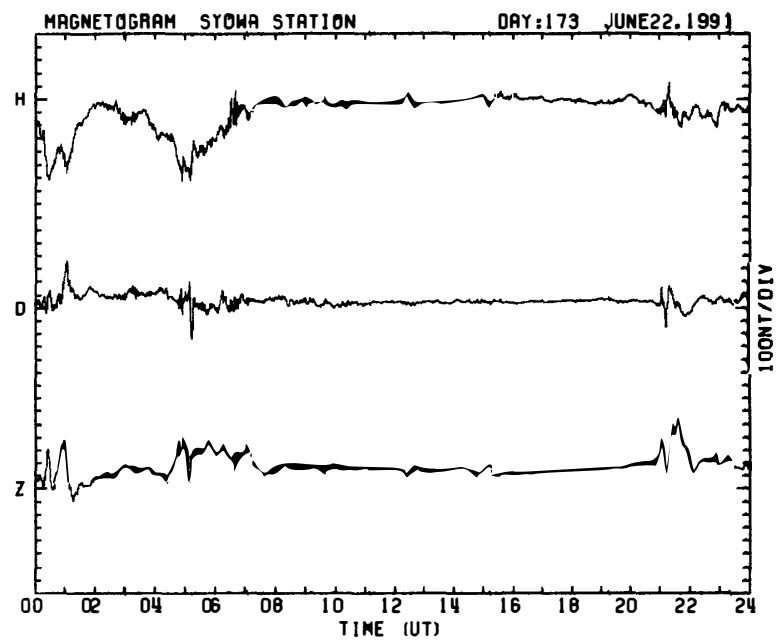
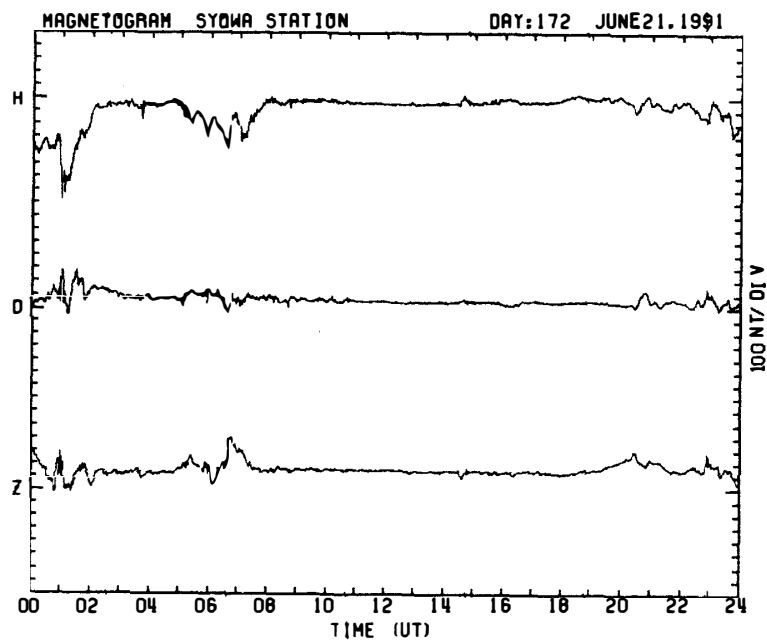


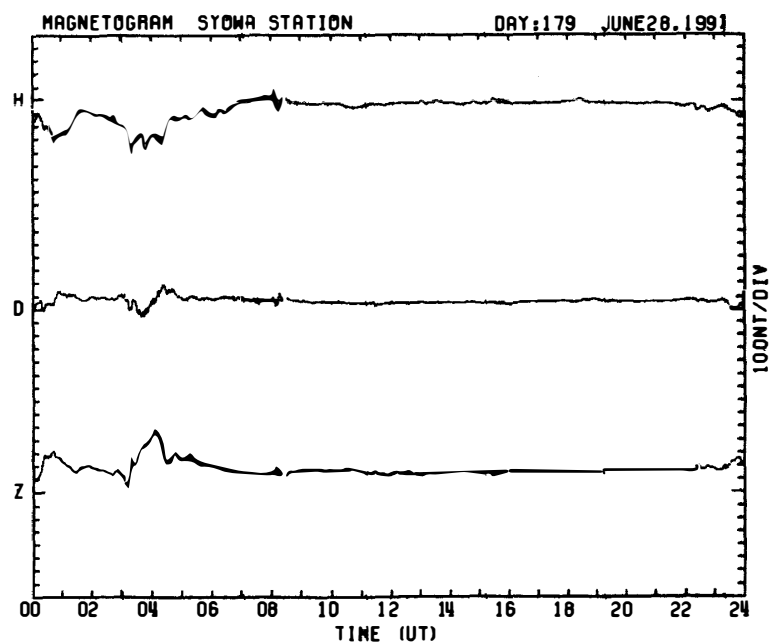
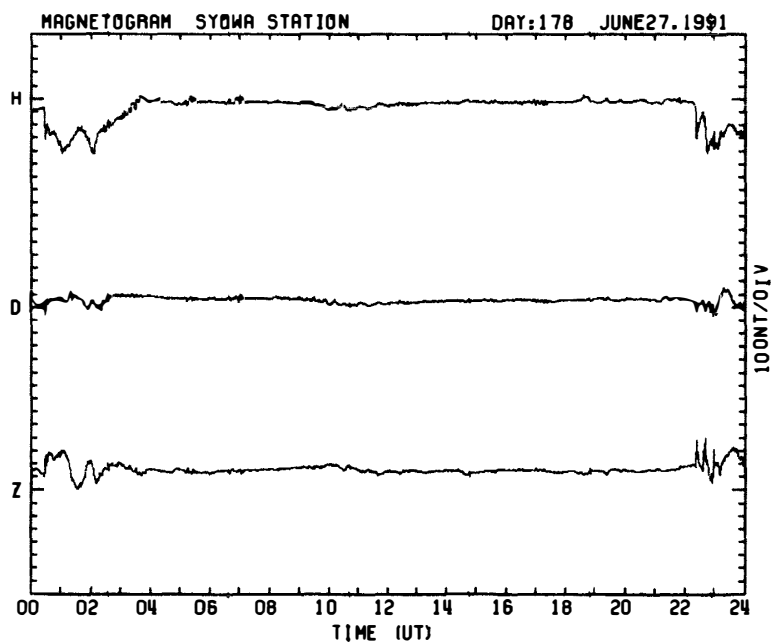
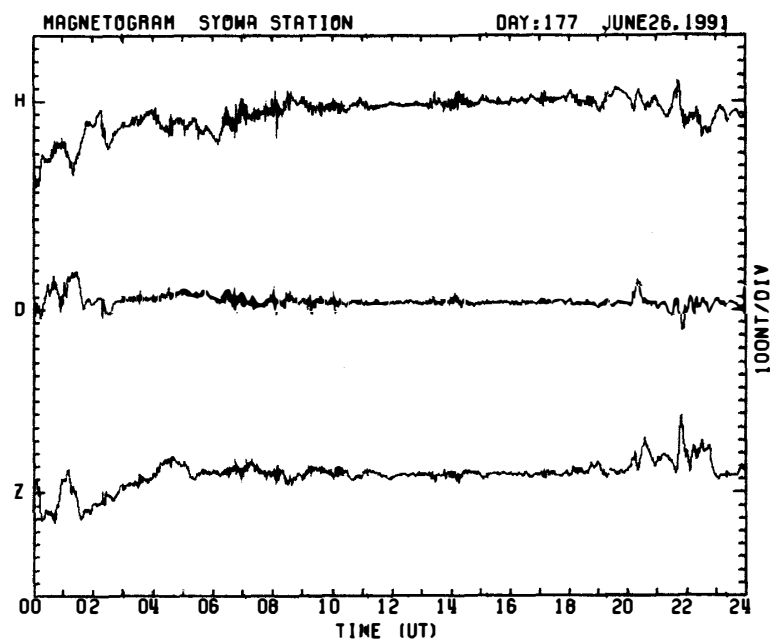
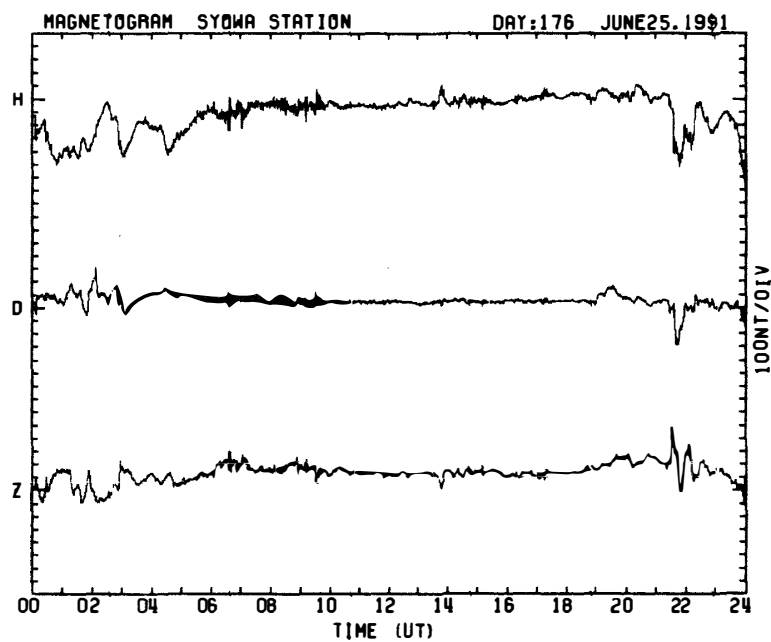


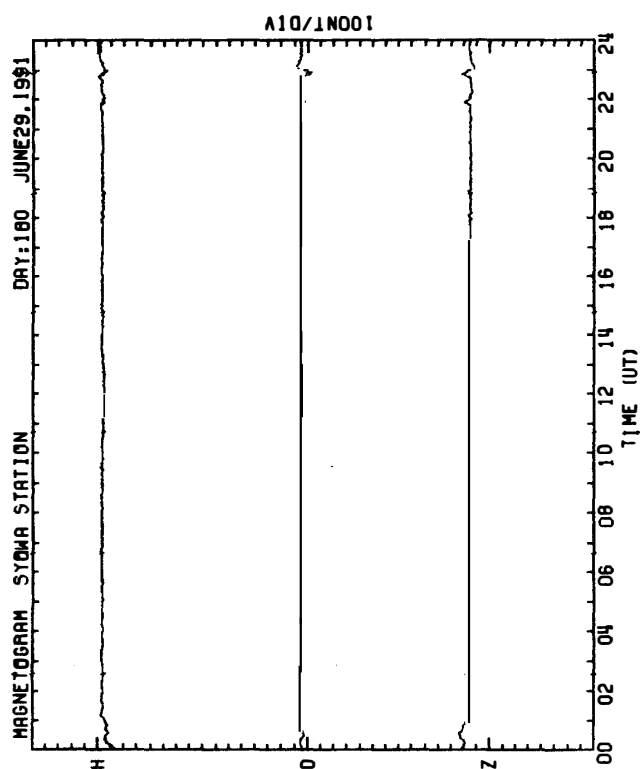
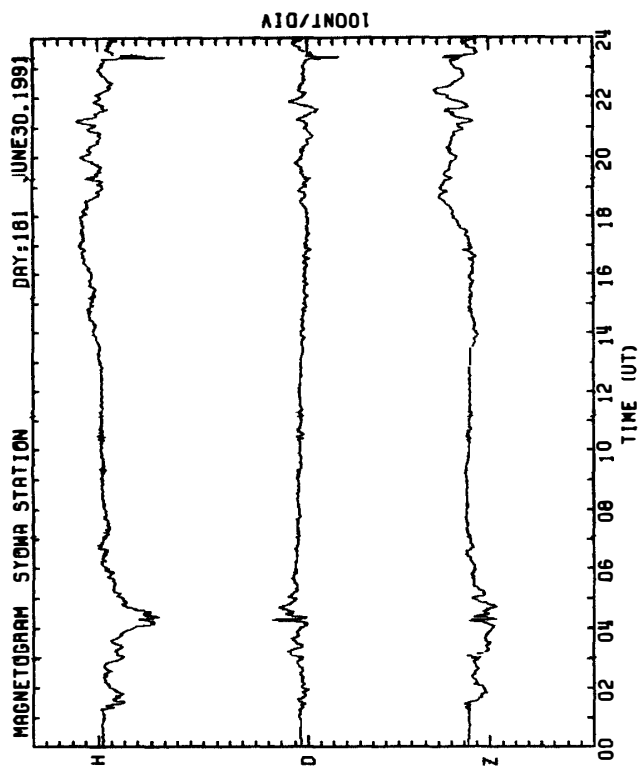


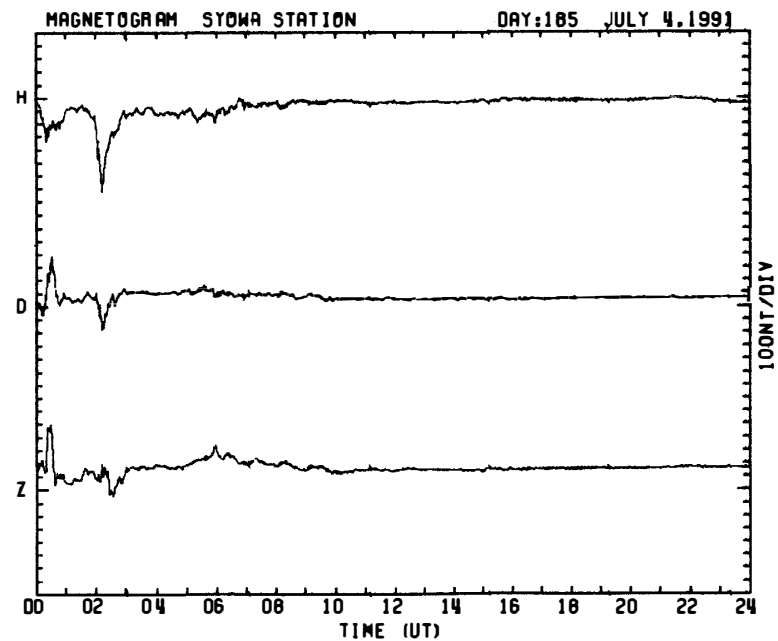
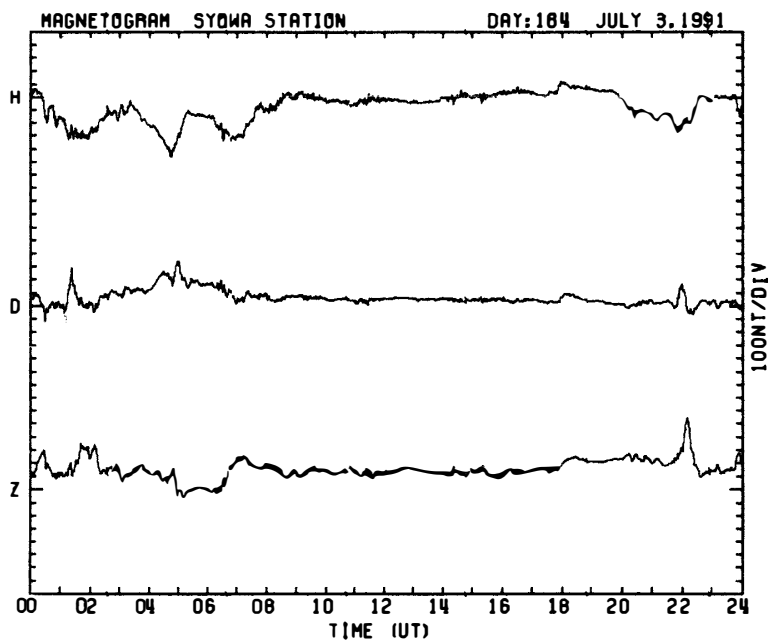
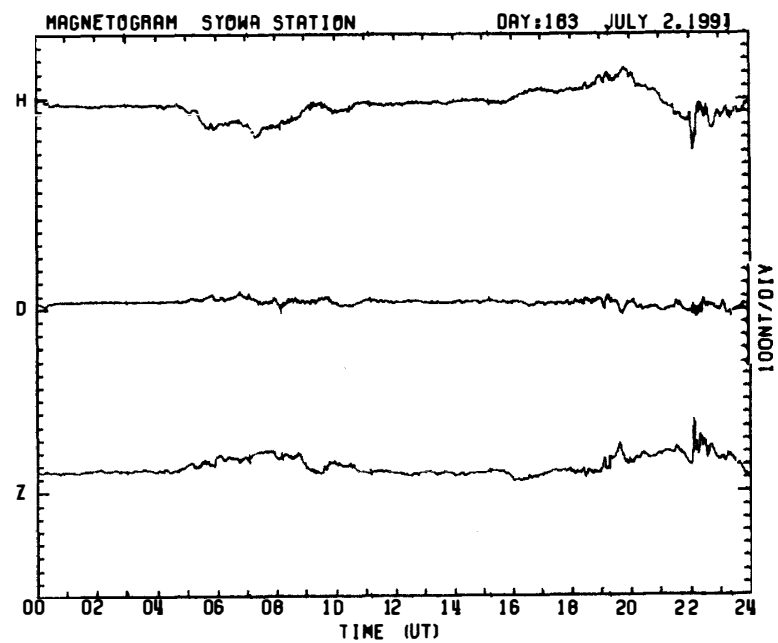
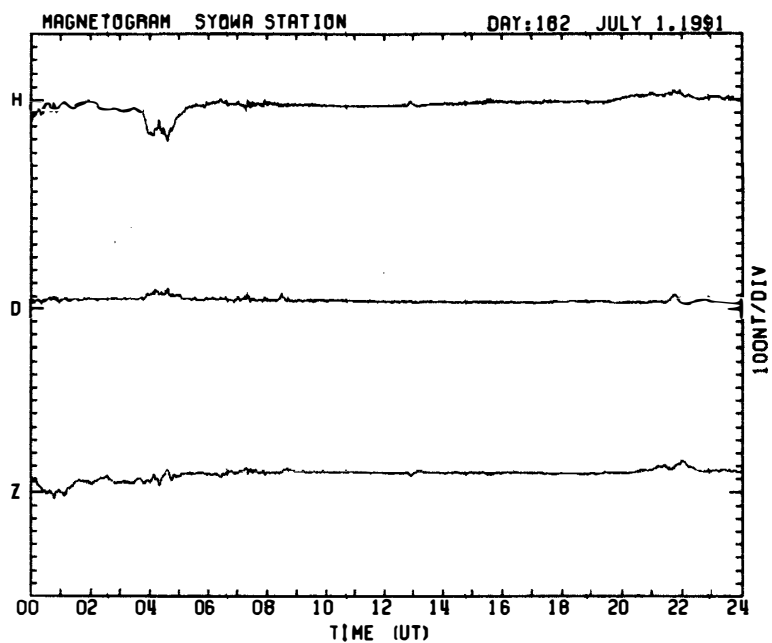


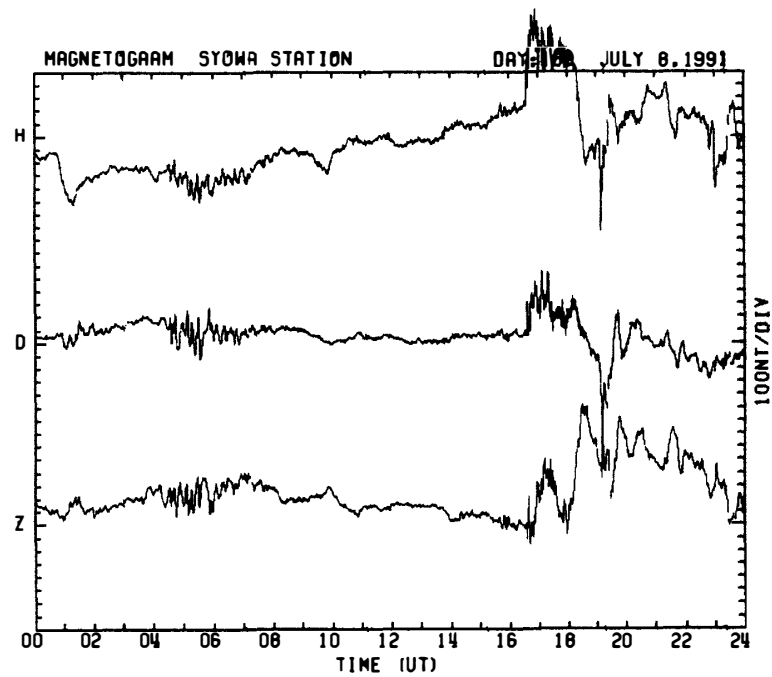
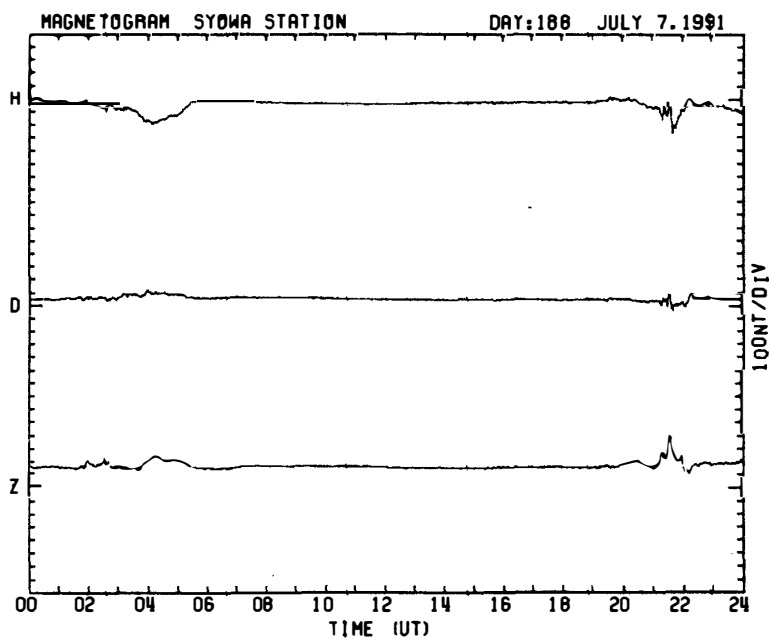
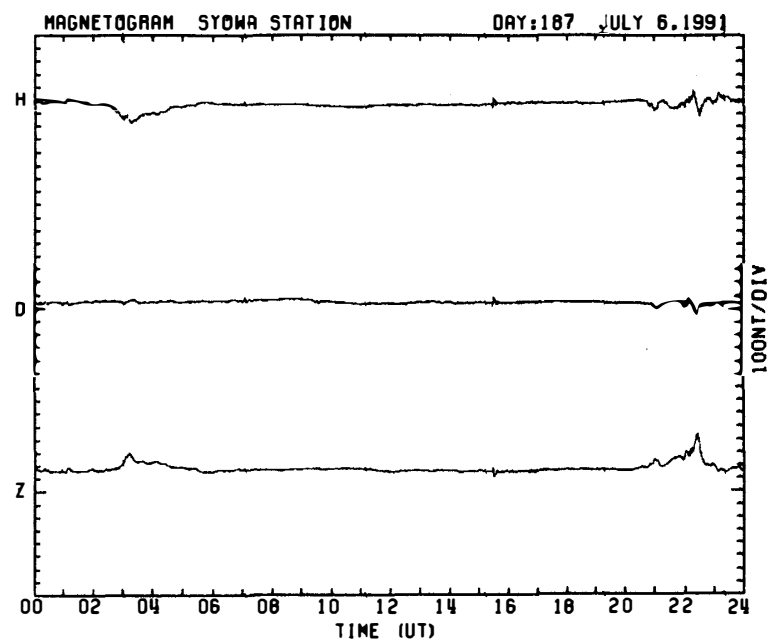
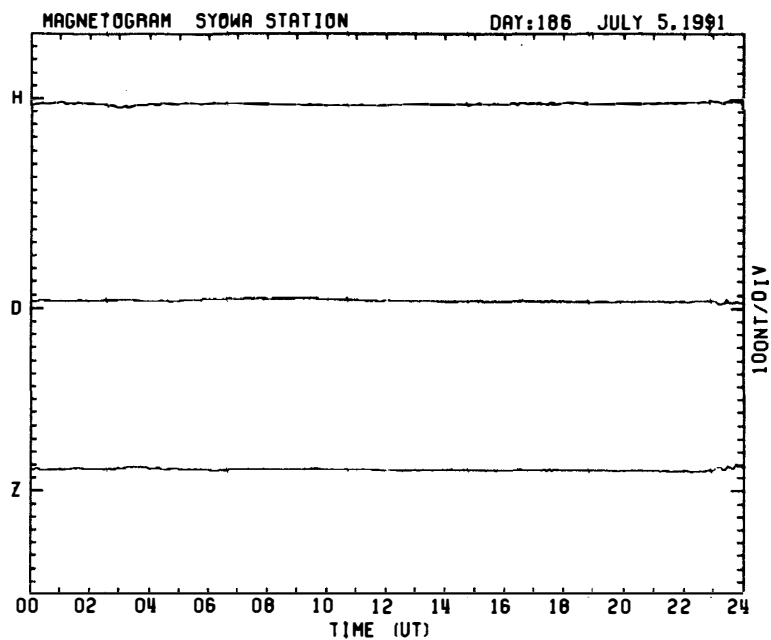


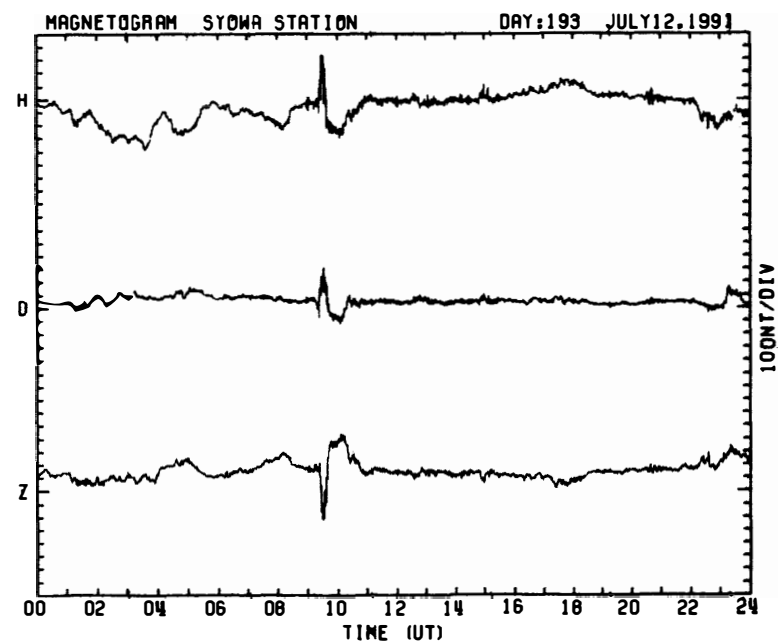
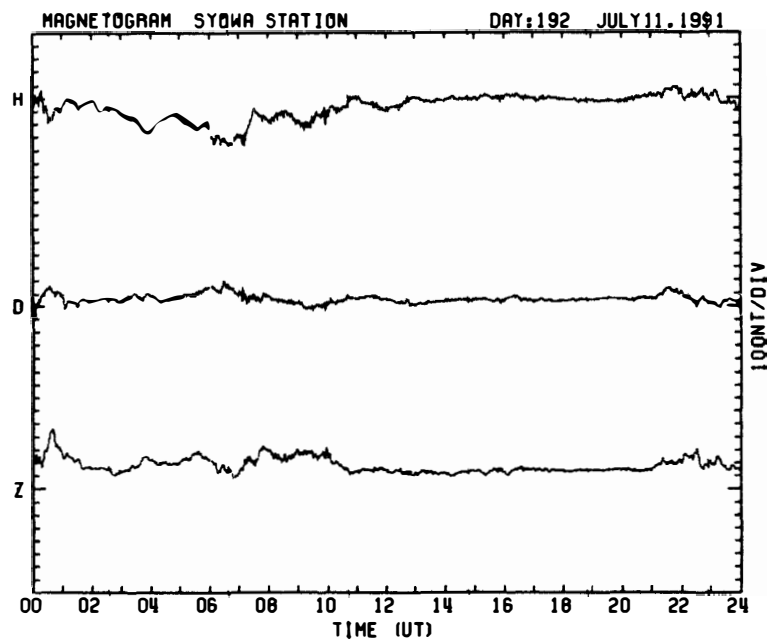
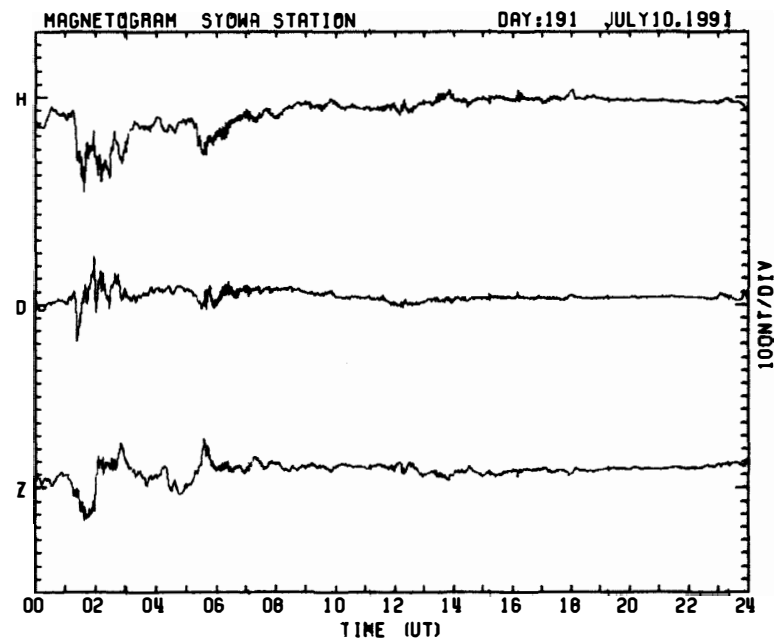
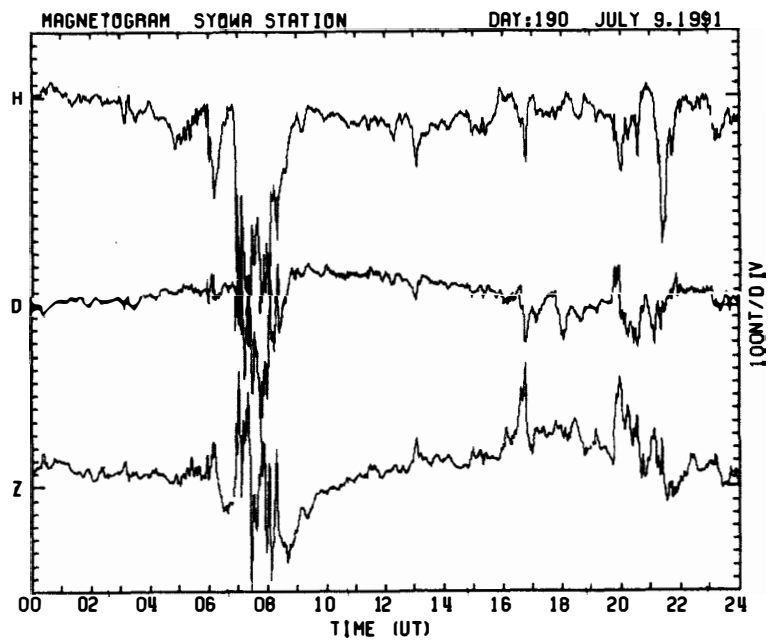


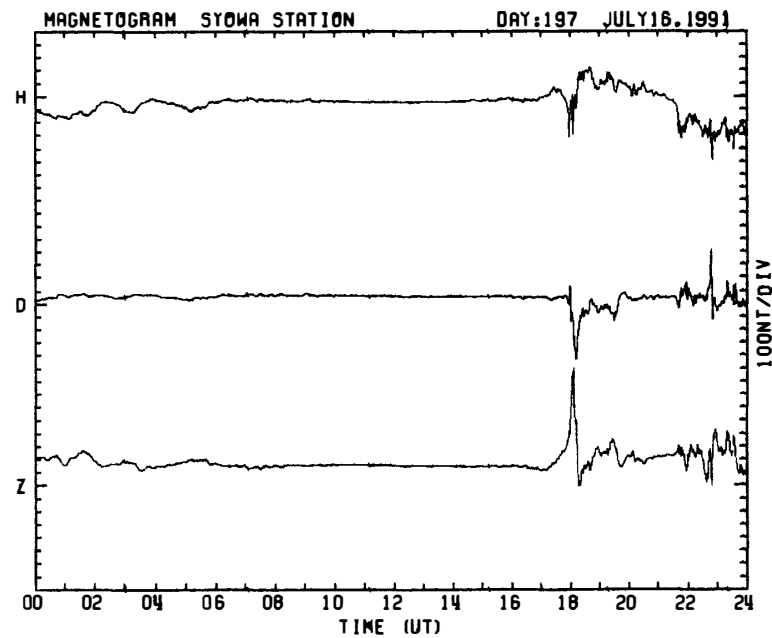
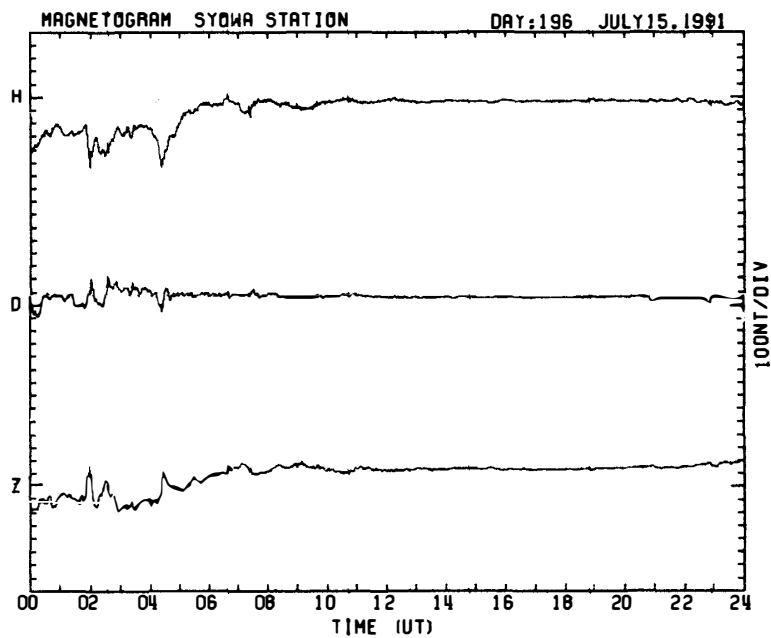
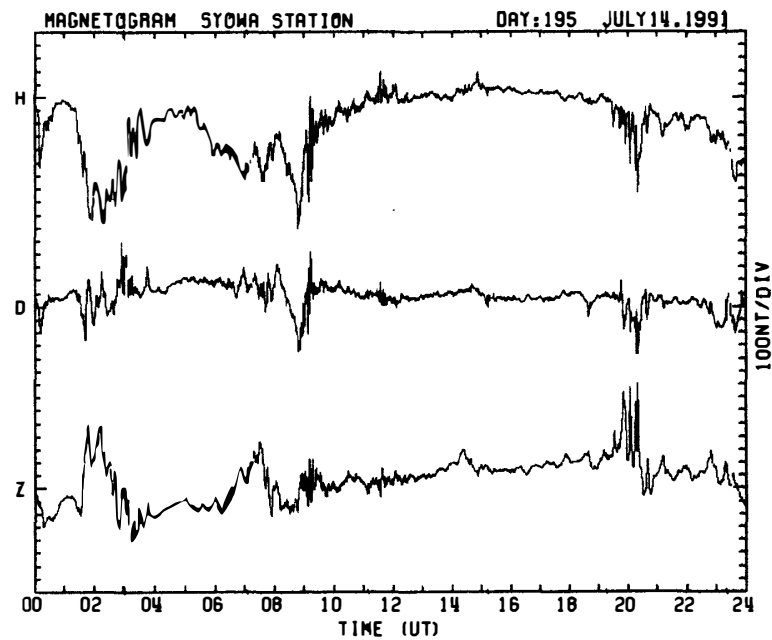
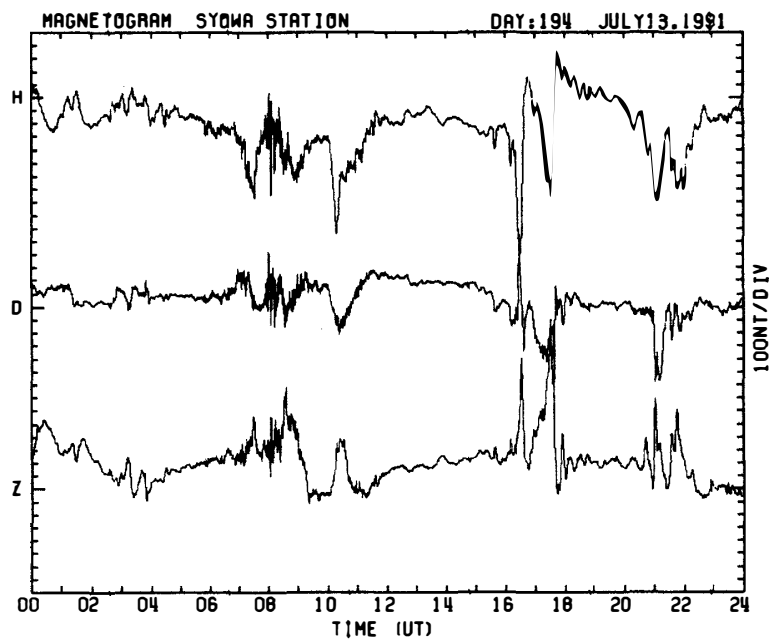


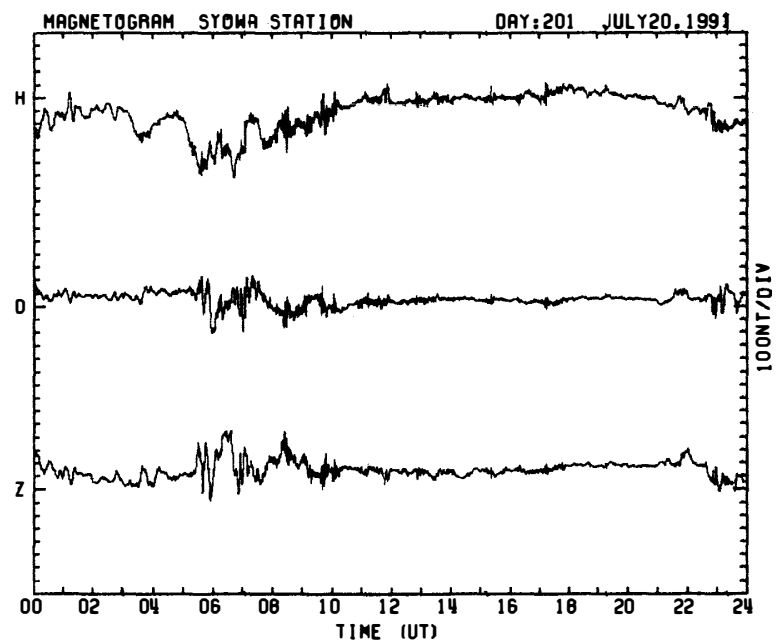
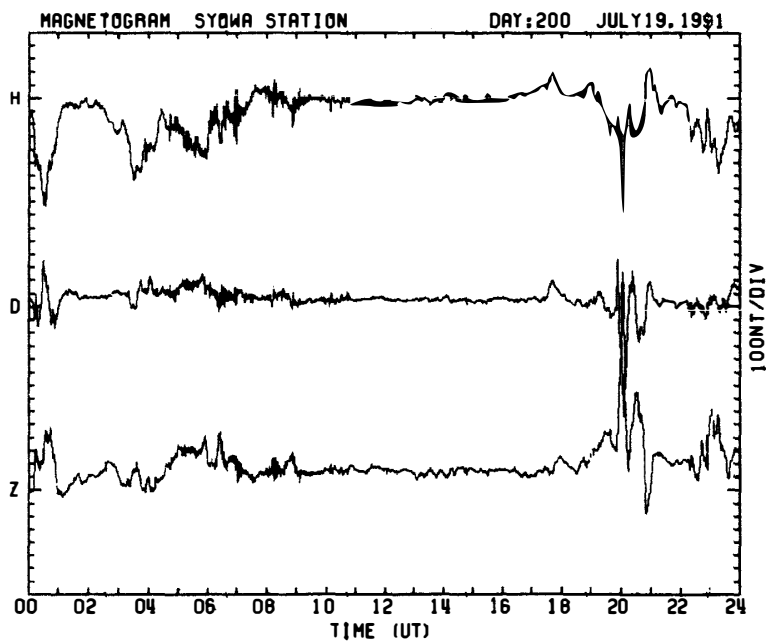
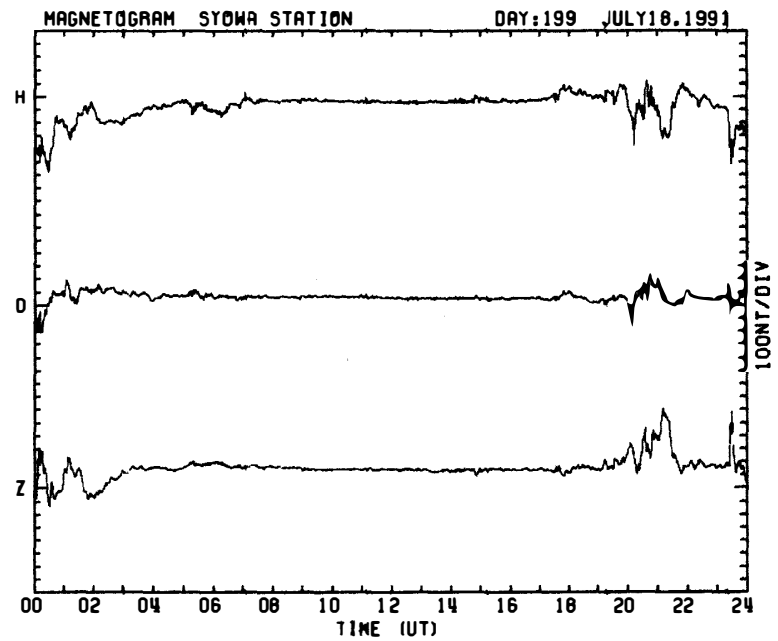
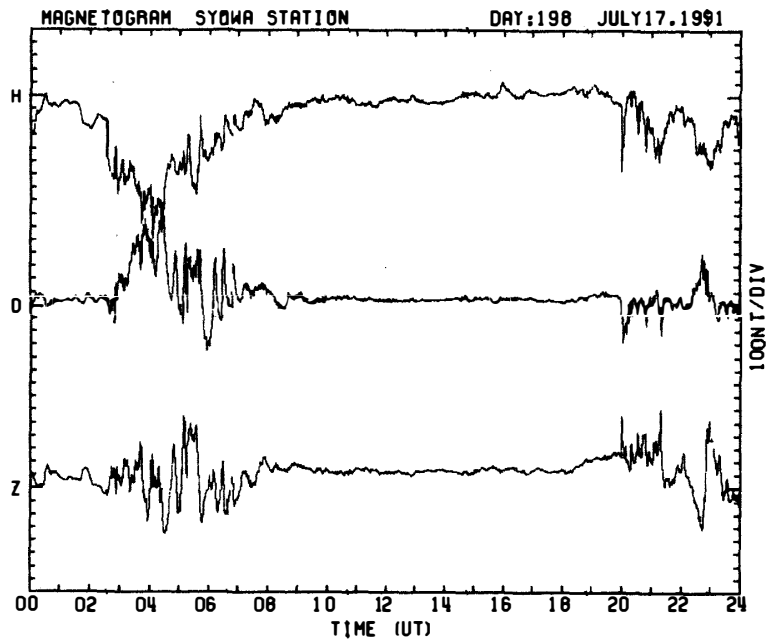


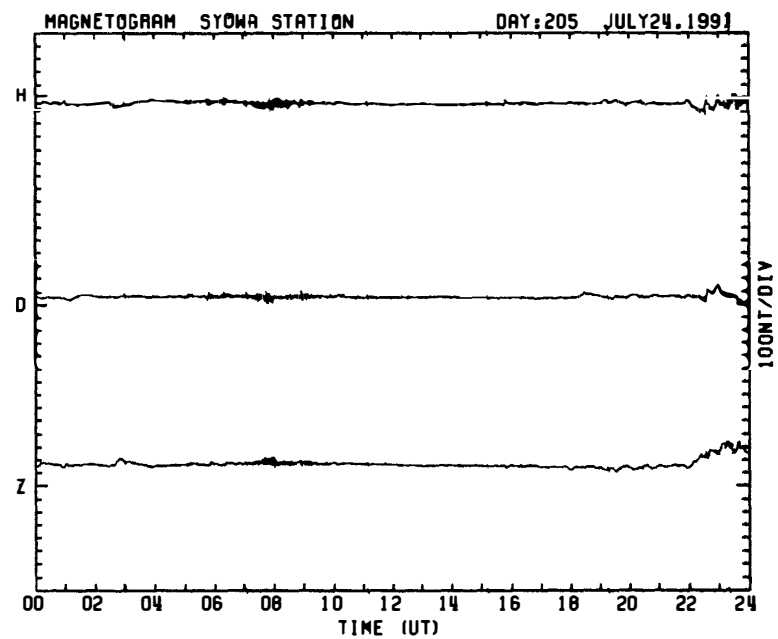
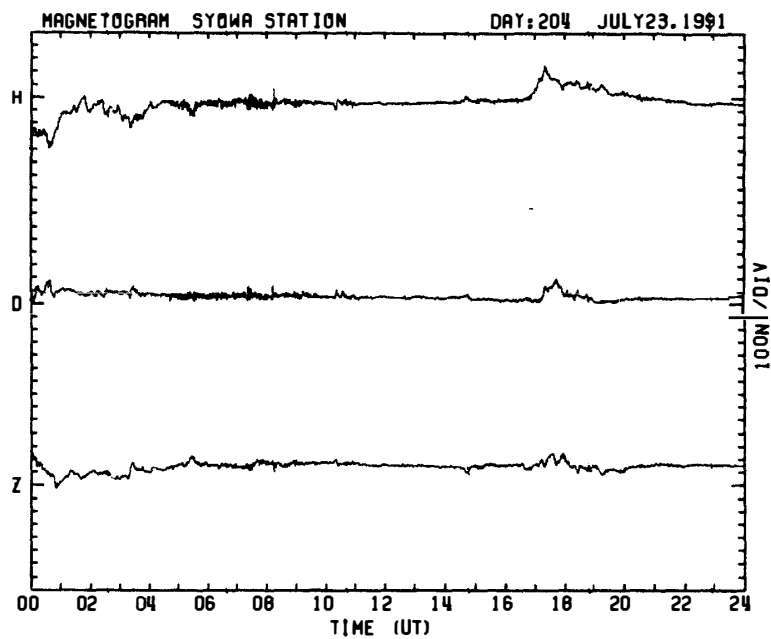
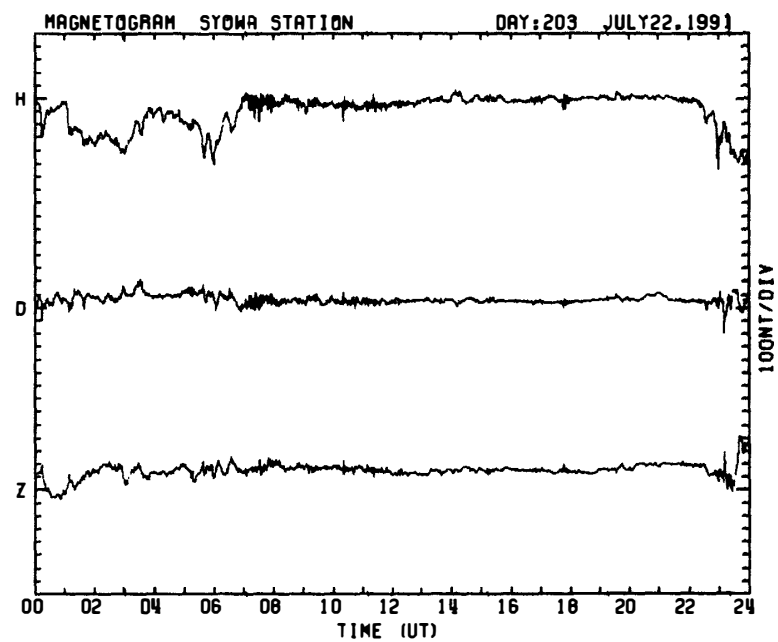
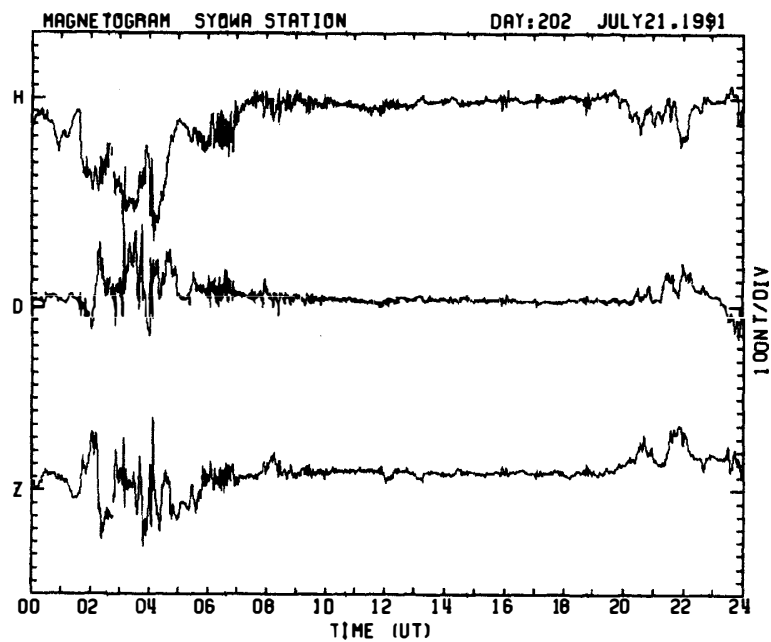


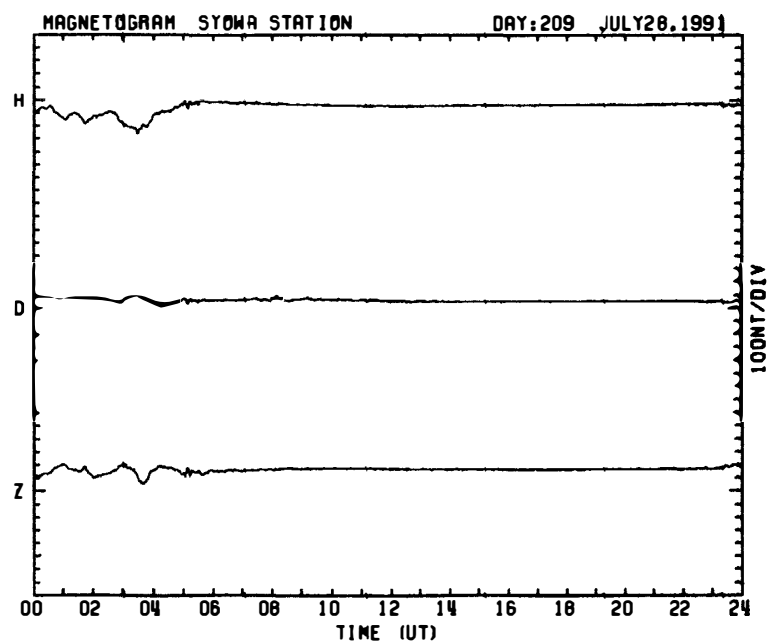
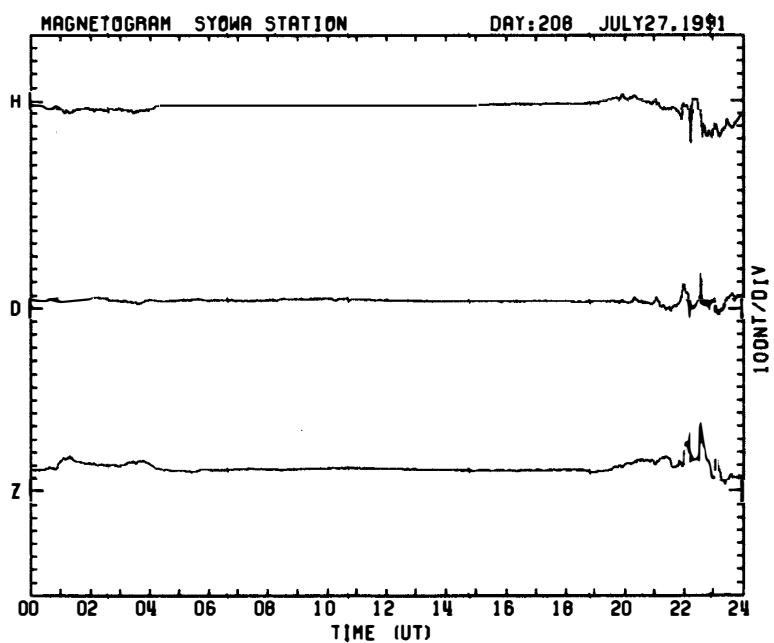
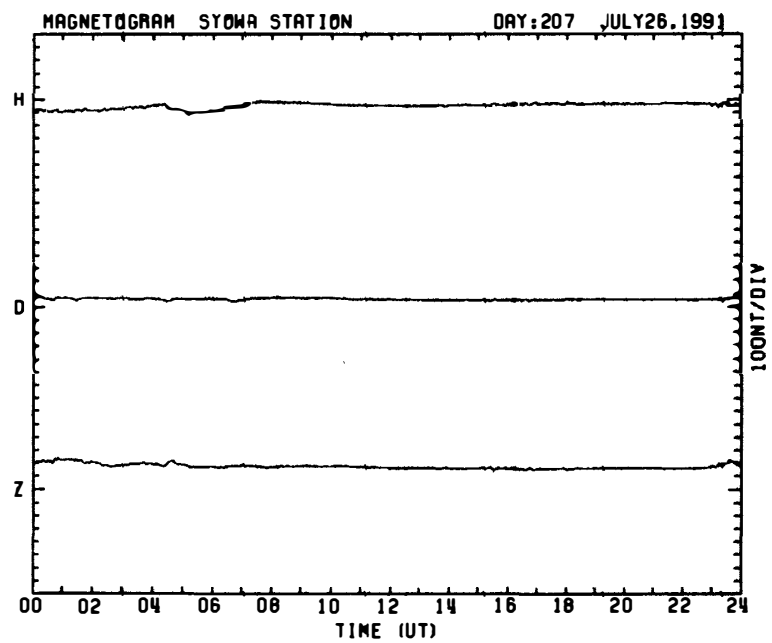
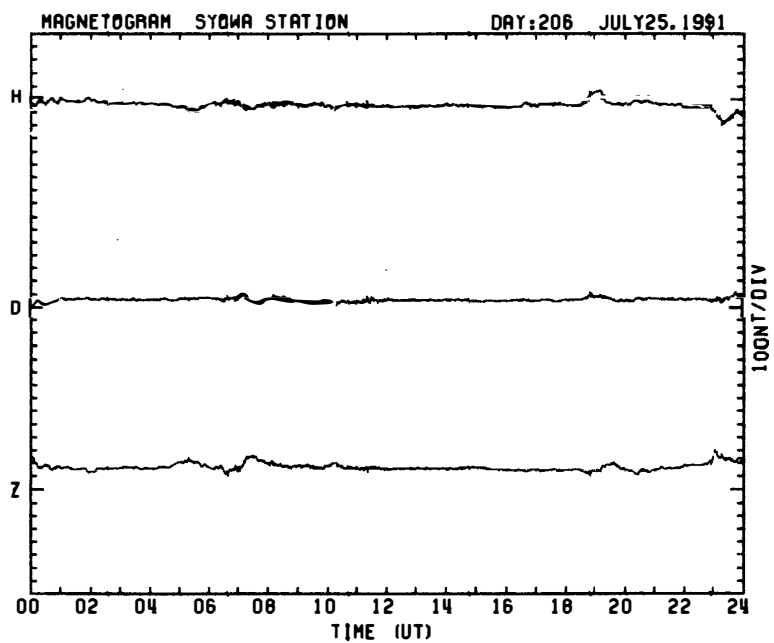


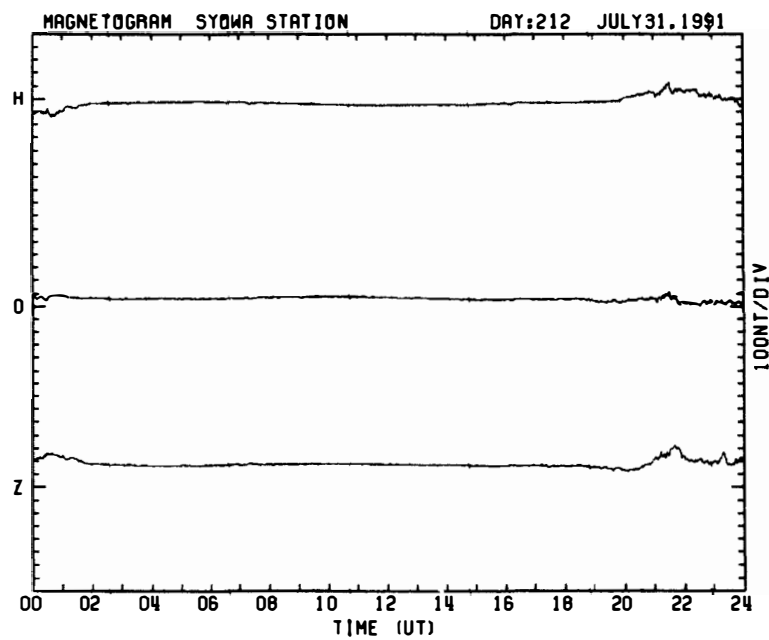
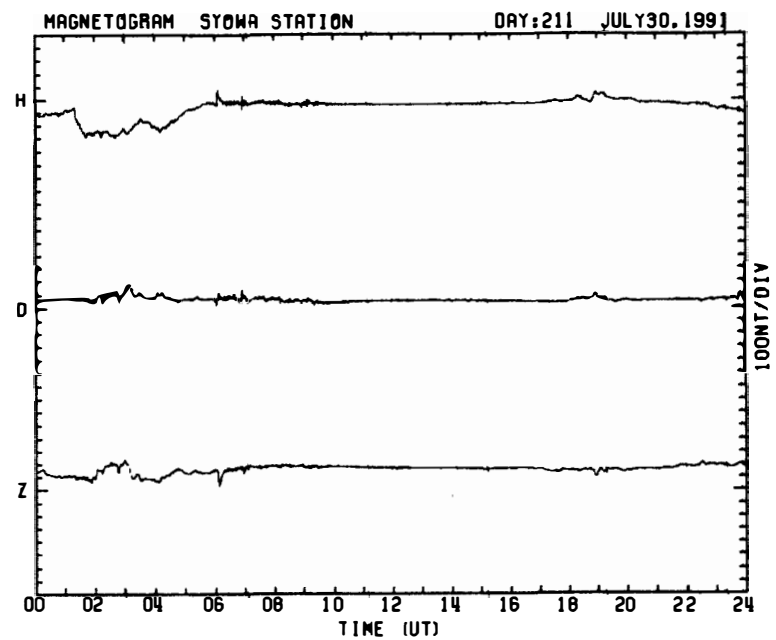
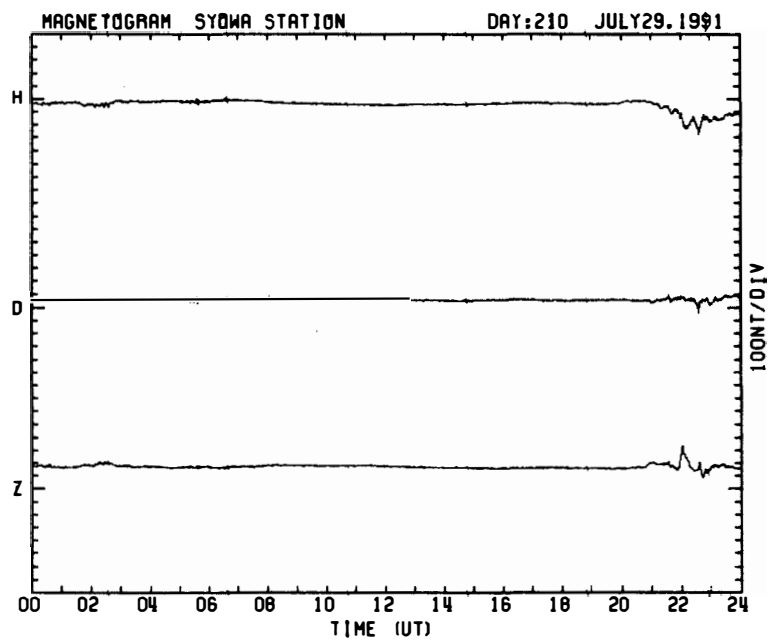


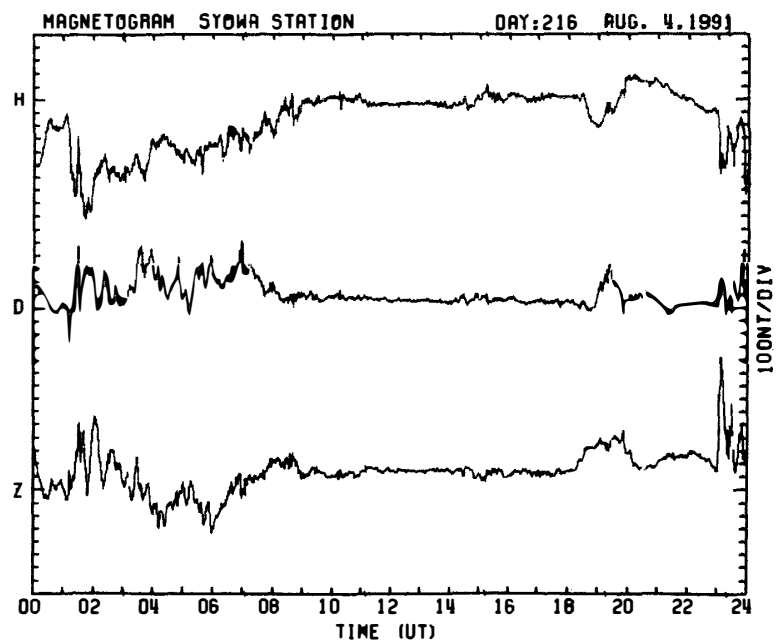
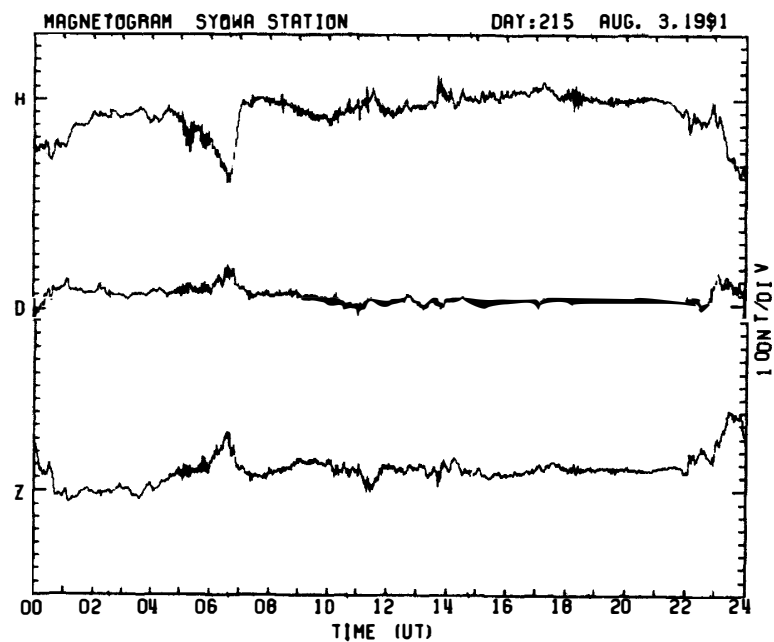
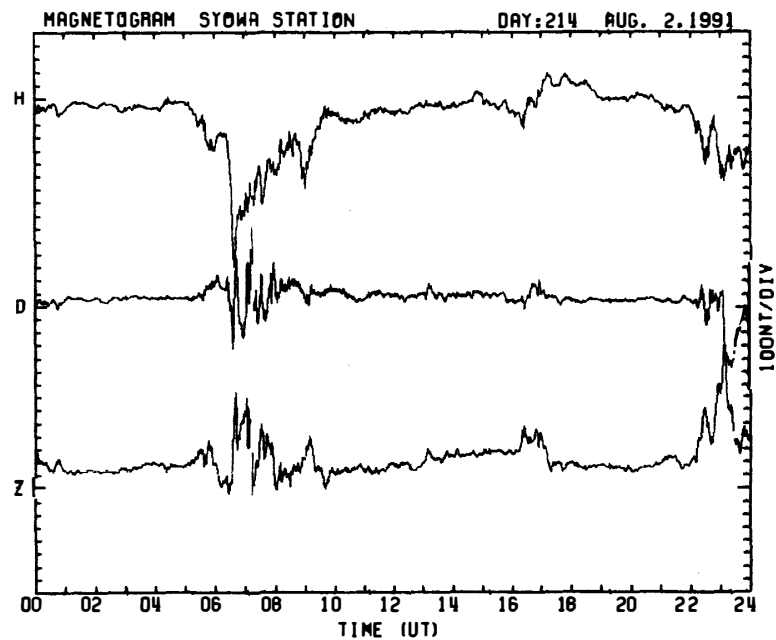
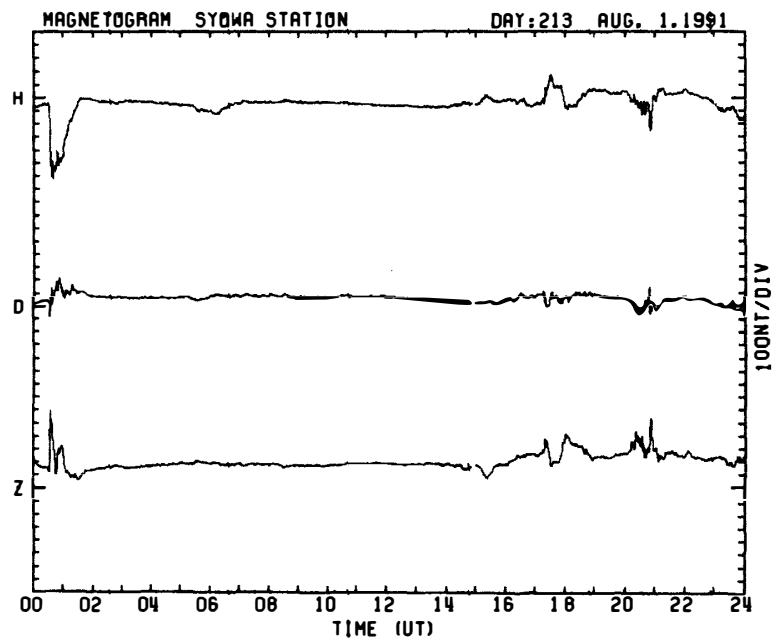


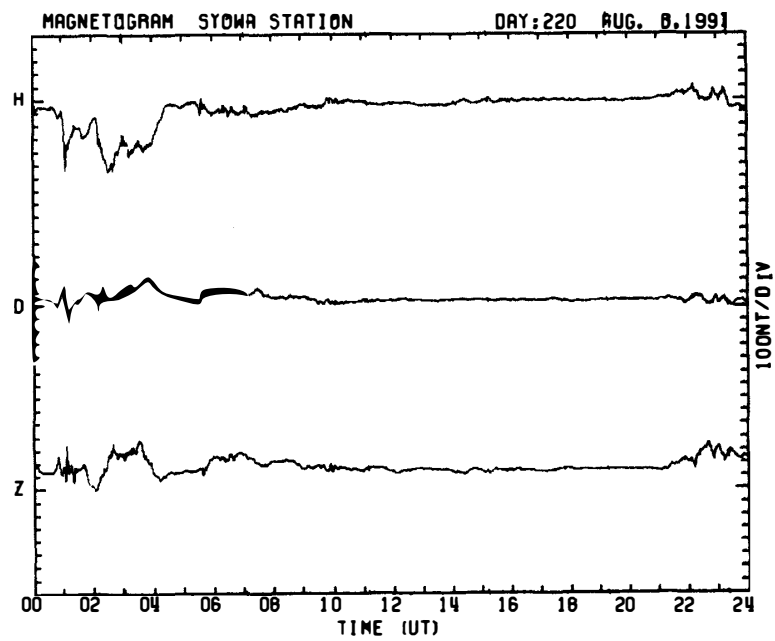
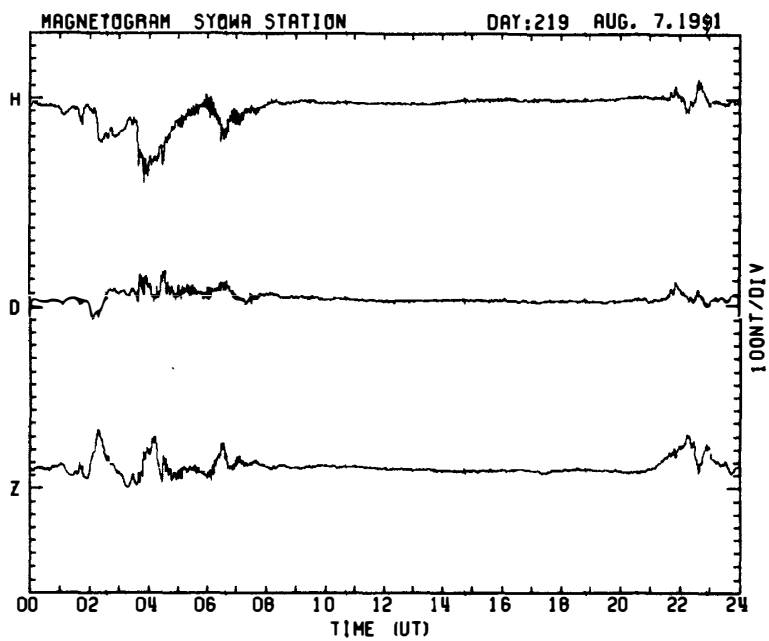
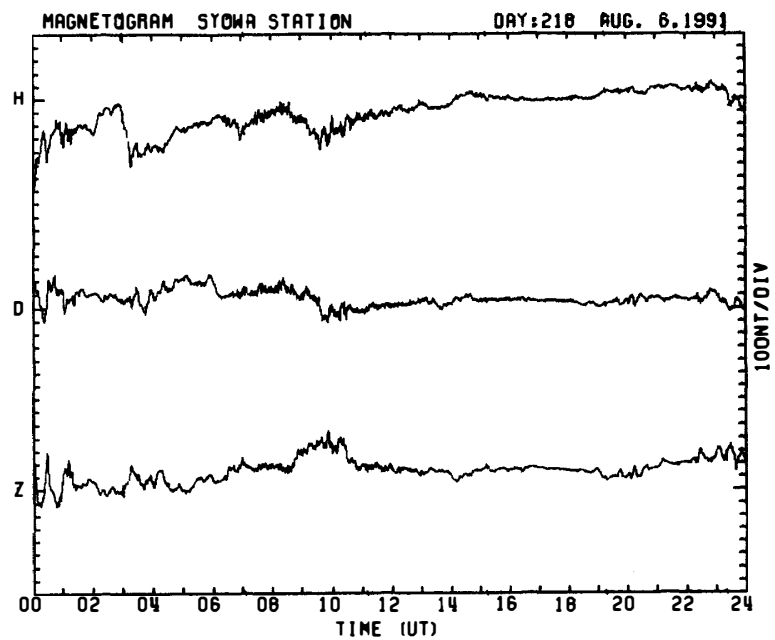
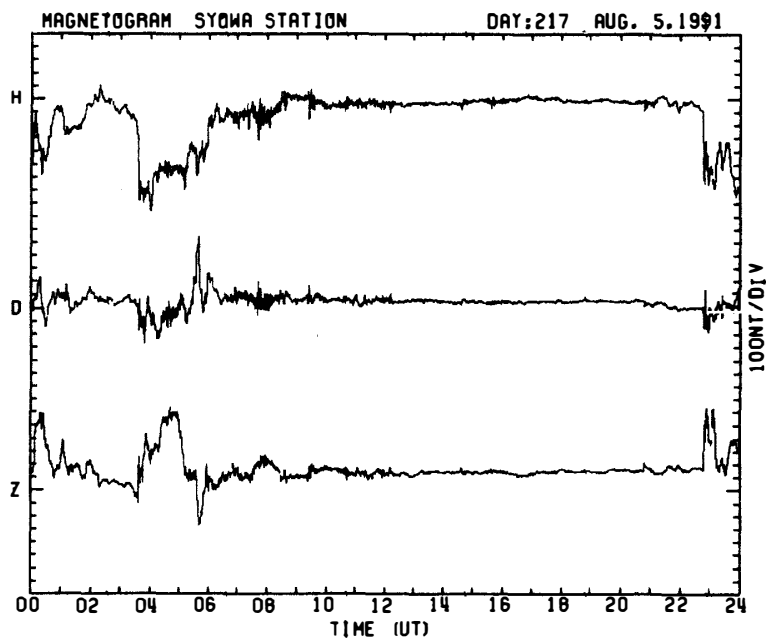


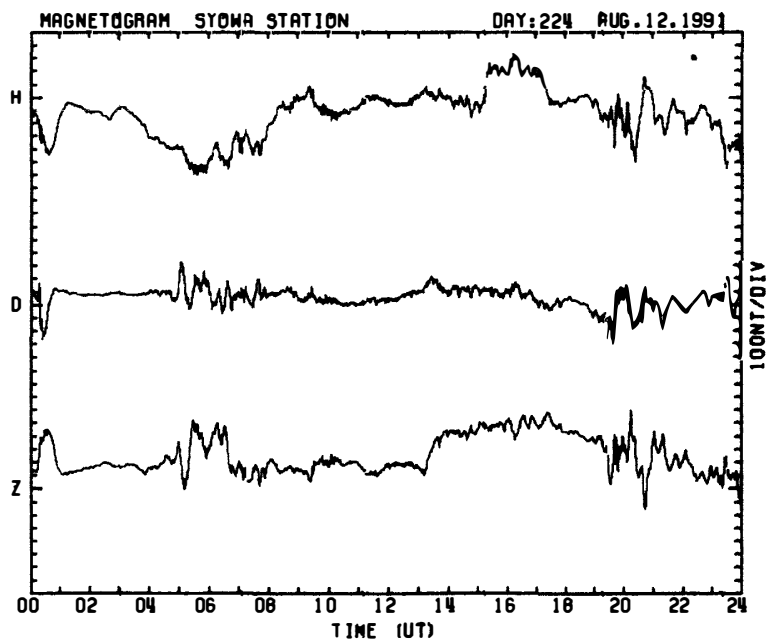
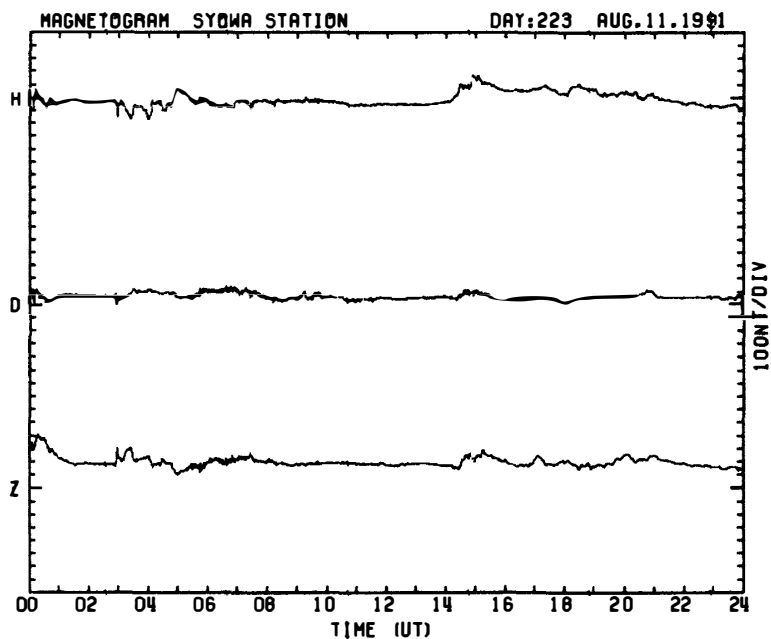
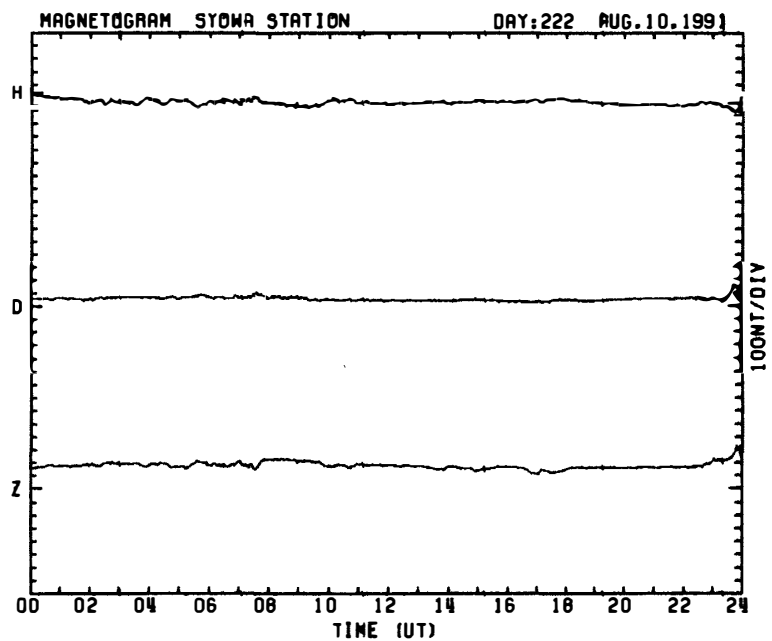
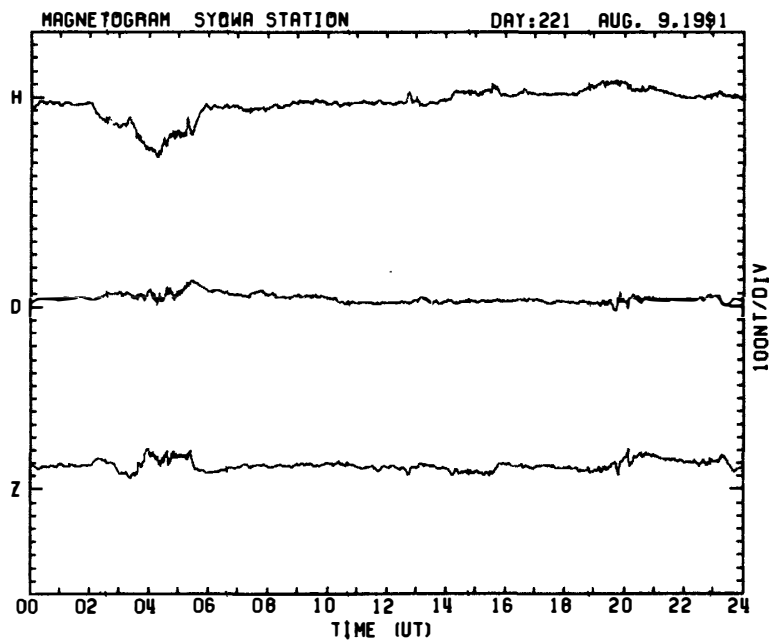


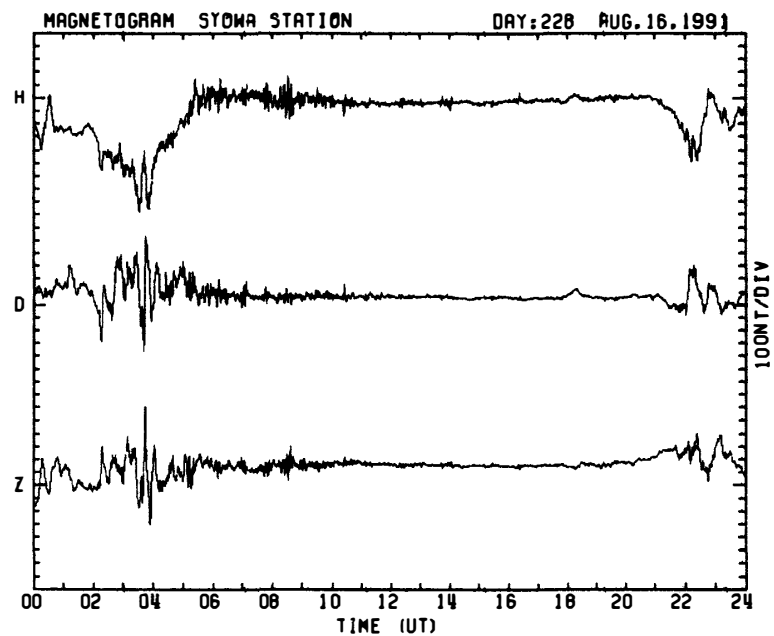
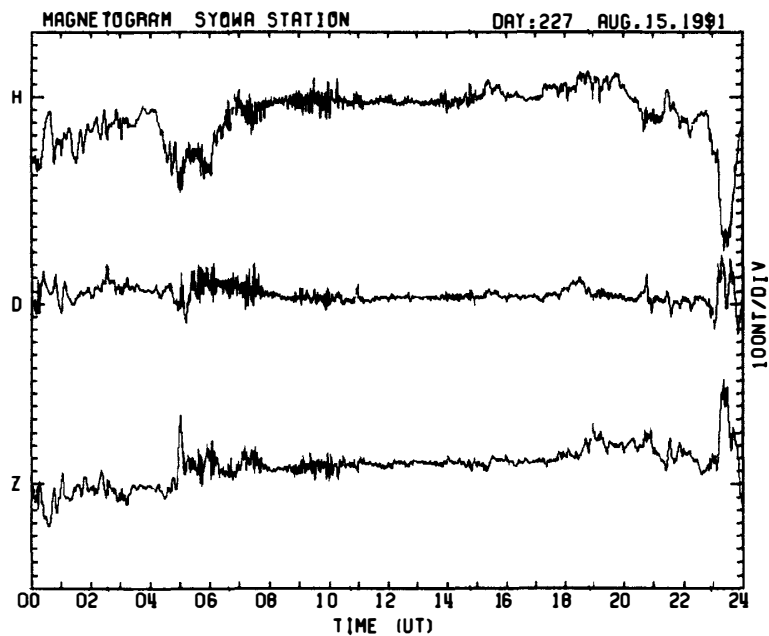
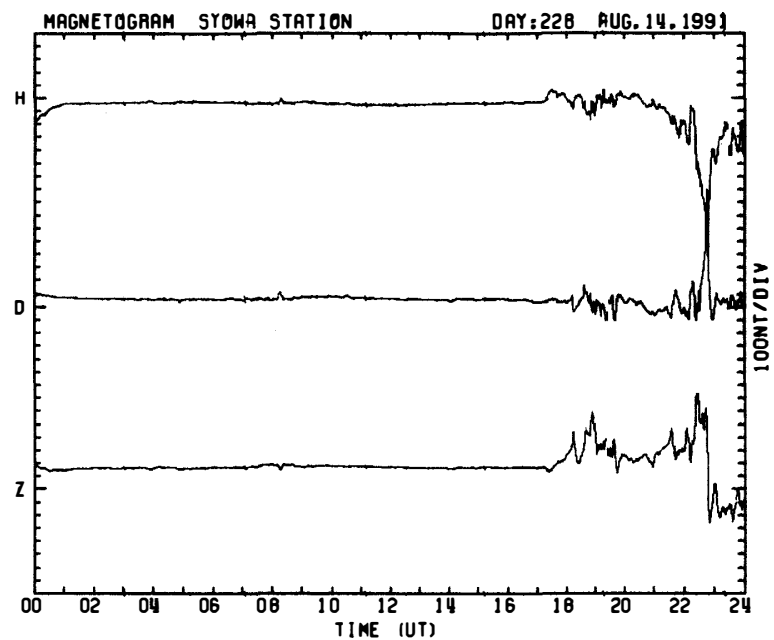
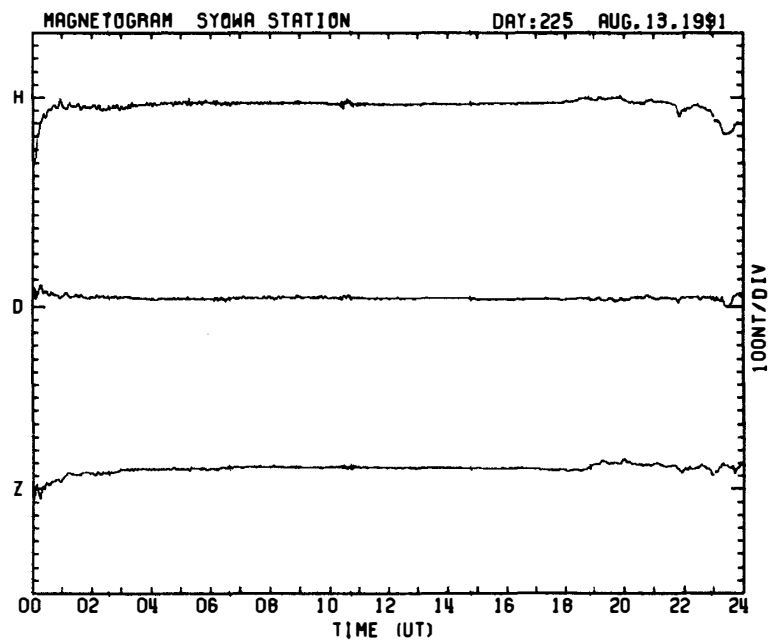


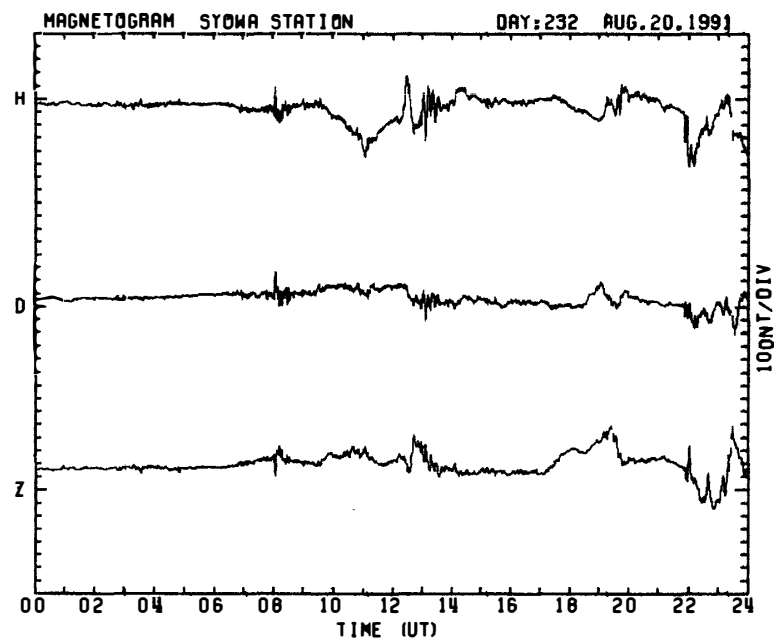
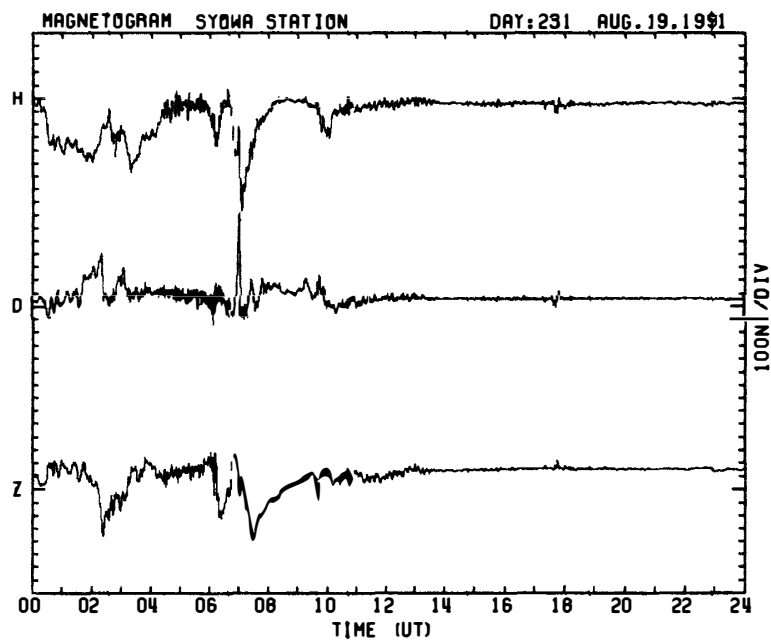
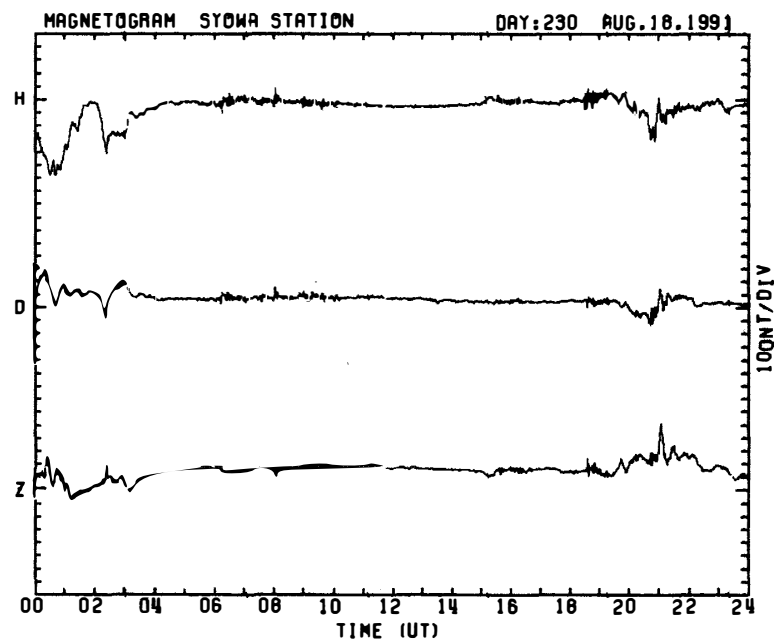
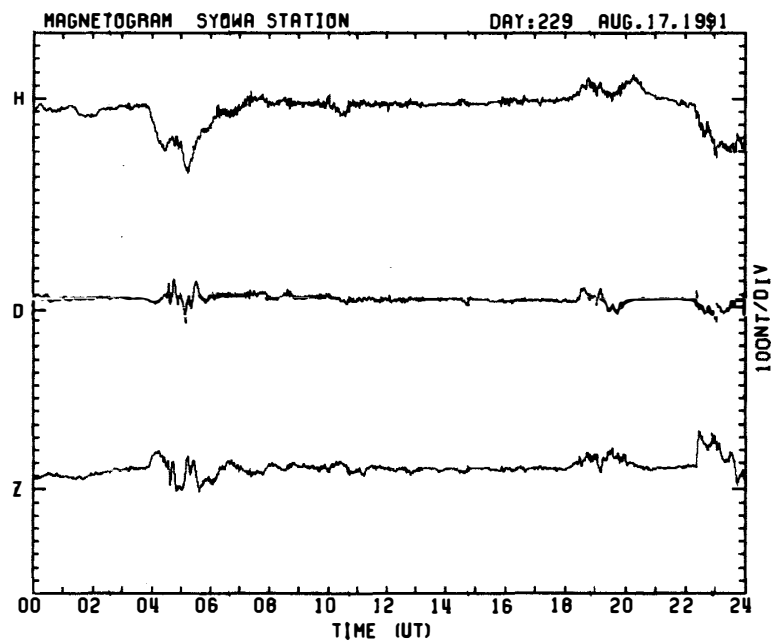


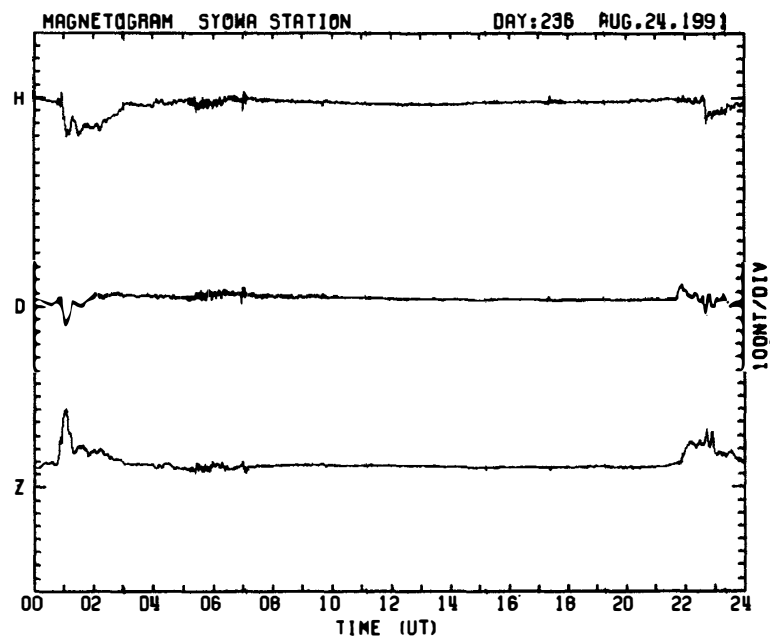
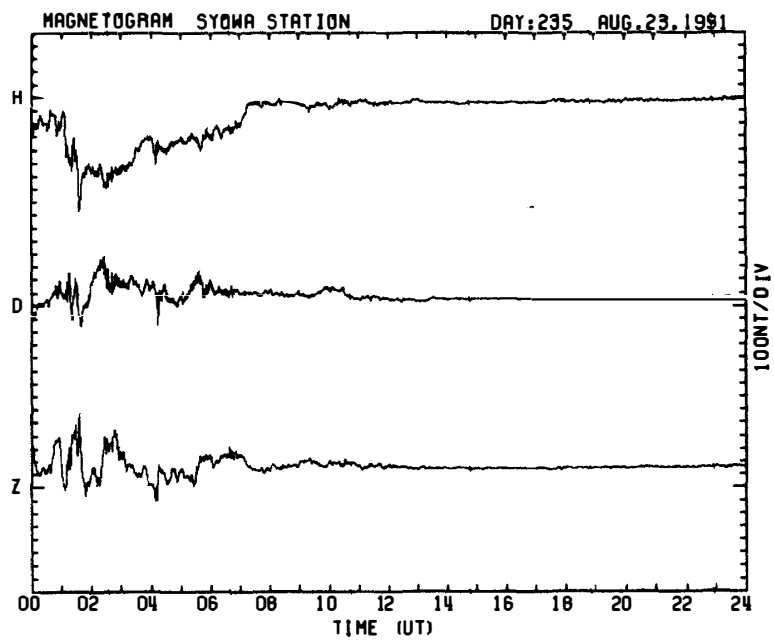
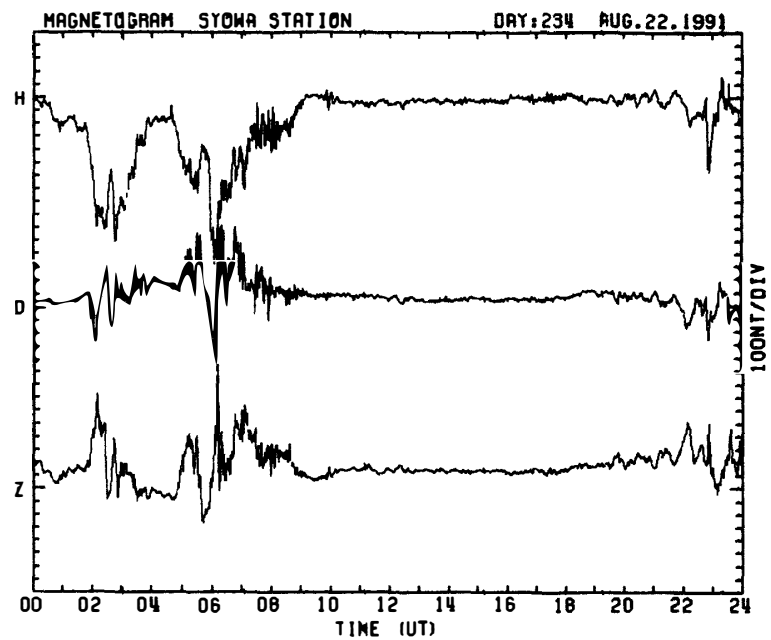
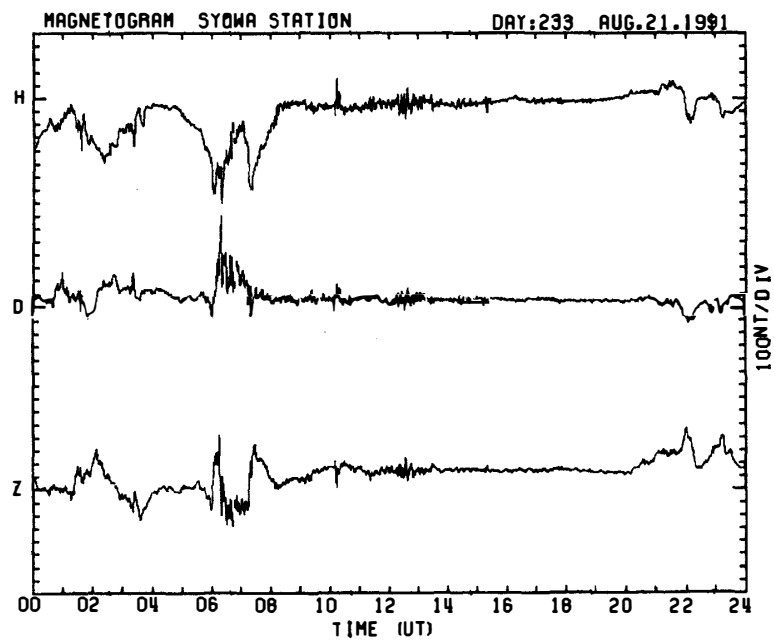


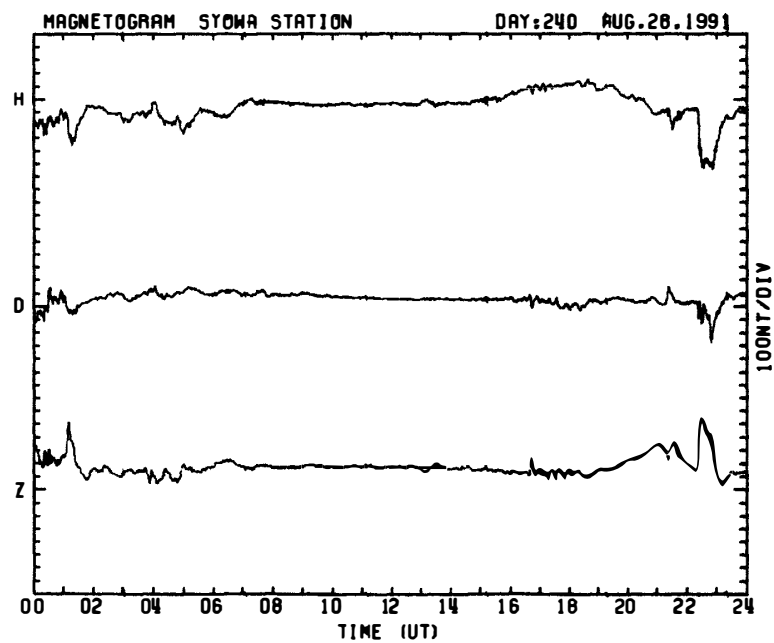
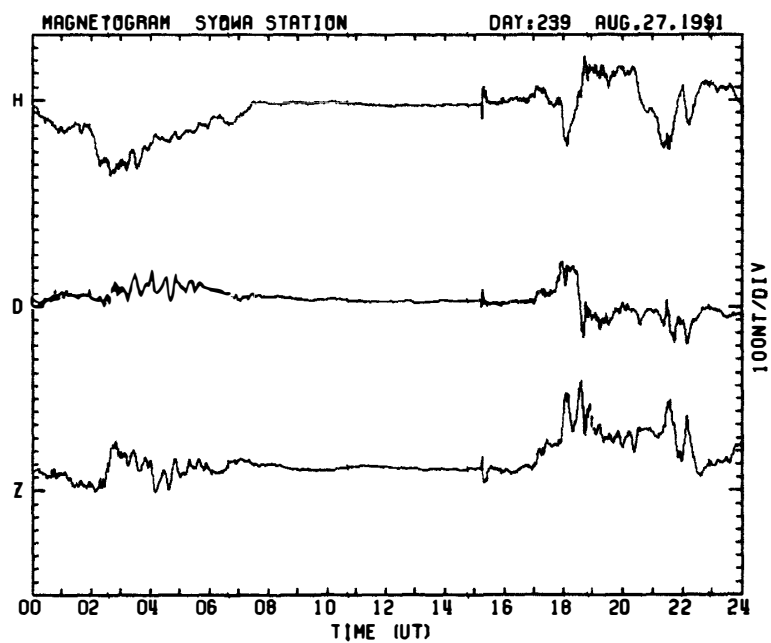
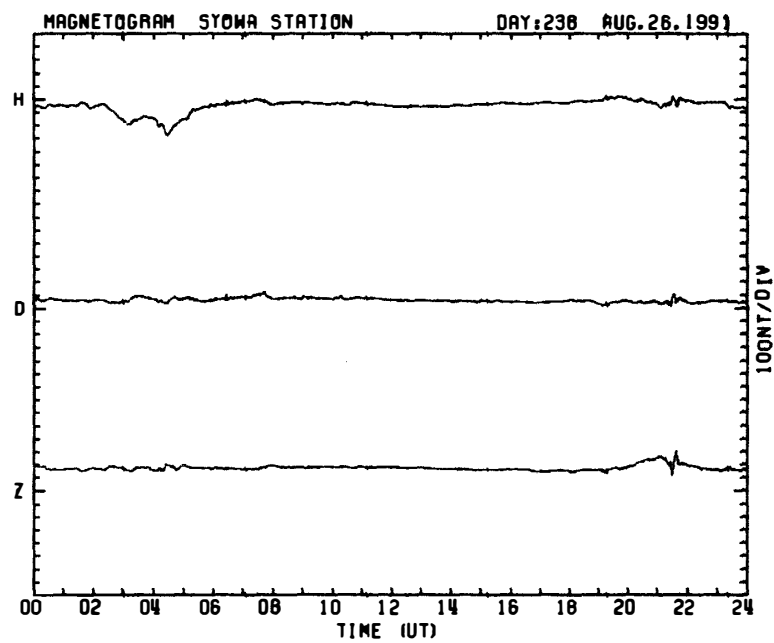
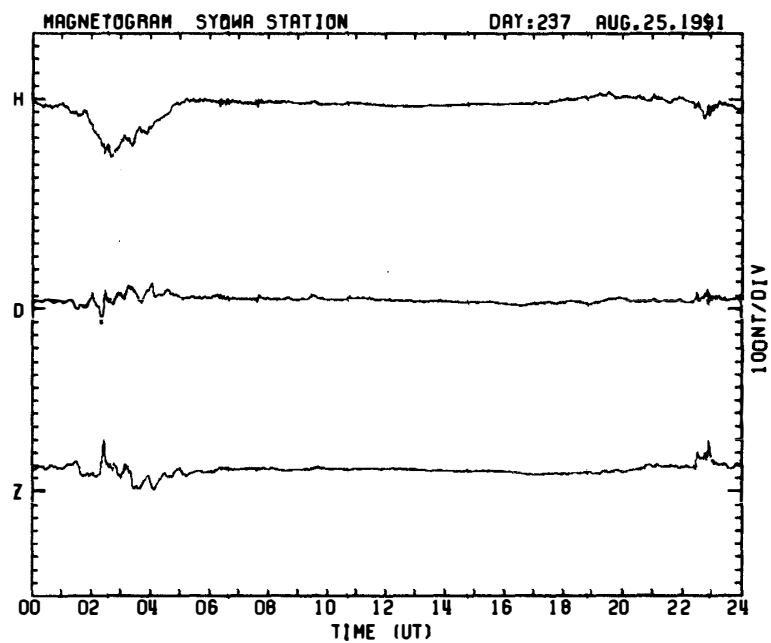


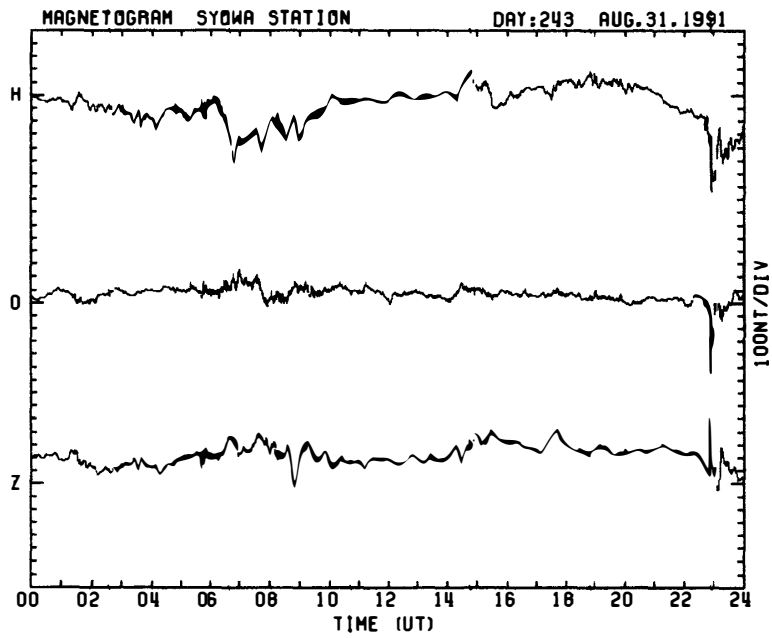
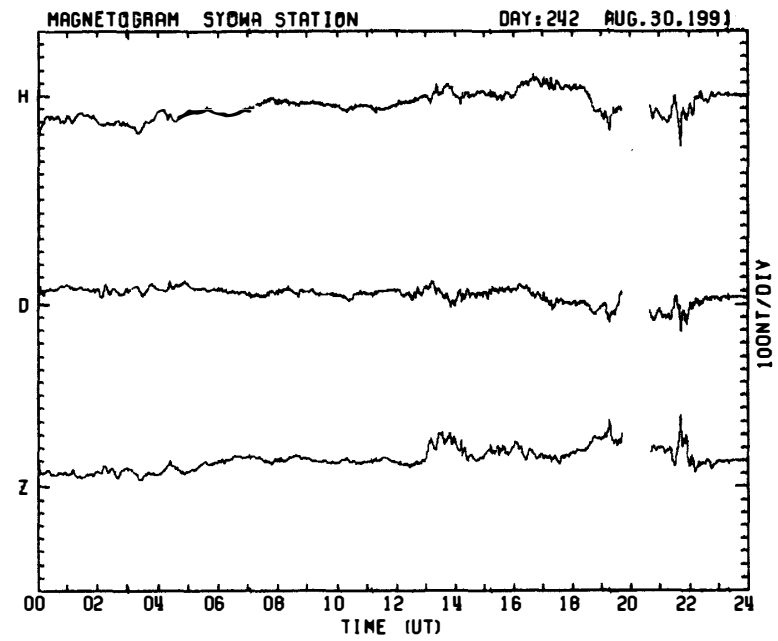
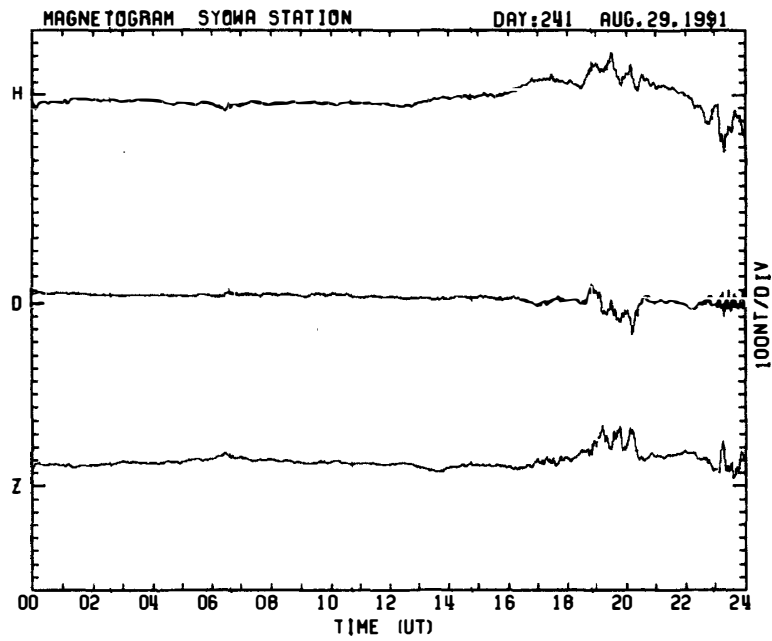


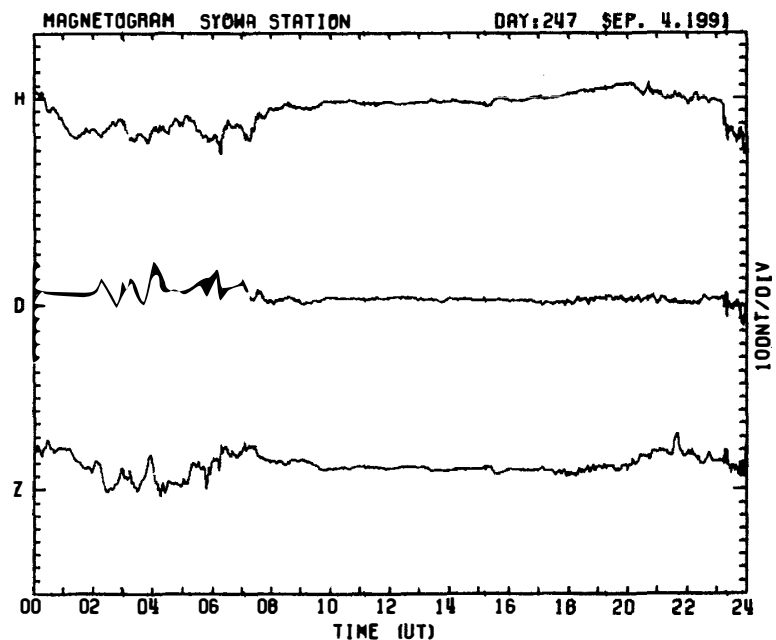
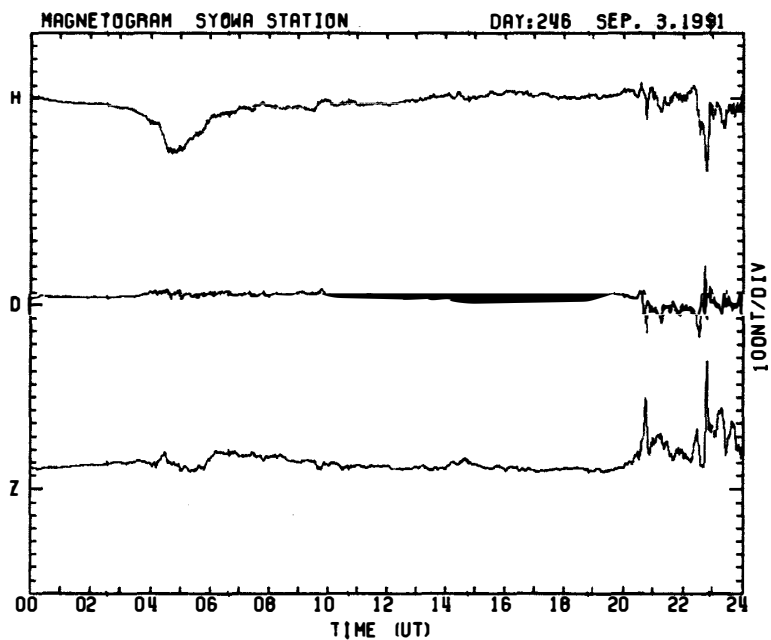
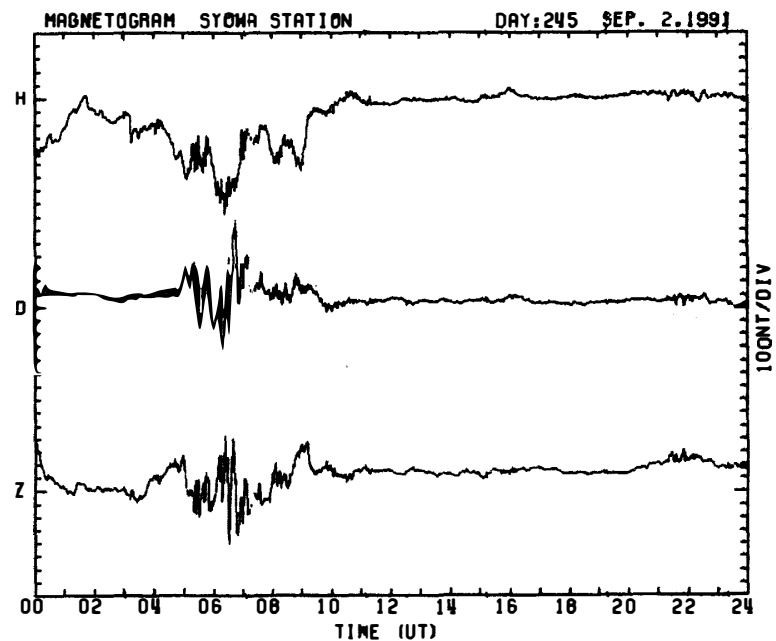
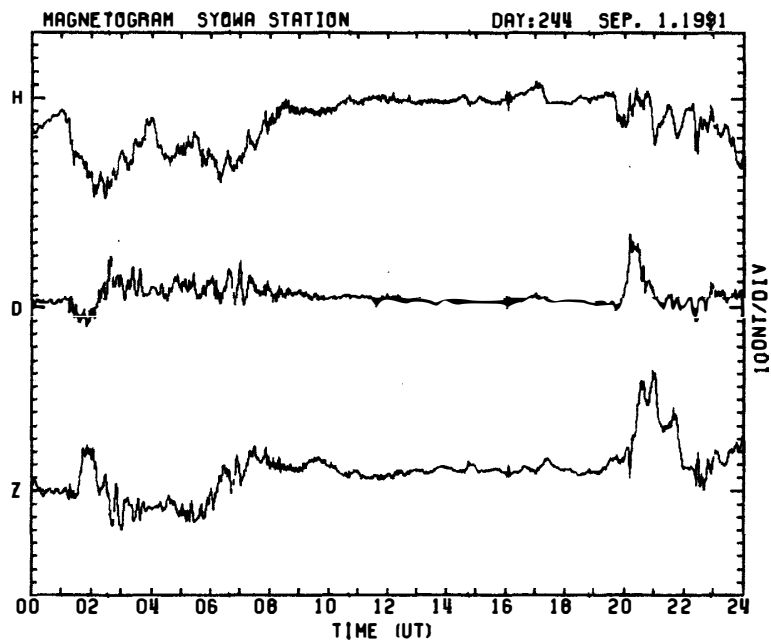


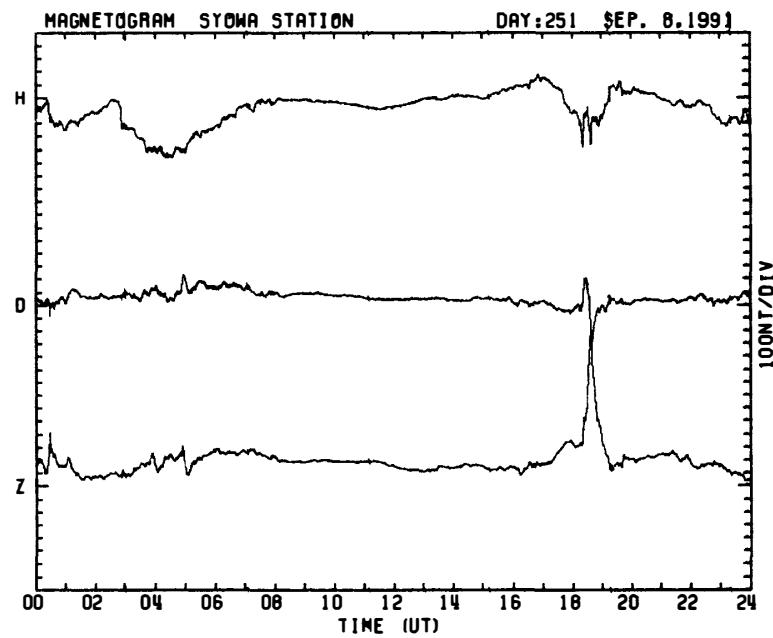
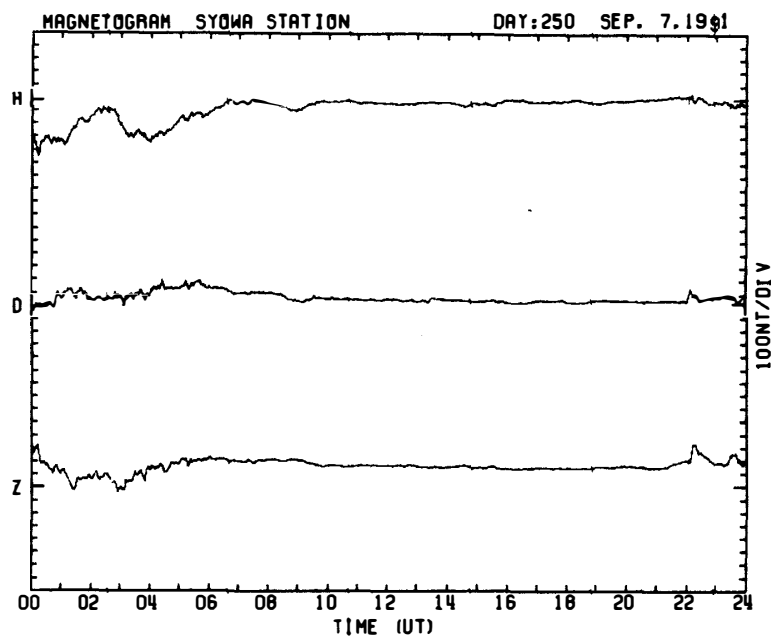
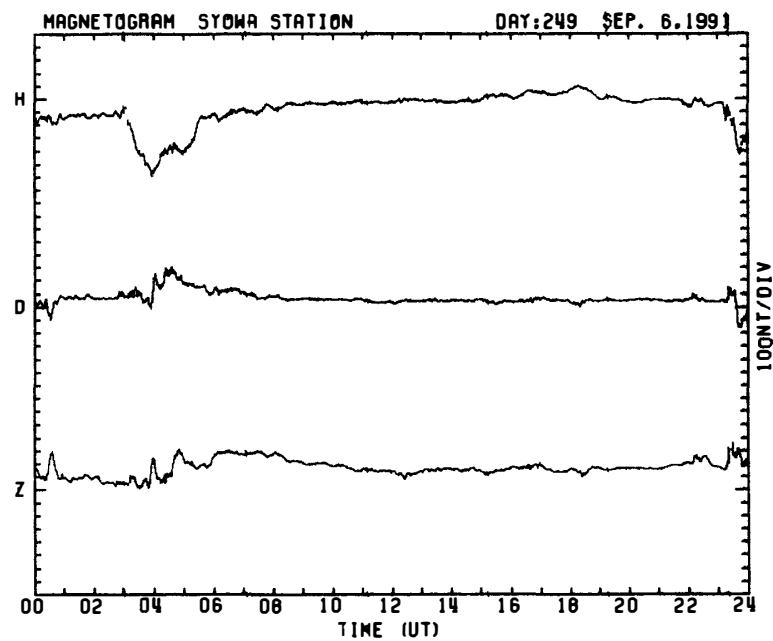
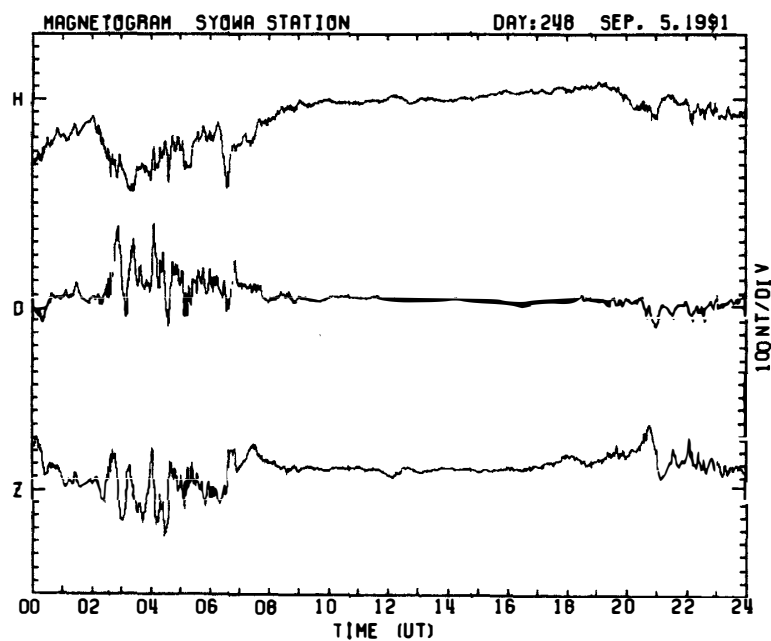


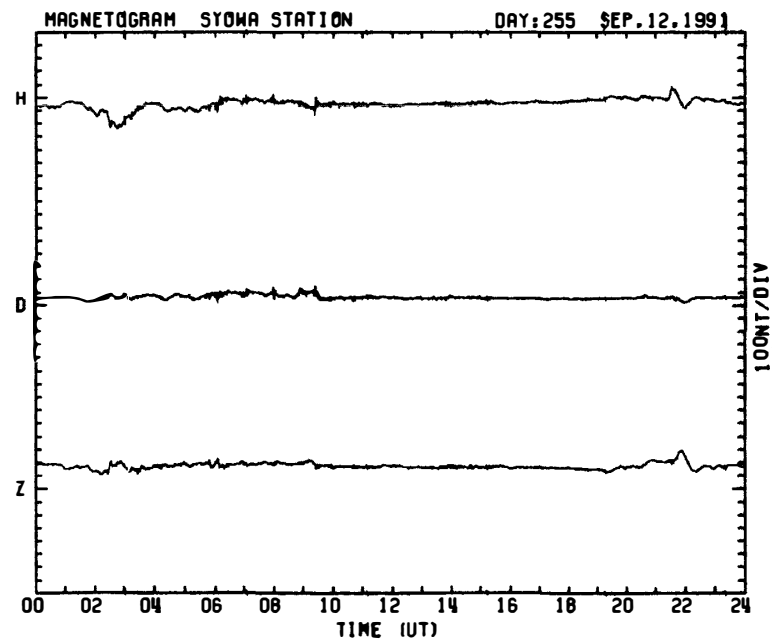
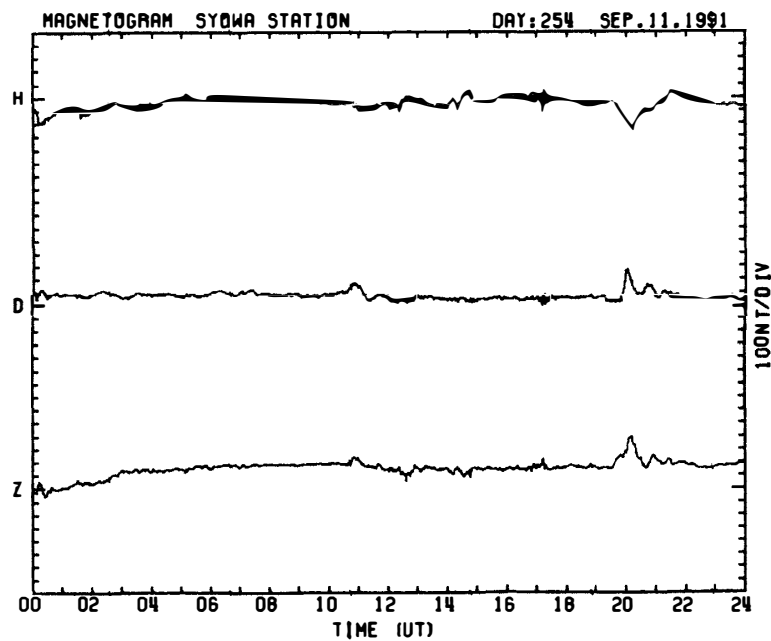
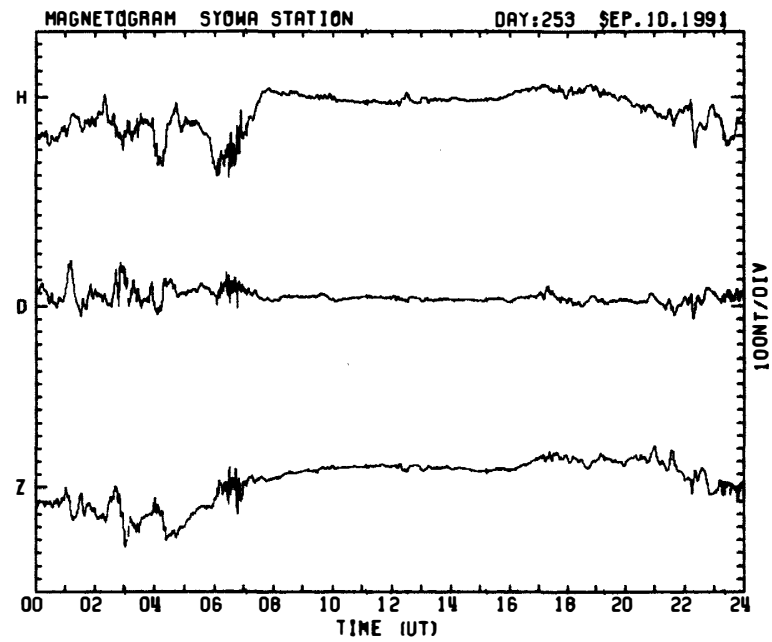
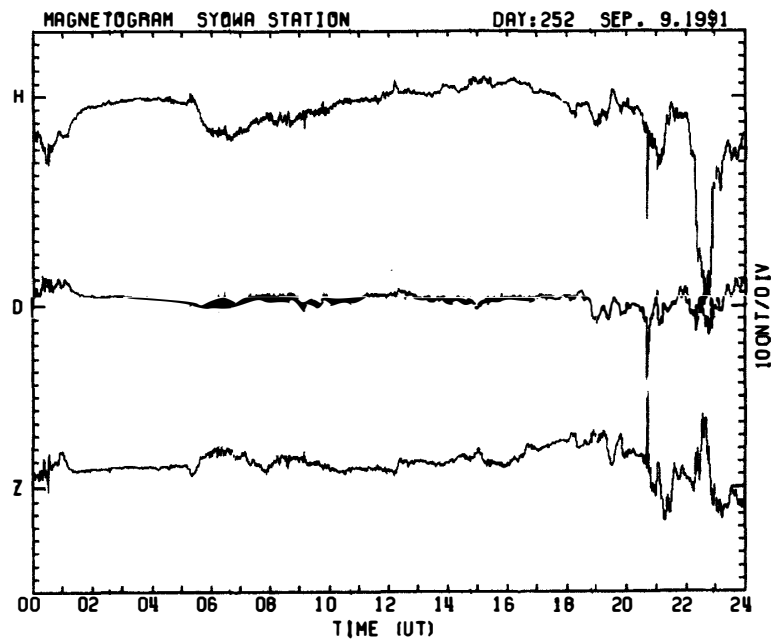


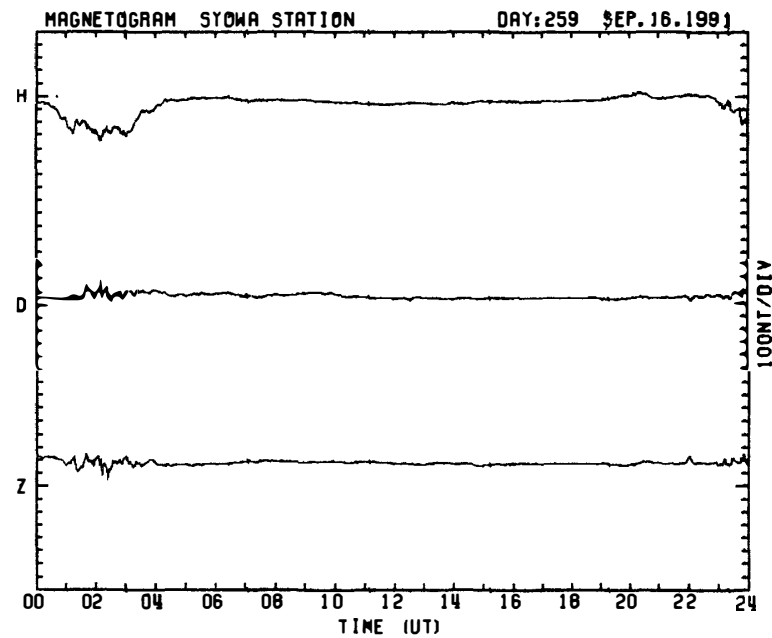
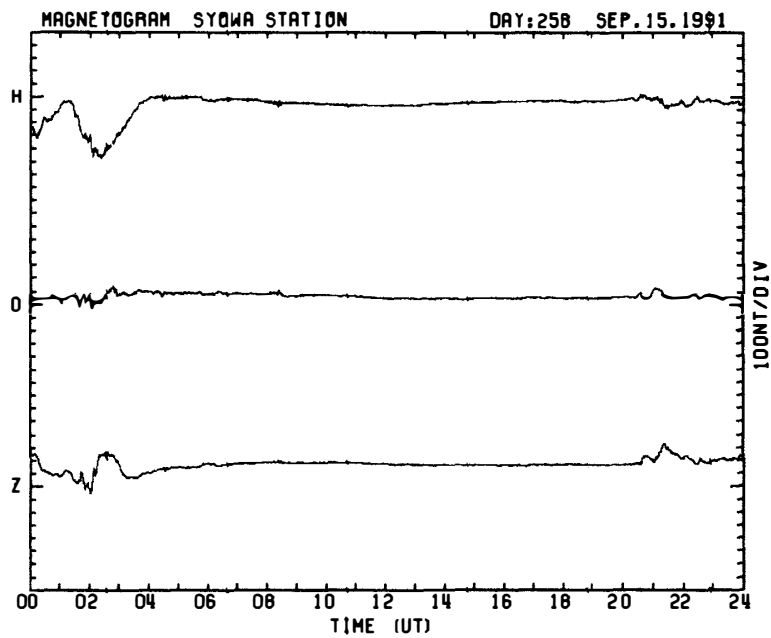
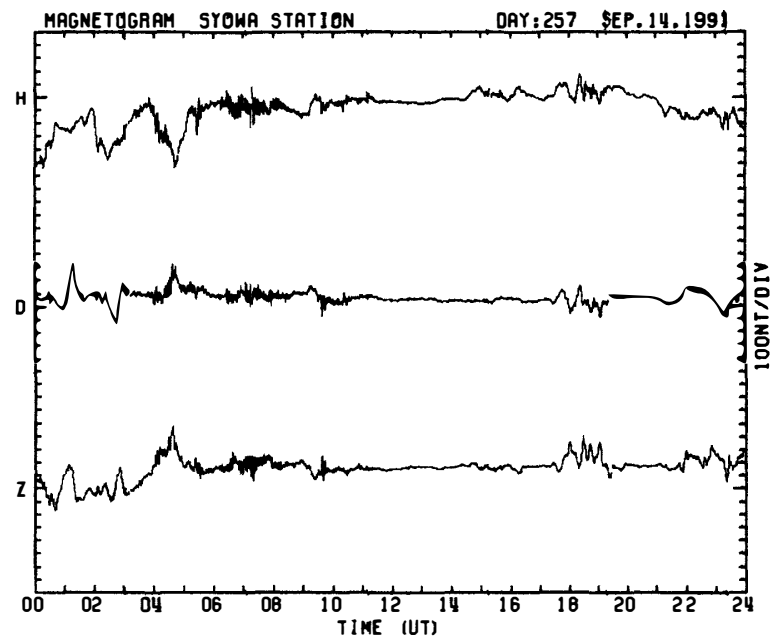
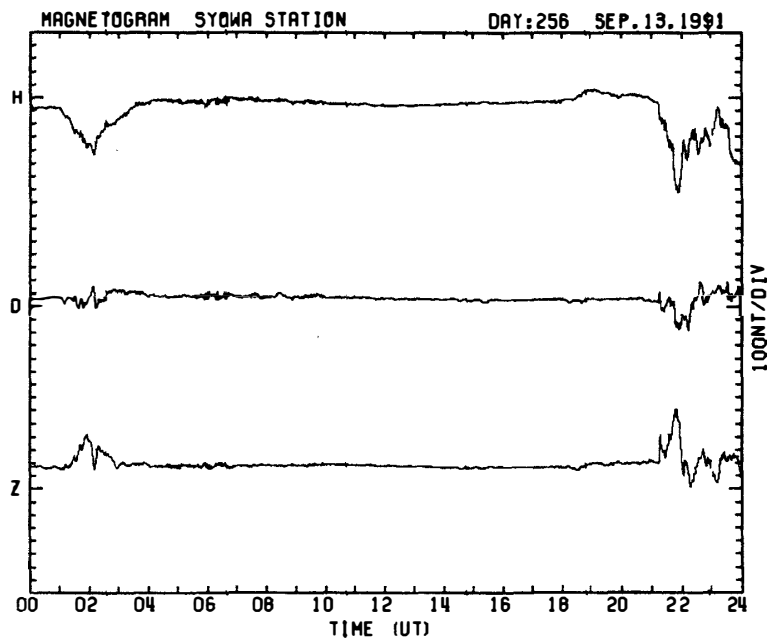


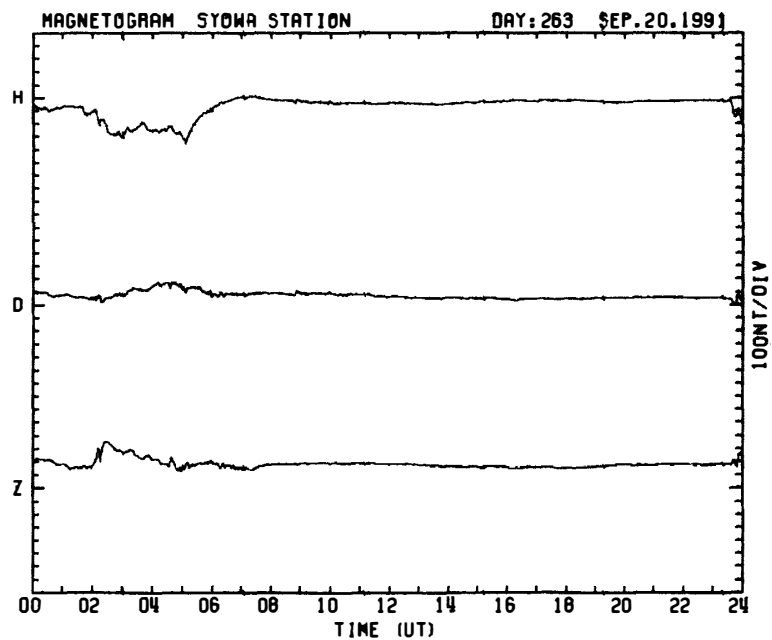
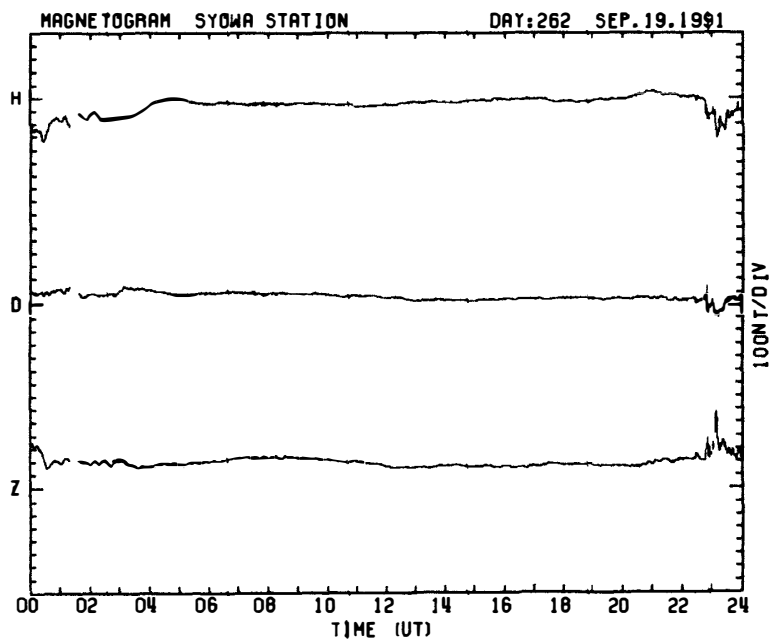
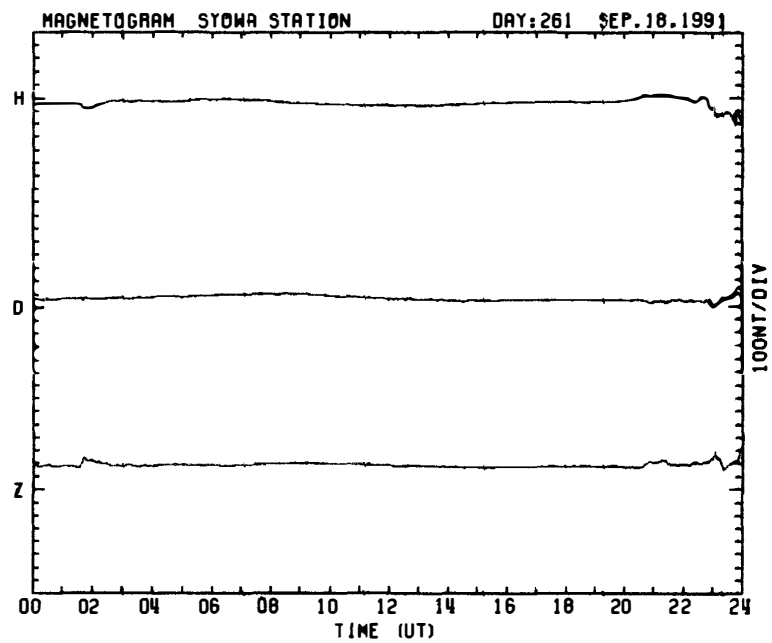
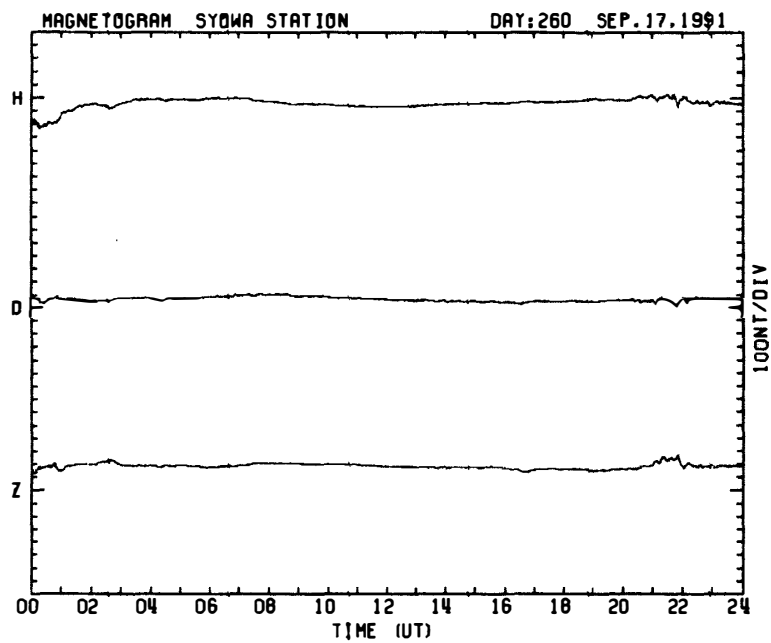


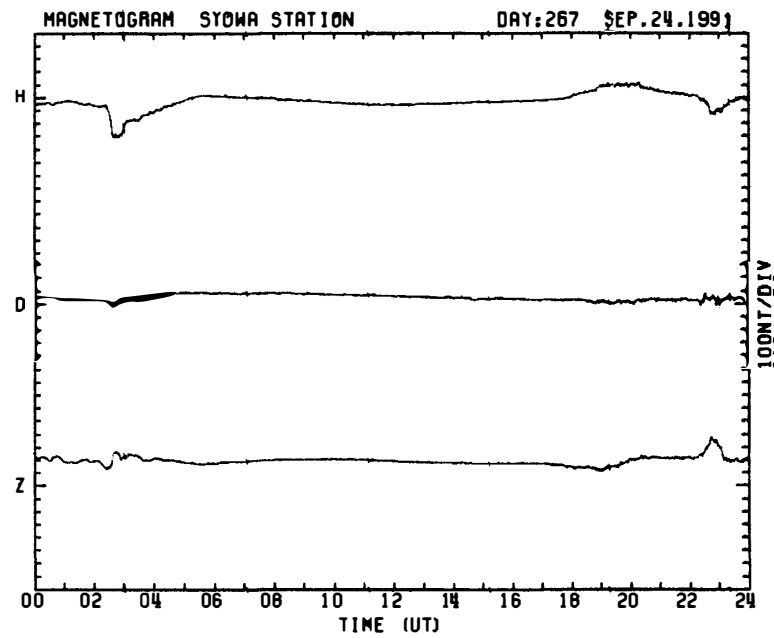
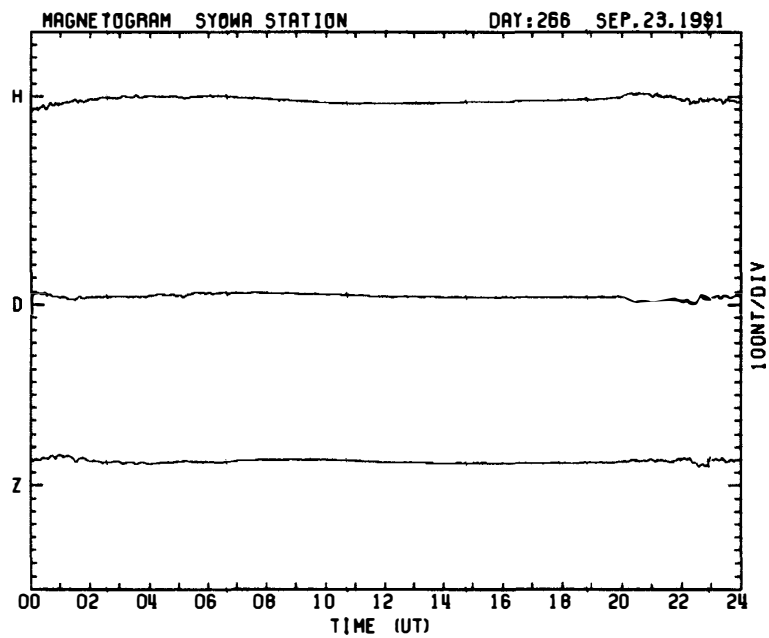
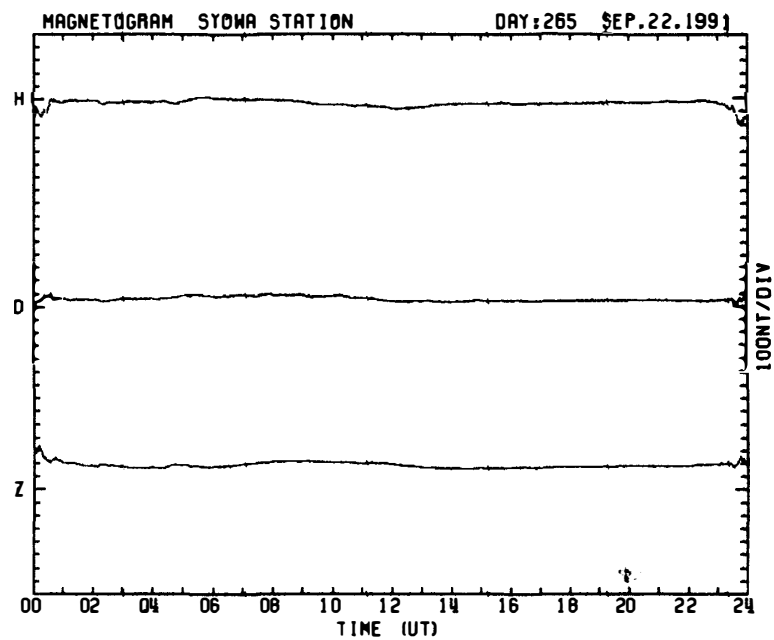
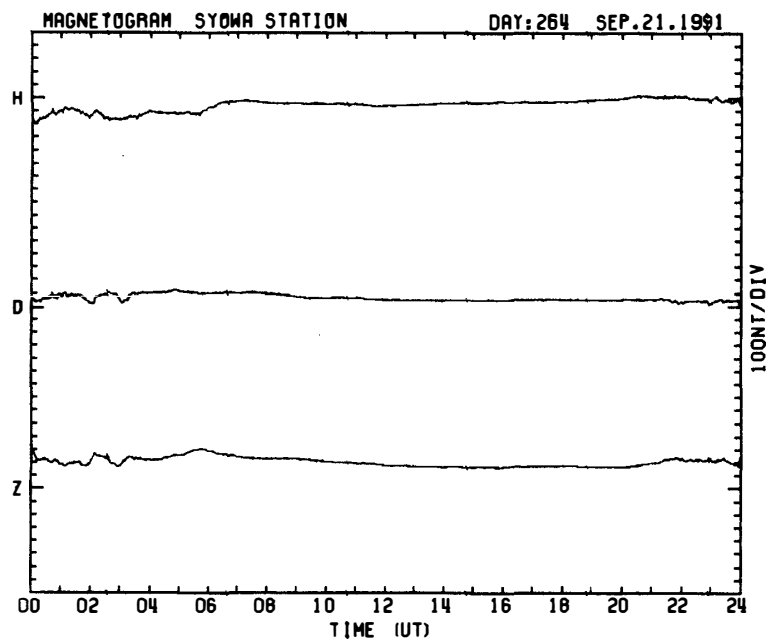


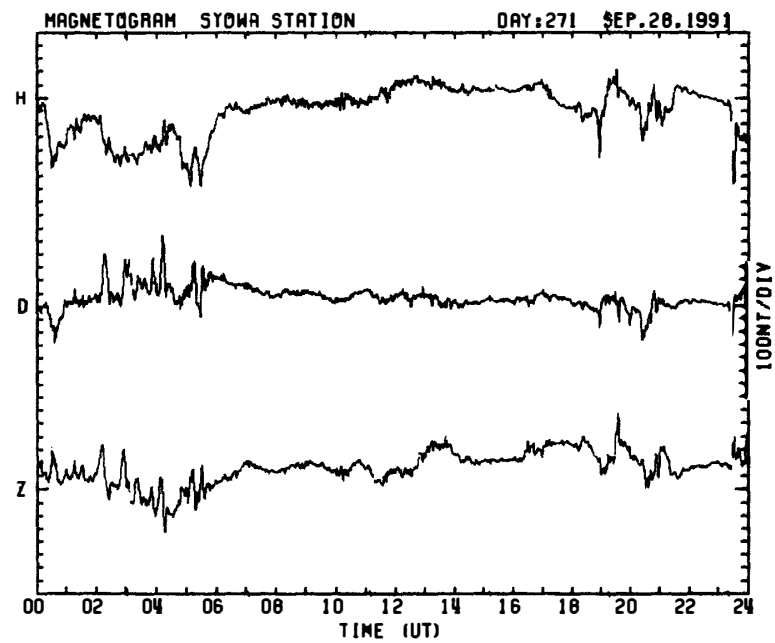
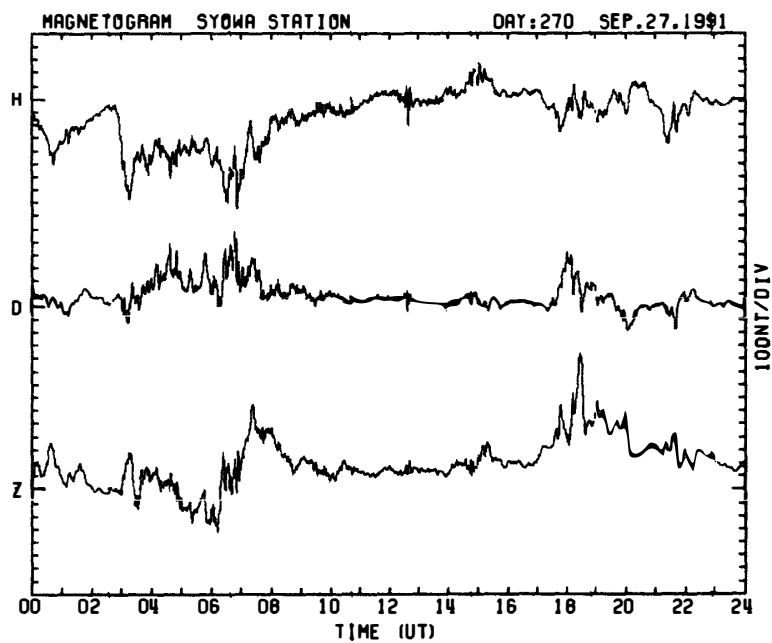
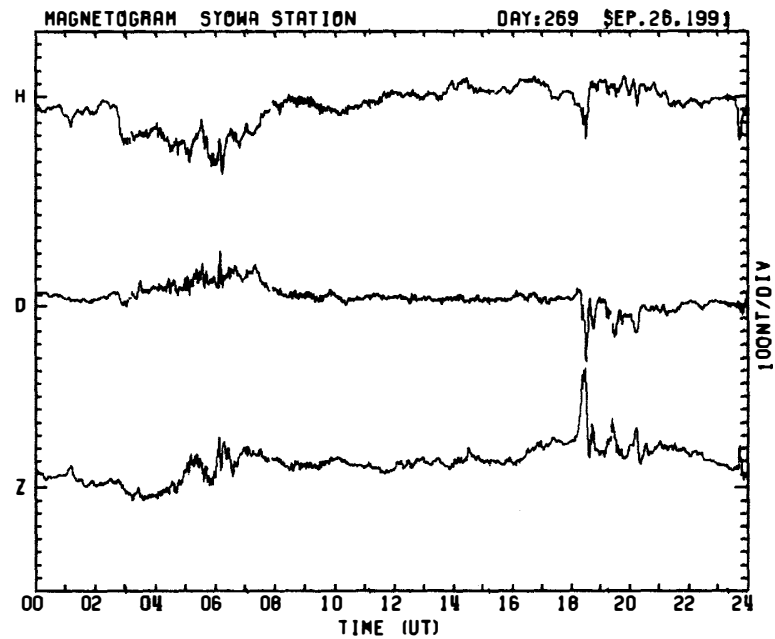
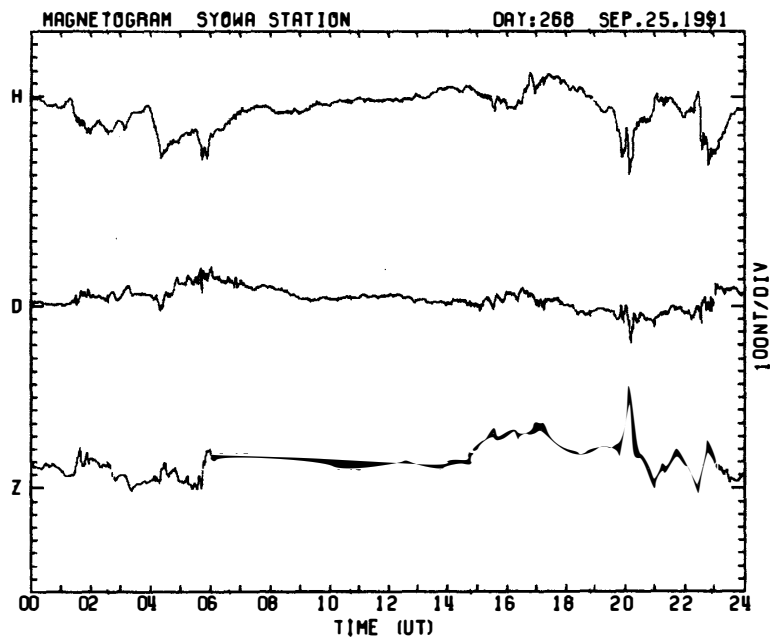


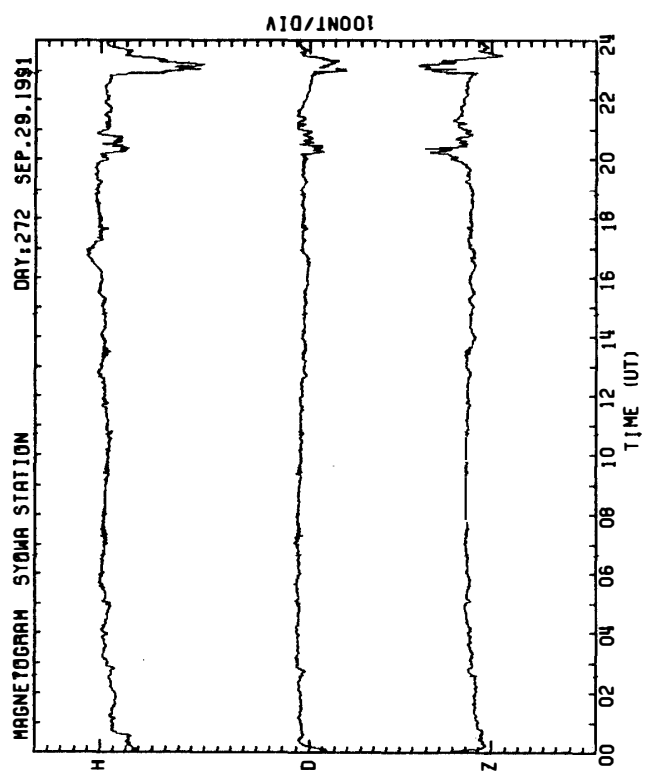
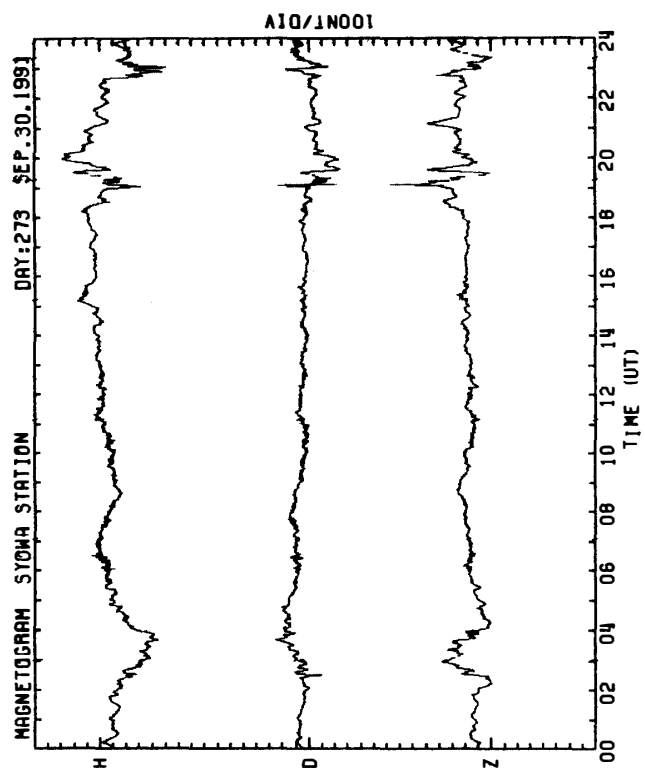


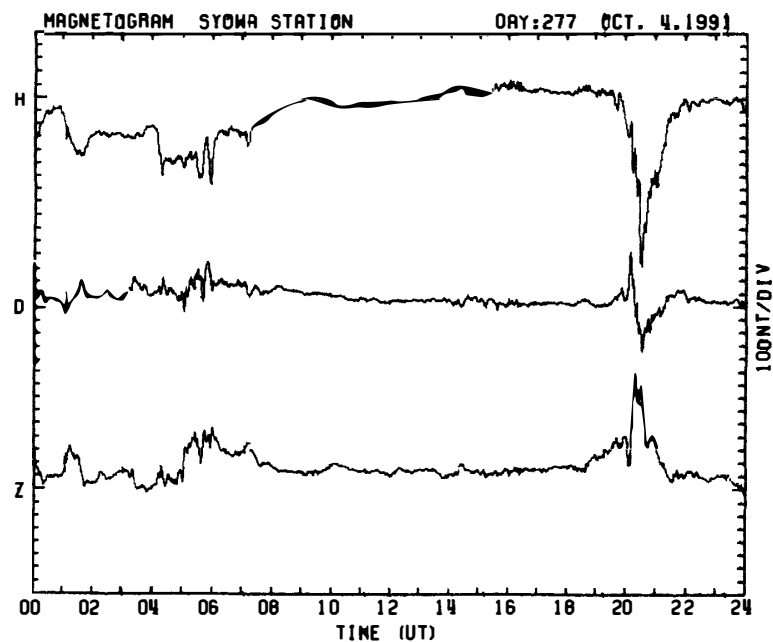
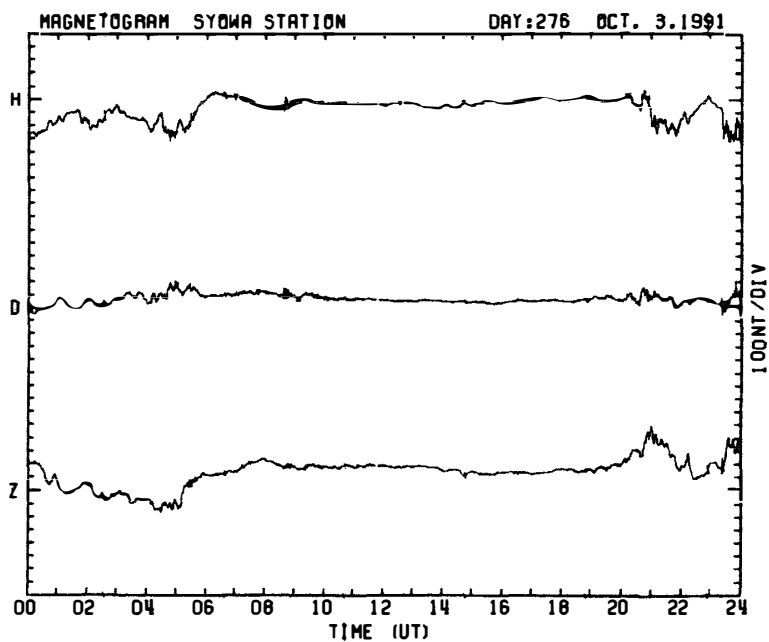
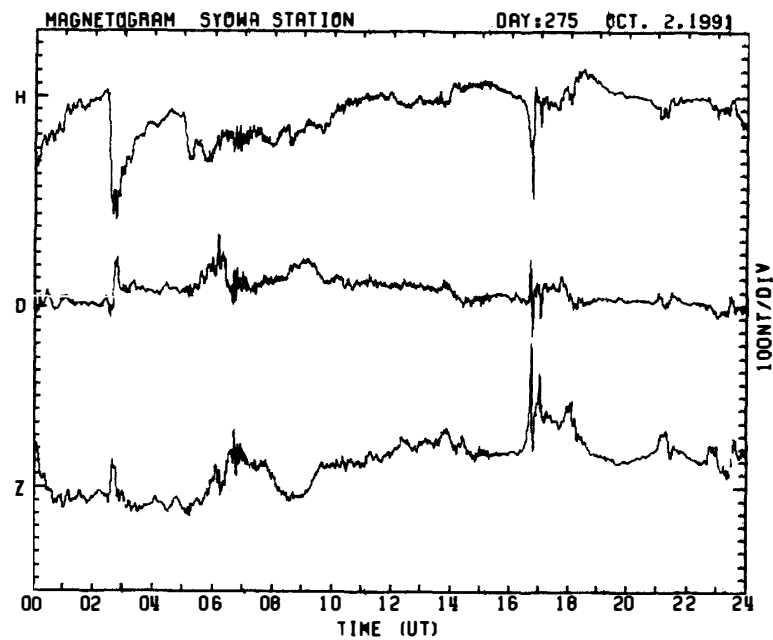
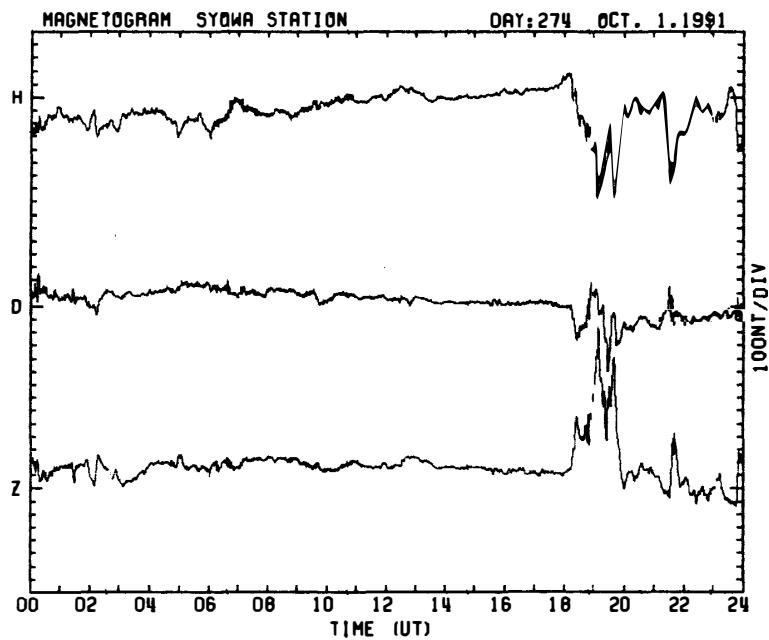


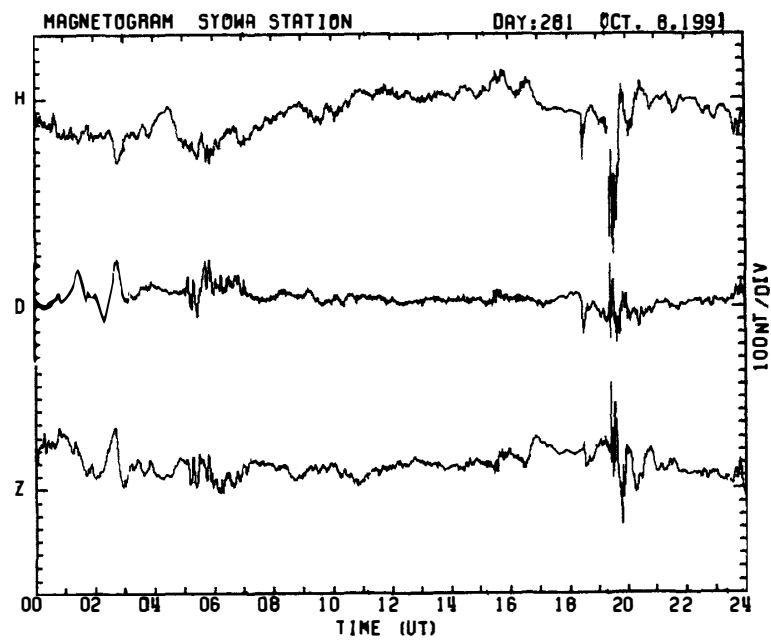
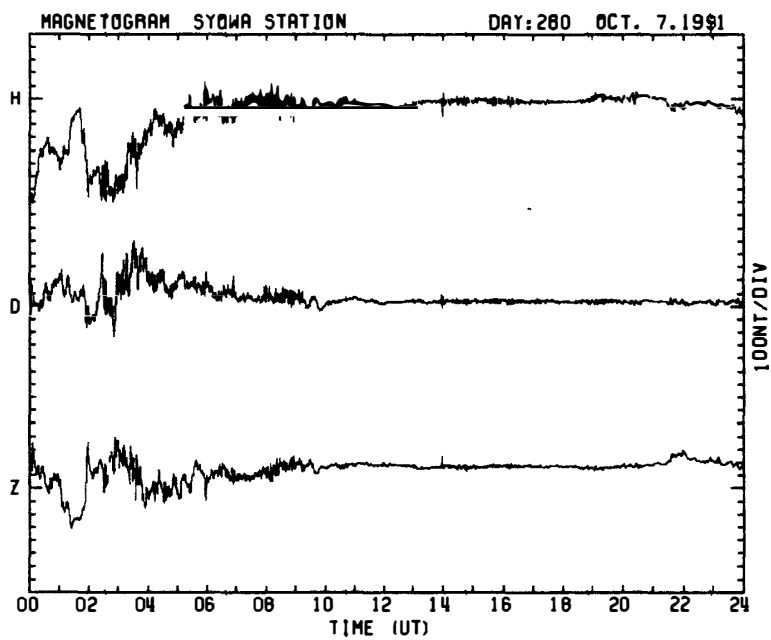
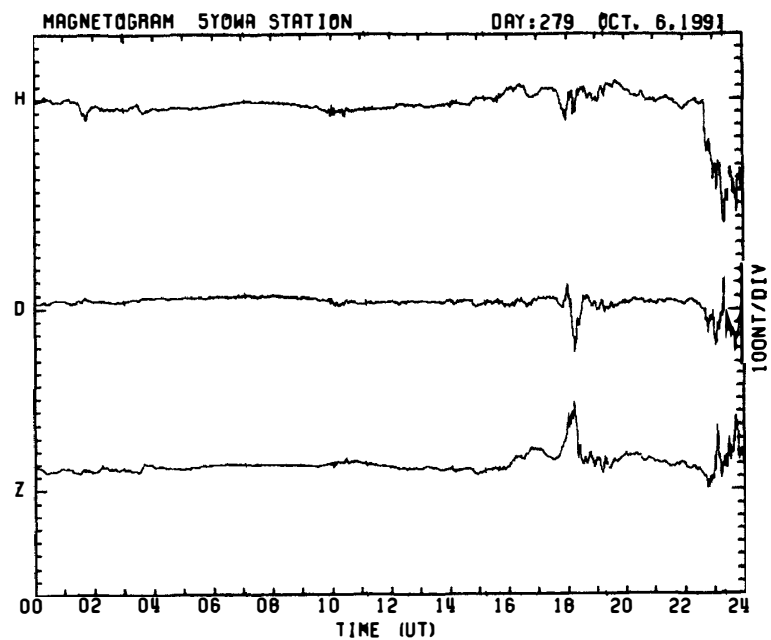
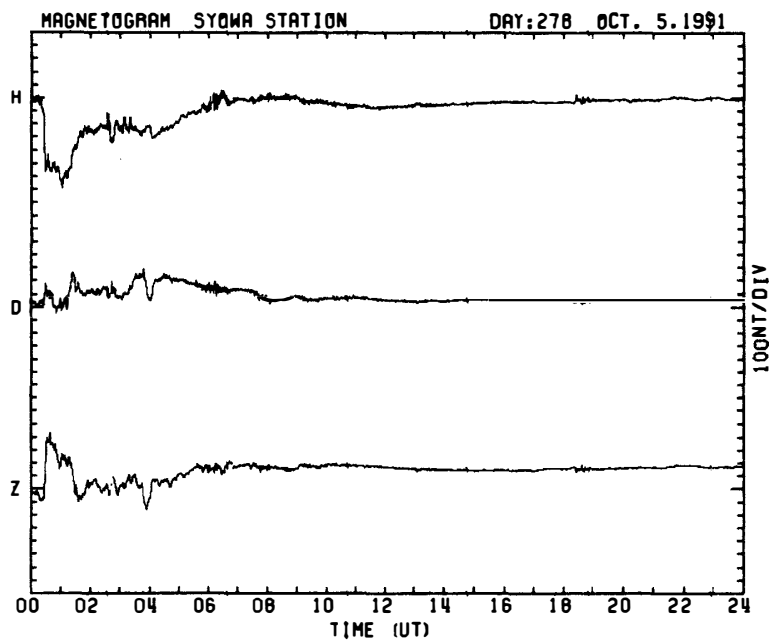


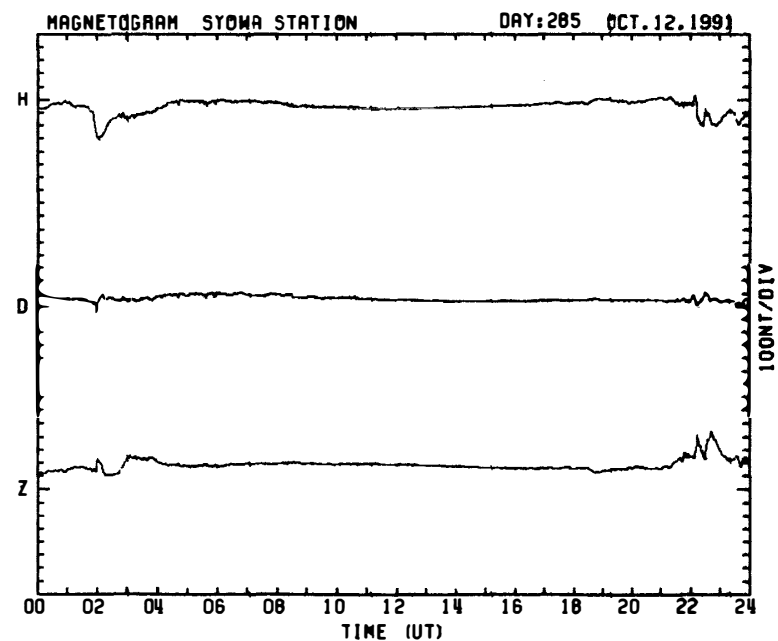
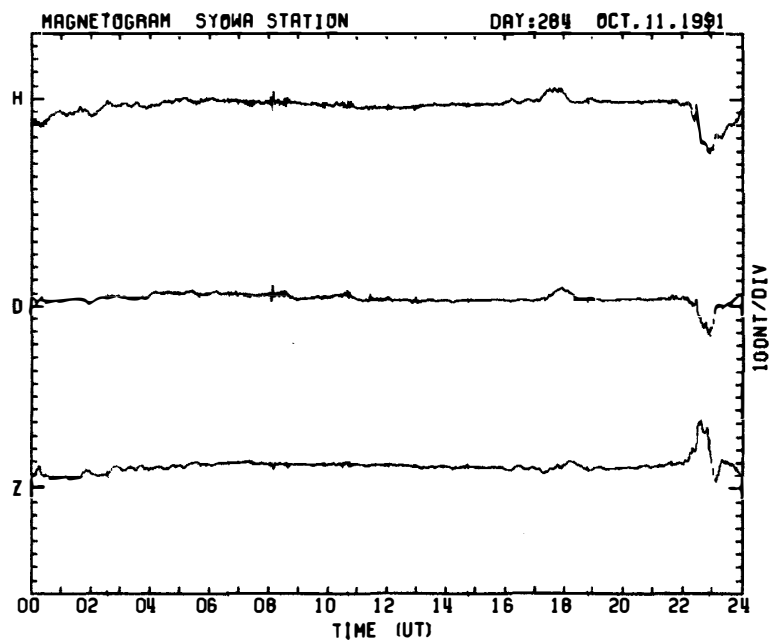
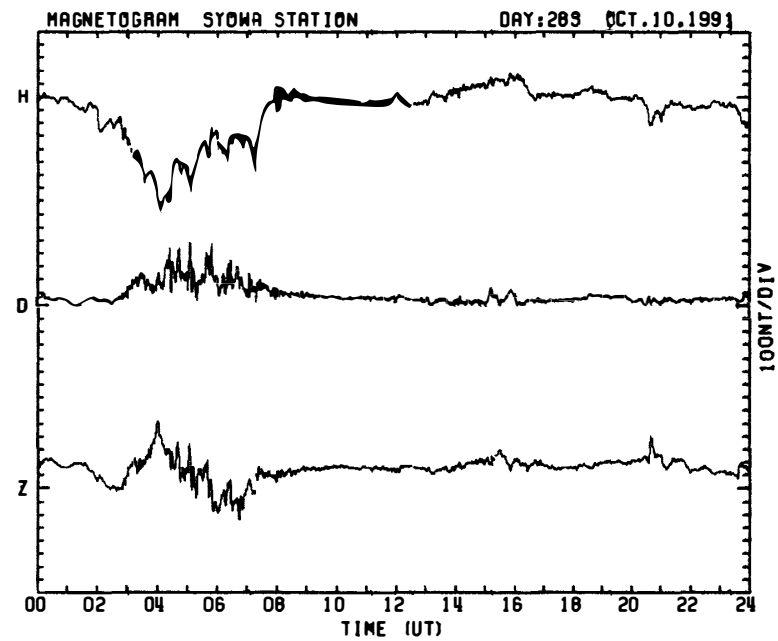
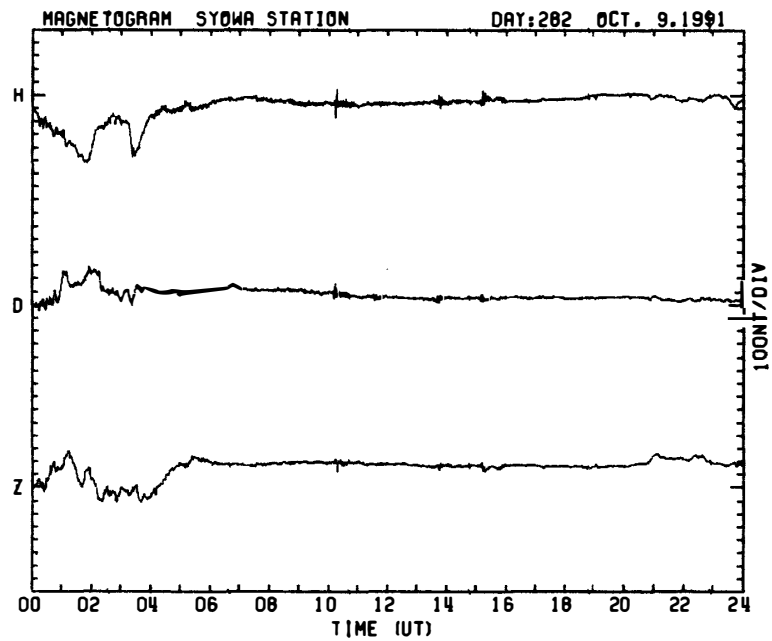


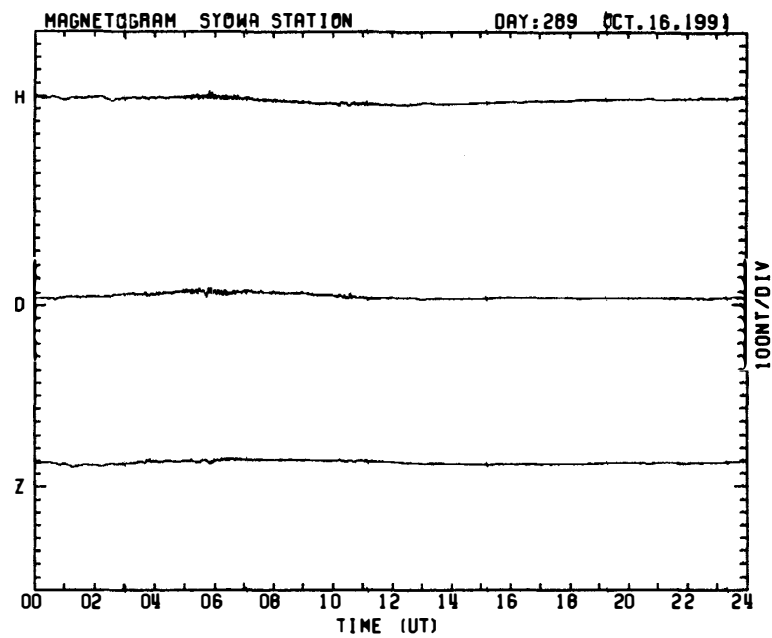
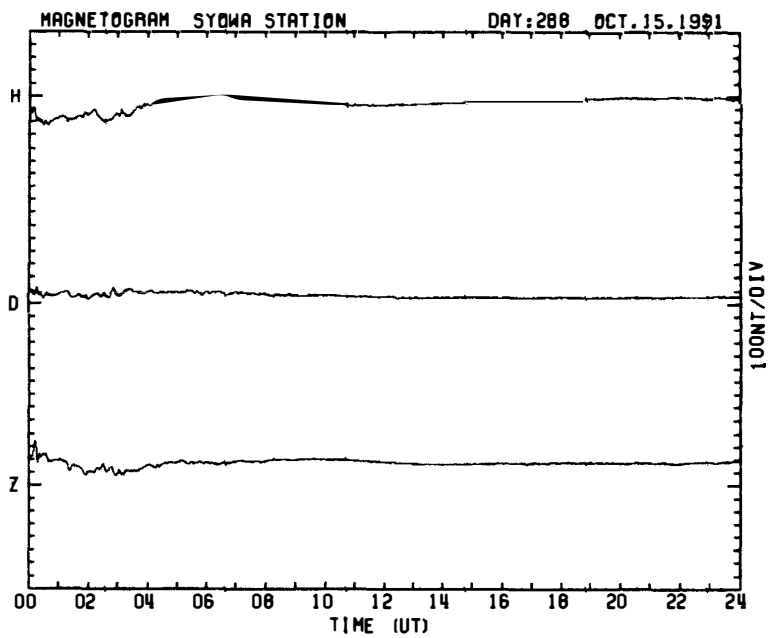
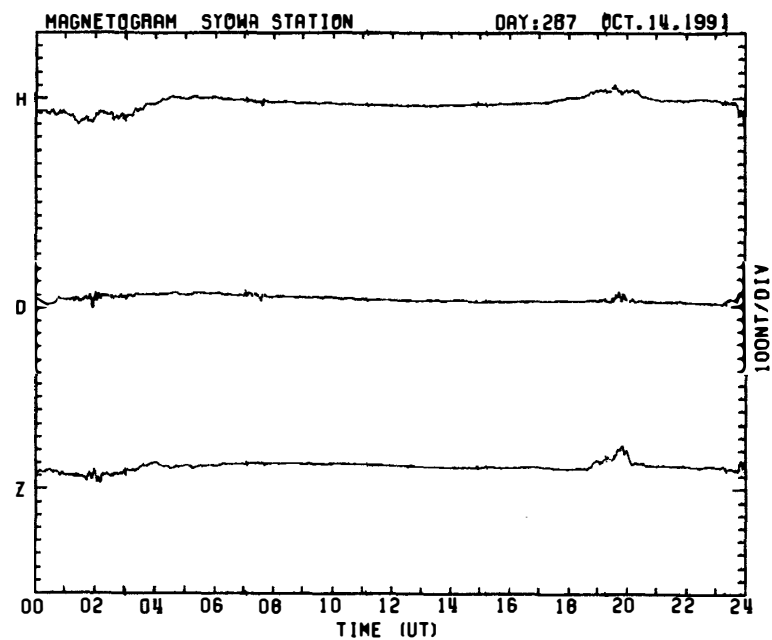
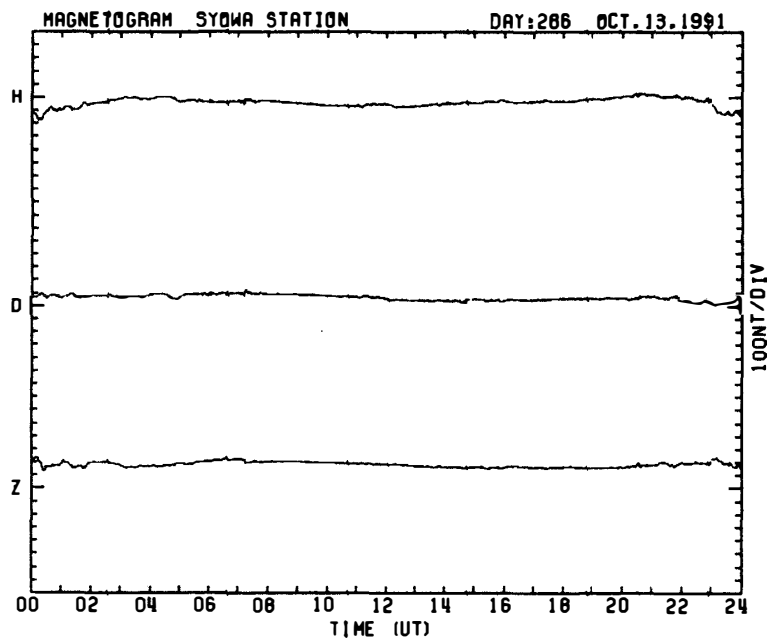


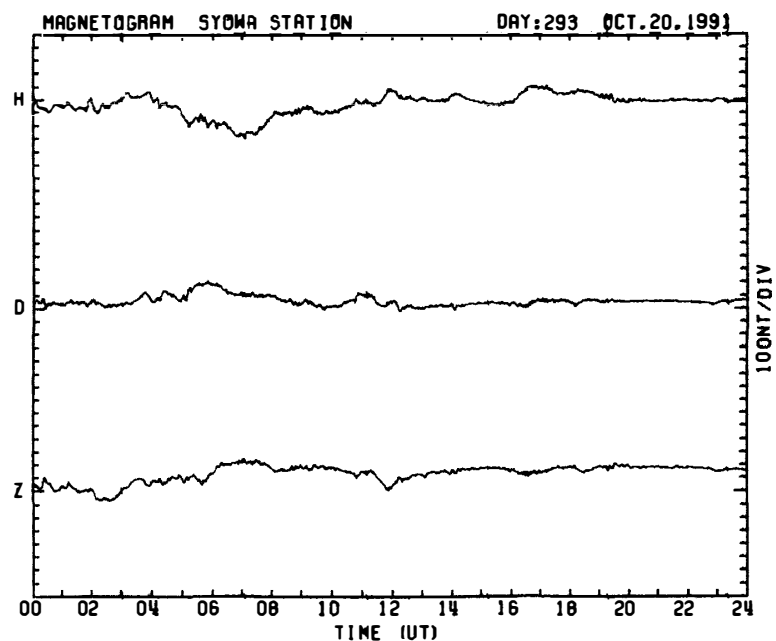
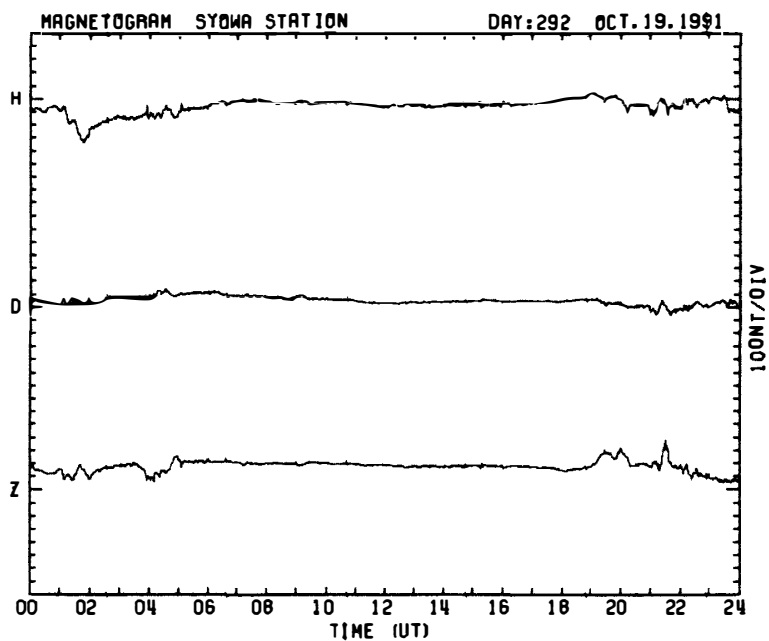
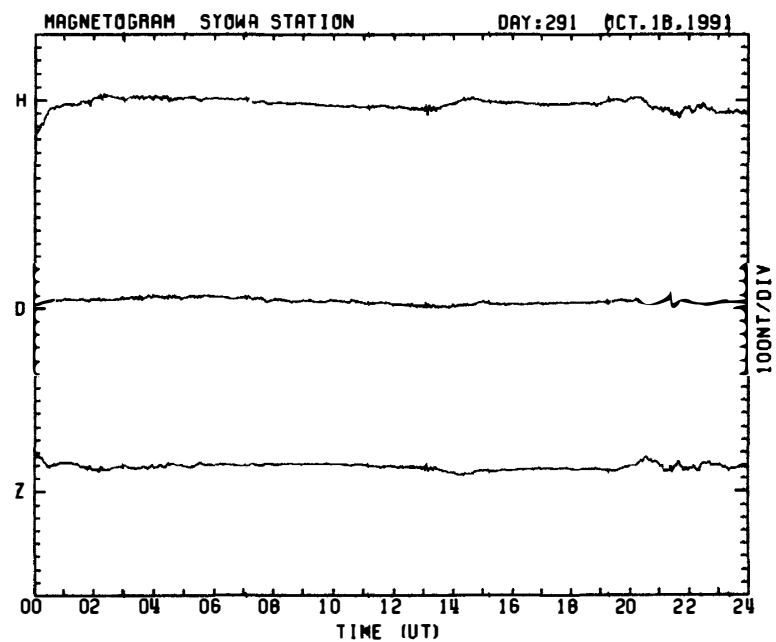
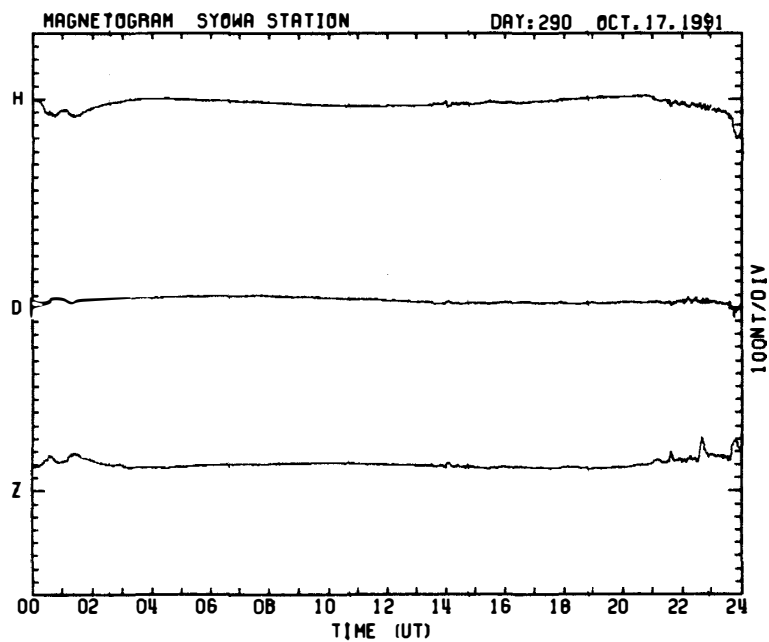


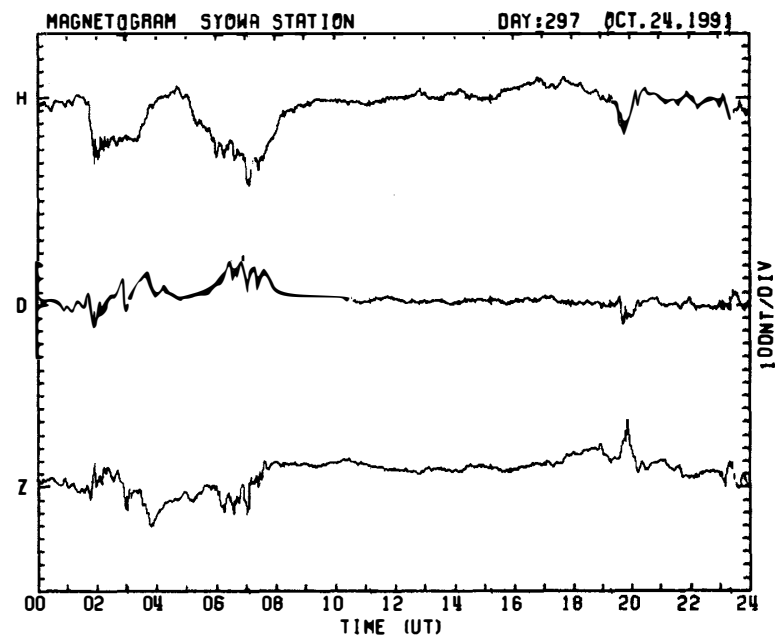
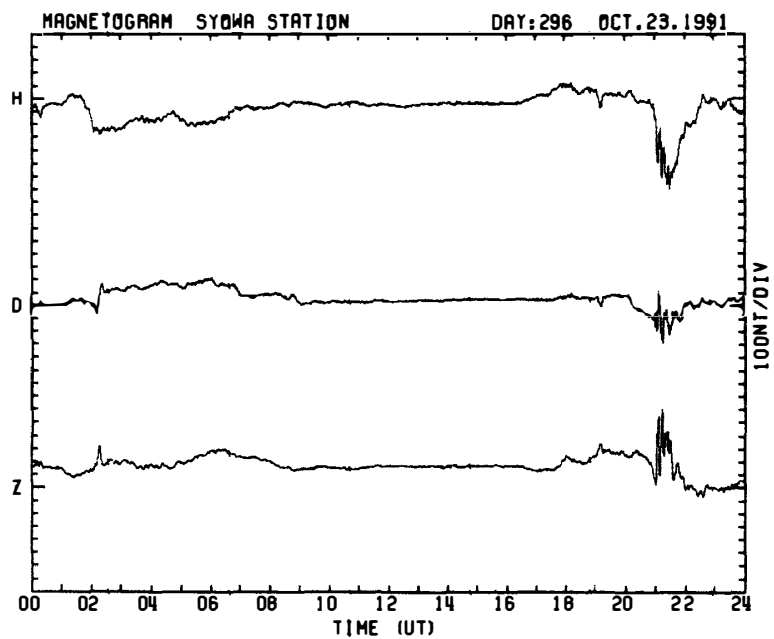
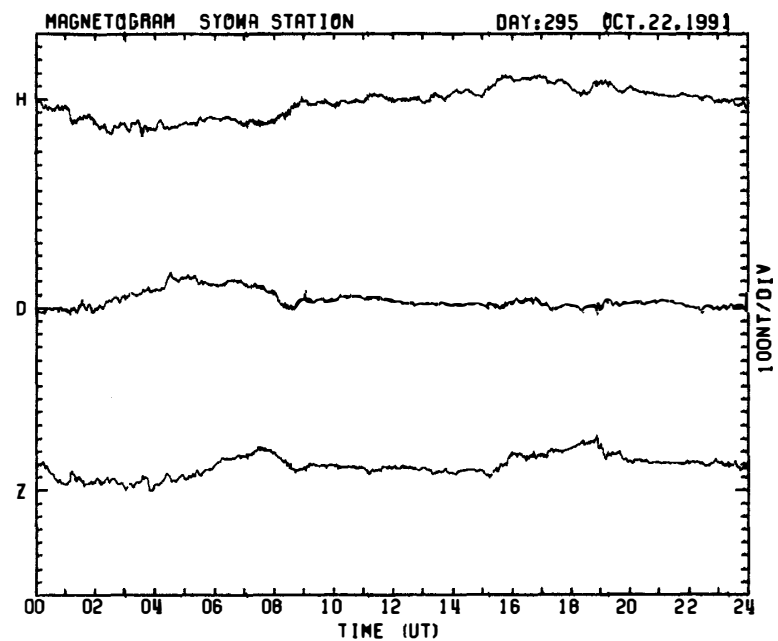
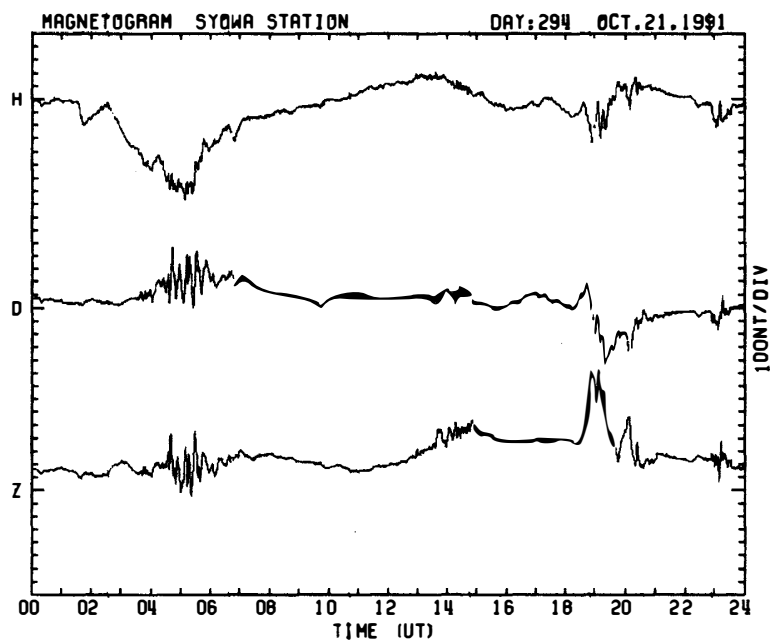


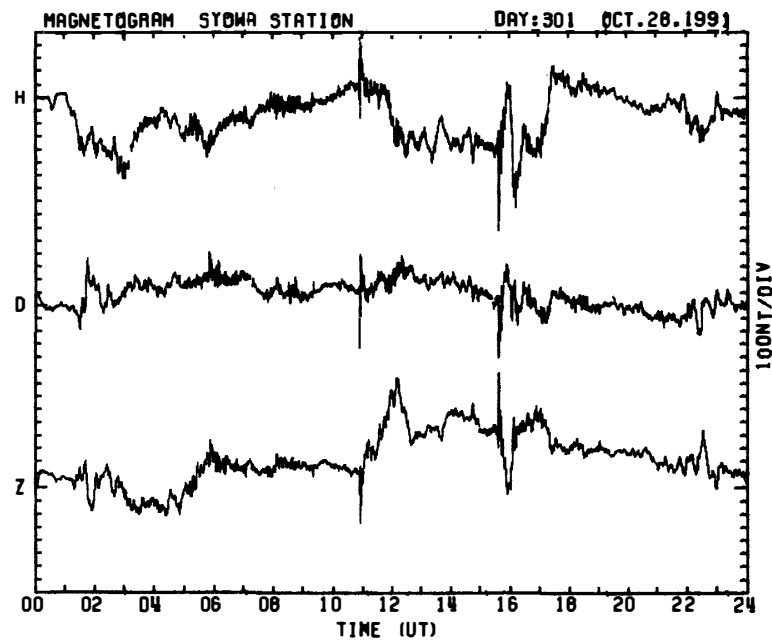
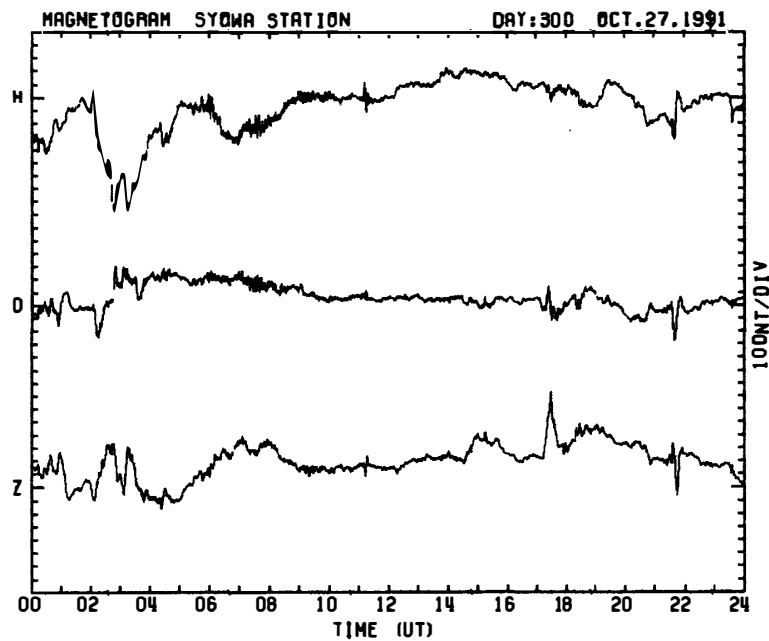
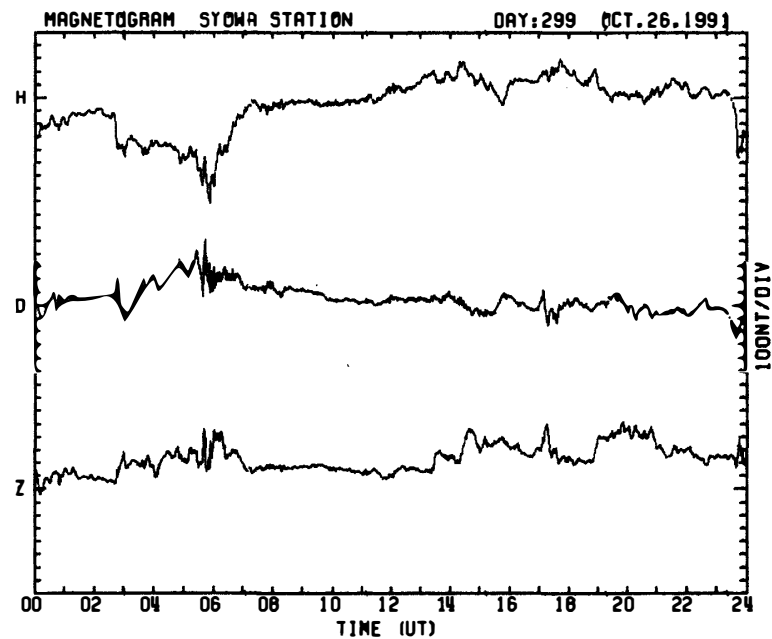
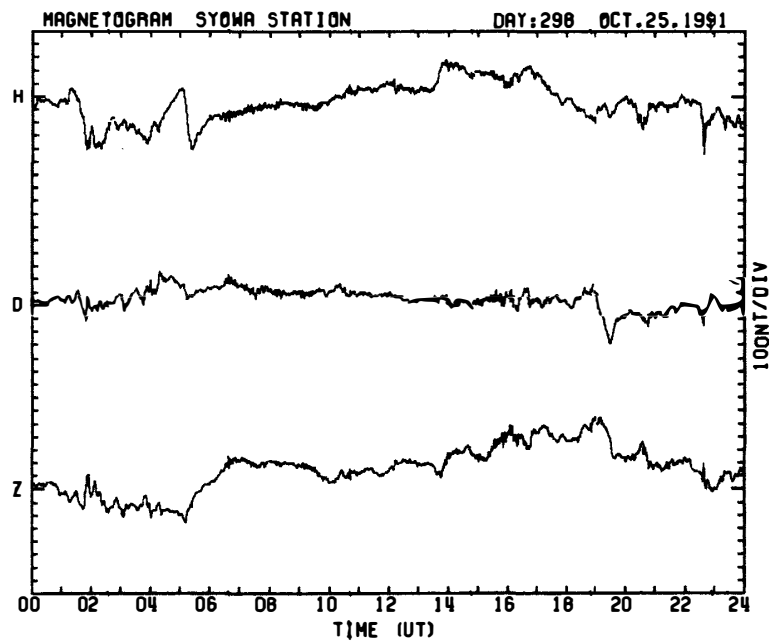


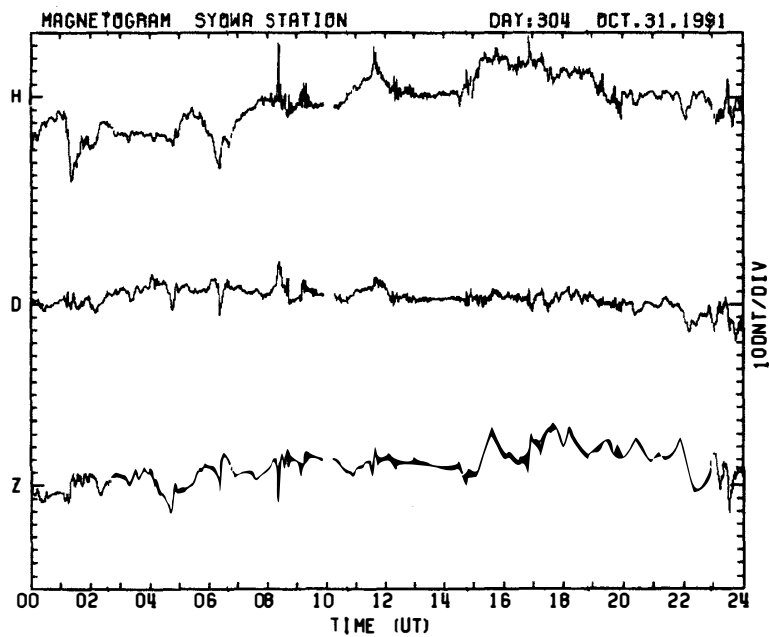
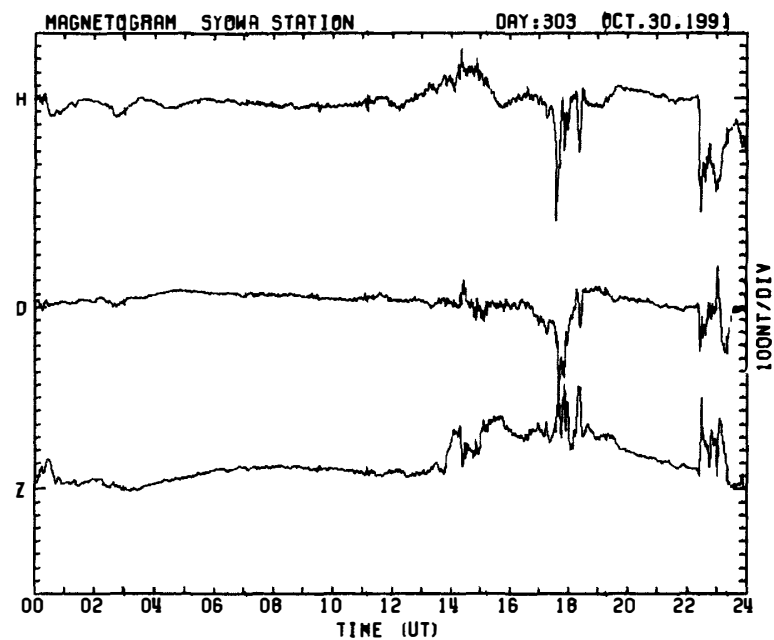
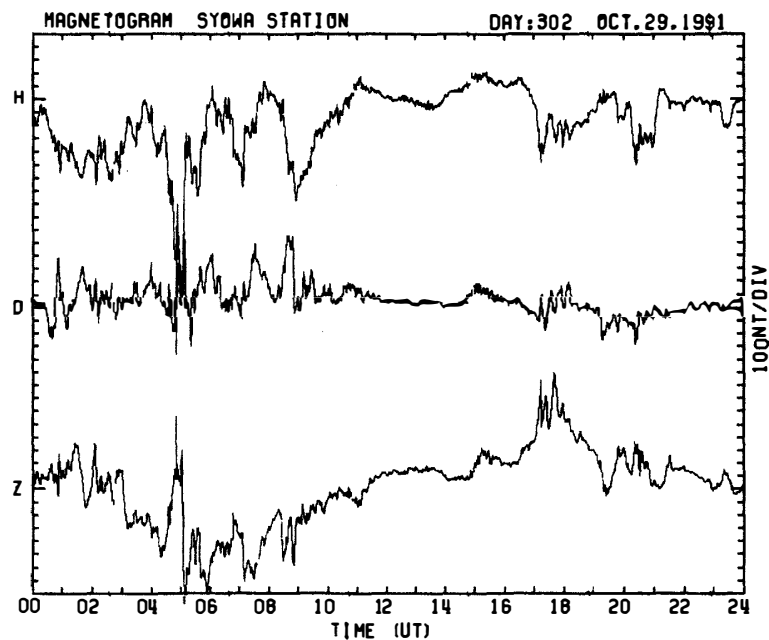












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