UPPER ATMOSPHERE PHYSICS DATA, SYOWA AND ASUKA STATIONS, 1988

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1. Introduction

This data book summarizes upper atmosphere physics data acquired by the "Upper Atmosphere Physics Monitoring Systems" at Syowa Station and Asuka Station in 1988. The items of observations at Syowa Station are as follows.

1) Geomagnetism: H-, D-, and Z-components of magnetic variations, Total force of the geomagnetic field, H-, D-, and z-components of magnetic pulsations.

2) ELF-VLF wave: Intensities at 0.35, 0.75, 1.2, 2, 4, 8, 30, 60 and 95 kHz, Wide-band (0-15 kHz) signal of ELF-VLF emissions.

3) Ionosphere : Cosmic noise absorption at 30MHz.

4) Aurora : Meridian scanning record at three wavelengths; OI 5577 Å, 6300 Å and H_β 4861 Å, Auroral intensity of N_2^+ 1NG 4278 Å in three directions (30° poleward, zenith and 30° equatorward).

The following are observation items for Asuka Station:

Geomagnetism: H-, D- and Z-components of magnetic variations,

H- and D-components of magnetic pulsations.

The Upper Atmosphere Physics Monitoring Systems were installed at Syowa Station in January 1981, and at Asuka Station in January 1987. An outline of the systems is given in Section 2. Section 3 presents 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 of January 1-December 31, 1988 for Syowa Station and Asuka Station are given in Appendix.

Digital tapes of the magnetograms and the summary plots of the monitoring data are available to users on 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 and the summary plots of the monitoring systems are available to scientists who cooperate the joint study of antarctic upper atmosphere physics. 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

A realtime digital data acquisition system of upper atmosphere physics was constructed at Syowa Station in January 1981 (Sato et al., 1984), and these data have been collected and published as 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), and this report forms the 8th volume of this series.

A block diagram of this system is shown in Fig. 1. The sensors for measuring weak natural electromagnetic waves such as ELF-VLF emissions, ULF magnetic pulsations and the cosmic radio noise absorption (CNA) were installed at a remote station on West Ongul Island located about 5 km apart from Syowa Station in order to avoid man-made electromagnetic interferences. The date of magnetic pulsations and CNA were transmitted to Syowa Station by a PCM telemeter in UHF band. Wide-band signals of ELF-VLF emissions were transmitted to Syowa Station by an FM telemeter in VHF band. The specifications of these telemeters are as follows:

	UHF telemeter	VHF telemeter
Modulation	: PCM	FM
Carrier frequency	: 1859 MHz	240 MHz
Transmitter power	: 0.4 W	0.4 W
Antenna	: Parabola (1mφ)	Yagi(7 elements)
Max. deviation	: 200 kHz	125 kHz
VCO stability	: better than 1%	better than 1%
VCO linearity	: better than 1%	better than 1%
Carrier spurious	: less than -30 dB	less than -30 dB

The electric power of the remote station has been supplied by a solar rechargeable battery system with the maximum output power of 530 W since February 1985. An additional solar battery system with the maximum power of 365 W was installed in January 1987 to reinforce the battery system in remote station. During the months of polar night, the rechargeable batteries with the capacity of 2000 Ah were charged up once a month by a 16 kVA diesel-engined dynamo.

At Syowa Station, the sensors of fluxgate and proton magnetometers were set up about 150 m apart from the data processing building. The meridian scanning photometer and three-direction photometers were placed on the roof of the date processing building. The data acquisition facilities were installed

inside the data processing building. All the outputs from the observation instruments were supplied to a switching matrix terminal board before they are fed to pen recorders, analog data recorders, and the MELCOM 70/25 computer system. Two sets of the TEAC DR-200 digital data logger system were installed next to the MELCOM 70/25 system as backup machines since January 1987, and recorded almost the same data simultaneously.

Analog data recordings are quite useful for studying wave phenomena in the ELF-VLF frequency range. For example, one roll of standard 3600 ft audio tape can record VLF emissions up to 15 kHz over 6 hours, while the recording time of standard 2400 ft digital tape is only 15 min if the recording density is 6250 BPI. The dynamic spectra of ELF-VLF emissions were obtained by FFT (Fast Fourier Transform) spectrum analyzer, then supplied to the MELCON 70/25. All the data were recorded with correct universal time supplied from a precise timekeeping system. This system consisted of NNSS satellite timing receiver, a quartz frequency standard with a stability of 2×10^{-11} /day, and a time code generator. The time code generator supplied IRIG-A, -B, -E and slow code for analog data recorders and 36-bit BCD code to the computer. The absolute accuracy of this system is about 1 ms. The timer in the computer is synchronized to the timekeeping system with a 10 kHz clock signal.

2.2. Asuka Station

The wintering observations for upper atmosphere physics have started from February 19, 1987 after constructions of the observation building and other facilities at Asuka Station. This volume, therefore, contains the second data set acquired at Asuka Station through a year.

A block diagram of the upper atmosphere physics monitoring system is shown in Fig. 2. Sensors of an induction and a fluxgate magnetometers were fixed under snow at the locations approximately 150 m southeast of the observation building. A loop antenna (1 m x 1 m square) in order to receive

omega signals for a time code generator was also set up about 50 m southeast apart from the observation building.

Outputs from the induction and the fluxgate magnetometers 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 simultaneously. 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 date 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 was ±2500 nT, and the frequency response was DC - 2 Hz. The noise level was less than 0.5 nT. The H-, D-, and Z-components of the magnetometer were supplied to a computer with sampling rate of 1 Hz. The H-component of the magnetometer was also recorded by a long-term analog data recorder, R-950L.

Continuous computer plots of magnetogram in the period of January 1 to December 31, 1988 are given in Appendix. In these plots, positive signs of the H-, D-, and Z-components indicate northward, eastward and upward, respectively. One division of the vertical axis corresponds to 100 nT.

(2) Total force of the geomagnetic field

The total force of the geomagnetic field (F) was continuously measured by a proton magnetometer. The observation range was 0 - 65000 nT, and the frequency response was up to 0.2 Hz. The noise level was less than 0.2 nT.

The digital output signals were recorded on digital magnetic tapes (MELCOM 70/25) with a sampling frequency of 0.1 Hz.

(3) ULF magnetic pulsations

The H-, D-, and Z-components of ULF magnetic pulsations were detected by three sets of search coil magnetometers. The search coil sensors had permalloy cores wound by copper wire (0.4 mmΦ, 40000 turns). The permalloy core had a dimension of 1 cm in diameter and 100 cm in length. The detectable intensity range of the magnetometer was 0.001-5 nT/s, and the frequency range 0.001-3 Hz. The search coil magnetometers were set at the remote station on West Ongul Island. The output signals from the telemetry receiver were supplied to a long-term analog data recorder R-950L, MELCOM 70/25 and TEAC DR-200 digital data recorders. The recording period on R-950L is listed in Table 1. The sampling frequency of the digital data was 1 Hz for each component.

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

The ordinary magnetogram was available also on chart papers with a recording speed of 5 cm/h. The sensitivities of the H-, D- and Z-components on the chart papers are 118 nT/cm, 100 nT/cm and 111 nT/cm, respectively. According to the maximum deviations of the H-component from its quiet-day baseline, K-indices were calculated for each 3-hour interval by using the following scale.

K-index	Deviation	K-index	Deviation
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 and 3 give the baseline values and K-indices at Syowa Station in 1988. 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 receiving site of natural ELF-VLF electromagnetic waves was located at the remote station in order to avoid man-made electromagnetic interferences. The ELF-VLF receiving system at the remote station comprised a triangle-shaped three turn loop antenna (10 m in height, 20 m in the length of the bottom side), a pre-amplifier and a main amplifier. The gains of the pre- and main amplifiers were 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 measured by using a 9-channel filter bank and detector units. The ELF-VLF emissions within the intensity range of 10^{-17} to 10^{-13} W/m^2 Hz were detected by this system. These data were supplied to the MELCOM 70/25 system with a sampling rate of 0.5 Hz.

The wide-band ELF-VLF signals up to 15 kHz were recorded on audio tape recorders. The wide-band signals were also supplied to an FFT spectrum analyzer, and the spectra in the frequency range of 0.1 - 2 kHz and 0.1 - 10 kHz were obtained every 10 min. These dynamic spectral data were also send to the computer. Some examples of the computer plots of ELF-VLF wave intensities and frequency-time spectrograms were shown by Sato et al. (1984).

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. The riometer was also installed at the remote station. The riometer data were supplied to the MELCOM 70/25 system with a sampling rate of 0.5 Hz.

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

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

3.1.4. Aurora

(1) Meridian scanning photometer

The auroral photoemission at the wavelengths of OI 5577 Å, 6300 Å and H_β 4861 Å, which are typical emission lines in electron and proton auroras, were observed by a new meridian scanning photometer installed in 1987. The interference filter for H_β was tilted with 1 s period to measure a doppler effect of the auroral H_β emission. The field of view of the photometer was 3° for 5577 Å and 6300 Å , and 5° for H_β. The scanning from the poleward horizon to the equatorward horizon required 30 s. The meridian scanning photometer had a digital interface to the TEAC DR-200 system for recording on digital magnetic tapes with a sampling frequency of 1 Hz.

(2) Three-direction photometer

A three-direction photometer detected 4278 Å emission at three zenith angles (zenith, 30° poleward and 30° equatoward). The field of view was 5°. The measurable auroral intensity was within the range from 7 R to 28 kR. The output signals were supplied to both the MELCOM 70/25 and the TEAC DR-200 with

a sampling rate of 1 Hz. Some examples of the auroral photometric observations were given by Ono et al. (1986).

(3) All-sky camera

Black and white all-sky aurora images were observed by 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 between February 28 and October 8, 1988, as given in Table 4. Inquiries or requests for the all-sky data copies should be addressed to World Data Center C2 for Aurora of NIPR.

3.2. Asuka Station

3.2.1. Magnetogram

Magnetic variations ware measured by a three-axis fluxgate magnetometer (SHIMAZU MB162), the same type as used at Syowa Station. The full-scale range was ± 2500 nT, and the frequency response was DC-2 Hz. The noise level was less than 0.5 nT. 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 0.5 Hz.

Continuous computer plots of magnetogram in the period of January 1 to December 31, 1988 are given in Appendix along with the magnetograms at Syowa Station. In these plots, positive signs of the H-, D-, and Z-components indicate northward, eastwartd and upward, respectively. One division of the vertical axis corresponds to 100 nT.

3.2.2. ULF magnetic pulsations

The H- and D-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 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 recording period on R-950L is listed in Table 5. The sampling frequency of the digital data was 0.5 Hz for each component.

4. Compiled Digital Tape Format

4.1. Syowa Station

4.1.1. MELCOM 70/25 data format

The digital magnetic tape outputs from MELCOM 70/25 minicomputer were compiled in a simplified form with HITAC M-260 computer system of the Information Processing Center, National Institute of Polar Research. The specifications of the complied digital tapes are as follows.

Track	:	9
Record density	:	6250 BPI
Record format	:	FB
Block length	:	20434 bytes
Logical record length	:	34 bytes
Label	:	Non-label

On these tapes, 17 kinds of upper atmospheric data are recorded for every one second in the following sequence.

Word number	Observation item	Word number	Observation item
1	VLF 750 Hz	10	CNA
2	VLF 2 kHz	11	Total mag. force
3	VLF 4 kHz	12	H-component of magn. filed
4	VLF 30 kHz	13	D-component of magn. field
5	VLF 350 Hz	14	Z-component of magn. field
6	VLF 1.2 kHz	15	H-component of ULF waves
7	VLF 8 kHz	16	D-component of ULF waves
8	VLF 60 kHz	17	Z-component of ULF waves
9	VLF 95 kHz		

Each data is recorded on the tape with 2 bytes in the binary form of signed 2's complement, and a set of these 17 kinds of data make a logical record of 34 bytes. The data for 10 min make a block of 20434 bytes. At the beginning of each block, the starting time of this period is recorded with 34 bytes. Figure 3 illustrates the structure of the compiled digital tape, in which one-day data (144 blocks) make one file and one-month data (28-31 files) make one volume. The more detailed information about the compiled MELCOM 70/25 MT data were reported by Sakurai et al. (1987).

4.1.2. TEAC DR-200 data format

The digital data recorded by a TEAC DR-200/MT-1000GP system have been available from 13h24m25s UT on April 14, 1987 in addition to the MELCOM 70/25 data. Simultaneous digital recordings had been continued using both the MELCOM 70/25 and TEAC DR-200 systems. The DR-200 system newly installed at Syowa Station in 1987 was almost the same system as those used in Iceland for the geomagnetic conjugate observations since 1984. The compilatory process of these data has been made based on the compilation process for the Iceland MT data. The specifications of the compiled digital tapes are as follows:

Track	:	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)

In these tapes, 20 kinds of upper atmospheric data are recorded every one second in the following sequence.

Word number	Observation item	Word number	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	Space
10	VLF 1.2 kHz	22	Space
11	VLF 2 kHz	23	Space
12	VLF 4 kHz	24	Space

Each date is recorded on a tape with 2 bytes in the binary form of signed 2's complement, and a set of these 24 data make a logical record of 48 bytes. The 10 min data make a block of 28848 bytes. One-day data (144 blocks) make one file and one-month data (28-31 files) make one volume. At the beginning of each block, the starting time of this period is recorded with 48 bytes in the following format:

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-component of the geomagn. field (nT)	= DATA*2500/2048
H-component of ULF waves (nT/s)	=DATA/141
D-component of ULF waves (nT/s)	=DATA/158
Z-component of ULF waves (nT/s)	=DATA/316

As for CNA, VLF and MBR data, individual calibration values are required to transform MT data. Inquiries about these data should be addressed to Upper Atmosphere Research Division of NIPR. The more detailed information about the compiled TEAC DR-200 MT data were reported by Uchida et al. (1988).

4.2. Asuka Station

The digital data recording with a TEAC DR-200/MT-800GP system started since February 19, 1987 at Asuka Station. The compilation of these data has been made in the same style as the DR-200 data from Syowa and Iceland Stations. The specification of the compiled digital tapes are as follows:

Track	: 9
Record density	: 6250 BPI
Record format	: FB
Block length	: 3612 bytes
Logical record length	: 12 bytes
Label	: Non-label
Filing	: Multi-file (1 file/day)

In these tapes, 6 kinds of geomagnetic data are recorded every 2 s in the following sequence.

Word number	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

H, D, Z-components of the geomagnetic field (nT) are obtained by DATA* 2500/2048. Further information about these data should be addressed to Upper Atmosphere Research Division of NIPR.

For co-researchers of NIPR, it is permitted to use the HITAC M-260H computer system of the Information Processing Center. The center has various kinds of softwares such as tape-to-tape copy, displays and spectrum analysis program.

Acknowledgments

It is a pleasure to acknowledge all the members of the 29th Japanese Antarctic Research Expedition for their enthusiastic support to the upper atmosphere physics observations both at Syowa Station and Asuka Station. The publication of this report was possible thanks to the support from all the members of the Upper Atmosphere Physics Research and Information Processing Center group of National Institute of Polar Research.

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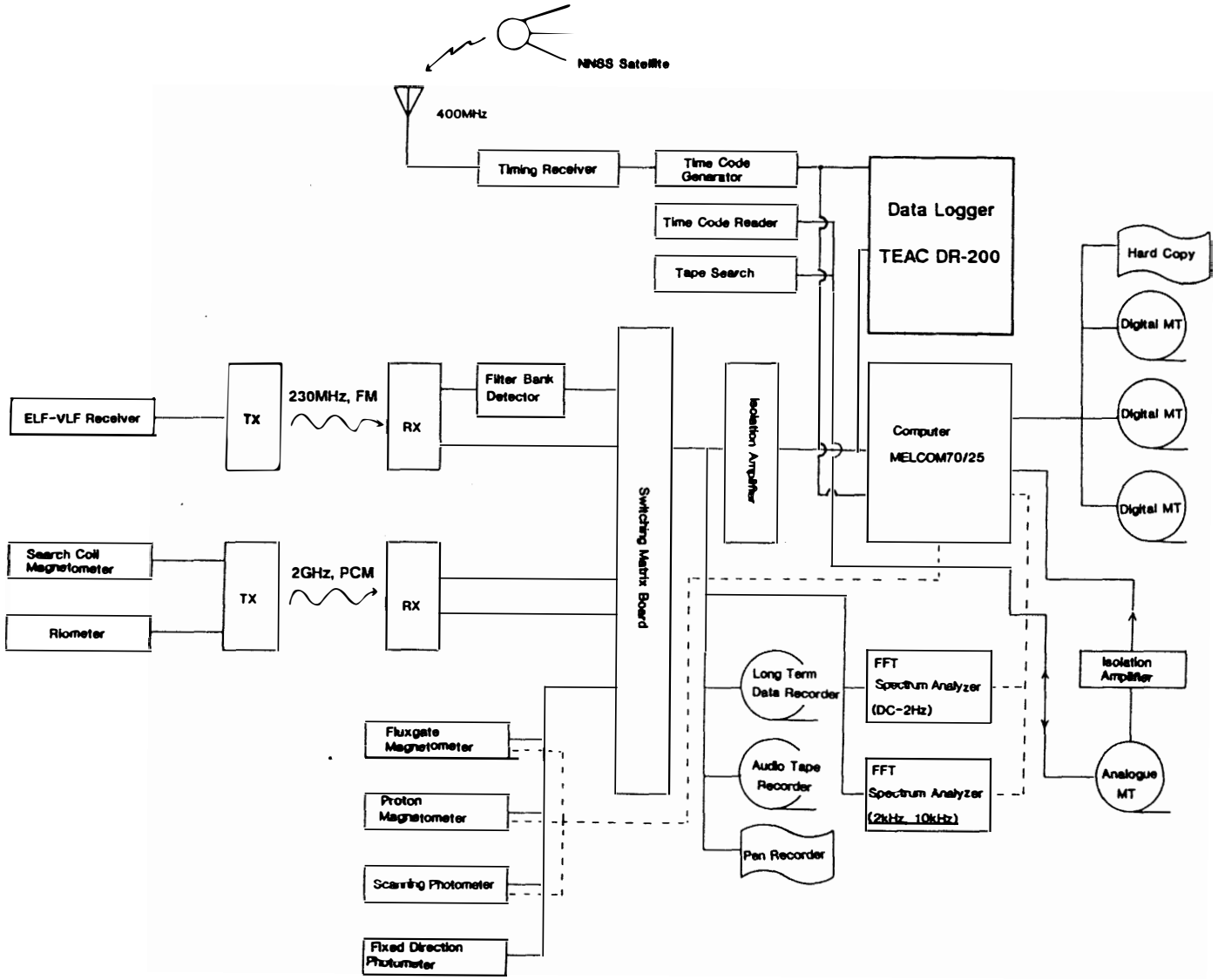


Fig. 1. Block diagram of the "Upper Atmosphere Physics" monitoring system at Syowa Station.

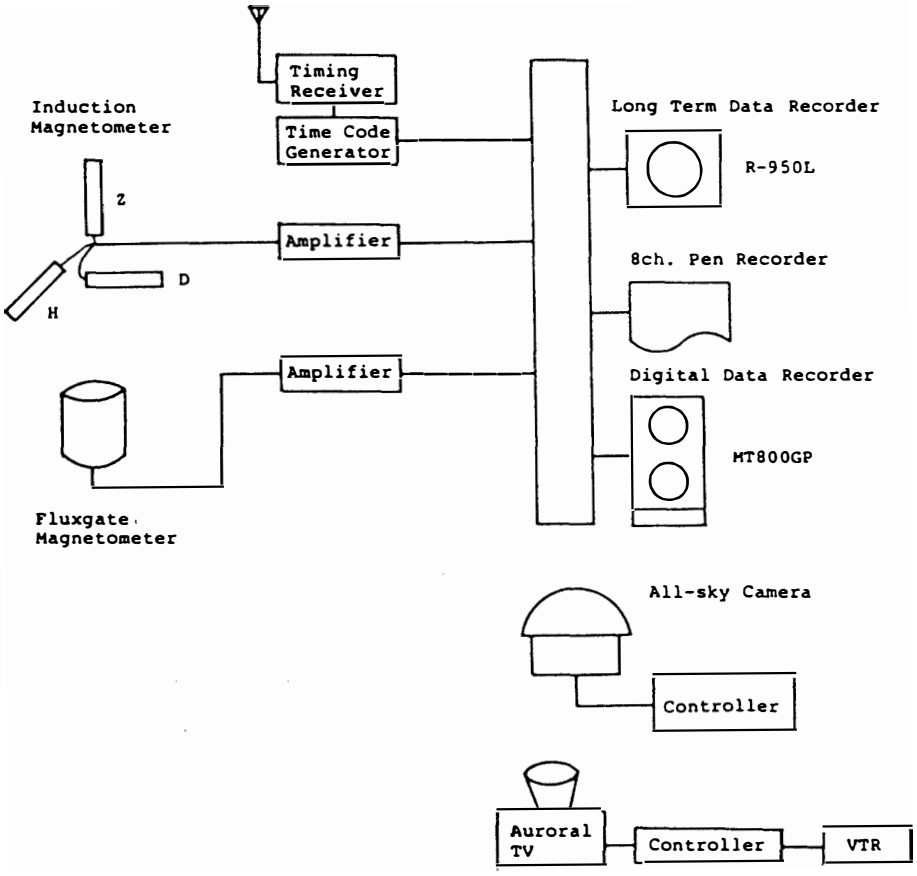


Fig. 2. Block diagram of the "Upper Atmosphere Physics" monitoring system at Asuka Stataion.

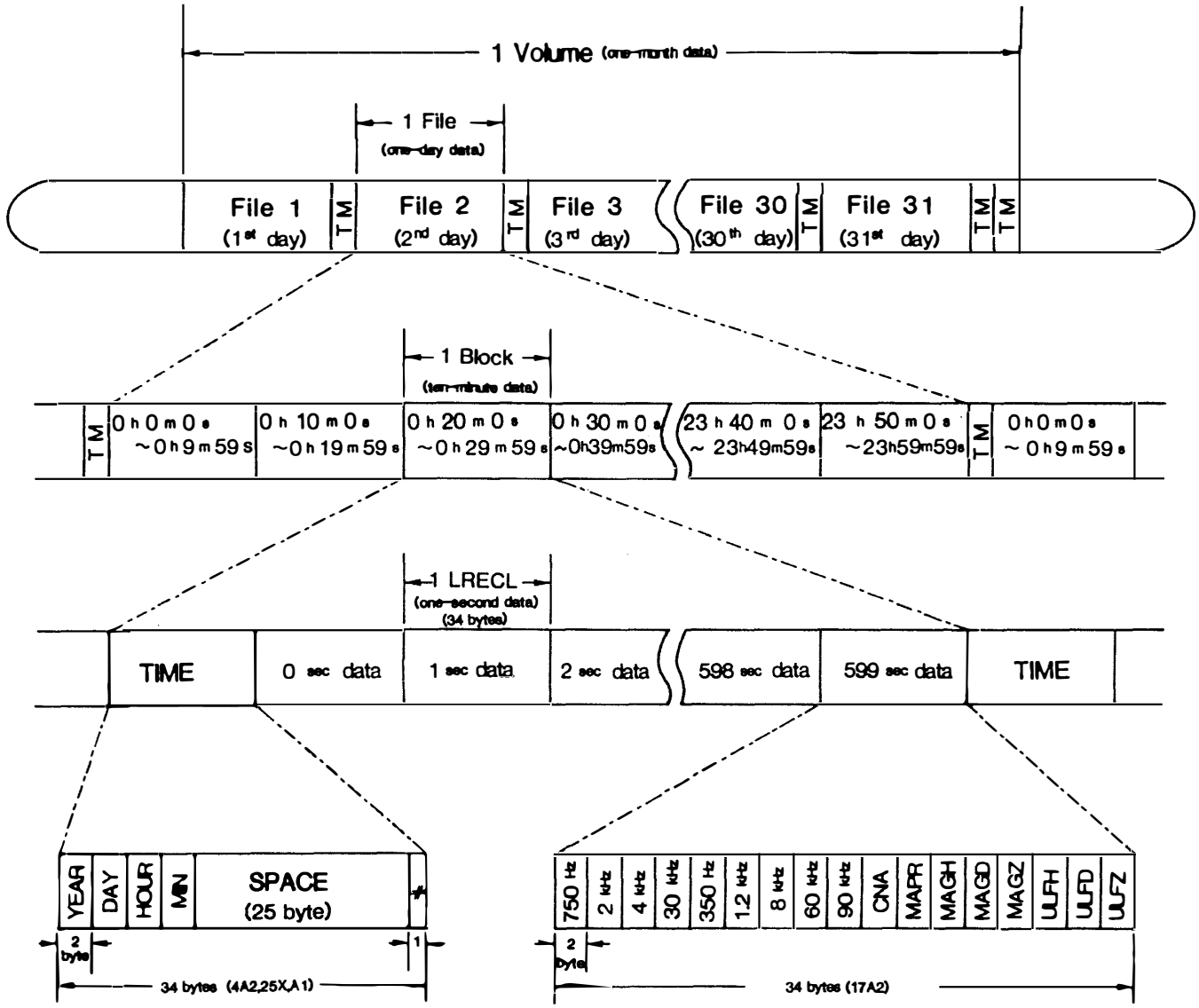


Fig. 3. The structure of the compiled digital tape format (MELCOM 70/25).

Table 1. Recording periods of ULF magnetic pulsations on a long-term analog data recorder, R-950L at Syowa Station.

Start Time		End Time		Tape
Date	Time(UT)	Date	Time(UT)	Number
Feb. 1	0118	Feb. 16	0554	88-01
Feb. 16	0611	Mar. 1	0617	88-02
Mar. 1	0631	Mar. 10	07XX	88-03
Mar. 10	0828	Mar. 16	1102	88-04
Mar. 16	1114	Apr. 1	0523	88-05
Apr. 1	2623	Apr. 16	1212	88-06
Apr. 16	1246	May 1	0741	88-07
May 1	0814	May 16	1152	88-08
May 16	1222	June 1	0609	88-09
June 1	0641	June 2	1646	88-10
June 4	1208	June 16	0743	88-11
June 16	0835	July 1	1257	88-12
July 1	1324	July 16	1103	88-13
July 16	1133	Aug. 1	0642	88-14
Aug. 1	0711	Aug. 16	0742	88-15
Aug. 16	0811	Aug. 31	0259	88-16
Aug. 31	1221	sep. 16	1119	88-17
Sep. 16	1146	Oct. 1	1341	88-18
Oct. 1	1308	Oct. 13	0756	88-19
Oct. 13	0857	Oct. 16	1212	88-20
Oct. 16	1250	Nov. 1	0730	88-21
Nov. 1	0900	Nov. 16	1651	88-22
Nov. 16	1832	Dec. 1	1645	88-23
Dec. 1	1803	Dec. 6	1057	88-24
Dec. 16	1123	Jan. 1	0906	88-25
Jan. 1	0932	Jan. 16	1024	88-26
Jan. 16	1050	Feb. 1	1648	88-27

Table 2. Baselines of the geomagnetic field at Syowa Station in 1988.

DATE	TIME (UT)	TOTAL INT. (nT)	HORI-ZONAL INT. (nT)	VERTICAL INT. (nT)	DECLINATION	DIPANGLE
FEB. 29 1988	14h 07m	44134	19023	39824	-47° 05.2'	-64° 28.1'
	14h 22m	44133	19019	39824	-47° 04.7'	-64° 28.3'
	14h 42m	44137	19022	39827	-47° 04.7'	-64° 28.2'
	14h 52m	44138	19019	39830	-47° 04.6'	-64° 28.5'
	14h 31m	44136	19021	39826	-47° 04.8'	-64° 28.3'
MAR. 24	11h 25m	44131	19015	39824	-47° 05.6'	-64° 28.6'
	11h 42m	44130	19017	39822	-47° 05.3'	-64° 28.4'
	12h 03m	44133	19016	39826	-47° 04.2'	-64° 28.6'
	12h 17m	44134	19014	39828	-47° 03.7'	-64° 28.8'
	12h 50m	44132	19016	39825	-47° 04.7'	-64° 28.6'
APR. 27	11h 33m	44137	19042	39818	-47° 06.6'	-64° 26.5'
	11h 43m	44137	19039	39820	-47° 05.9'	-64° 26.8'
	12h 03m	44137	19013	39832	-47° 06.0'	-64° 29.0'
	12h 17m	44139	19014	39834	-47° 05.6'	-64° 27.7'
	11h 54m	44138	19027	39826	-47° 06.0'	-64° 27.5'
MAY 26	10h 25m	44128	19036	39811	-47° 07.0'	-64° 26.7'
	10h 32m	44128	19039	39809	-47° 06.8'	-64° 26.4'
	10h 46m	44128	19032	39812	-47° 06.9'	-64° 27.0'
	10h 55m	44129	19034	39813	-47° 06.9'	-64° 26.9'
	10h 40m	44128	19035	39811	-47° 06.9'	-64° 26.8'
JULY 28	11h 18m	44113	19040	39793	-47° 07.8'	-64° 25.8'
	11h 28m	44116	19041	39796	-47° 07.8'	-64° 25.9'
	11h 45m	44113	19038	39793	-47° 07.5'	-64° 26.0'
	11h 55m	44114	19038	39795	-47° 06.9	-64° 26.0'
	11h 37m	44114	19039	39794	-47° 07.5'	-64° 25.9'
SEP. 7	12h 26m	44110	19033	39792	-47° 09.2'	-64° 26.3'
	12h 35m	44104	19030	39788	-47° 09.4'	-64° 26.4'
	12h 52m	44101	19027	39786	-47° 10.1'	-64° 26.4'
	13h 00m	44101	19023	39787	-47° 10.0'	-64° 26.8'
	12h 43m	44104	19028	39788	-47° 09.7'	-64° 26.5'
SEP. 28	12h 25m	44098	19027	39783	-47° 08.0'	-64° 26.4'
	12h 33m	44098	19021	39785	-47° 07.8'	-64° 26.9'
	12h 50m	44100	19023	39786	-47° 10.0'	-64° 26.9'
	13h 00m	44102	19023	39788	-47° 07.5'	-64° 26.8'
	12h 42m	44100	19024	39786	-47° 08.3'	-64° 26.8'

DATE	TIME (UT)	TOTAL INT. (nT)	HORI-ZONAL INT.(nT)	VERTICAL INT. (nT)	DECLINATION	DIPANGLE
OCT. 28	12h 23m	44114	19037	39795	-47° 03.5'	-64° 26.1'
	12h 33m	44116	19035	39798	-47° 02.9'	-64° 26.3'
	12h 46m	44110	19027	39795	-47° 03.1'	-64° 26.8'
	12h 55m	44107	19023	39794	-47° 03.5'	-64° 27.0'
	12h 39m	44112	19031	39796	-47° 03.3'	-64° 26.6'
DEC. 6	11h 27m	44098	19033	39780	-47° 09.2'	-64° 25.8'
	11h 37m	44101	19036	39782	-47° 09.1'	-64° 25.7'
	11h 54m	44090	19029	39773	-47° 08.1'	-64° 25.9'
	12h 02m	44094	19029	39776	-47° 08.1'	-64° 26.0'
	11h 45m	44096	19032	39778	-47° 08.6'	-64° 25.9'
DEC. 31	11h 51m	44067	19027	39748	-47° 11.2'	-64° 25.2'
	12h 00m	44073	19028	39754	-47° 11.7'	-64° 25.3'
	12h 19m	44086	19042	39761	-47° 11.4'	-64° 24.6'
	12h 29m	44091	19041	39768	-47° 10.3'	-64° 24.9'
	12h 10m	44079	19035	39758	-47° 11.2'	-64° 25.0'
JAN. 30 1989	13h 46m				-47° 11.5'	-64° 25.6'
	14h 07m	44079	19031	39759	-47° 10.4'	-64° 25.3'
	14h 39m	44078	19021	39763	-47° 07.0'	-64° 26.1'
	14h 57m	44098	19039	39777	-47° 05.7'	-64° 25.3'
	14h 22m	44085	19030	39766	-47° 08.7'	-64° 25.6'

Table 3. K-indices at Syowa Station in 1988.

	FEB. (1988)		MAR.		APR.		MAY		JUNE		JULY		AUG.		SEP.		OCT.		NOV.		DEC.		JAN. (1989)	
1	4220	1122	3221	0123	5532	1356	3111	1112	1111	1111	----	2245	4411	0021	6652	3324	5422	1135	2321	1443	2223	3111	---2	3433
2	2221	1233	2221	1115	3543	3236	1212	1124	2000	0100	4433	2241	4111	0022	6421	2225	4221	0111	5433	4564	1243	5433	3221	2233
3	2221	1112	3220	1223	5443	1484	3311	1134	0000	0000	2201	1124	4531	0101	4411	1144	1110	0111	6543	4355	4433	3633	1221	1222
4	2221	1124	5452	3435	5545	4563	5441	1133	0000	0001	5500	0000	1100	0001	4222	1114	2221	0134	2222	3333	5521	2322	3431	2123
5	4563	3343	3411	1144	6442	1146	1123	3137	1000	0034	0000	0111	0000	1224	3311	0001	6632	2433	5421	4422	2221	2222	5665	4533
6	3322	2225	6542	3452	7764	4442	7796	4554	4410	0200	2321	2234	2110	0002	1111	0020	6443	3442	2532	3333	2221	1122	3343	2122
7	3421	1122	4332	1336	2442	2333	2211	2236	0012	---6	4432	1133	3100	0000	2131	0011	4211	1113	4532	3445	2221	1212	3233	2333
8	3111	1232	3652	3232	2110	1122	4422	2324	44--	--33	4432	2155	0000	0000	1111	1133	3211	2233	4432	4464	3322	2313	2332	5544
9	2222	2344	3442	1322	5211	1212	3322	2222	0000	0034	4000	0001	3212	1343	1110	0034	4422	2444	3222	4433	2221	1232	3433	5435
10	2432	3221	2221	2235	2423	3223	4431	1223	55--	----	0110	1122	5111	0136	3111	0134	5676	5465	5542	3312	3333	3421	5433	2431
11	1222	3233	4422	3234	4311	1412	2322	2111	----	0110	3333	3335	4332	2102	3454	4546	3422	2113	2221	1245	2323	4533	3232	4665
12	4442	1343	3221	1125	5422	2333	4110	0013	0000	0000	5632	2125	3321	4224	6543	1345	3221	1132	3343	4425	3543	2323	5543	3222
13	3432	3422	3121	0122	3211	1125	3100	0110	4300	0012	4210	1002	5533	4334	4542	2243	2422	1122	3222	2232	4442	4354	2222	4554
14	2222	1122	4231	2245	4421	1123	0010	0110	5534	2236	5521	0044	6434	2325	4332	2223	3310	1112	3433	3234	2322	3355	3322	2336
15	3333	3432	3443	2255	2110	0113	2311	0111	5311	0015	5411	1443	3443	3435	5531	2312	1110	1222	5532	2233	4551	2222	4553	5565
16	2112	3552	5533	1233	2010	1111	1432	3313	5421	1024	4444	3333	5532	1233	3421	2011	4421	0233	2543	3354	4422	5654	4464	3455
17	4422	2235	4321	1132	1110	0104	3433	4334	5452	2024	3311	3213	4411	0002	5542	3335	3322	1134	4443	3232	3455	4255	4545	4554
18	5322	2246	4221	1223	4321	0111	6444	3125	3322	1324	2533	2122	4511	1211	6542	2145	4433	4455	2322	3232	4443	3436	5533	3222
19	2221	1231	1110	0012	1222	0123	5211	1110	5434	3443	3133	2112	4411	1124	4533	2256	3332	2233	3221	1111	4443	4454	3431	0223
20	1111	1135	2222	1112	2111	1324	4310	1122	5553	2111	2100	0001	5531	2232	4332	1135	5551	2346	1211	2113	3332	1232	4321	5645
21	4553	2246	1111	0112	4321	0116	3431	1225	1231	1101	2354	4323	3301	0004	5321	1143	5421	1124	4321	0123	4533	3232	5543	4545
22	7764	4755	2111	0112	6744	3544	4421	2221	3432	2222	---3	23--	4651	1022	5562	2322	3111	0112	2231	1112	5543	1353	5553	5435
23	6753	2332	1111	1133	6552	2234	1310	0115	3421	1014	---3	2111	5521	0127	5452	1224	2321	1222	1331	1013	3331	1123	5543	3435
24	5522	2233	5410	1113	3121	0034	3231	0133	3411	2334	2331	1034	3322	1124	4212	1024	3321	0124	4320	0012	3332	2123	3322	2333
25	5531	2255	1221	1443	4111	0134	3110	1114	4564	2332	3411	0012	3343	2244	6321	2235	3421	0113	4321	1233	4334	4532	3332	2335
26	5311	1354	5553	2467	3420	0012	4510	0100	5431	1256	2433	3366	4310	1124	1222	1113	2222	1234	4543	4432	4434	5445	3332	2323
27	3421	1134	7452	3454	2311	0235	0010	0002	----	1133	6552	2213	6433	1343	4221	1011	2212	1343	4432	3323	4454	4432	5542	4211
28	3321	1122	4443	3466	4432	1135	1110	0111	4333	2112	4222	2245	3222	1136	3221	0122	5421	1222	2321	2233	3332	3434	4531	4442
29	1211	1122	4544	2554	4321	0001	1121	1123	2652	235-	5110	0034	4443	1325	2221	0111	4411	1111	4321	3323	5333	4234	3222	3431
30			6752	2235	2221	1112	2521	1134	---2	34--	4321	0004	6552	0124	1222	1134	3211	1133	3346	5441	3423	2333	3322	3234
31			4521	2345			4211	2222			3431	1013	4313	0434			2233	2223			3332	3443	4542	4447

Table 4. Observation peiods of a 35 mm all-sky camera at Syowa Station in 1988.

Date	Start / Stop Time (UT)								
	h	m	s	h	m	s	h	m	s
Feb. 25				21	01	00	-22	00	07
Mar. 4				22	07	00	-23	41	37
5				20	01	00	-23	40	07
10							20	46	00
11	-00	00	07	20	21	00	-22	32	07
12							19	21	00
13	-00	23	37				19	40	00
14	-00	37	37						
15							19	45	00
16	-00	21	37						
20							19	01	00
21	-00	49	37						
24							19	00	00
25	-00	59	37				18	40	00
26	-01	04	07						
Apr. 7							19	00	00
8	-02	00	07						
12							22	01	00
13	-02	29	37	19	10	00	-22	18	47
14							18	00	00
15	-02	19	37				21	40	00
16	-02	30	07				18	00	00
17	-02	26	37				21	44	00
18	-02	40	07						
19							21	40	00
20	-01	40	37						
21							23	00	00
22	-02	40	07						
23							18	00	00
24	-02	39	37				18	00	00
25	-02	21	37				18	03	00
26	-01	07	37						
May 8				18	00	00	-23	02	07
12							18	00	00
13	-02	59	37						

Date		Start / Stop Time (UT)								
		h	m	s	h	m	s	h	m	s
May	17							20	00	00
	18	-03	59	37				22	00	00
	19	-01	59	37						
	20							18	30	00
	21	-03	59	37				18	10	00
	22	-03	51	37						
	23							18	04	00
	24	-03	59	37	18	00	00	-21	59	37
June	6							18	30	00
	7	-03	59	37				18	30	00
	8	-03	46	07				18	02	00
	9	-03	59	37				19	00	00
	10	-04	29	37	21	00	00	-21	59	37
	12							19	01	00
	13	-03	59	37				18	05	00
	14	-03	59	37				18	00	00
	15	-03	59	37						
	18				20	02	00	-23	44	57
	23							21	00	00
	24	-02	52	37	18	01	00	-19	32	37
	26							18	15	00
	27	-03	59	37				18	49	00
	28	-03	59	37				21	00	00
	29	-03	54	07						
July	4				18	02	00	-21	05	37
	7							18	00	00
	8	-03	59	37				18	00	00
	9	-03	57	07						
	10							18	00	00
	11	-03	59	37				18	00	00
	12	-04	29	37				18	00	00
	13	-03	59	37	21	00	00	-21	54	37
	17							20	30	00
	18	-00	29	57						
	19							22	01	00

Date	Start / Stop (UT)								
	h	m	s	h	m	s	h	m	s
July 20	-01	15	37						
23							18	00	00
24	-03	59	37						
25				18	00	00	-22	34	57
30							20	00	00
31	-03	59	37				18	00	00
Aug. 1	-03	59	37				19	06	00
2	-03	59	37						
6							23	02	00
7	-03	59	37				18	00	00
8	-03	29	37						
9							18	00	00
10	-01	58	47				18	04	00
11	-03	29	07	18	00	00	-22	58	17
12							21	30	00
13	-02	59	37				18	00	00
14	-02	59	37				18	00	00
15	-02	59	37						
17							18	00	00
18	-02	59	37				18	00	00
19	-02	49	07						
20				22	01	00	-22	59	57
21							18	00	00
22	-02	59	57						
24							20	00	00
25	-02	00	07						
26							18	01	00
27	-02	29	37				18	00	00
28	-02	29	37				18	01	00
29	-02	58	57				18	00	00
30	-02	59	57				18	37	00
31	-02	31	57				18	00	00
Sep. 1	-02	59	57				18	00	00
2	-02	59	57						
3							22	41	00

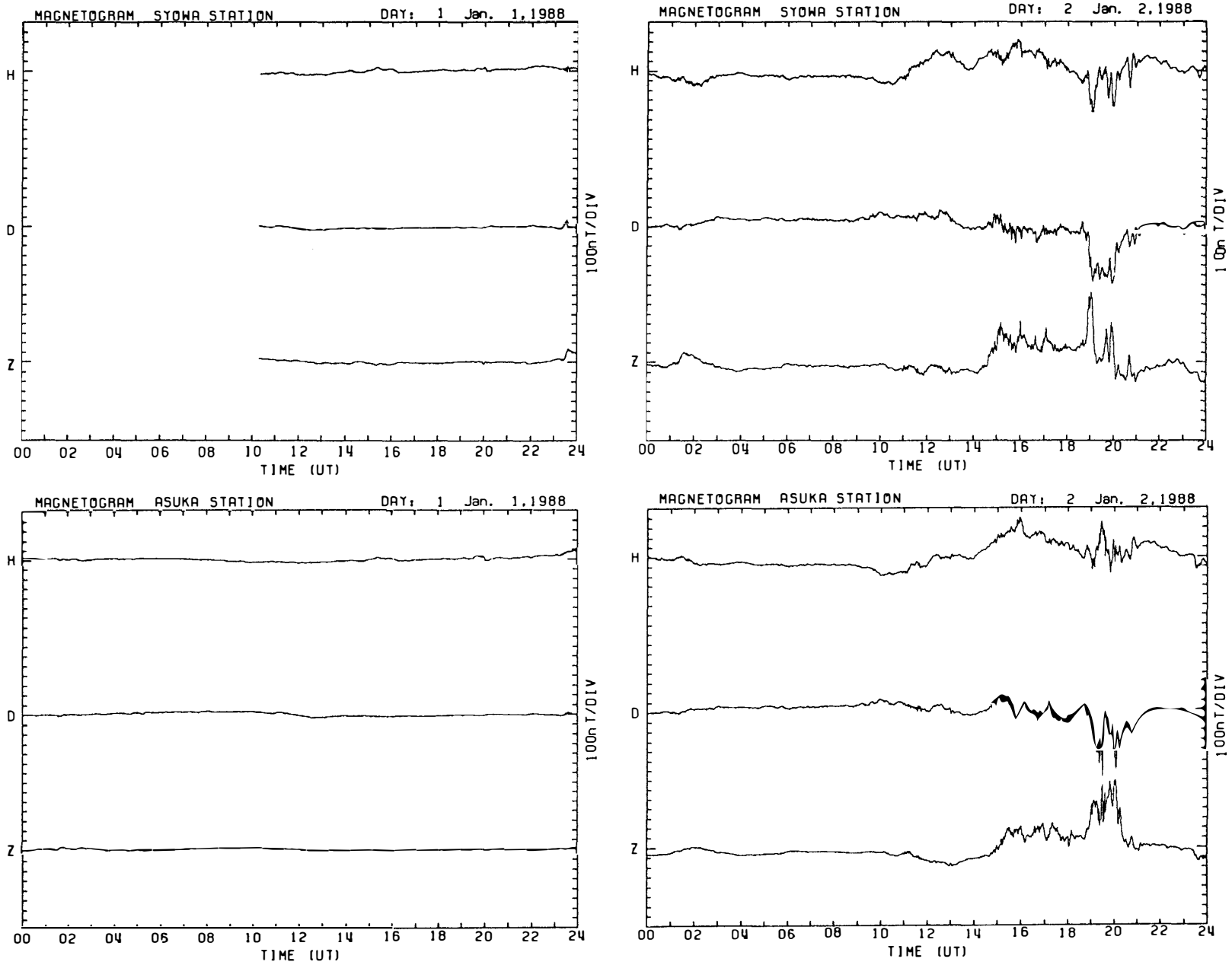
Date	Start / Stop (UT)								
	h	m	s	h	m	s	h	m	s
Sep. 4	-02	59	57				18	00	00
5	-02	59	57				18	02	00
6	-02	59	57	18	00	00	-19	59	27
7							20	02	00
8	-01	56	57				18	03	00
9	-02	29	57				18	00	00
10	-02	29	57				18	00	00
11	-02	29	57						
12							18	00	00
13	-02	29	57				18	05	00
14	-02	29	57				18	04	00
15	-02	29	57				19	02	00
16	-02	29	57				19	00	00
17	-02	05	37				18	10	00
18	-02	09	57				18	13	00
19	-02	07	57				18	13	00
20	-00	25	47						
21							18	10	00
22	-01	59	57				21	02	00
23	-01	21	17				18	33	00
24	-01	59	57						
25							20	02	00
26	-00	59	57				18	30	00
27	-00	38	57				20	02	00
28	-00	33	07	19	30	00	-23	59	57
29							19	30	00
30	-00	59	57	19	31	00	-23	59	57
Oct. 2				20	01	00	-23	53	57

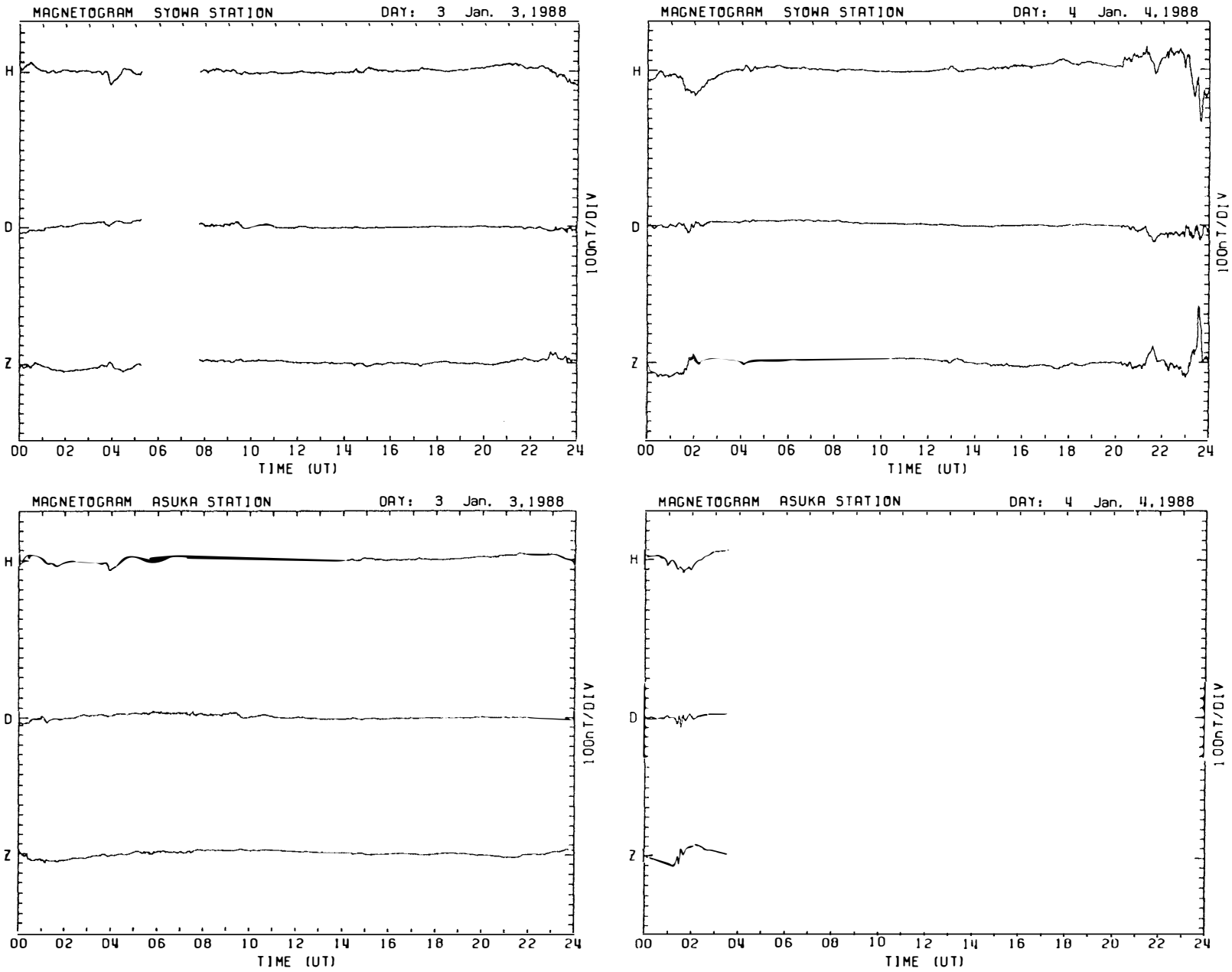
Table 5. Recording periods of ULF magnetic pulsations on a long-term analog data recorder, R-950L at Asuka Station.

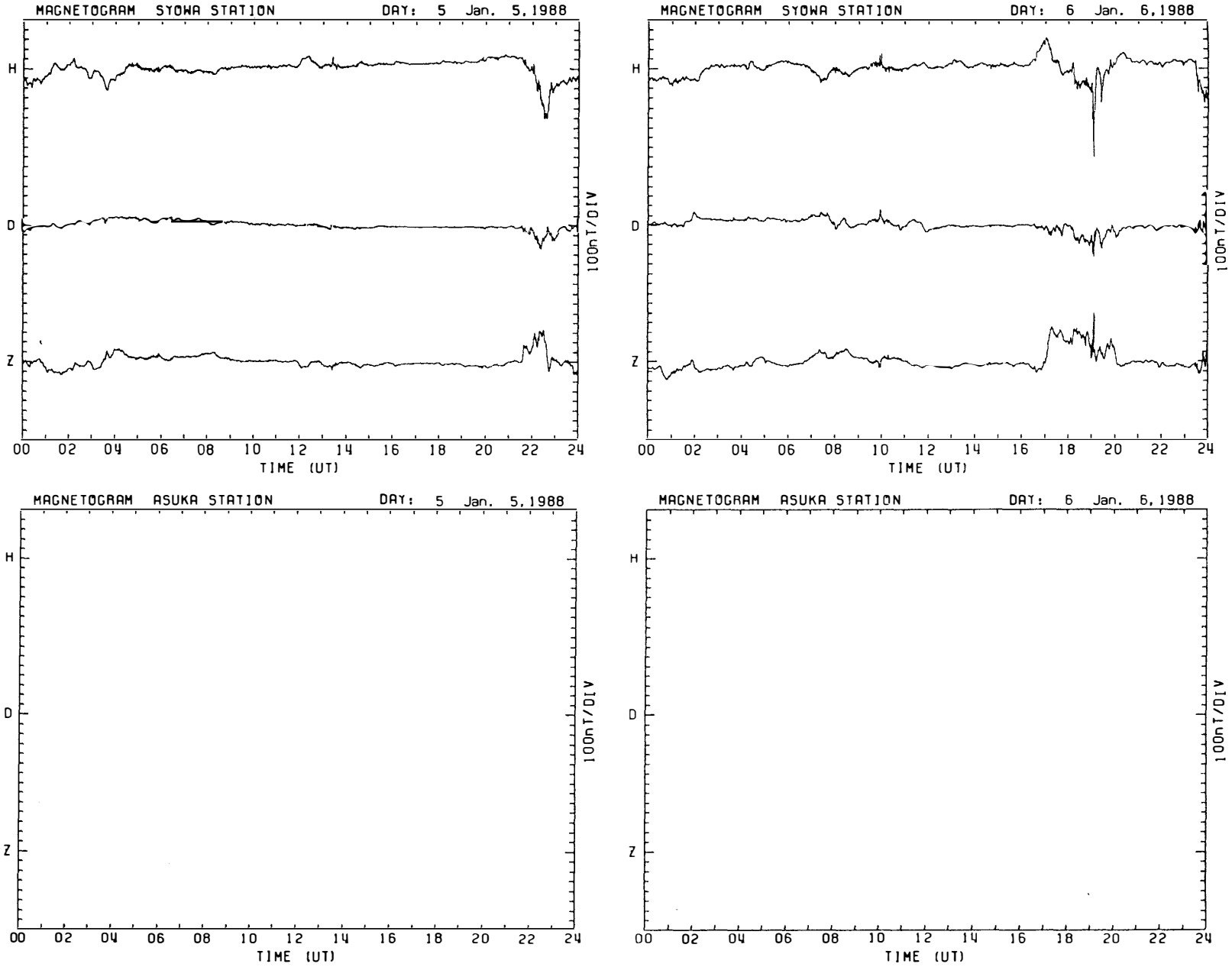
Start Time		End Time		Tape
Date	Time(UT)	Date	Time(UT)	Number
87' Dec. 24	1515	88' Jan. 15	1158	88-01
Jan. 15	1243	Jan. 31	1200	88-02
Jan. 31	1233	Feb. 29	0640	88-03
Feb. 29	0646	Mar. 15	1030	88-04
Mar. 15	1118	Mar. 31	0745	88-05
Mar. 31	0835	Apr. 15	0717	88-06
Apr. 15	0807	Apr. 30	0802	88-07
Apr. 30	0843	May 15	0713	88-08
May 15	0757	May 31	0611	88-09
May 31	0657	June 15	0615	88-10
June 15	0704	June 30	0726	88-11
June 30	0811	July 15	0615	88-12
July 15	0704	July 31	0731	88-13
July 31	0855	Aug. 15	0621	88-14
Aug. 15	0731	Aug. 18	?	88-15
Aug. 22	0650	Aug. 31	1134	88-16
Aug. 31	1157	Sep. 15	0629	88-17
Sep. 15	0650	Sep. 30	1025	88-18
Sep. 30	1057	Oct. 15	1039	88-19
Oct. 15	1103	Oct. 31	0644	88-20
Oct. 31	0700	Nov. 15	0721	88-21
Nov. 15	0713	Nov. 30	0636	88-22
Nov. 30	0713	Dec. 20	0738	88-23

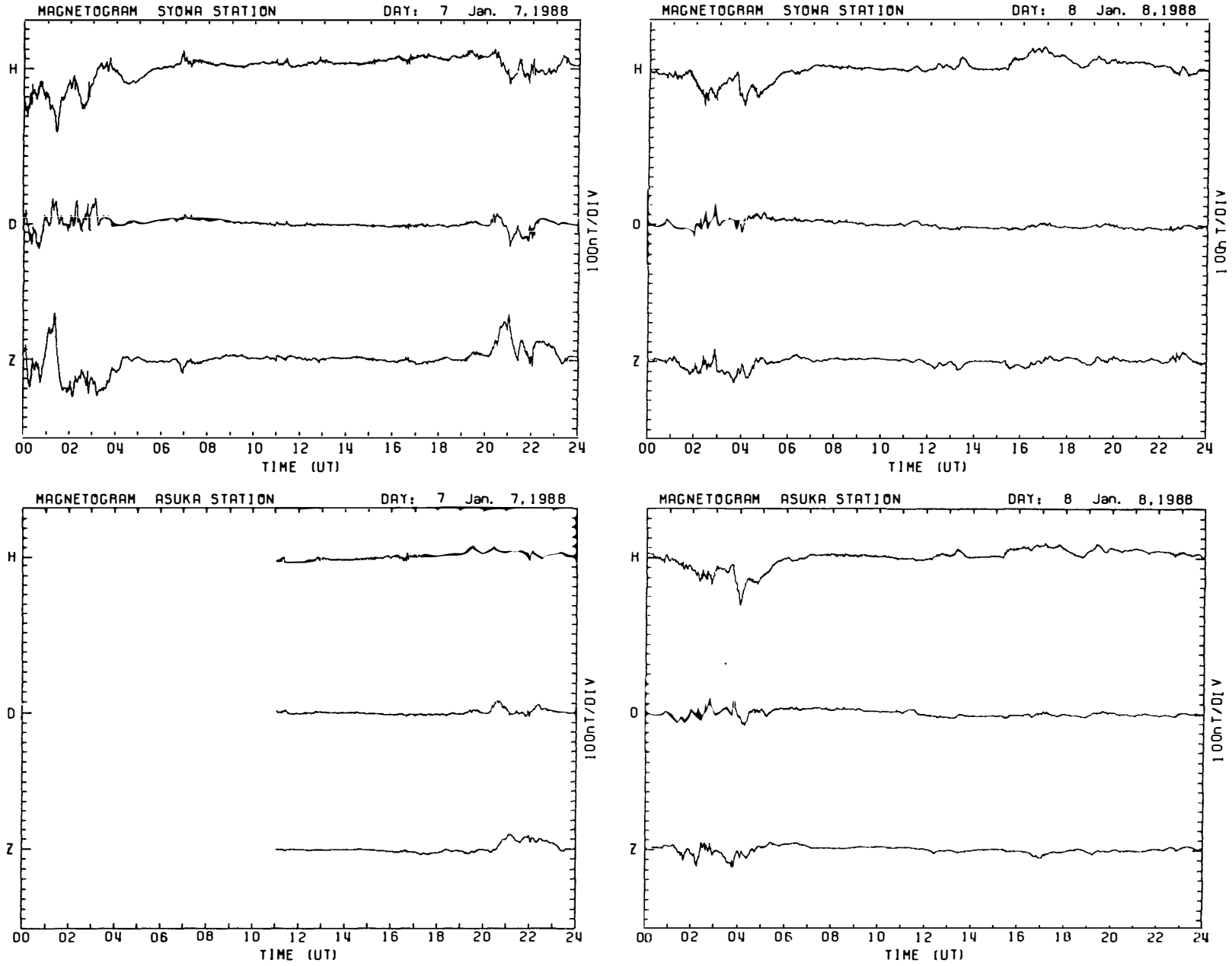
Appendix

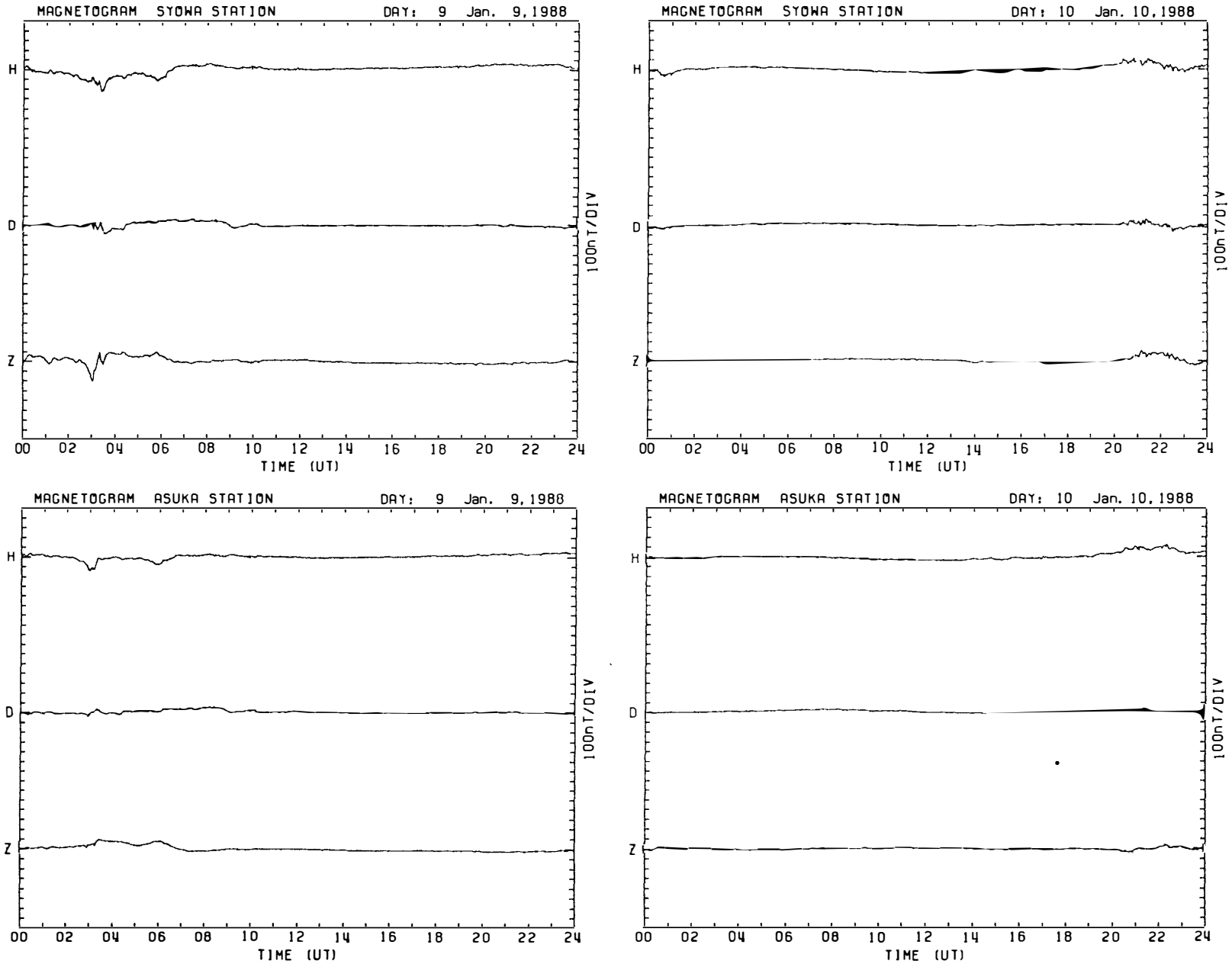
Continuous computer plots of magnetogram in 1988

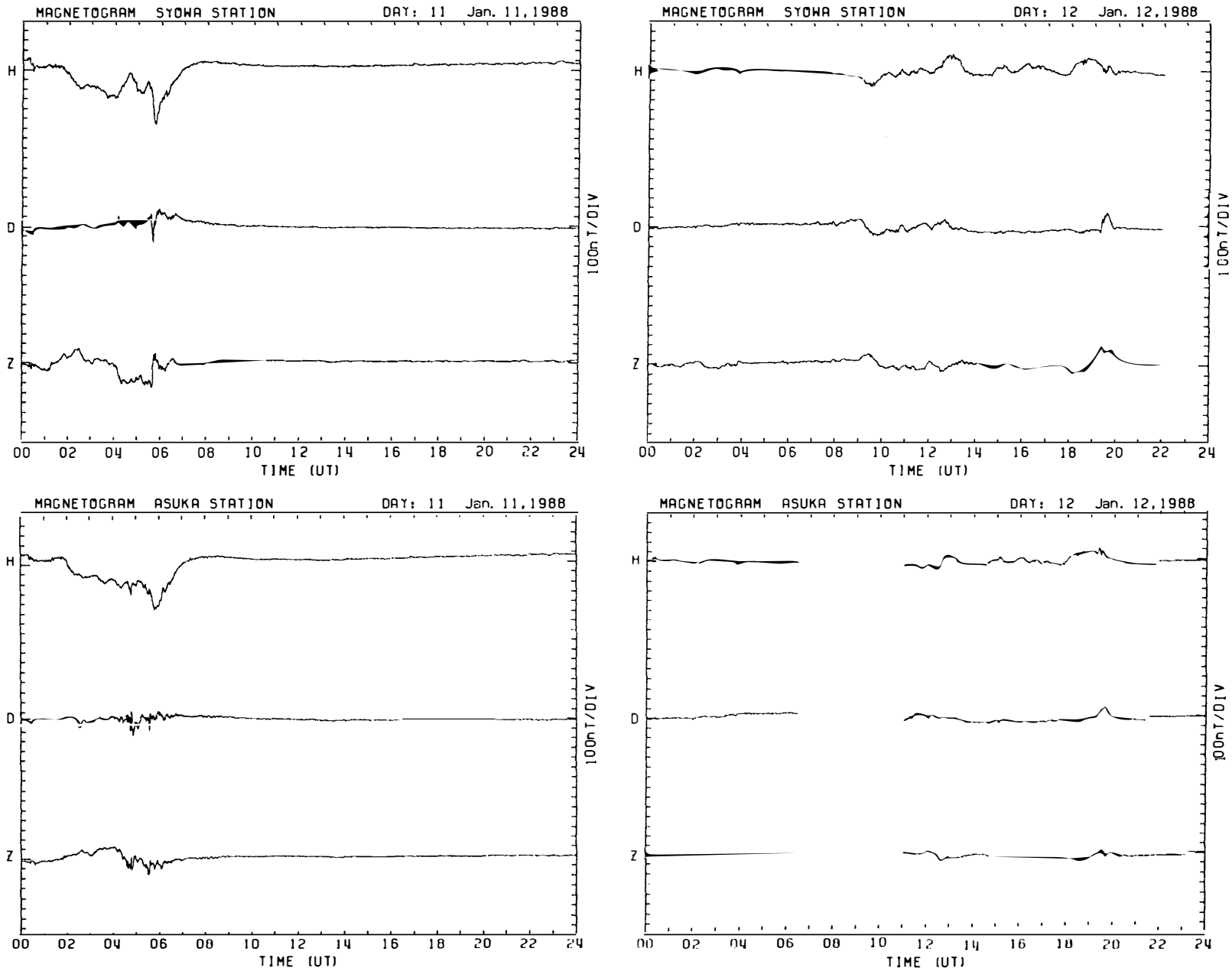

MAGNETOGRAM SYOWA STATION DAY: 1 Jan. 1,1988
MAGNETOGRAM SYOWA STATION DAY: 2 Jan. 2,1988
MAGNETOGRAM ASUKA STATION DAY: 1 Jan. 1,1988
MAGNETOGRAM ASUKA STATION DAY: 2 Jan. 2,1988
H
D
Z
100nT/DIV
00 02 04 06 08 10 12 14 16 18 20 22 24
TIME (UT)

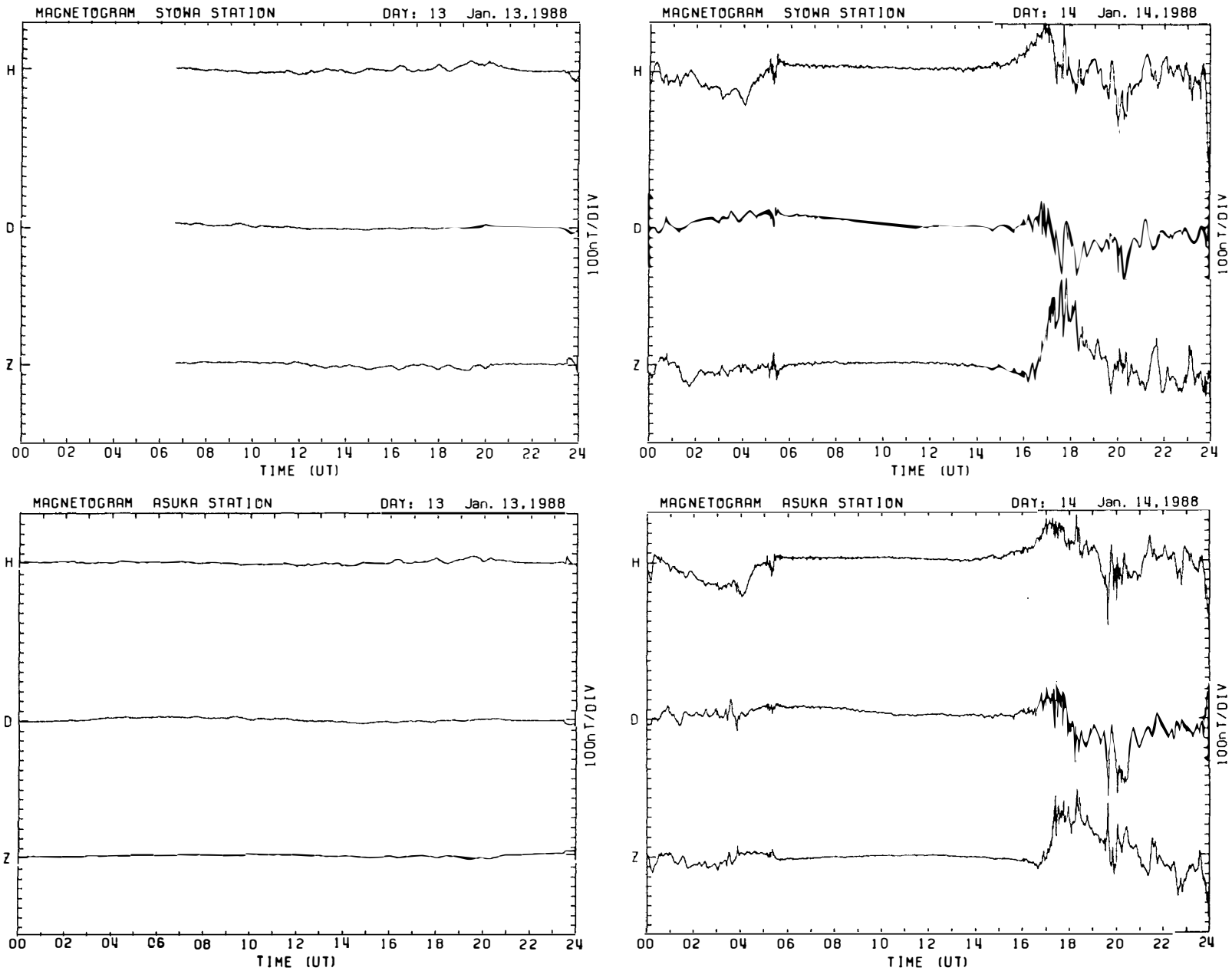

MAGNETOGRAM SYOWA STATION DAY: 3 Jan. 3,1988
MAGNETOGRAM SYOWA STATION DAY: 4 Jan. 4,1988
MAGNETOGRAM ASUKA STATION DAY: 3 Jan. 3,1988
MAGNETOGRAM ASUKA STATION DAY: 4 Jan. 4,1988
H
D
Z
100nT/DIV
00 02 04 06 08 10 12 14 16 18 20 22 24
TIME (UT)

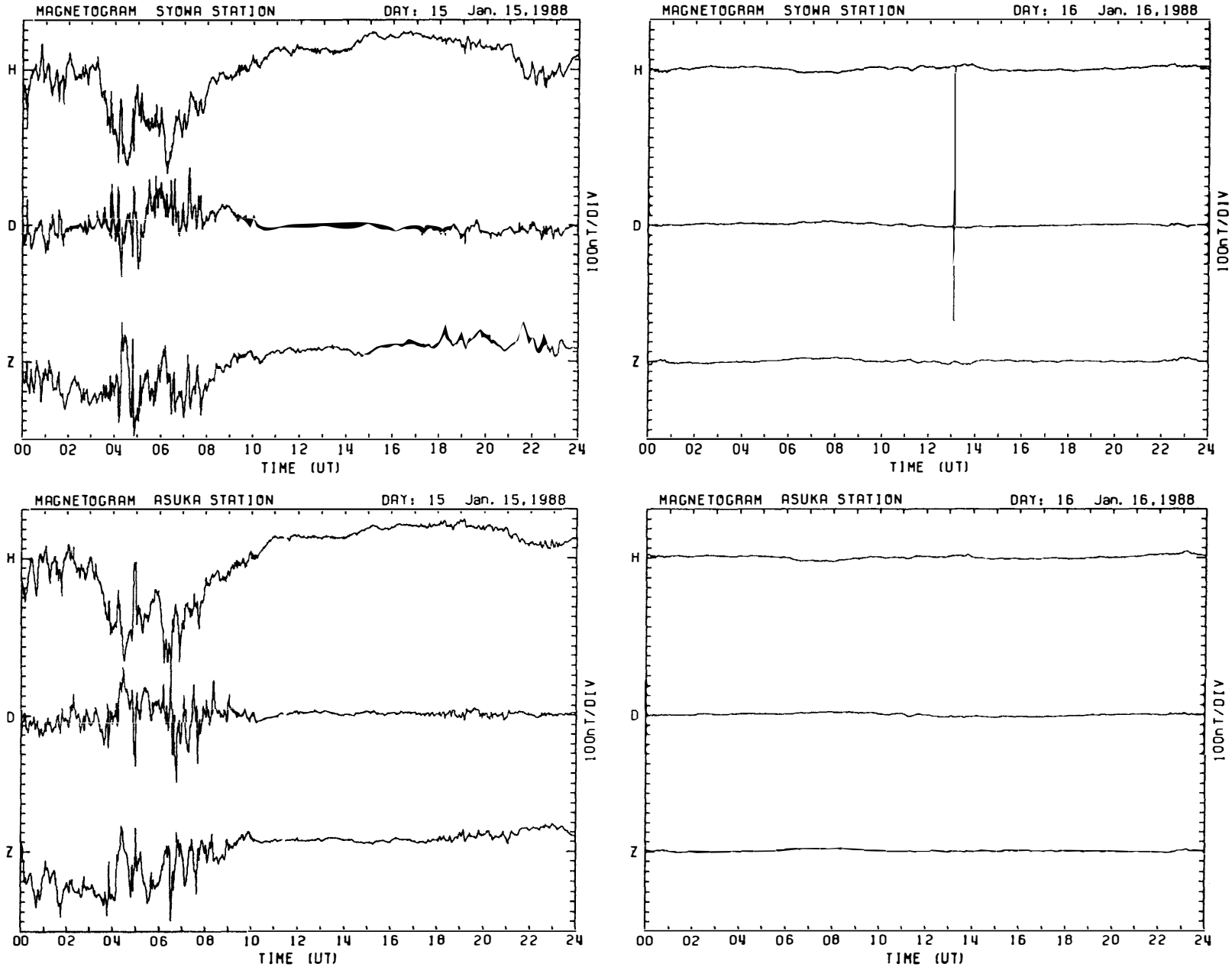

MAGNETOGRAM SYOWA STATION DAY: 5 Jan. 5,1988
MAGNETOGRAM SYOWA STATION DAY: 6 Jan. 6,1988
MAGNETOGRAM ASUKA STATION DAY: 5 Jan. 5,1988
MAGNETOGRAM ASUKA STATION DAY: 6 Jan. 6,1988
H
D
Z
100nT/DIV
00 02 04 06 08 10 12 14 16 18 20 22 24
TIME (UT)

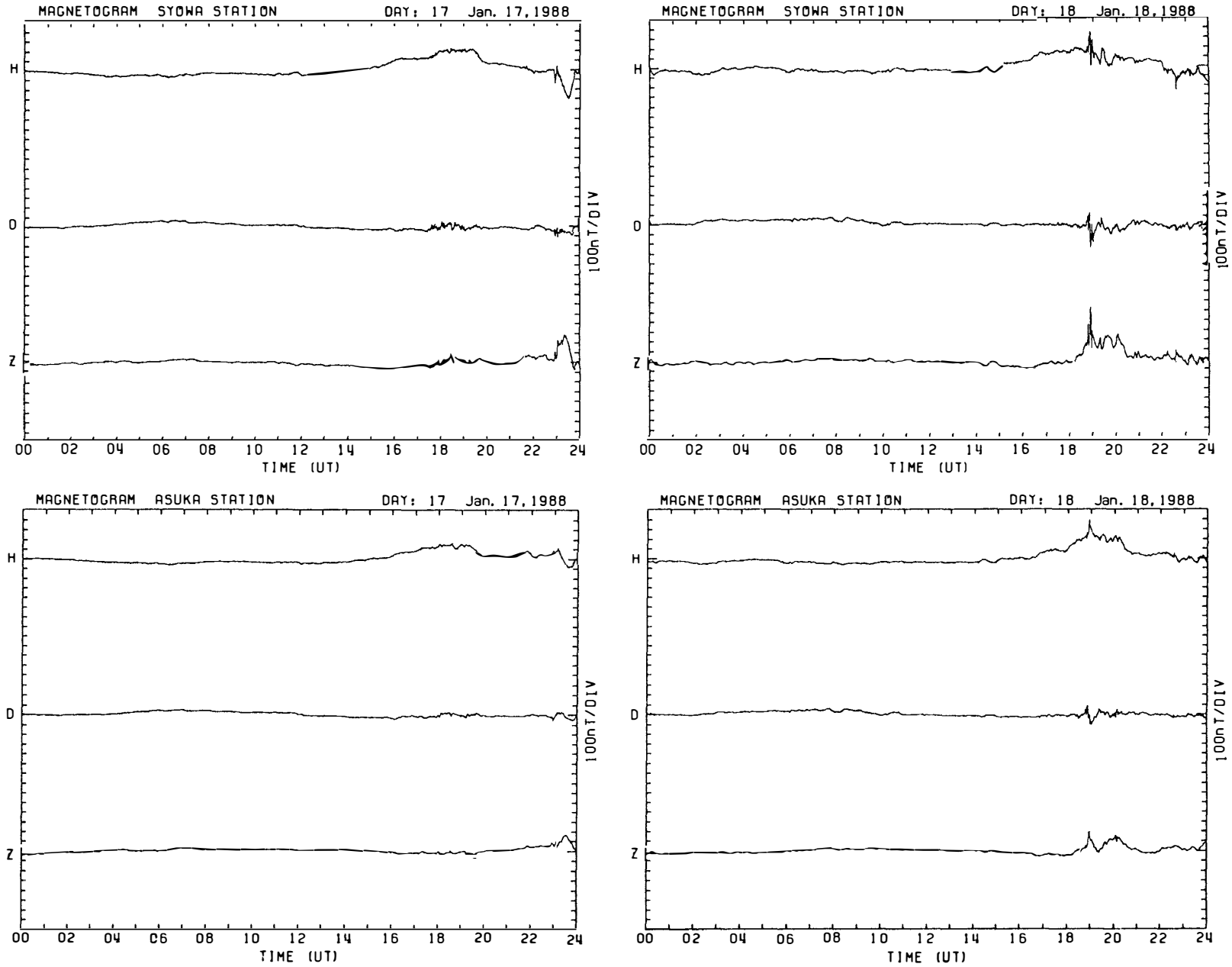

MAGNETOGRAM SYOWA STATION DAY: 7 Jan. 7,1988
MAGNETOGRAM SYOWA STATION DAY: 8 Jan. 8,1988
MAGNETOGRAM ASUKA STATION DAY: 7 Jan. 7,1988
MAGNETOGRAM ASUKA STATION DAY: 8 Jan. 8,1988
H
D
Z
100nT/DIV
00 02 04 06 08 10 12 14 16 18 20 22 24
TIME (UT)

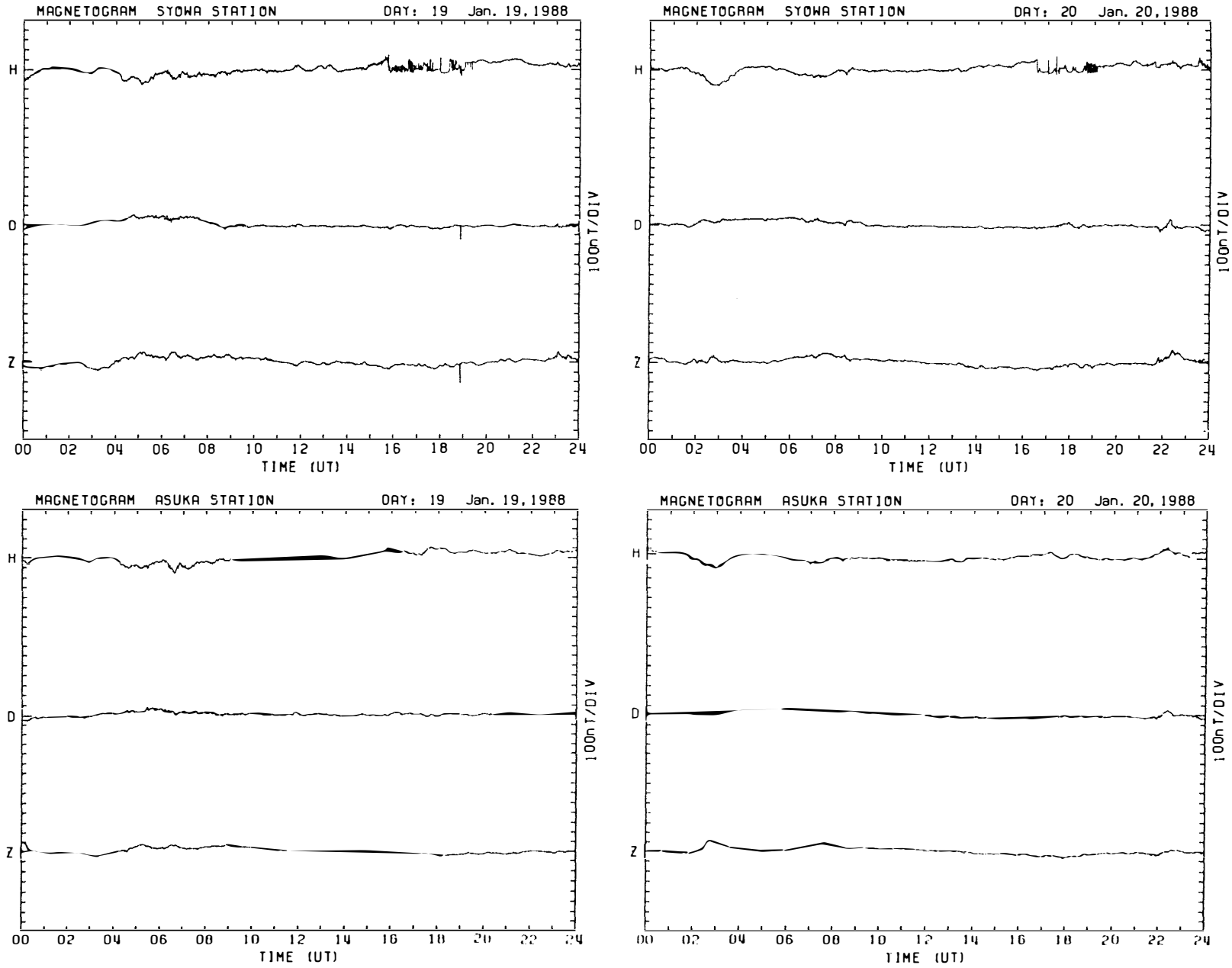

MAGNETOGRAM SYOWA STATION DAY: 9 Jan. 9,1988
MAGNETOGRAM SYOWA STATION DAY: 10 Jan. 10,1988
MAGNETOGRAM ASUKA STATION DAY: 9 Jan. 9,1988
MAGNETOGRAM ASUKA STATION DAY: 10 Jan. 10,1988
H
D
Z
100nT/DIV
00 02 04 06 08 10 12 14 16 18 20 22 24
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 11 Jan. 11,1988
MAGNETOGRAM SYOWA STATION DAY: 12 Jan. 12,1988
MAGNETOGRAM ASUKA STATION DAY: 11 Jan. 11,1988
MAGNETOGRAM ASUKA STATION DAY: 12 Jan. 12,1988
H
D
Z
100nT/DIV
00 02 04 06 08 10 12 14 16 18 20 22 24
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 13 Jan. 13,1988
MAGNETOGRAM SYOWA STATION DAY: 14 Jan. 14,1988
MAGNETOGRAM ASUKA STATION DAY: 13 Jan. 13,1988
MAGNETOGRAM ASUKA STATION DAY: 14 Jan. 14,1988
H
D
Z
100nT/DIV
00 02 04 06 08 10 12 14 16 18 20 22 24
TIME (UT)


MAGNETOGRAM SYOWA STATION
DAY: 15 Jan. 15,1988
MAGNETOGRAM SYOWA STATION
DAY: 16 Jan. 16,1988
MAGNETOGRAM ASUKA STATION
DAY: 15 Jan. 15,1988
MAGNETOGRAM ASUKA STATION
DAY: 16 Jan. 16,1988
H
D
Z
100nT/DIV
00 02 04 06 08 10 12 14 16 18 20 22 24
TIME (UT)


MAGNETOGRAM SYOWA STATION
DAY: 17 Jan. 17,1988
MAGNETOGRAM SYOWA STATION
DAY: 18 Jan. 18,1988
MAGNETOGRAM ASUKA STATION
DAY: 17 Jan. 17,1988
MAGNETOGRAM ASUKA STATION
DAY: 18 Jan. 18,1988
H
D
Z
100nT/DIV
00 02 04 06 08 10 12 14 16 18 20 22 24
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 19 Jan. 19, 1988
MAGNETOGRAM SYOWA STATION DAY: 20 Jan. 20, 1988
MAGNETOGRAM ASUKA STATION DAY: 19 Jan. 19, 1988
MAGNETOGRAM ASUKA STATION DAY: 20 Jan. 20, 1988
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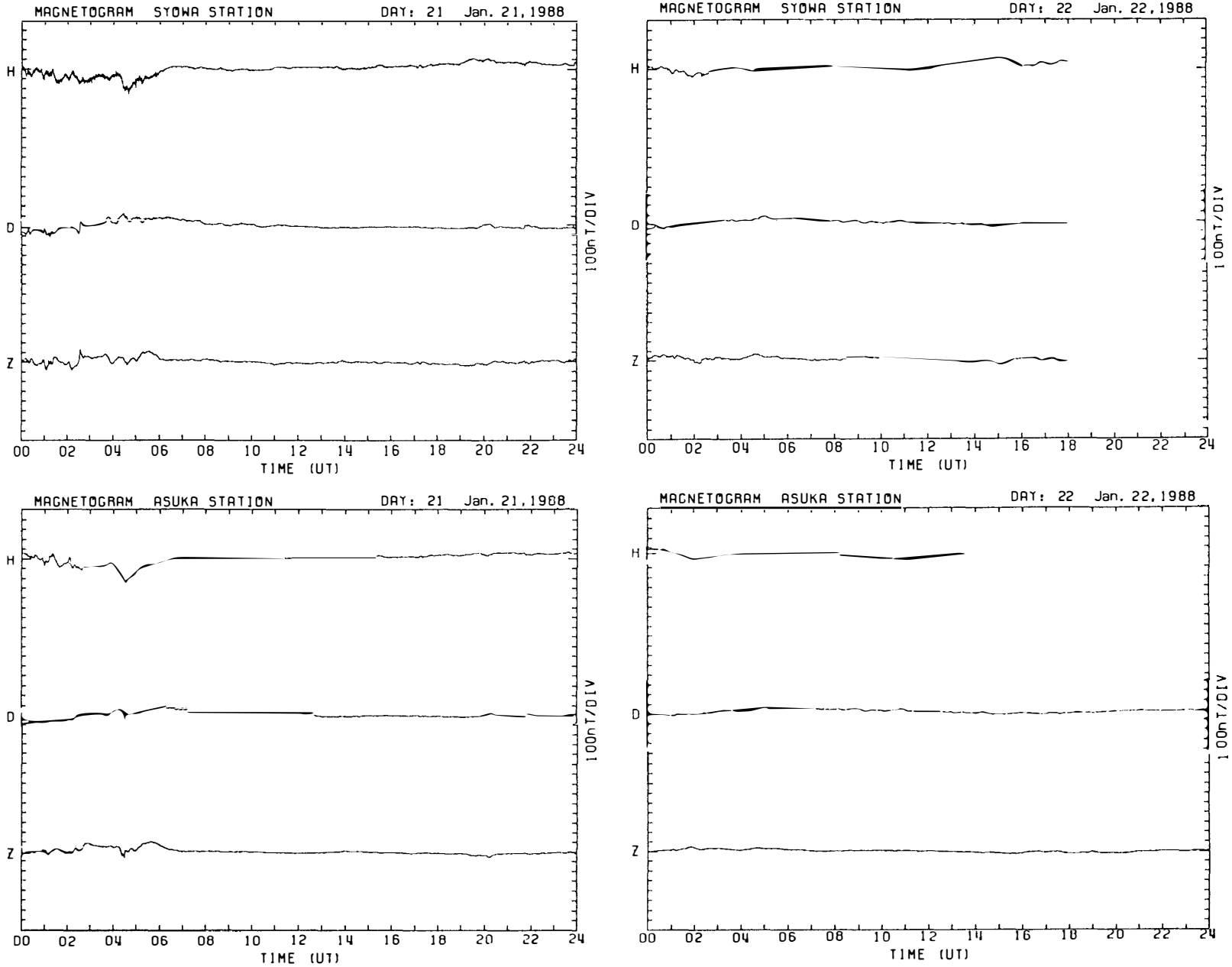
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 21 Jan. 21,1988
MAGNETOGRAM SYOWA STATION DAY: 22 Jan. 22,1988
MAGNETOGRAM ASUKA STATION DAY: 21 Jan. 21,1988
MAGNETOGRAM ASUKA STATION DAY: 22 Jan. 22,1988
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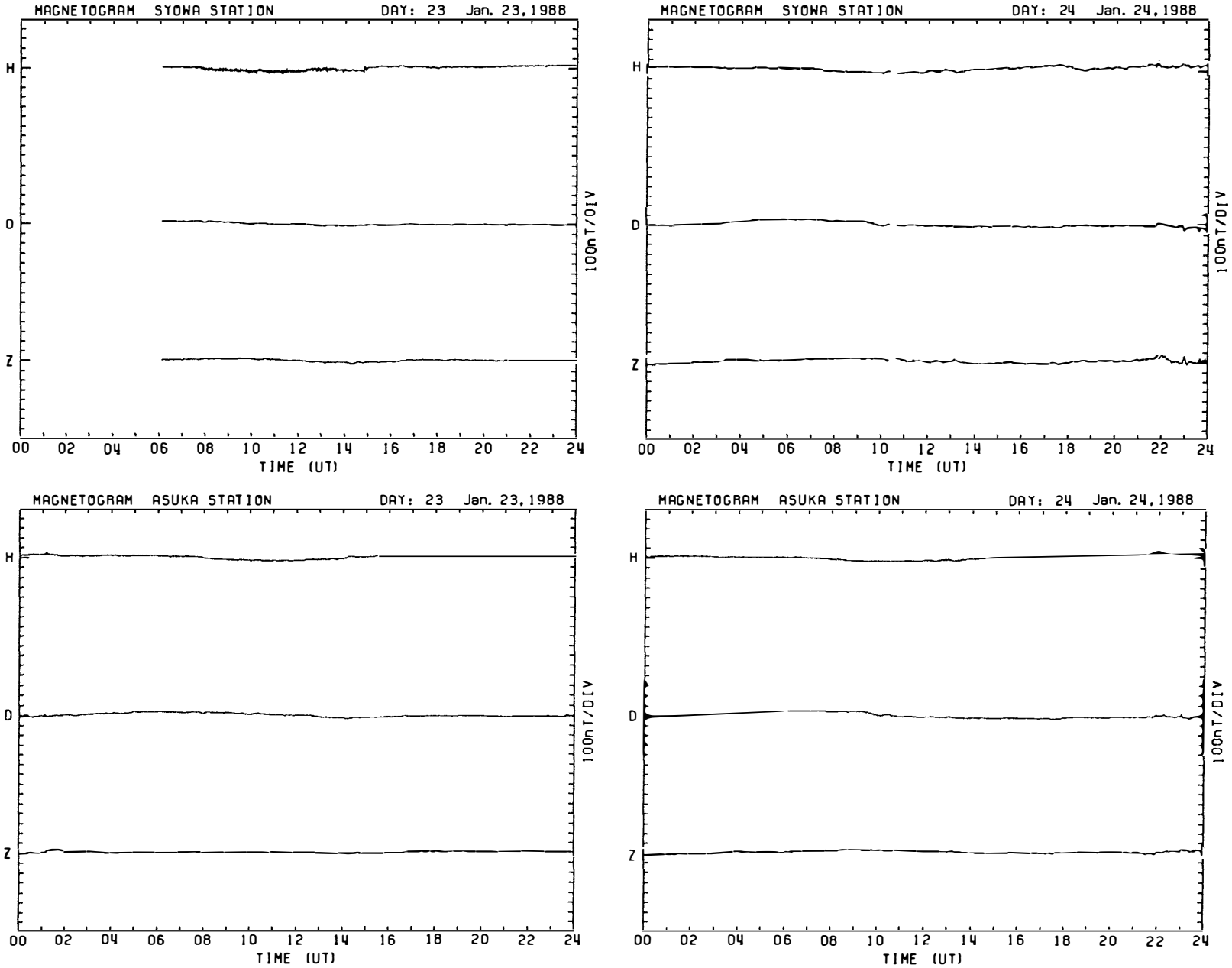
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 23 Jan. 23,1988
MAGNETOGRAM SYOWA STATION DAY: 24 Jan. 24,1988
MAGNETOGRAM ASUKA STATION DAY: 23 Jan. 23,1988
MAGNETOGRAM ASUKA STATION DAY: 24 Jan. 24,1988
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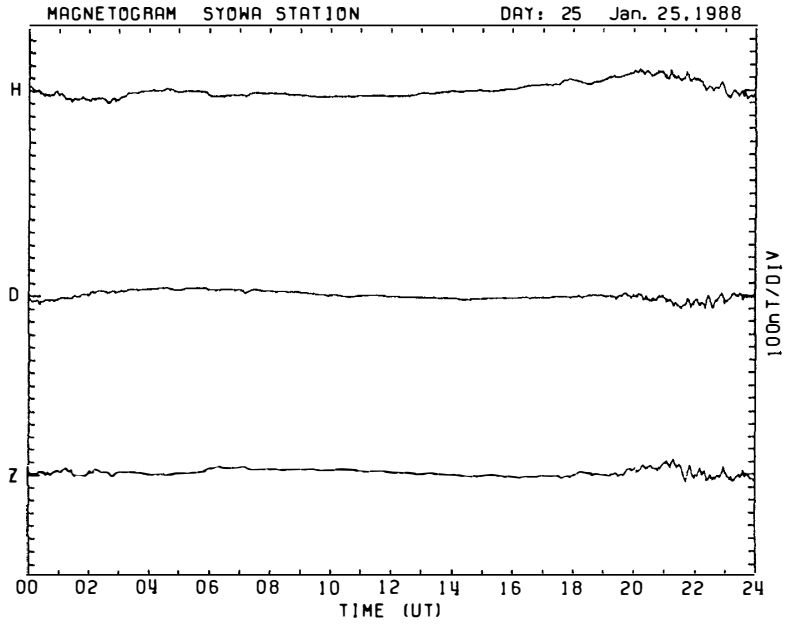
TIME (UT)


MAGNETOGRAM SYOWA STATION
DAY: 25 Jan. 25,1988
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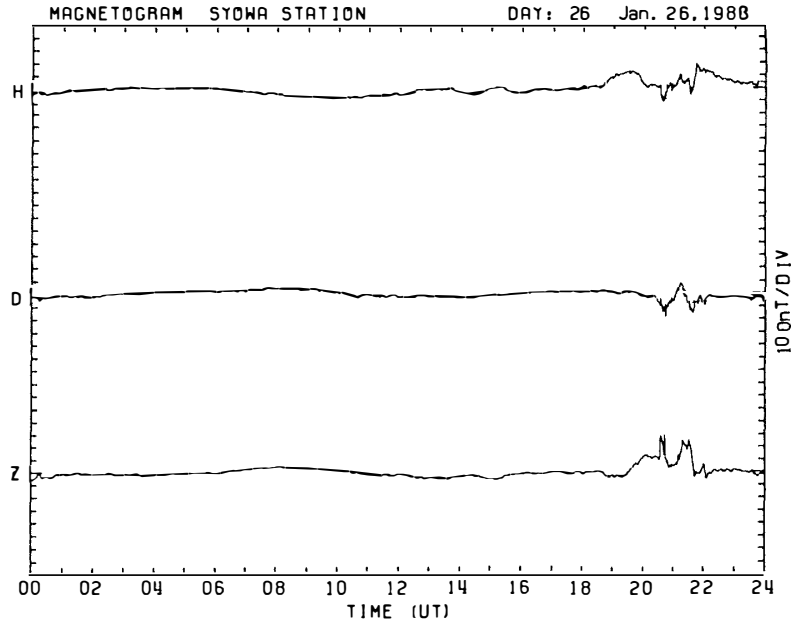
TIME (UT)


MAGNETOGRAM SYOWA STATION
DAY: 26 Jan. 26,1988
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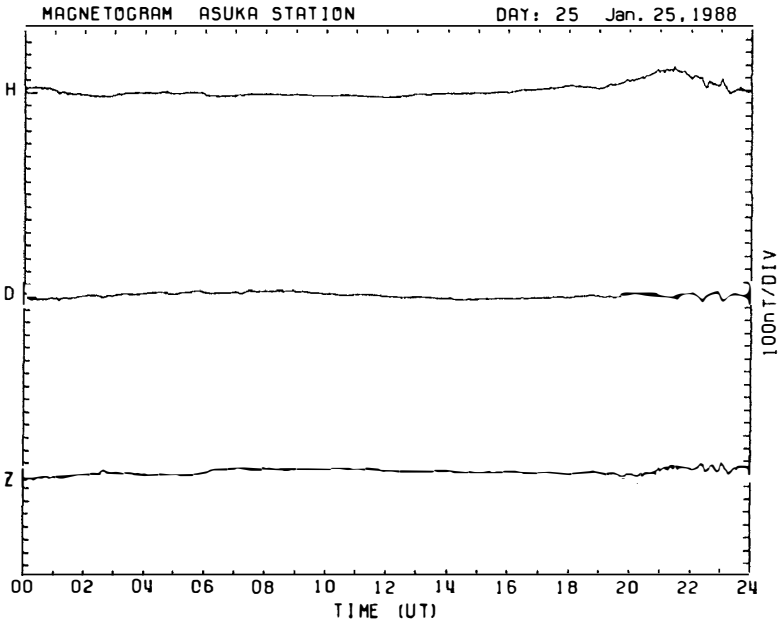
TIME (UT)


MAGNETOGRAM ASUKA STATION
DAY: 25 Jan. 25,1988
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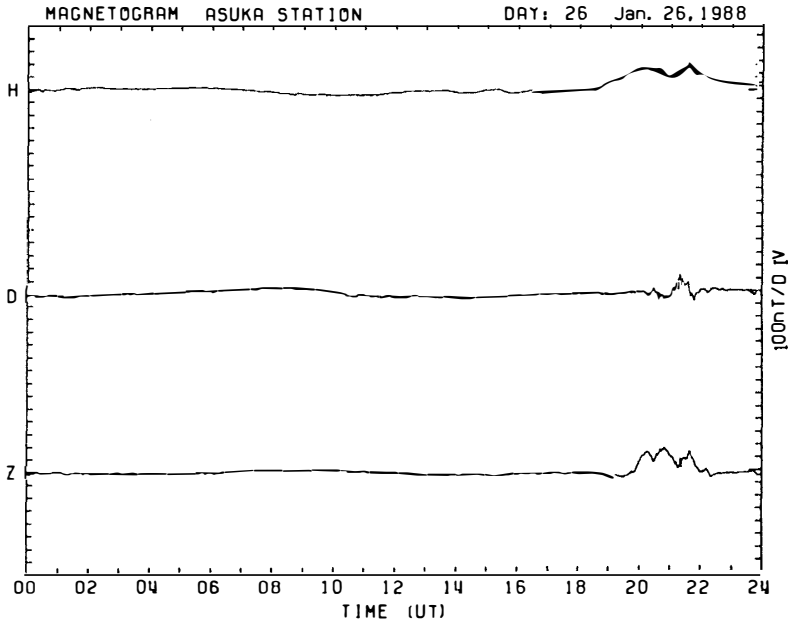
TIME (UT)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DAY: 26 Jan. 26,1988
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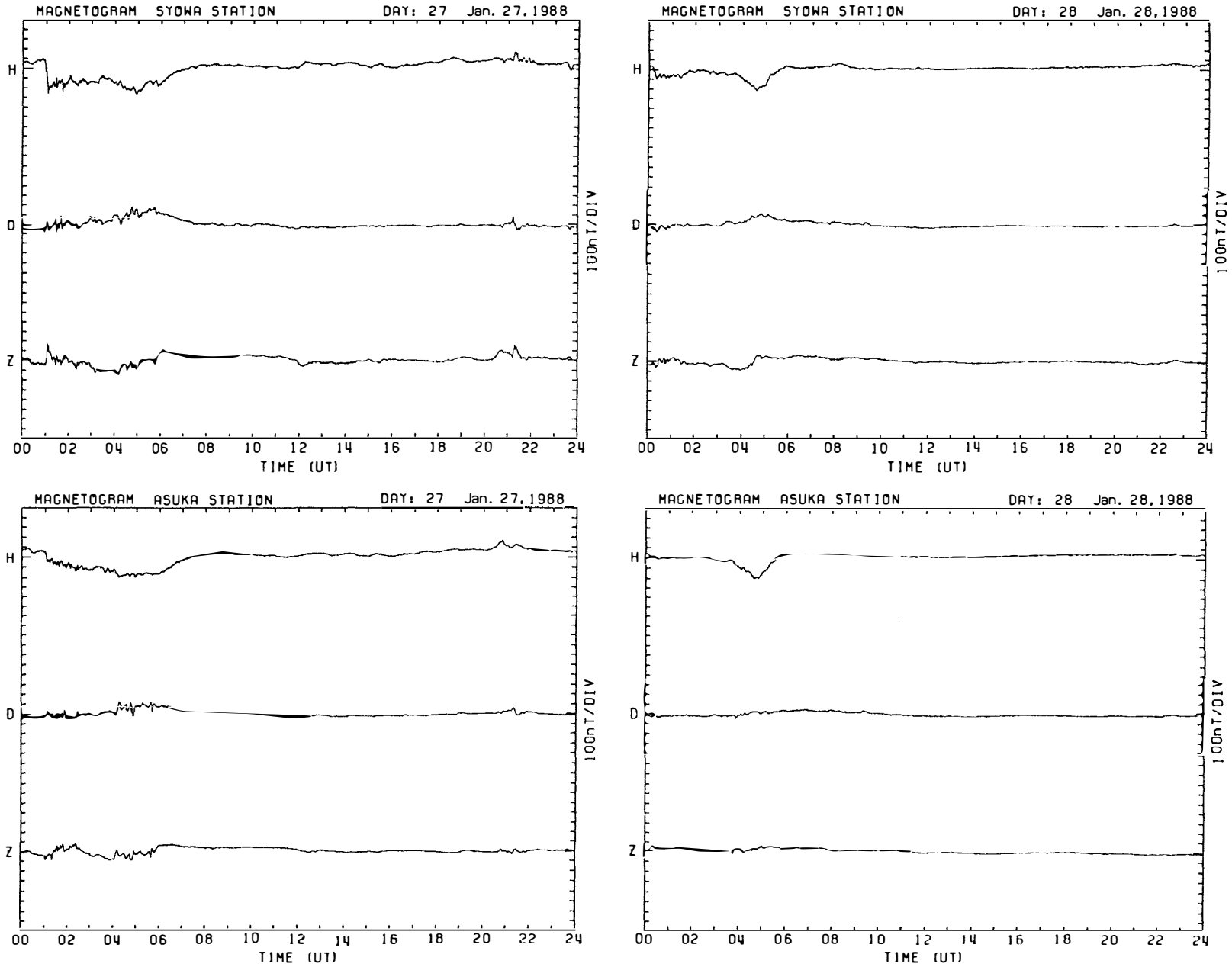
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 27 Jan. 27,1988
MAGNETOGRAM SYOWA STATION DAY: 28 Jan. 28,1988
MAGNETOGRAM ASUKA STATION DAY: 27 Jan. 27,1988
MAGNETOGRAM ASUKA STATION DAY: 28 Jan. 28,1988
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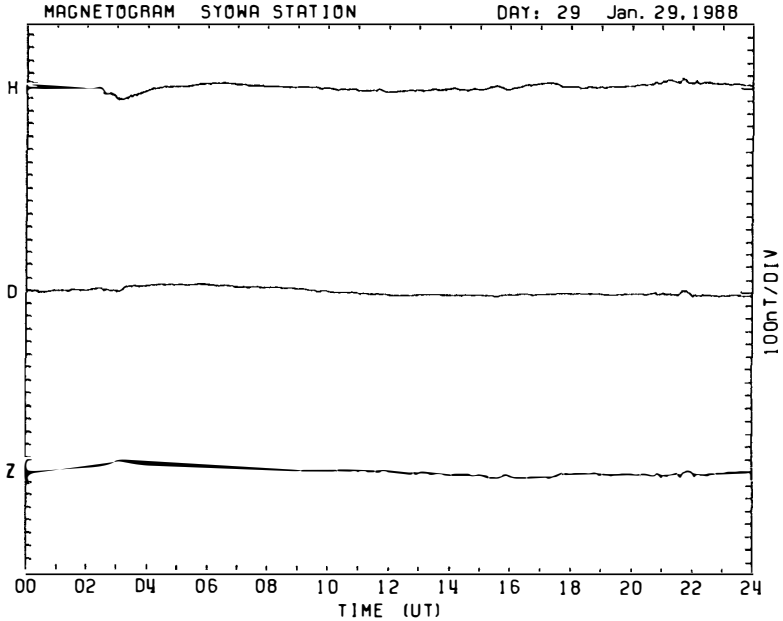
TIME (UT)


MAGNETOGRAM SYOWA STATION
DAY: 29 Jan. 29,1988
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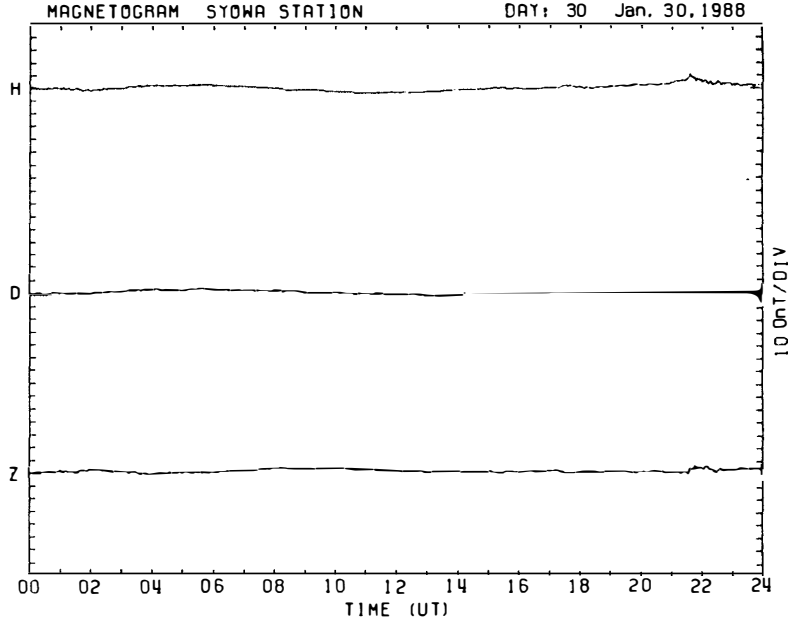
00 02 04 06 08 10 12 14 16 18 20 22 24
TIME (UT)


MAGNETOGRAM SYOWA STATION
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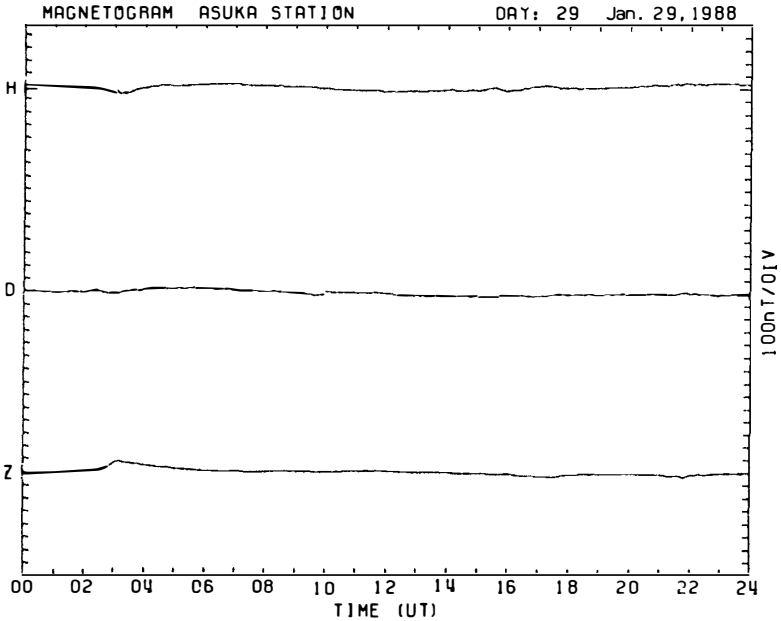
TIME (UT)


MAGNETOGRAM ASUKA STATION
DAY: 29 Jan. 29,1988
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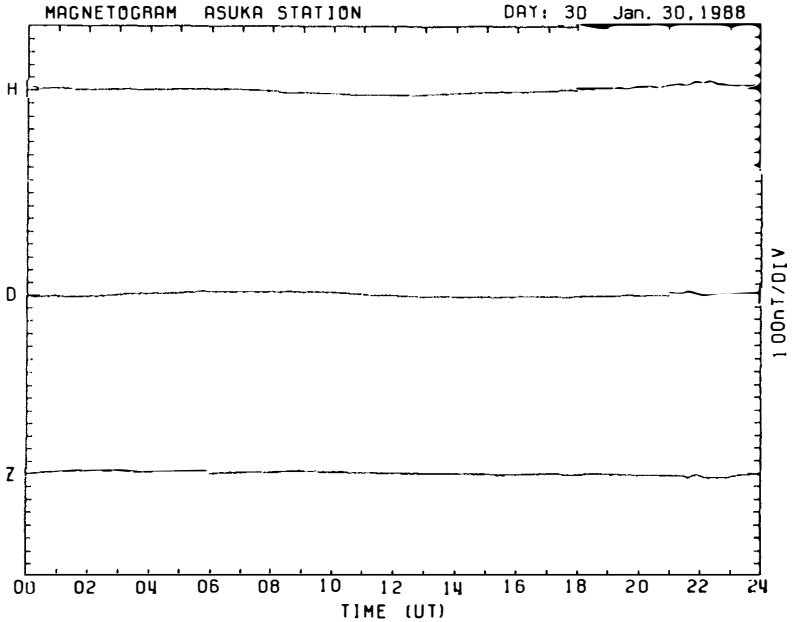
TIME (UT)


MAGNETOGRAM ASUKA STATION
DAY: 30 Jan. 30,1988
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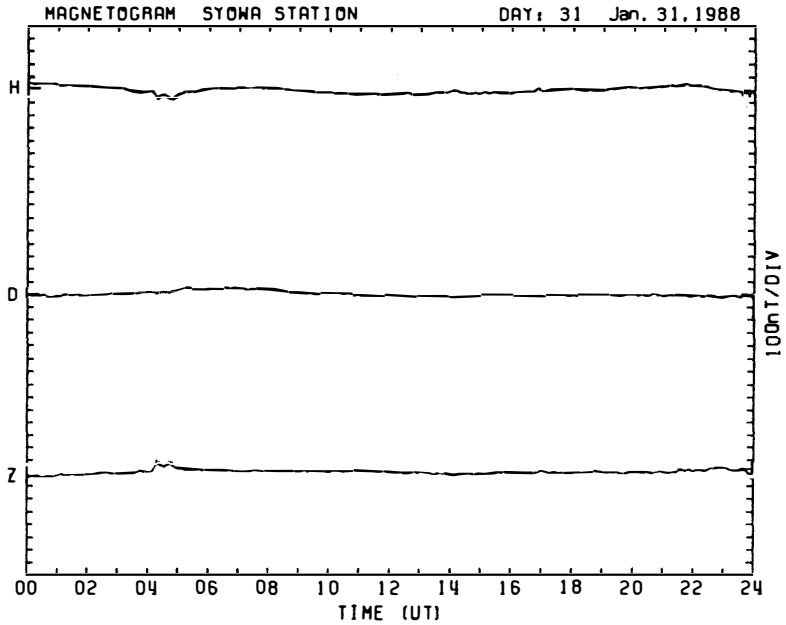
TIME (UT)


MAGNETOGRAM SYOWA STATION
DAY: 31 Jan. 31, 1988
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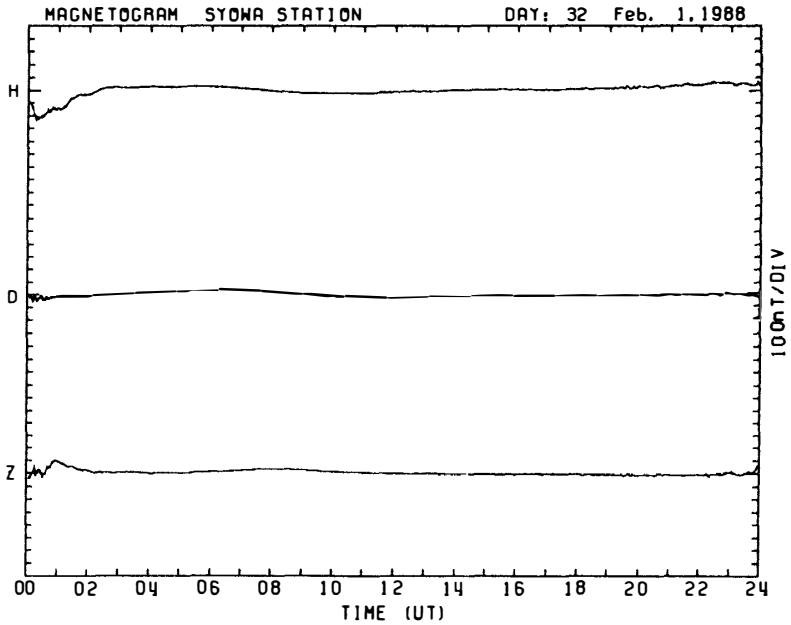
TIME (UT)


MAGNETOGRAM SYOWA STATION
DAY: 32 Feb. 1, 1988
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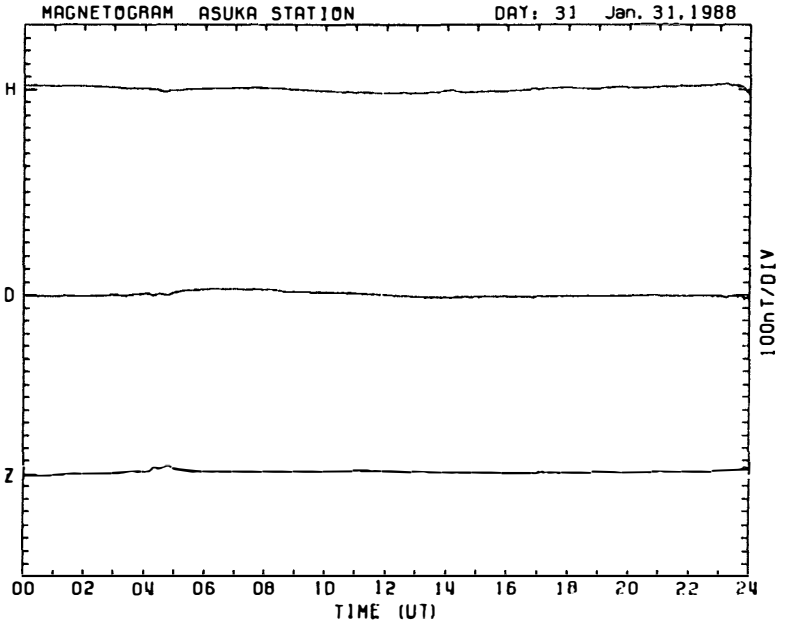
TIME (UT)


MAGNETOGRAM ASUKA STATION
DAY: 31 Jan. 31, 1988
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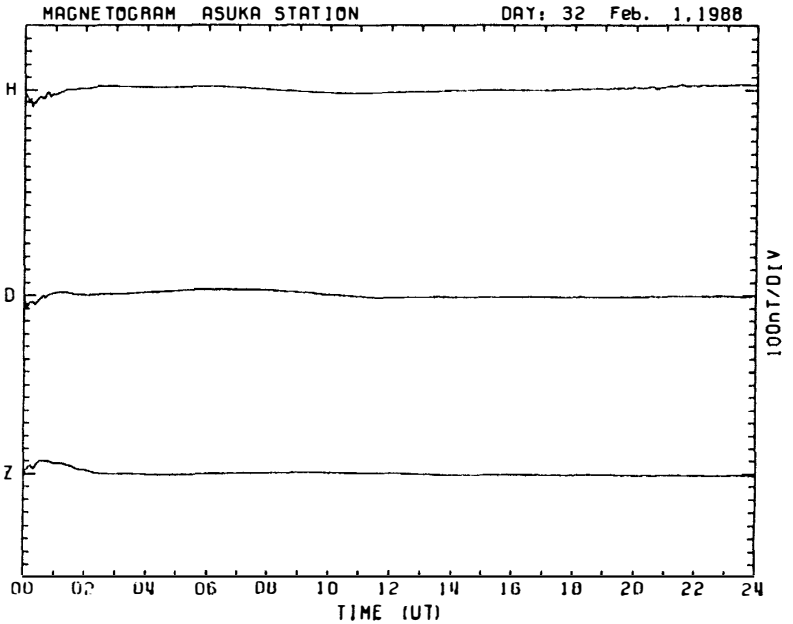
TIME (UT)


MAGNETOGRAM ASUKA STATION
DAY: 32 Feb. 1, 1988
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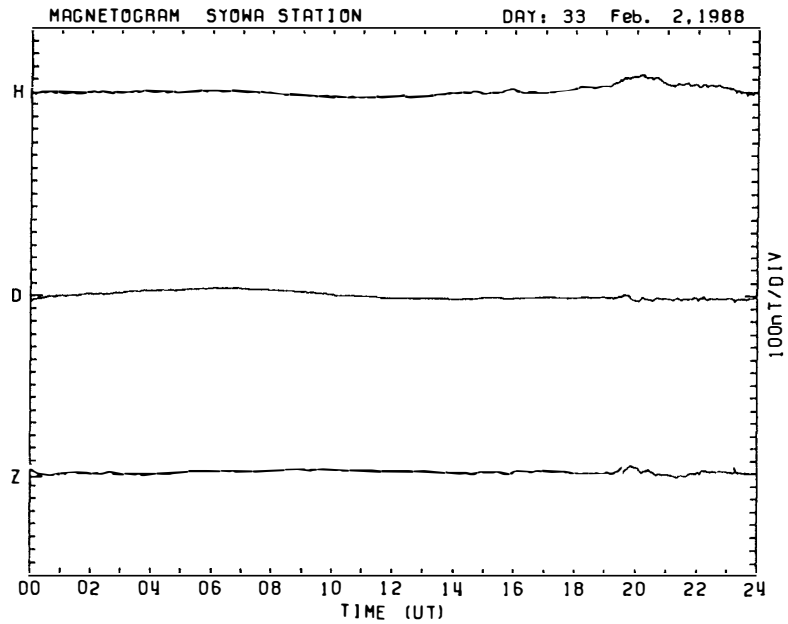
TIME (UT)


MAGNETOGRAM STOWA STATION
DAY: 33 Feb. 2,1988
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100nT/DIV
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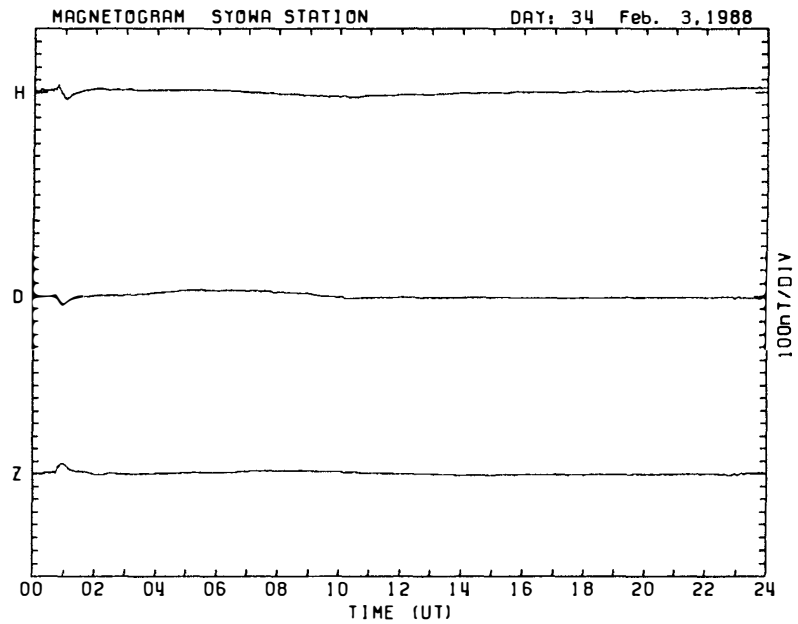
TIME (UT)


MAGNETOGRAM STOWA STATION
DAY: 34 Feb. 3,1988
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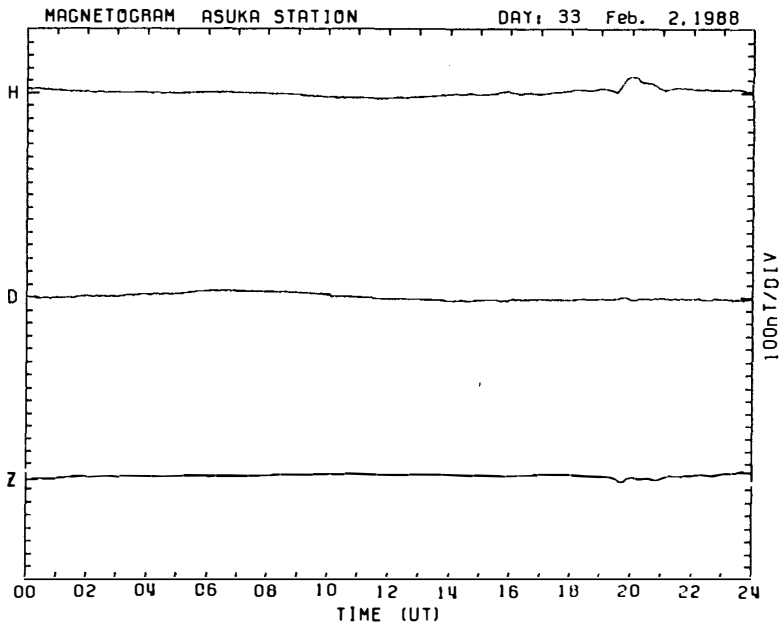
TIME (UT)


MAGNETOGRAM ASUKA STATION
DAY: 33 Feb. 2,1988
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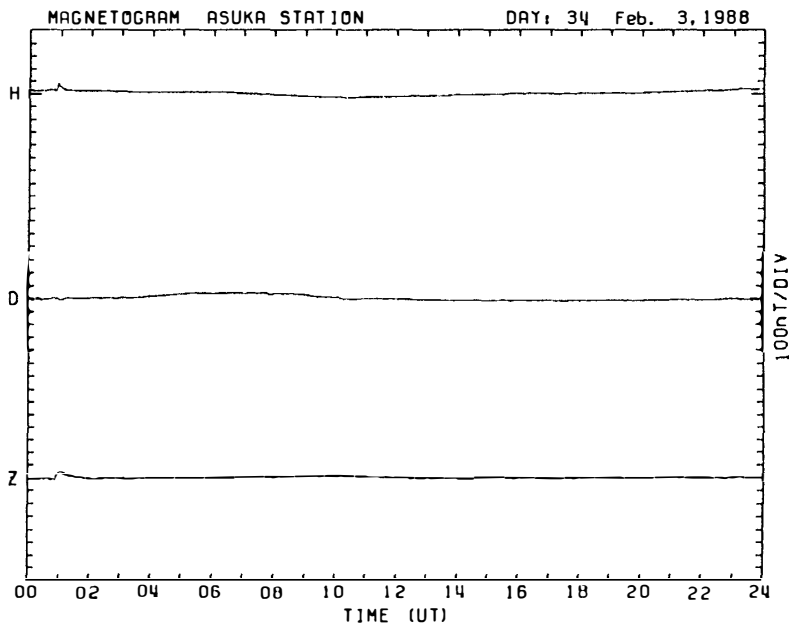
TIME (UT)


MAGNETOGRAM ASUKA STATION
DAY: 34 Feb. 3,1988
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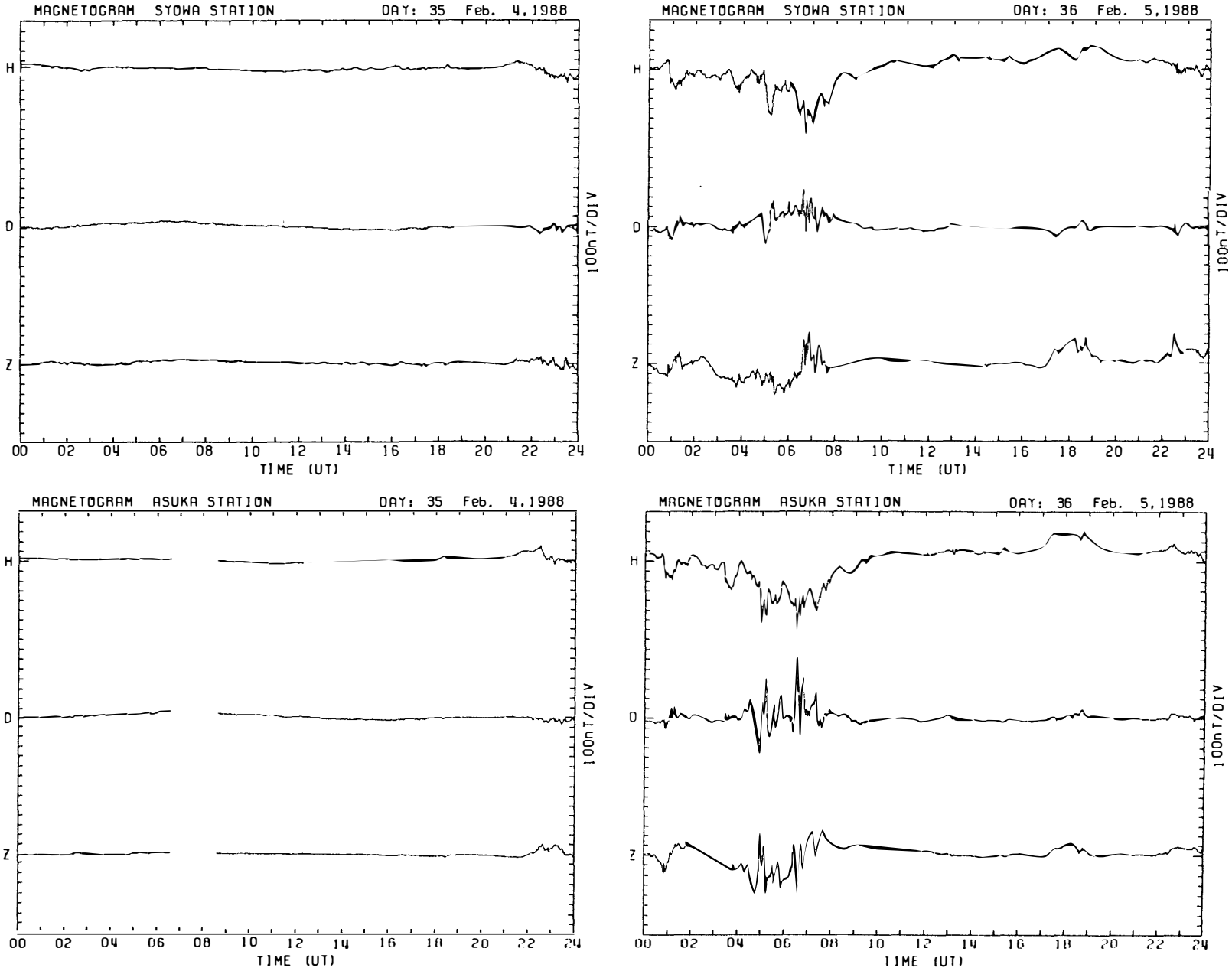
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 35 Feb. 4,1988
MAGNETOGRAM SYOWA STATION DAY: 36 Feb. 5,1988
MAGNETOGRAM ASUKA STATION DAY: 35 Feb. 4,1988
MAGNETOGRAM ASUKA STATION DAY: 36 Feb. 5,1988
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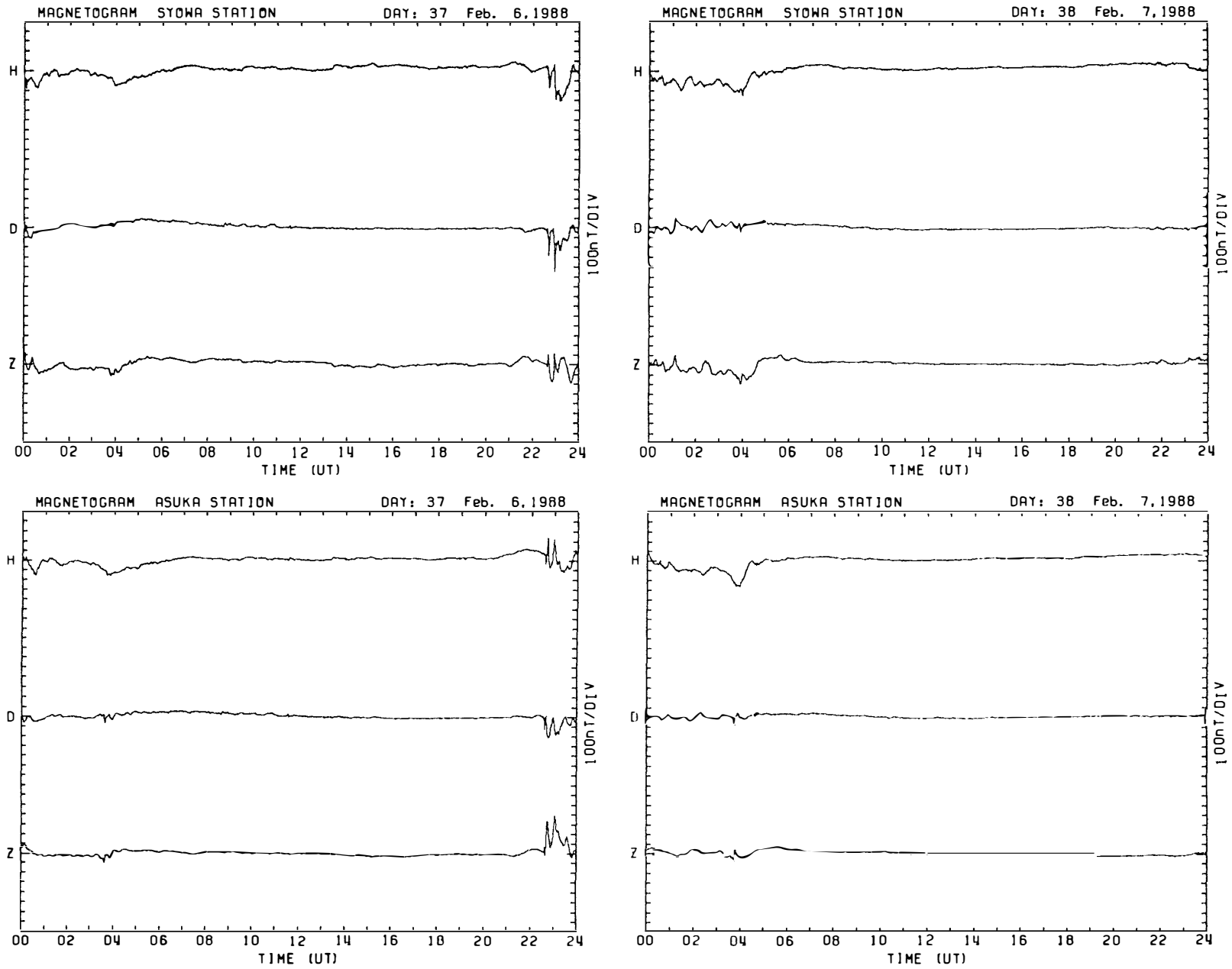
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 37 Feb. 6,1988
MAGNETOGRAM SYOWA STATION DAY: 38 Feb. 7,1988
MAGNETOGRAM ASUKA STATION DAY: 37 Feb. 6,1988
MAGNETOGRAM ASUKA STATION DAY: 38 Feb. 7,1988
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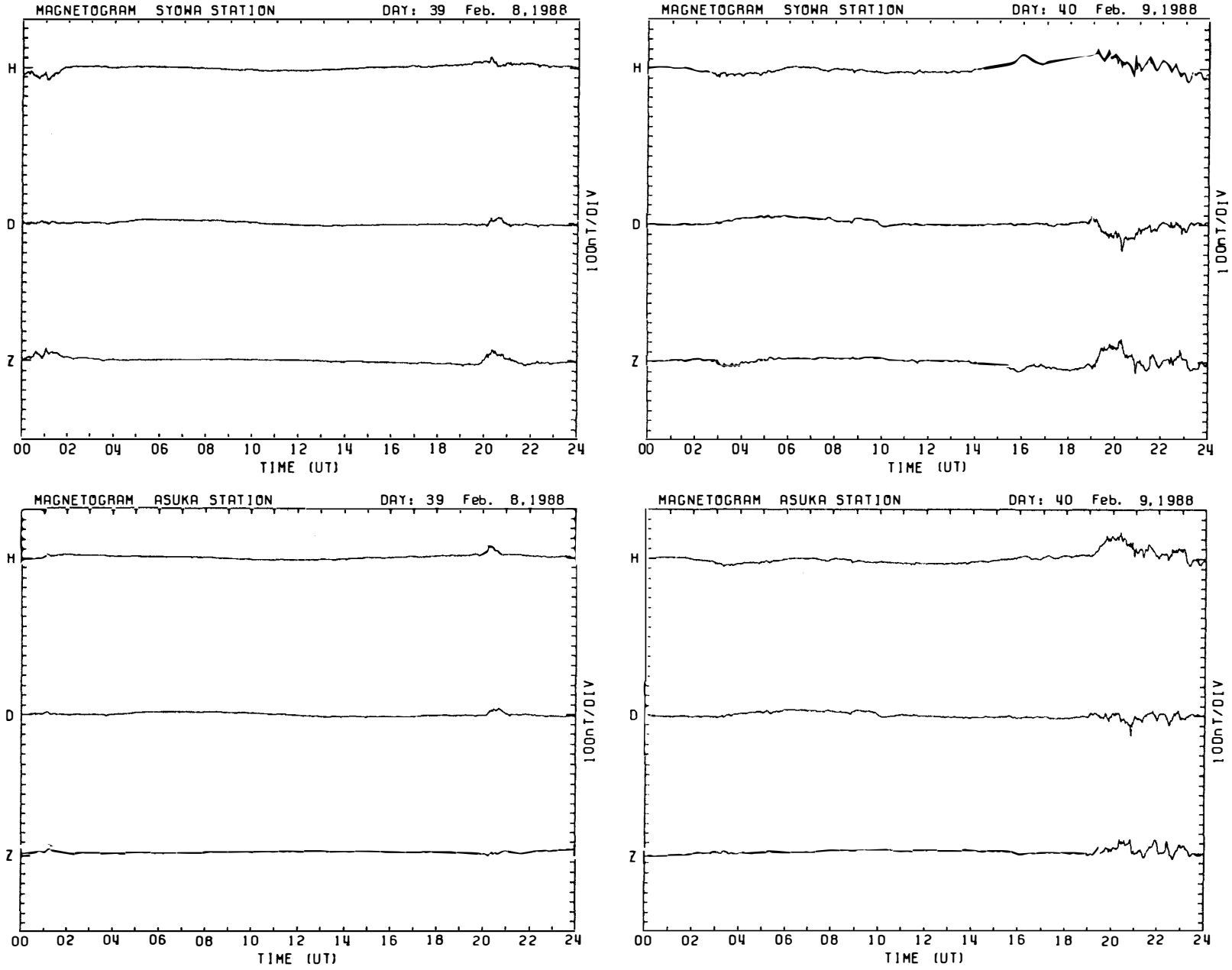
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 39 Feb. 8,1988
MAGNETOGRAM SYOWA STATION DAY: 40 Feb. 9,1988
MAGNETOGRAM ASUKA STATION DAY: 39 Feb. 8,1988
MAGNETOGRAM ASUKA STATION DAY: 40 Feb. 9,1988
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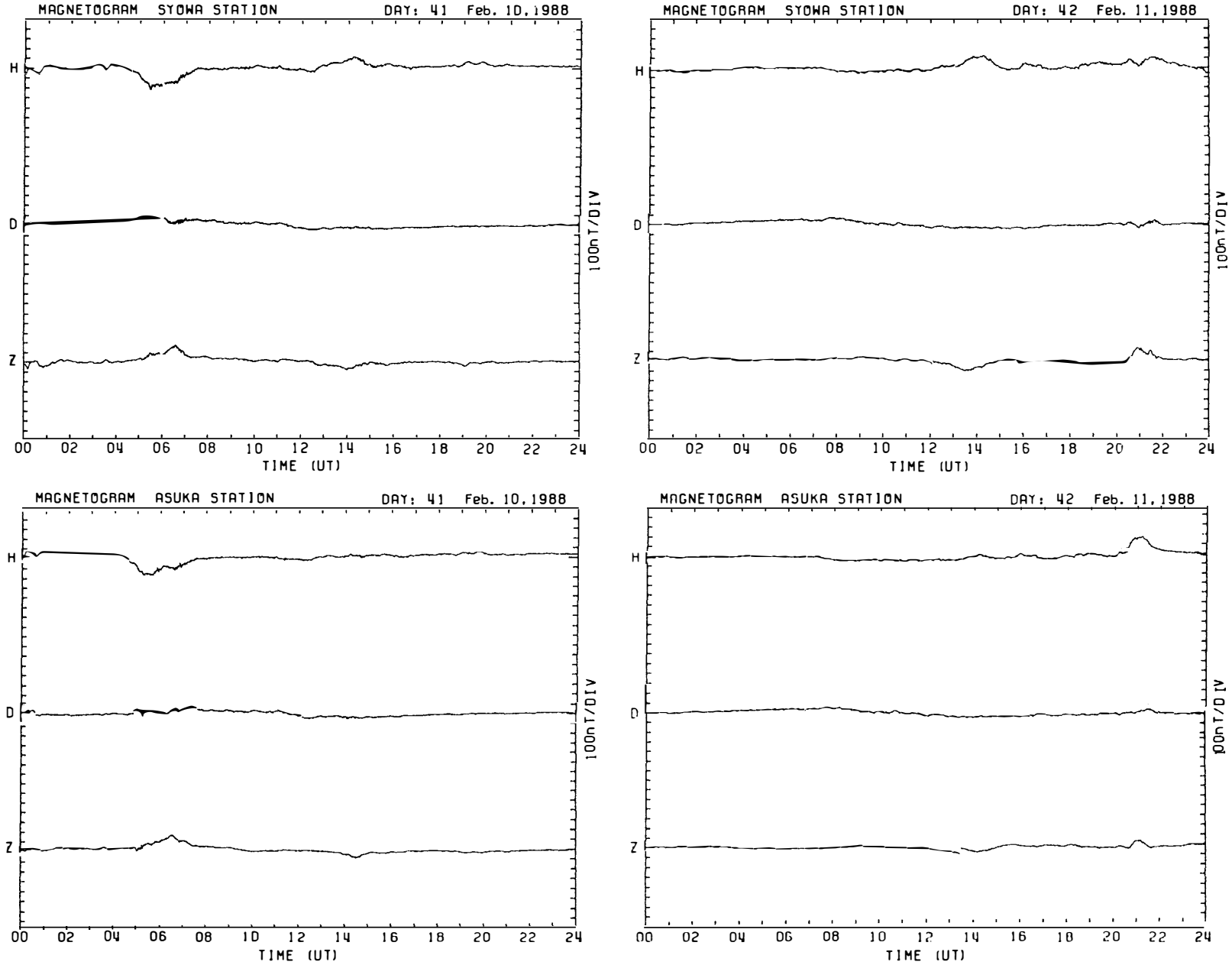
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 41 Feb. 10, 1988
MAGNETOGRAM SYOWA STATION DAY: 42 Feb. 11, 1988
MAGNETOGRAM ASUKA STATION DAY: 41 Feb. 10, 1988
MAGNETOGRAM ASUKA STATION DAY: 42 Feb. 11, 1988
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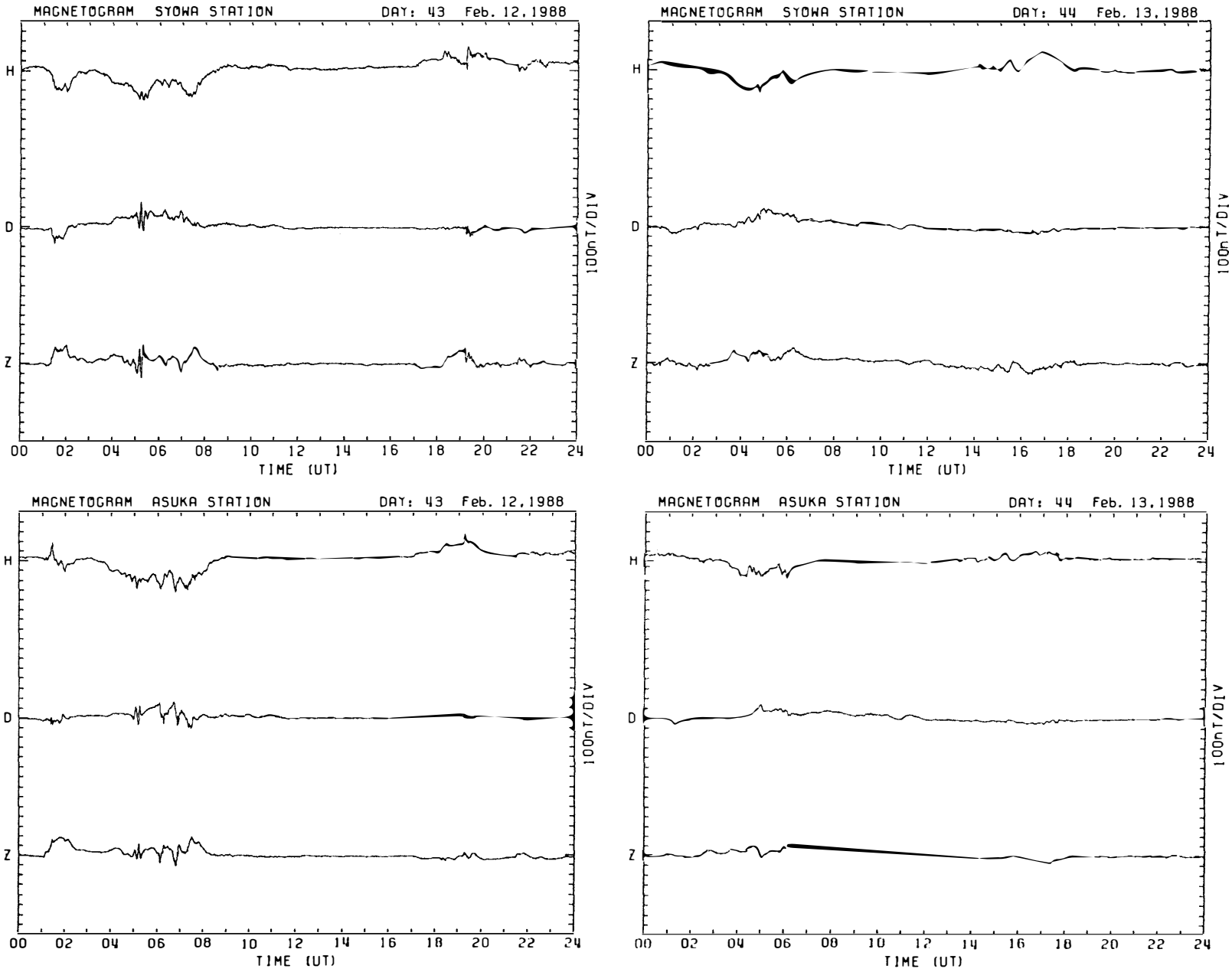
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 43 Feb. 12,1988
MAGNETOGRAM SYOWA STATION DAY: 44 Feb. 13,1988
MAGNETOGRAM ASUKA STATION DAY: 43 Feb. 12,1988
MAGNETOGRAM ASUKA STATION DAY: 44 Feb. 13,1988
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100nT/DIV
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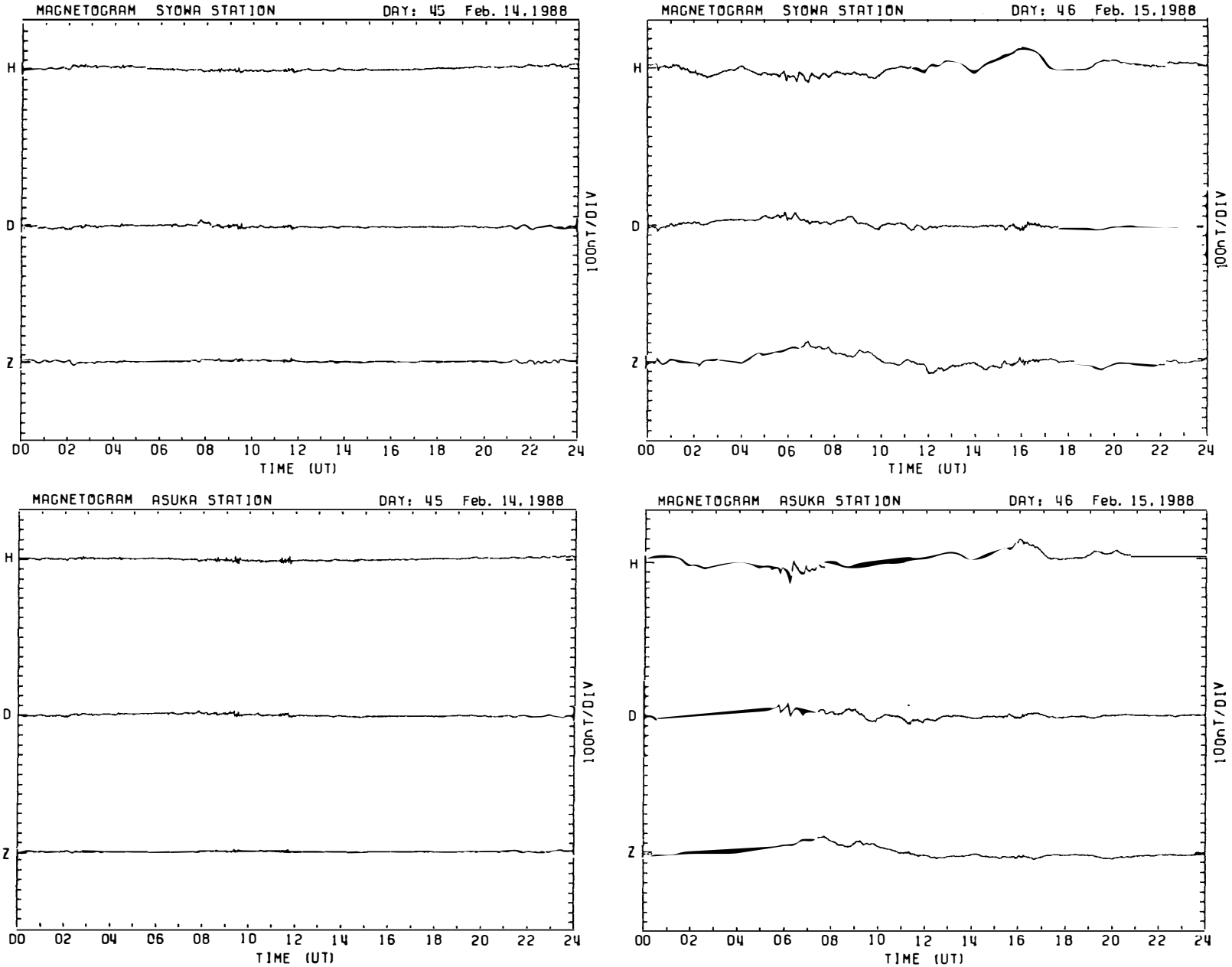
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 45 Feb. 14,1988
MAGNETOGRAM SYOWA STATION DAY: 46 Feb. 15,1988
MAGNETOGRAM ASUKA STATION DAY: 45 Feb. 14,1988
MAGNETOGRAM ASUKA STATION DAY: 46 Feb. 15,1988
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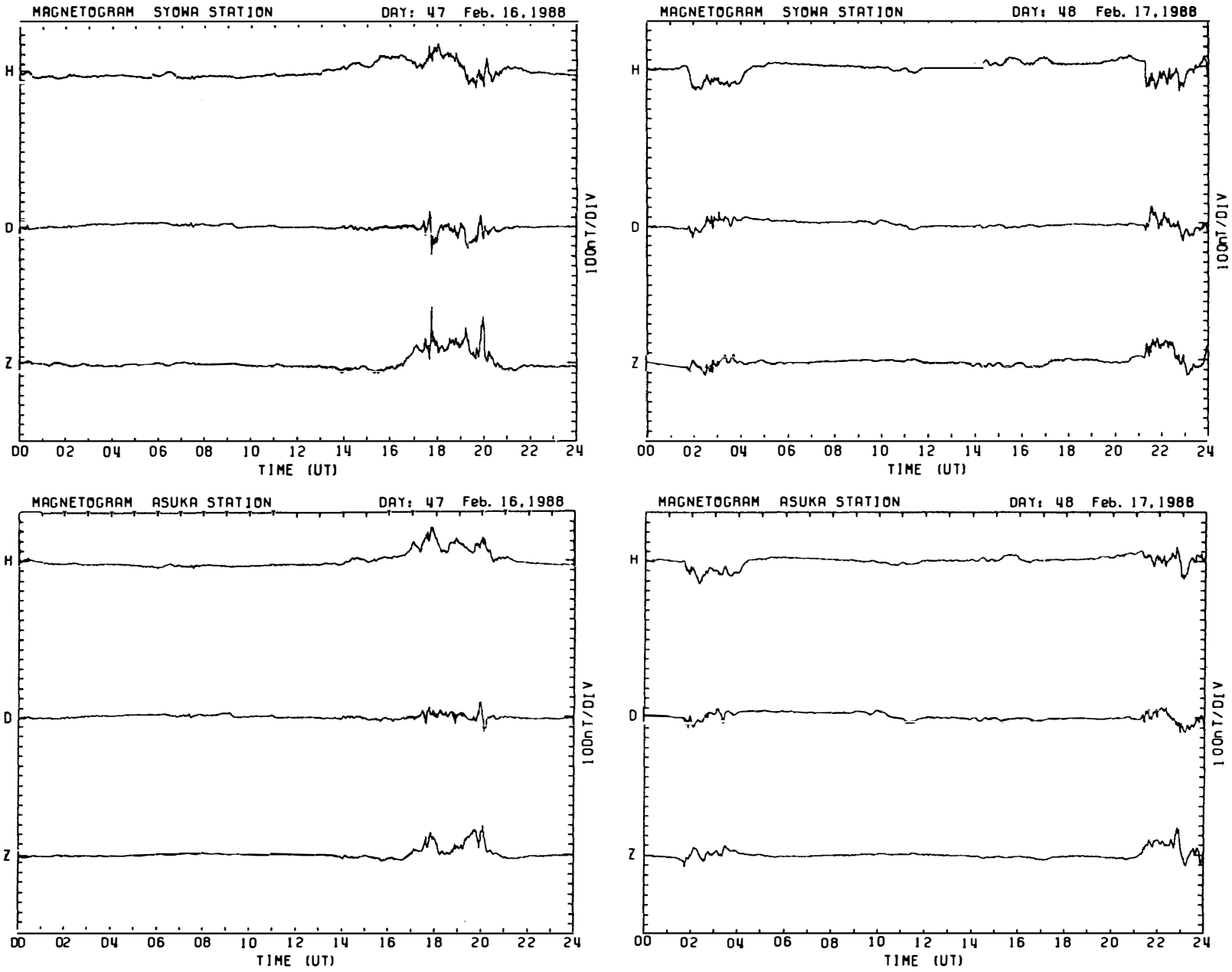
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 47 Feb. 16,1988
MAGNETOGRAM SYOWA STATION DAY: 48 Feb. 17,1988
MAGNETOGRAM ASUKA STATION DAY: 47 Feb. 16,1988
MAGNETOGRAM ASUKA STATION DAY: 48 Feb. 17,1988
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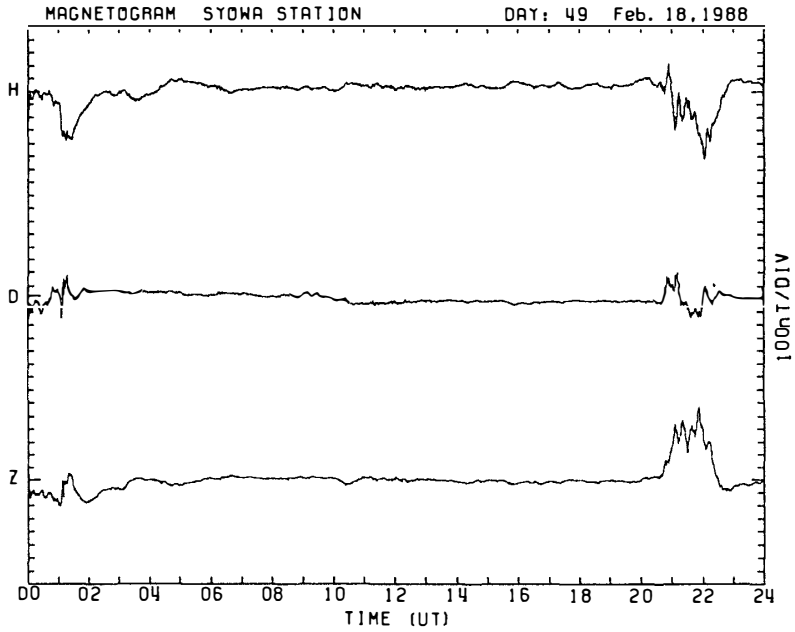
TIME (UT)


MAGNETOGRAM SYOWA STATION
DAY: 49 Feb. 18,1988
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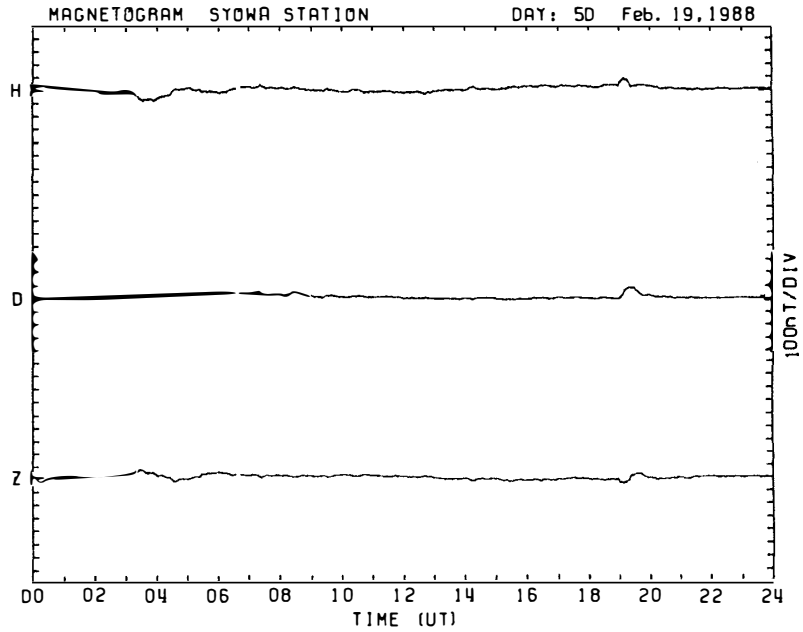
TIME (UT)


MAGNETOGRAM SYOWA STATION
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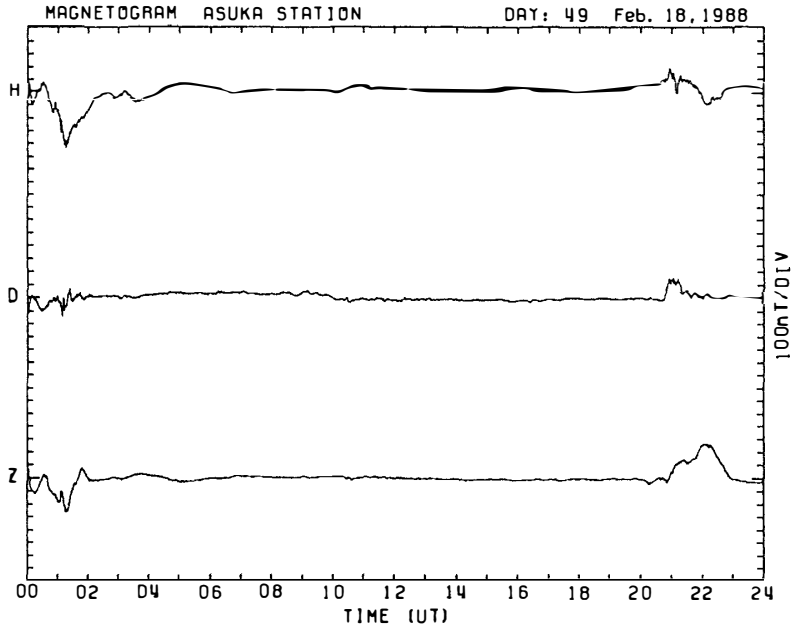
TIME (UT)


MAGNETOGRAM ASUKA STATION
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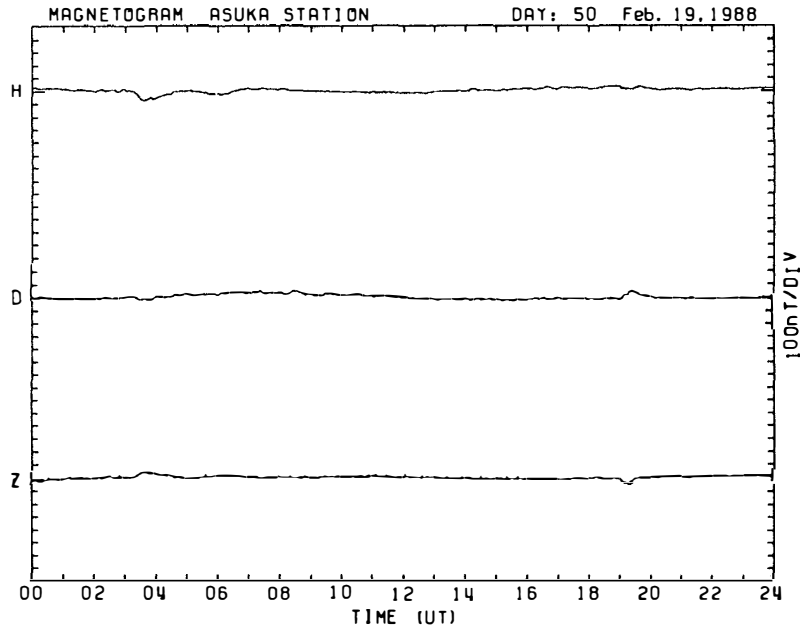
TIME (UT)


MAGNETOGRAM ASUKA STATION
DAY: 50 Feb. 19,1988
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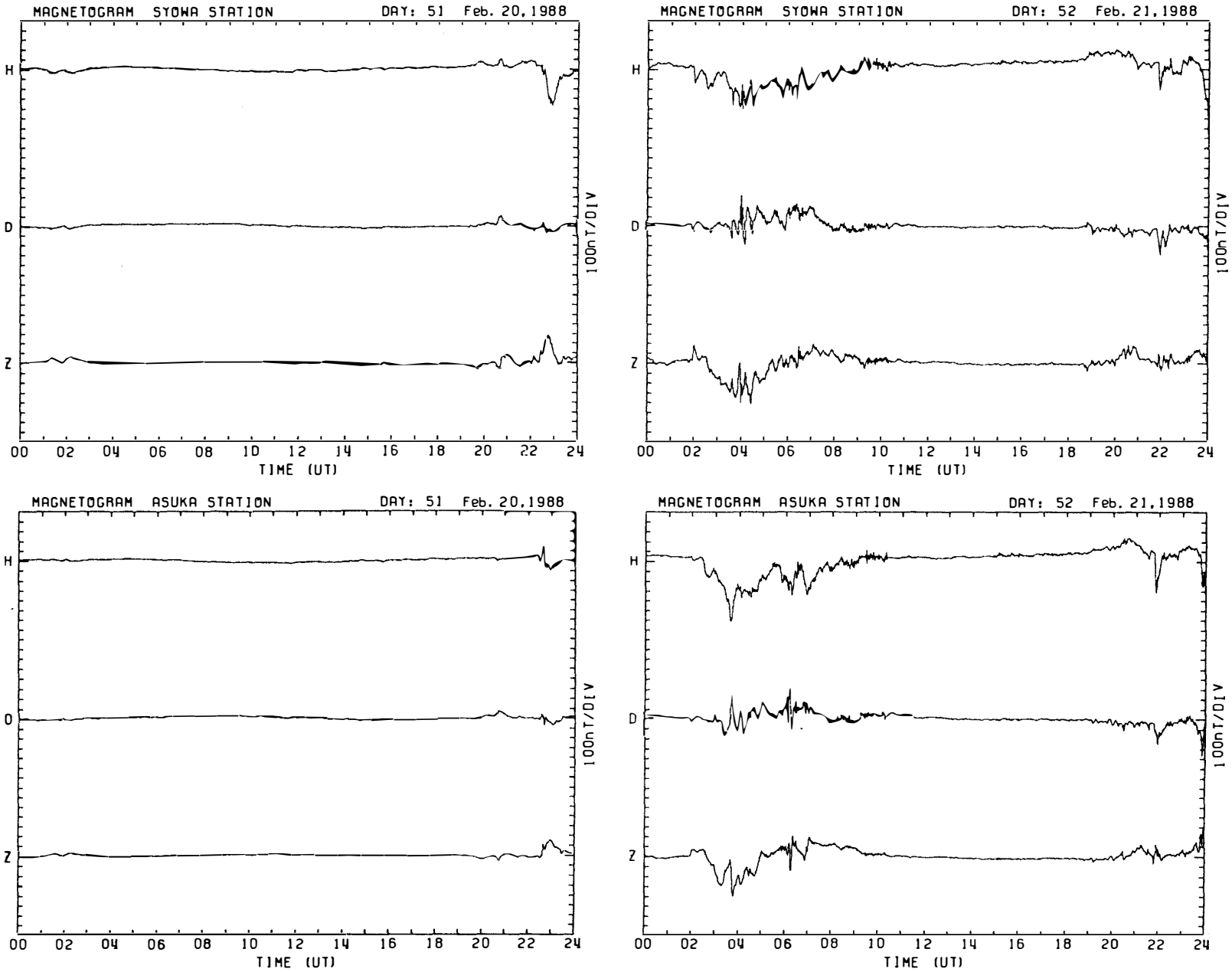
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 51 Feb. 20,1988
MAGNETOGRAM SYOWA STATION DAY: 52 Feb. 21,1988
MAGNETOGRAM ASUKA STATION DAY: 51 Feb. 20,1988
MAGNETOGRAM ASUKA STATION DAY: 52 Feb. 21,1988
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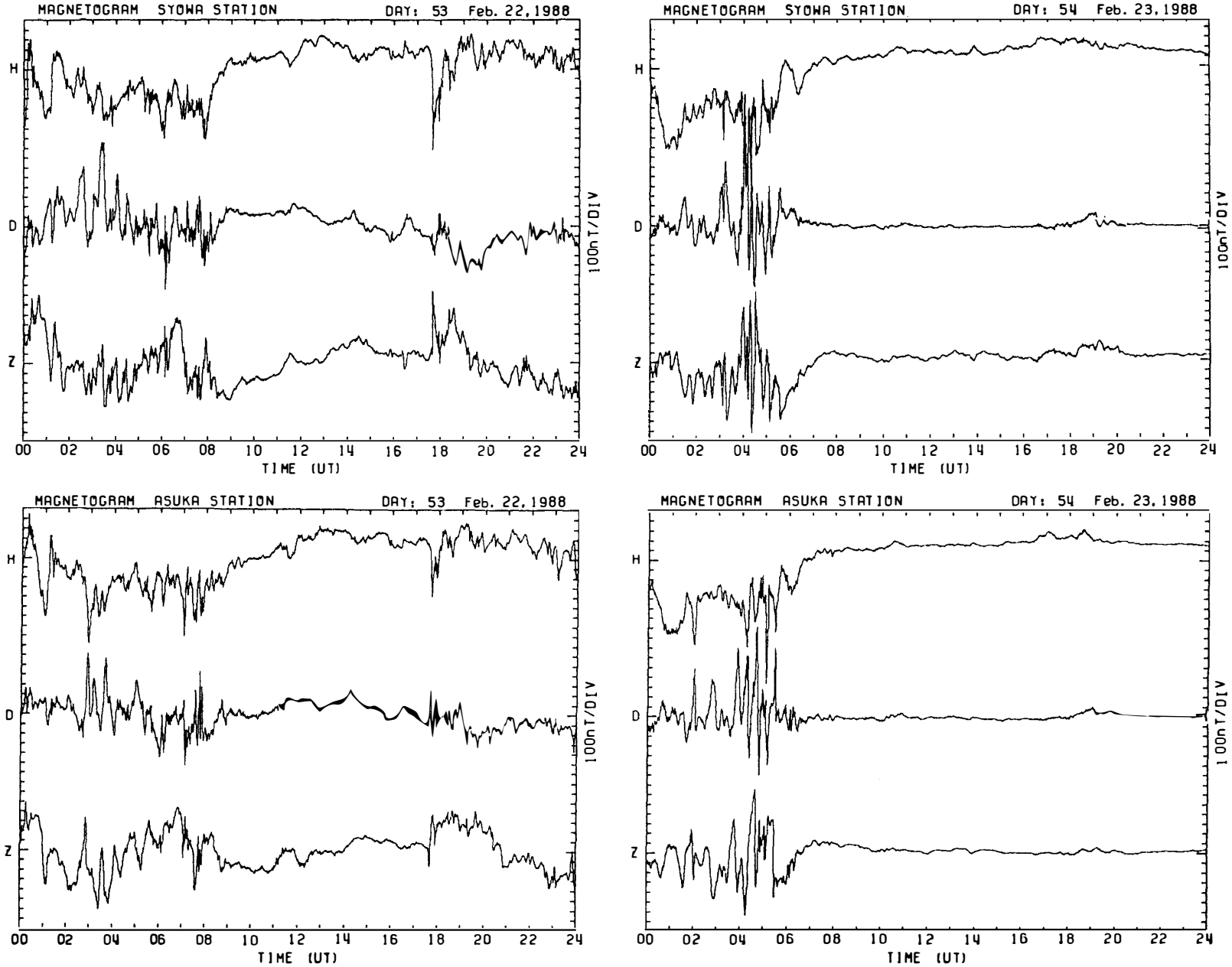
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 53 Feb. 22,1988
MAGNETOGRAM SYOWA STATION DAY: 54 Feb. 23,1988
MAGNETOGRAM ASUKA STATION DAY: 53 Feb. 22,1988
MAGNETOGRAM ASUKA STATION DAY: 54 Feb. 23,1988
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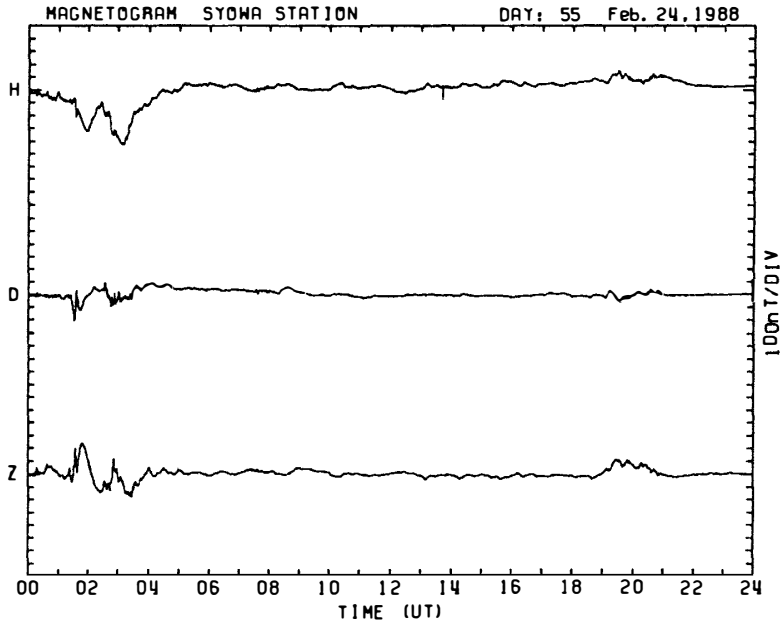
TIME (UT)


MAGNETOGRAM SYOWA STATION
DAY: 55 Feb. 24,1988
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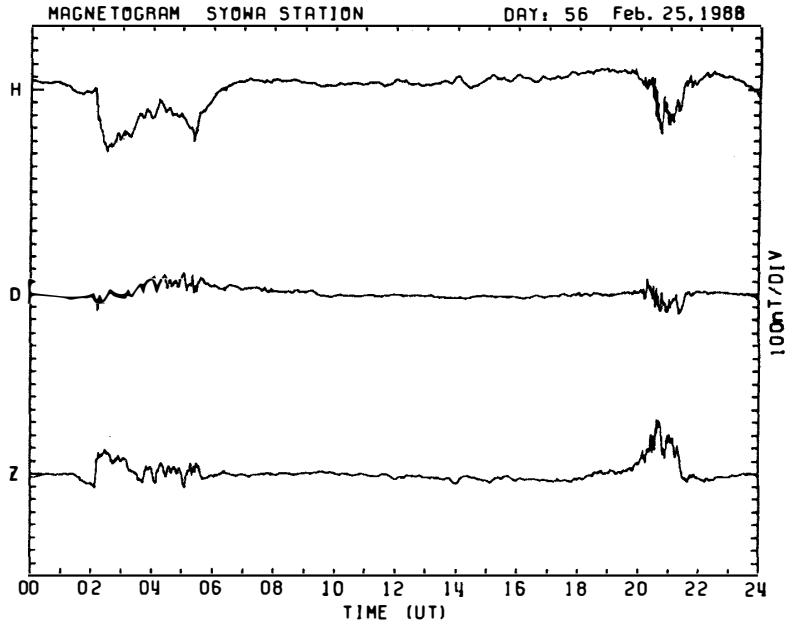
TIME (UT)


MAGNETOGRAM SYOWA STATION
DAY: 56 Feb. 25,1988
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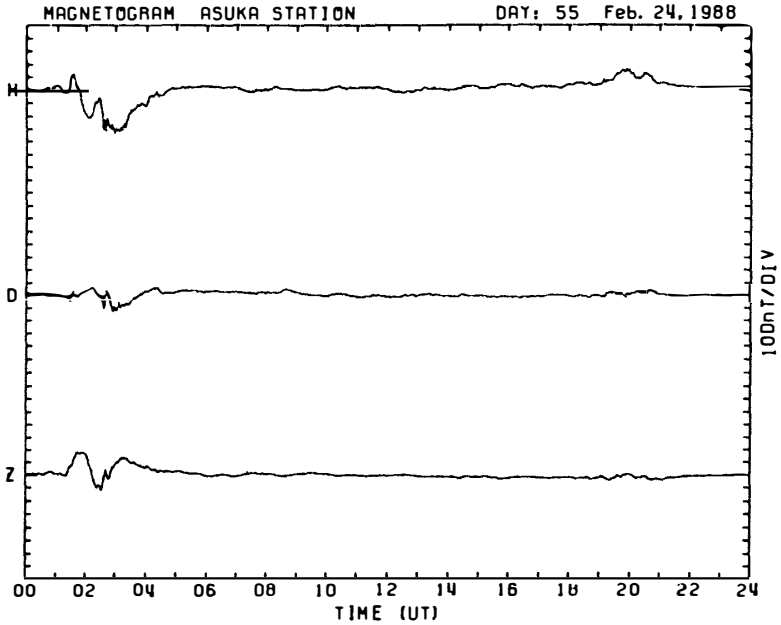
TIME (UT)


MAGNETOGRAM ASUKA STATION
DAY: 55 Feb. 24,1988
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100nT/DIV
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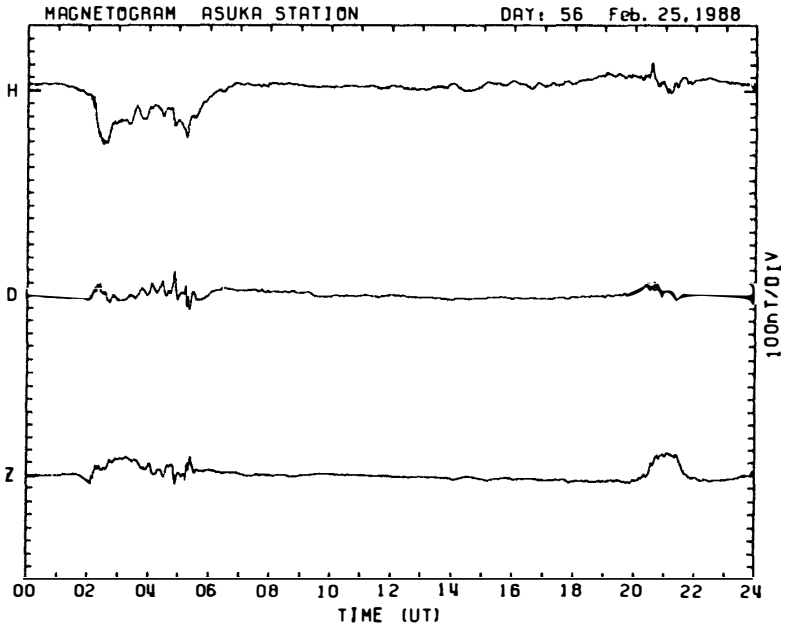
TIME (UT)


MAGNETOGRAM ASUKA STATION
DAY: 56 Feb. 25,1988
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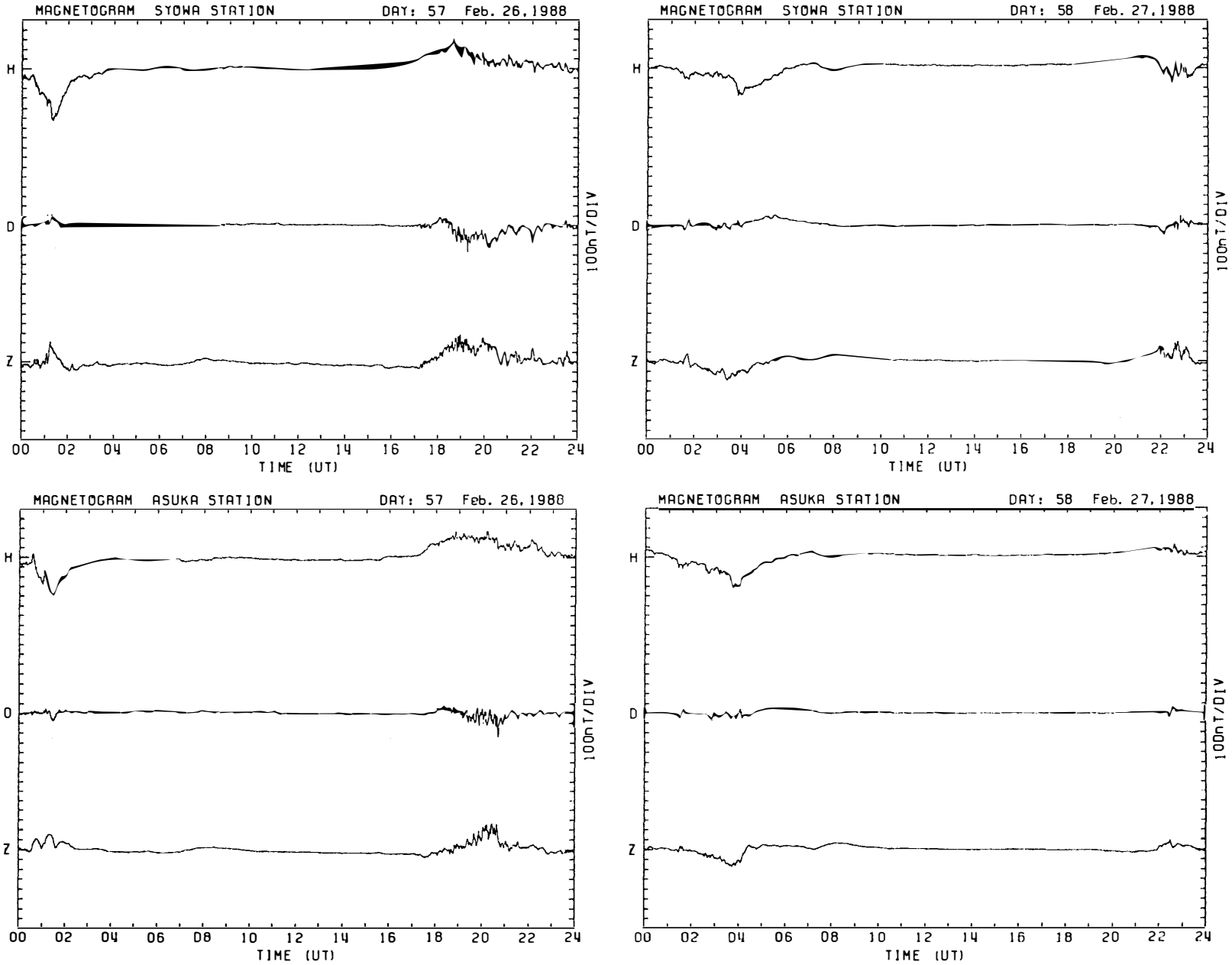
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 57 Feb. 26,1988
MAGNETOGRAM SYOWA STATION DAY: 58 Feb. 27,1988
MAGNETOGRAM ASUKA STATION DAY: 57 Feb. 26,1988
MAGNETOGRAM ASUKA STATION DAY: 58 Feb. 27,1988
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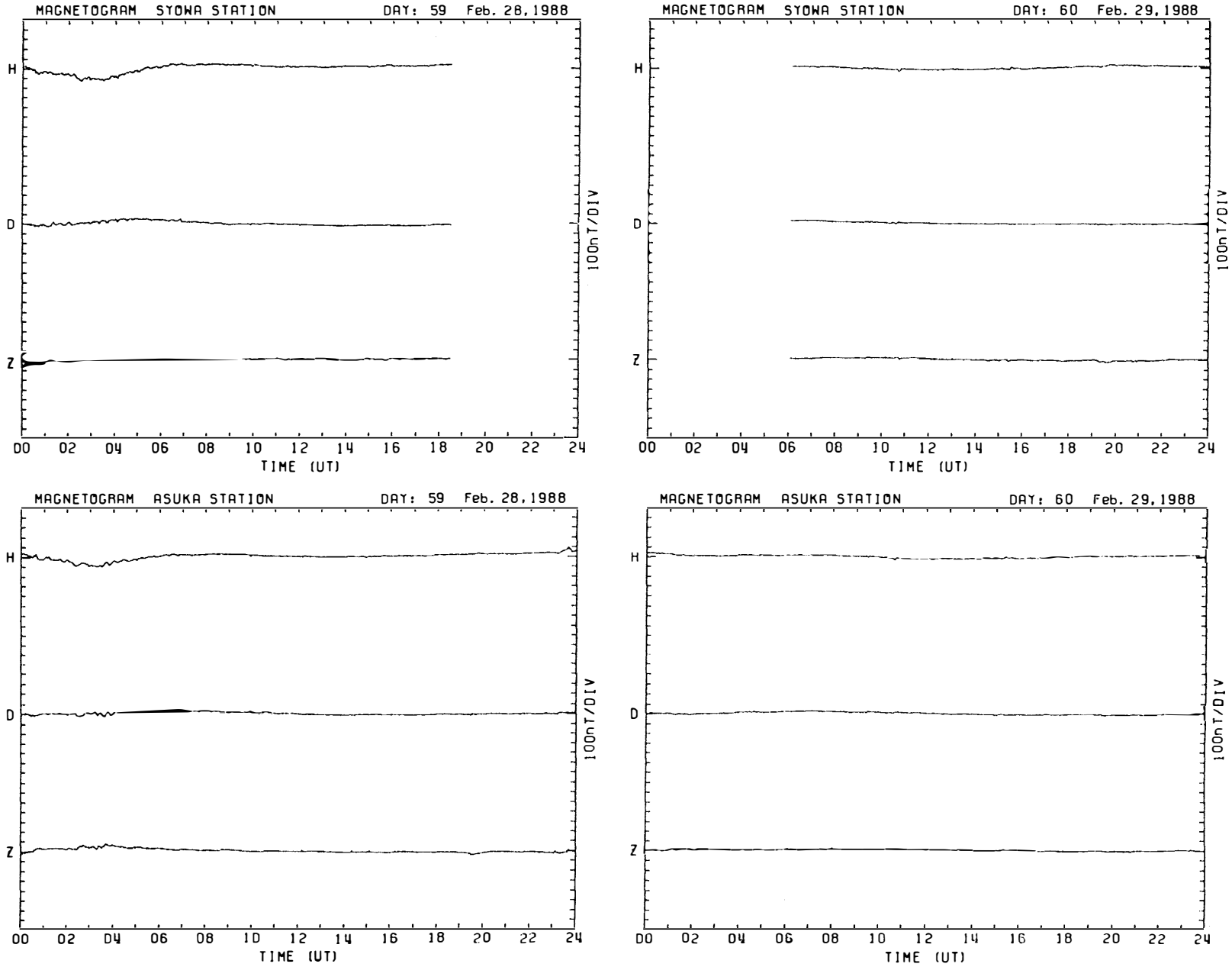
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 59 Feb. 28,1988
MAGNETOGRAM SYOWA STATION DAY: 60 Feb. 29,1988
MAGNETOGRAM ASUKA STATION DAY: 59 Feb. 28,1988
MAGNETOGRAM ASUKA STATION DAY: 60 Feb. 29,1988
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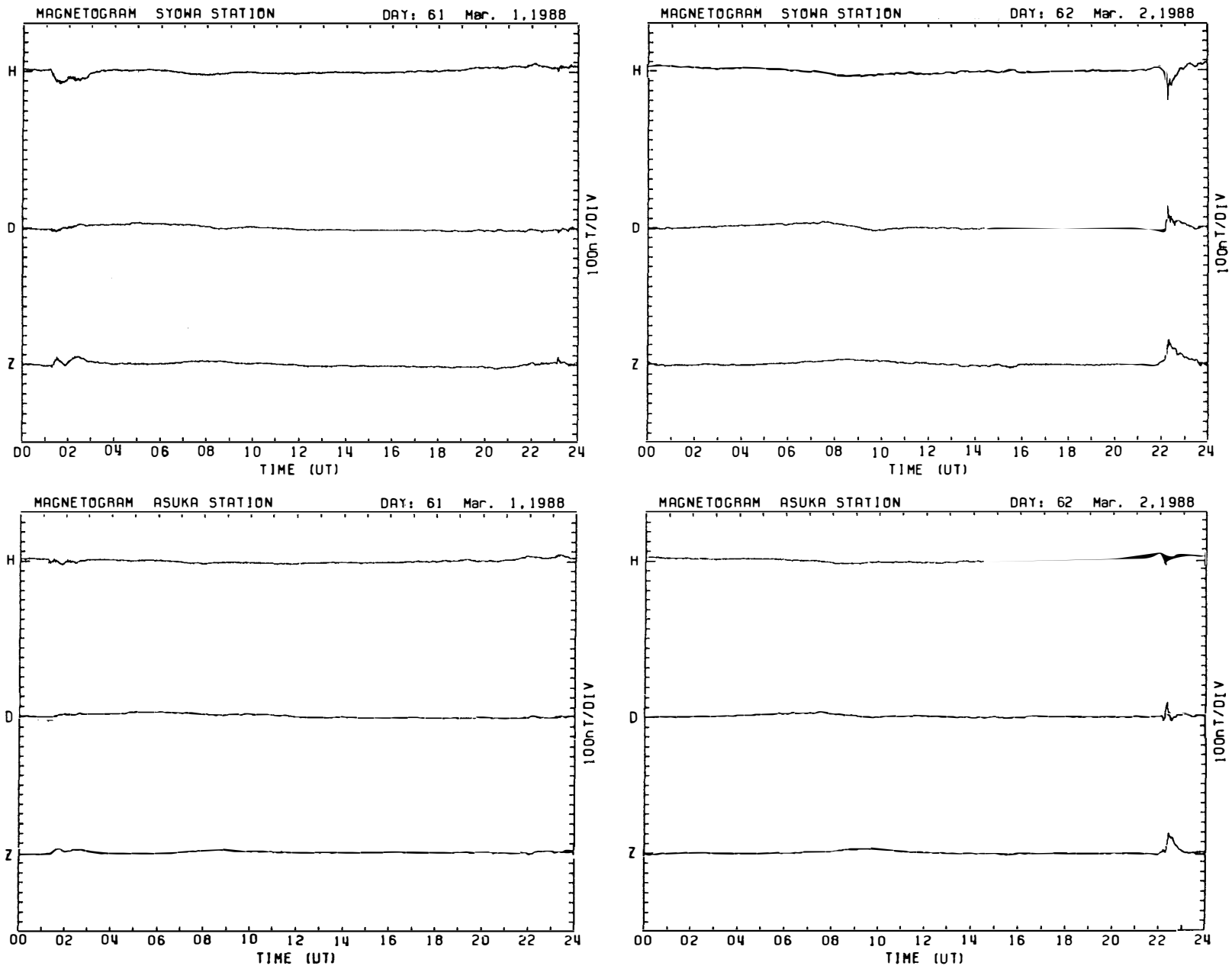
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 61 Mar. 1,1988
MAGNETOGRAM SYOWA STATION DAY: 62 Mar. 2,1988
MAGNETOGRAM ASUKA STATION DAY: 61 Mar. 1,1988
MAGNETOGRAM ASUKA STATION DAY: 62 Mar. 2,1988
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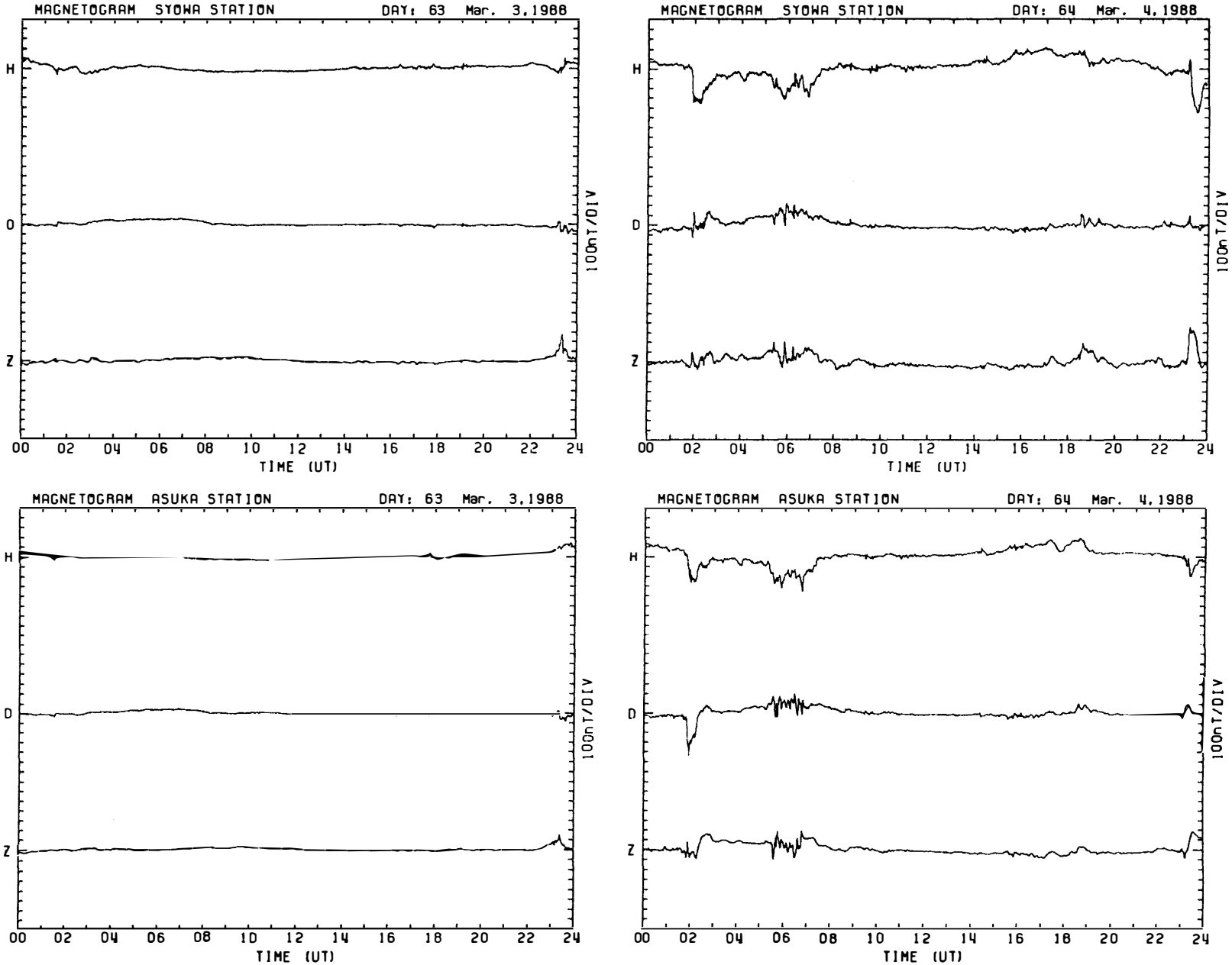
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 63 Mar. 3,1988
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MAGNETOGRAM ASUKA STATION DAY: 63 Mar. 3,1988
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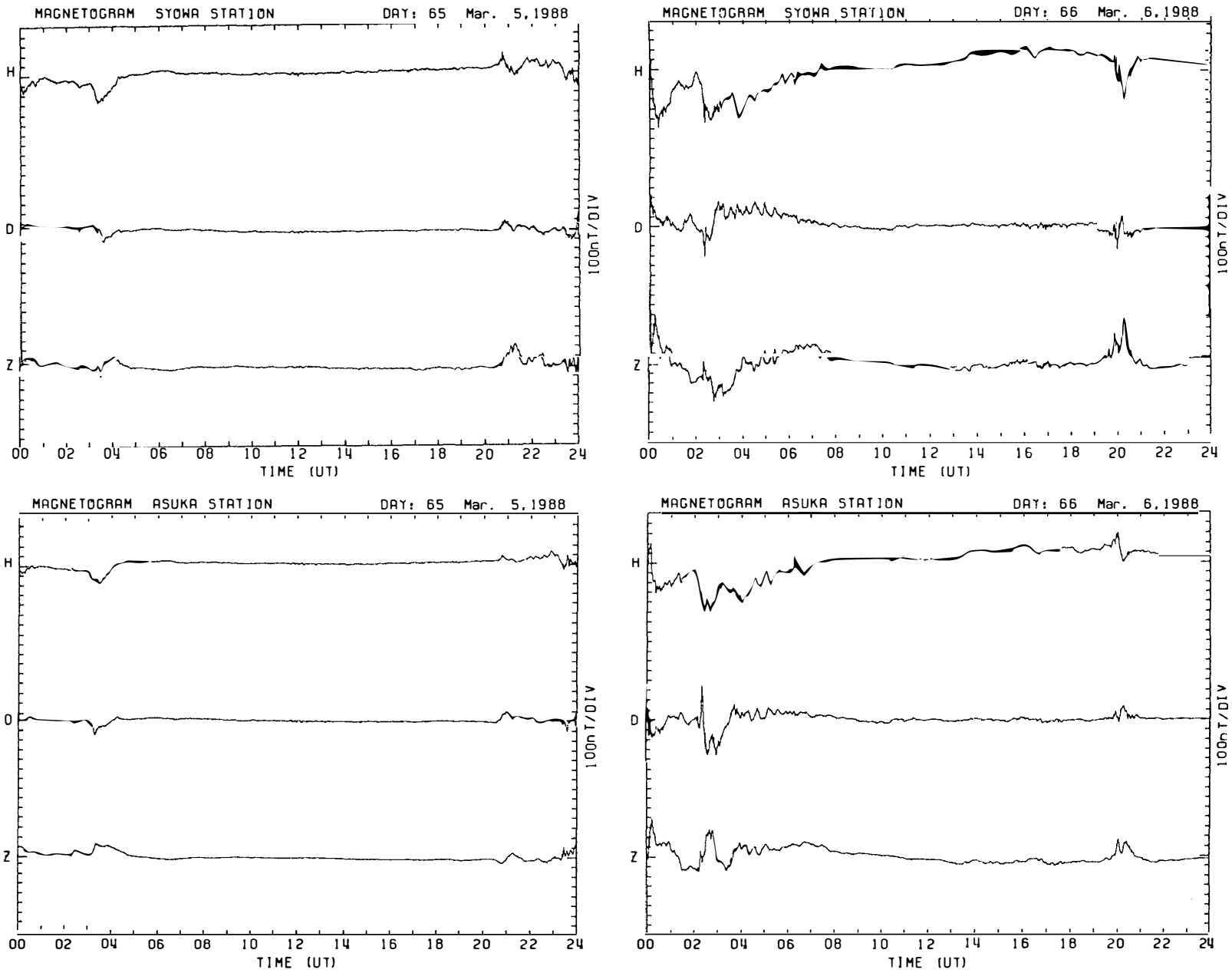
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 65 Mar. 5,1988
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MAGNETOGRAM ASUKA STATION DAY: 65 Mar. 5,1988
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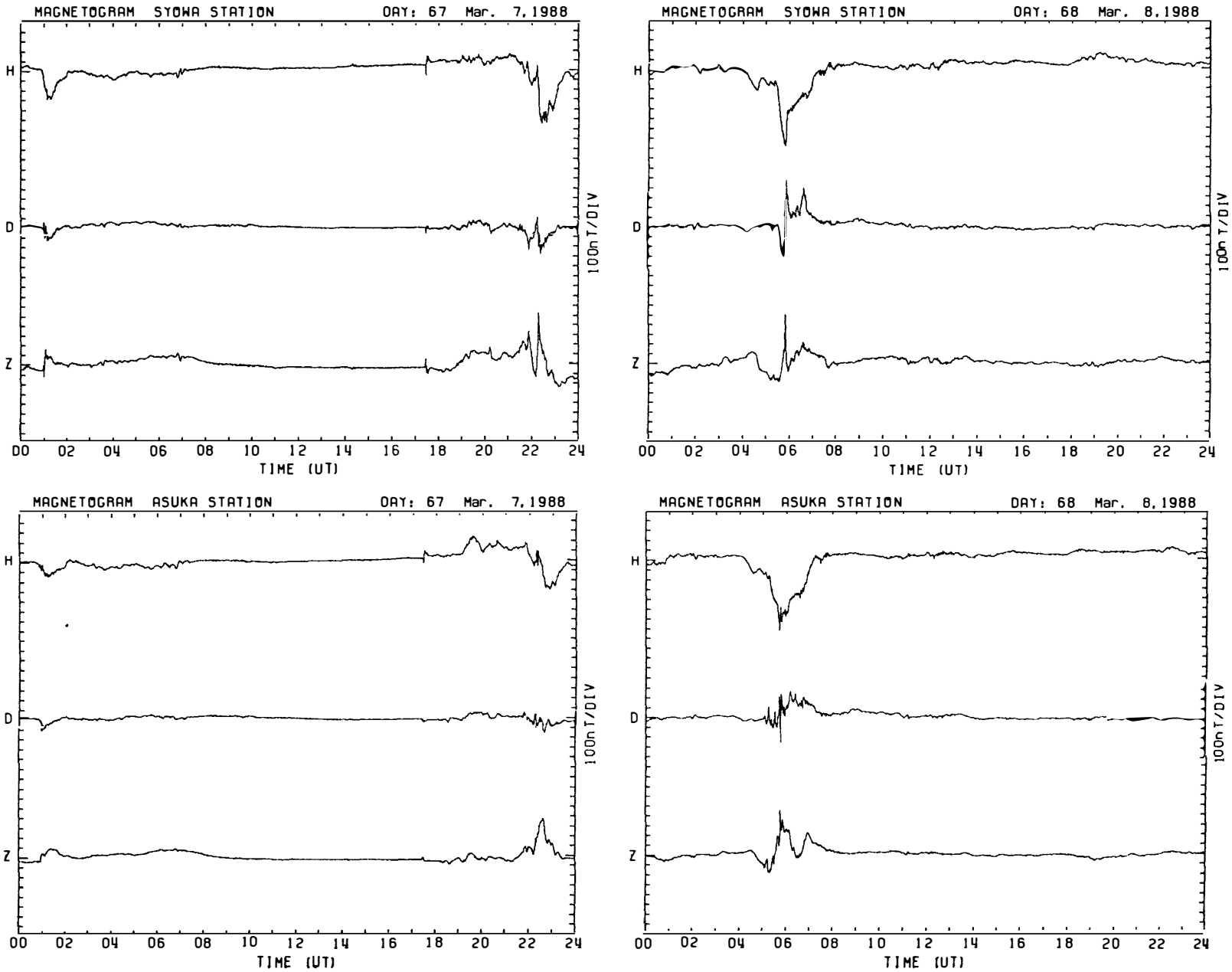
MAGNETOGRAM SYOWA STATION DAY: 67 Mar. 7,1988
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MAGNETOGRAM ASUKA STATION DAY: 67 Mar. 7,1988
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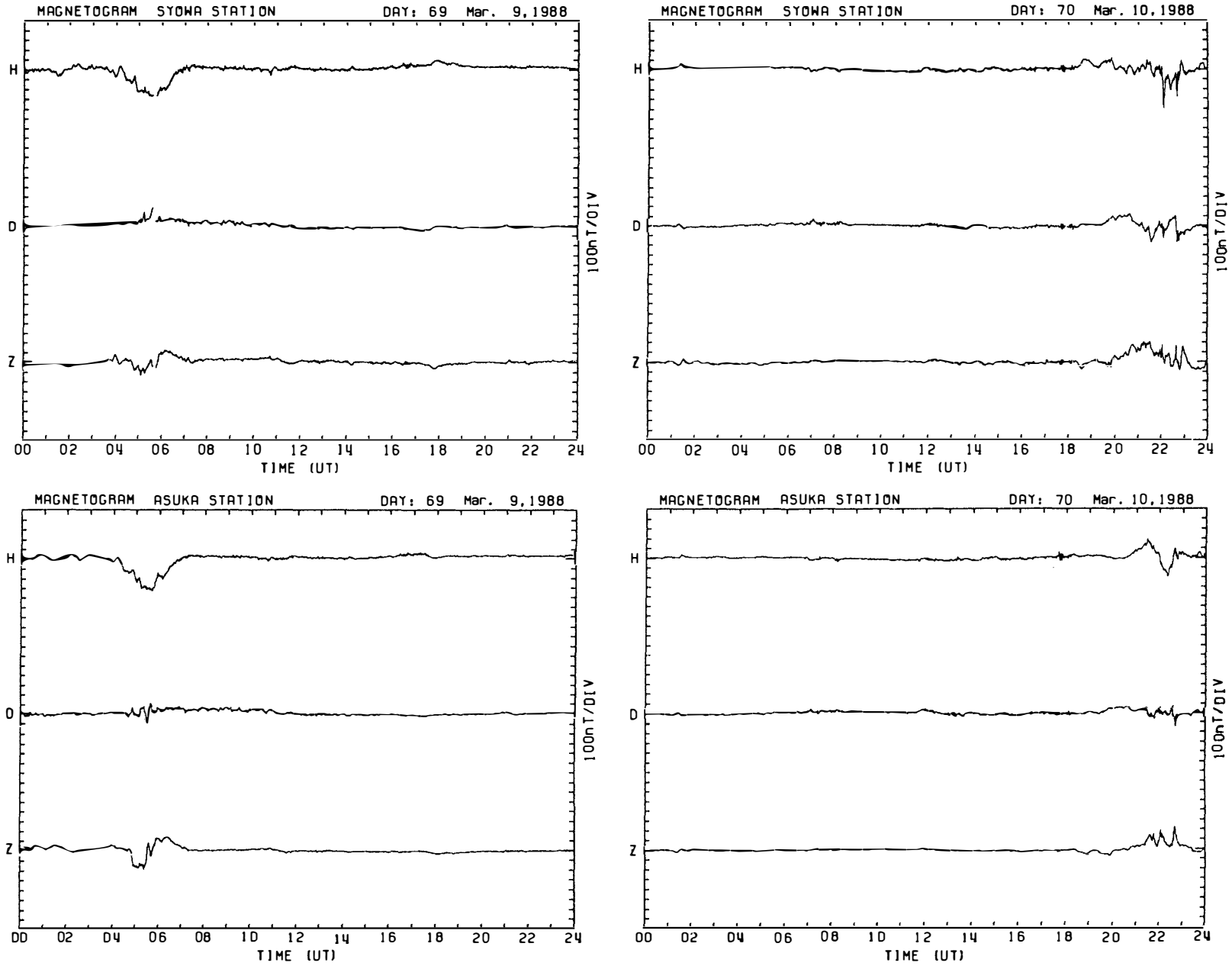
MAGNETOGRAM SYOWA STATION DAY: 69 Mar. 9,1988
MAGNETOGRAM SYOWA STATION DAY: 70 Mar. 10,1988
MAGNETOGRAM ASUKA STATION DAY: 69 Mar. 9,1988
MAGNETOGRAM ASUKA STATION DAY: 70 Mar. 10,1988
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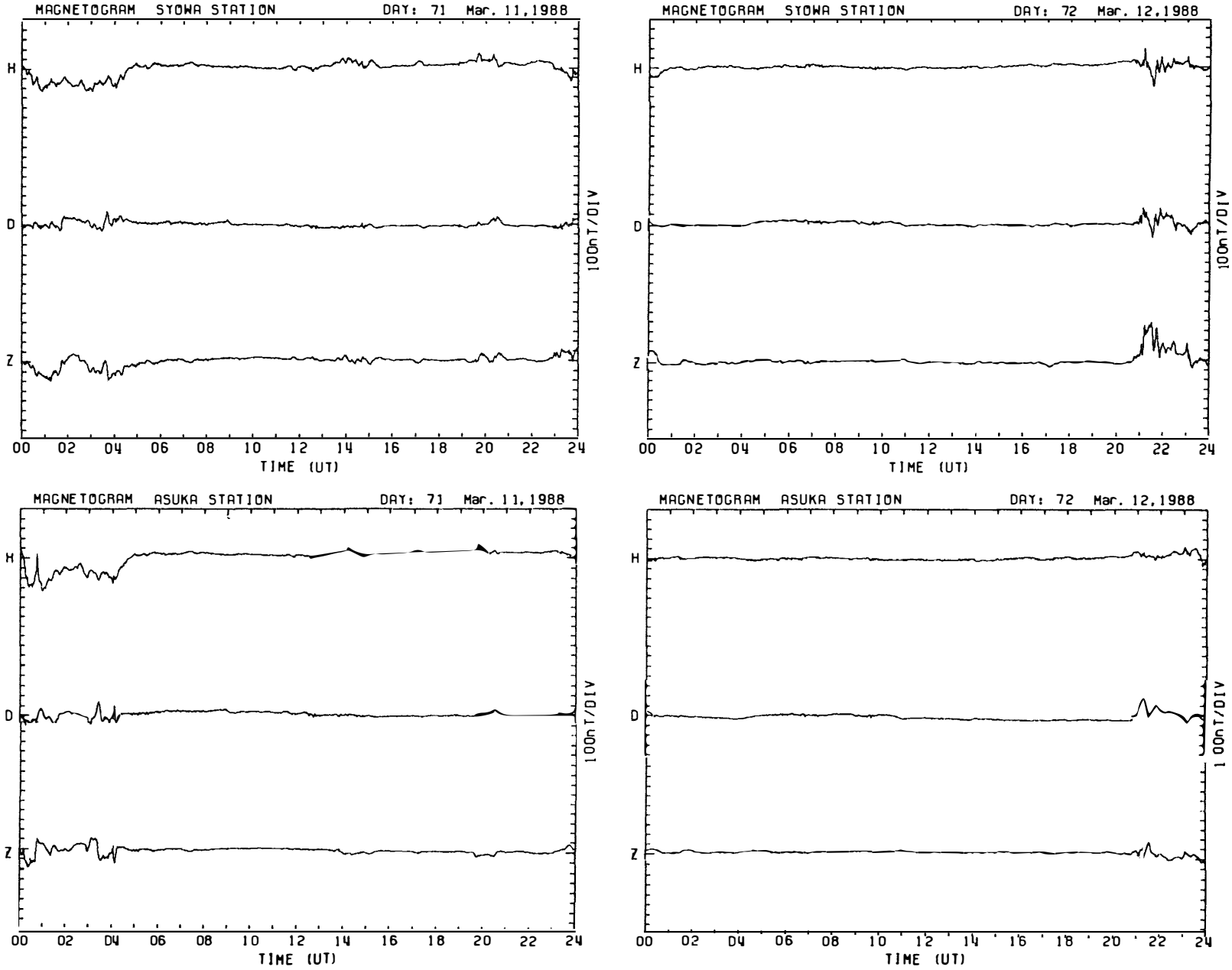
MAGNETOGRAM SYOWA STATION DAY: 71 Mar. 11,1988
MAGNETOGRAM SYOWA STATION DAY: 72 Mar. 12,1988
MAGNETOGRAM ASUKA STATION DAY: 71 Mar. 11,1988
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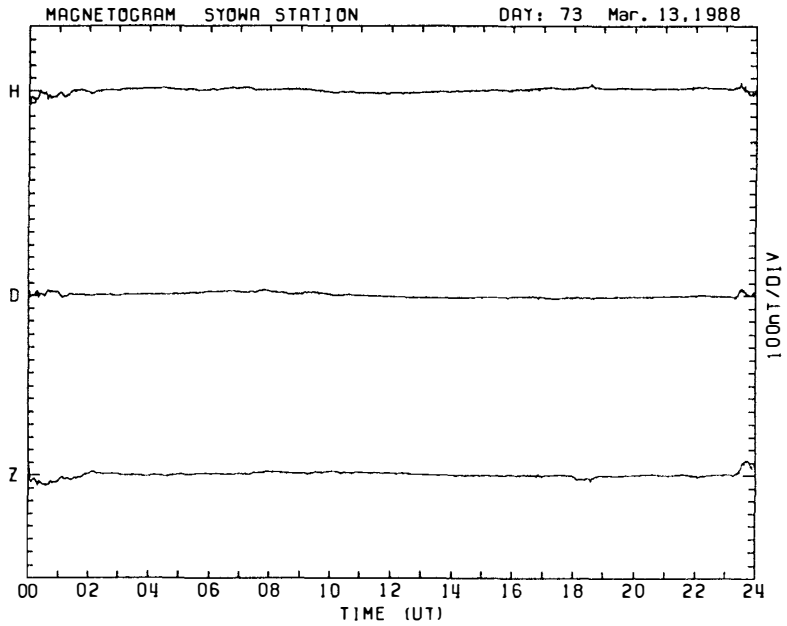
MAGNETOGRAM SYOWA STATION
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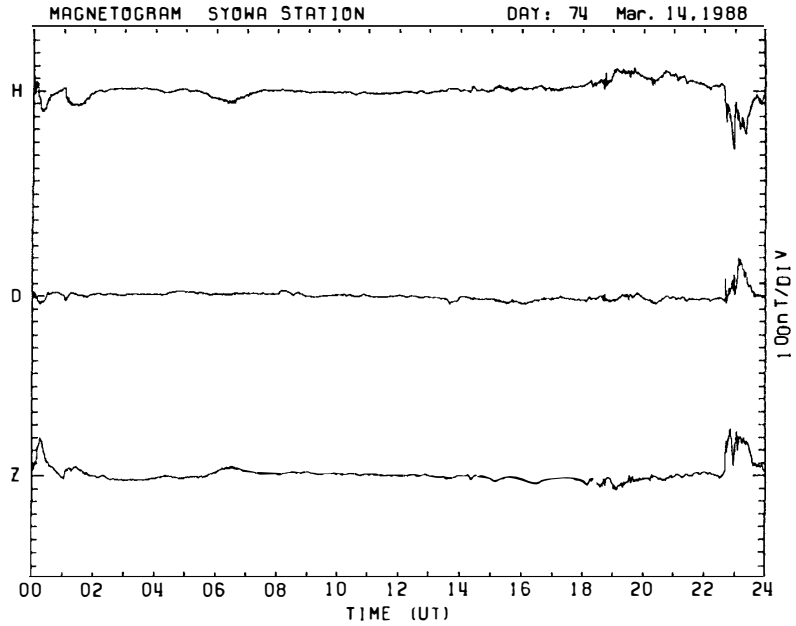
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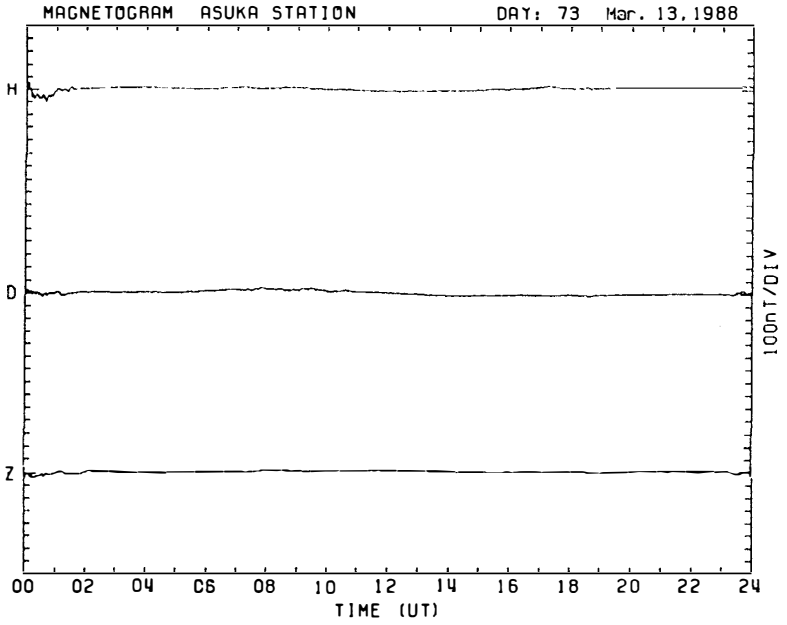
TIME (UT)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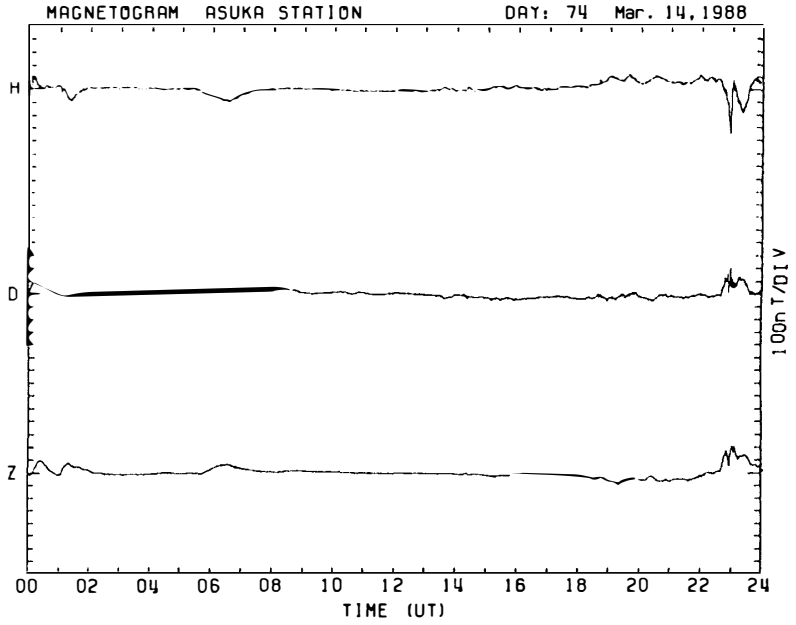
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DAY: 74 Mar. 14,1988
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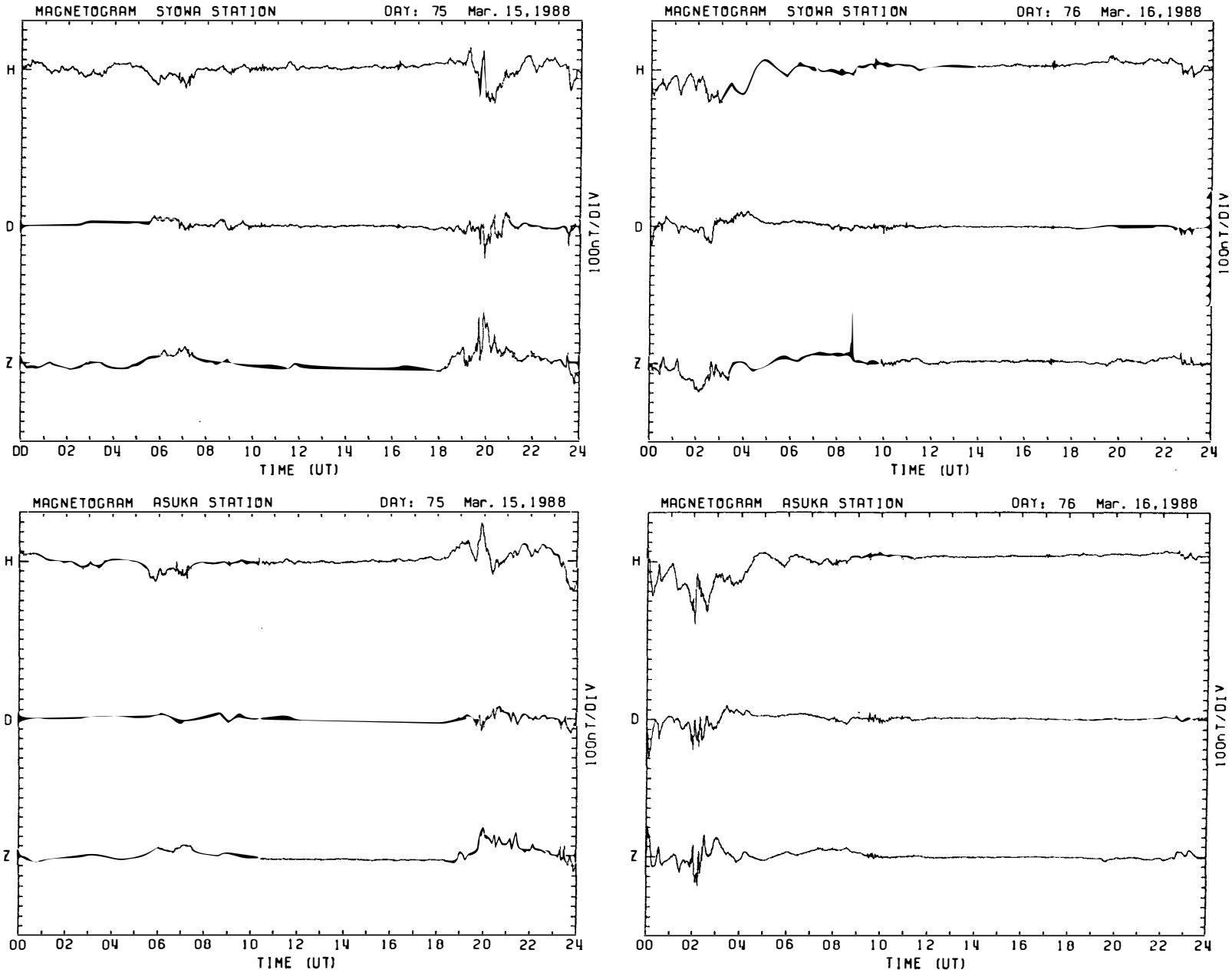
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 75 Mar. 15,1988
MAGNETOGRAM SYOWA STATION DAY: 76 Mar. 16,1988
MAGNETOGRAM ASUKA STATION DAY: 75 Mar. 15,1988
MAGNETOGRAM ASUKA STATION DAY: 76 Mar. 16,1988
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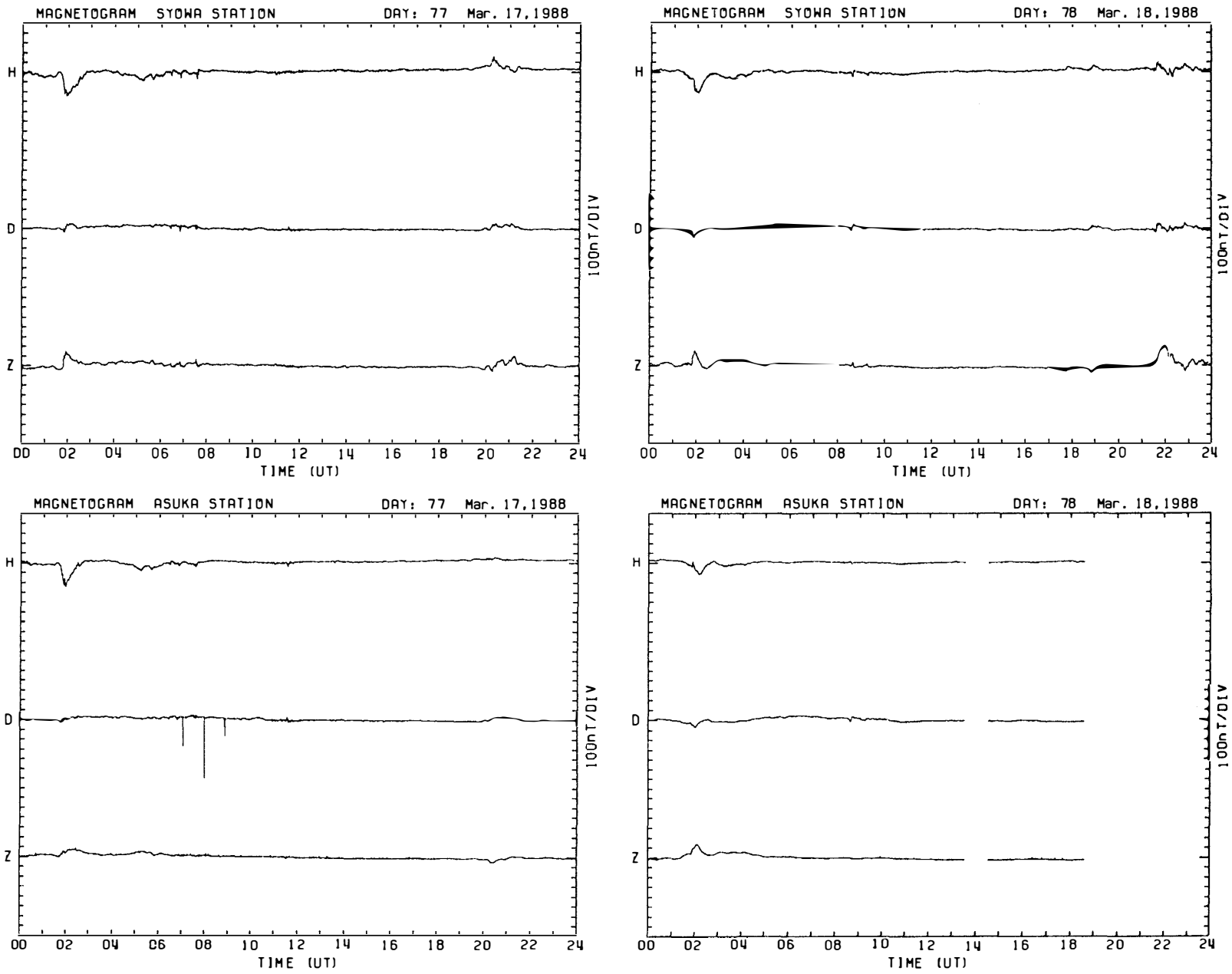
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 77 Mar. 17,1988
MAGNETOGRAM SYOWA STATION DAY: 78 Mar. 18,1988
MAGNETOGRAM ASUKA STATION DAY: 77 Mar. 17,1988
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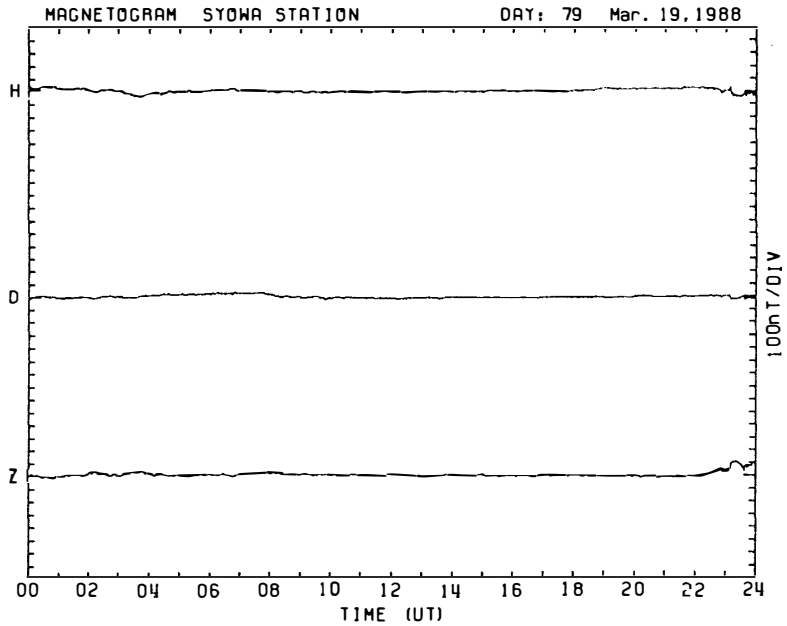
TIME (UT)


MAGNETOGRAM SYOWA STATION
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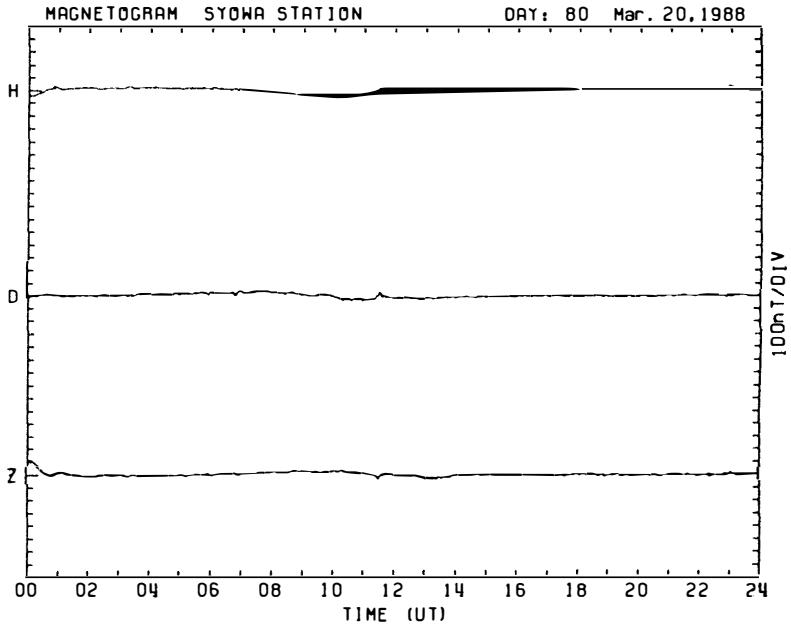
TIME (UT)


MAGNETOGRAM SYOWA STATION
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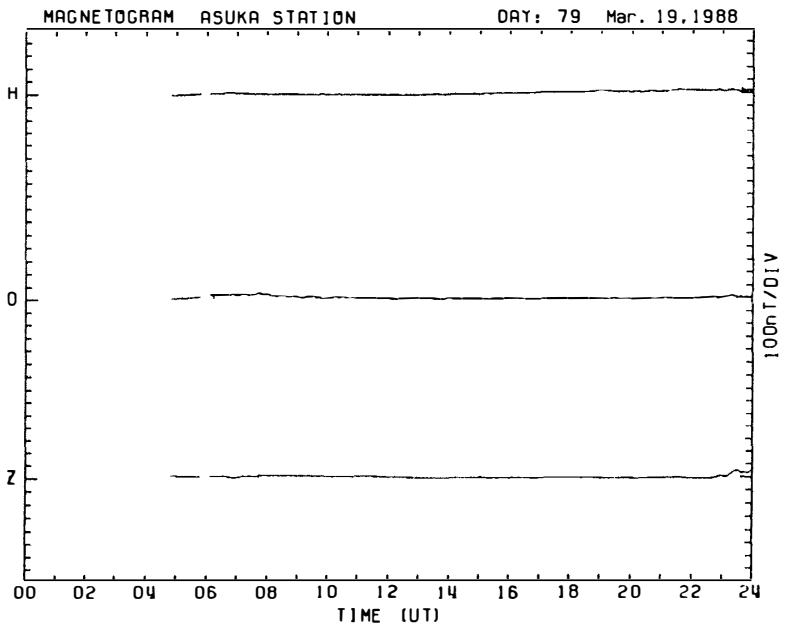
TIME (UT)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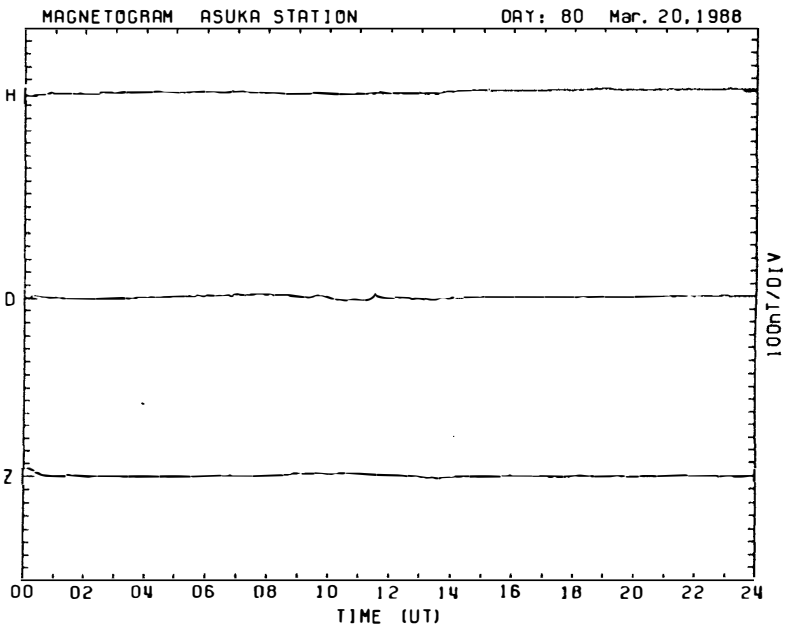
TIME (UT)


MAGNETOGRAM ASUKA STATION
DAY: 80 Mar. 20,1988
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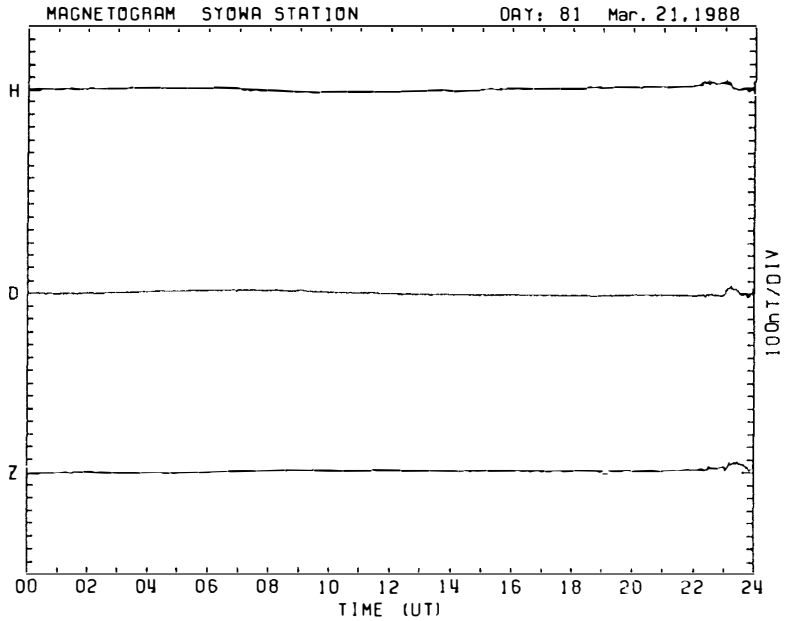
TIME (UT)


MAGNETOGRAM SYOWA STATION
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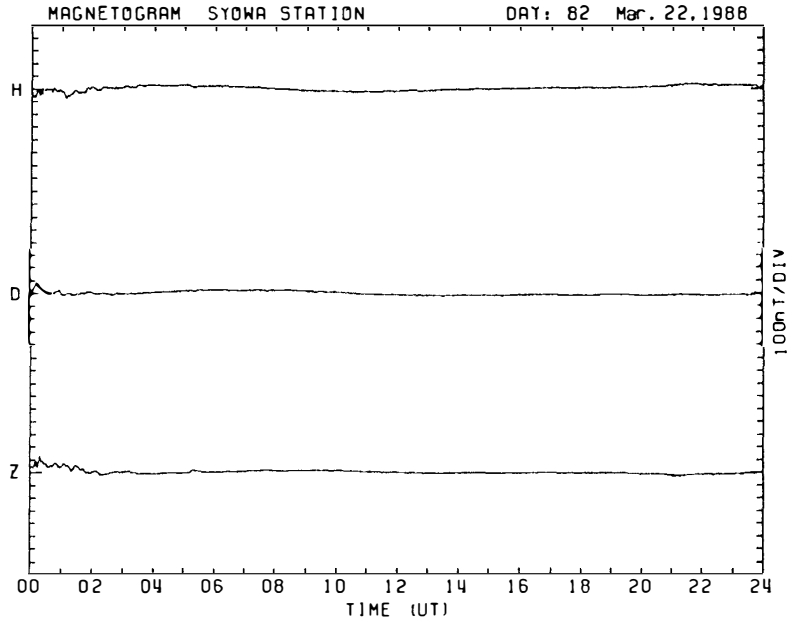
TIME (UT)


MAGNETOGRAM SYOWA STATION
DAY: 82 Mar. 22,1988
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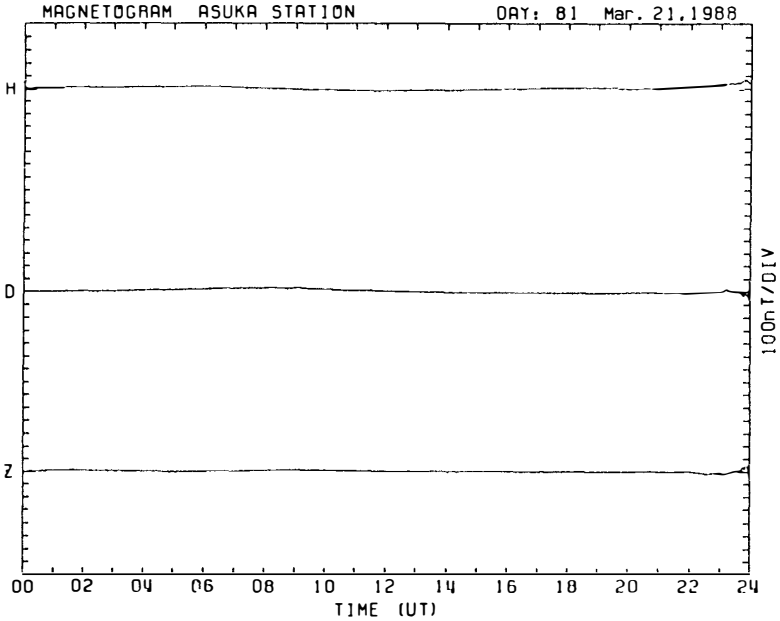
TIME (UT)


MAGNETOGRAM ASUKA STATION
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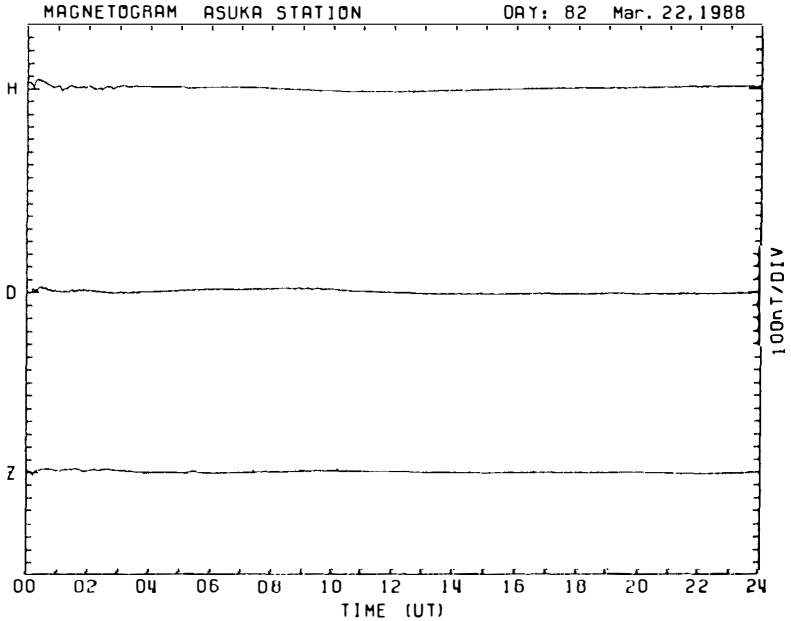
TIME (UT)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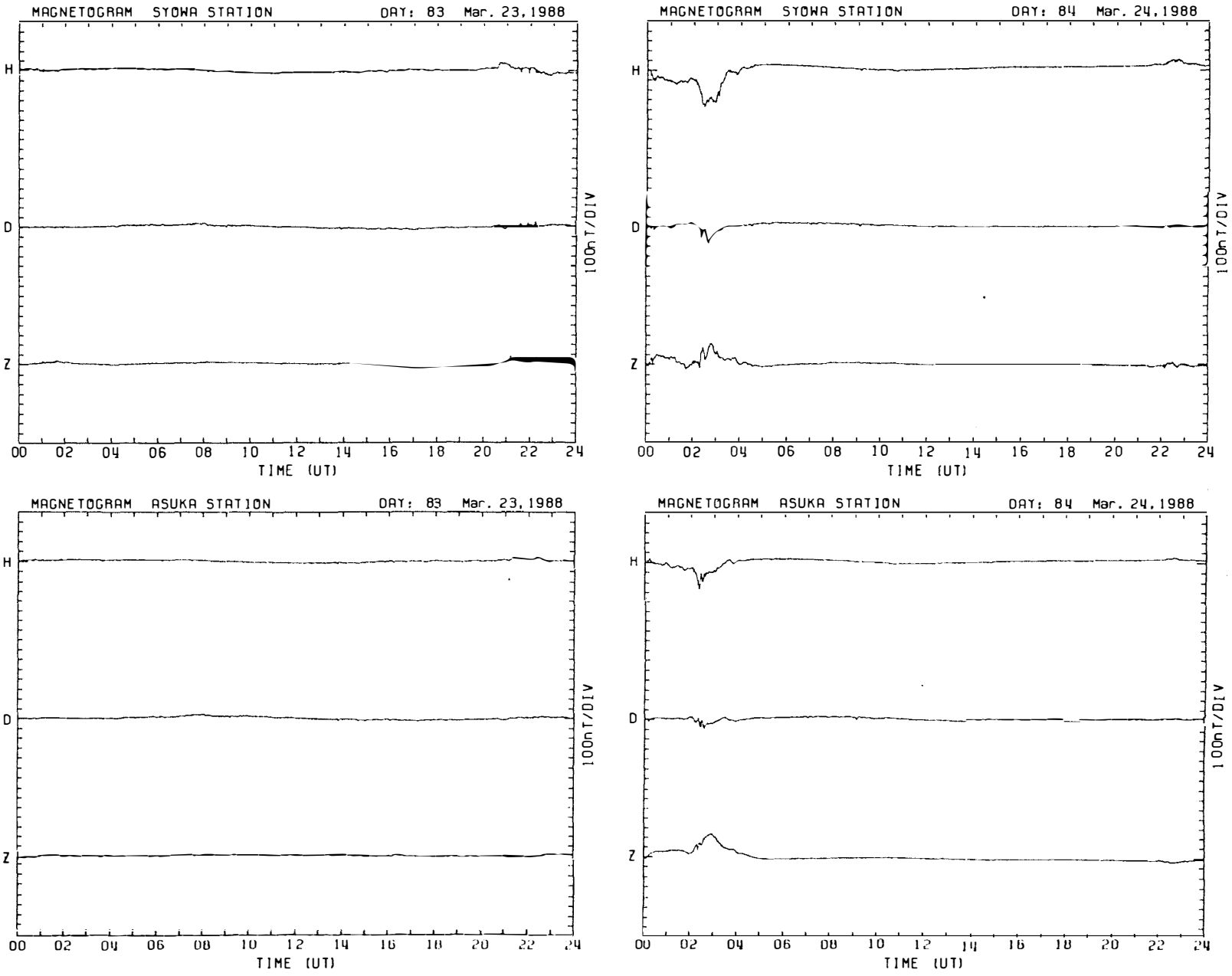
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 83 Mar. 23,1988
MAGNETOGRAM SYOWA STATION DAY: 84 Mar. 24,1988
MAGNETOGRAM ASUKA STATION DAY: 83 Mar. 23,1988
MAGNETOGRAM ASUKA STATION DAY: 84 Mar. 24,1988
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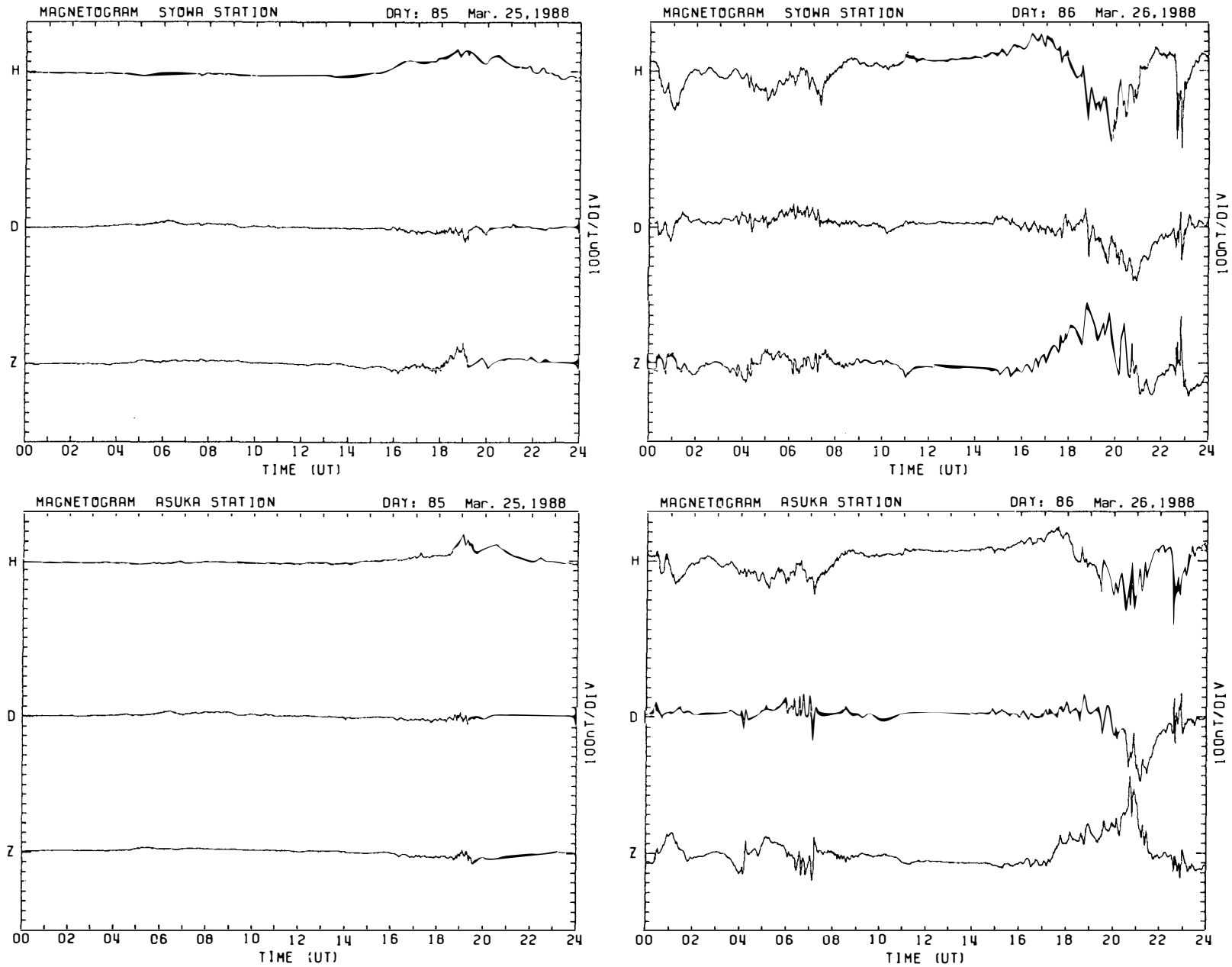
TIME (UT)


MAGNETOGRAM SYOWA STATION
DAY: 85 Mar. 25,1988
MAGNETOGRAM SYOWA STATION
DAY: 86 Mar. 26,1988
MAGNETOGRAM ASUKA STATION
DAY: 85 Mar. 25,1988
MAGNETOGRAM ASUKA STATION
DAY: 86 Mar. 26,1988
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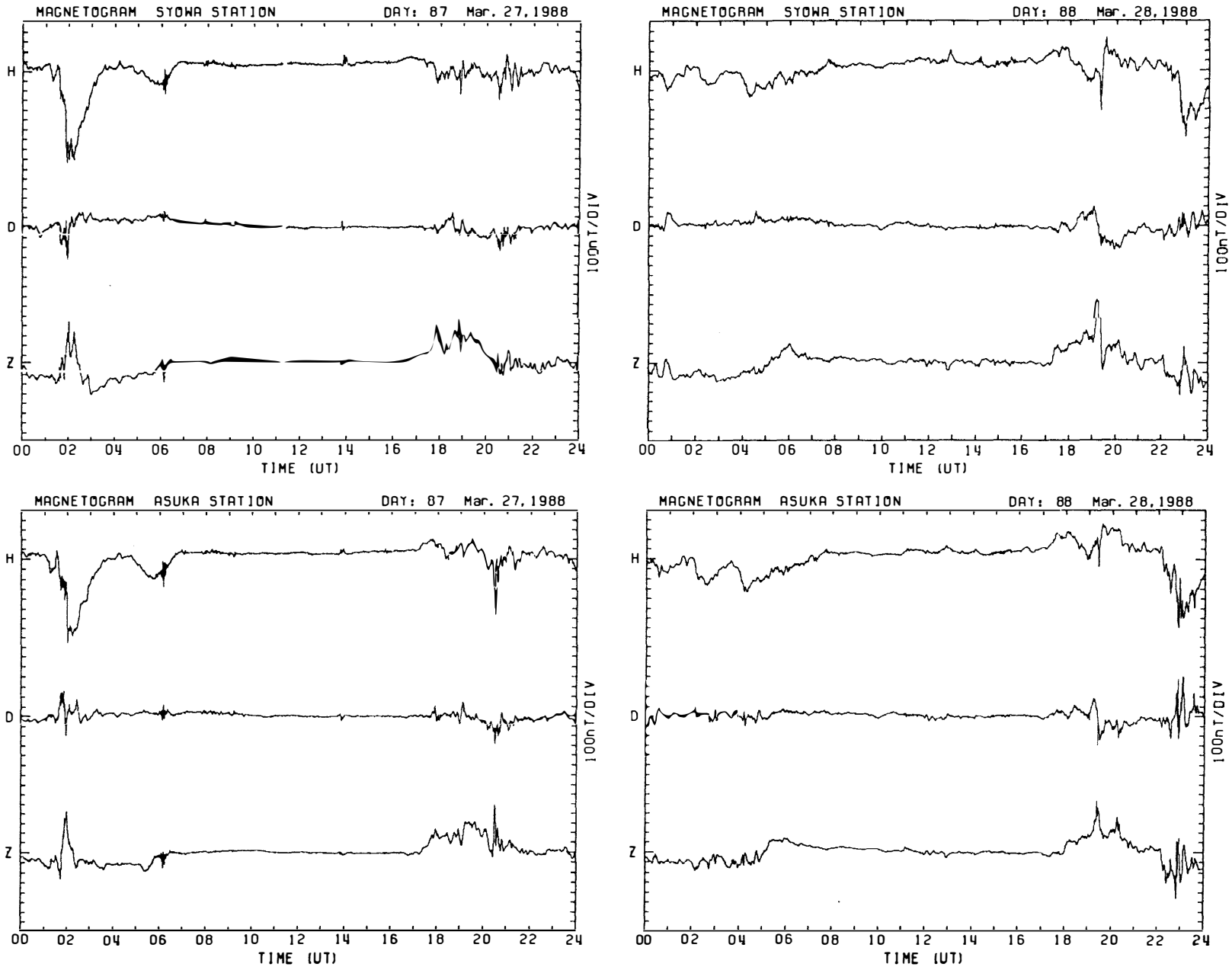
TIME (UT)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MAGNETOGRAM SYOWA STATION DAY: 88 Mar. 28,1988
MAGNETOGRAM ASUKA STATION DAY: 87 Mar. 27,1988
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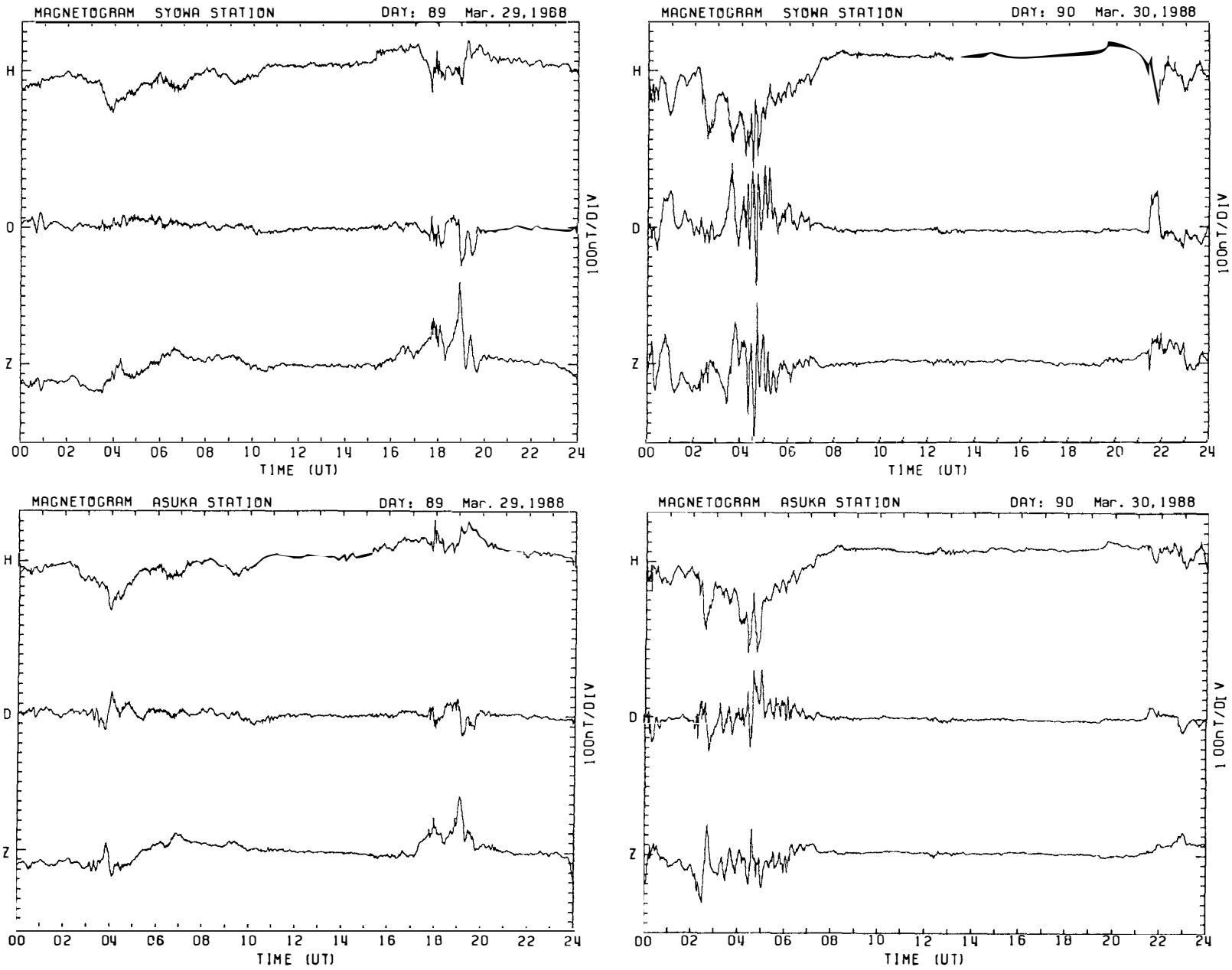
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 89 Mar. 29,1988
MAGNETOGRAM SYOWA STATION DAY: 90 Mar. 30,1988
MAGNETOGRAM ASUKA STATION DAY: 89 Mar. 29,1988
MAGNETOGRAM ASUKA STATION DAY: 90 Mar. 30,1988
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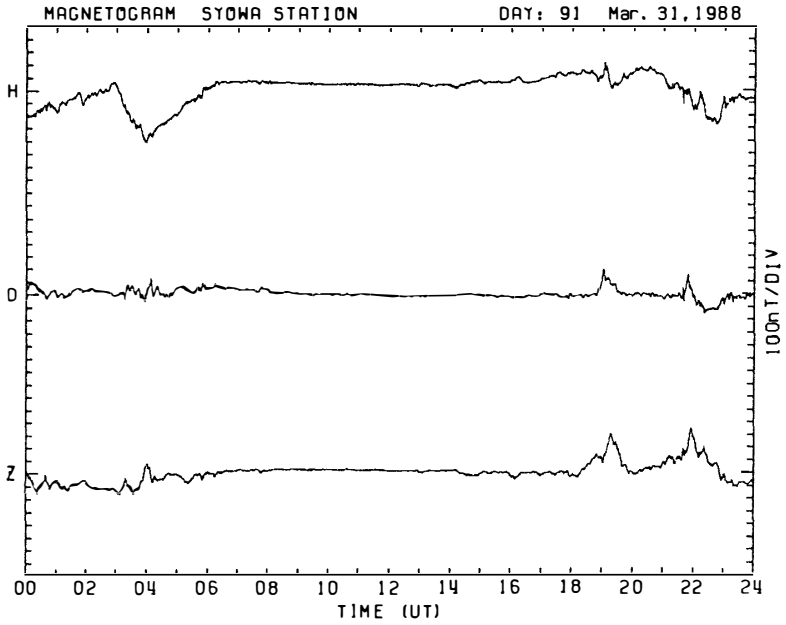
TIME (UT)


MAGNETOGRAM SYOWA STATION
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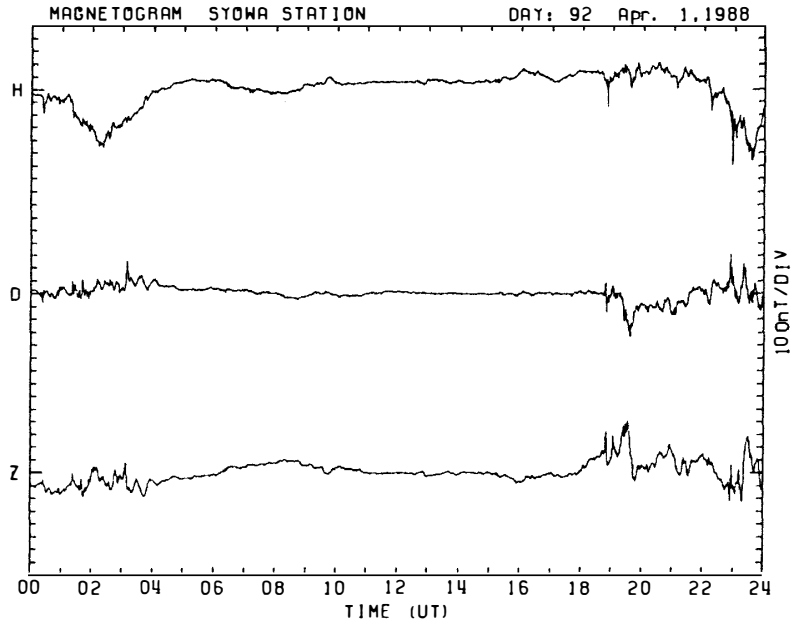
TIME (UT)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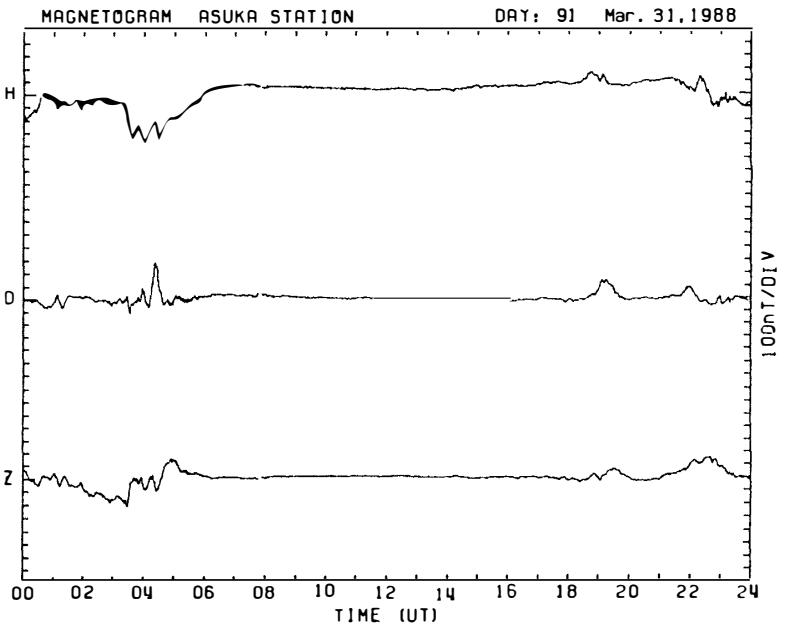
TIME (UT)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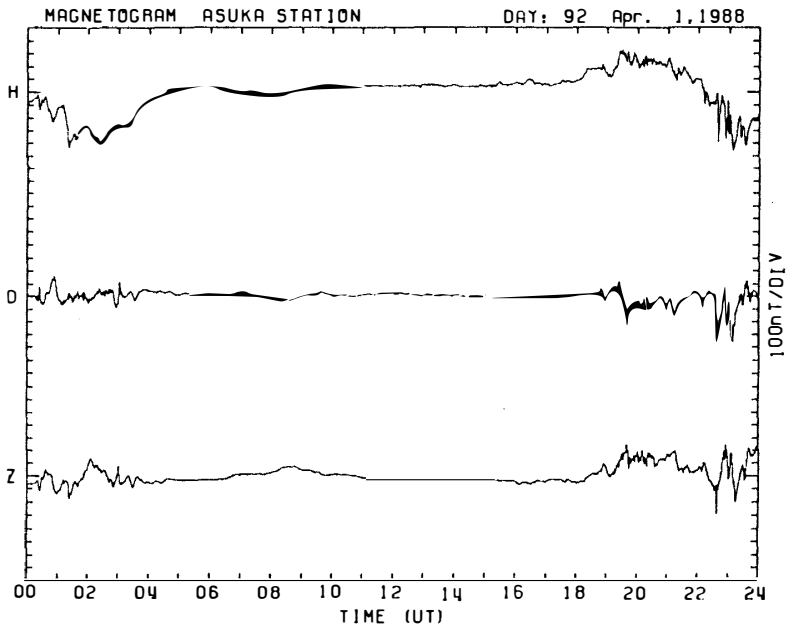
TIME (UT)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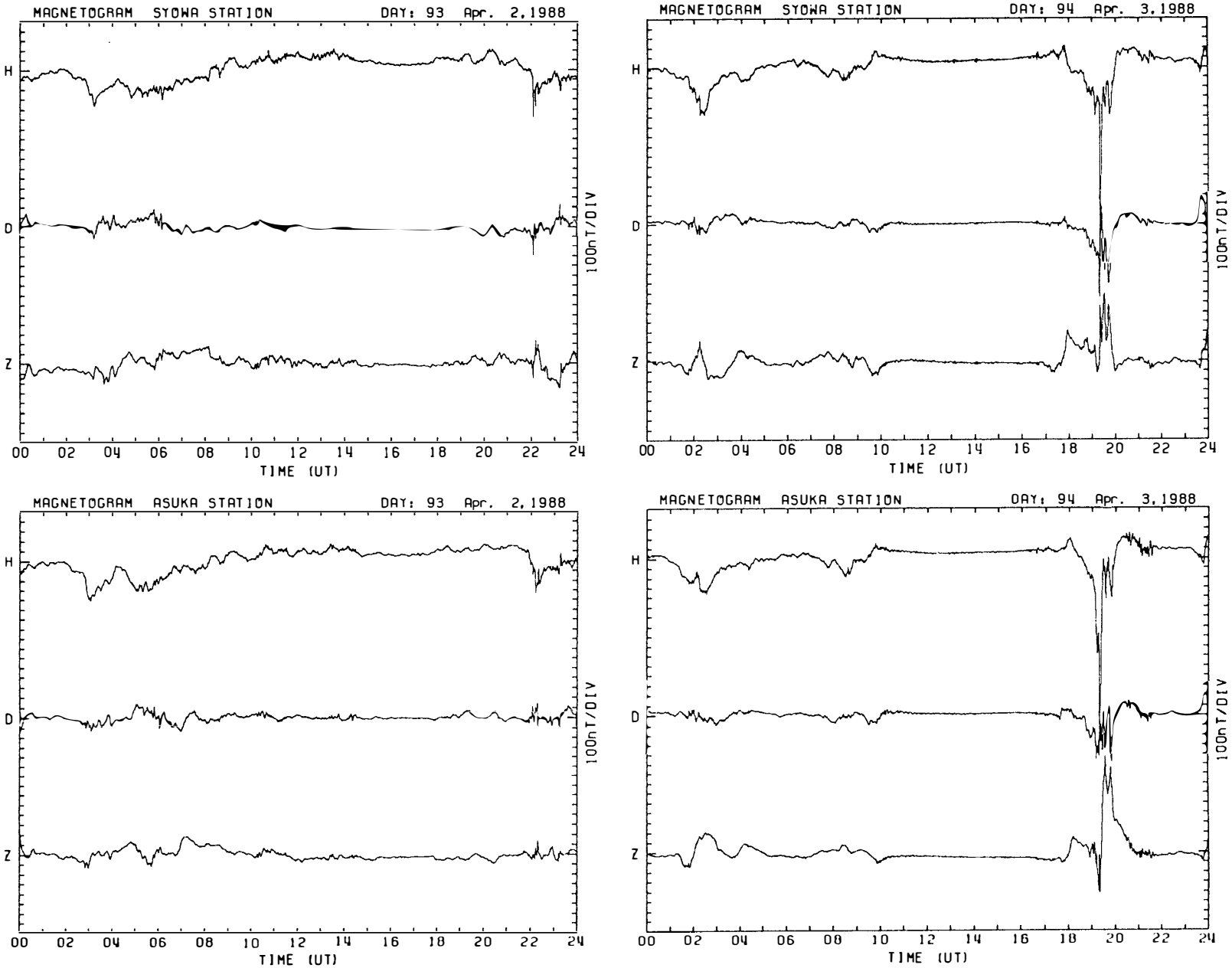
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY: 93 Apr. 2,1988
MAGNETOGRAM SYOWA STATION DAY: 94 Apr. 3,1988
MAGNETOGRAM ASUKA STATION DAY: 93 Apr. 2,1988
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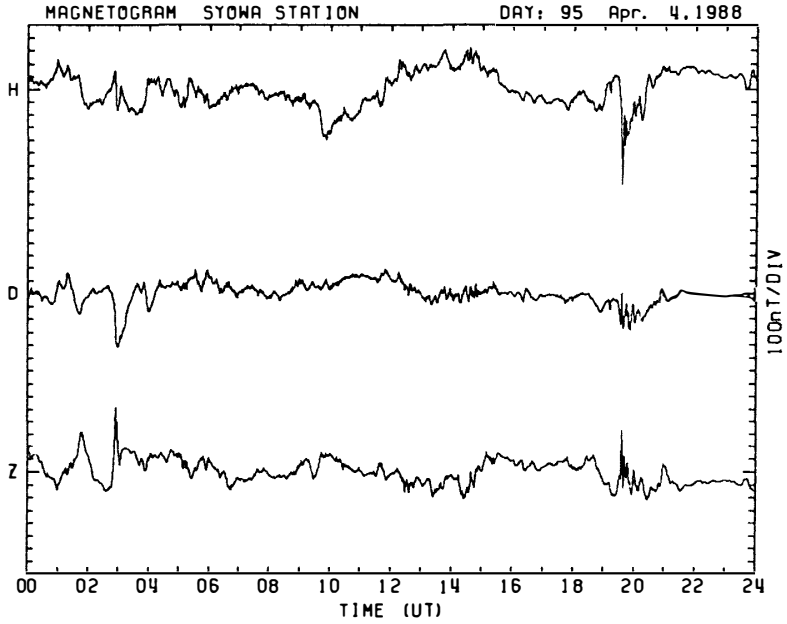
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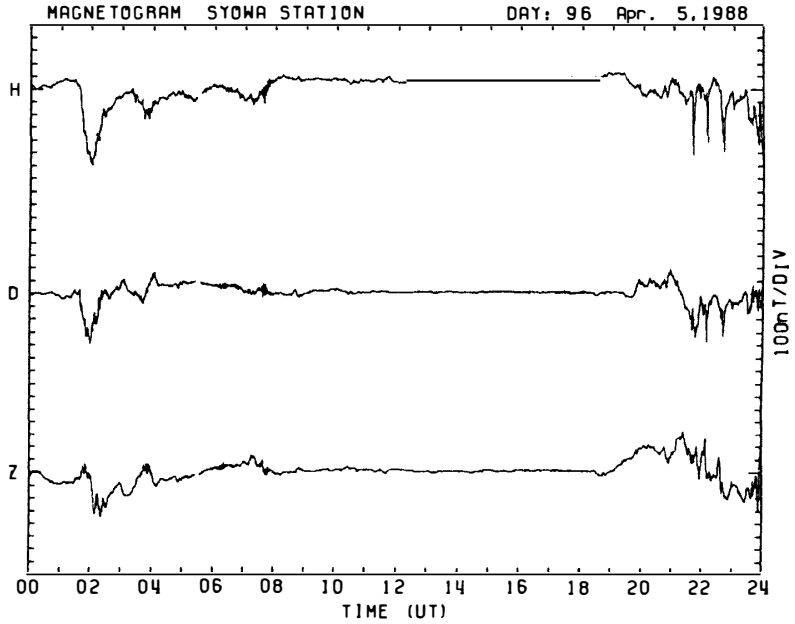
TIME (UT)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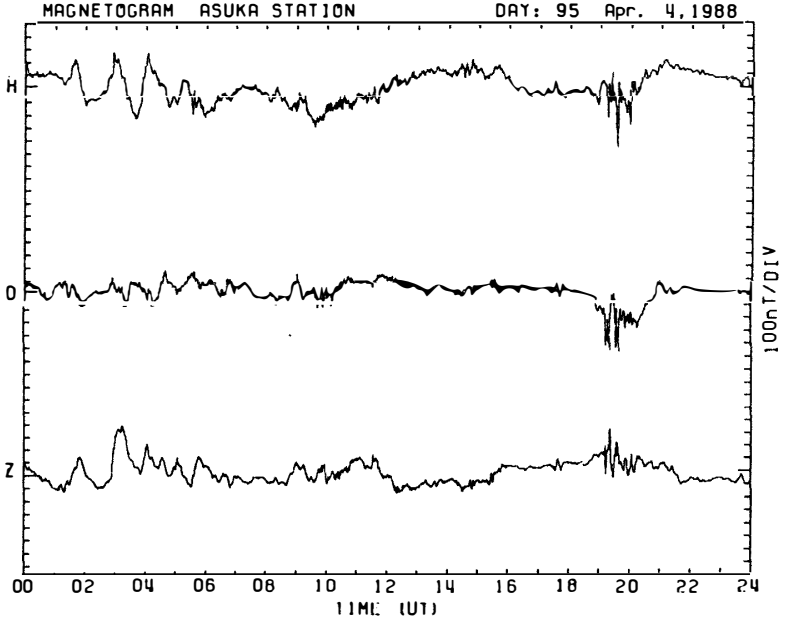
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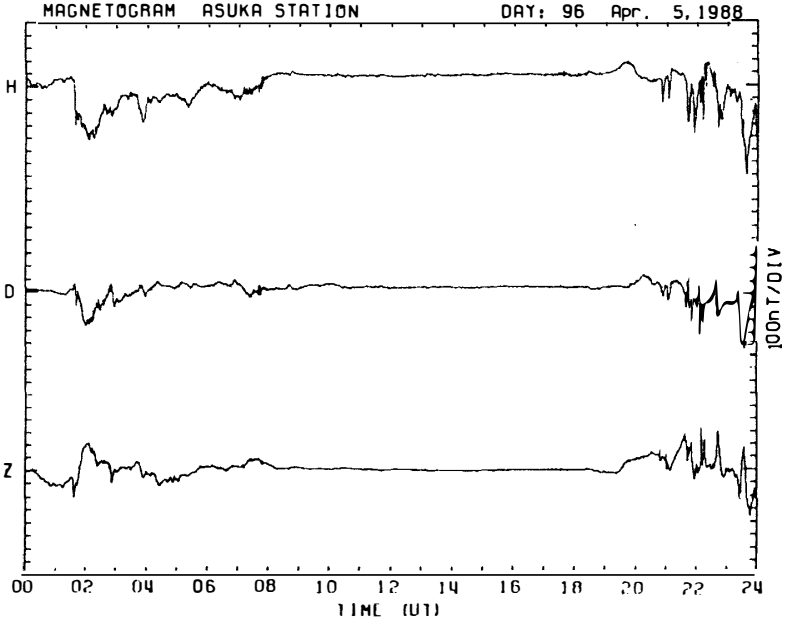
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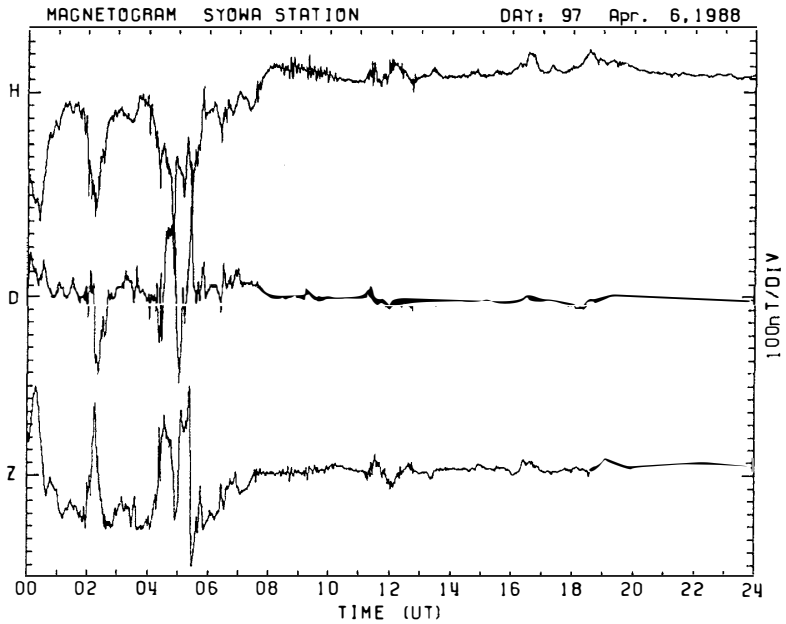
MAGNETOGRAM SYOWA STATION
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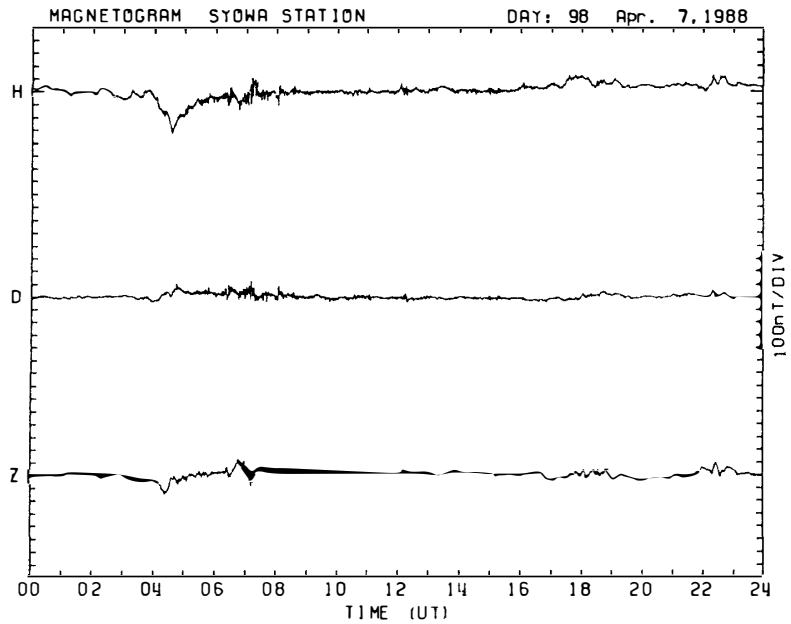
MAGNETOGRAM SYOWA STATION
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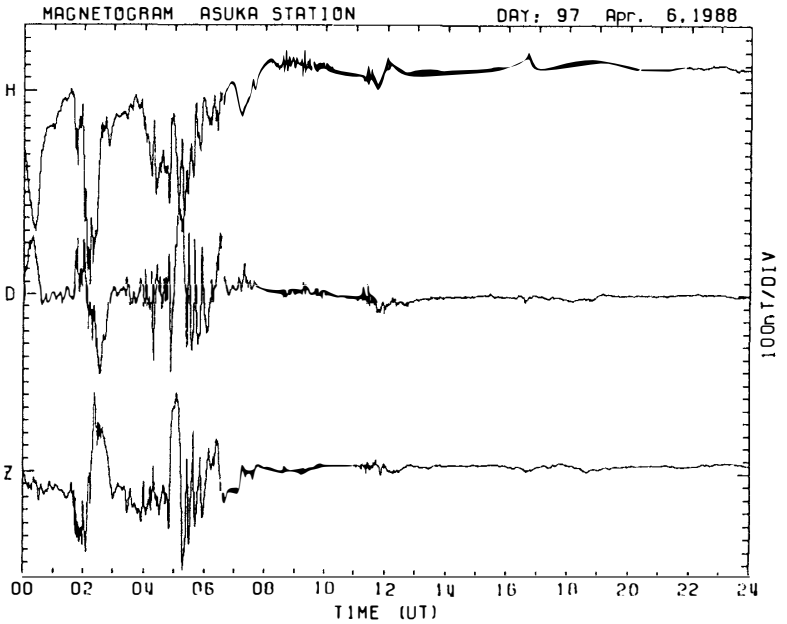
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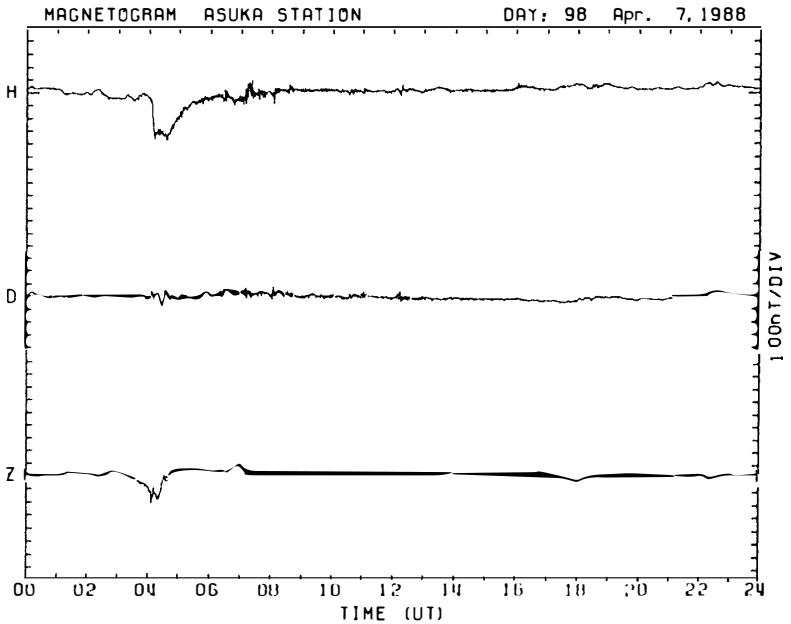
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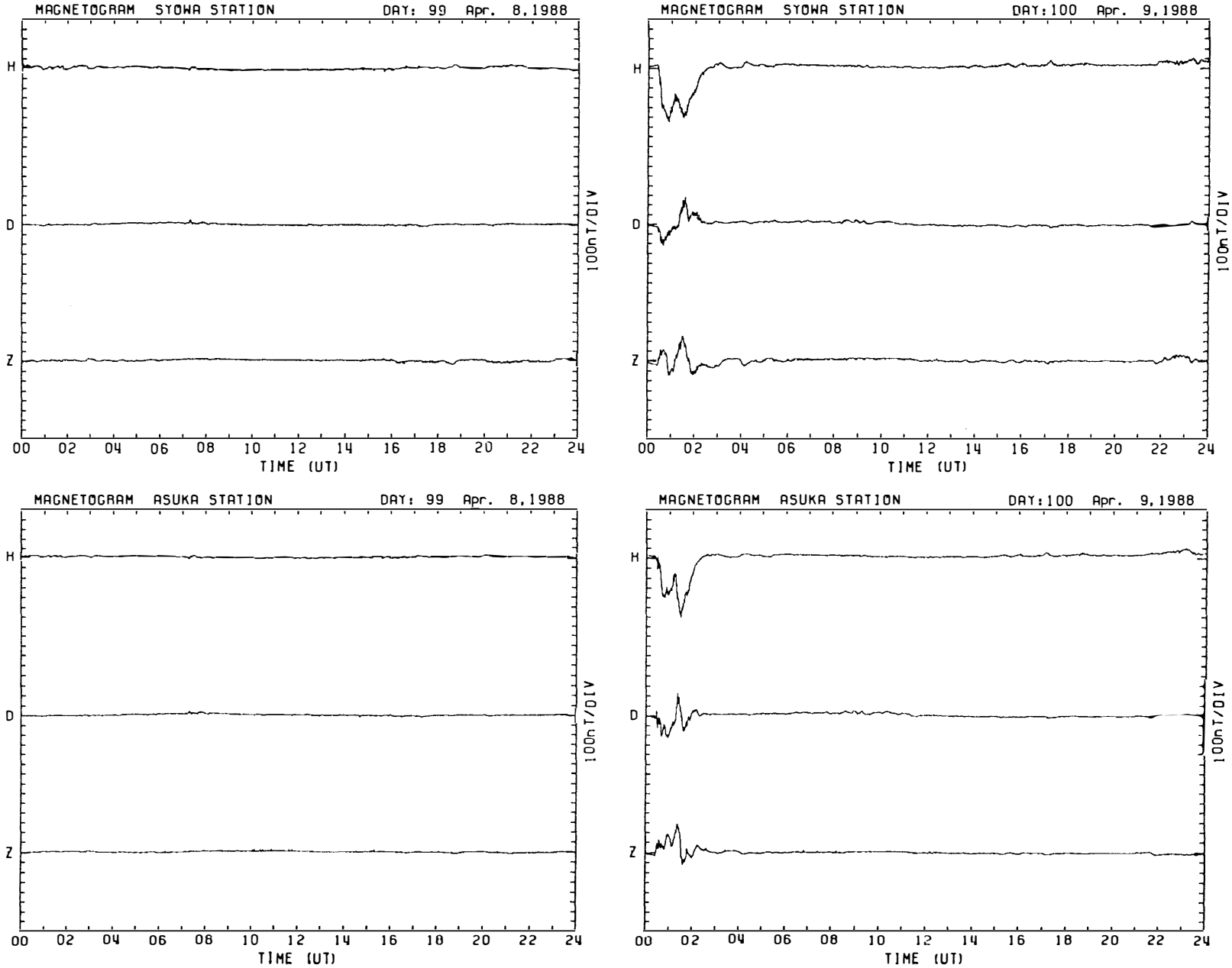
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MAGNETOGRAM ASUKA STATION DAY: 99 Apr. 8,1988
MAGNETOGRAM ASUKA STATION DAY:100 Apr. 9,1988
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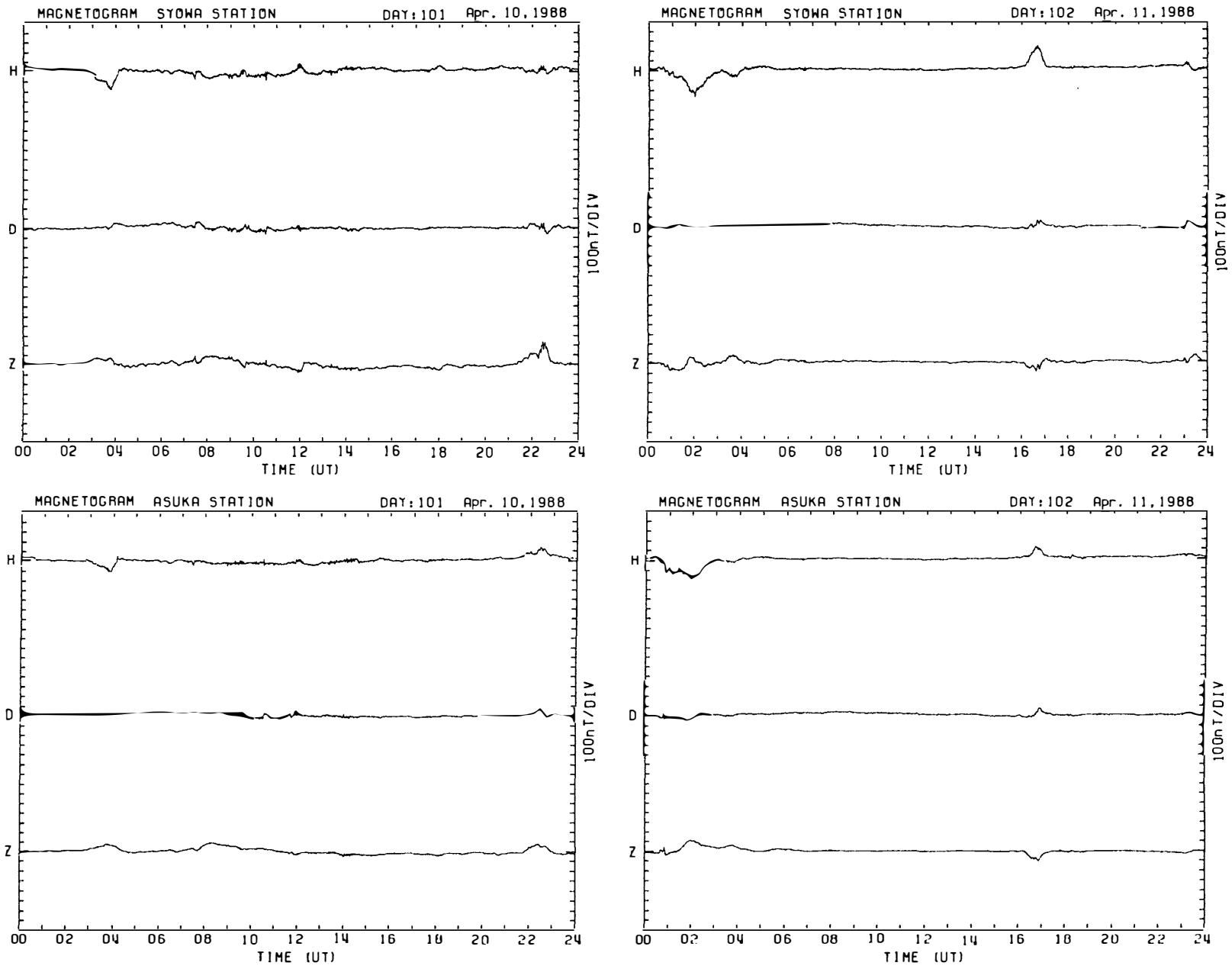
TIME (UT)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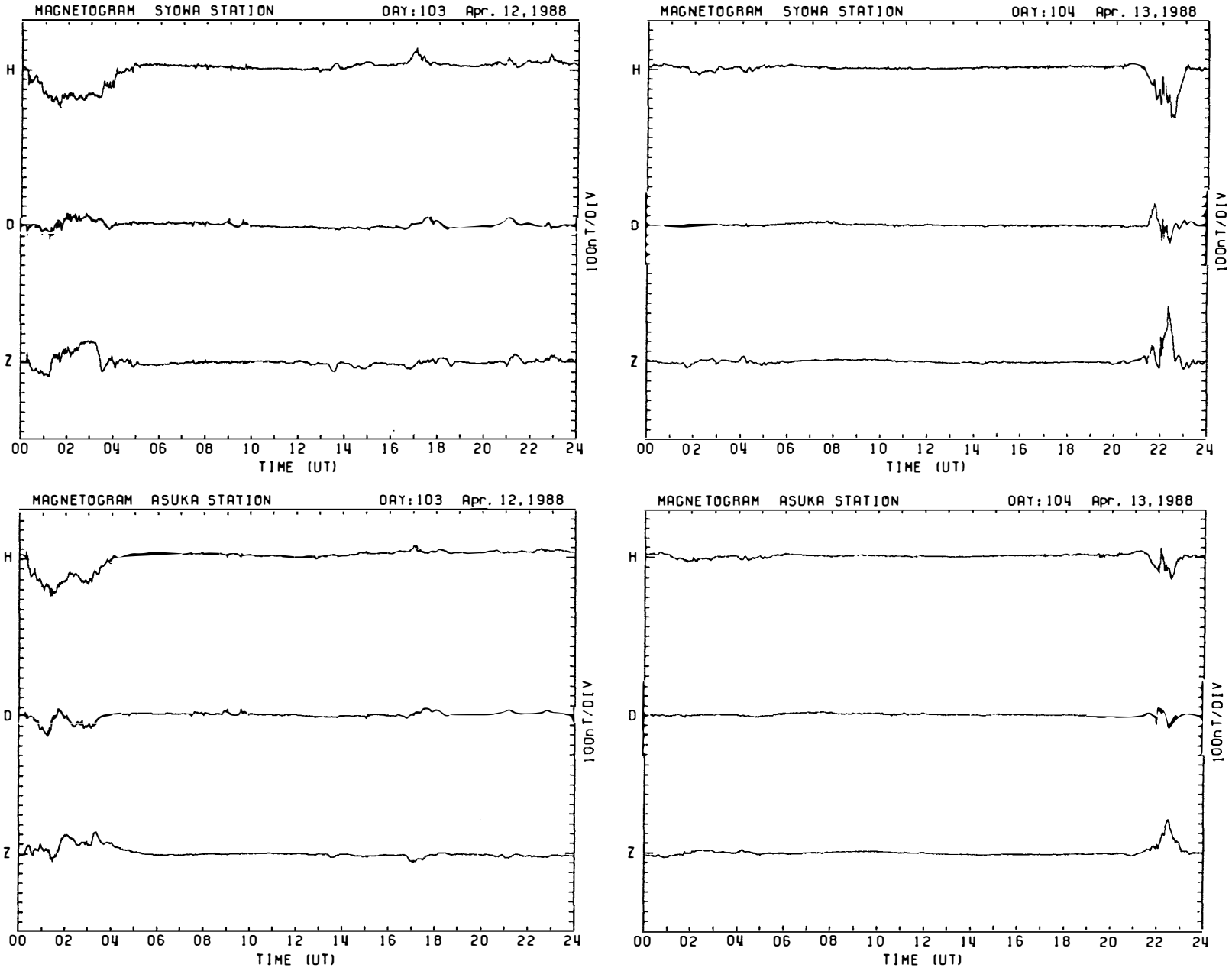
TIME (UT)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MAGNETOGRAM ASUKA STATION DAY:103 Apr. 12,1988
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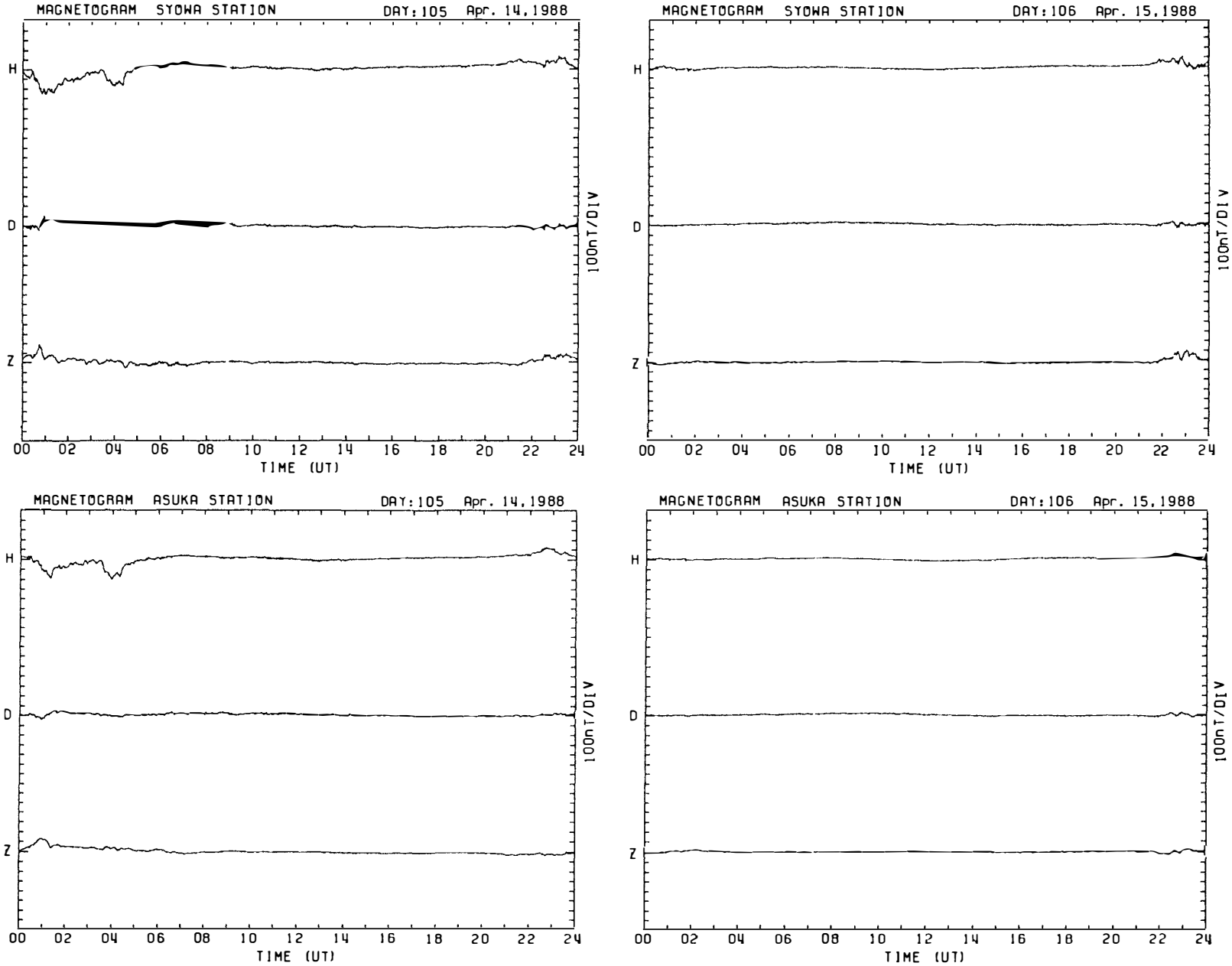
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DAY:105 Apr. 14,1988
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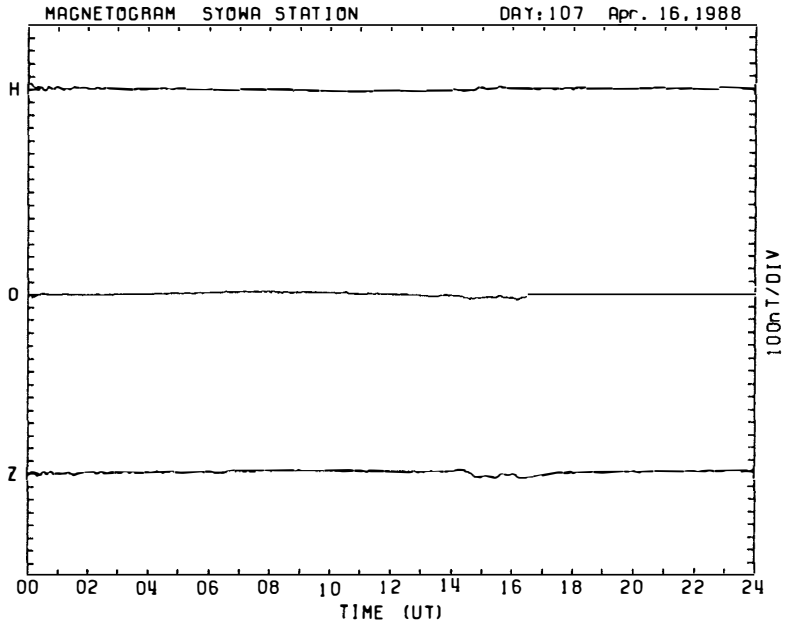
TIME (UT)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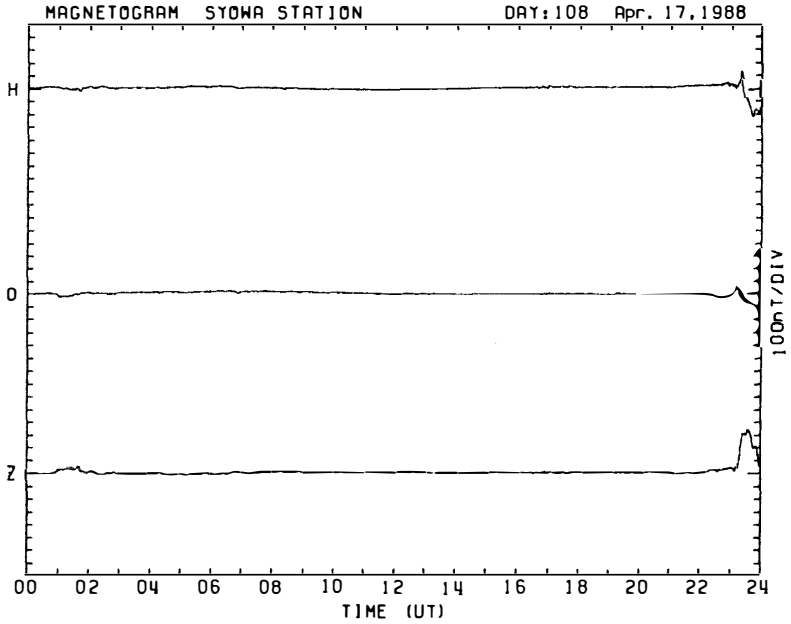
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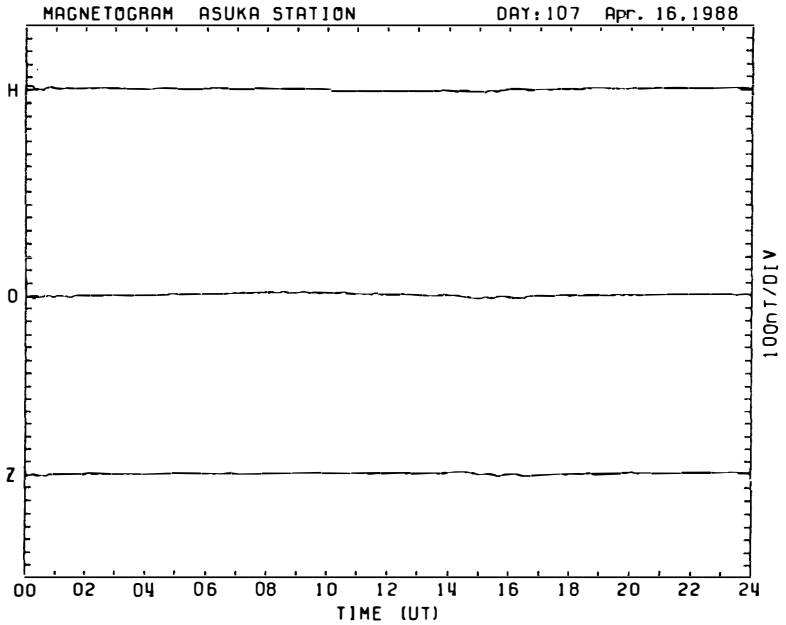
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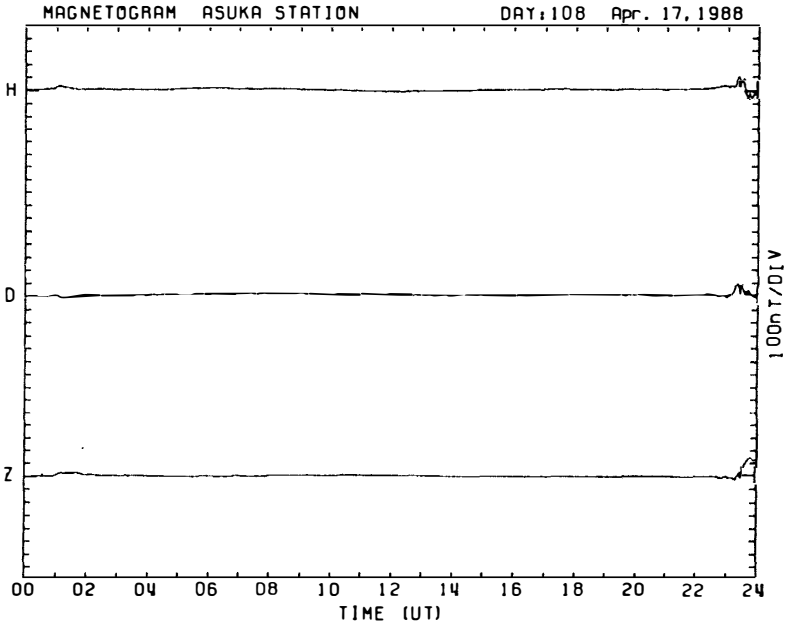
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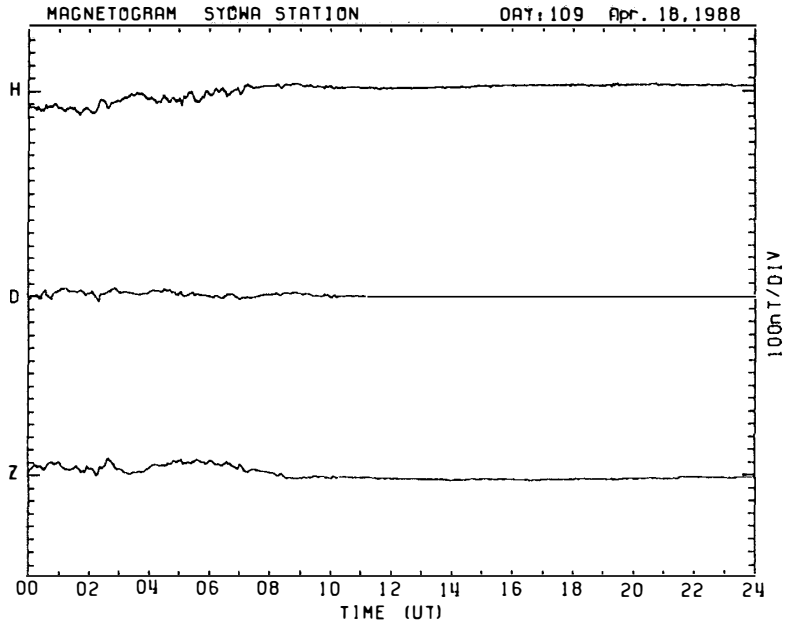
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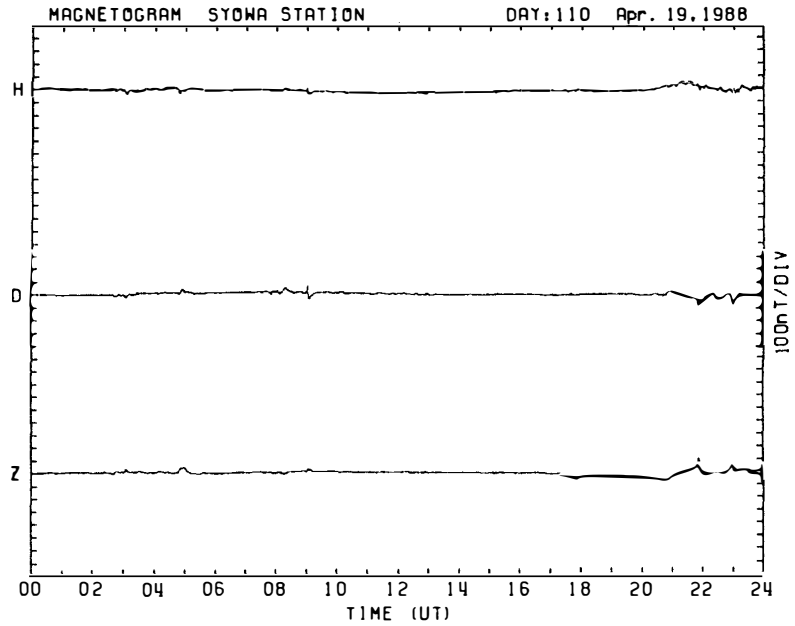
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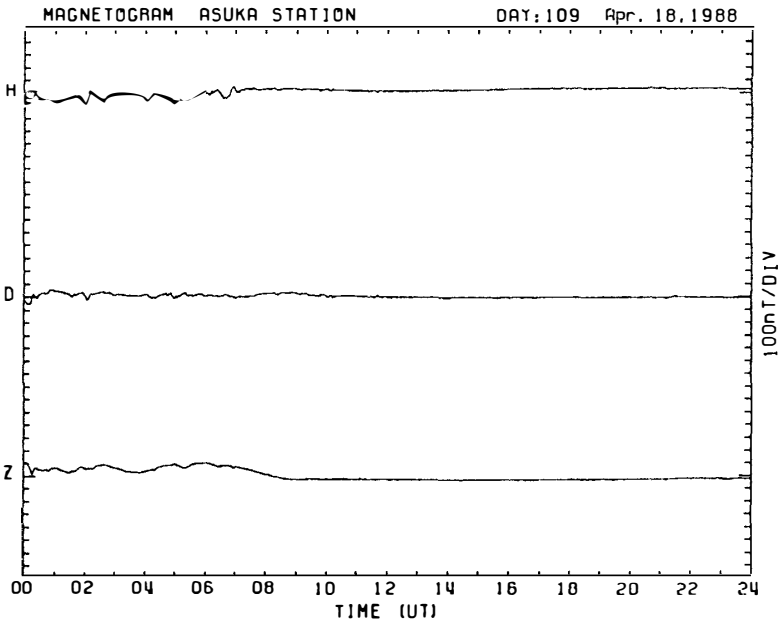
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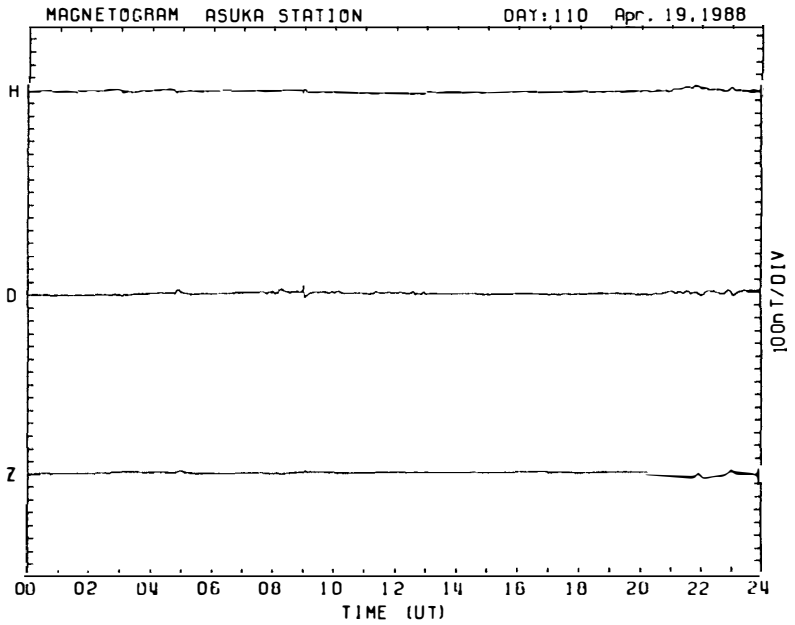
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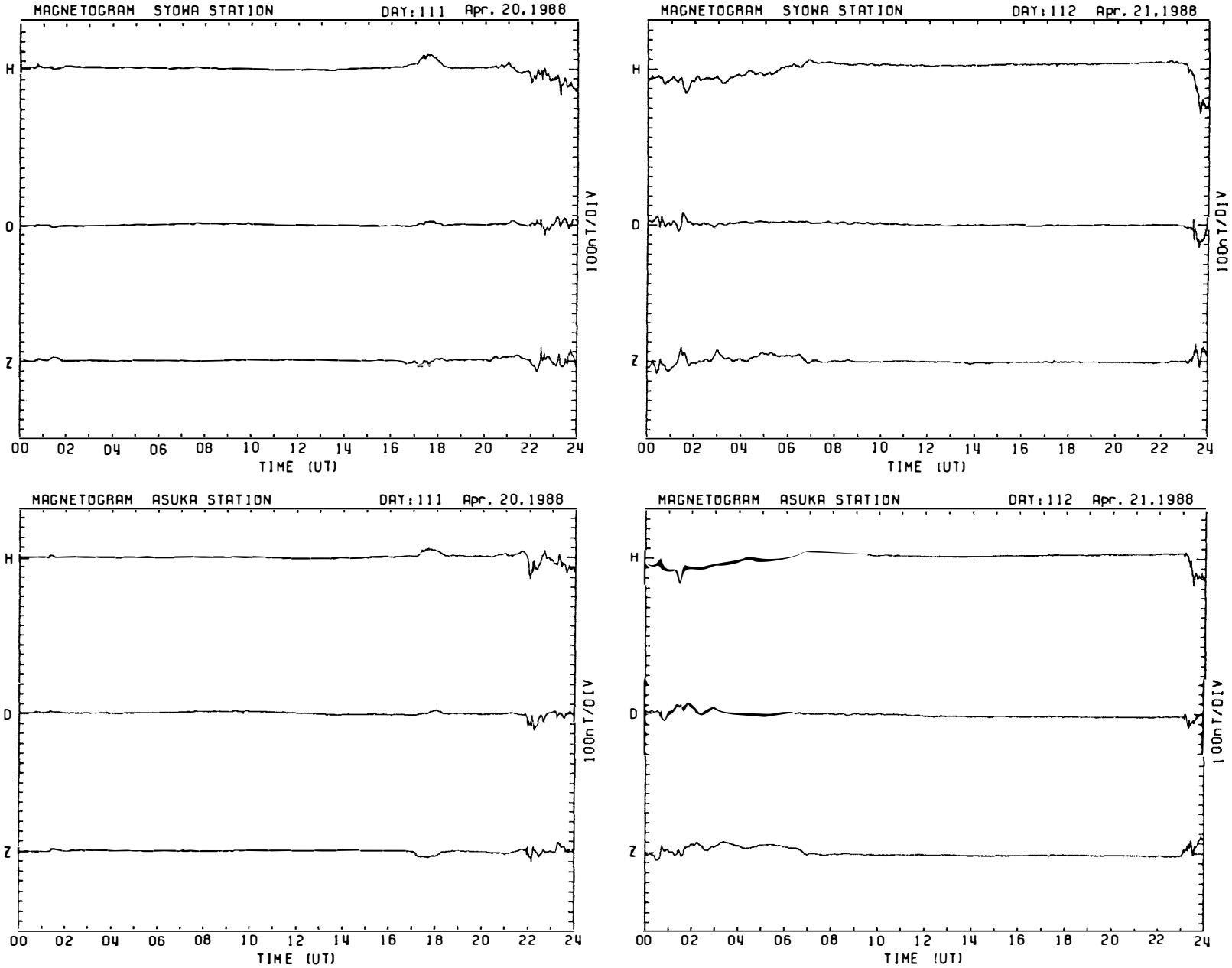
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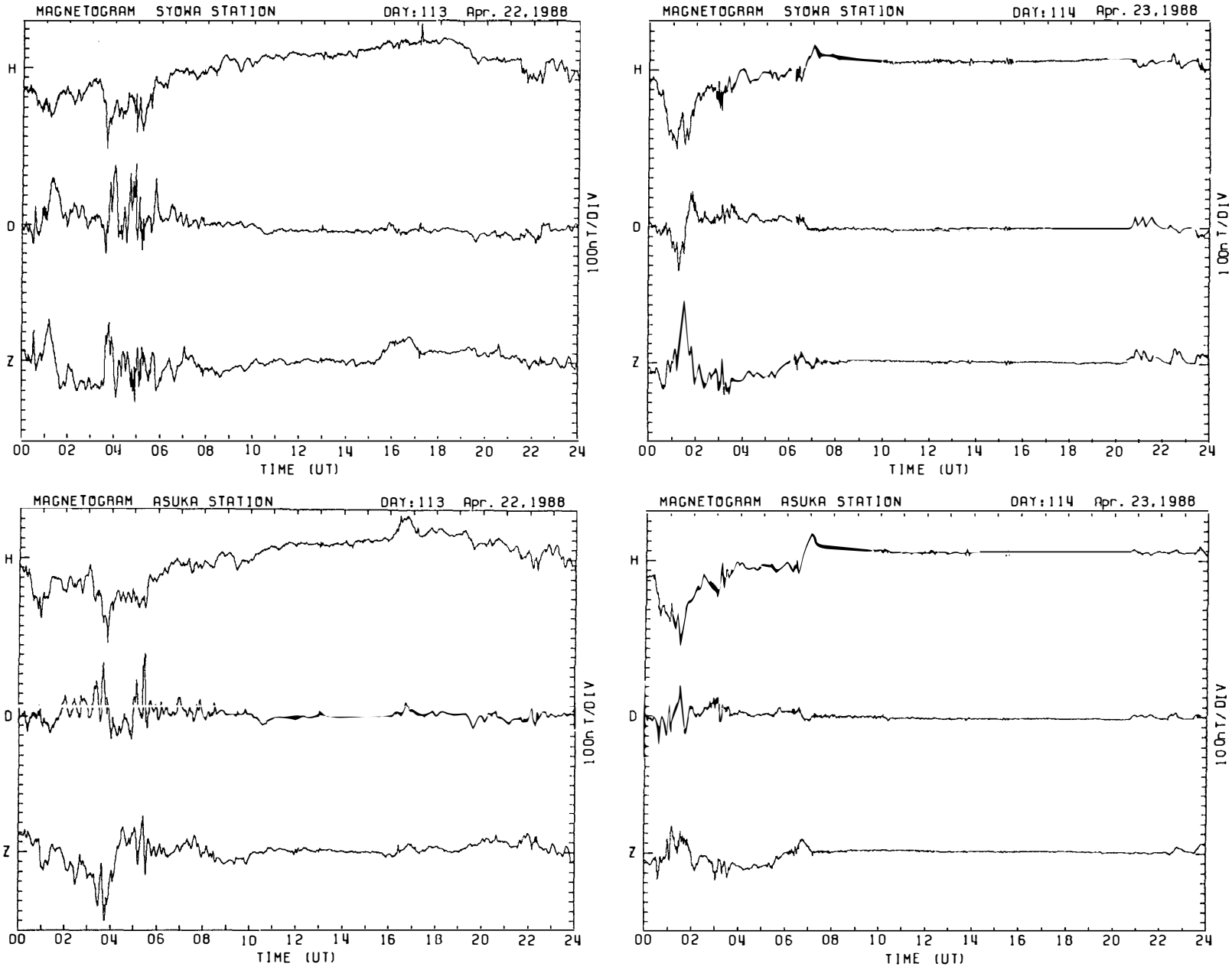
TIME (UT)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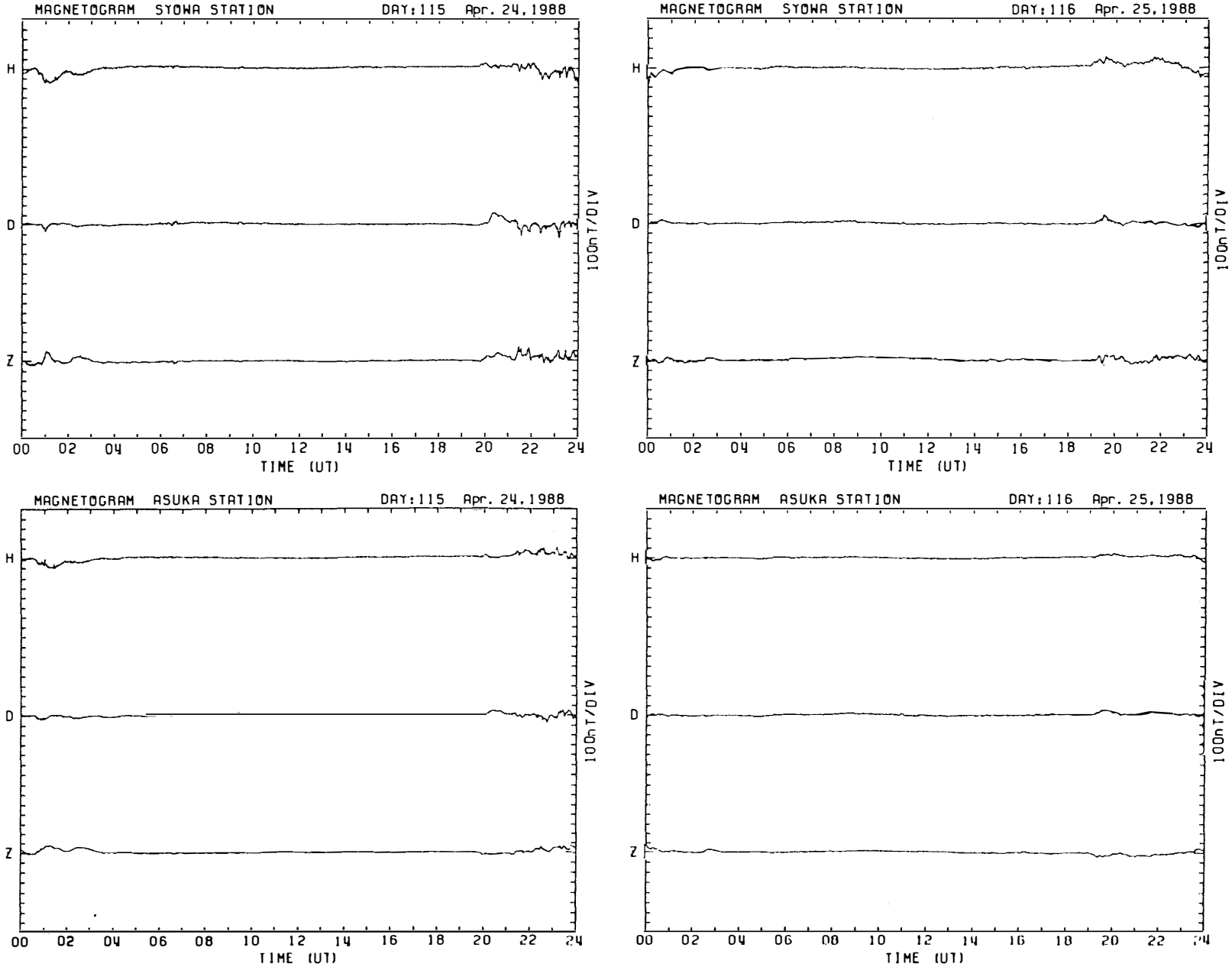
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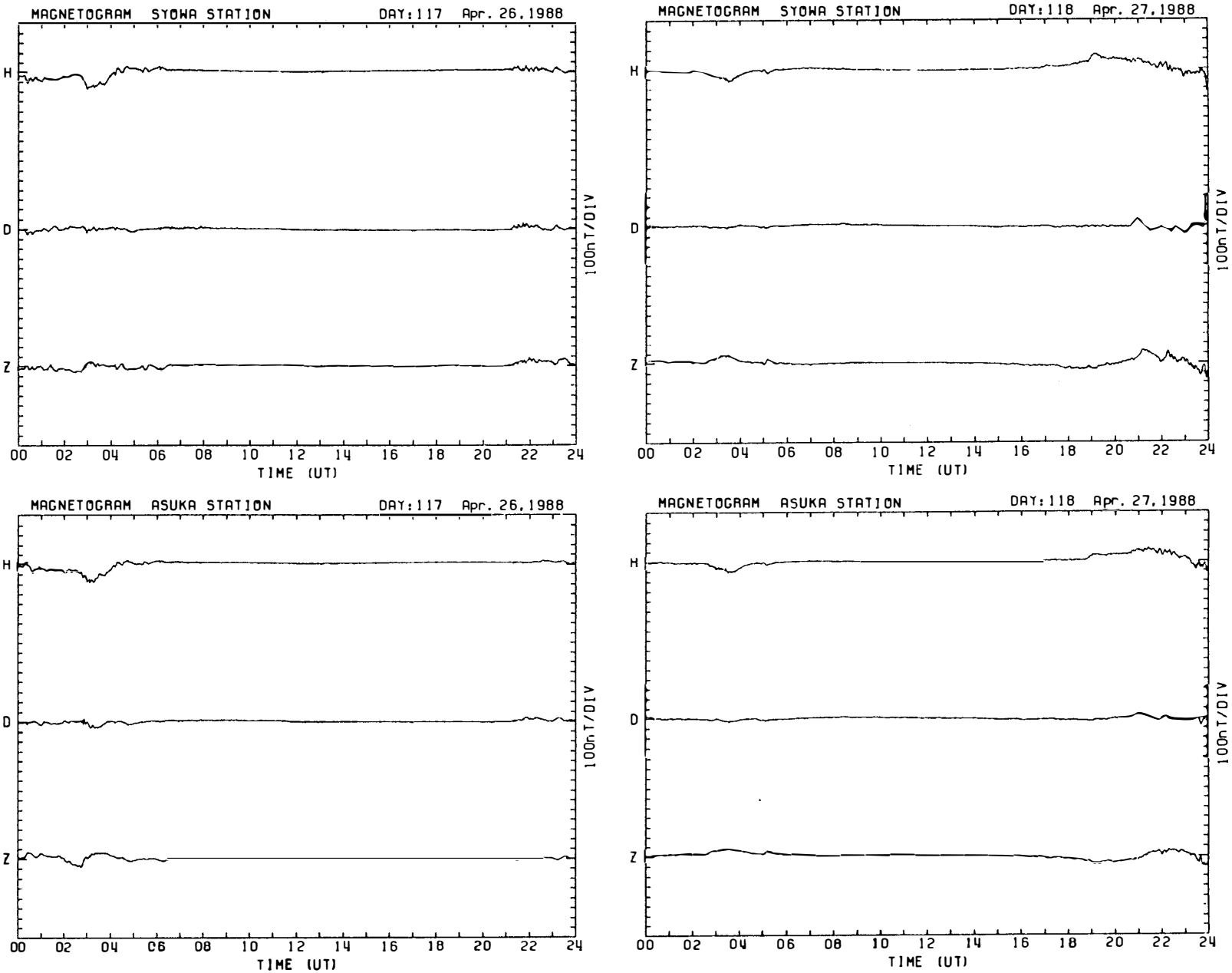
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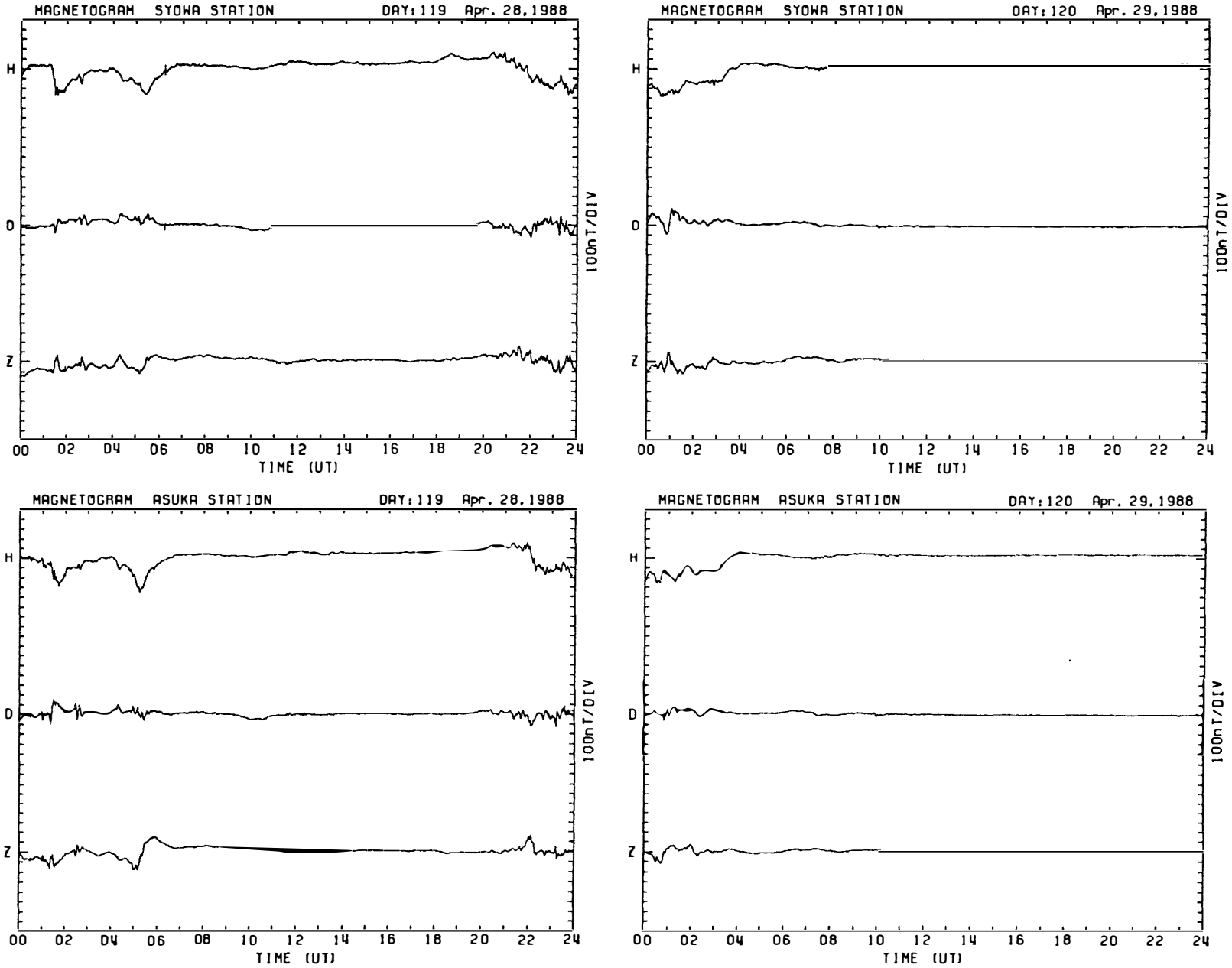
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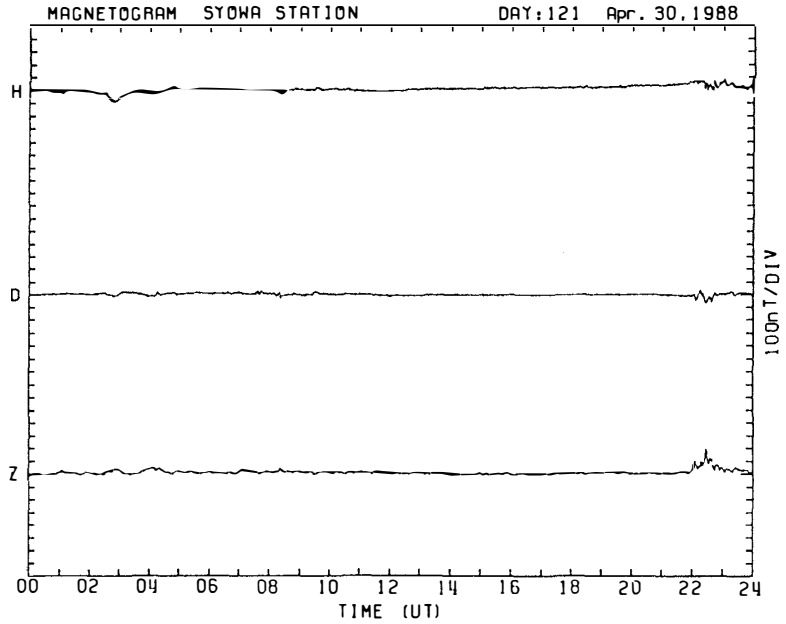
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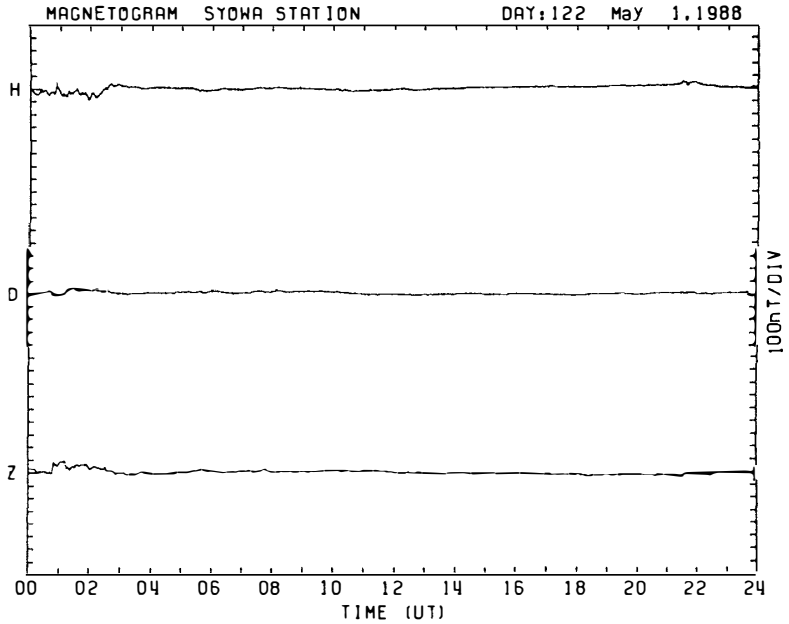
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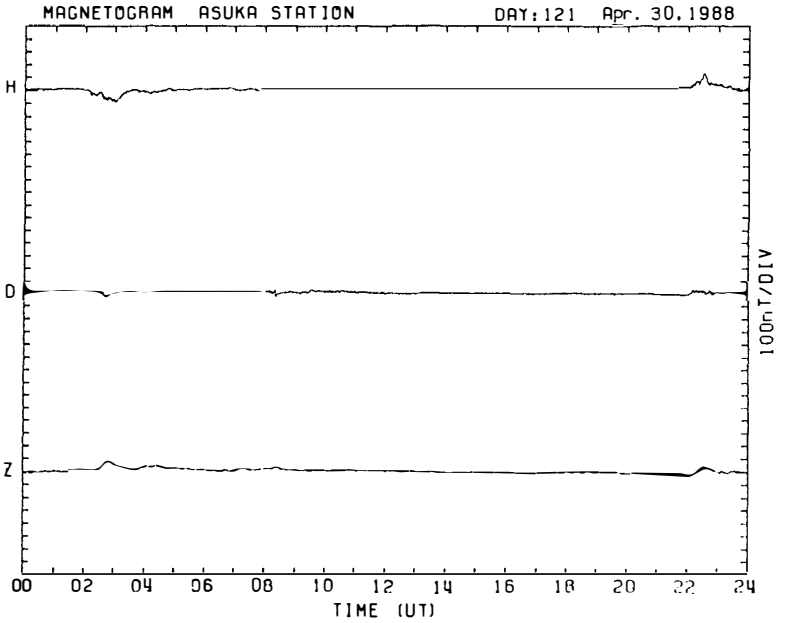
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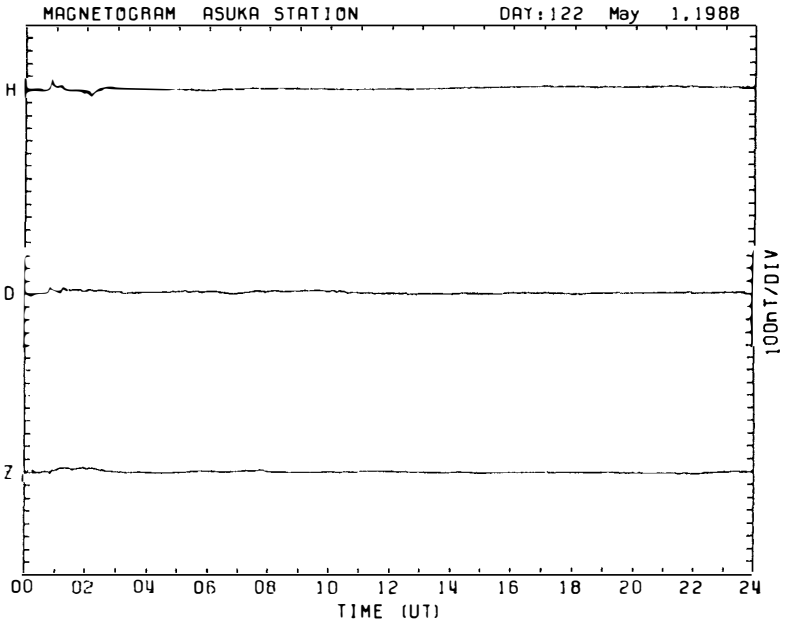
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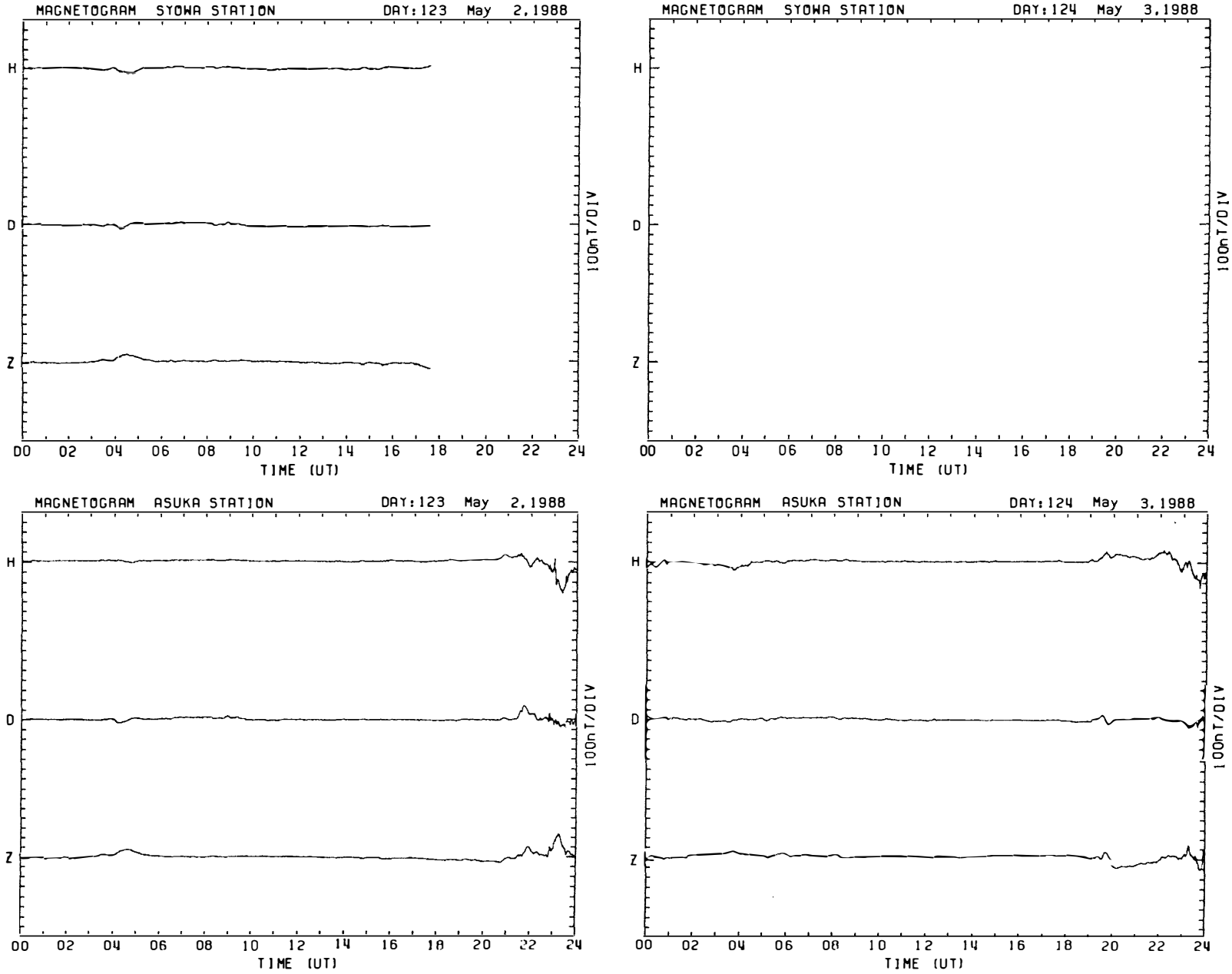
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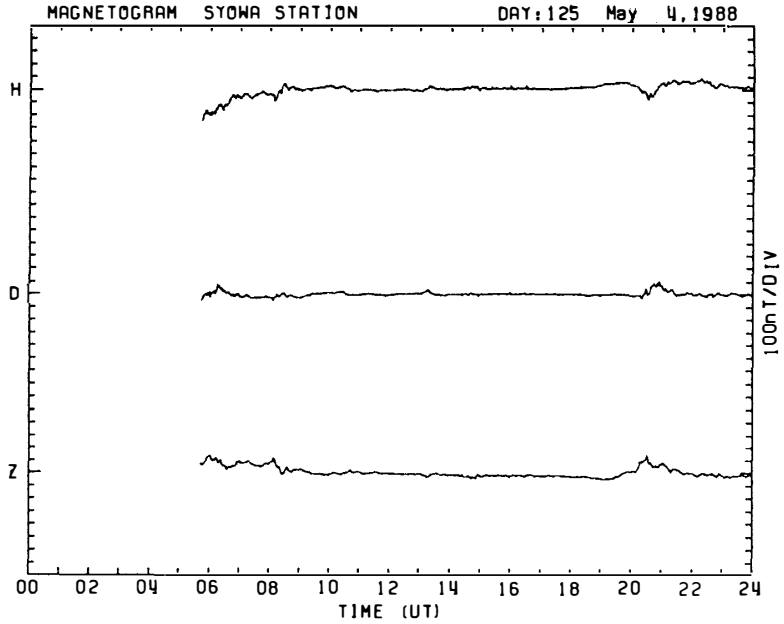
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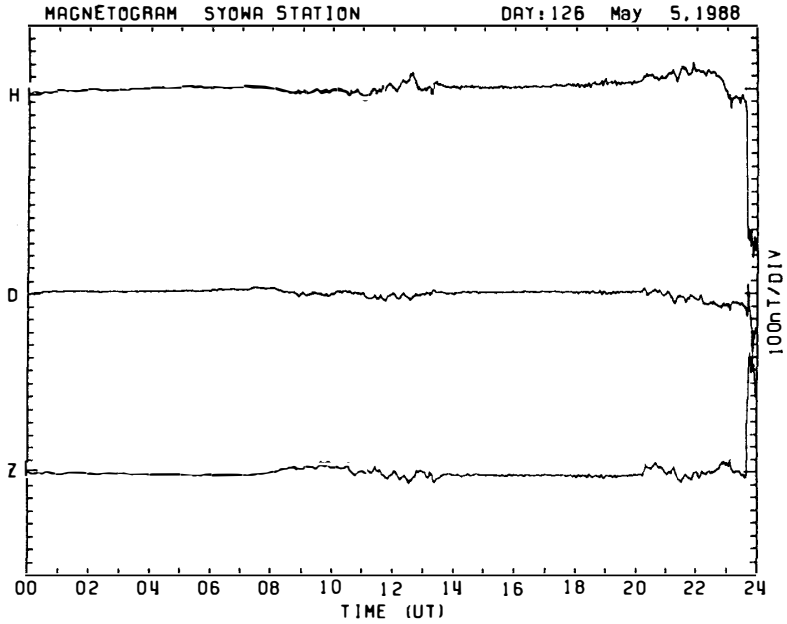
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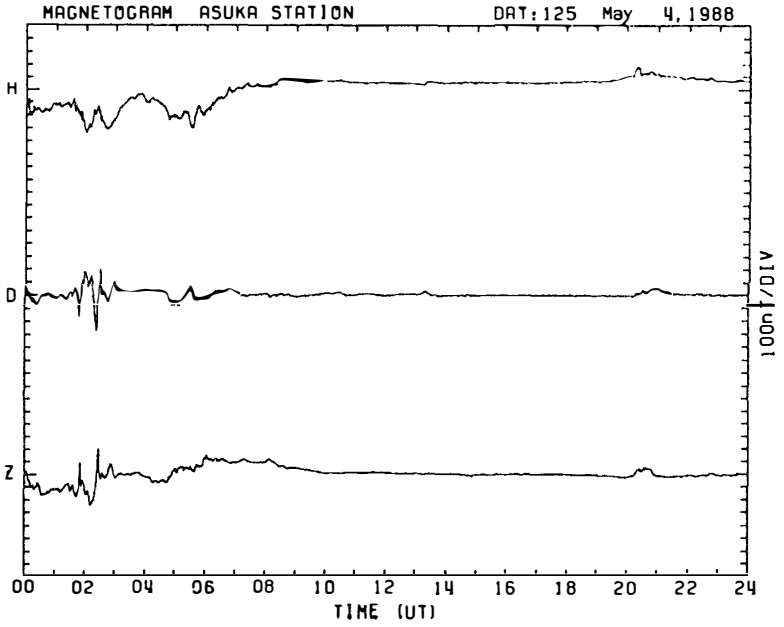
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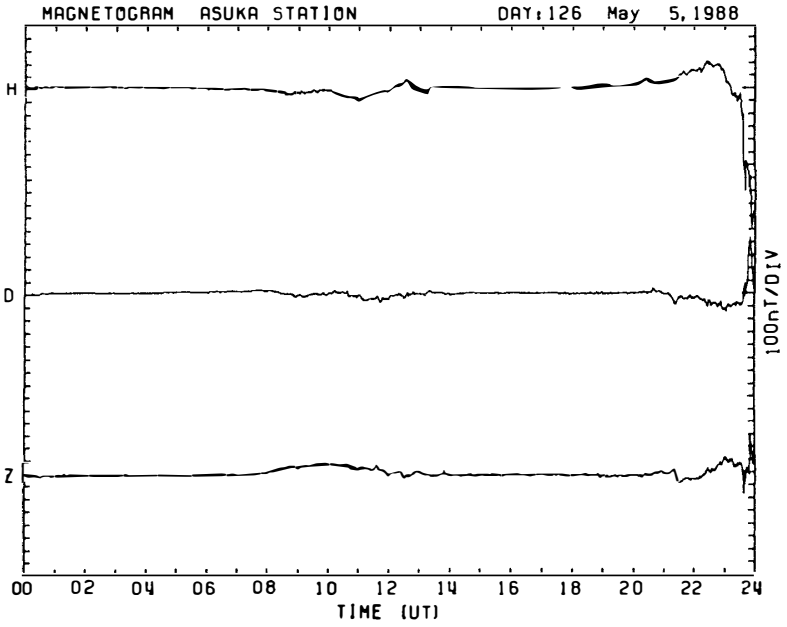
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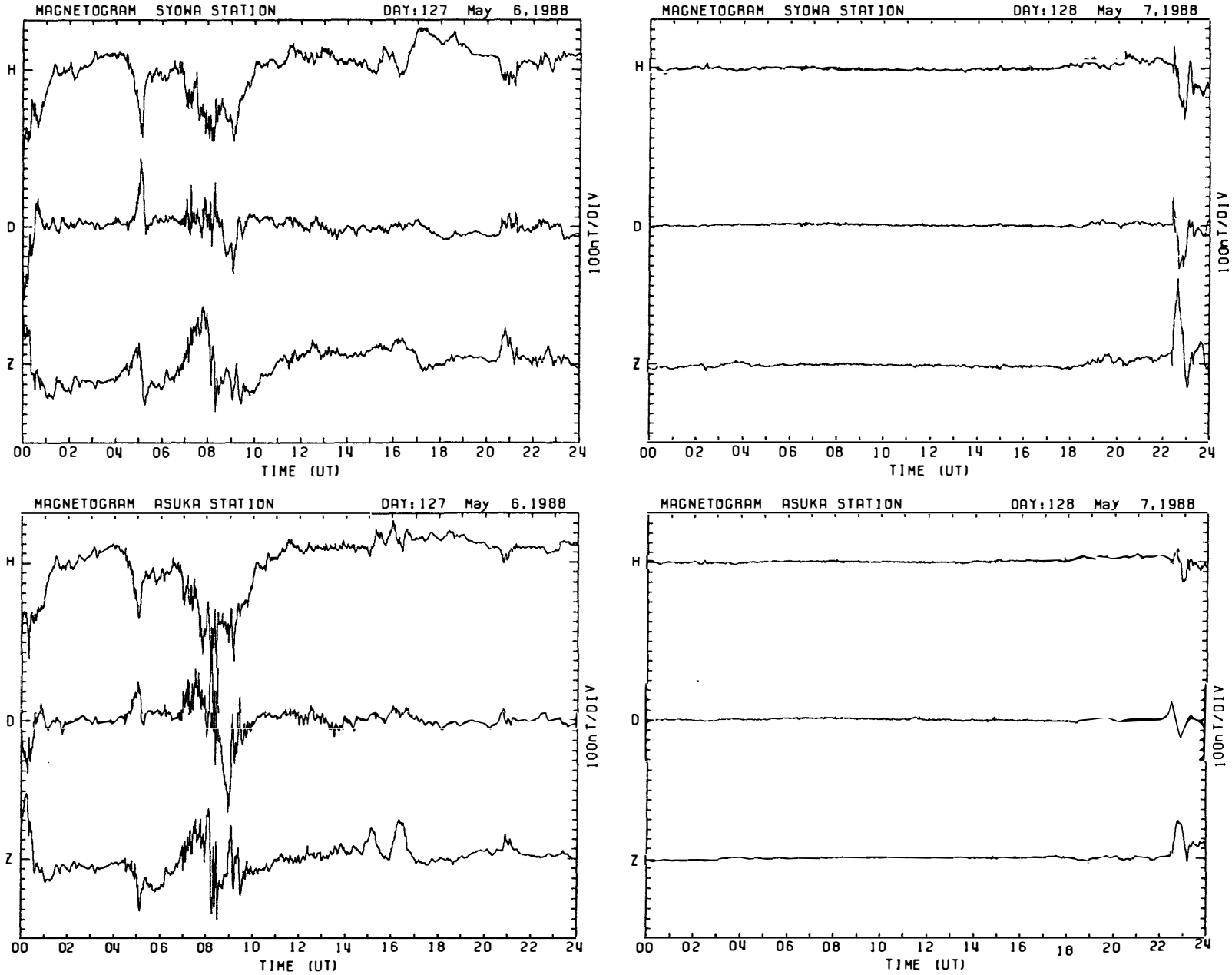
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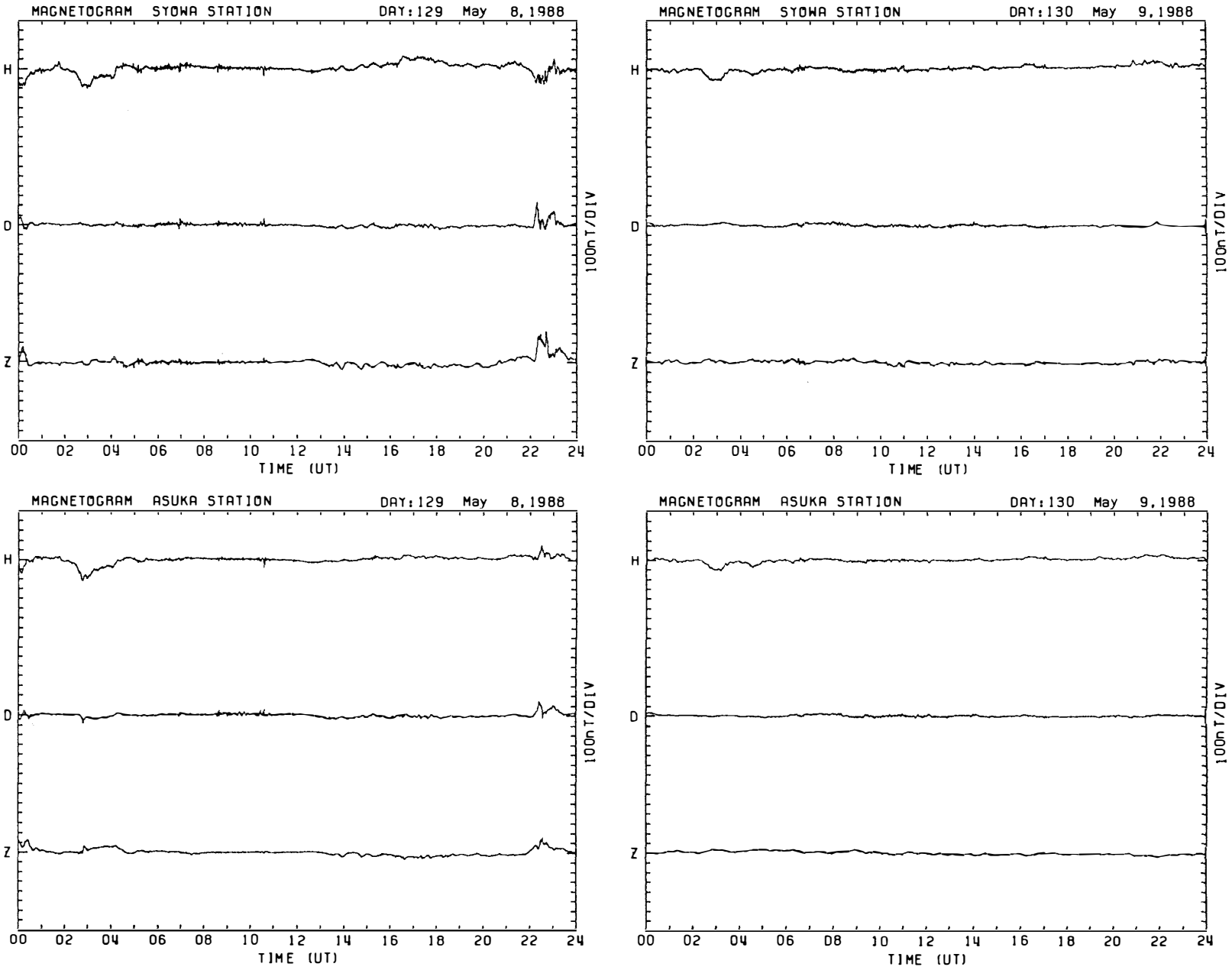
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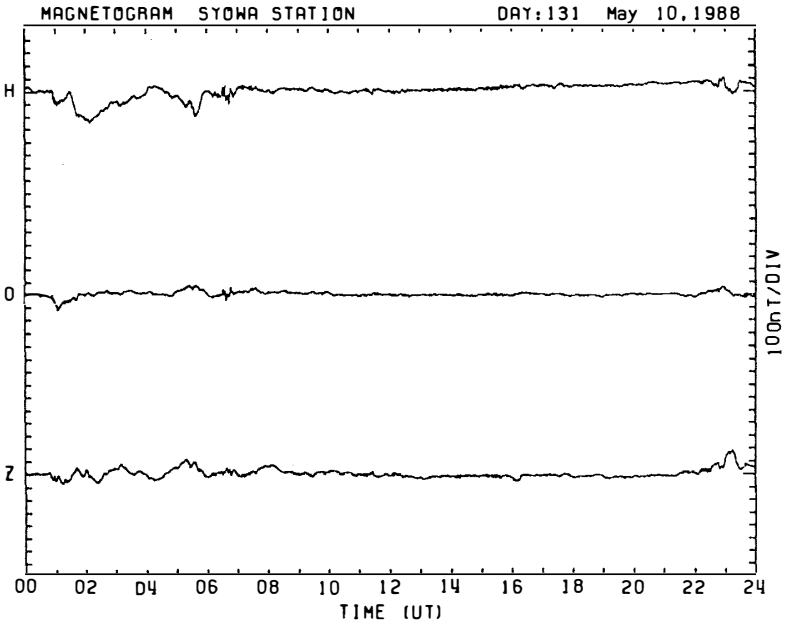
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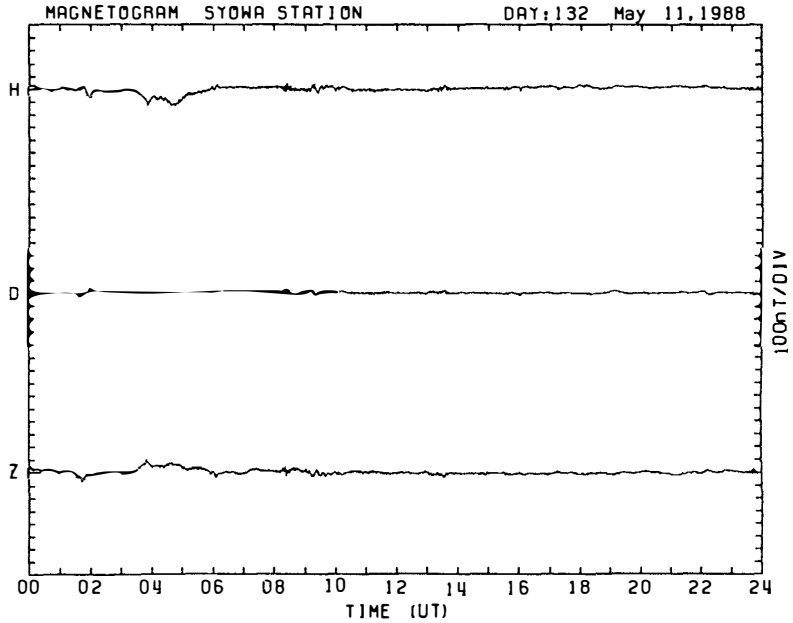
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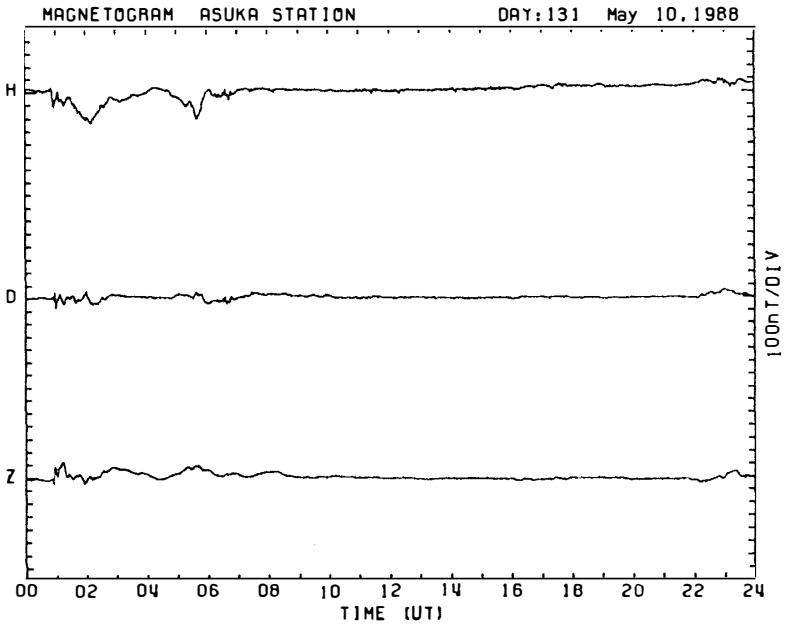
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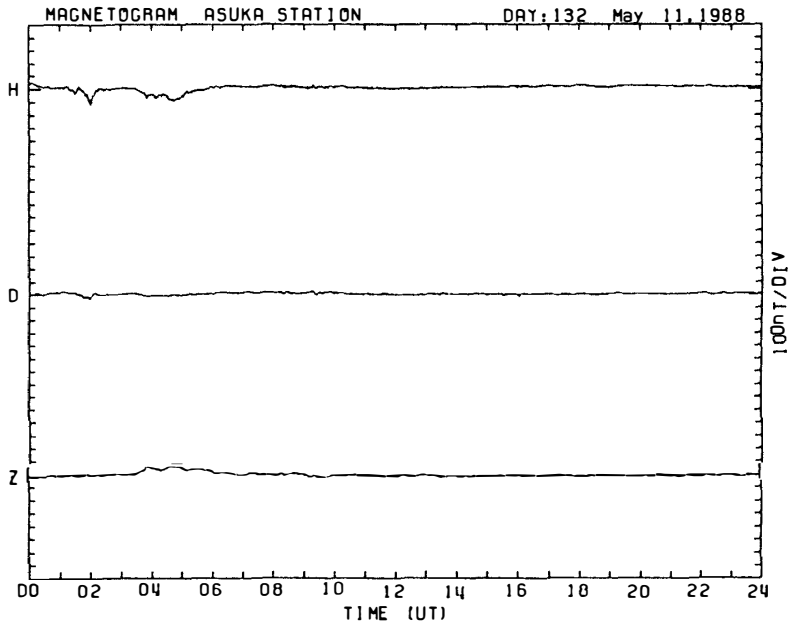
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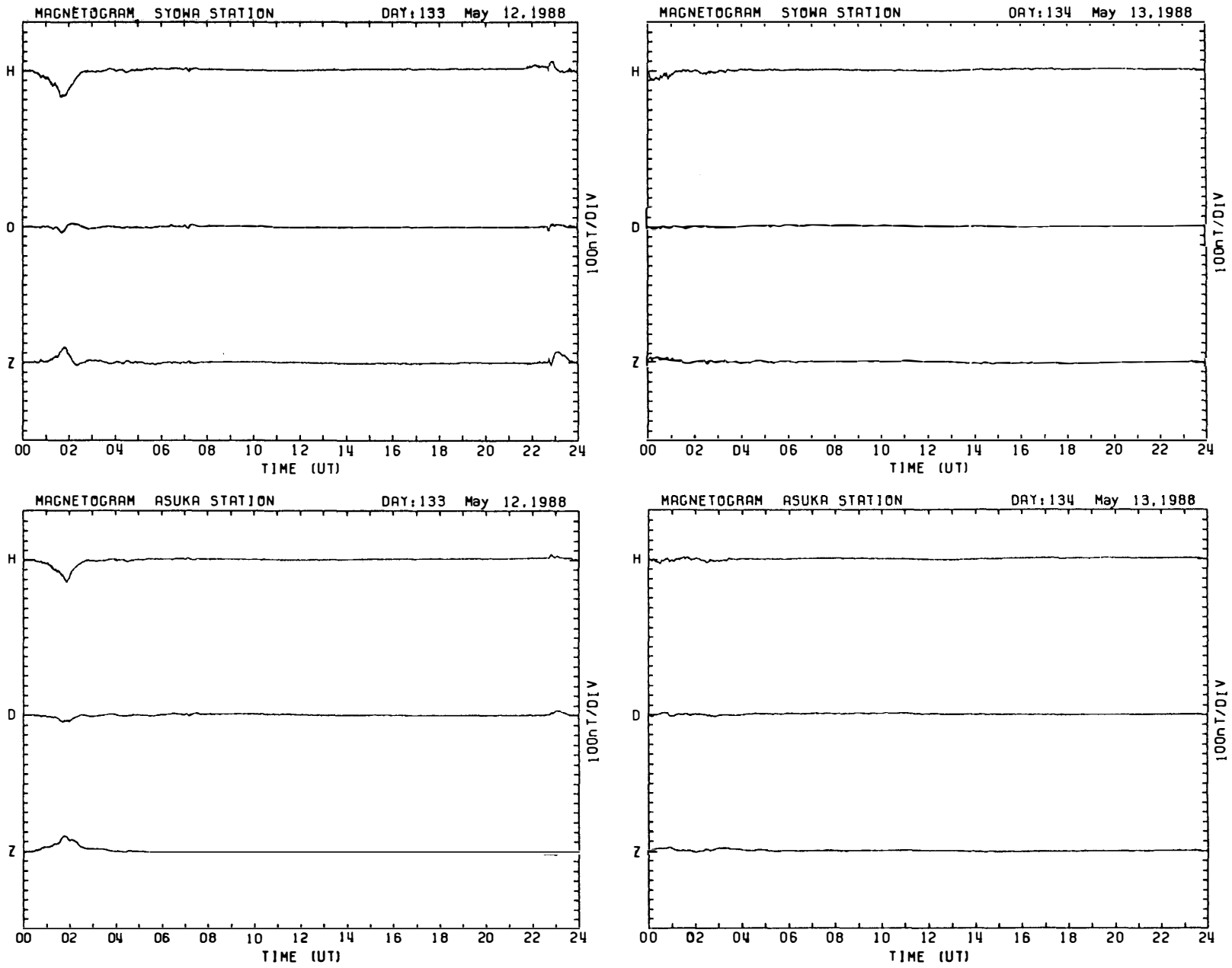
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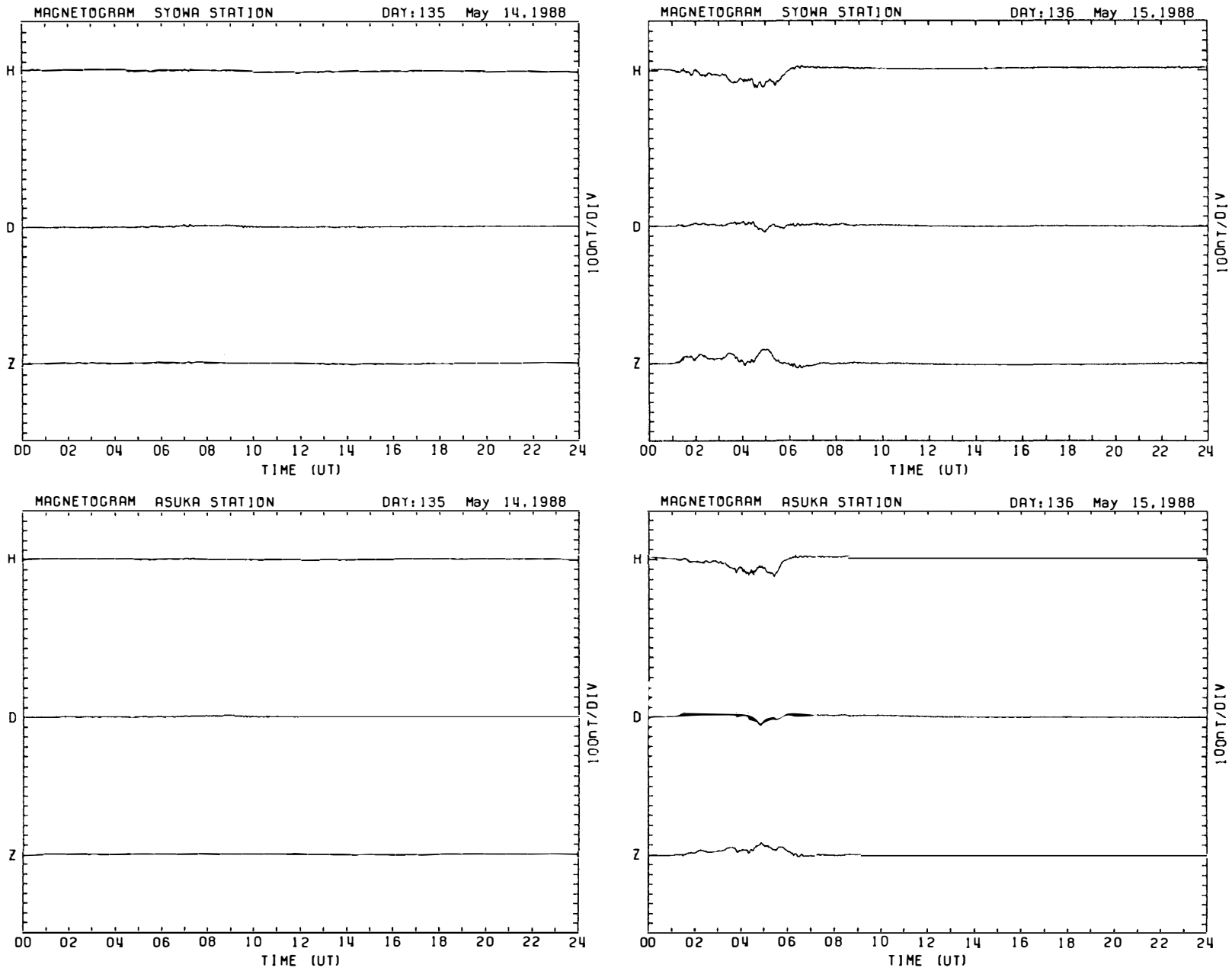
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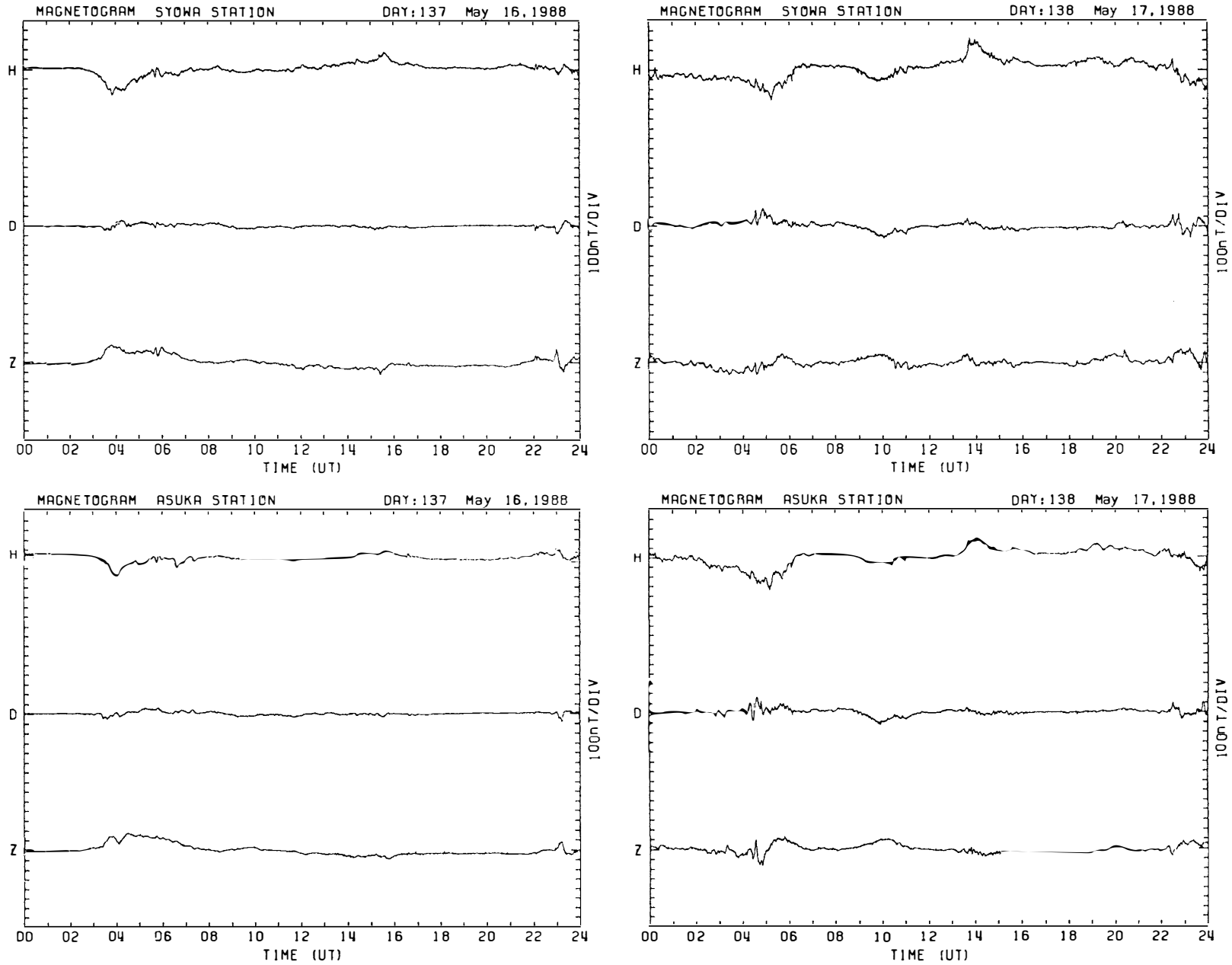
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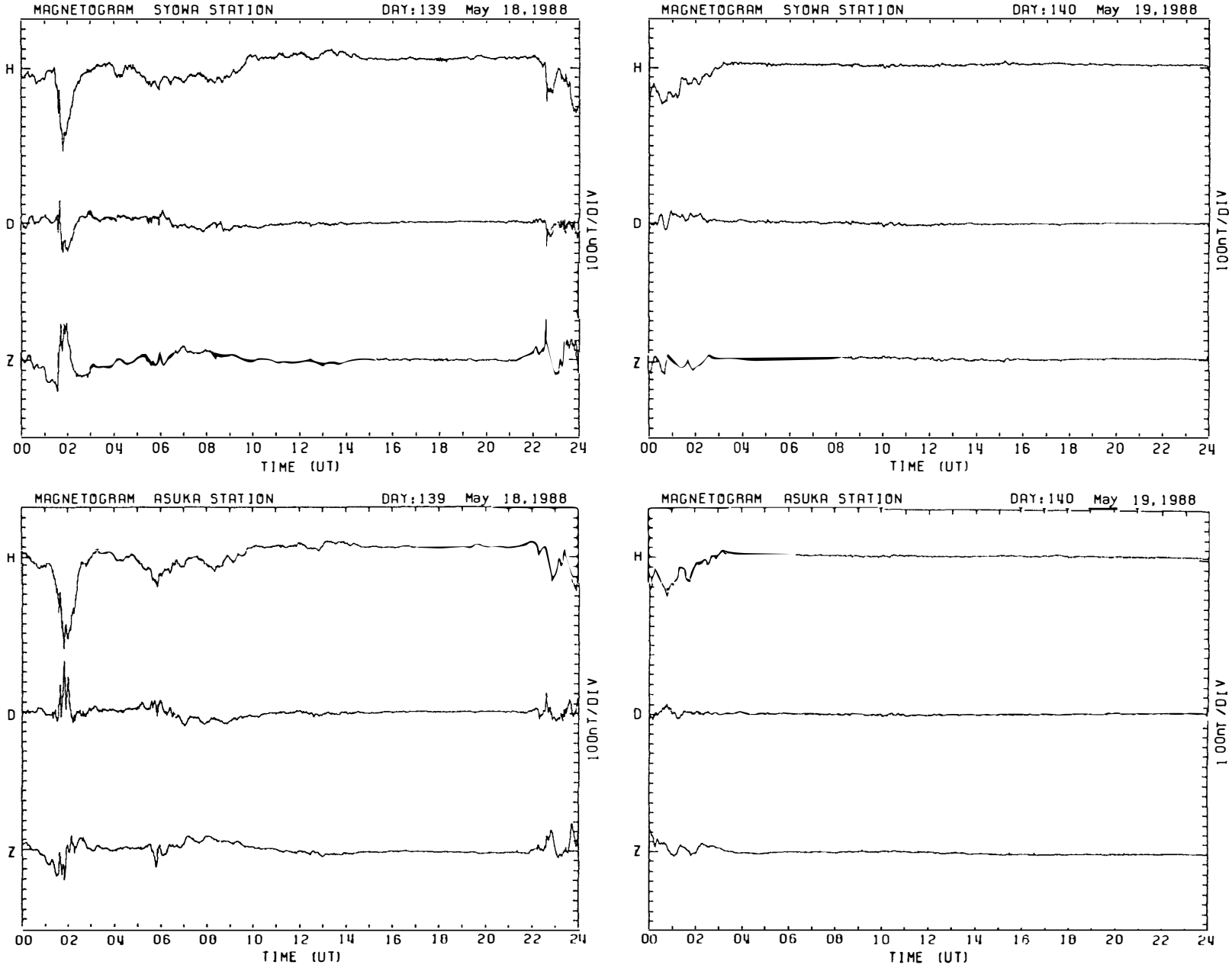
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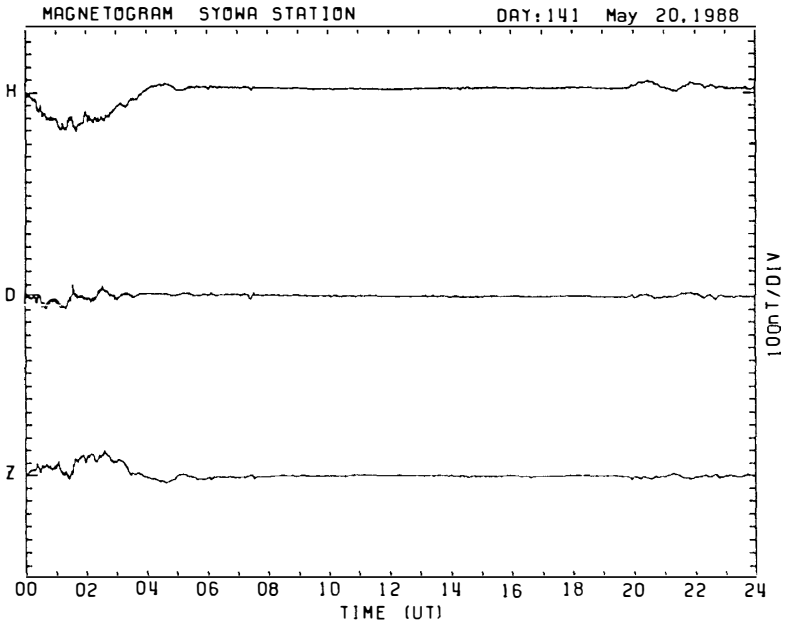
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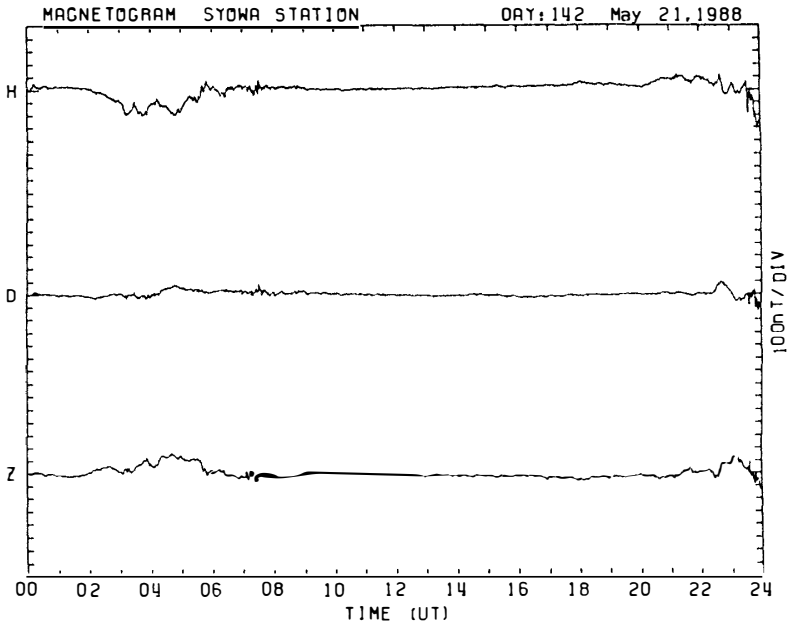
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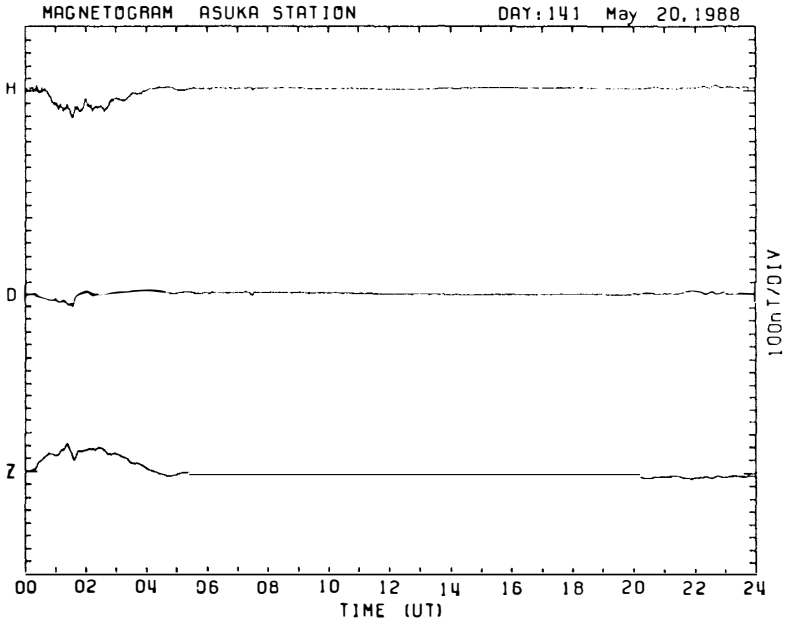
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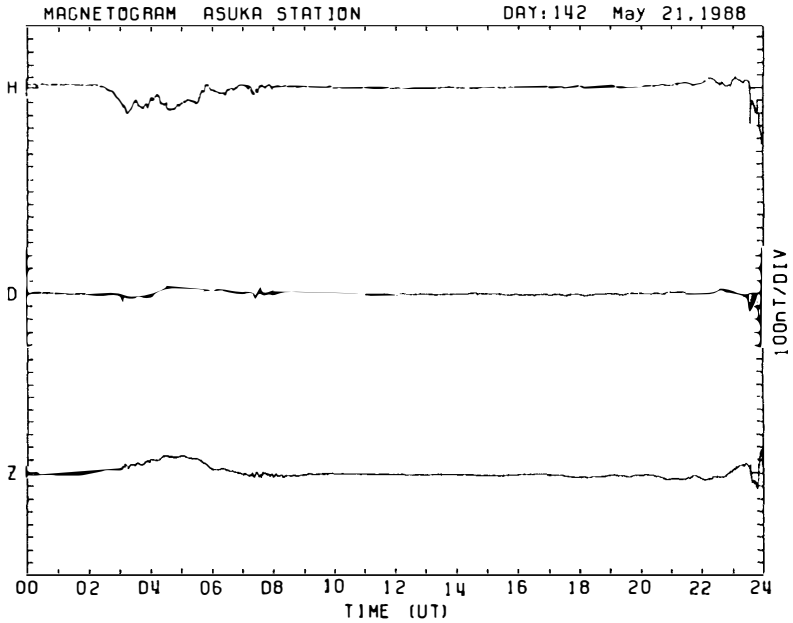
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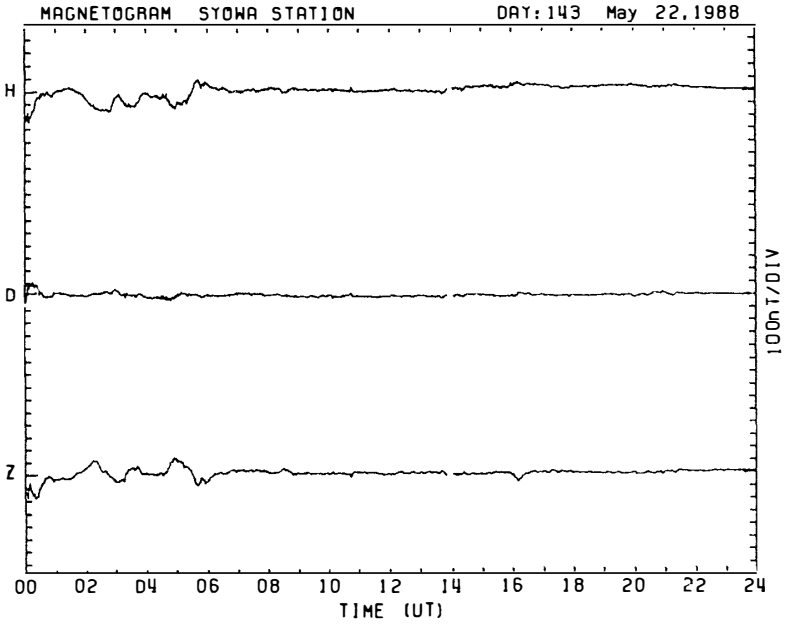
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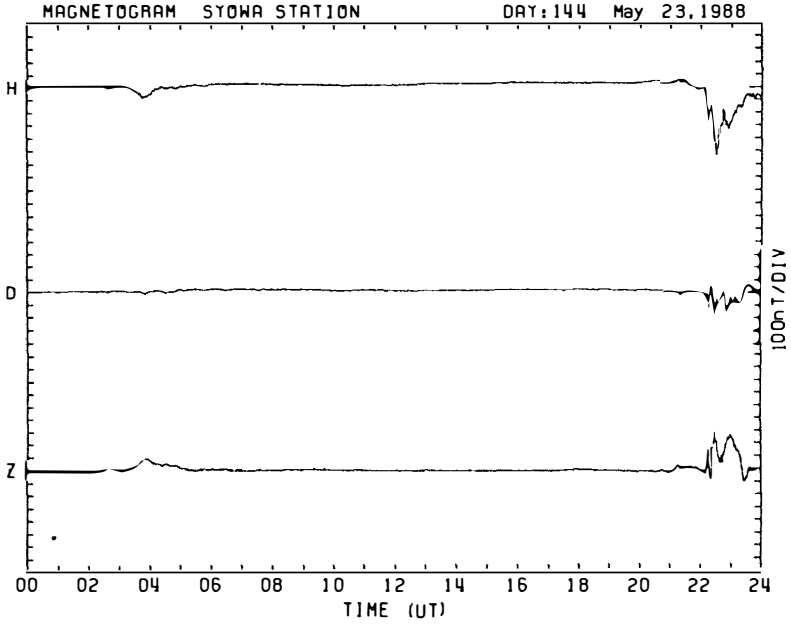
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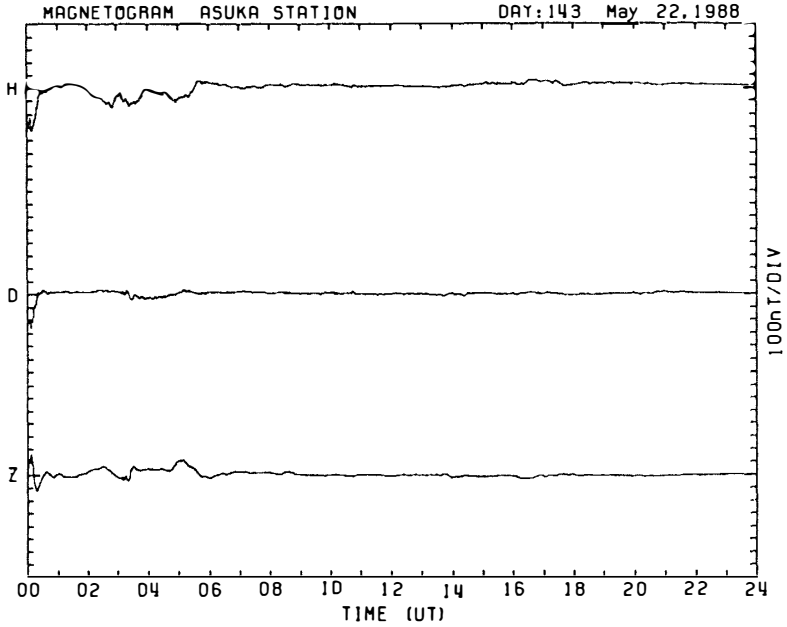
TIME (UT)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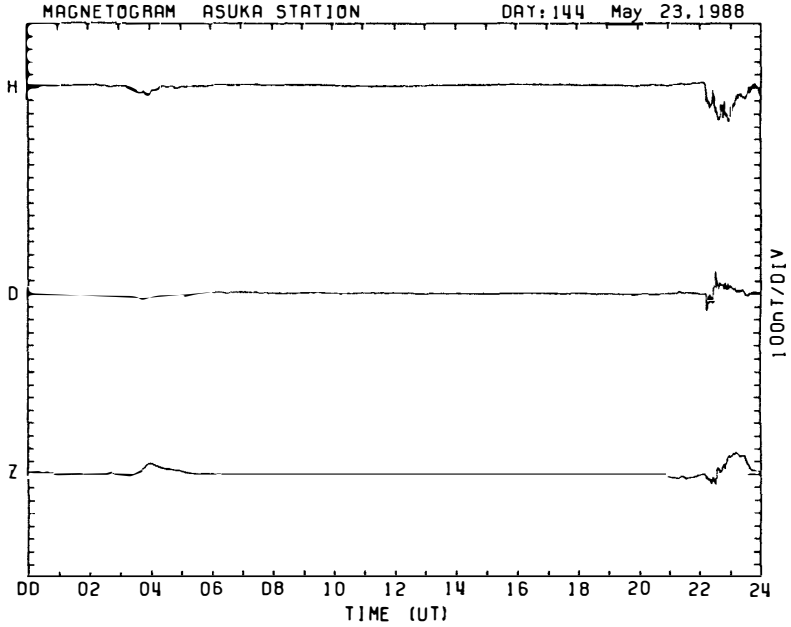
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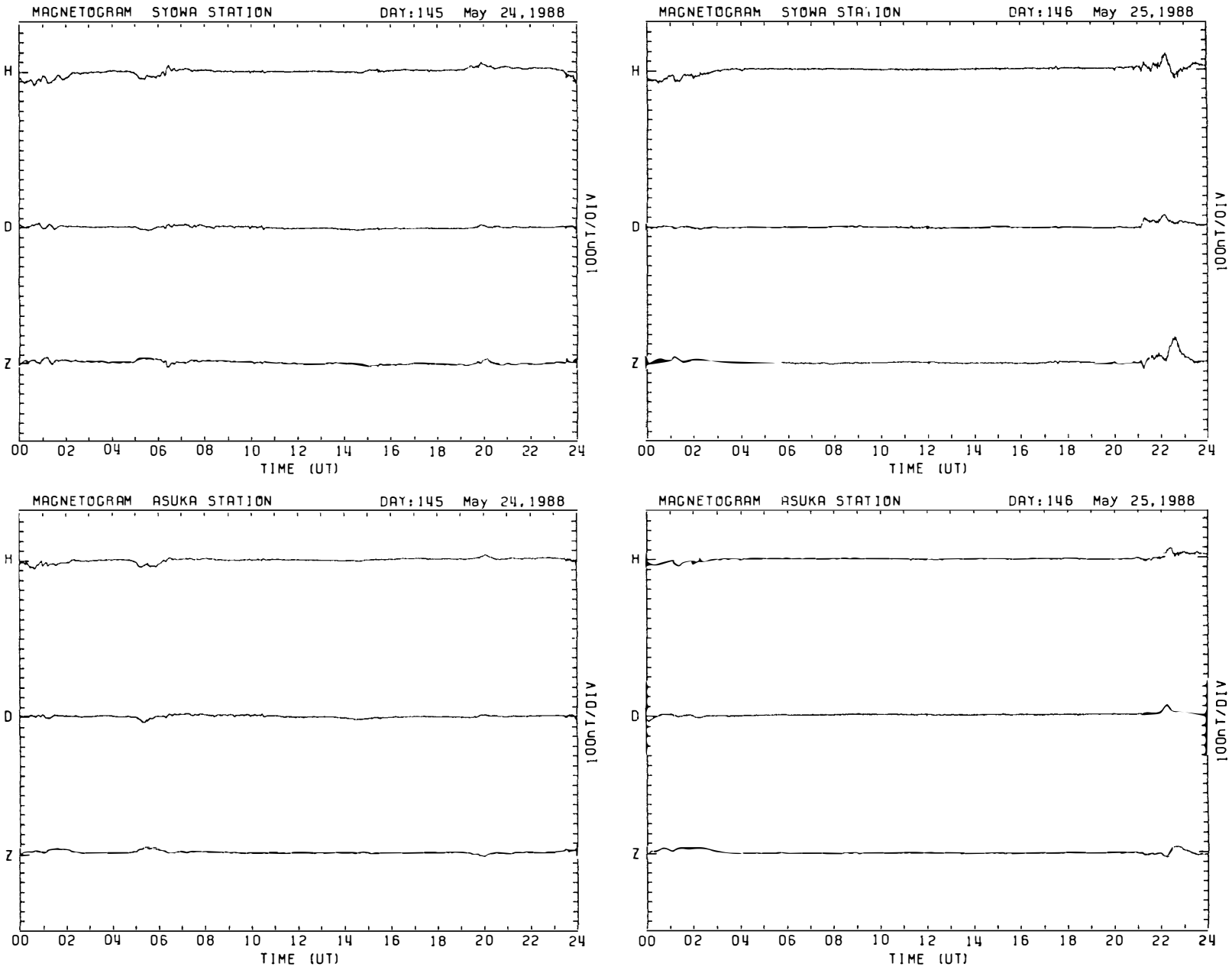
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MAGNETOGRAM ASUKA STATION DAY:145 May 24,1988
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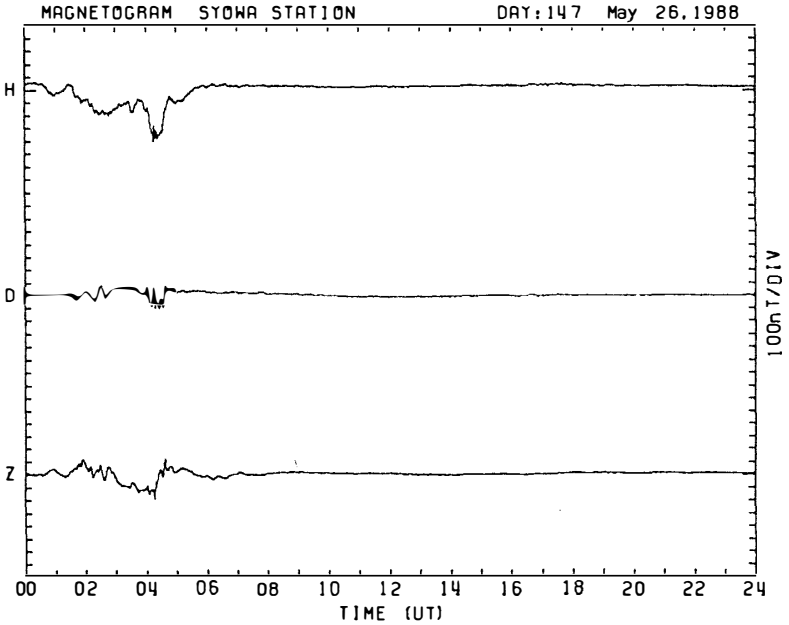
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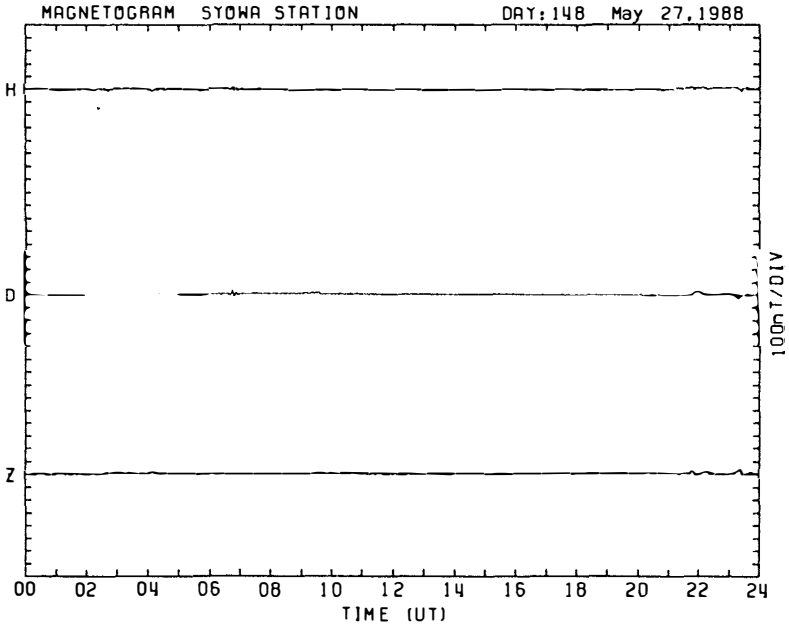
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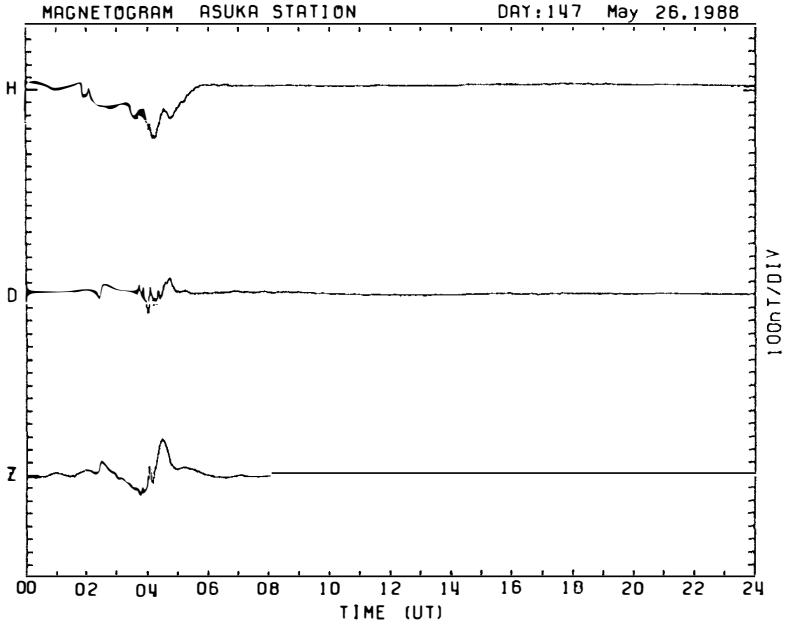
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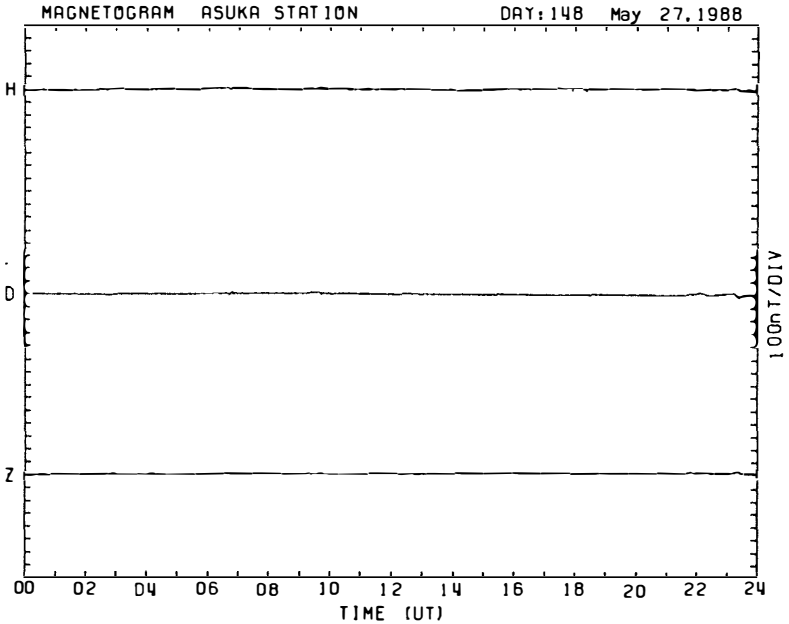
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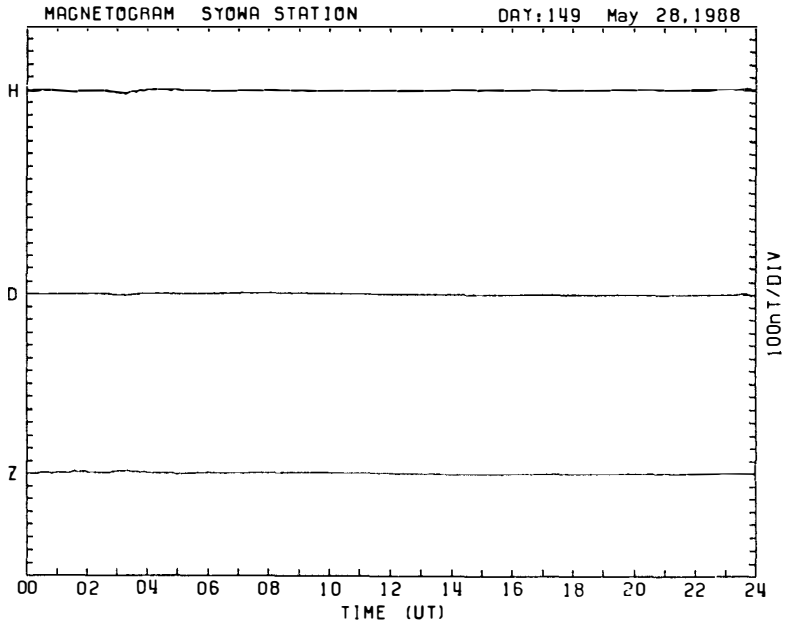
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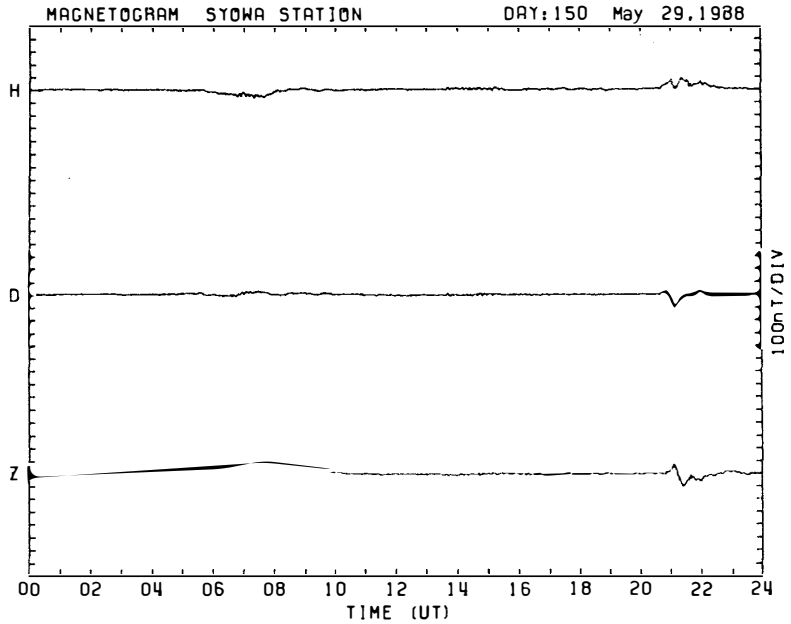
TIME (UT)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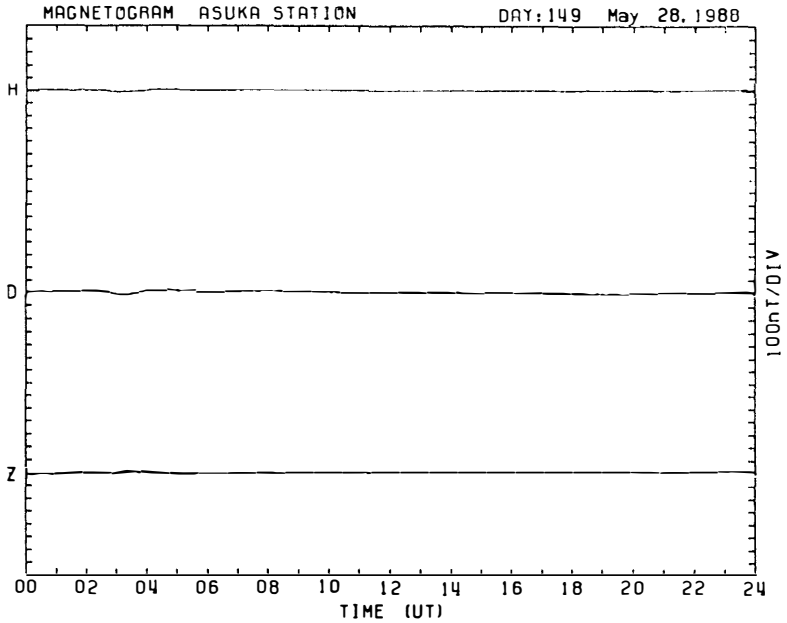
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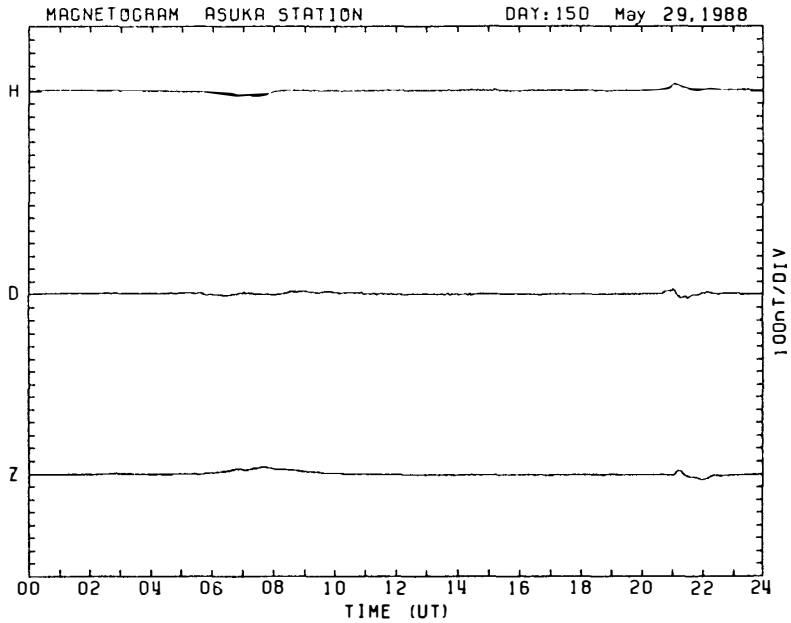
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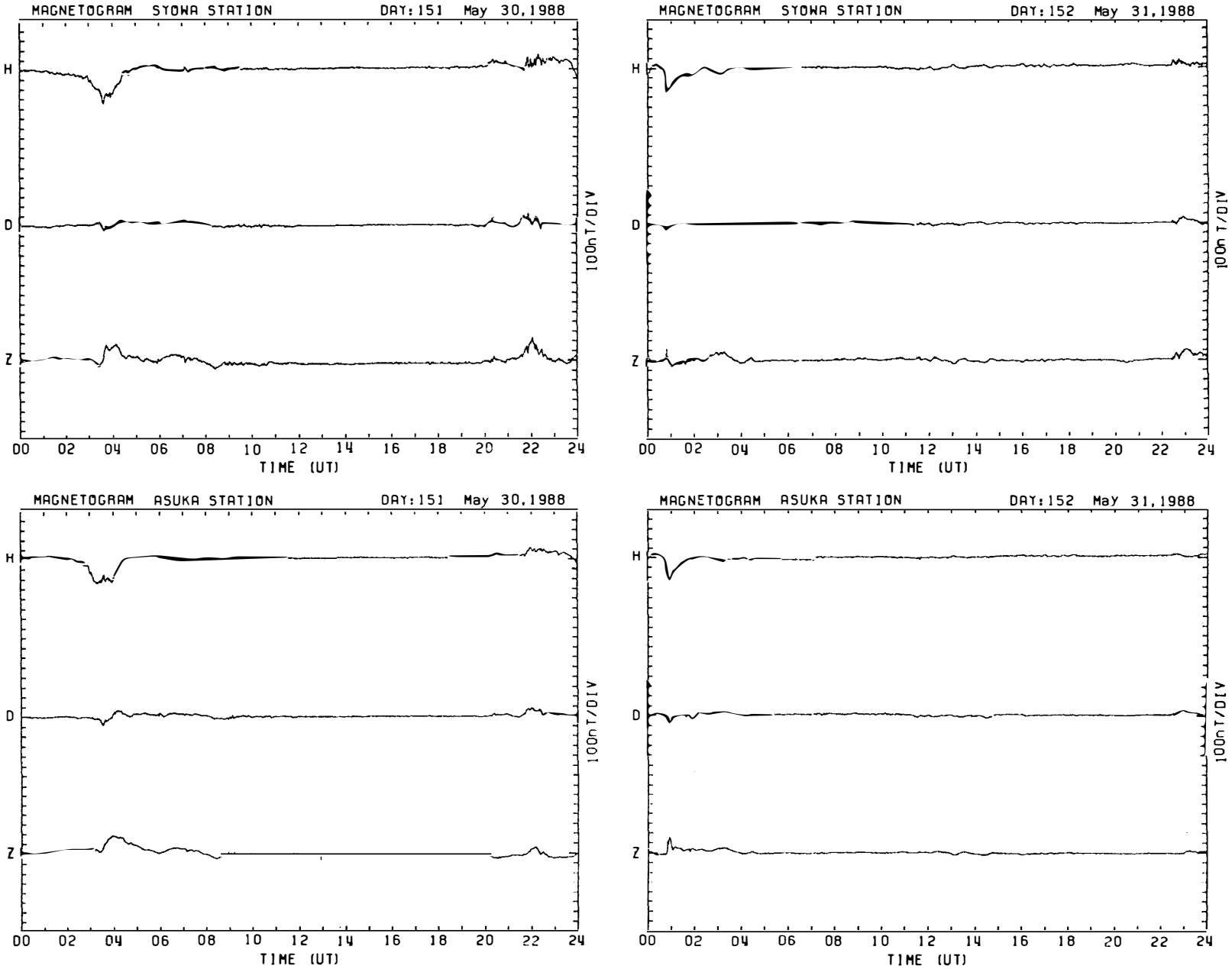
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MAGNETOGRAM ASUKA STATION DAY:151 May 30,1988
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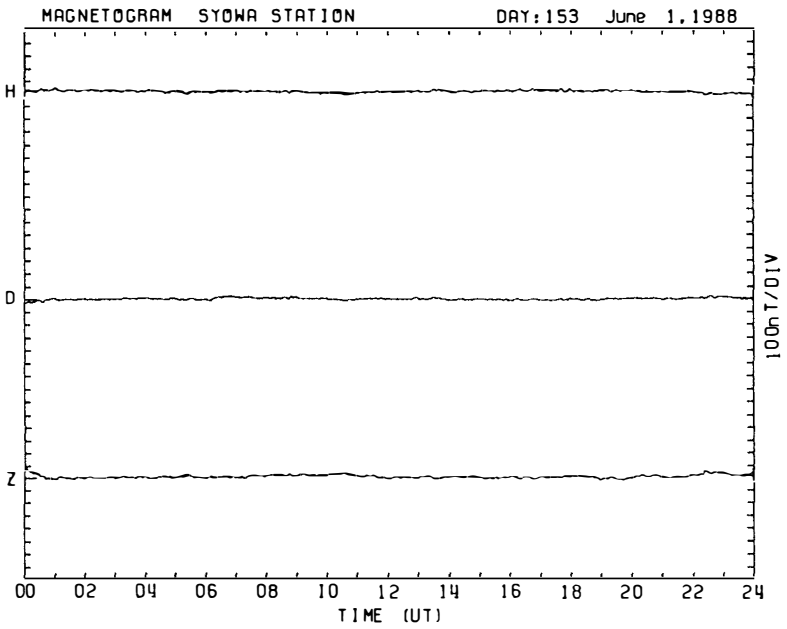
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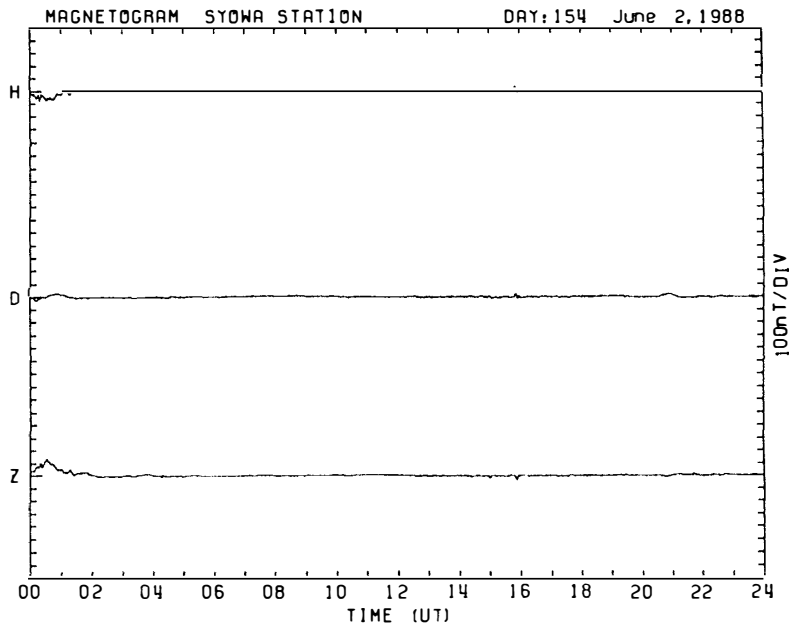
TIME (UT)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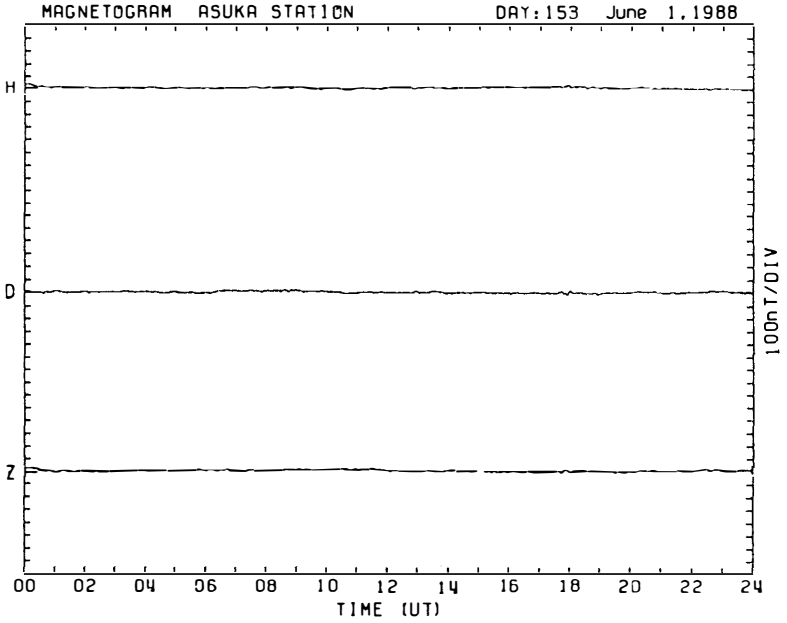
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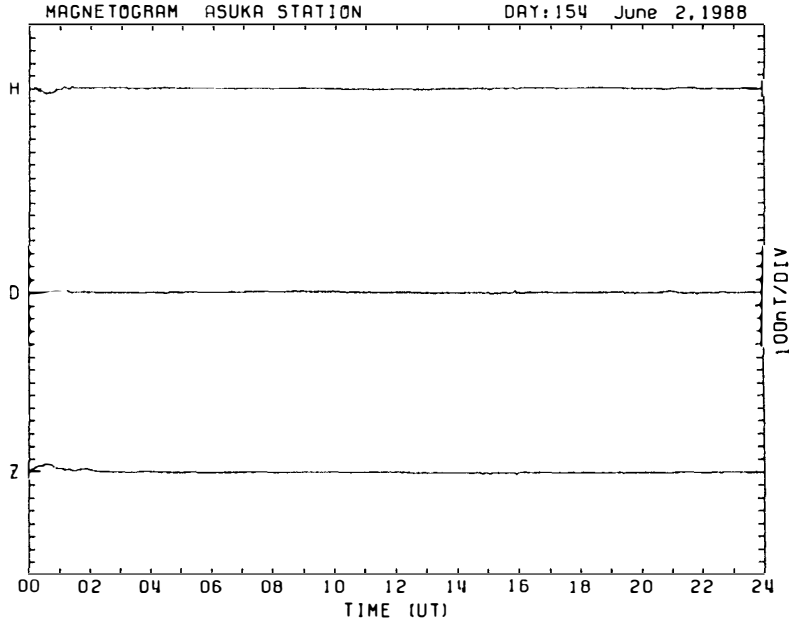
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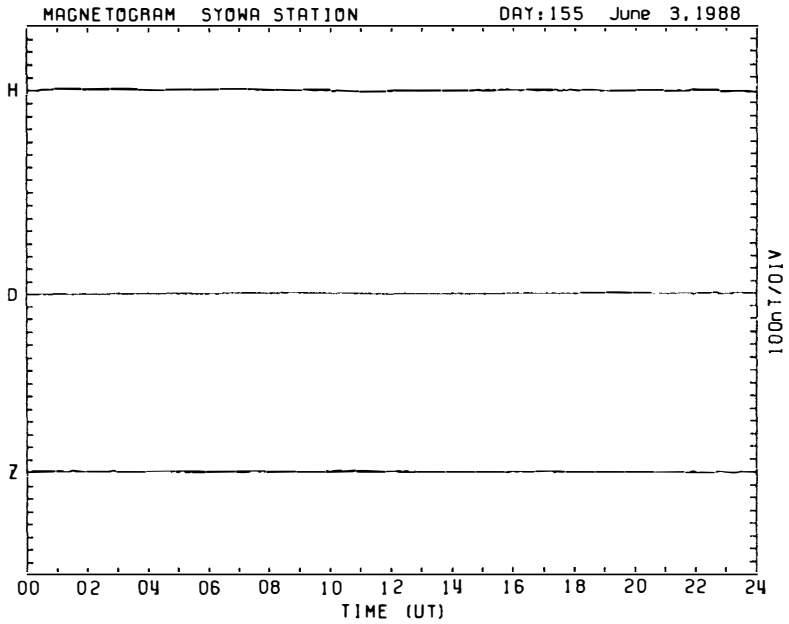
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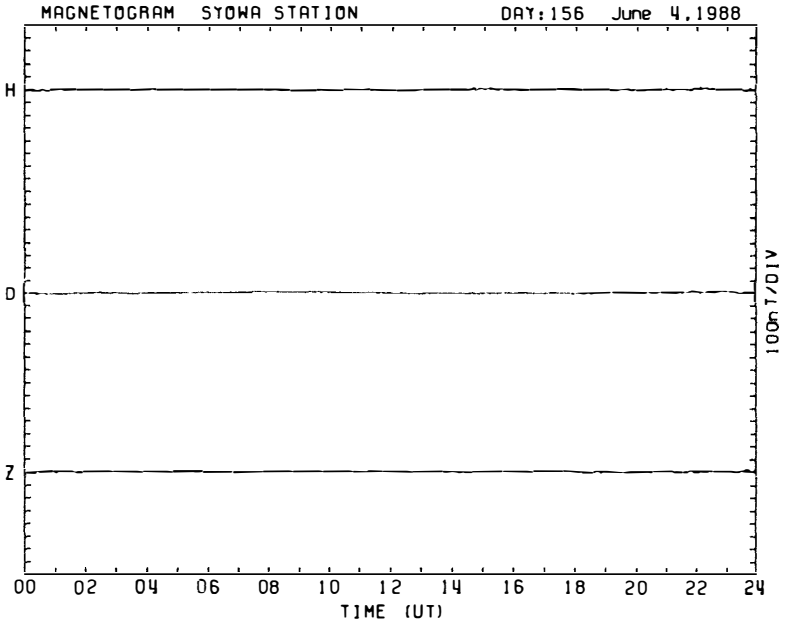
TIME (UT)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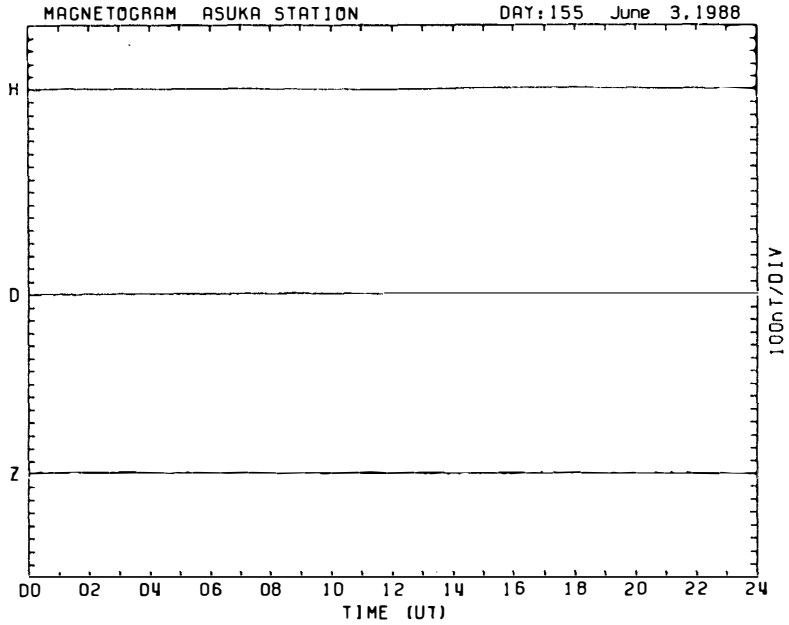
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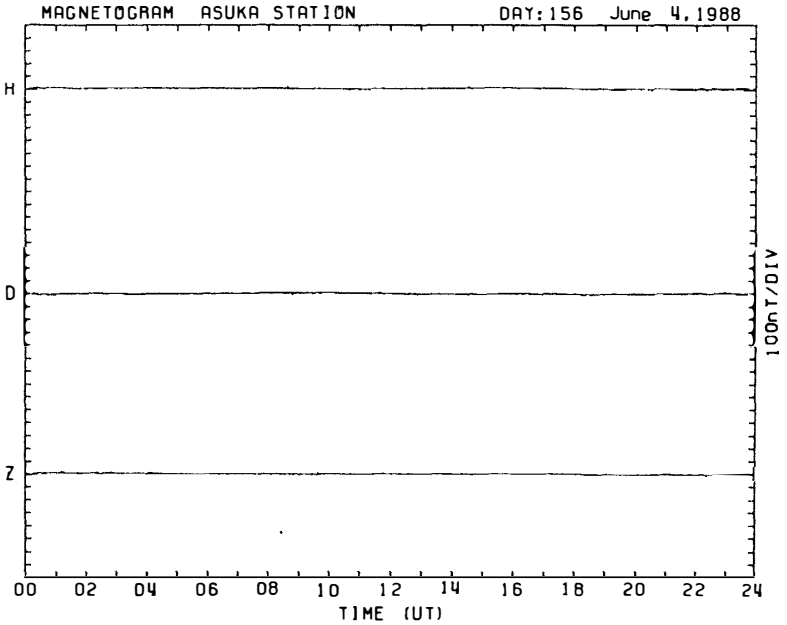
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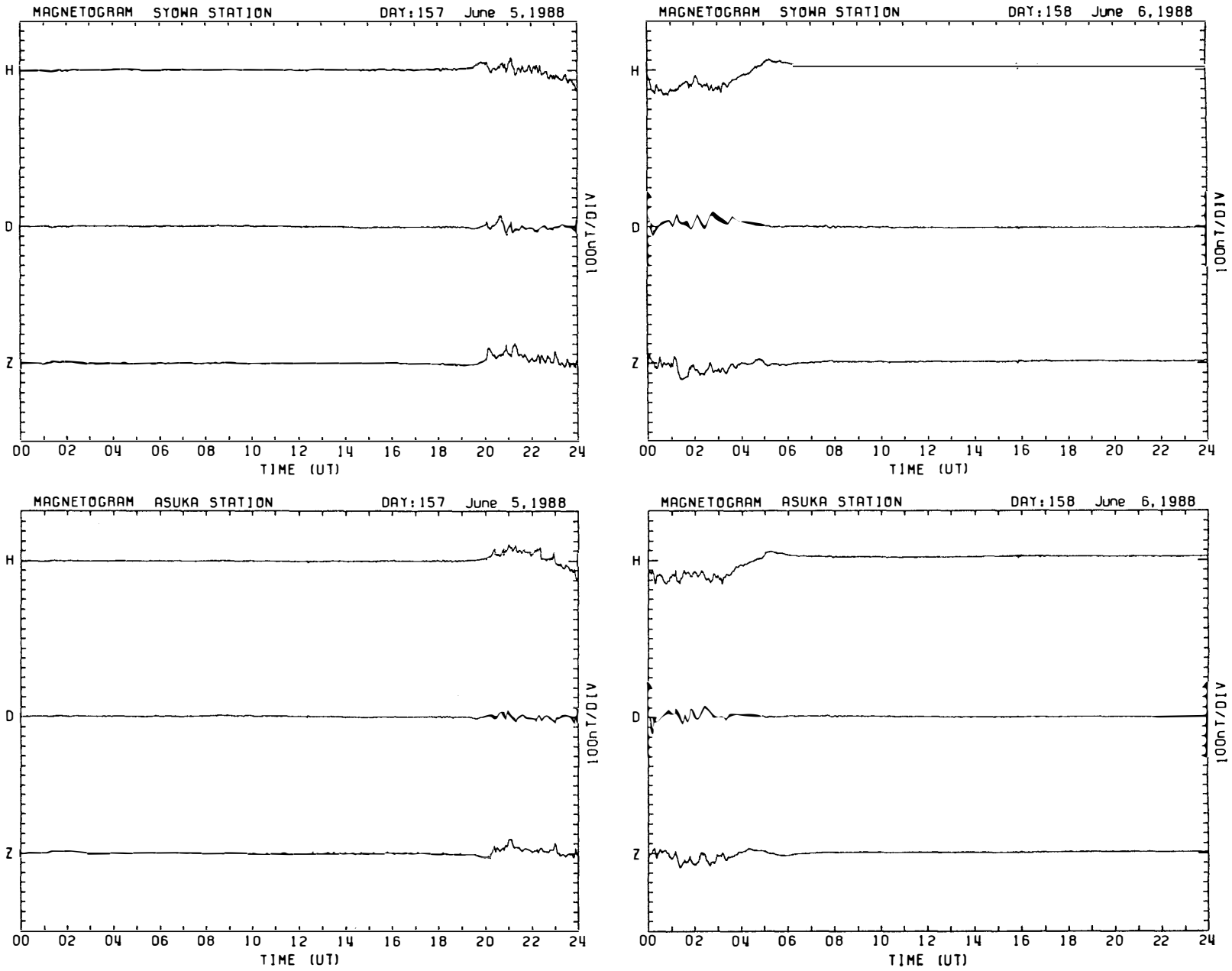
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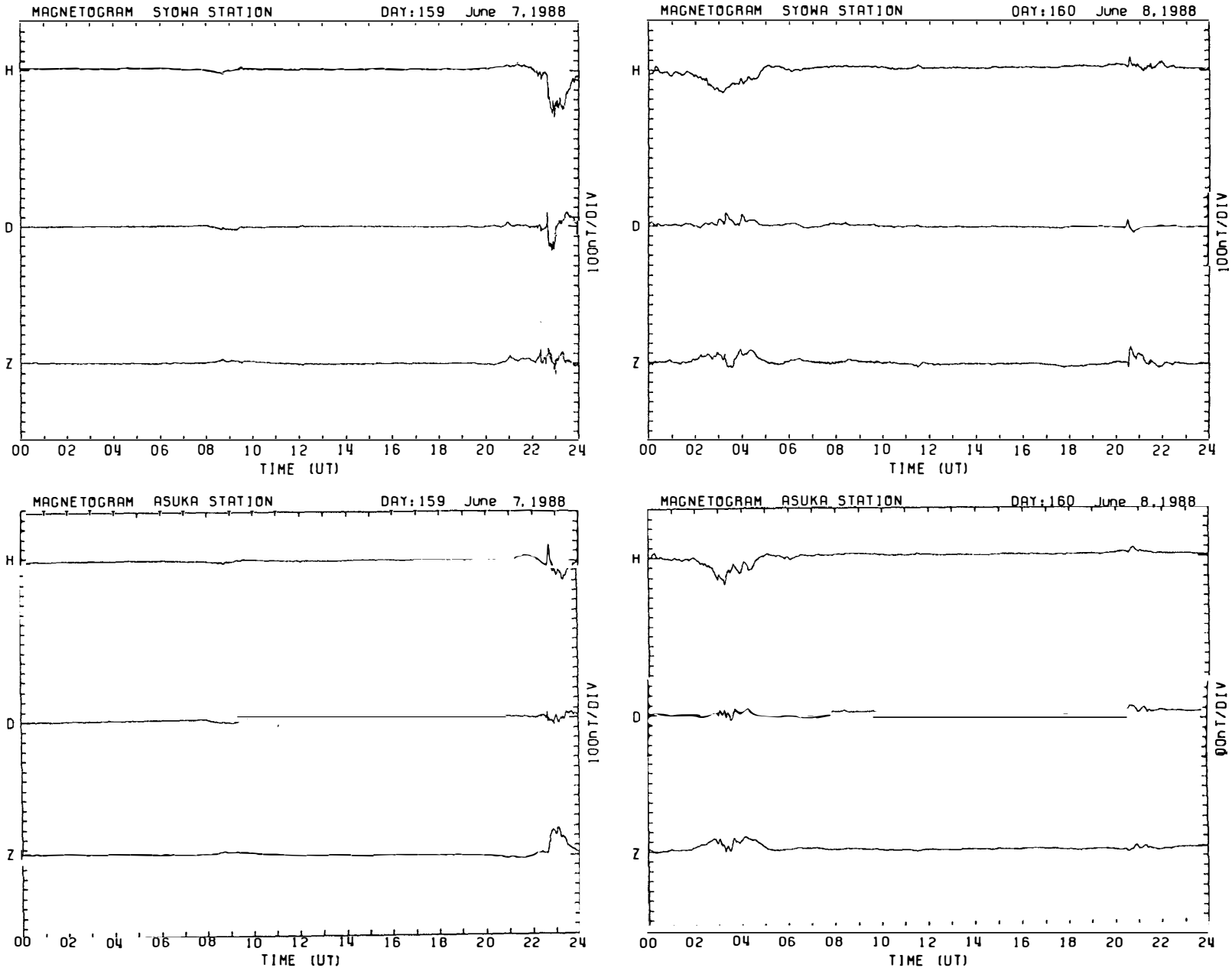
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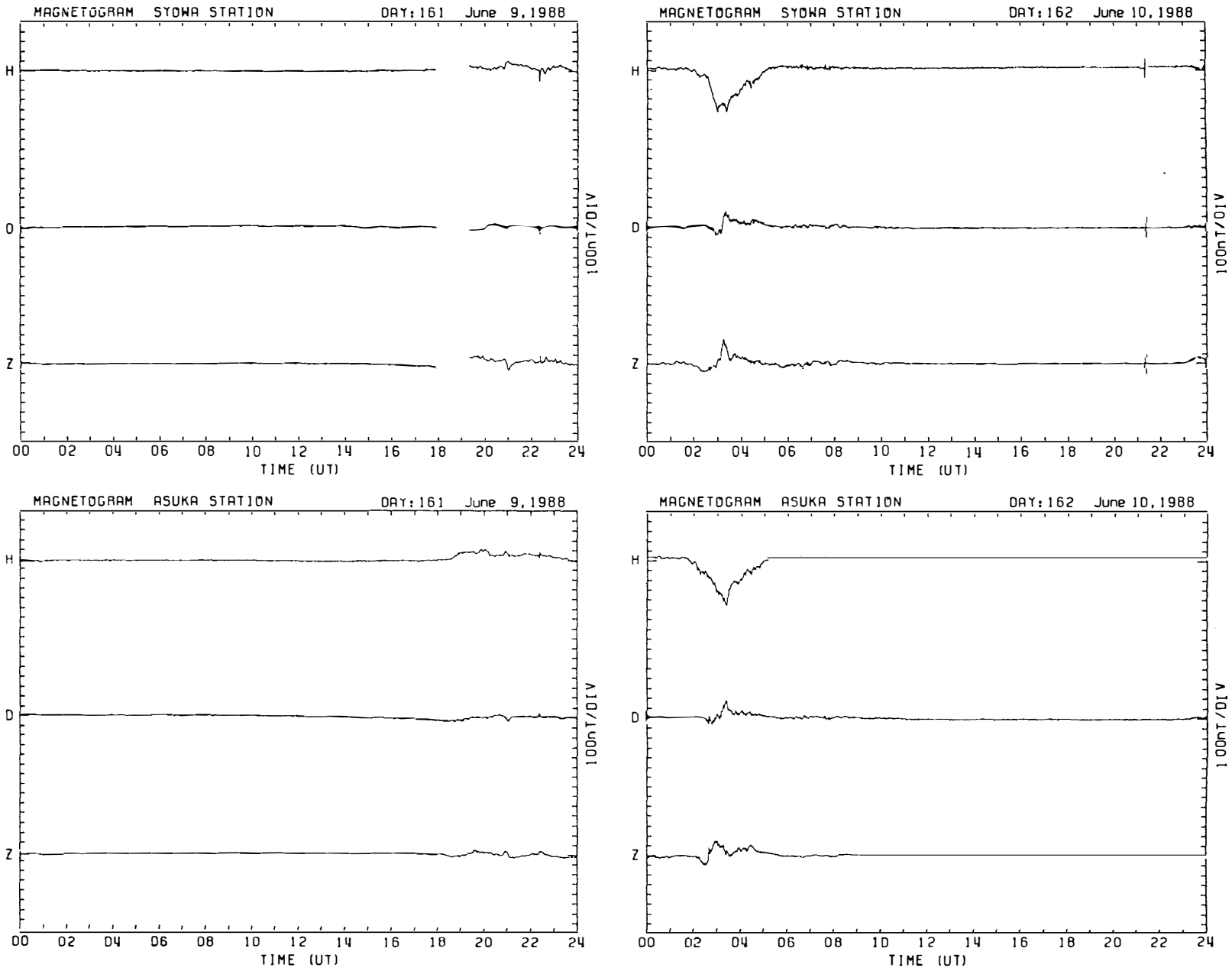
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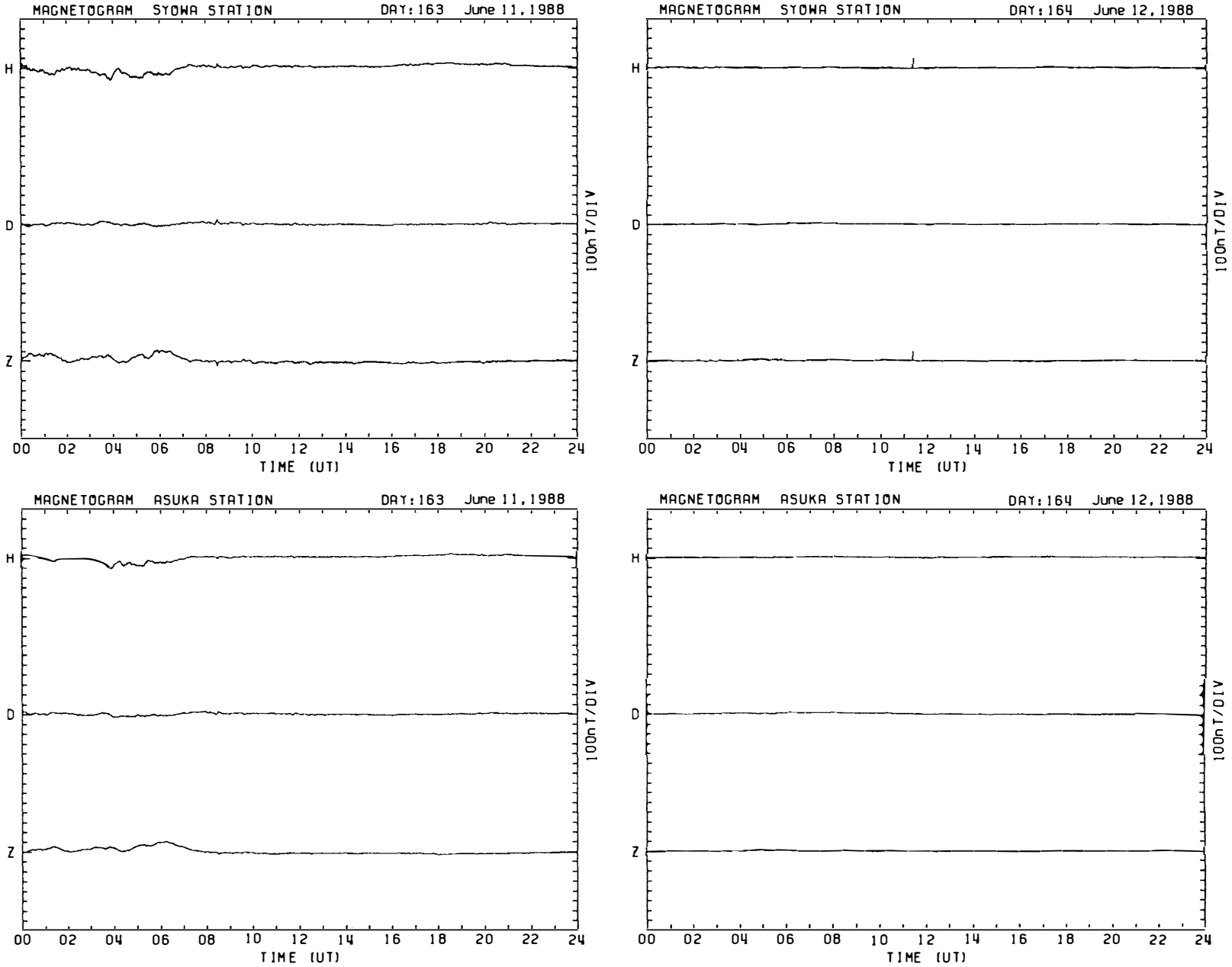
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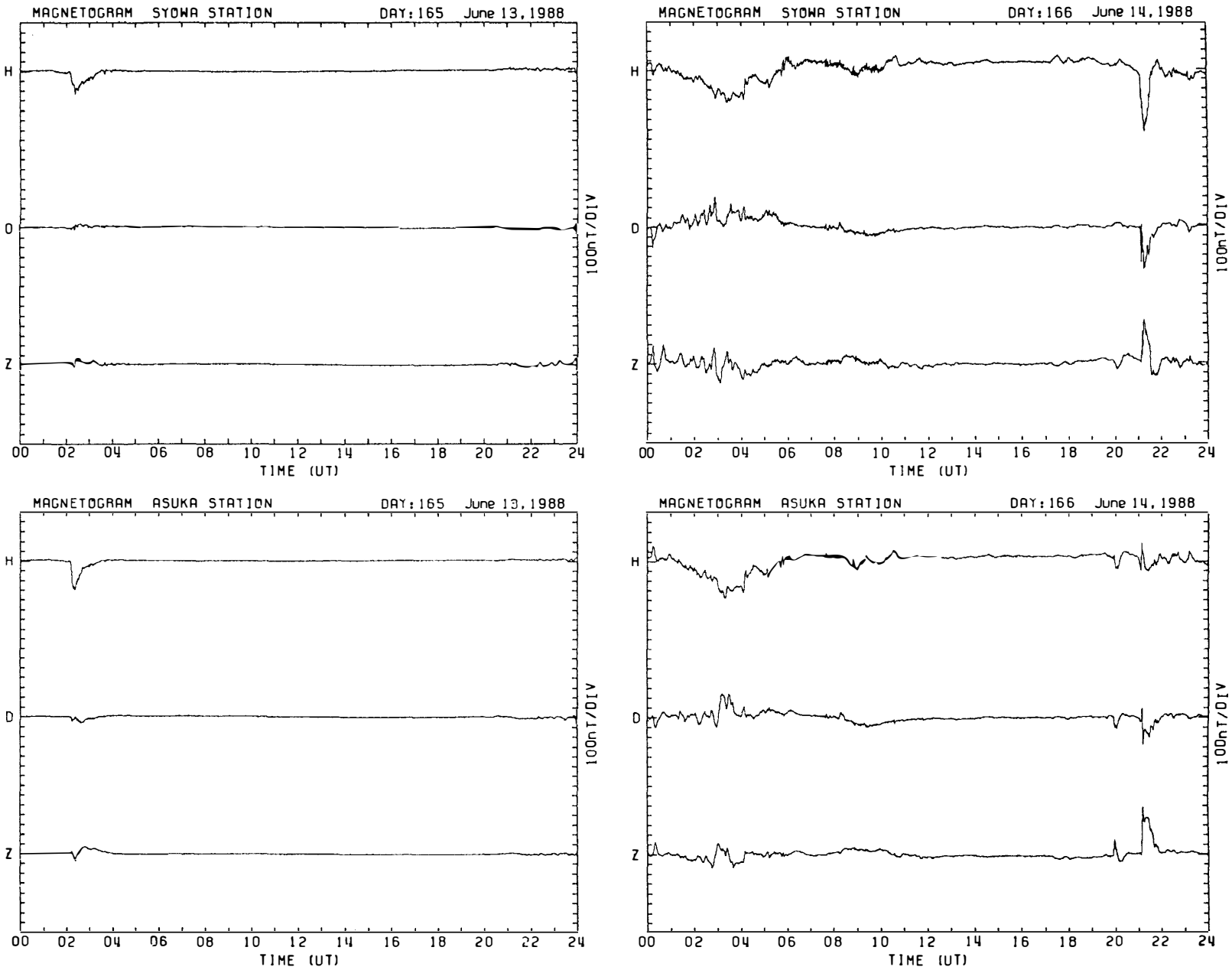
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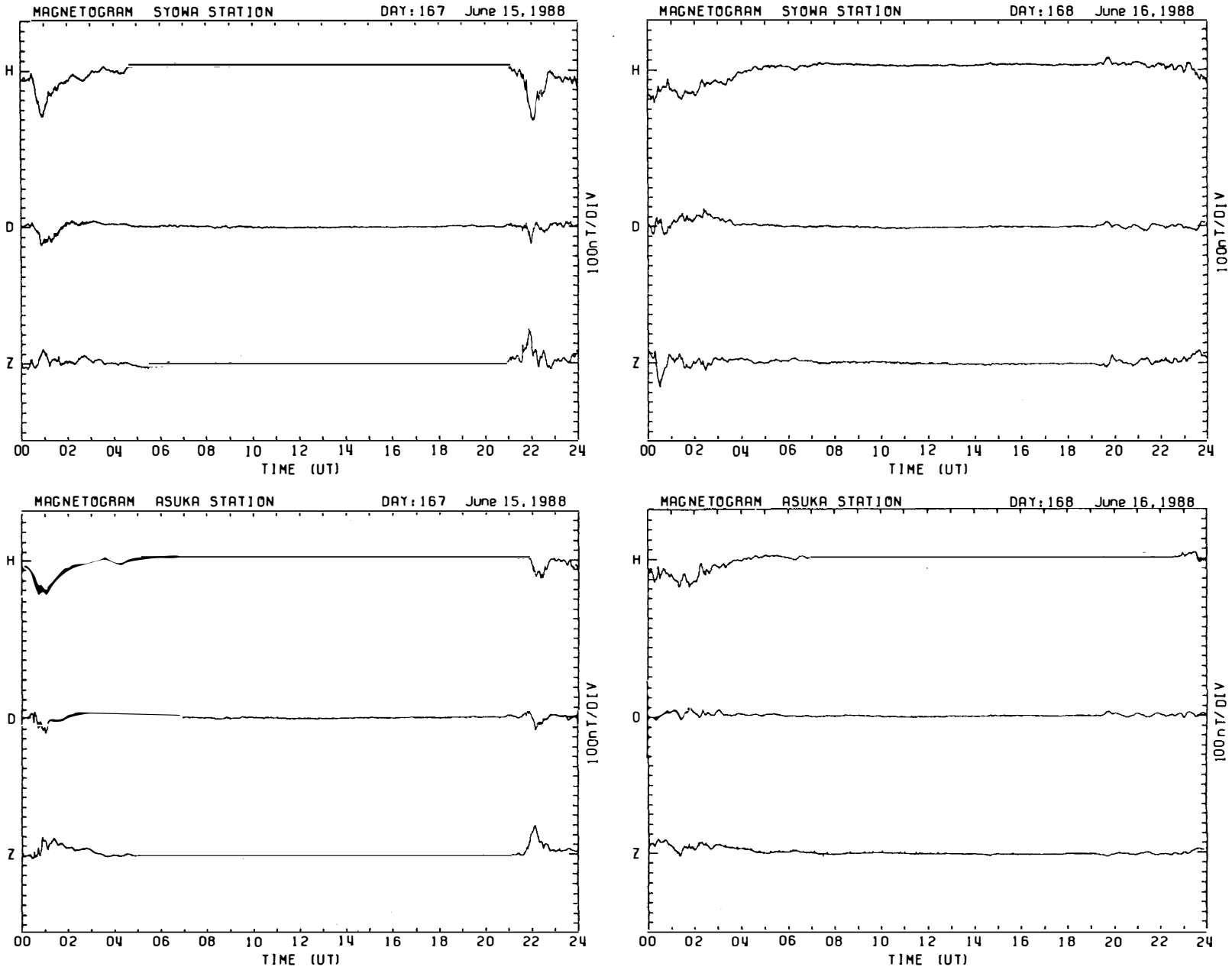
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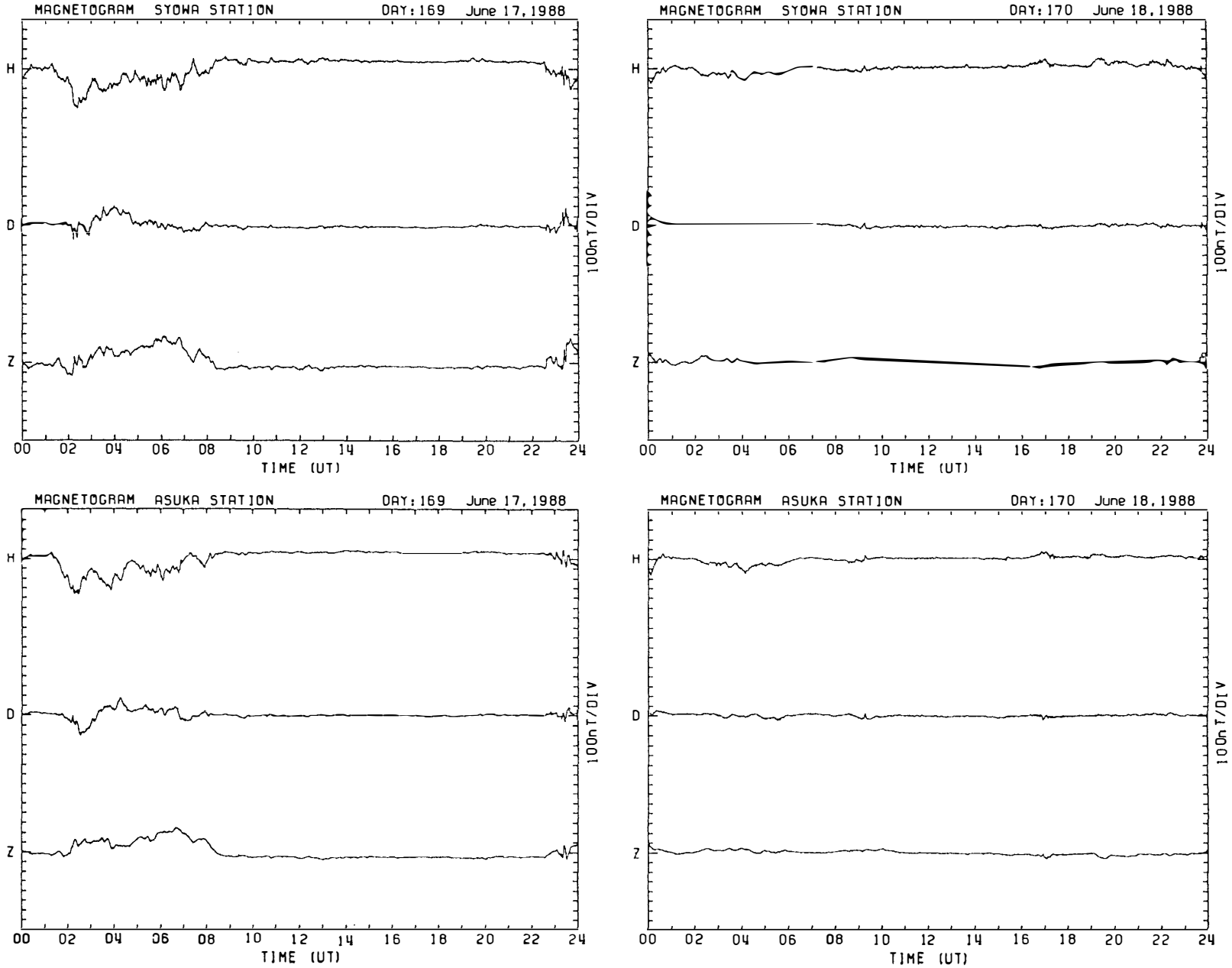
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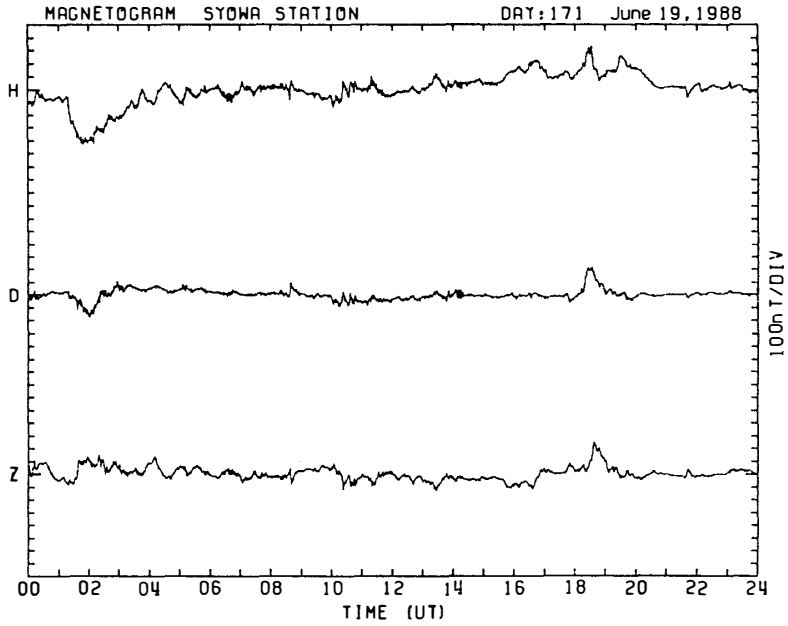
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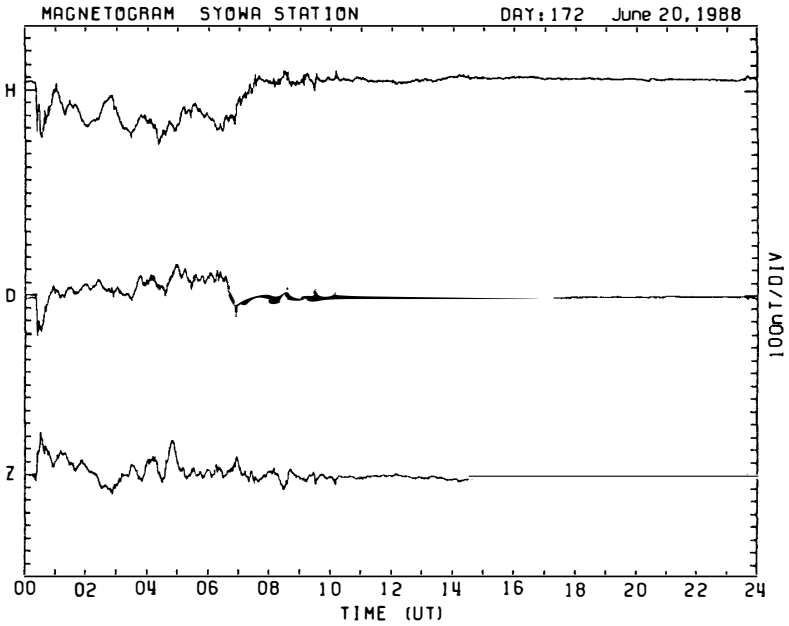
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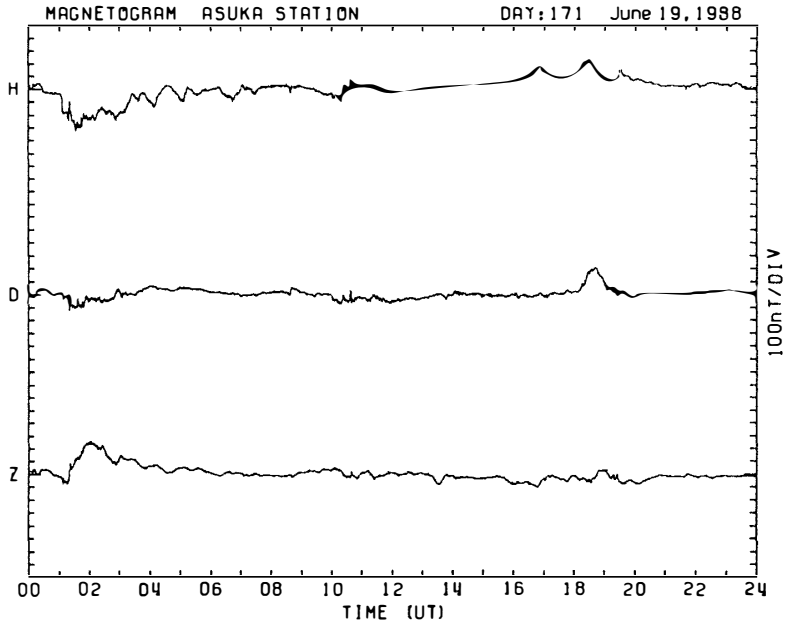
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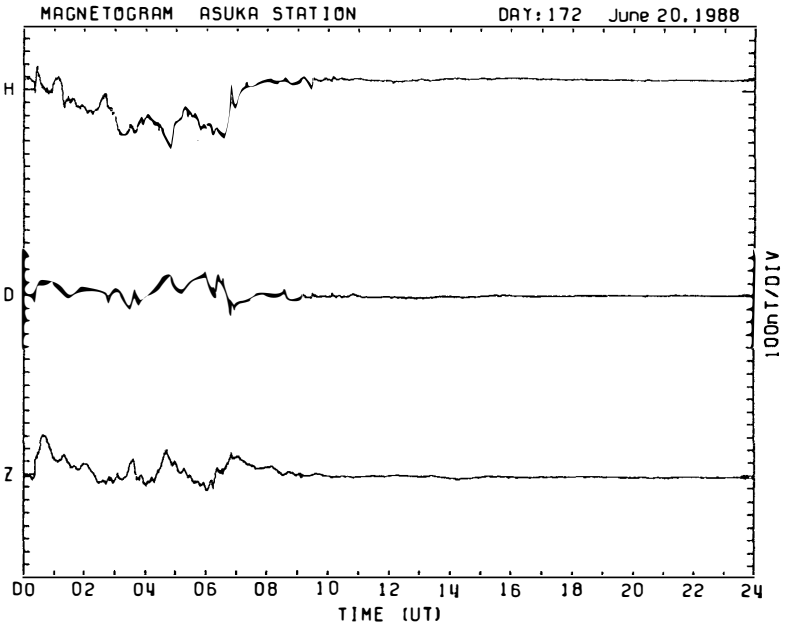
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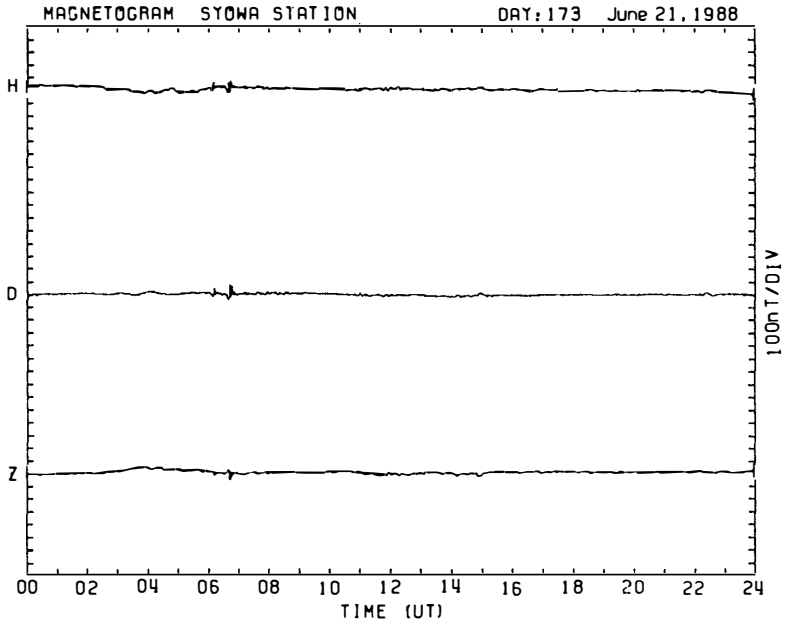
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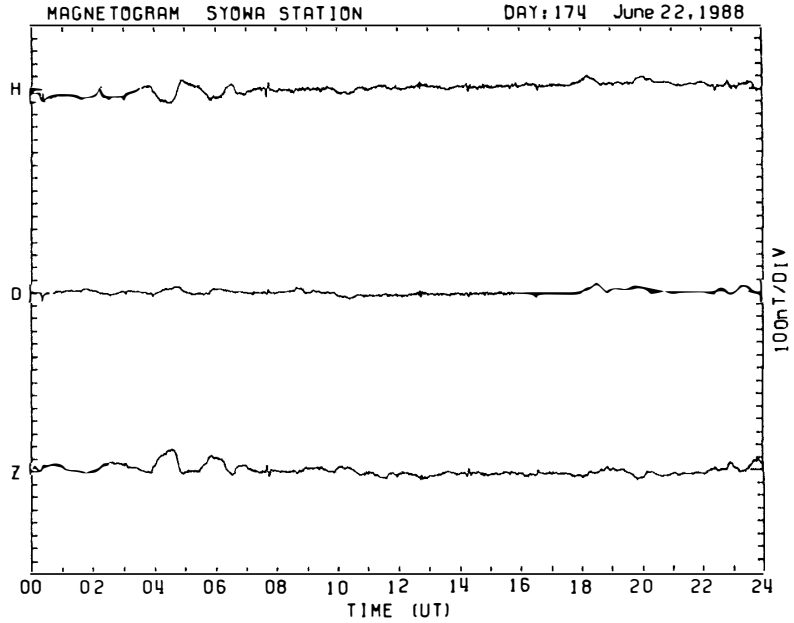
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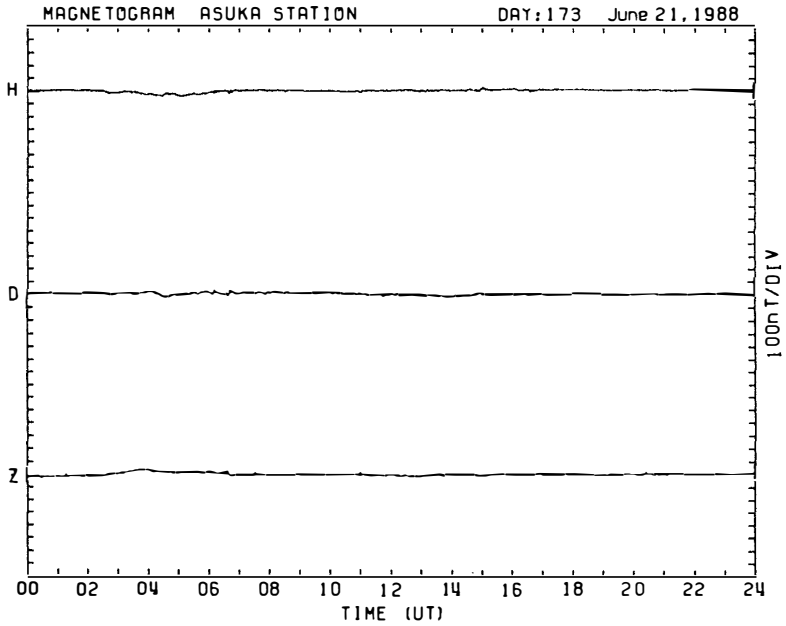
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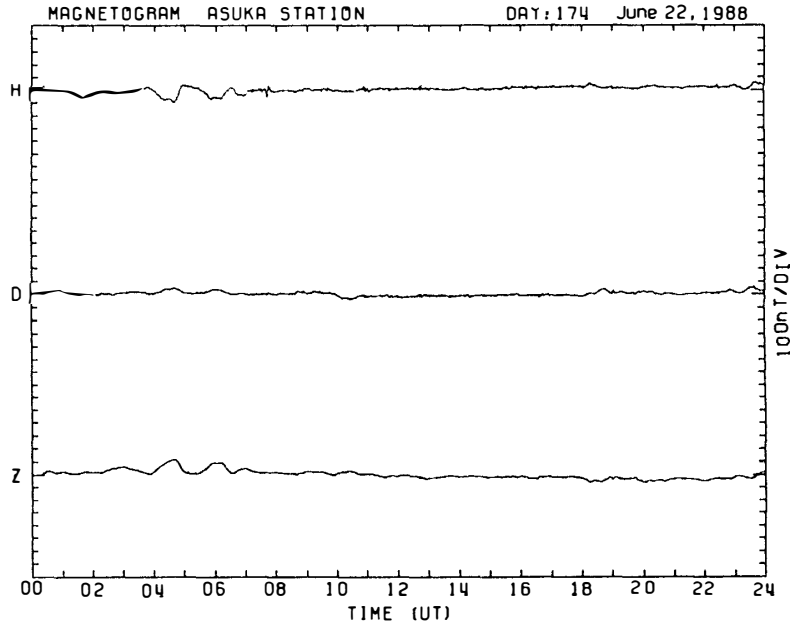
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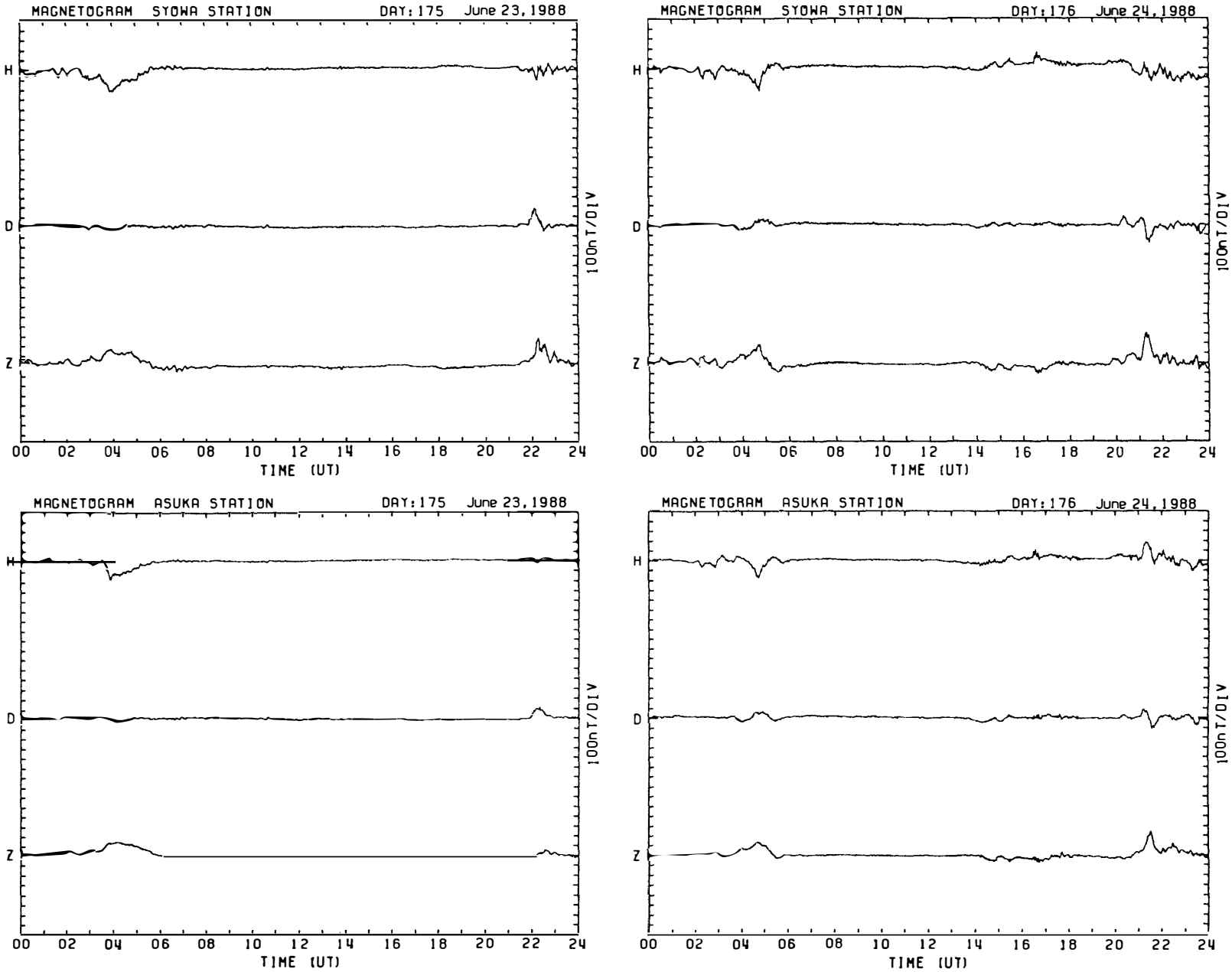
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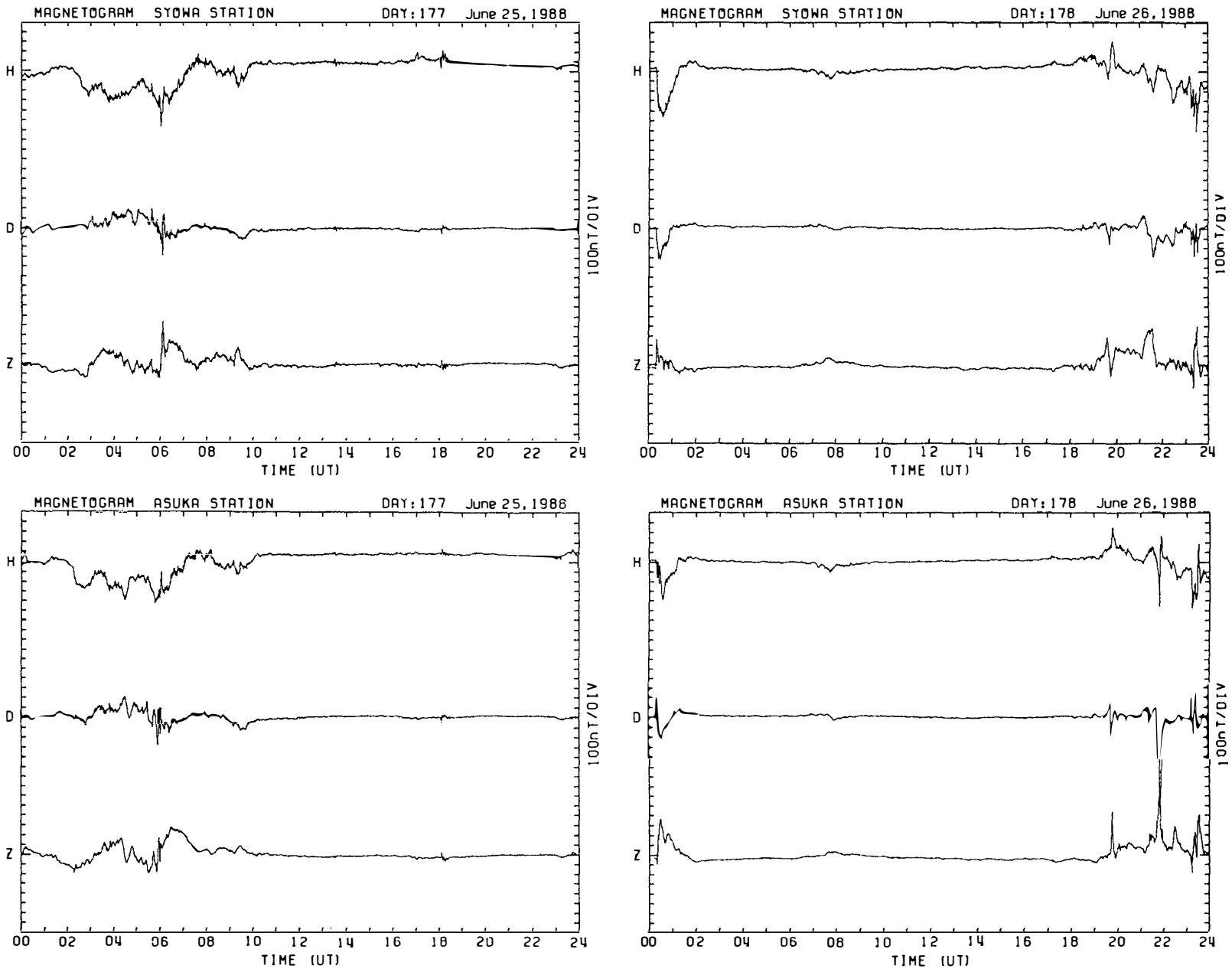
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MAGNETOGRAM ASUKA STATION DAY:177 June 25,1986
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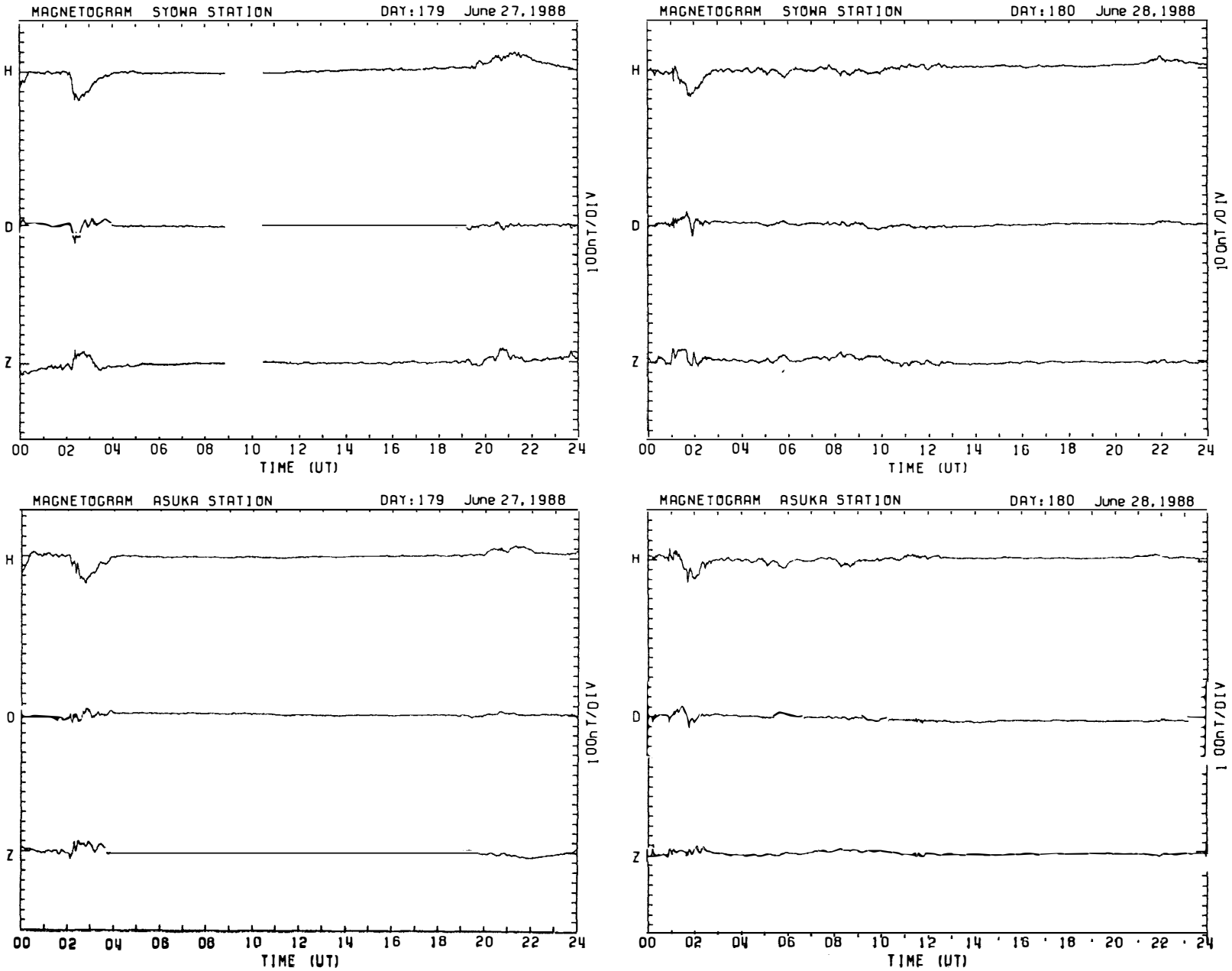
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MAGNETOGRAM SYOWA STATION DAY:180 June 28,1988
MAGNETOGRAM ASUKA STATION DAY:179 June 27,1988
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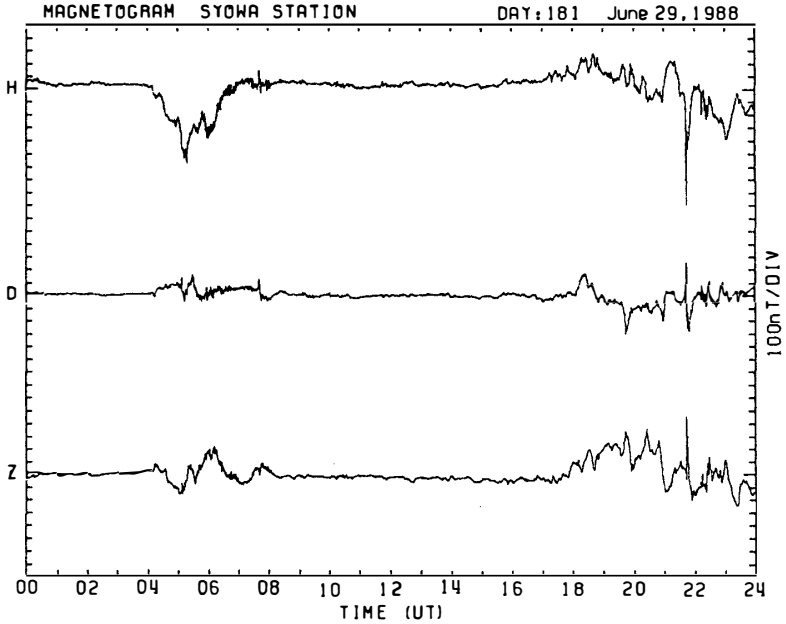
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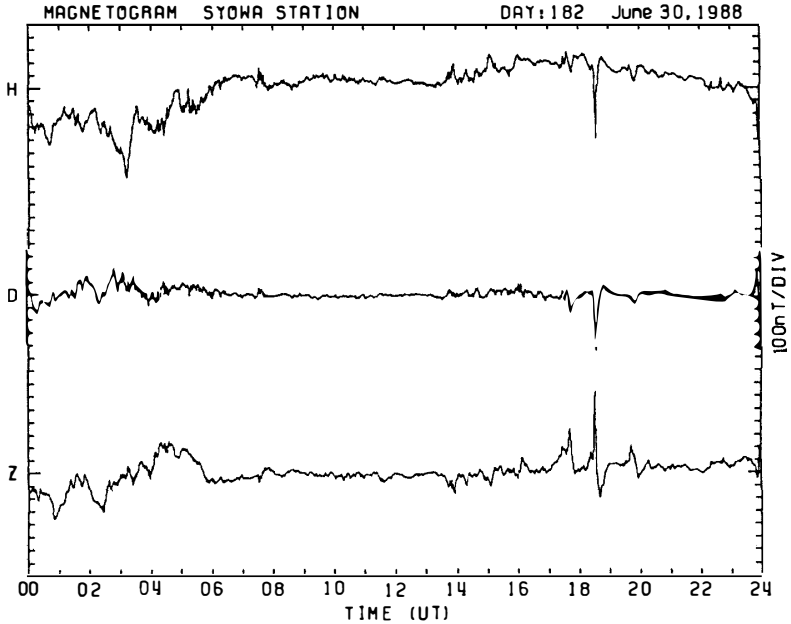
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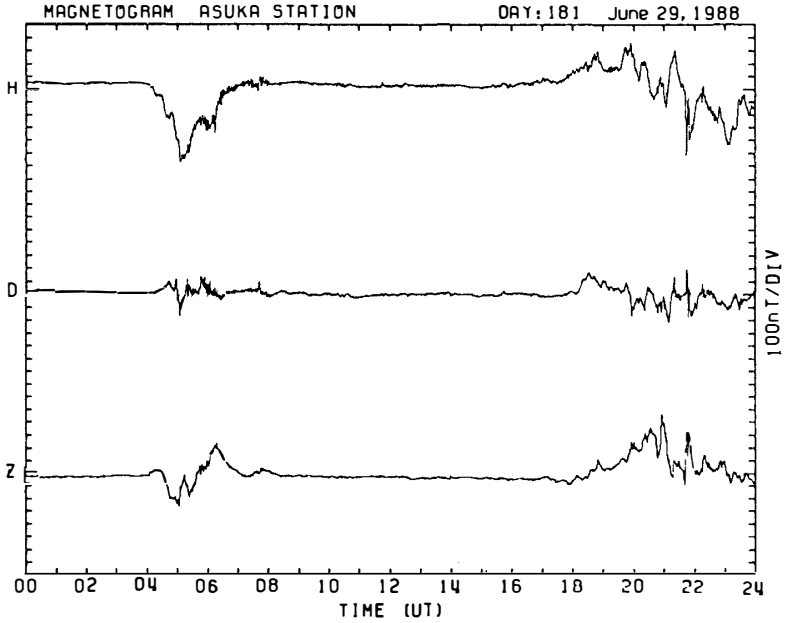
TIME (UT)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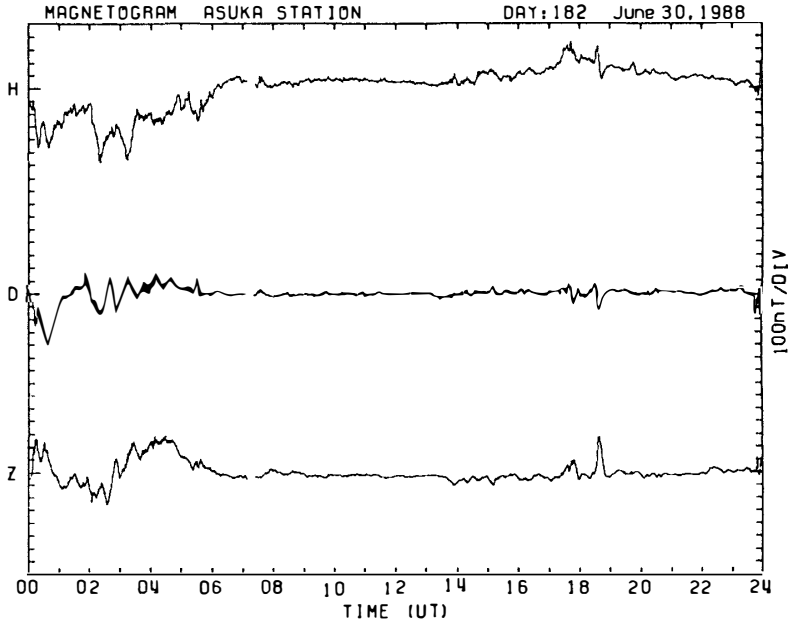
TIME (UT)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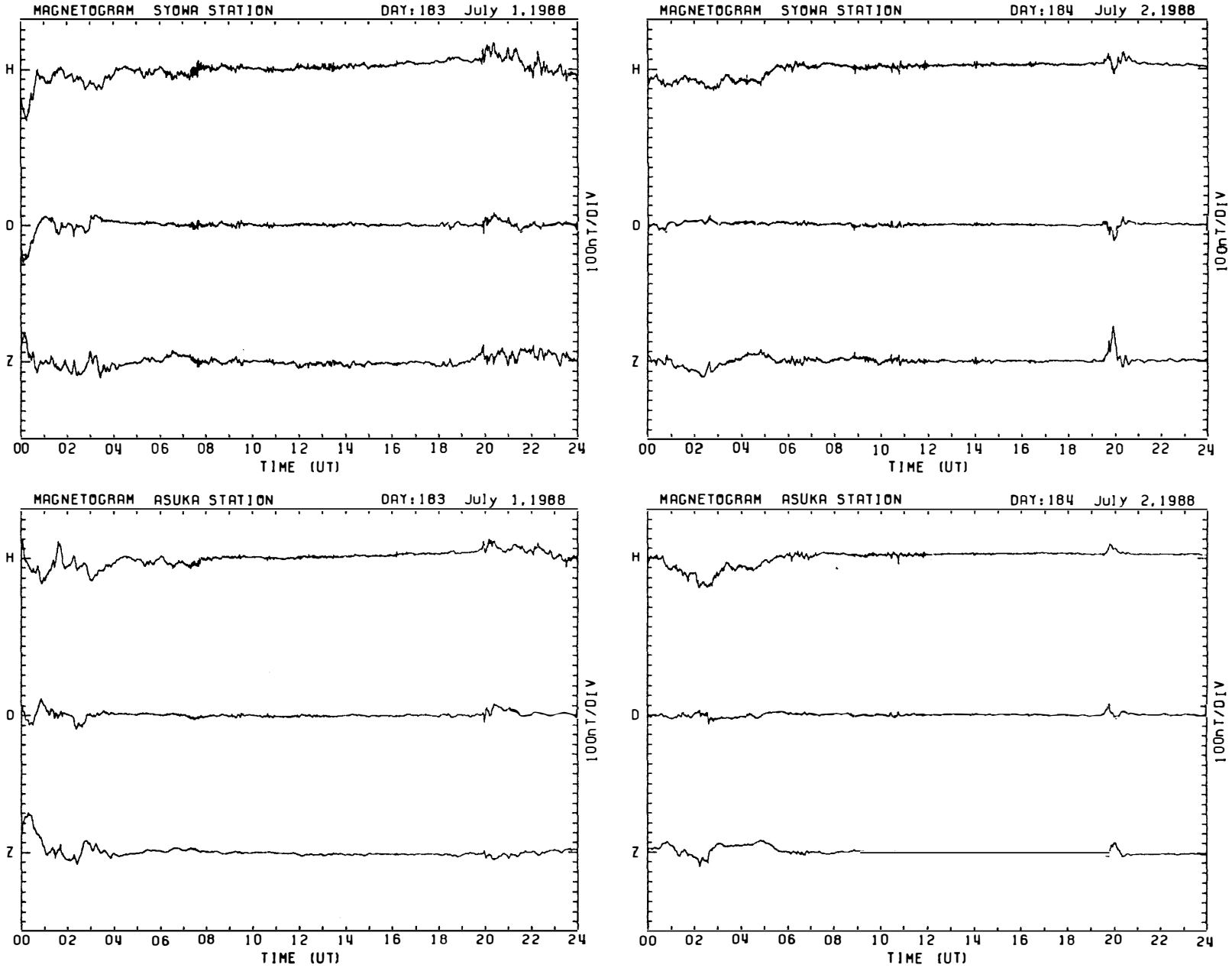
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MAGNETOGRAM ASUKA STATION DAY:183 July 1,1988
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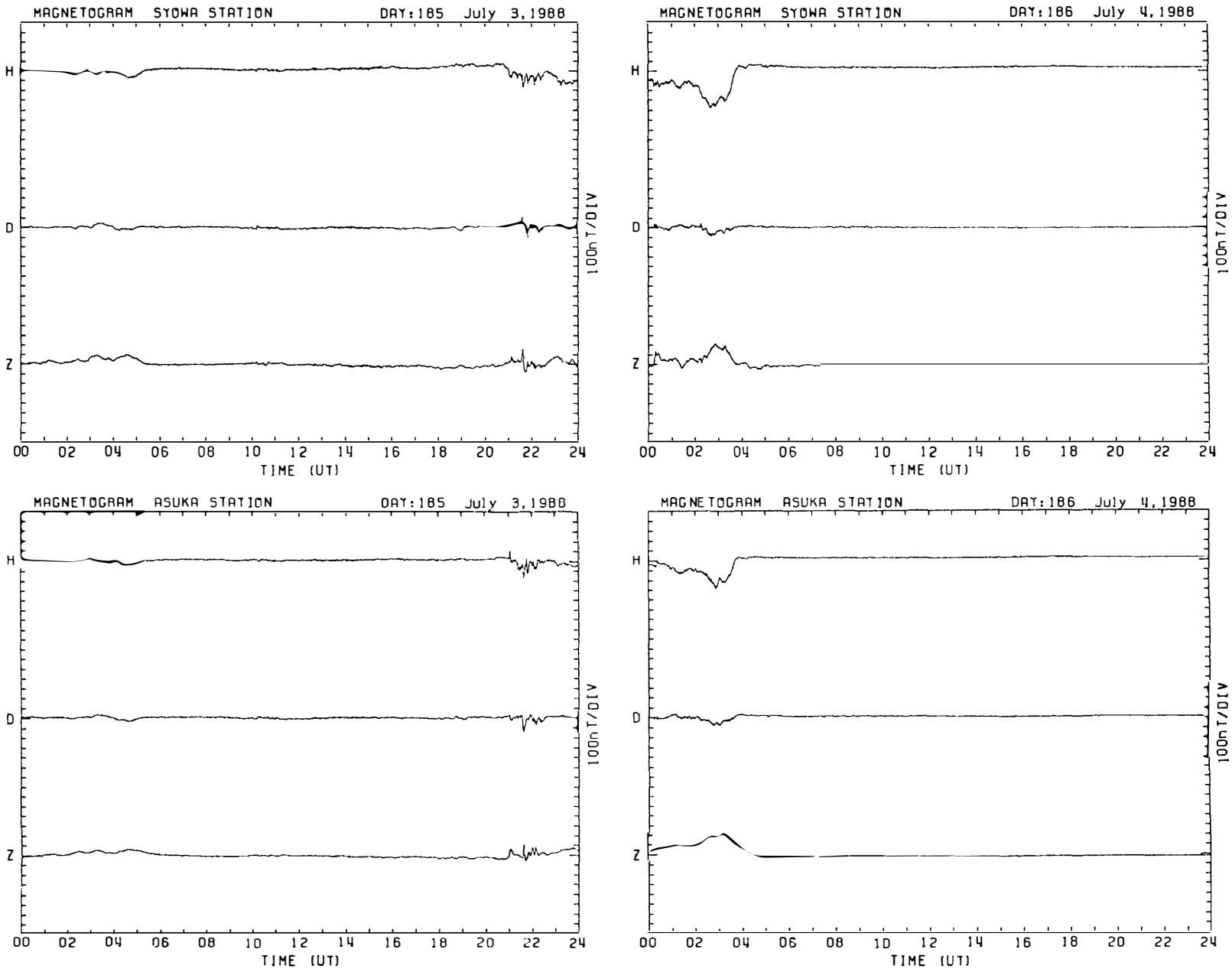
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MAGNETOGRAM ASUKA STATION DAY:185 July 3,1988
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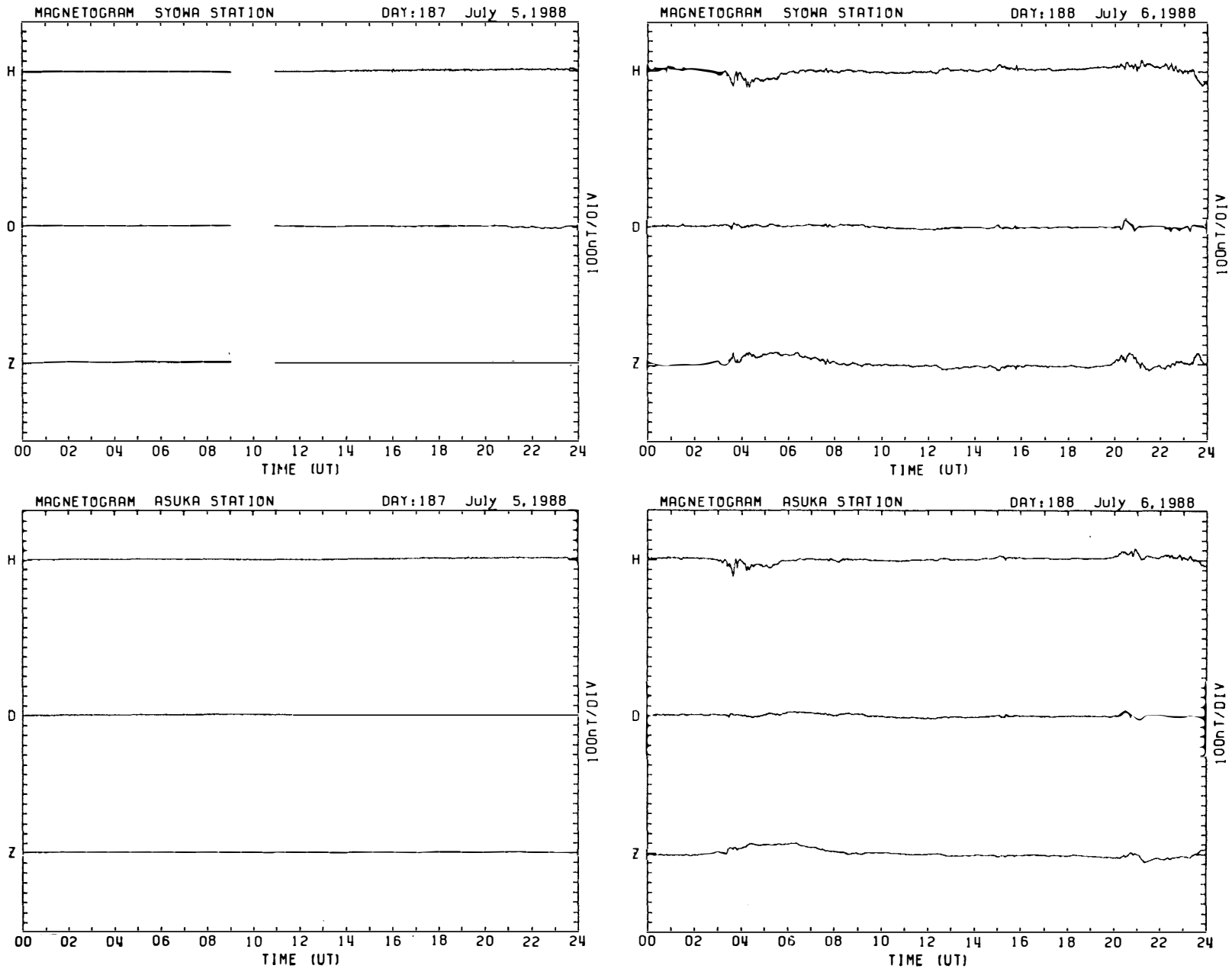
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MAGNETOGRAM ASUKA STATION DAY:187 July 5,1988
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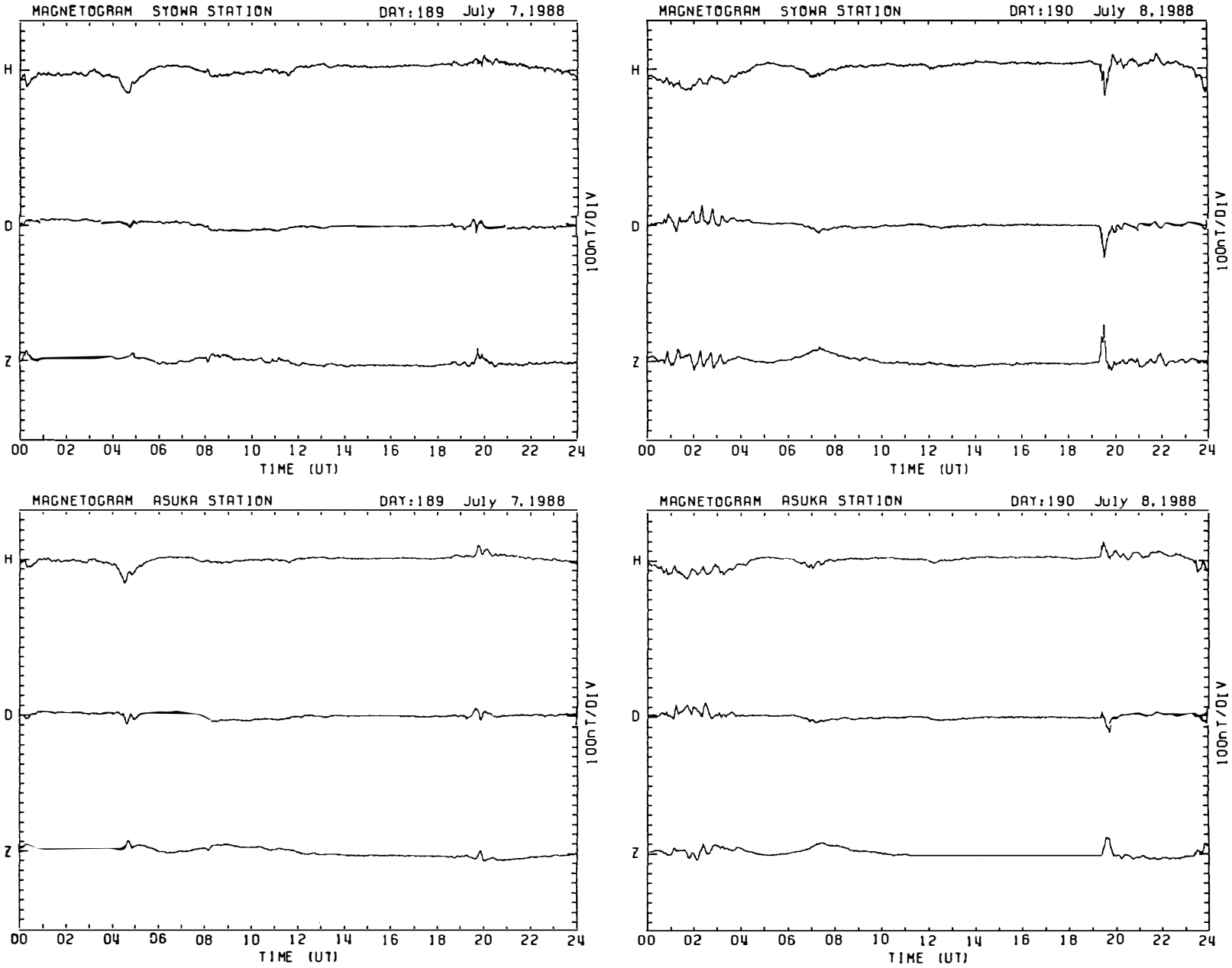
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MAGNETOGRAM ASUKA STATION DAY:189 July 7,1988
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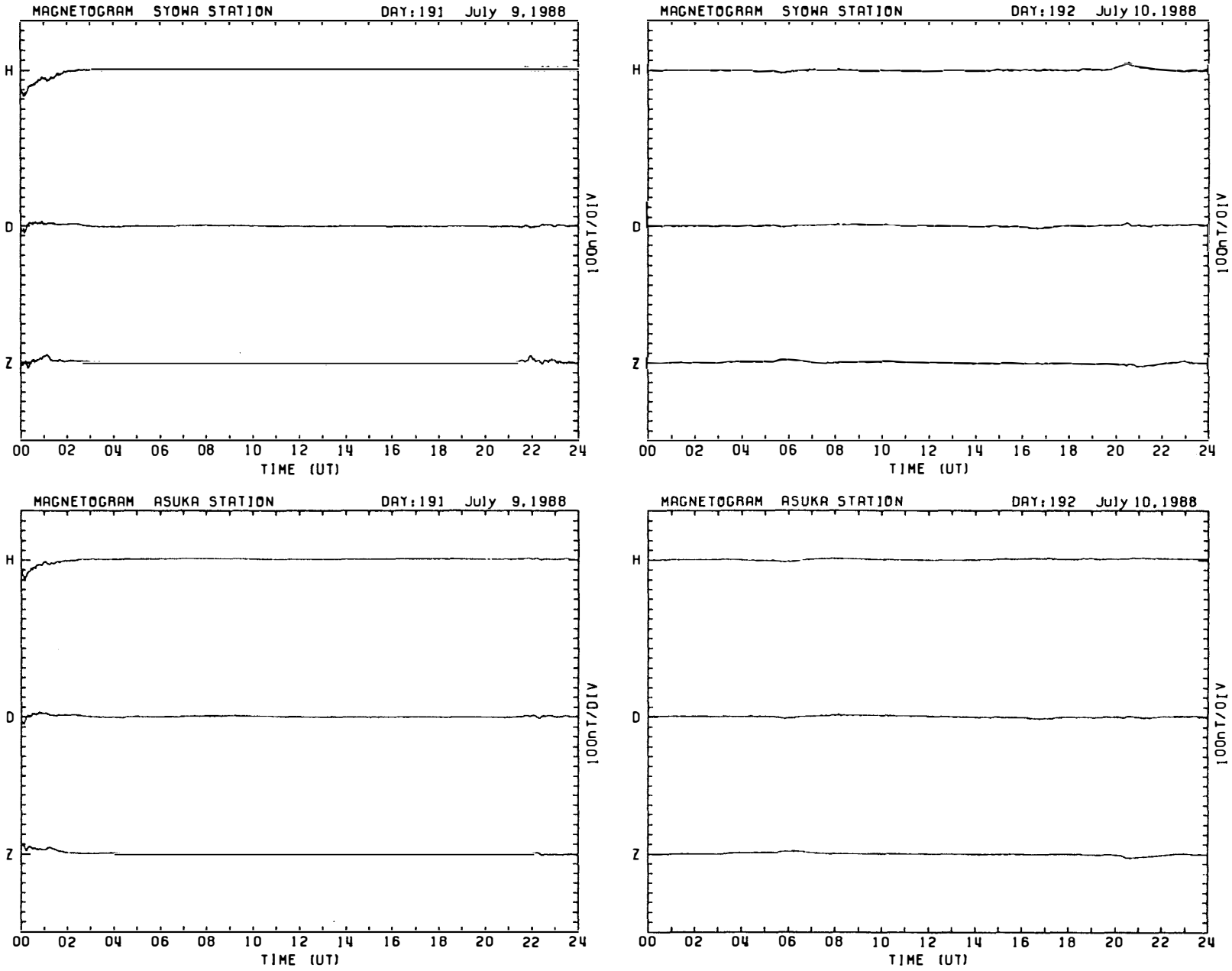
TIME (UT)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MAGNETOGRAM SYOWA STATION DAY:192 July 10,1988
MAGNETOGRAM ASUKA STATION DAY:191 July 9,1988
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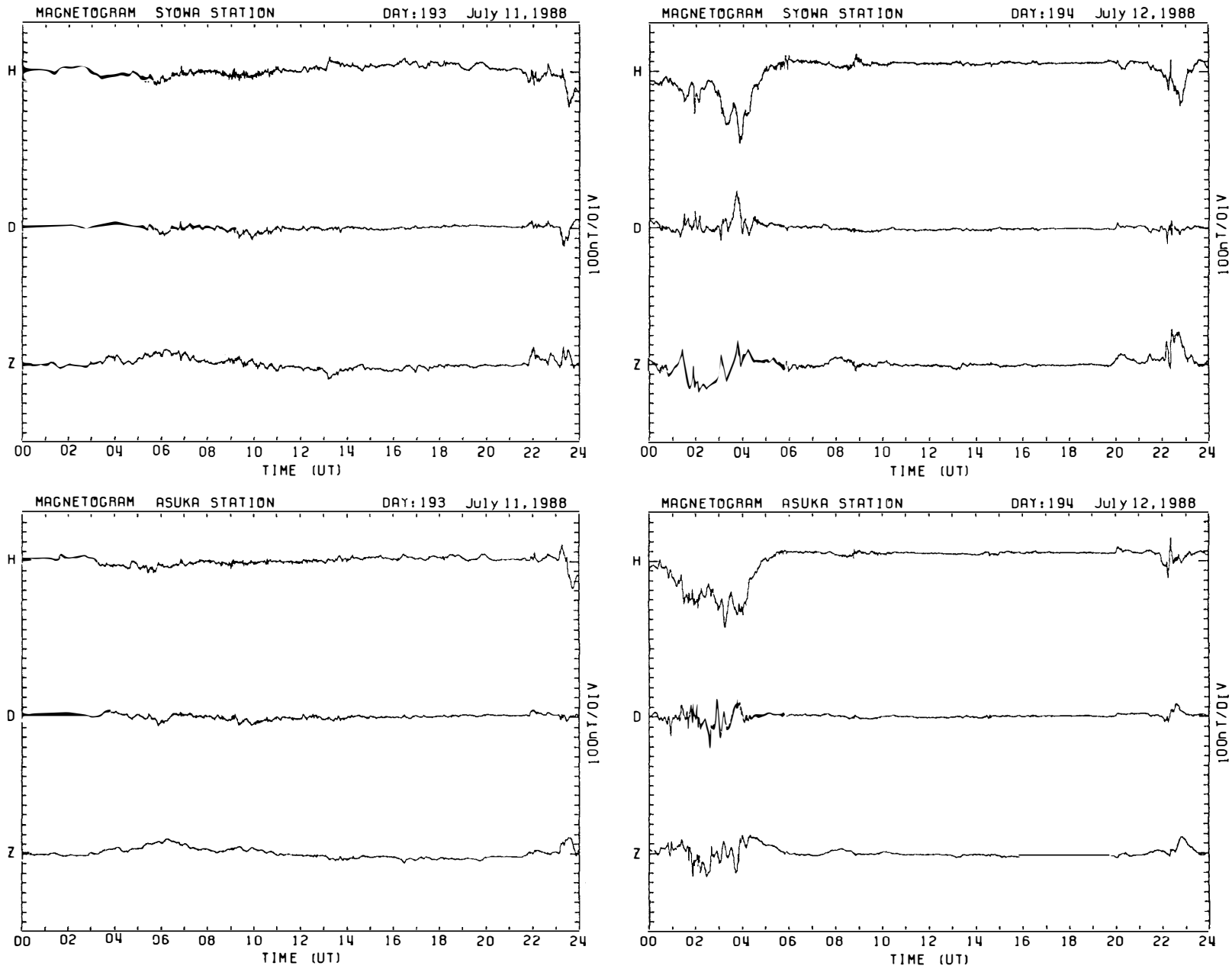
TIME (UT)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MAGNETOGRAM SYOWA STATION DAY:194 July 12,1988
MAGNETOGRAM ASUKA STATION DAY:193 July 11,1988
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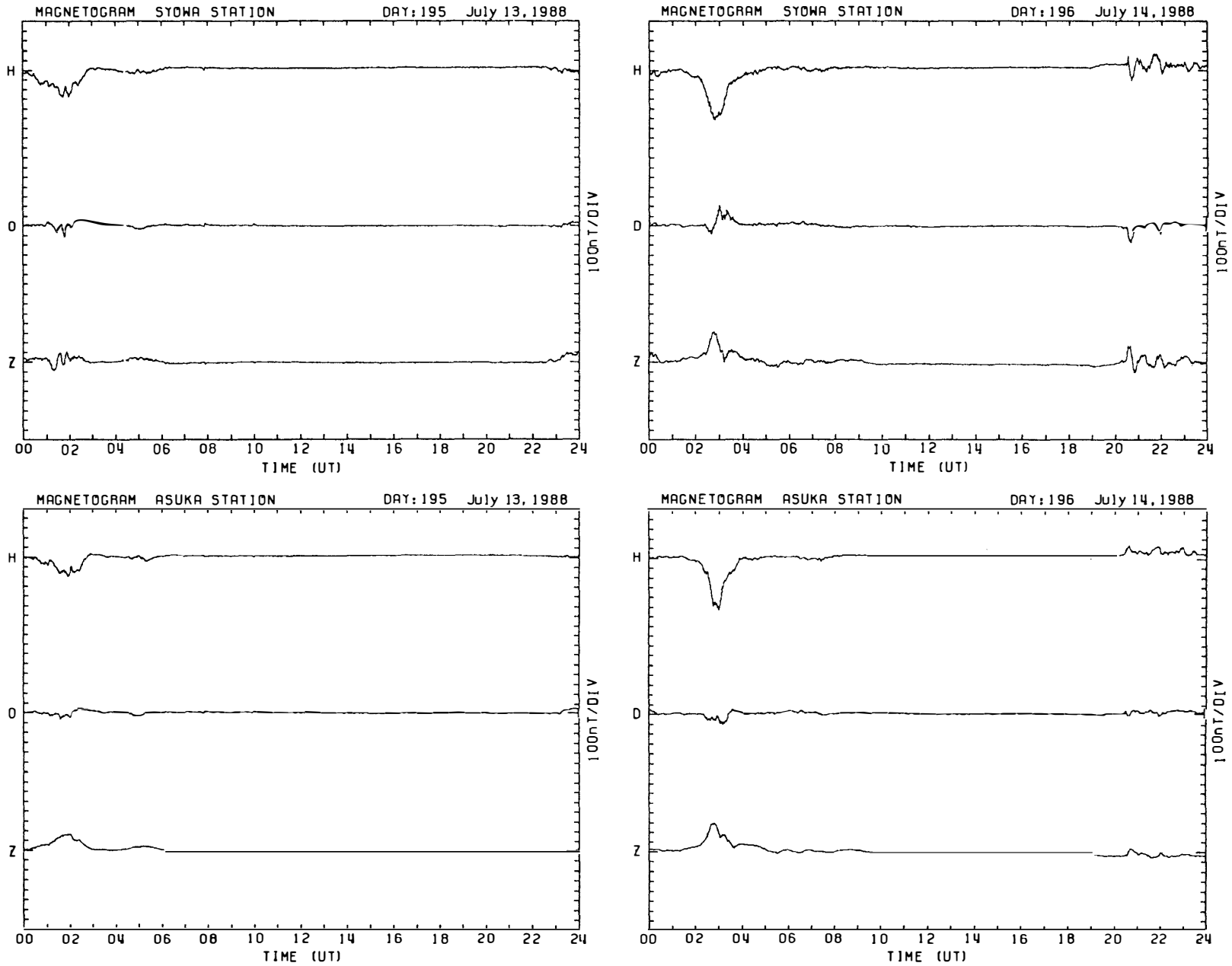
TIME (UT)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MAGNETOGRAM ASUKA STATION DAY:195 July 13,1988
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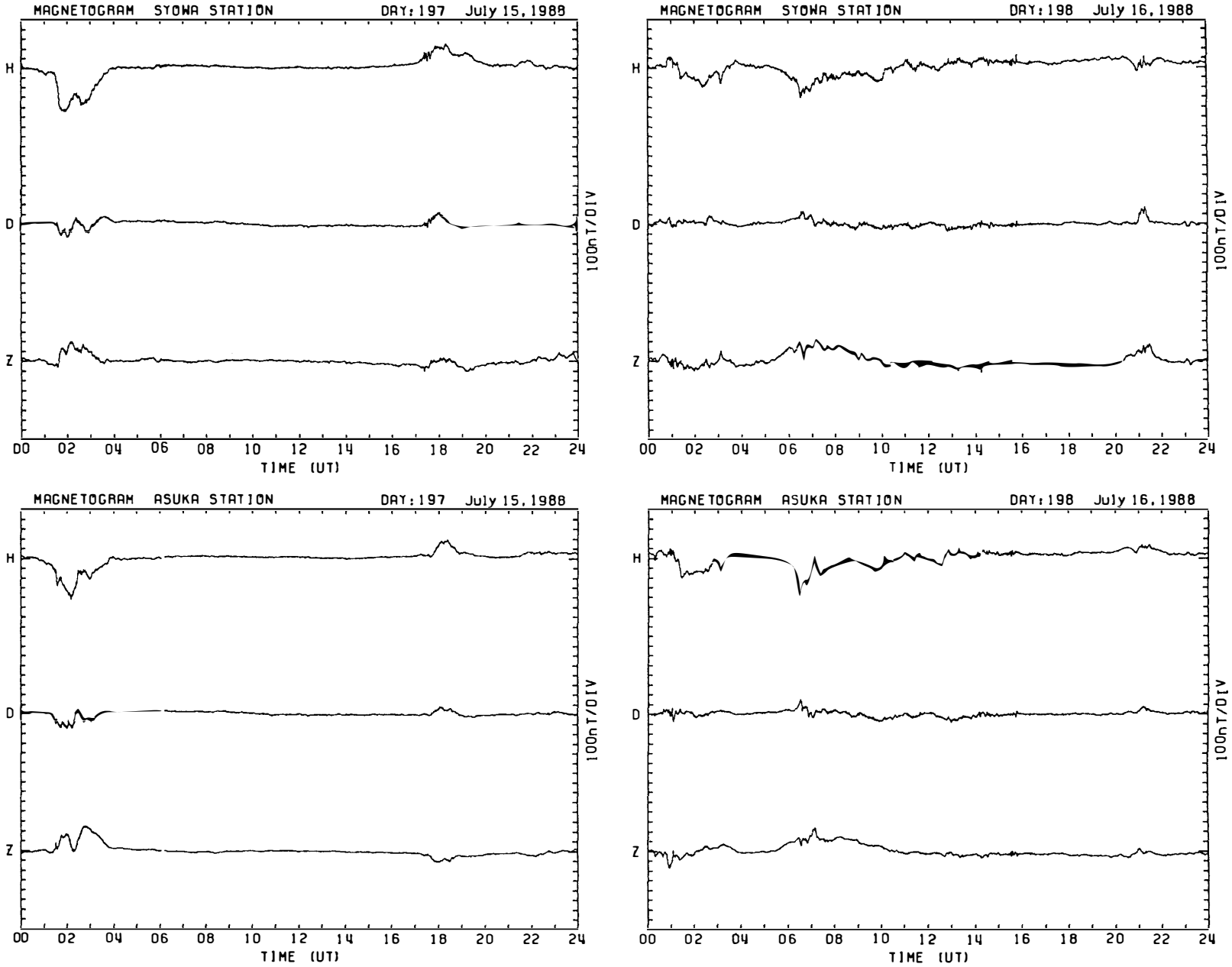
MAGNETOGRAM STOWA STATION DAY:197 July 15,1988
MAGNETOGRAM STOWA STATION DAY:198 July 16,1988
MAGNETOGRAM ASUKA STATION DAY:197 July 15,1988
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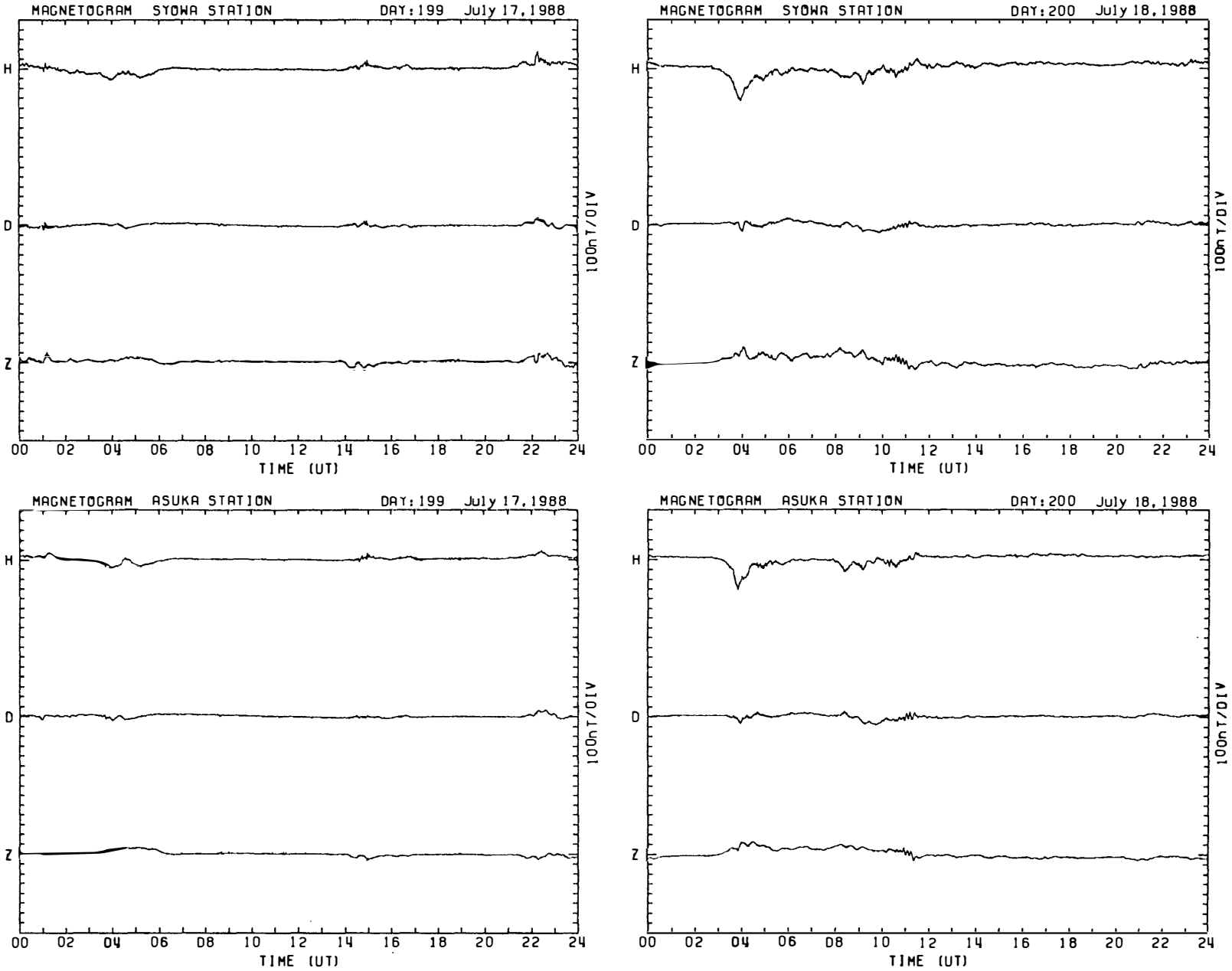
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MAGNETOGRAM SYOWA STATION DAY:200 July 18,1988
MAGNETOGRAM ASUKA STATION DAY:199 July 17,1988
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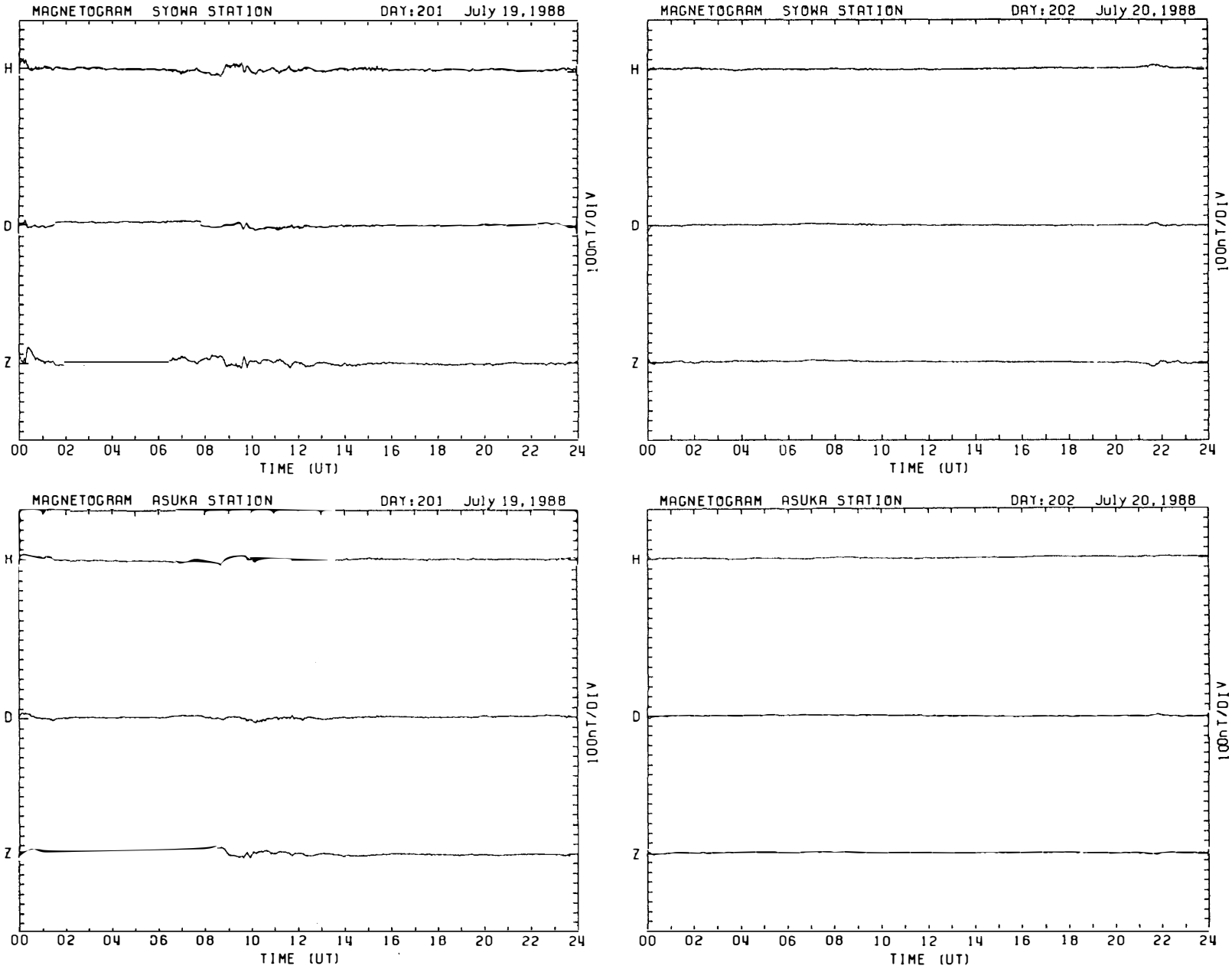
TIME (UT)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MAGNETOGRAM SYOWA STATION DAY:202 July 20,1988
MAGNETOGRAM ASUKA STATION DAY:201 July 19,1988
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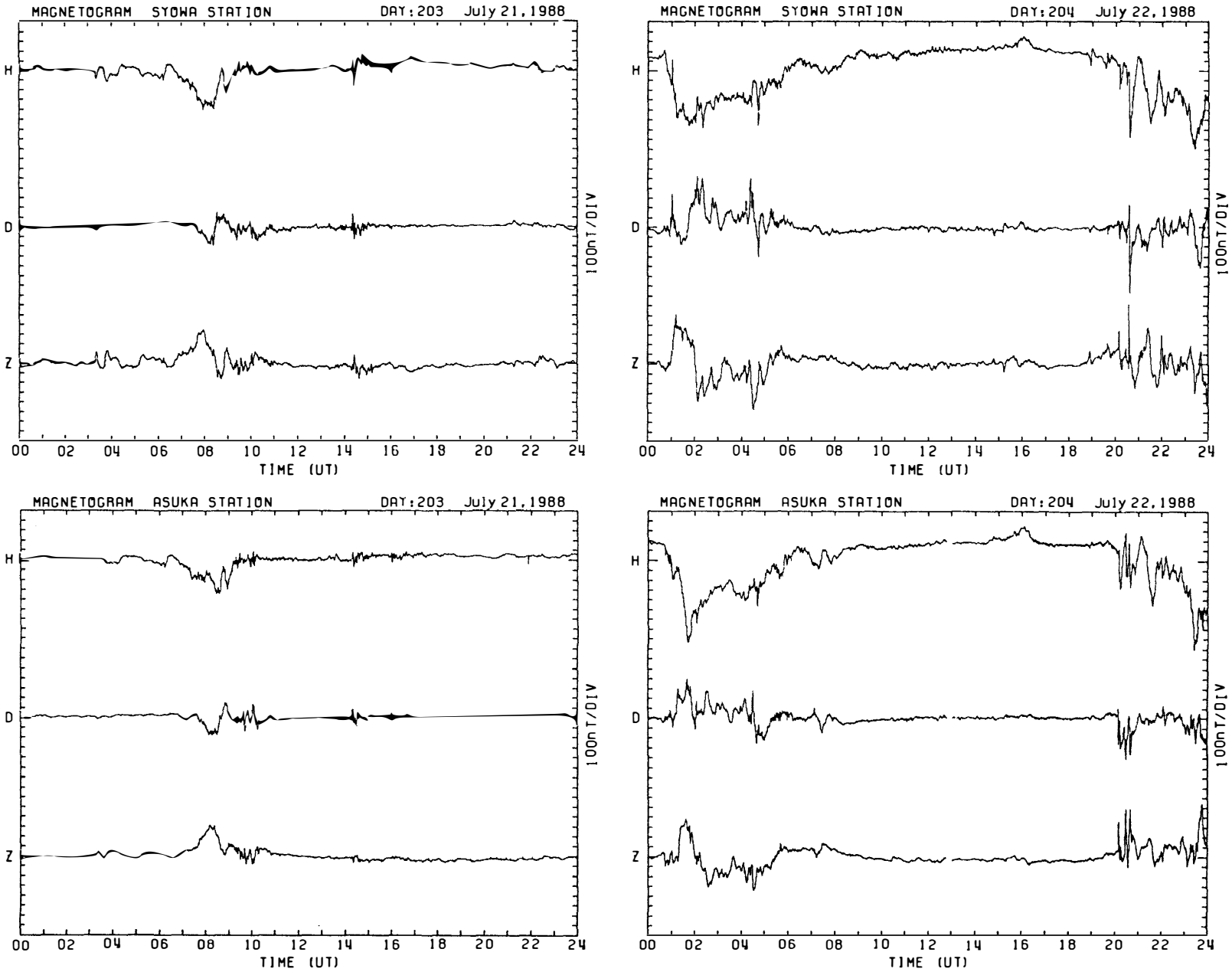
TIME (UT)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MAGNETOGRAM SYOWA STATION DAY:204 July 22,1988
MAGNETOGRAM ASUKA STATION DAY:203 July 21,1988
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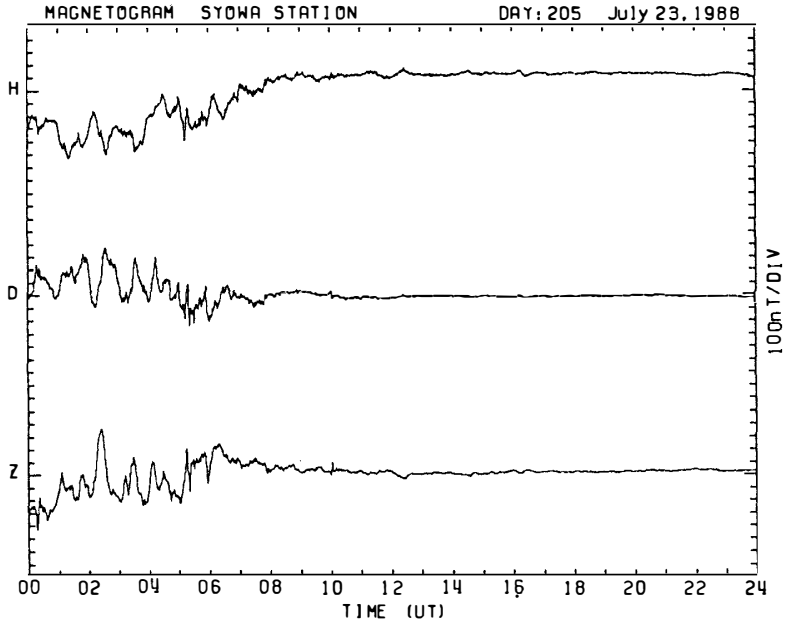
TIME (UT)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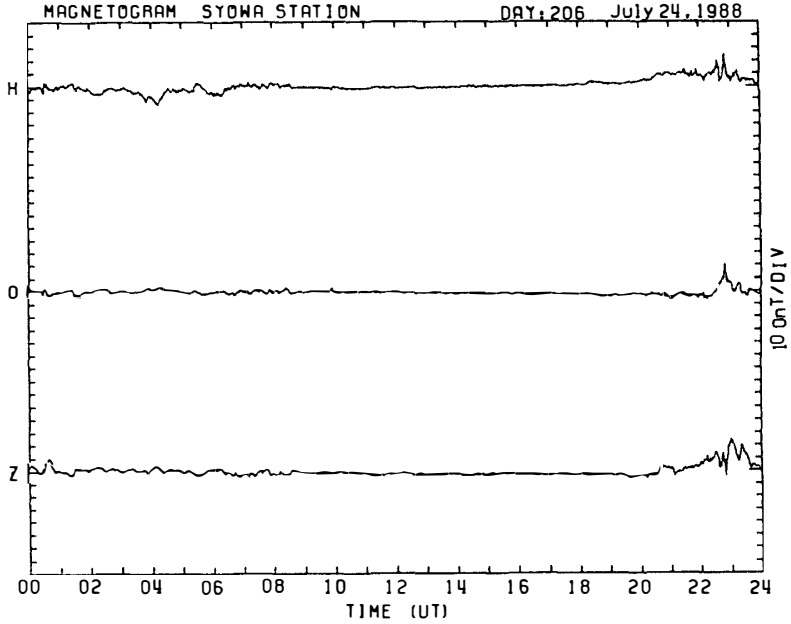
TIME (UT)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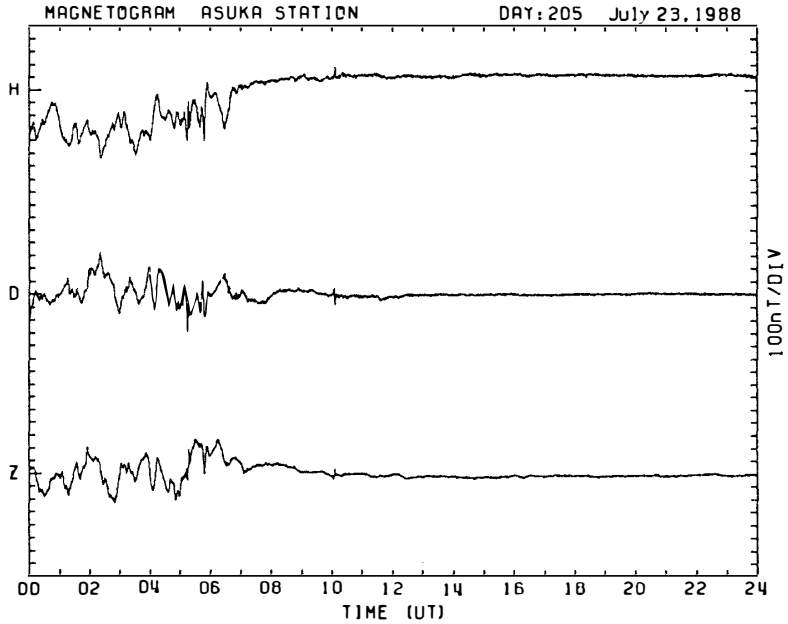
TIME (UT)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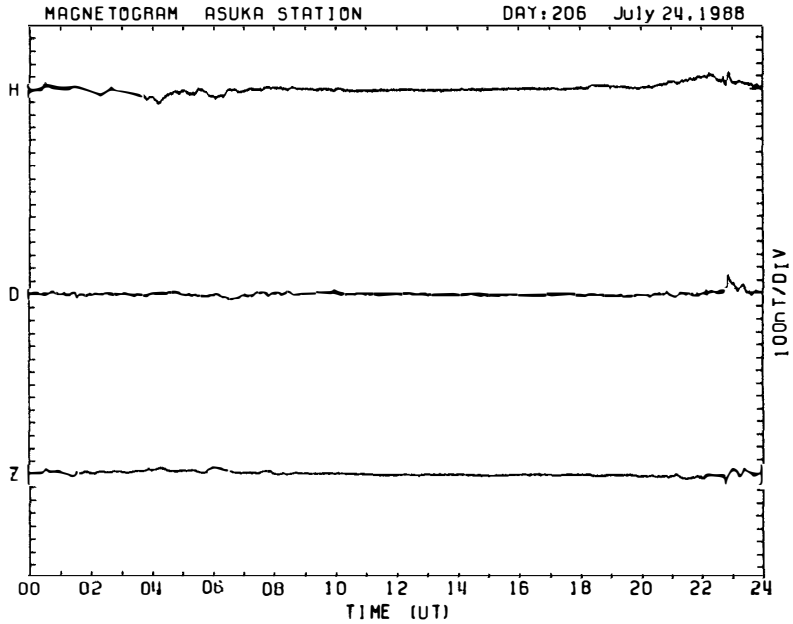
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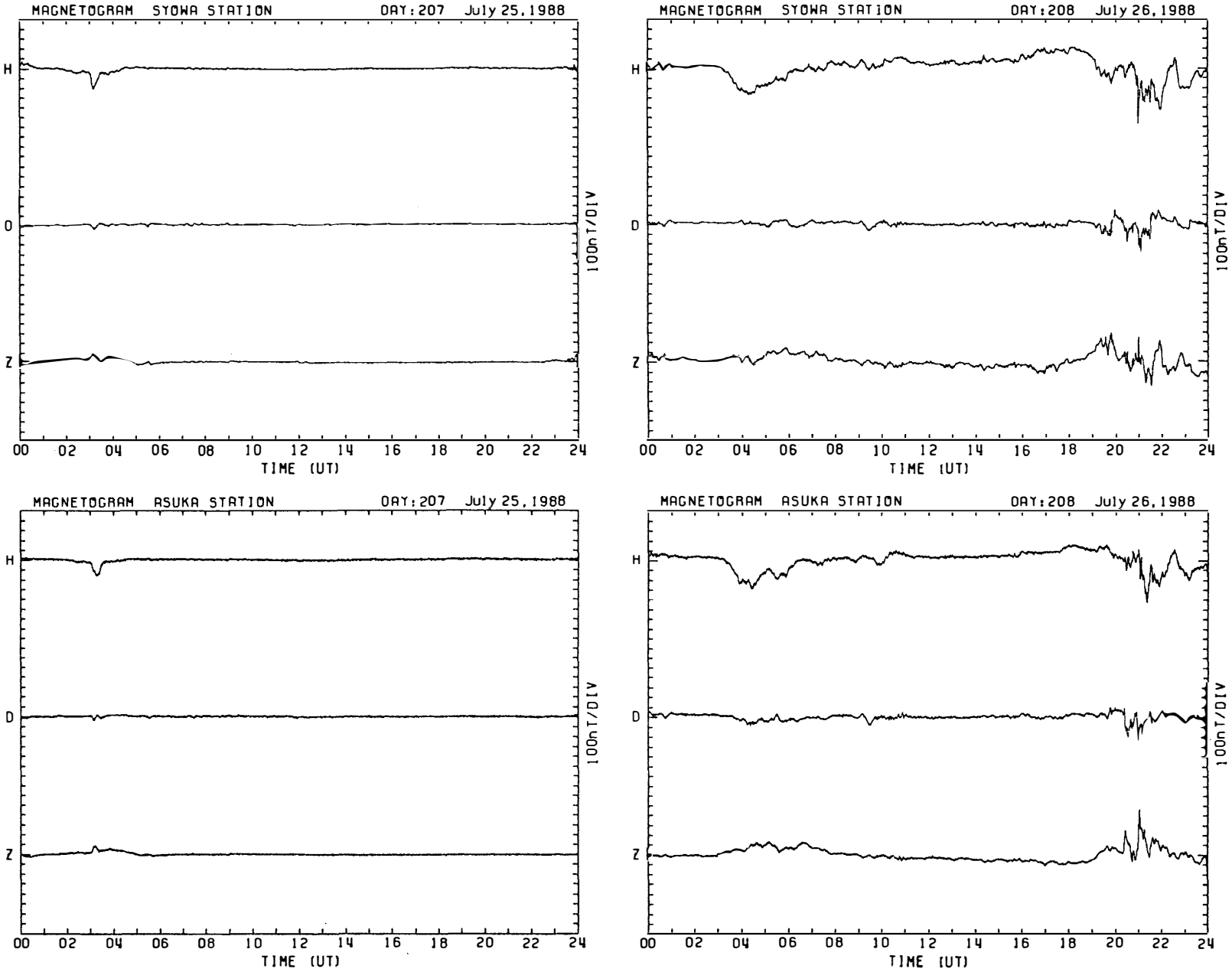
MAGNETOGRAM SYOWA STATION DAY:207 July 25,1988
MAGNETOGRAM SYOWA STATION DAY:208 July 26,1988
MAGNETOGRAM ASUKA STATION DAY:207 July 25,1988
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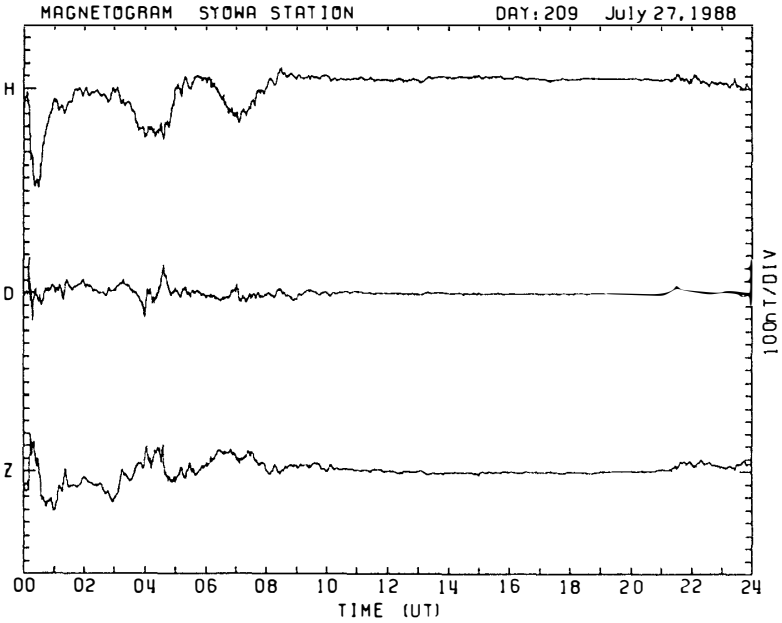
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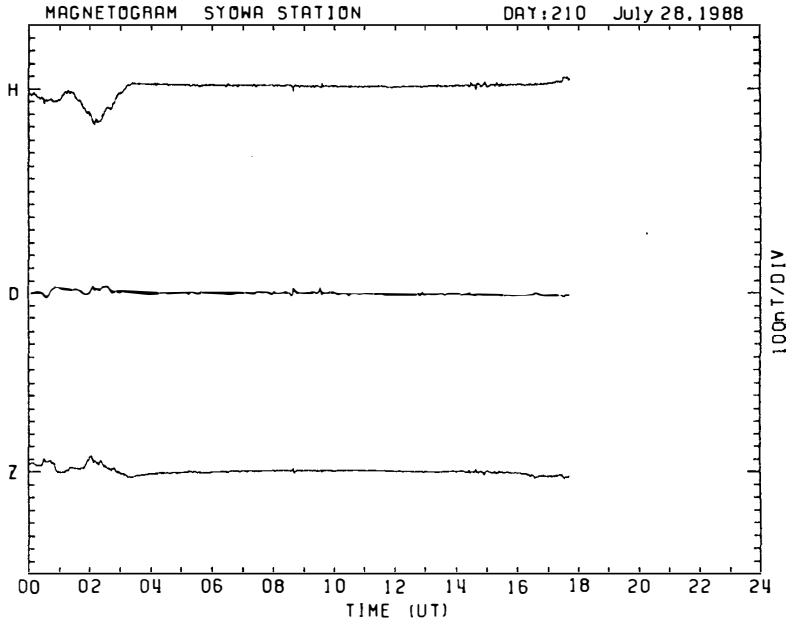
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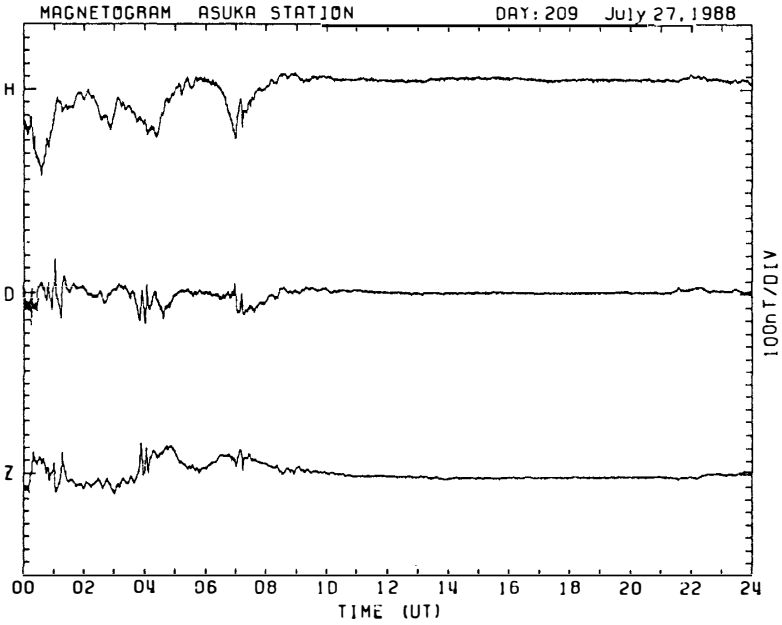
TIME (UT)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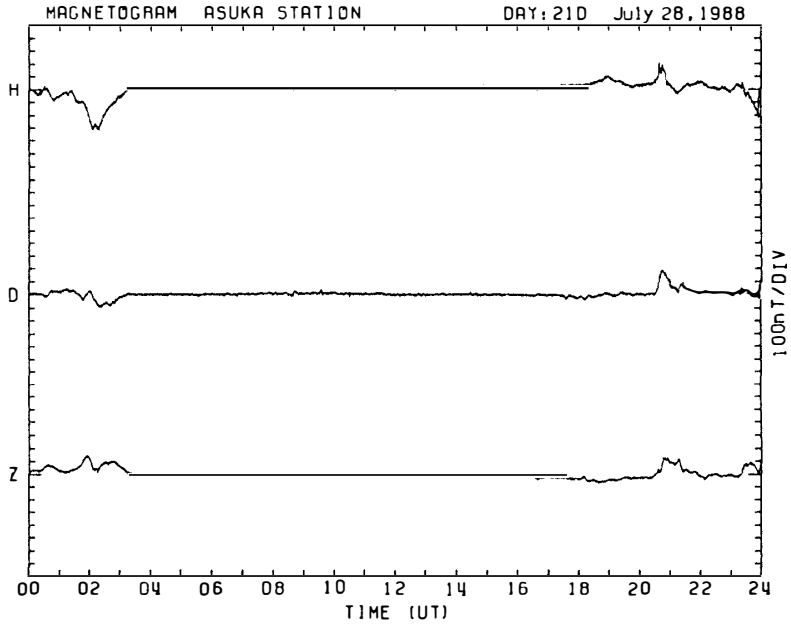
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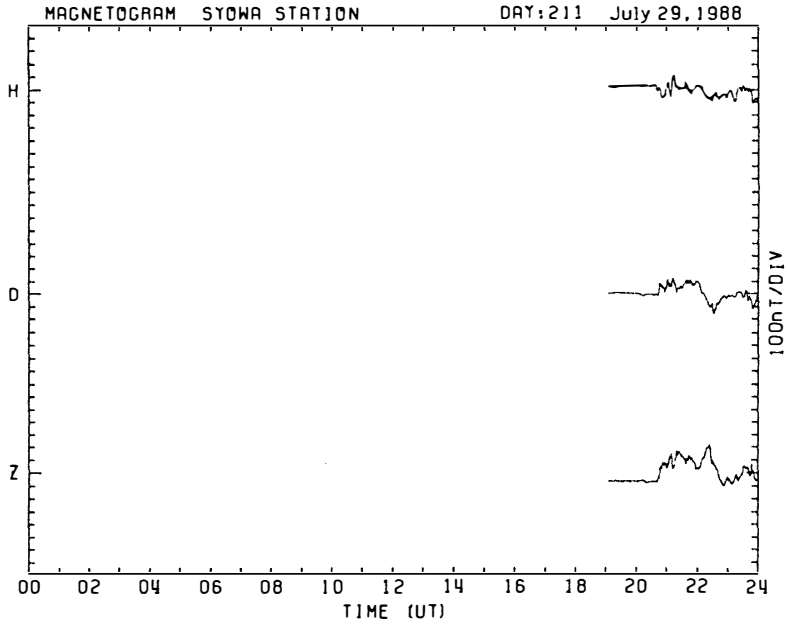
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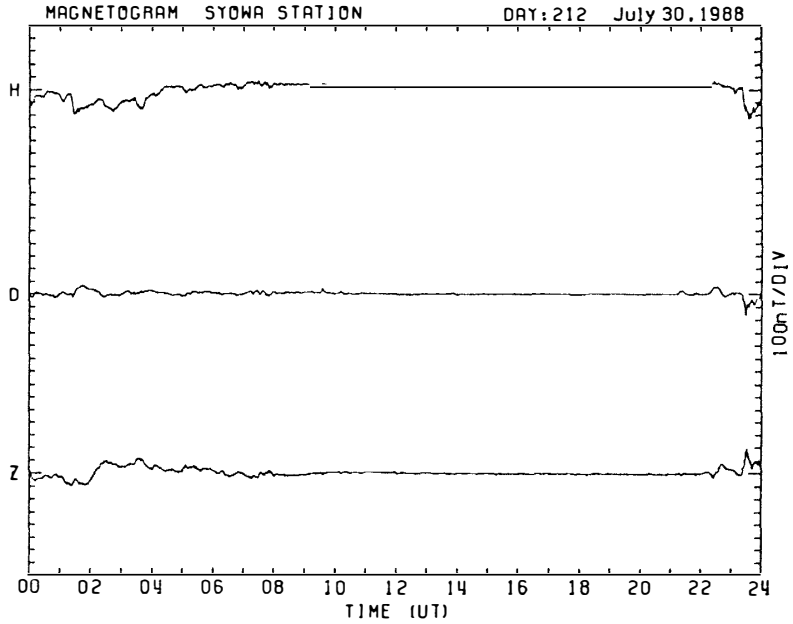
TIME (UT)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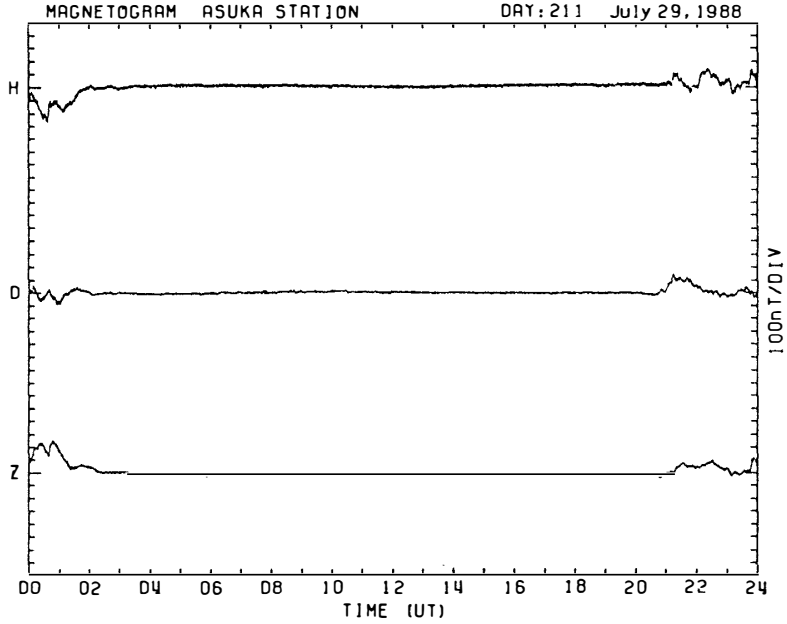
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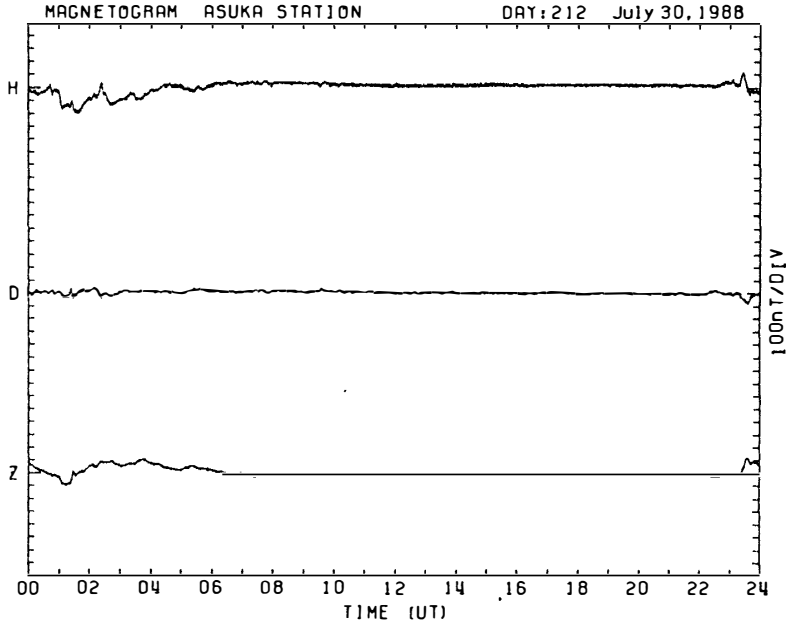
TIME (UT)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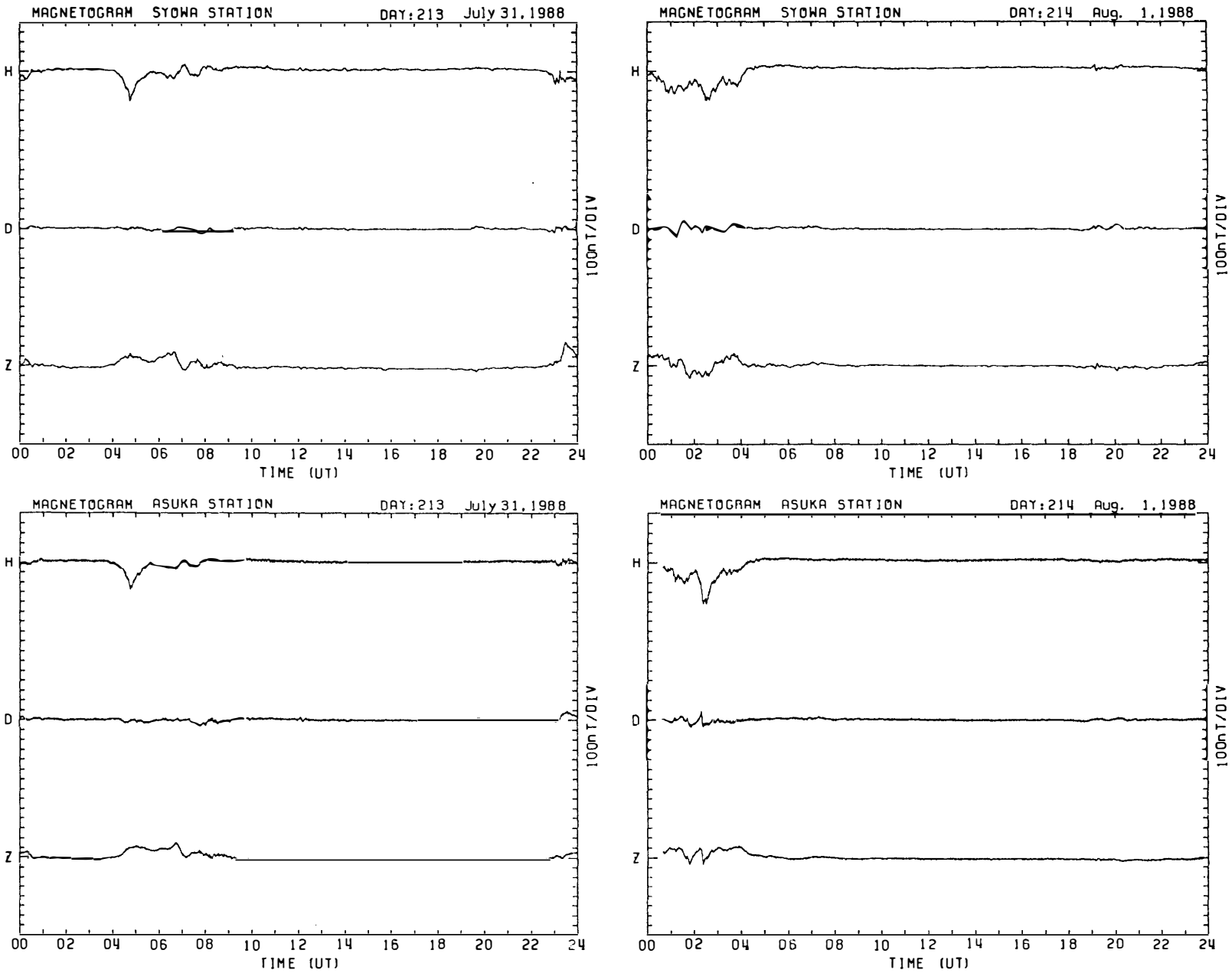
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MAGNETOGRAM ASUKA STATION DAY:213 July 31,1988
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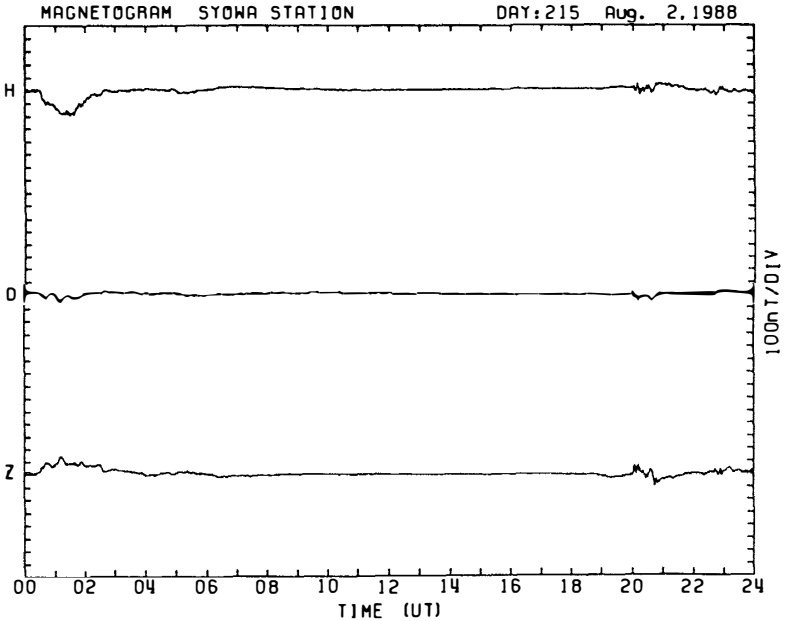
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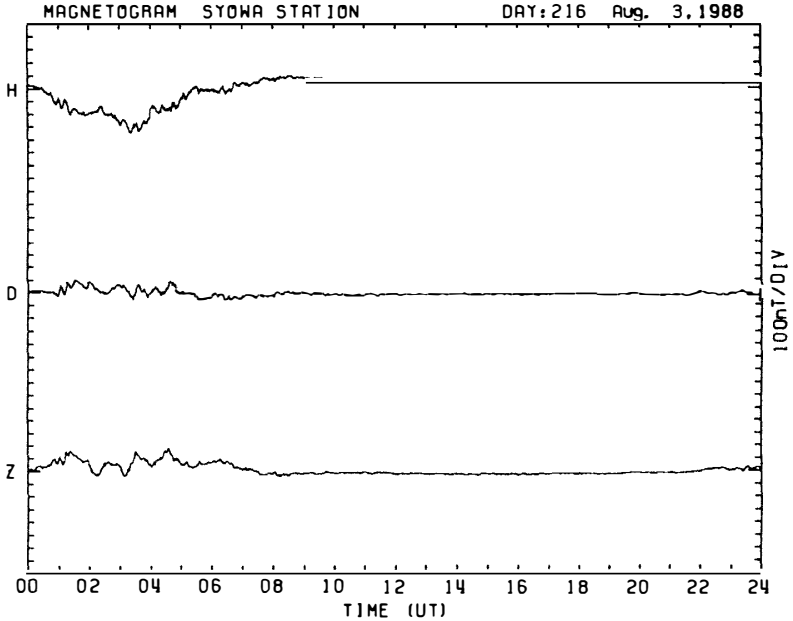
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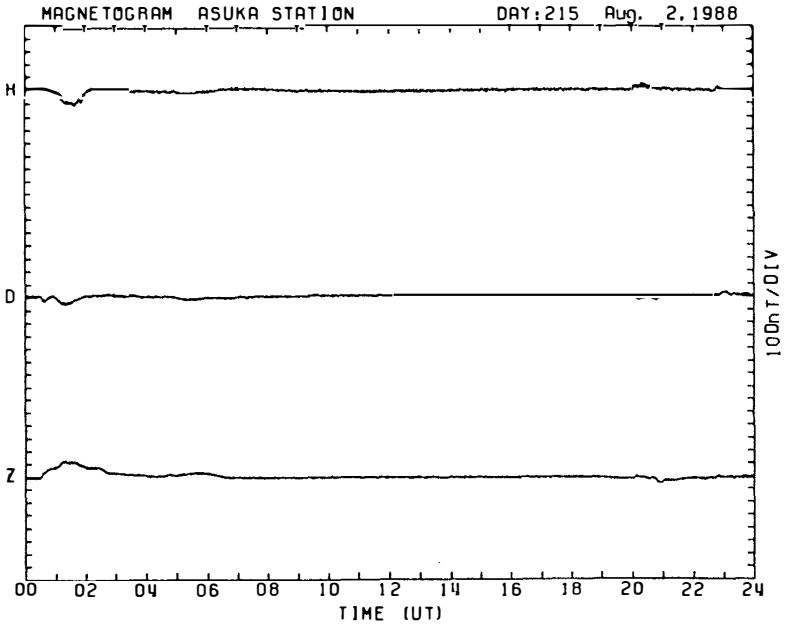
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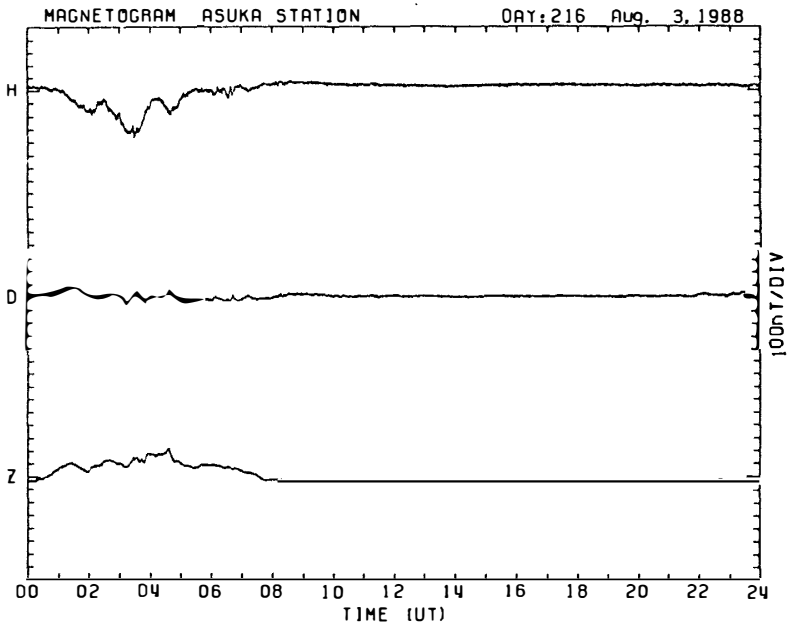
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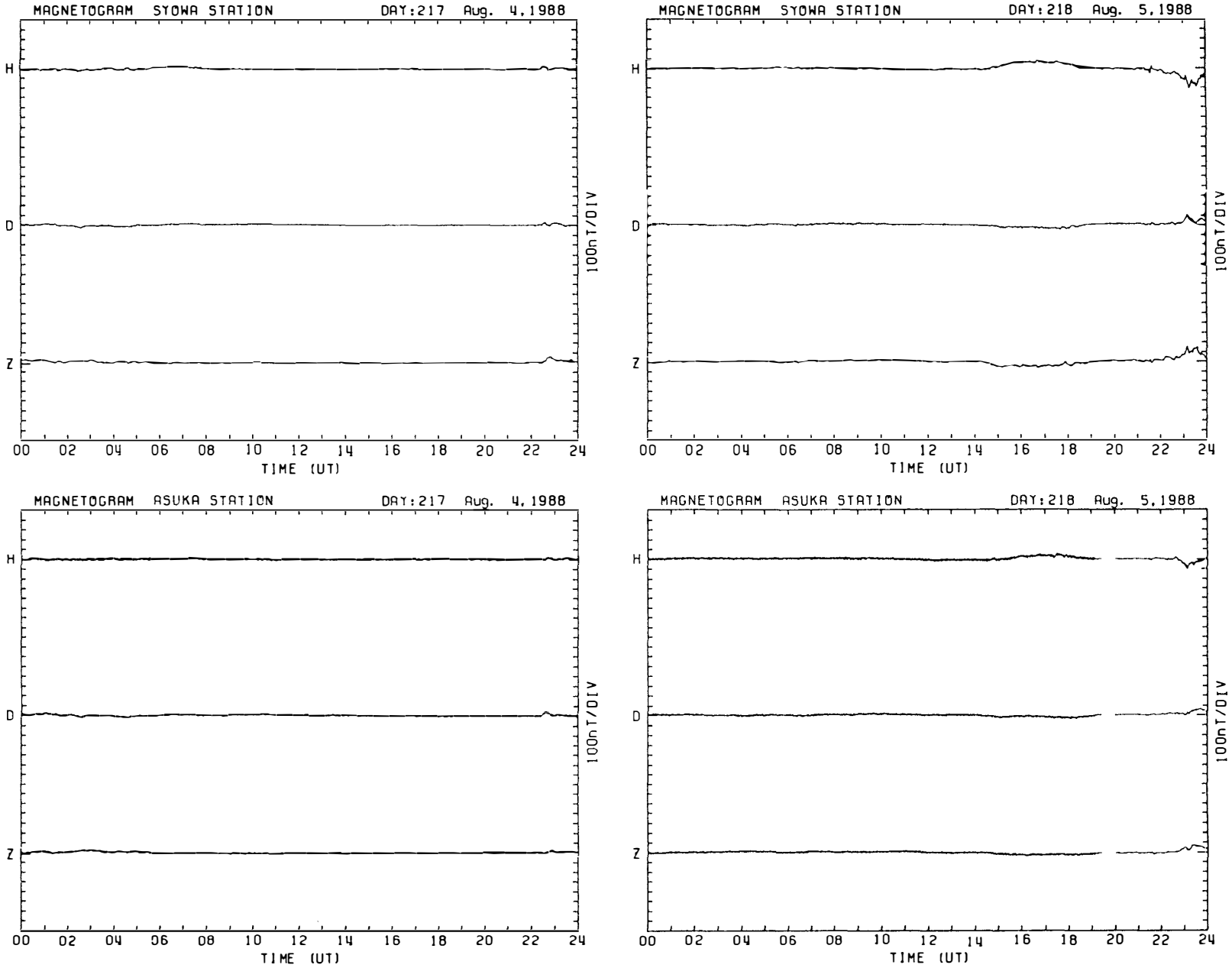
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MAGNETOGRAM ASUKA STATION DAY:217 Aug. 4,1988
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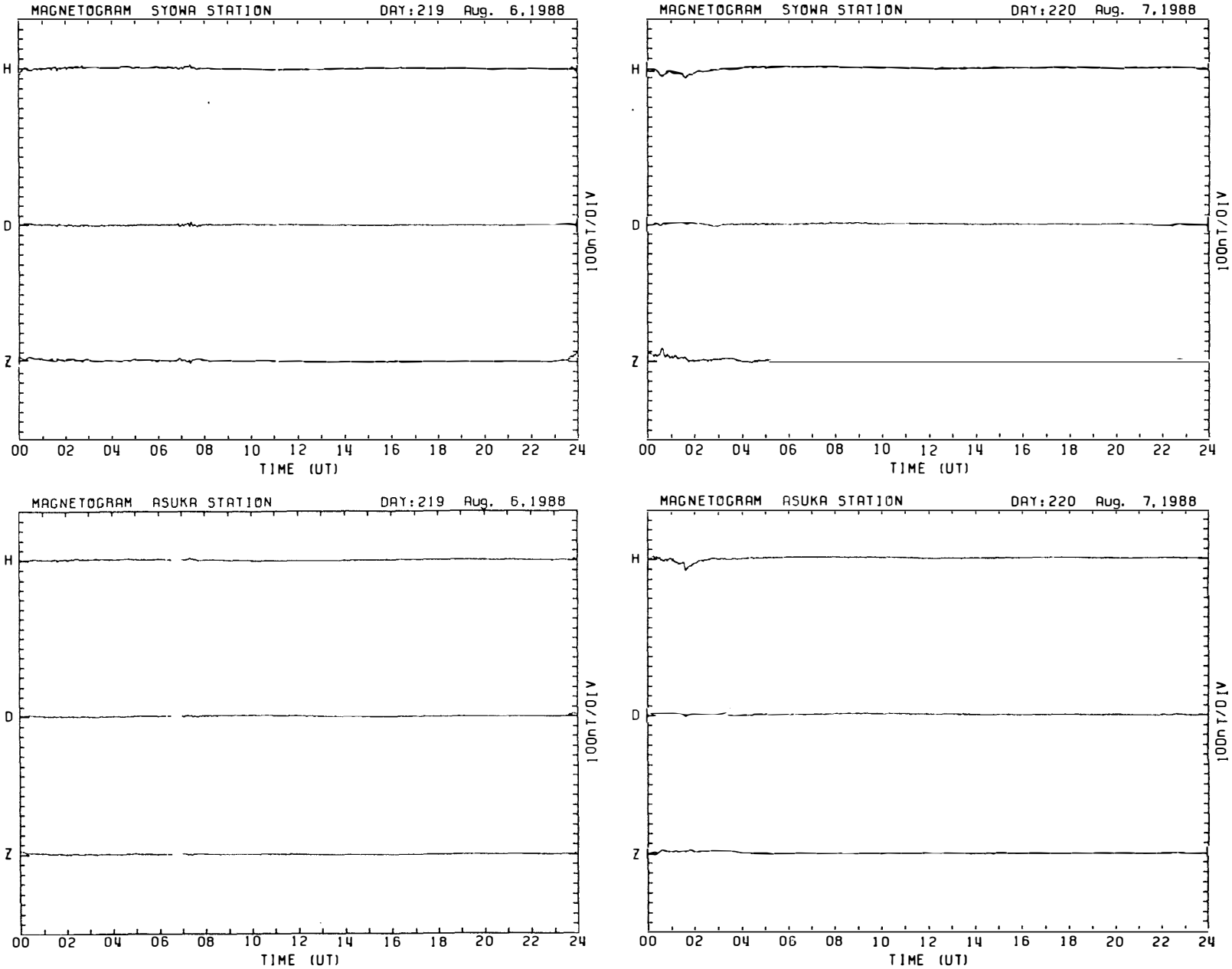
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MAGNETOGRAM ASUKA STATION DAY:219 Aug. 6,1988
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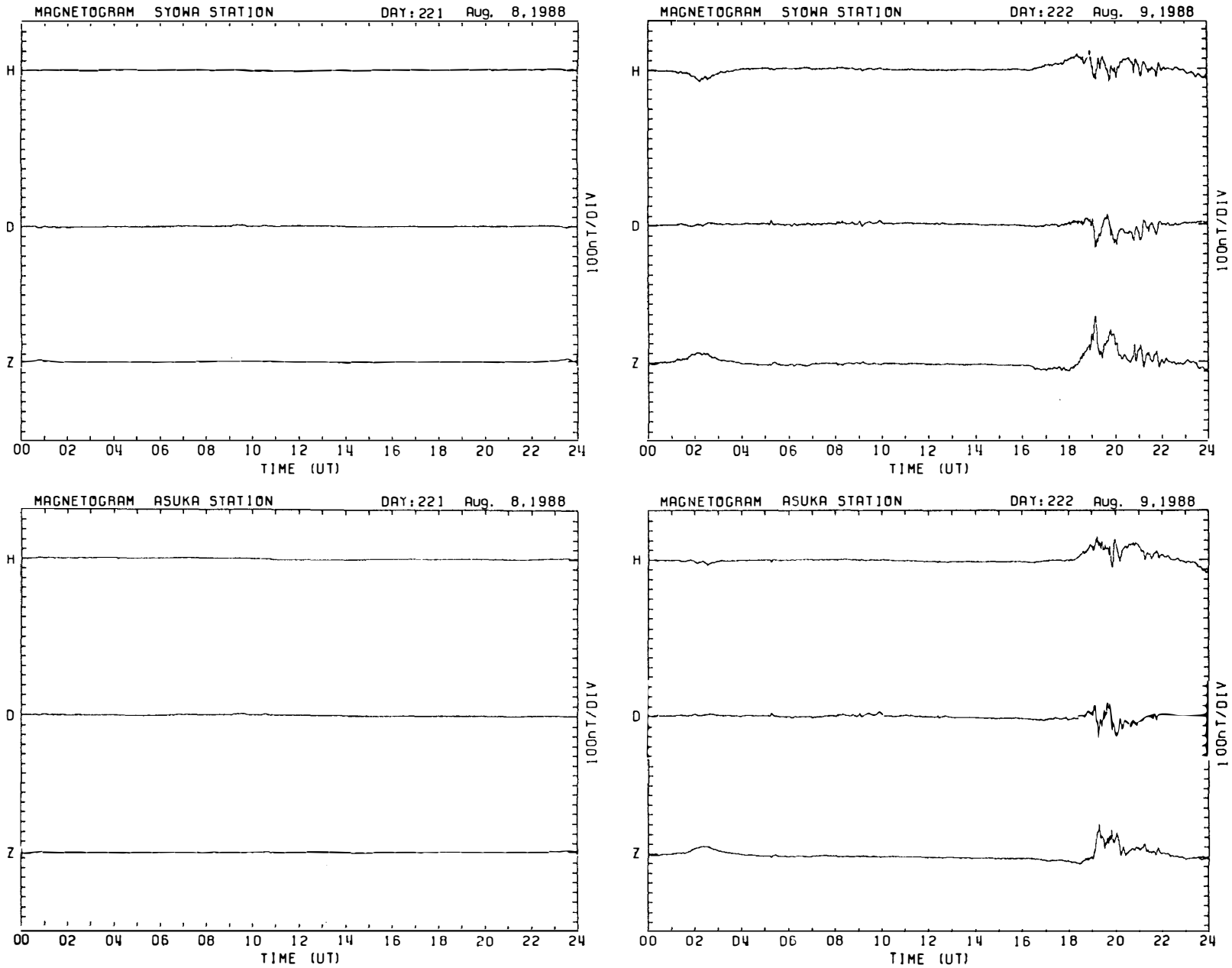
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MAGNETOGRAM ASUKA STATION DAY:221 Aug. 8,1988
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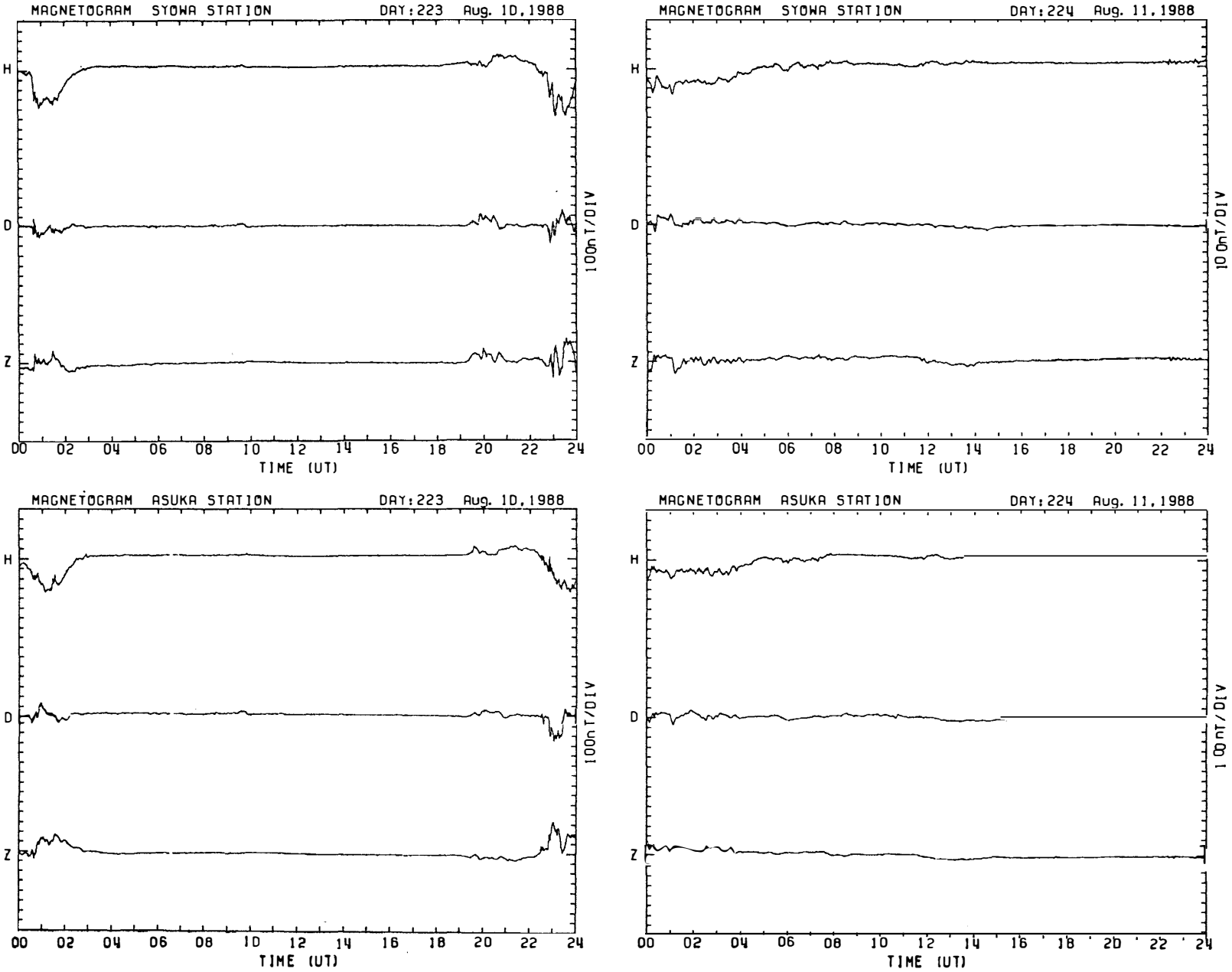
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MAGNETOGRAM ASUKA STATION DAY:223 Aug. 10,1988
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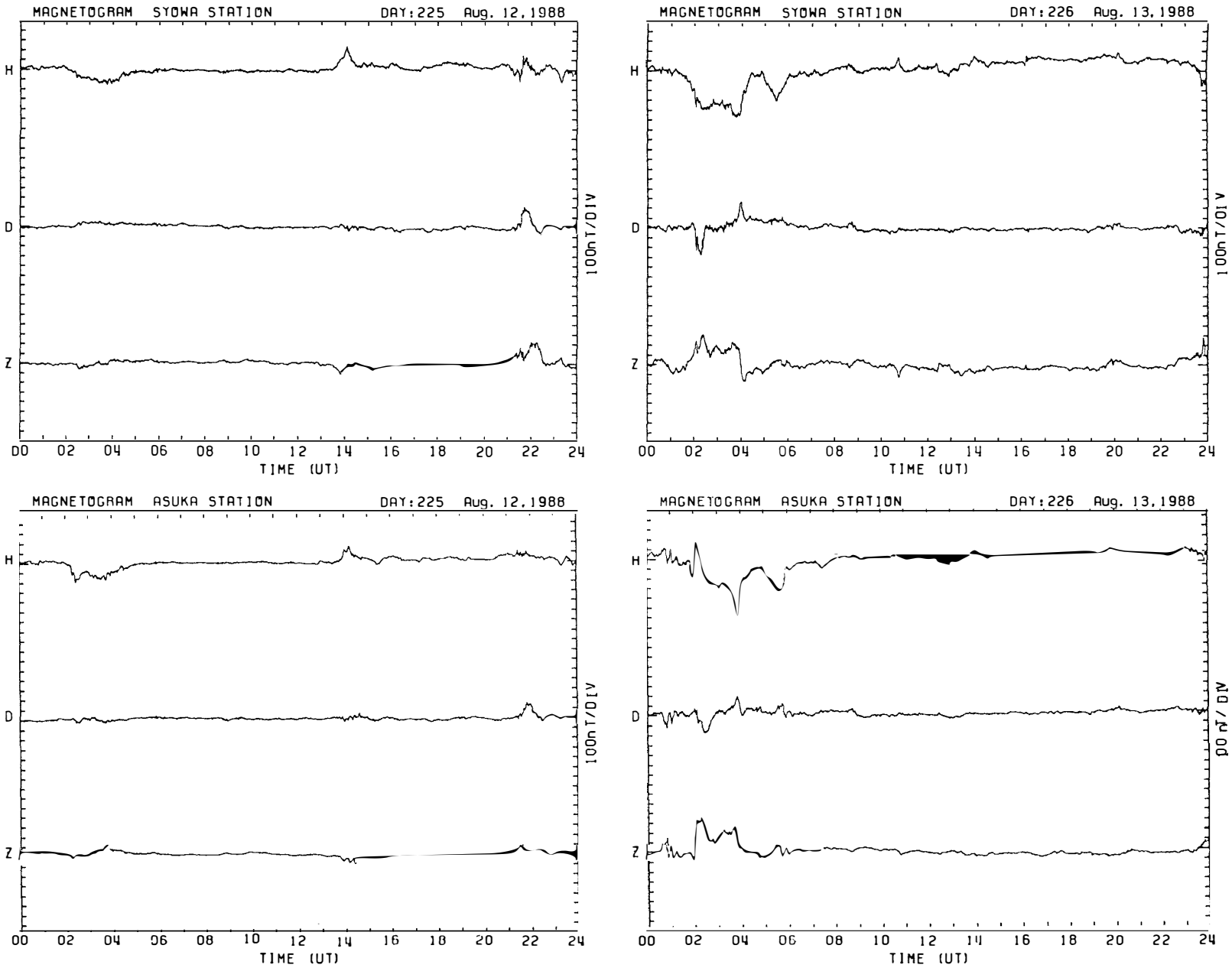
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MAGNETOGRAM ASUKA STATION DAY:225 Aug. 12,1988
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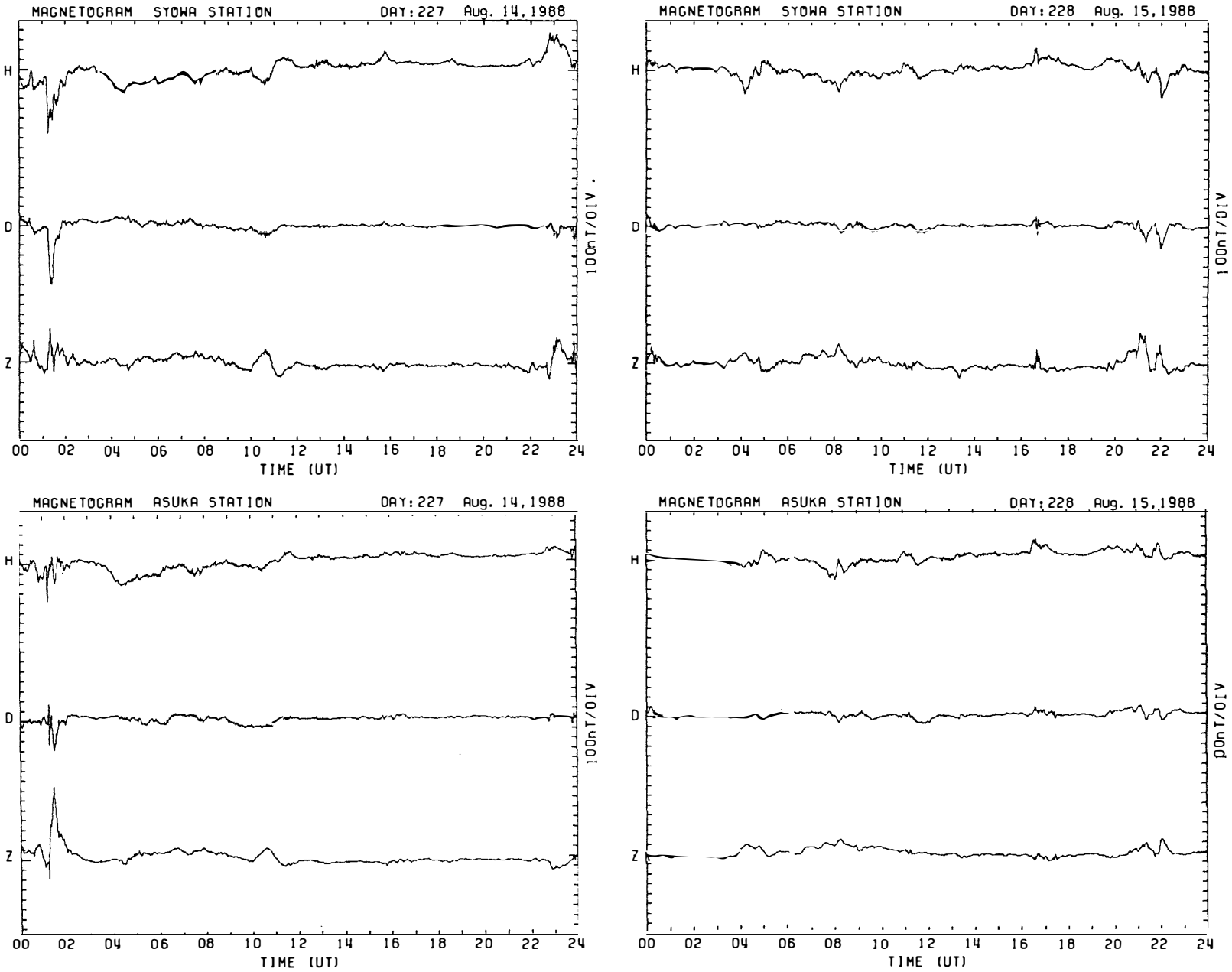
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MAGNETOGRAM ASUKA STATION DAY:227 Aug. 14,1988
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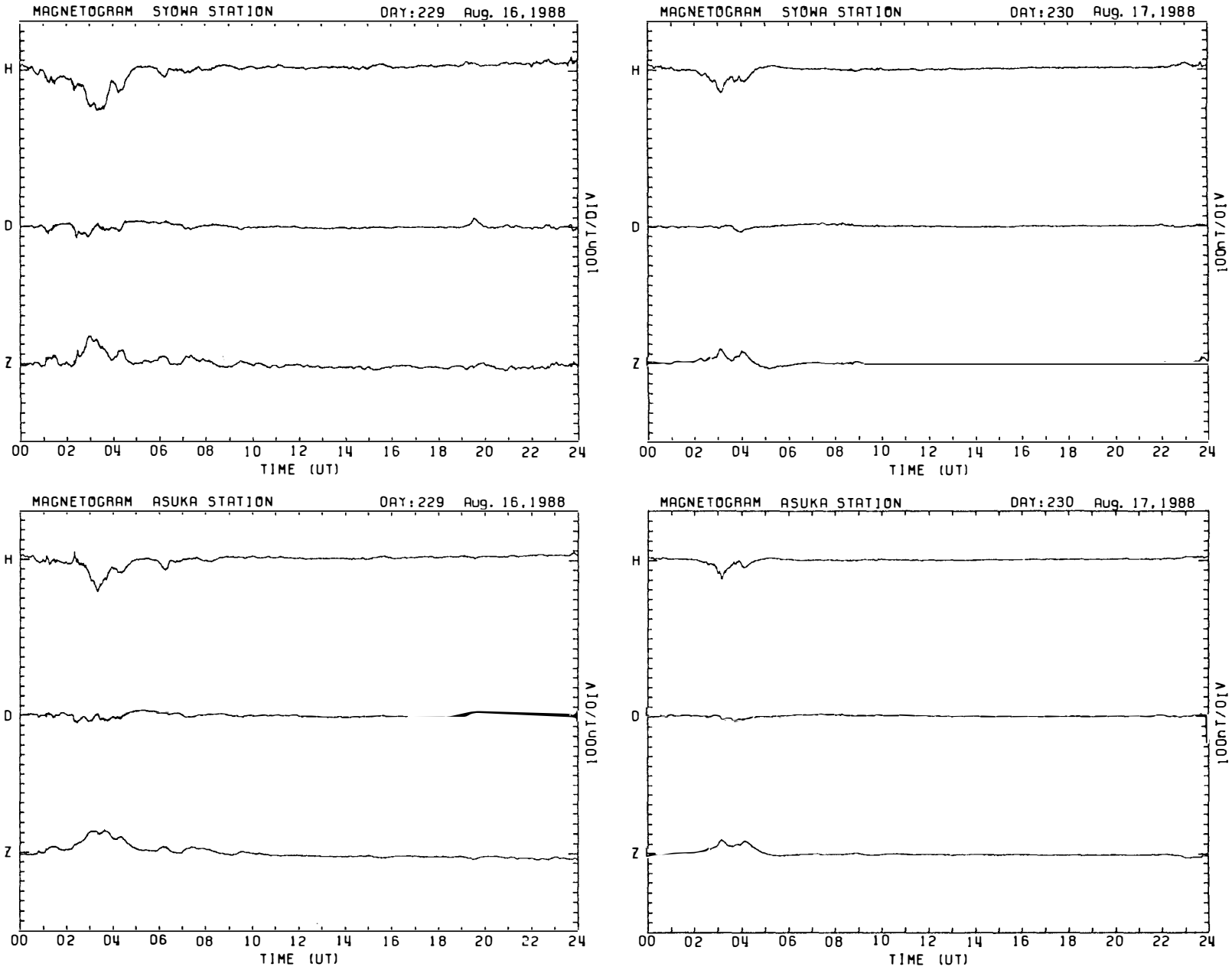
MAGNETOGRAM SYOWA STATION DAY:229 Aug. 16,1988
MAGNETOGRAM SYOWA STATION DAY:230 Aug. 17,1988
MAGNETOGRAM ASUKA STATION DAY:229 Aug. 16,1988
MAGNETOGRAM ASUKA STATION DAY:230 Aug. 17,1988
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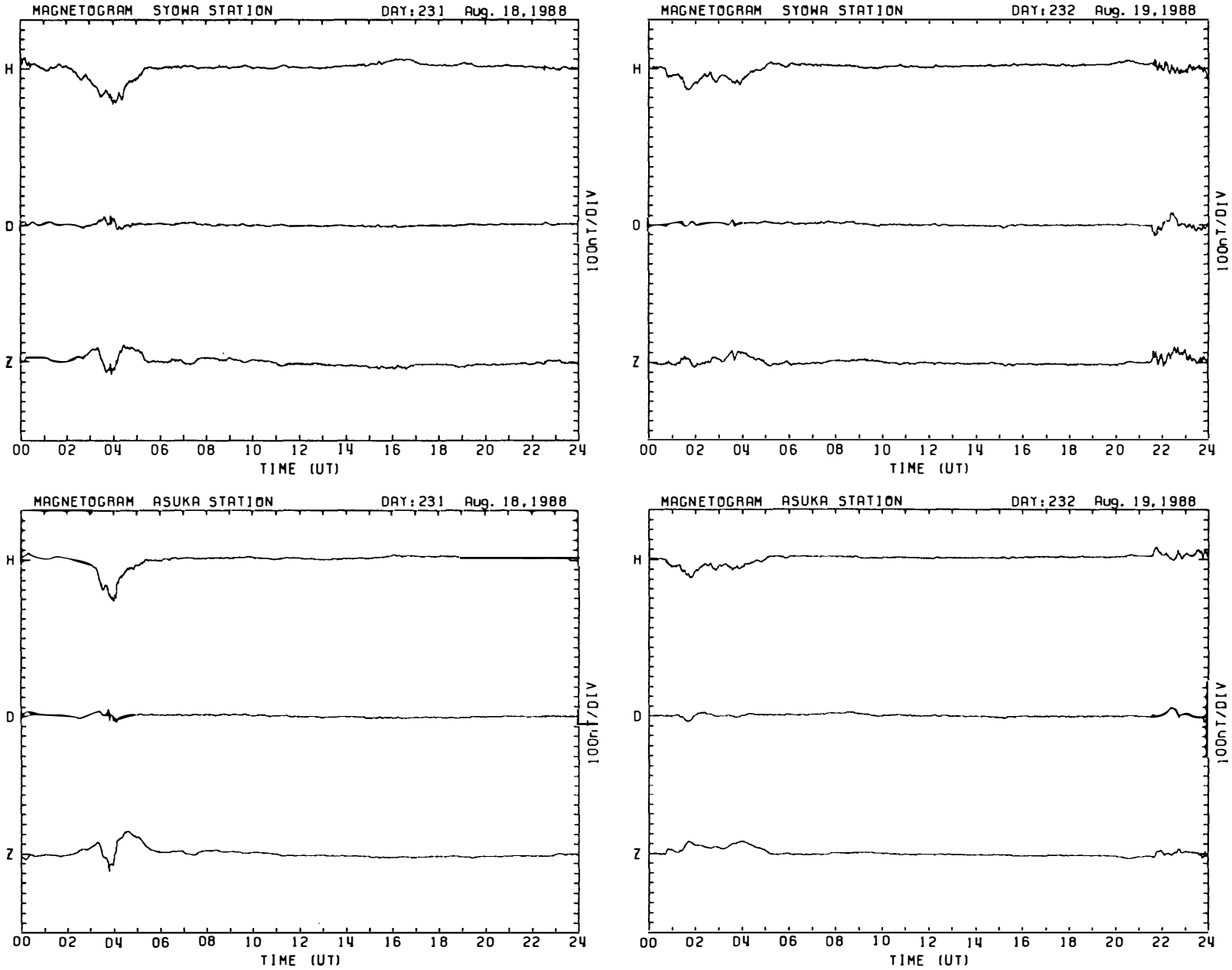
TIME (UT)


MAGNETOGRAM SYOWA STATION DAY:231 Aug. 18,1988
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MAGNETOGRAM ASUKA STATION DAY:231 Aug. 18,1988
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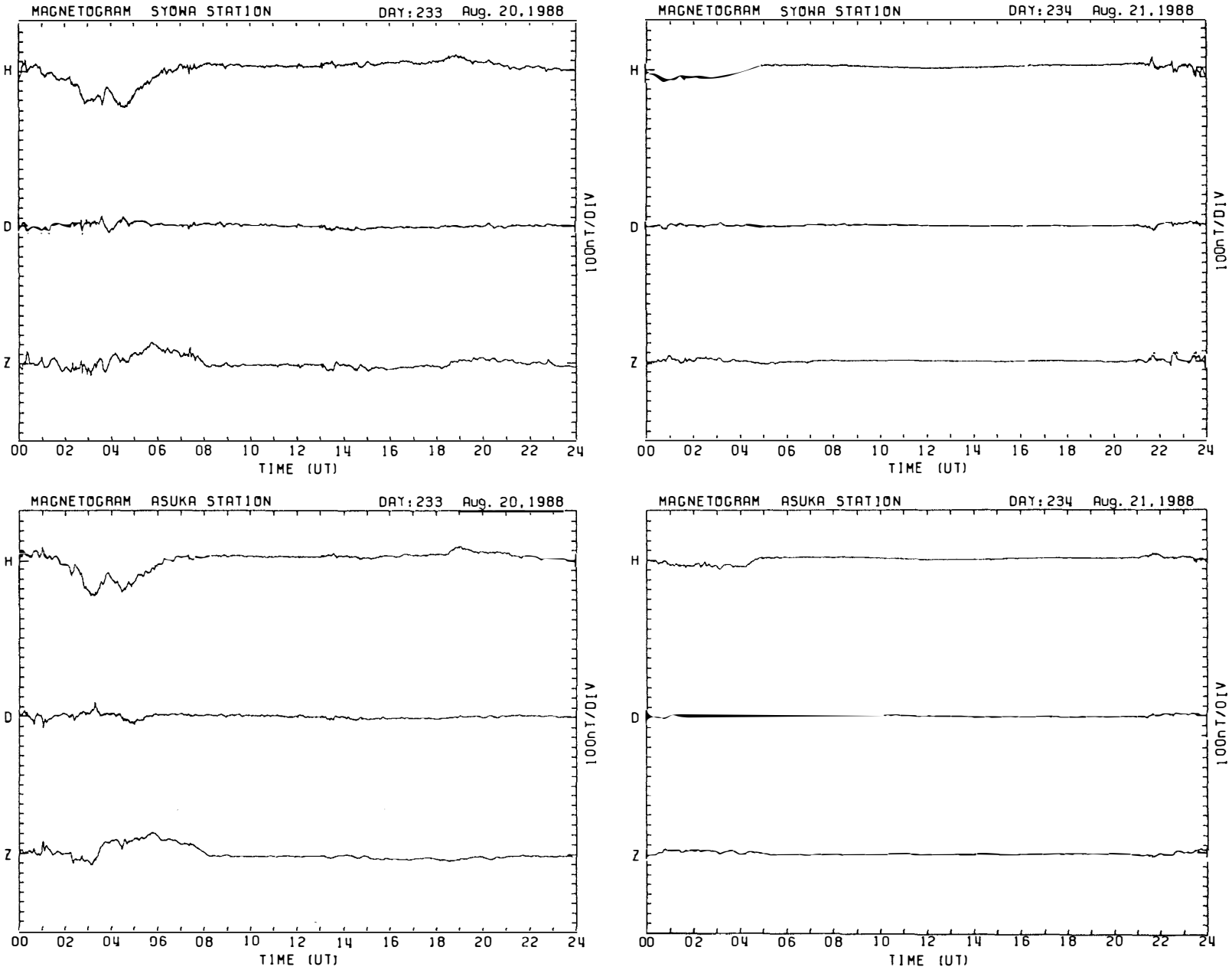
TIME (UT)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MAGNETOGRAM ASUKA STATION DAY:233 Aug. 20,1988
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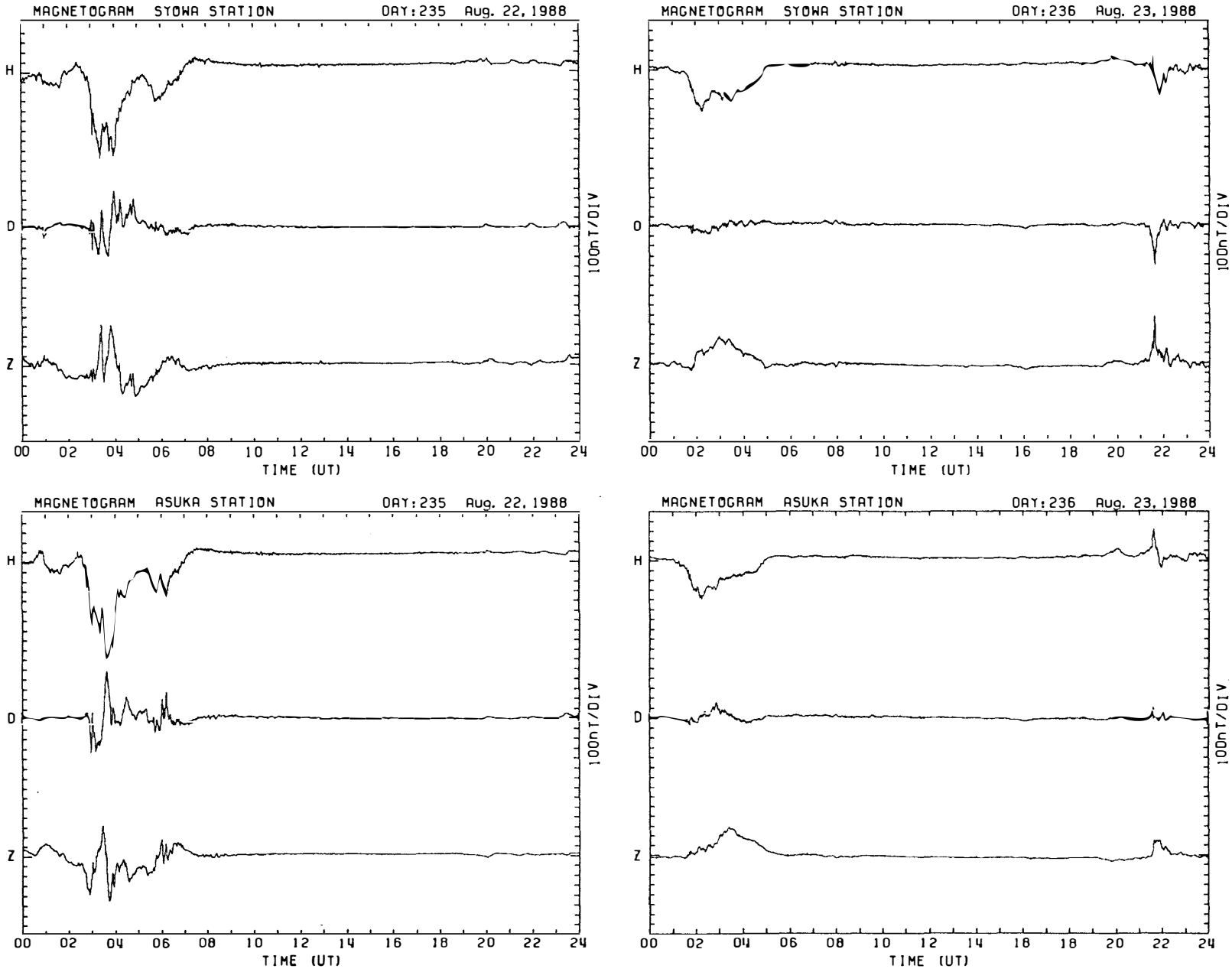
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MAGNETOGRAM SYOWA STATION DAY:236 Aug. 23, 1988
MAGNETOGRAM ASUKA STATION DAY:235 Aug. 22, 1988
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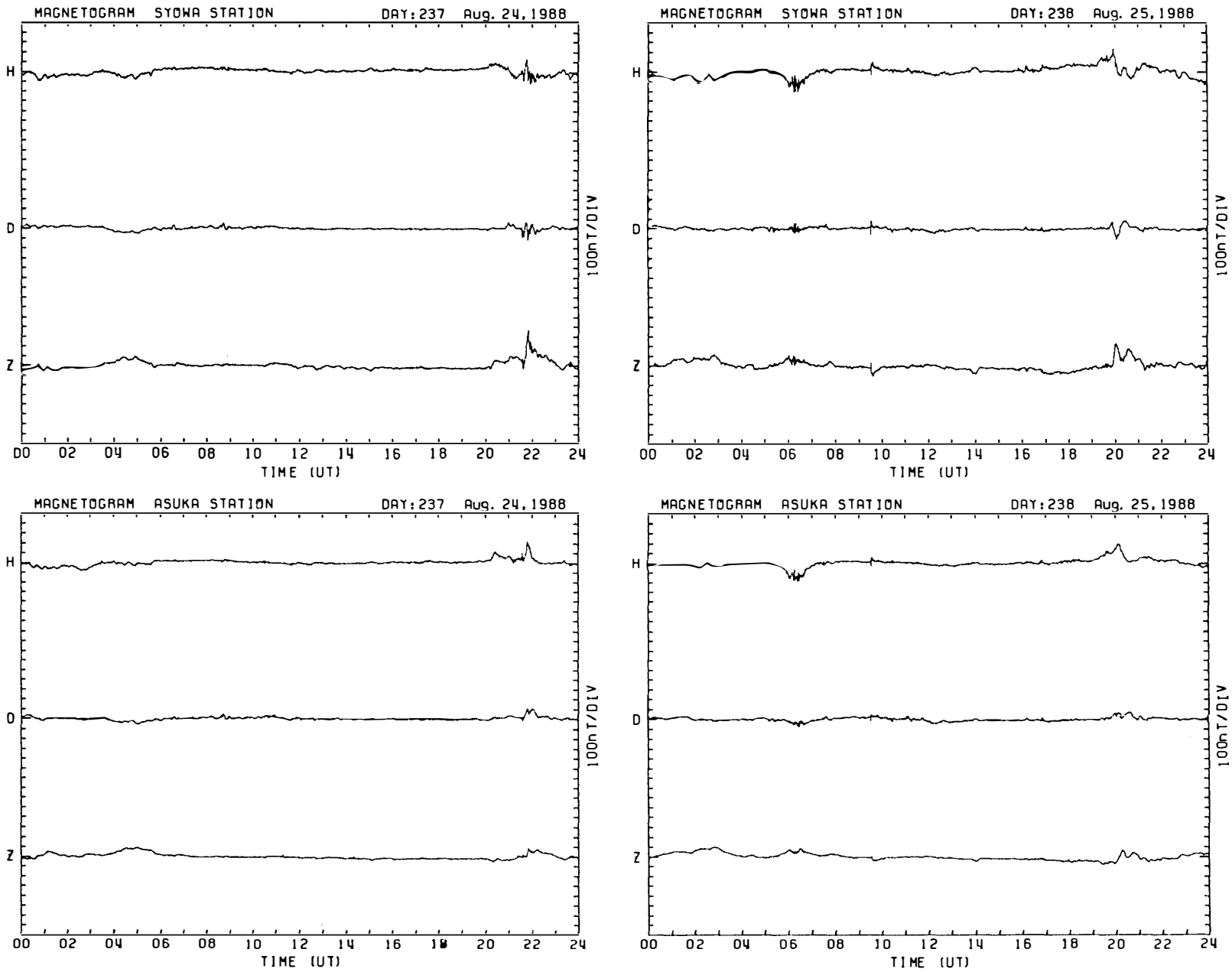
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MAGNETOGRAM SYOWA STATION DAY:238 Aug. 25,1988
MAGNETOGRAM ASUKA STATION DAY:237 Aug. 24,1988
MAGNETOGRAM ASUKA STATION DAY:238 Aug. 25,1988
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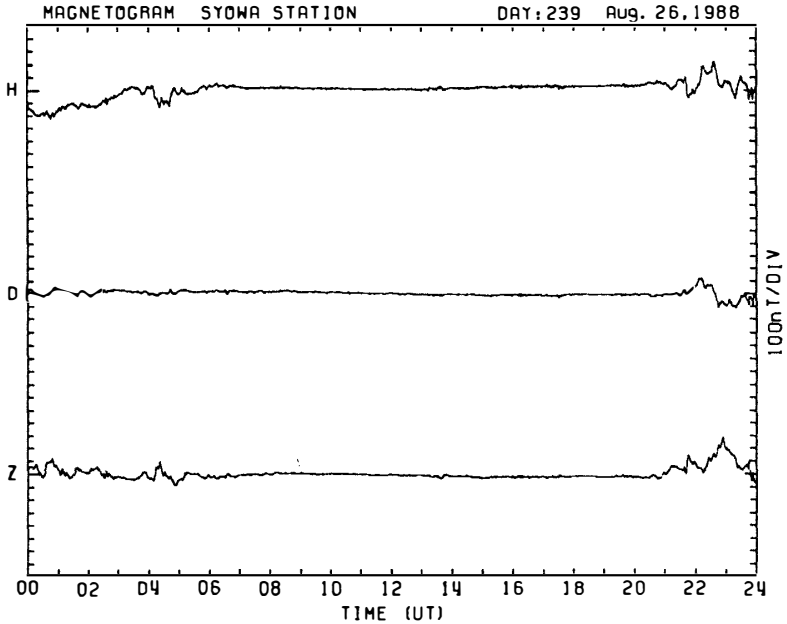
TIME (UT)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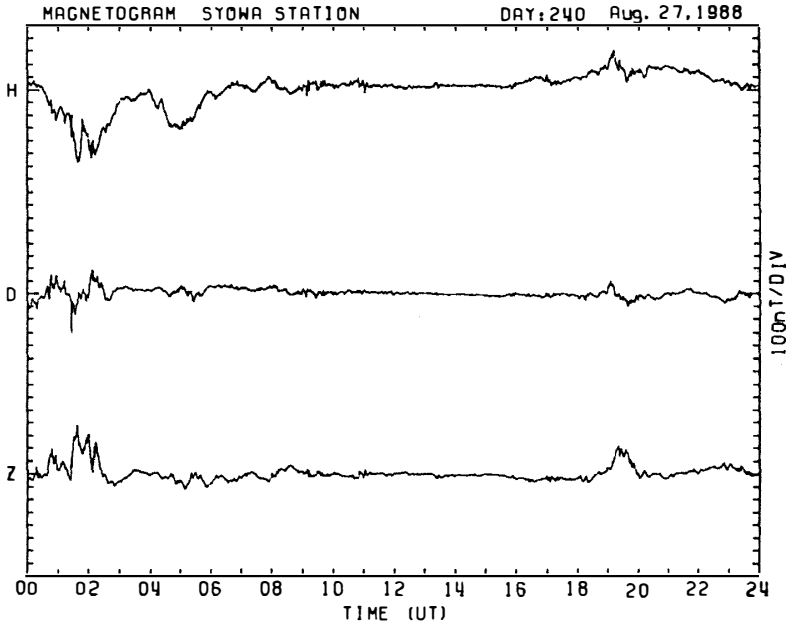
TIME (UT)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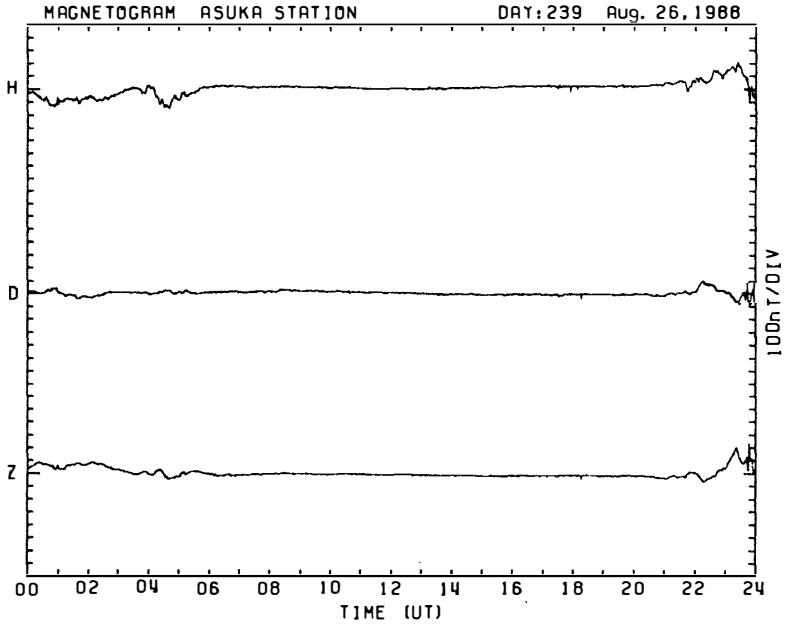
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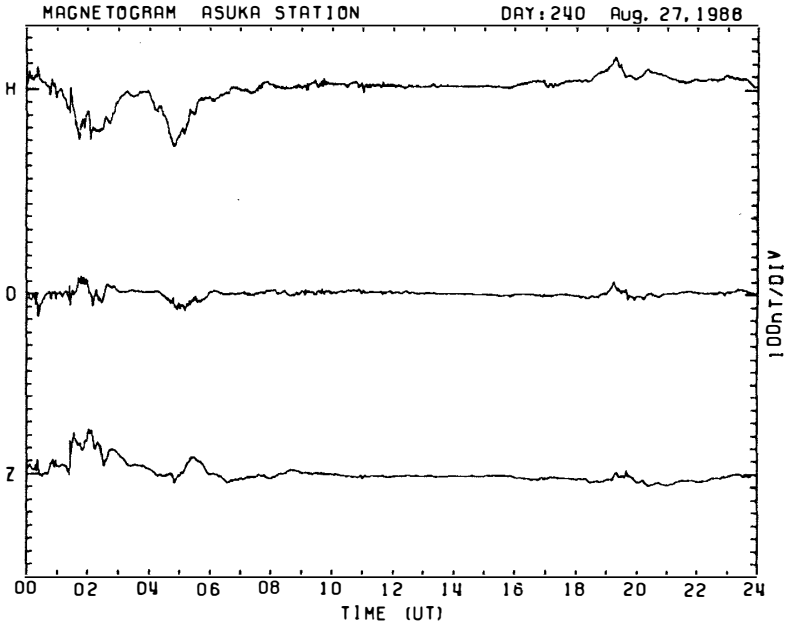
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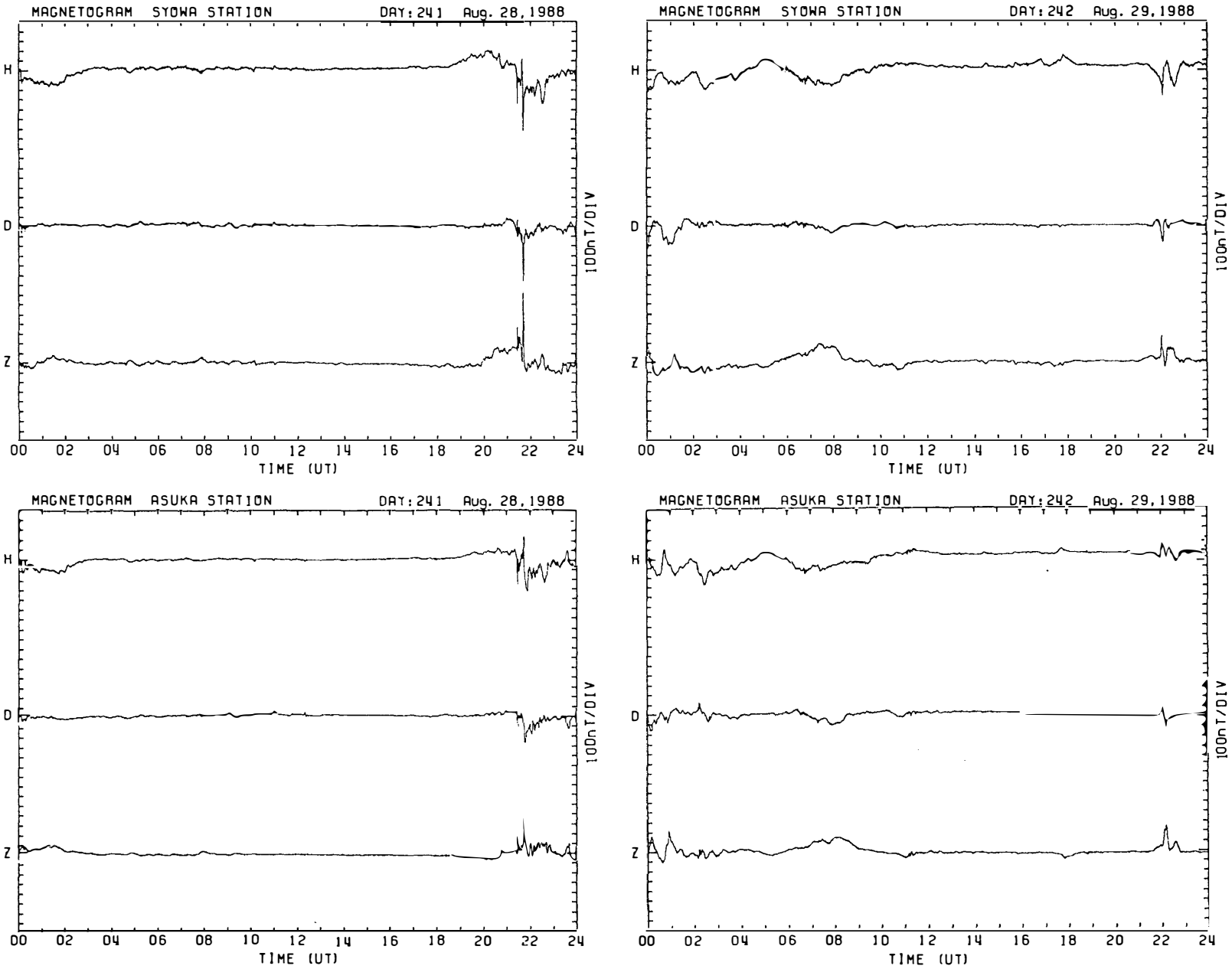
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DAY:242 Aug. 29,1988
MAGNETOGRAM ASUKA STATION
DAY:241 Aug. 28,1988
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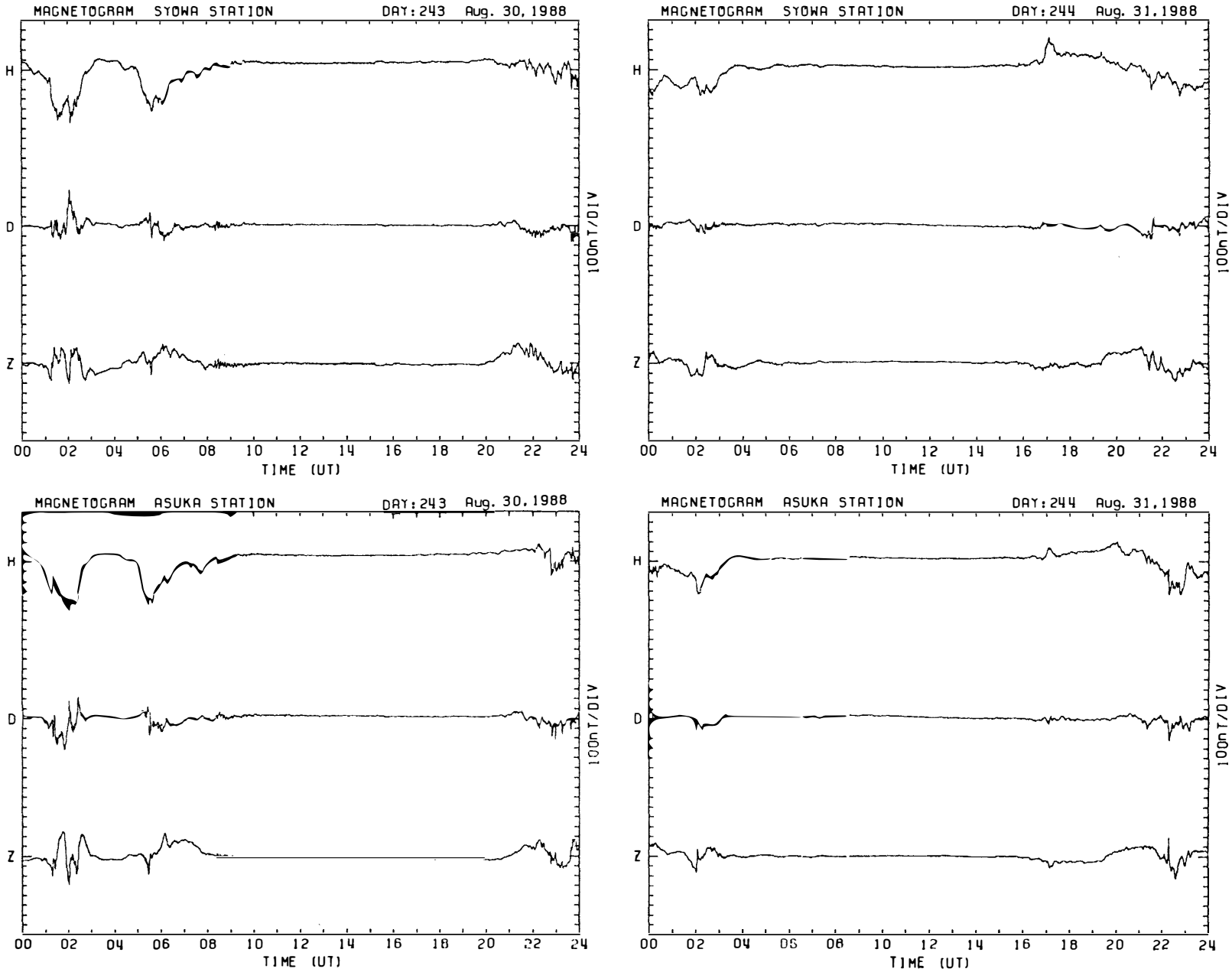
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MAGNETOGRAM ASUKA STATION DAY:243 Aug. 30,1988
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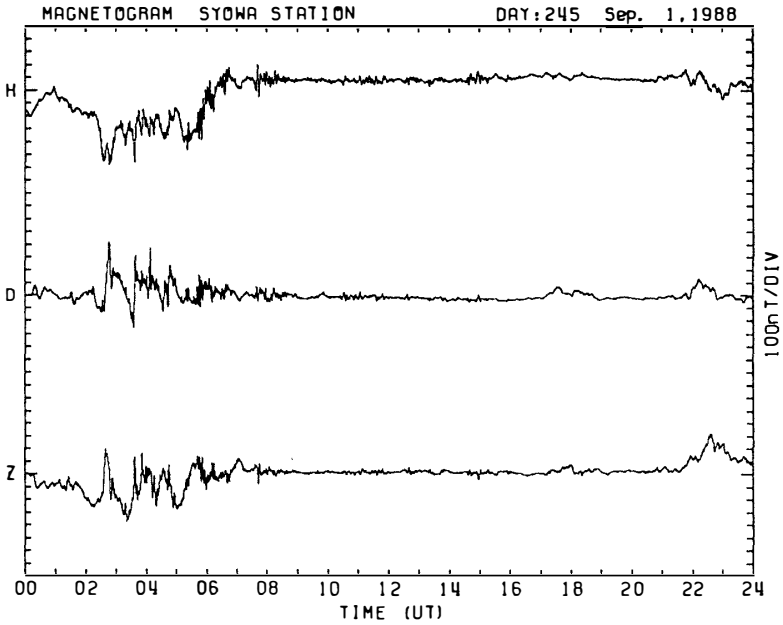
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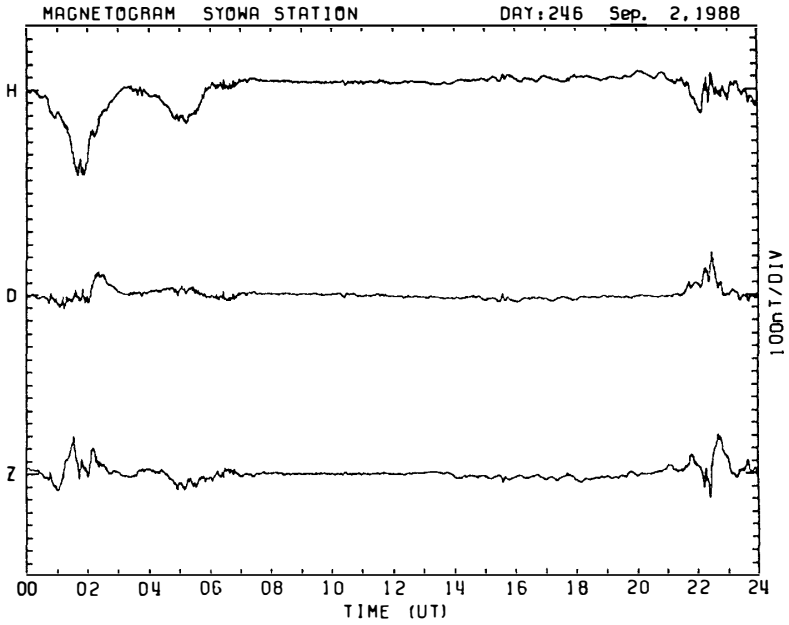
TIME (UT)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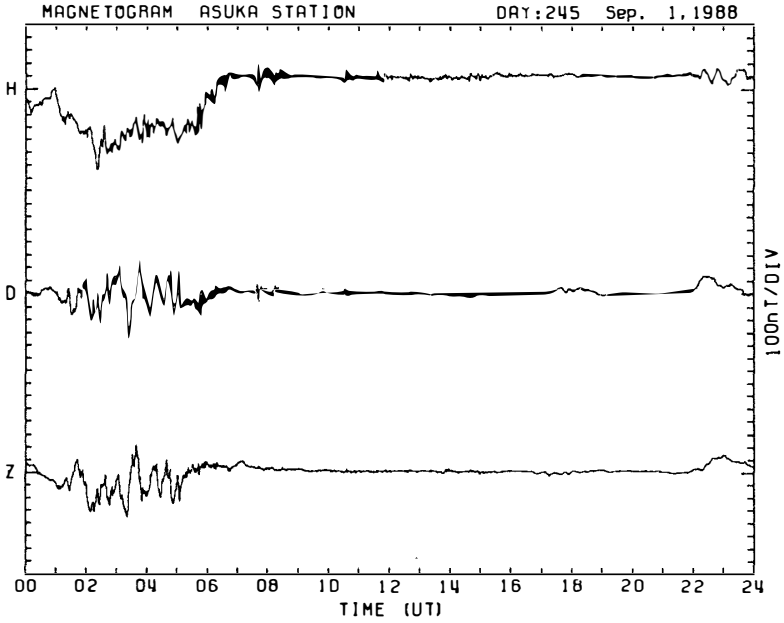
TIME (UT)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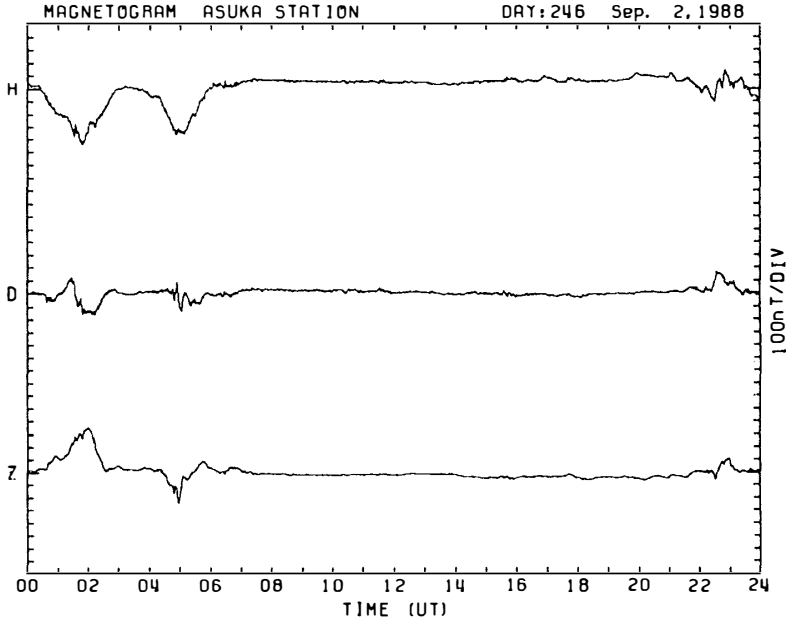
TIME (UT)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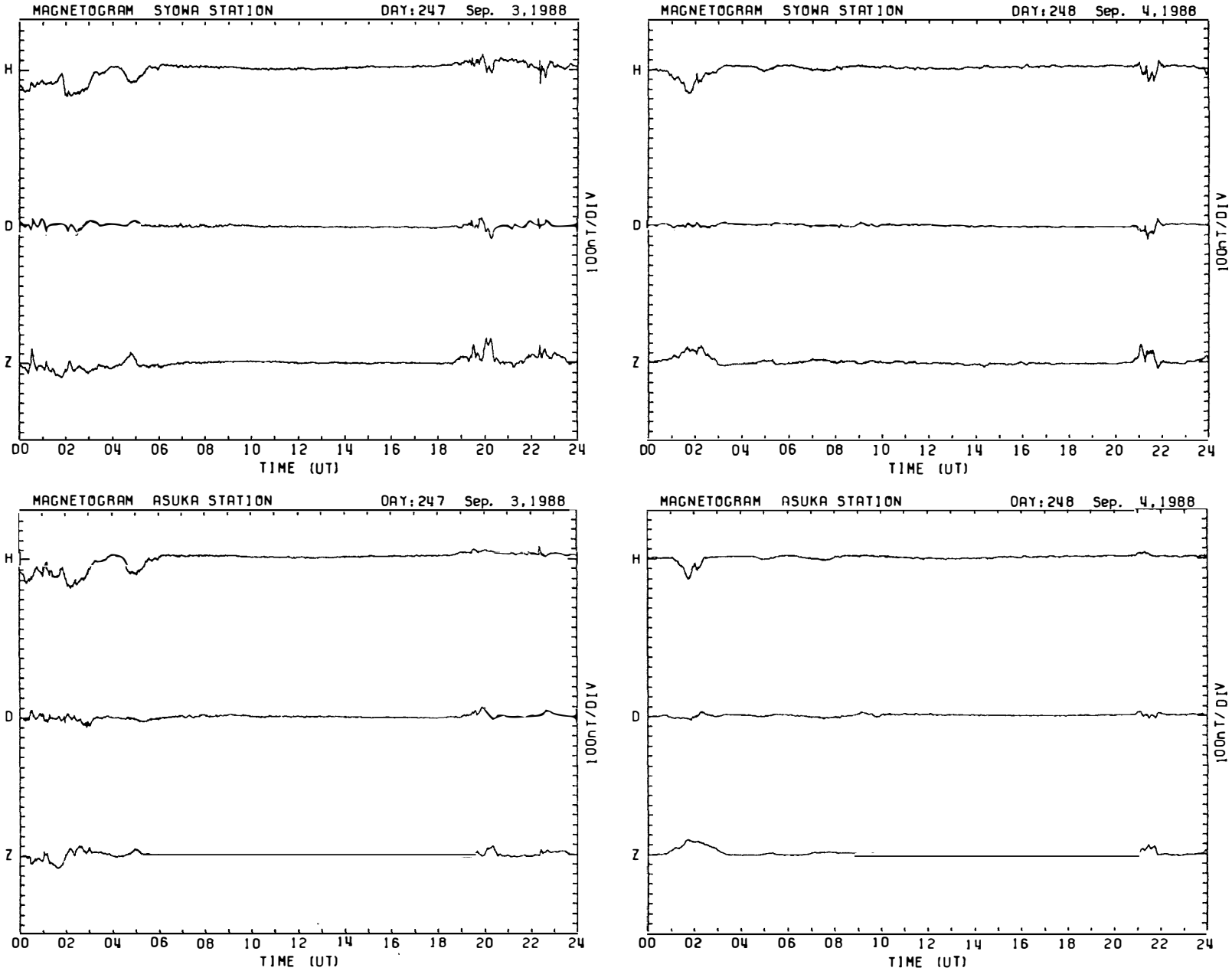
MAGNETOGRAM SYOWA STATION DAY:247 Sep. 3,1988
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MAGNETOGRAM ASUKA STATION DAY:247 Sep. 3,1988
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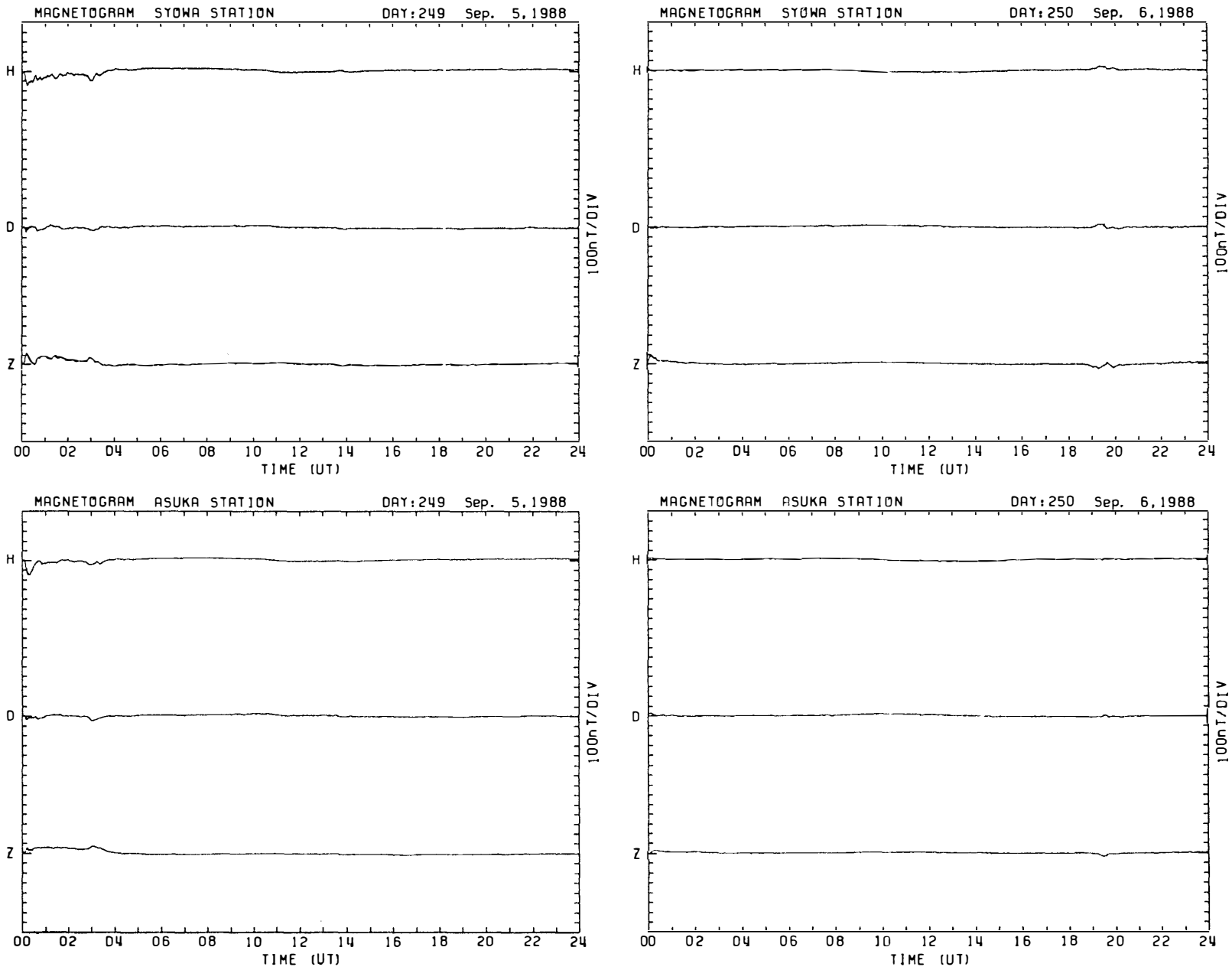
TIME (UT)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MAGNETOGRAM ASUKA STATION DAY:249 Sep. 5,1988
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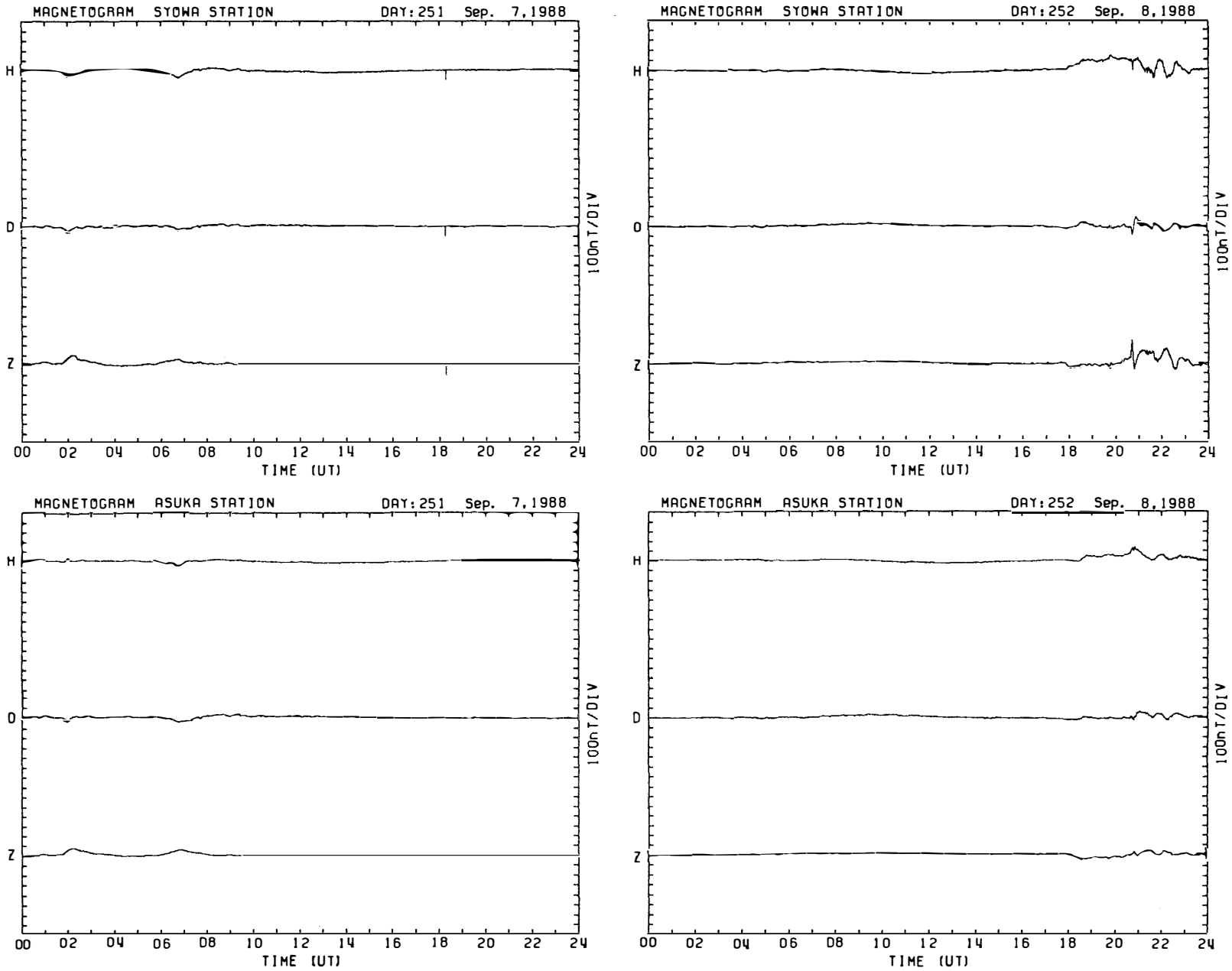
TIME (UT)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MAGNETOGRAM ASUKA STATION DAY:251 Sep. 7,1988
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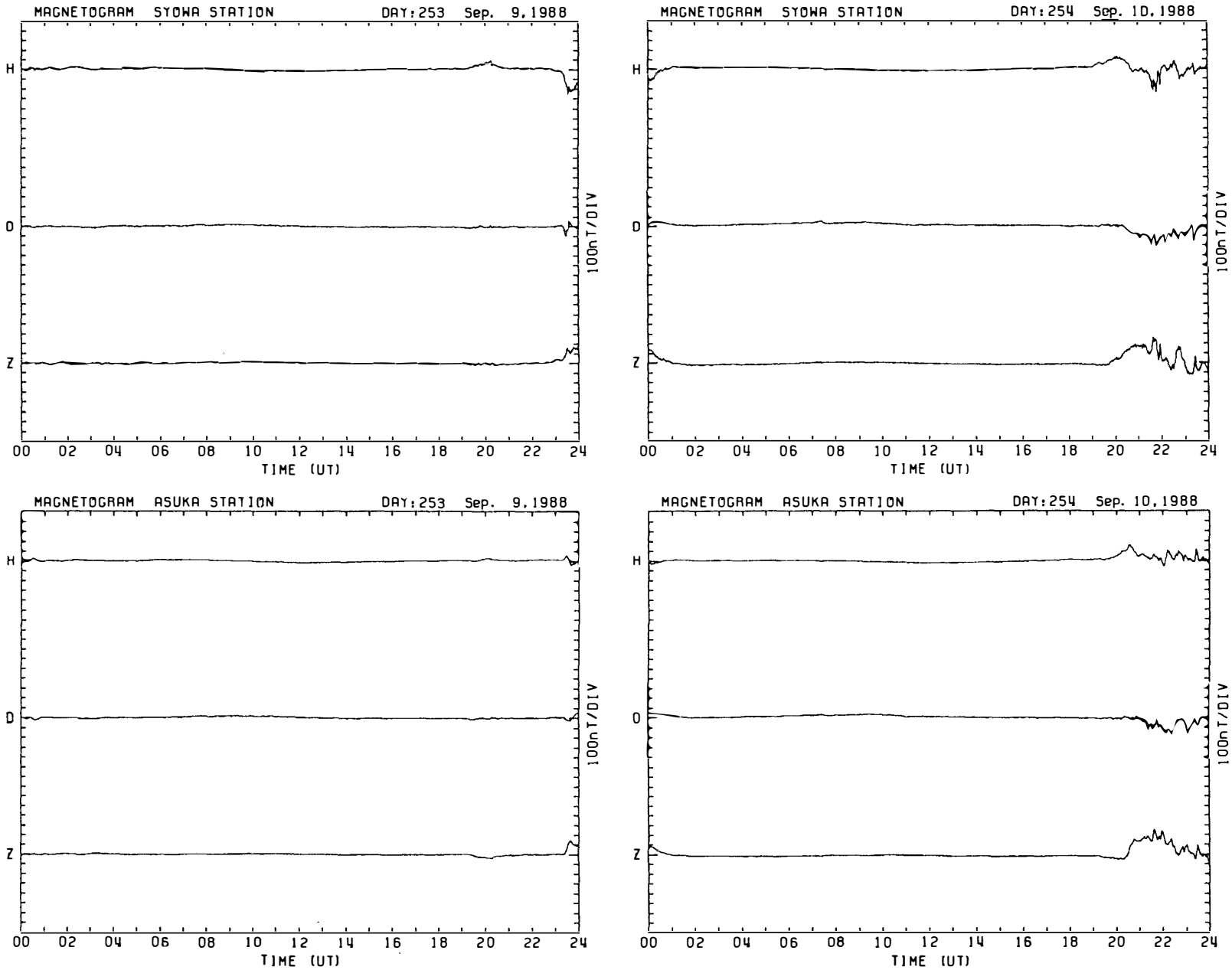
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MAGNETOGRAM ASUKA STATION DAY:253 Sep. 9,1988
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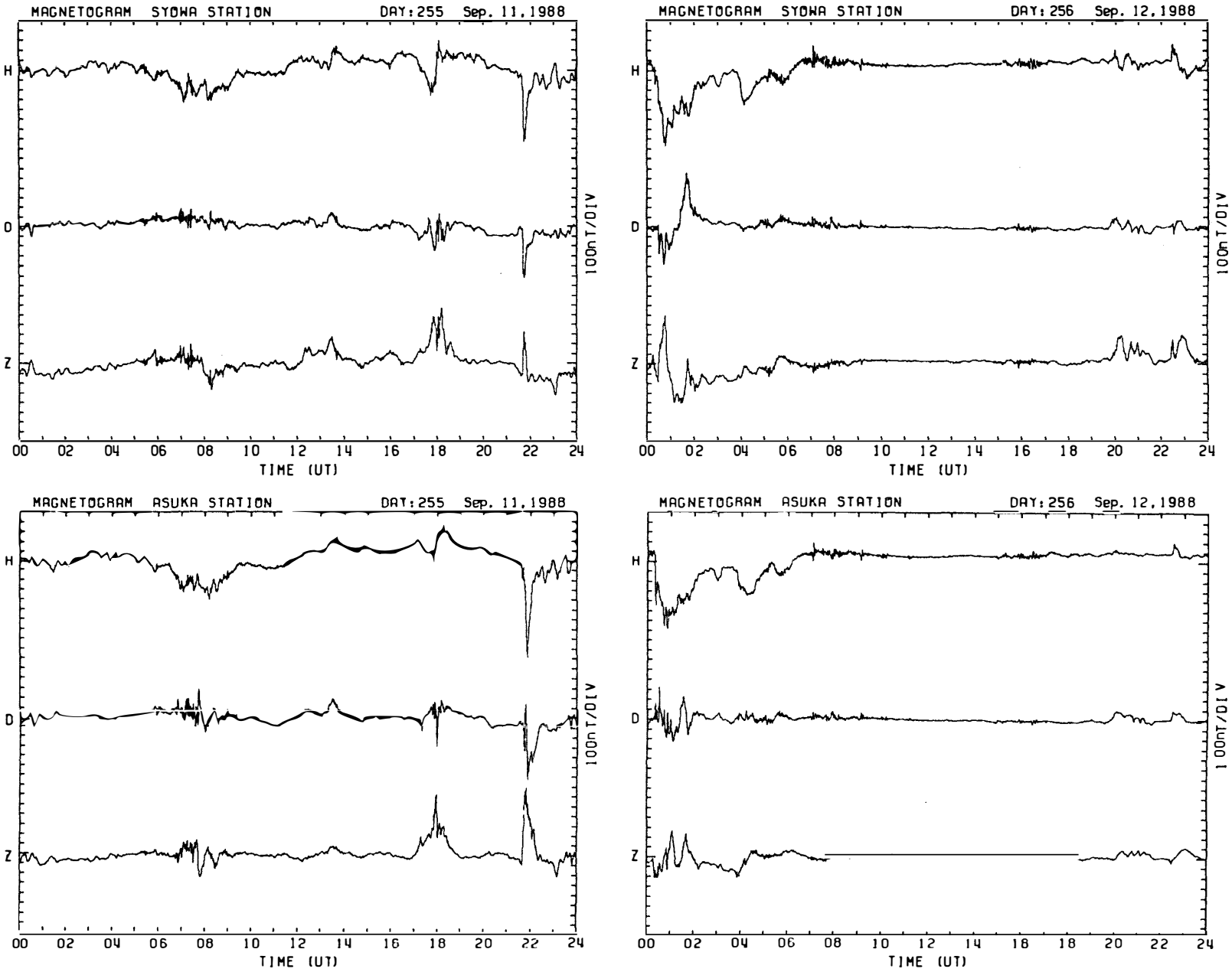
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MAGNETOGRAM ASUKA STATION DAY:255 Sep. 11,1988
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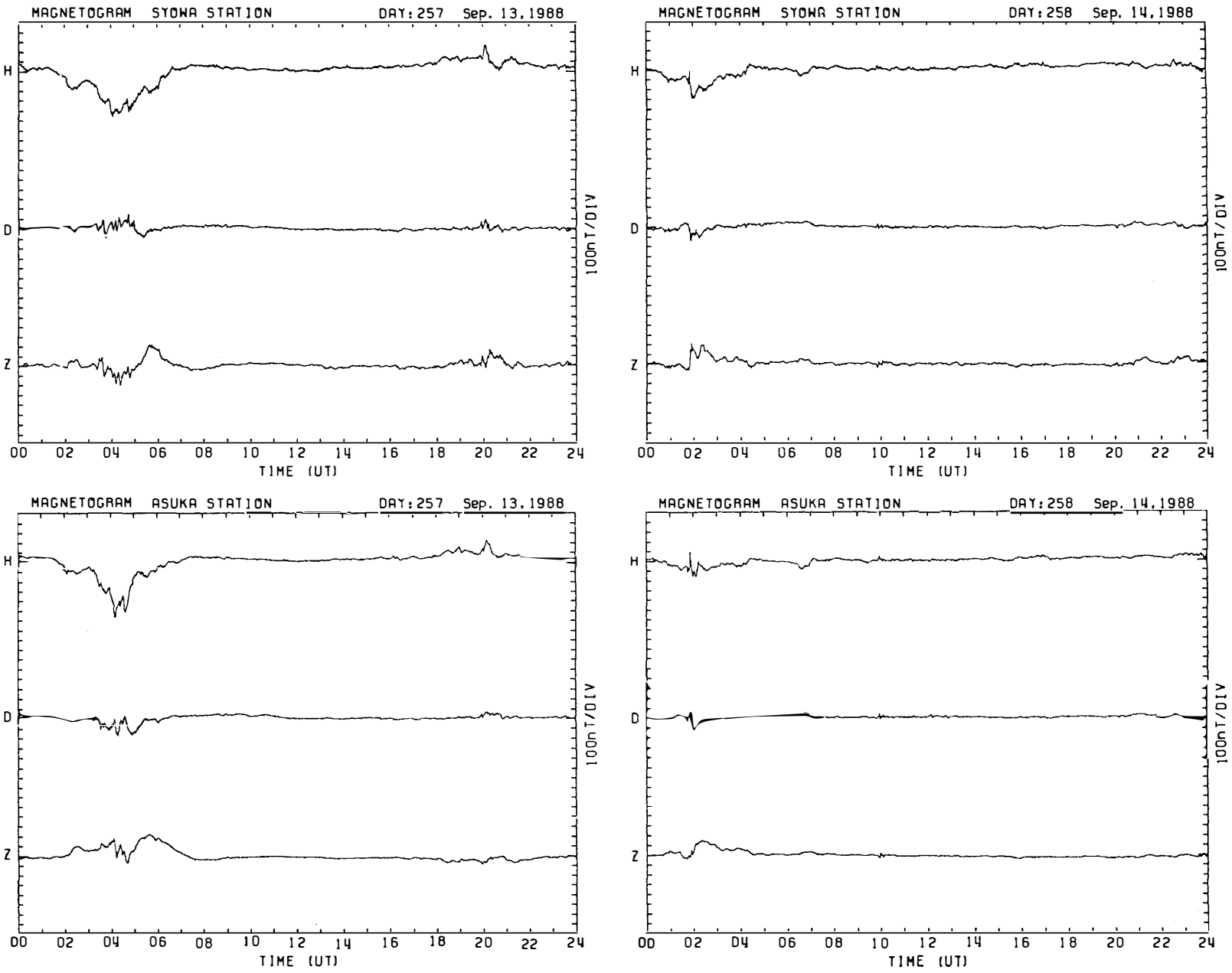
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MAGNETOGRAM ASUKA STATION DAY:257 Sep. 13,1988
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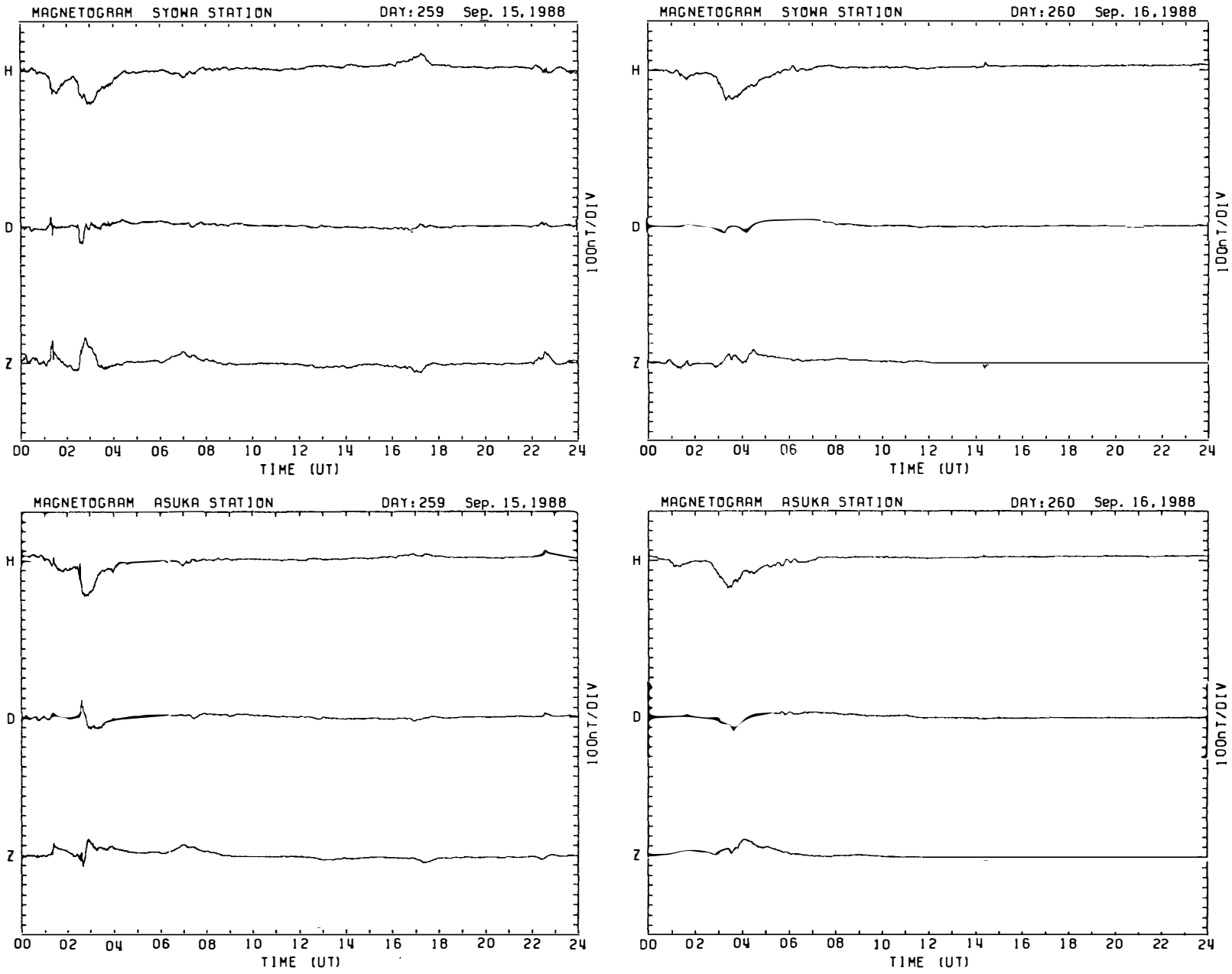
MAGNETOGRAM SYOWA STATION DAY:259 Sep. 15,1988
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MAGNETOGRAM ASUKA STATION DAY:259 Sep. 15,1988
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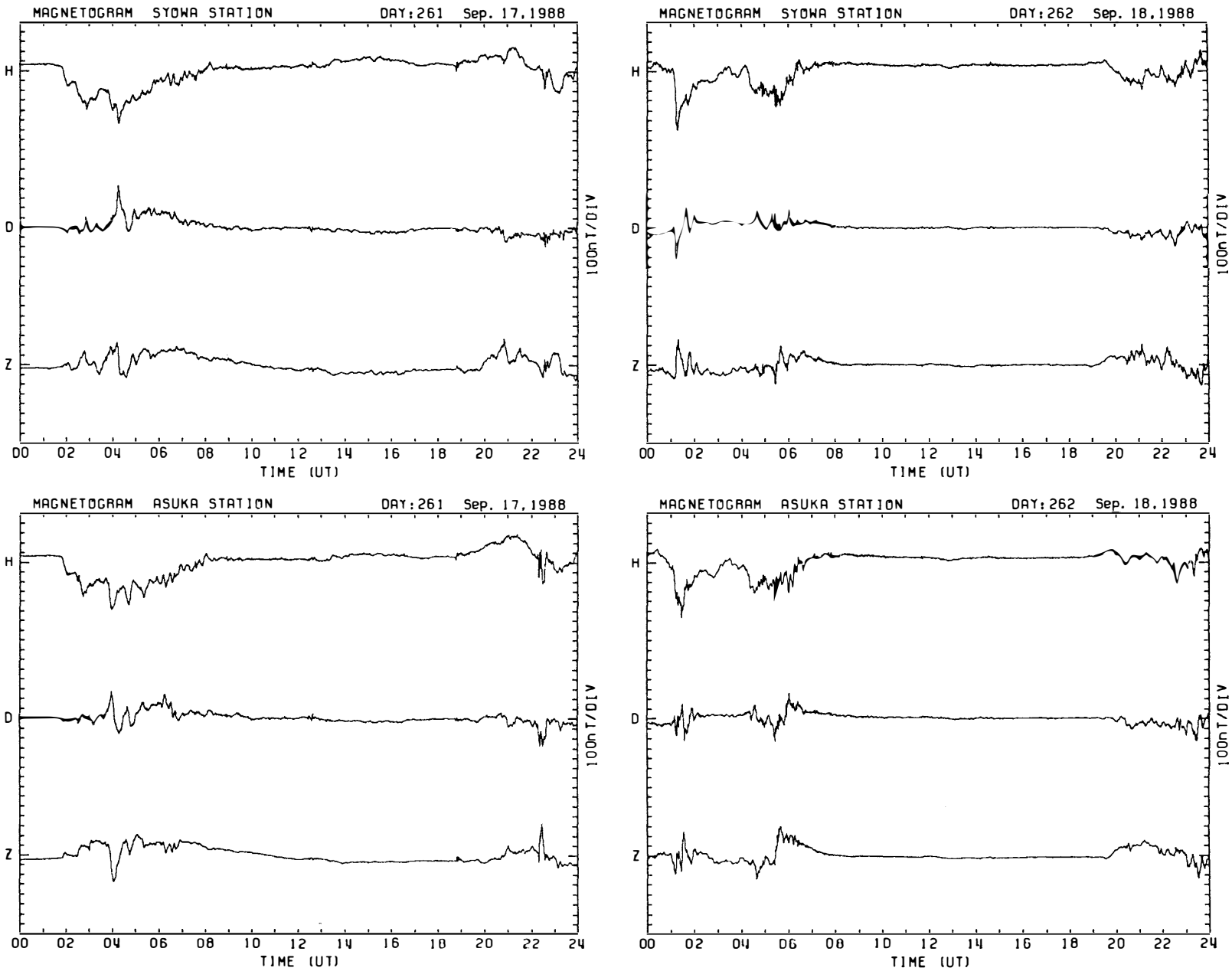
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MAGNETOGRAM ASUKA STATION DAY:261 Sep. 17,1988
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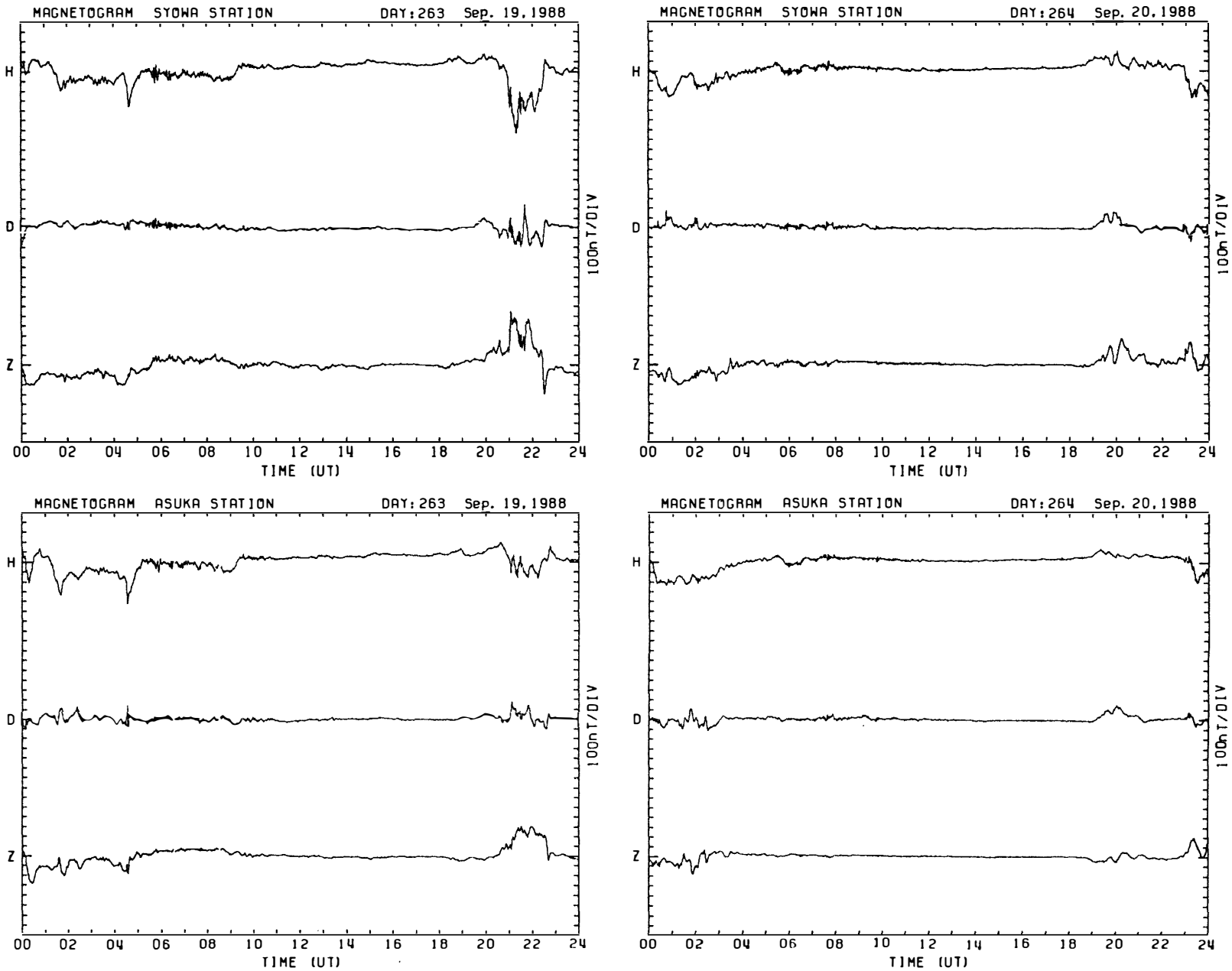
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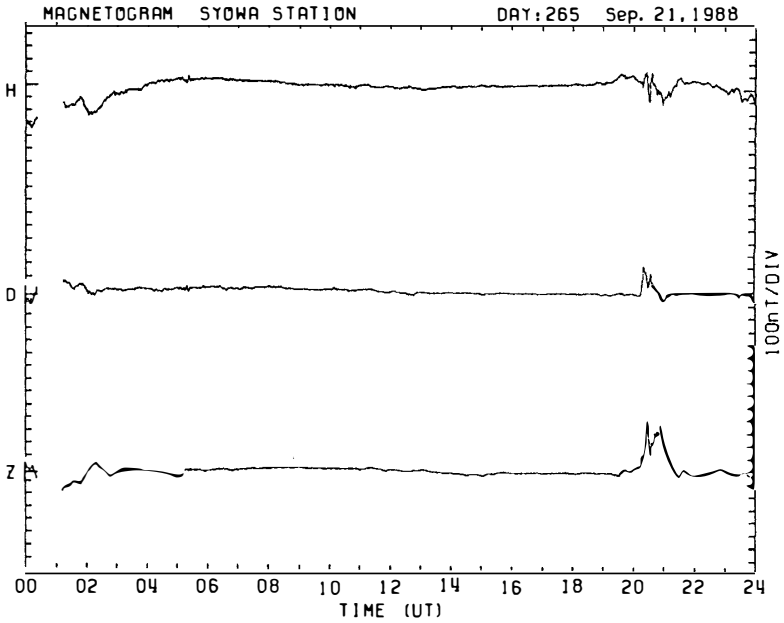
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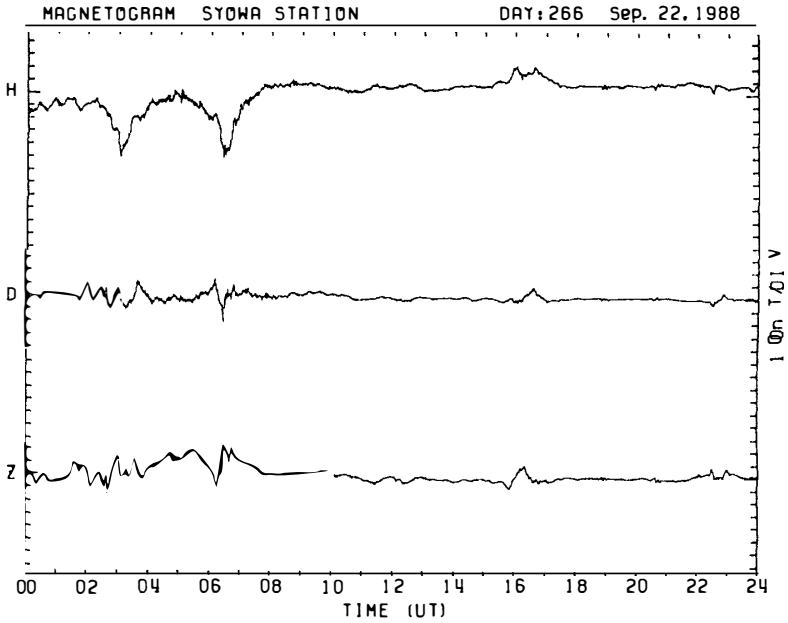
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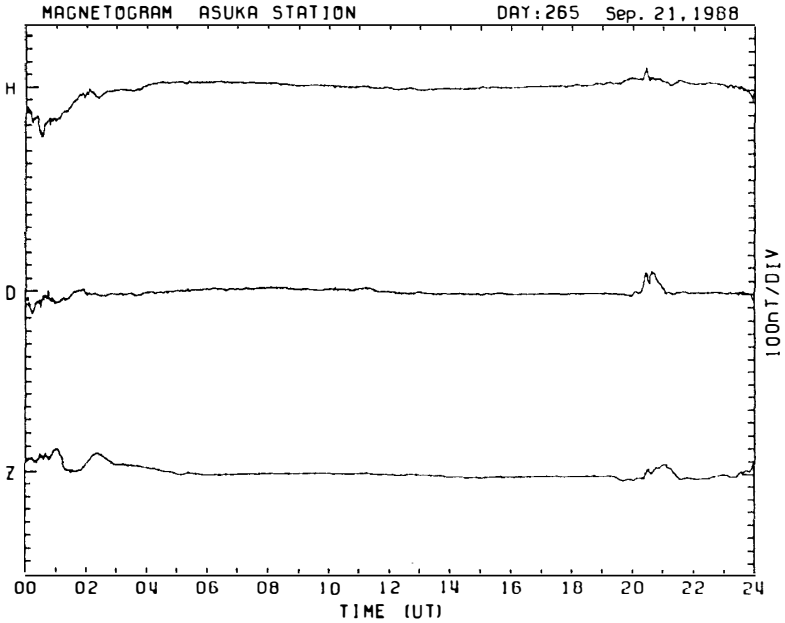
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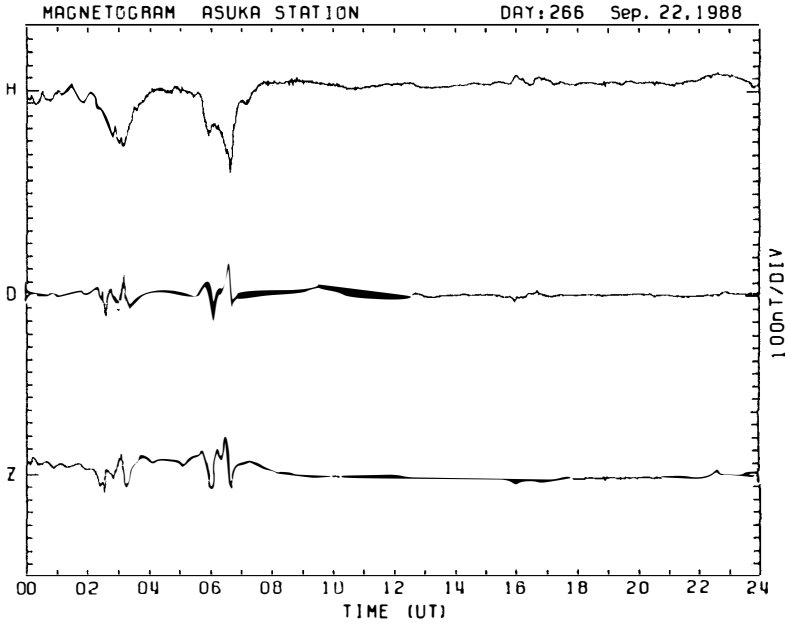
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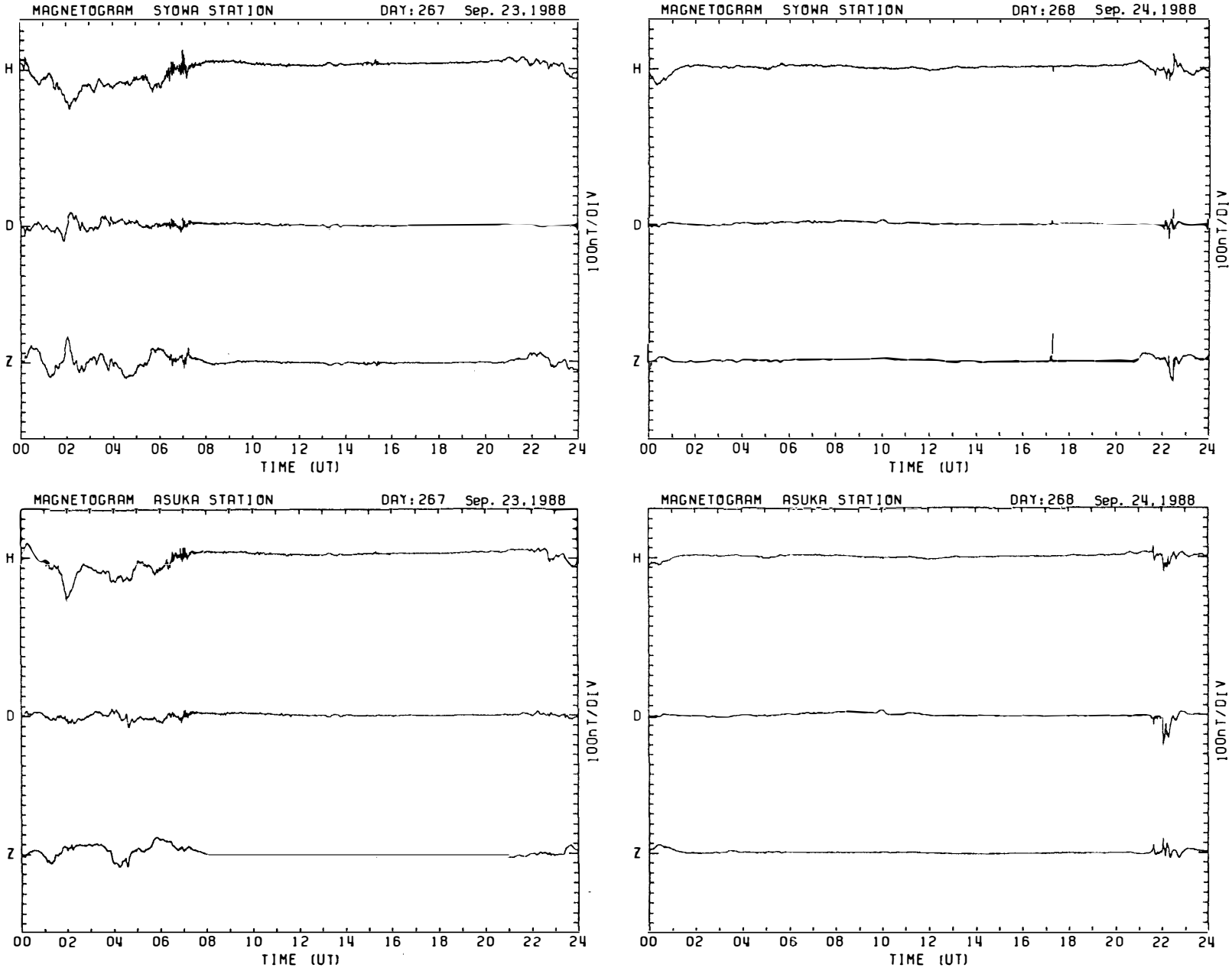
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MAGNETOGRAM ASUKA STATION DAY:267 Sep. 23,1988
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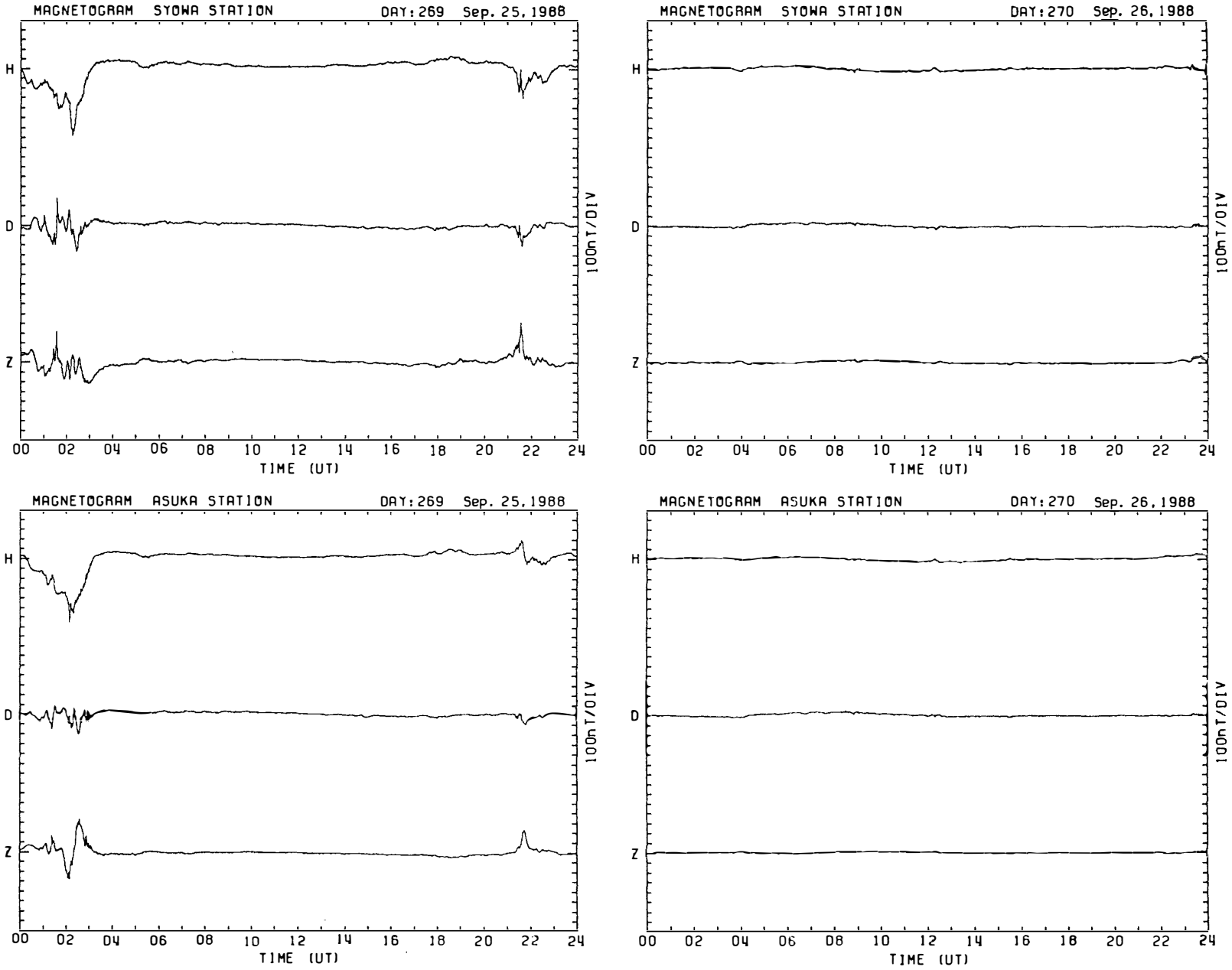
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MAGNETOGRAM SYOWA STATION DAY:270 Sep. 26, 1988
MAGNETOGRAM ASUKA STATION DAY:269 Sep. 25, 1988
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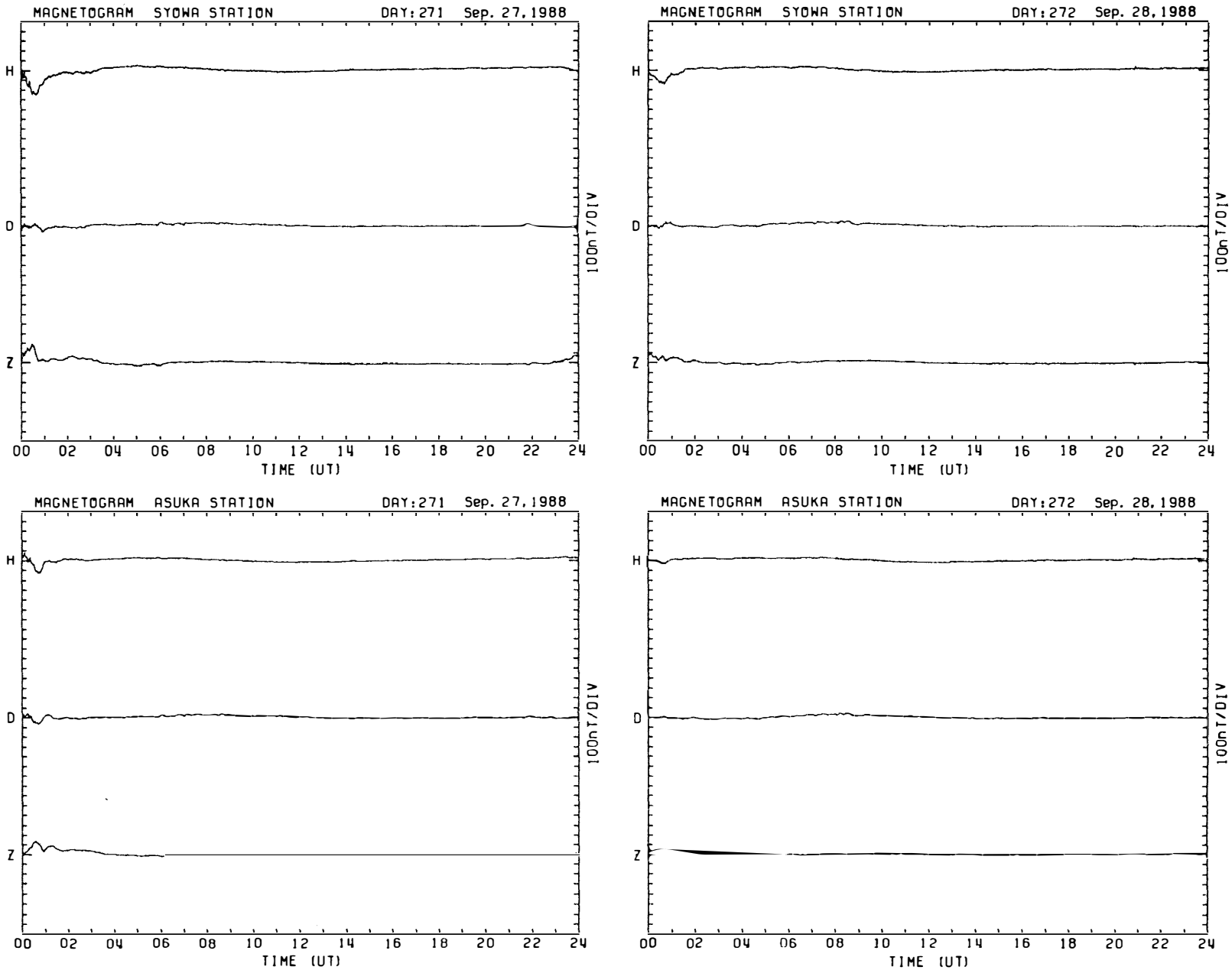
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MAGNETOGRAM SYOWA STATION DAY:272 Sep. 28,1988
MAGNETOGRAM ASUKA STATION DAY:271 Sep. 27,1988
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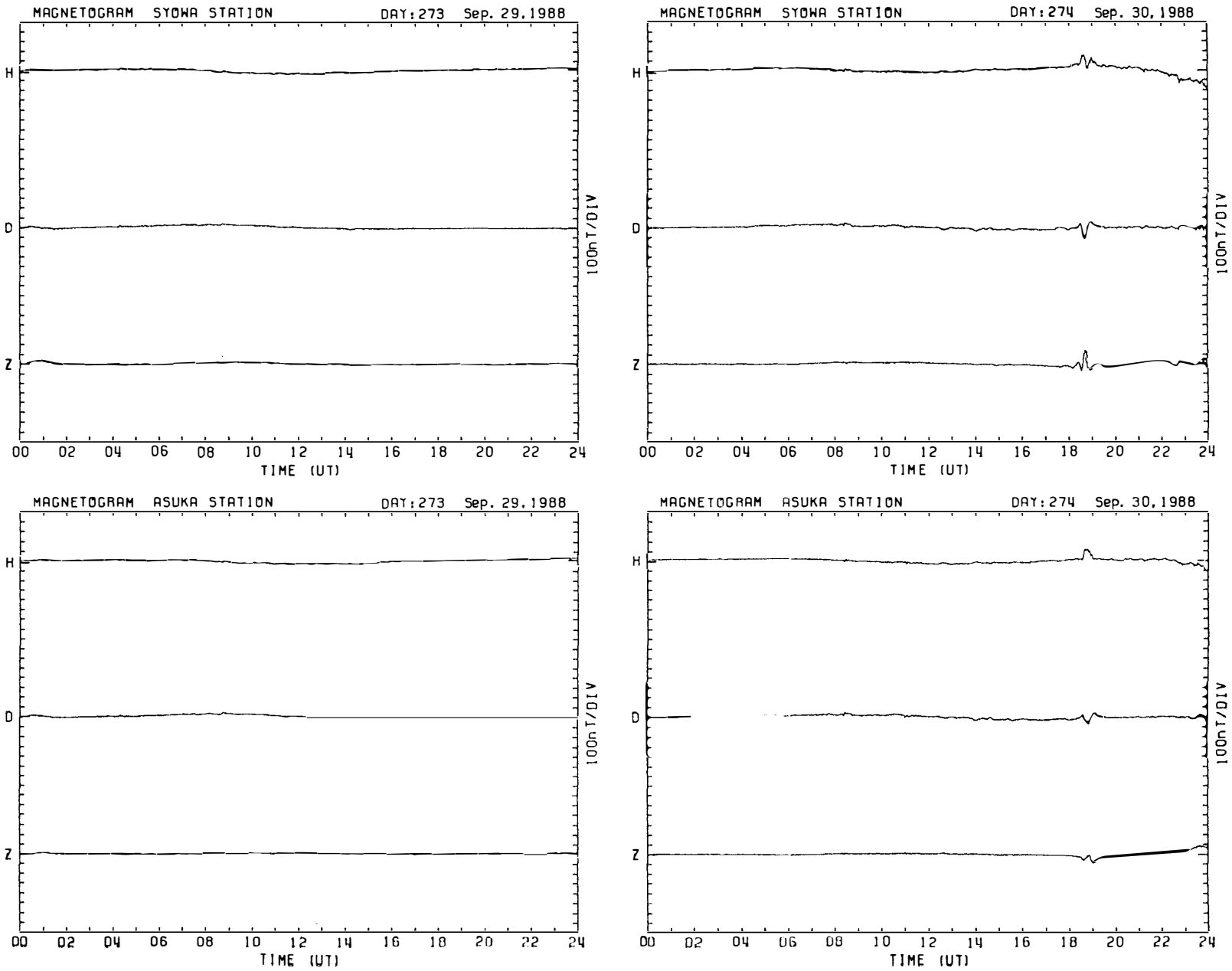
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MAGNETOGRAM SYOWA STATION DAY:274 Sep. 30,1988
MAGNETOGRAM ASUKA STATION DAY:273 Sep. 29,1988
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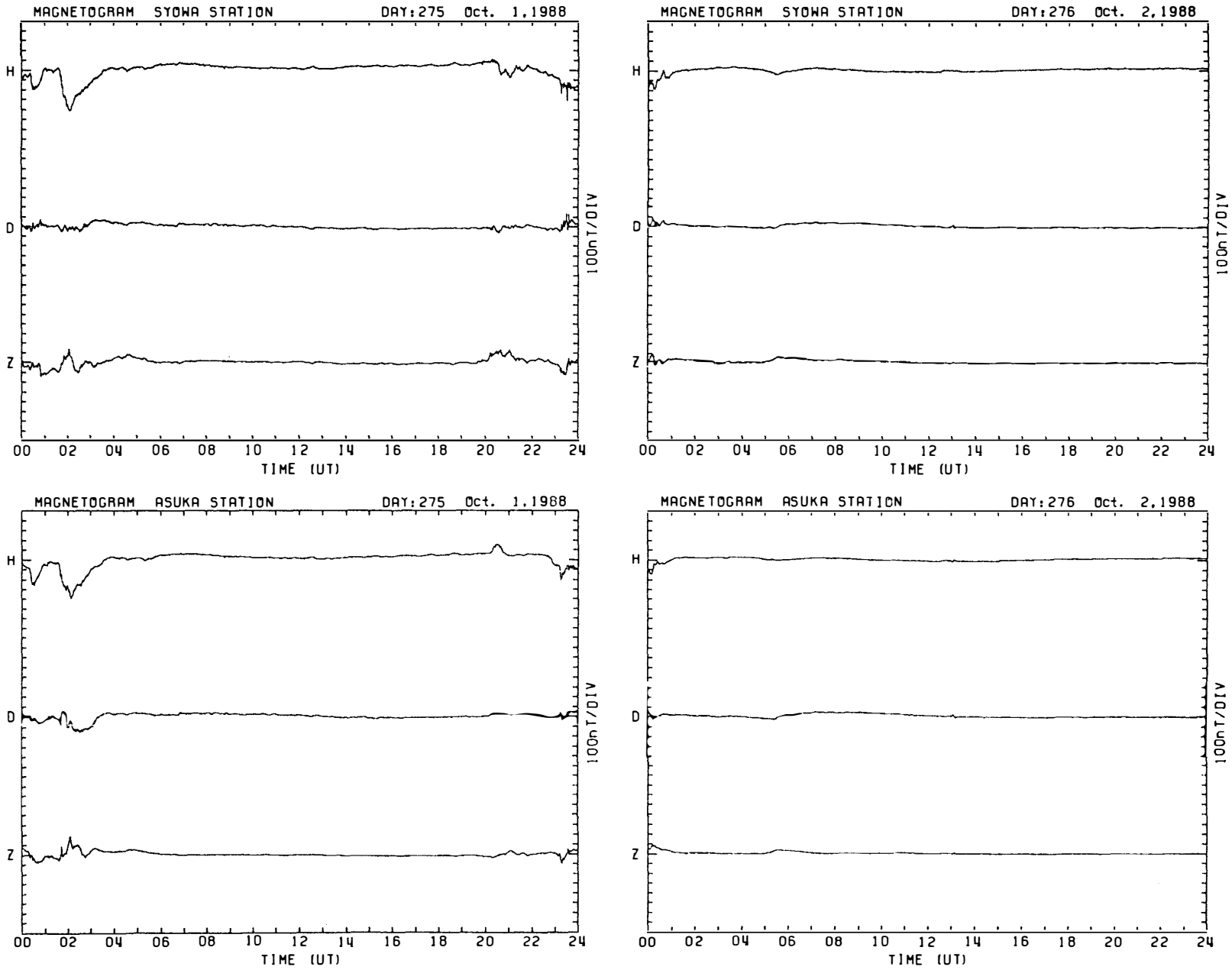
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MAGNETOGRAM SYOWA STATION DAY:276 Oct. 2,1988
MAGNETOGRAM ASUKA STATION DAY:275 Oct. 1,1988
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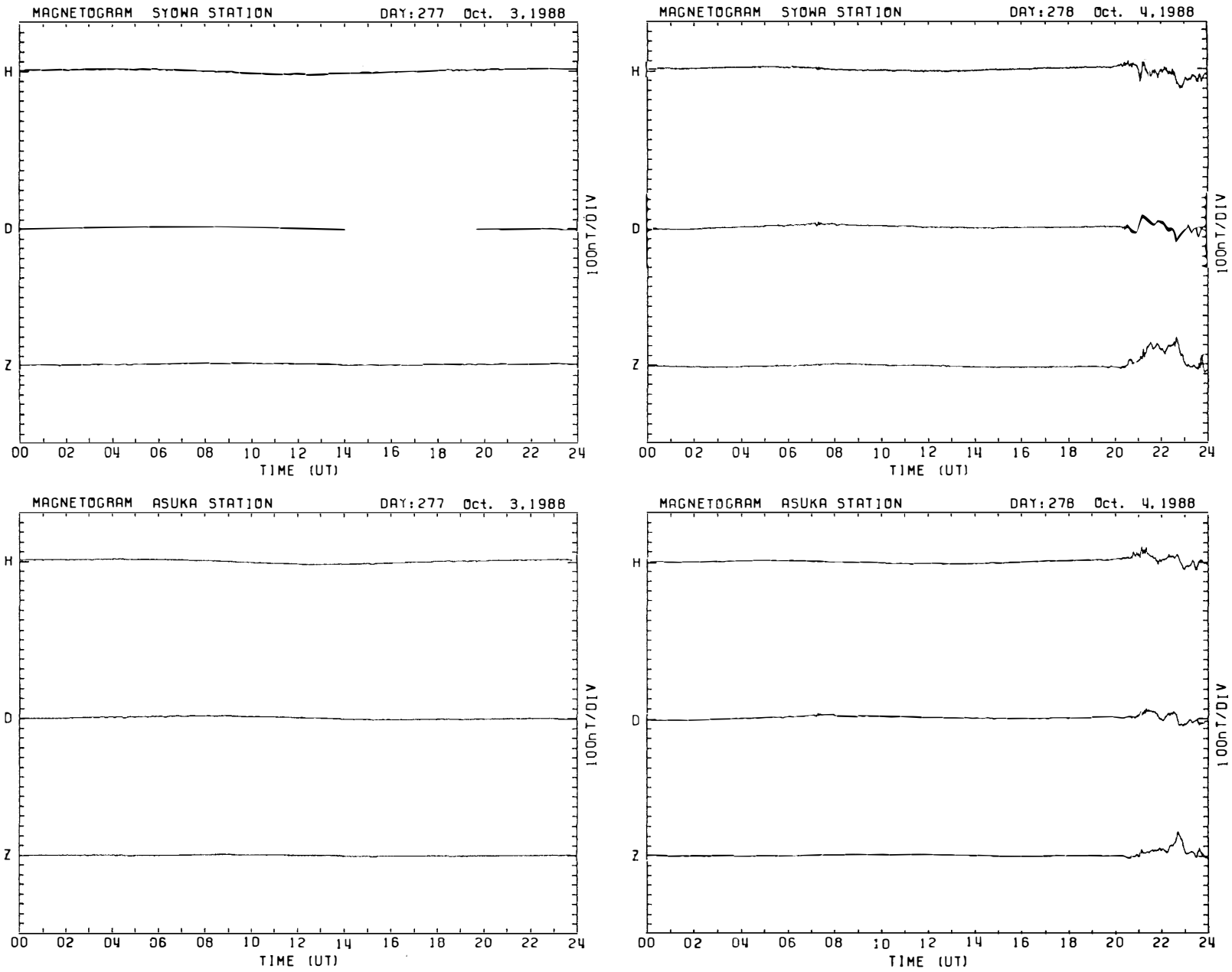
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MAGNETOGRAM SYOWA STATION
DAY:278 Oct. 4,1988
MAGNETOGRAM ASUKA STATION
DAY:277 Oct. 3,1988
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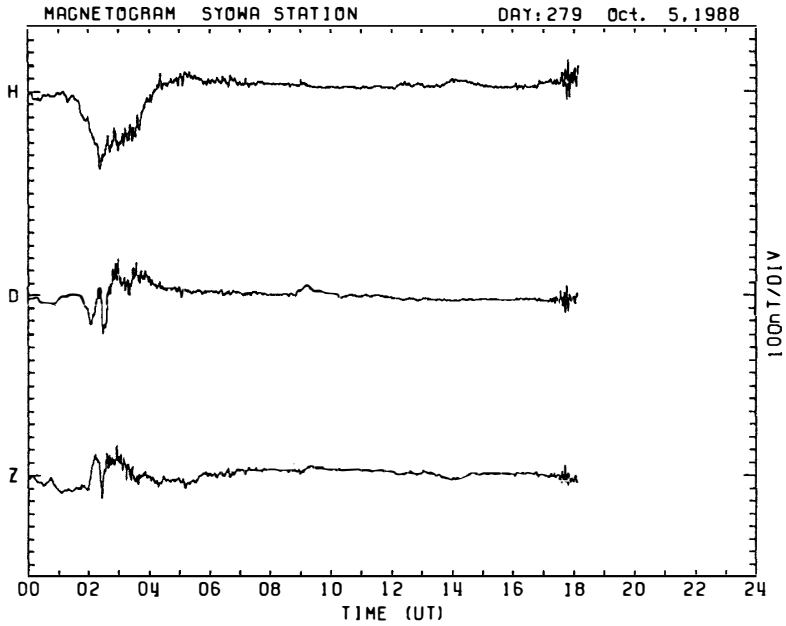
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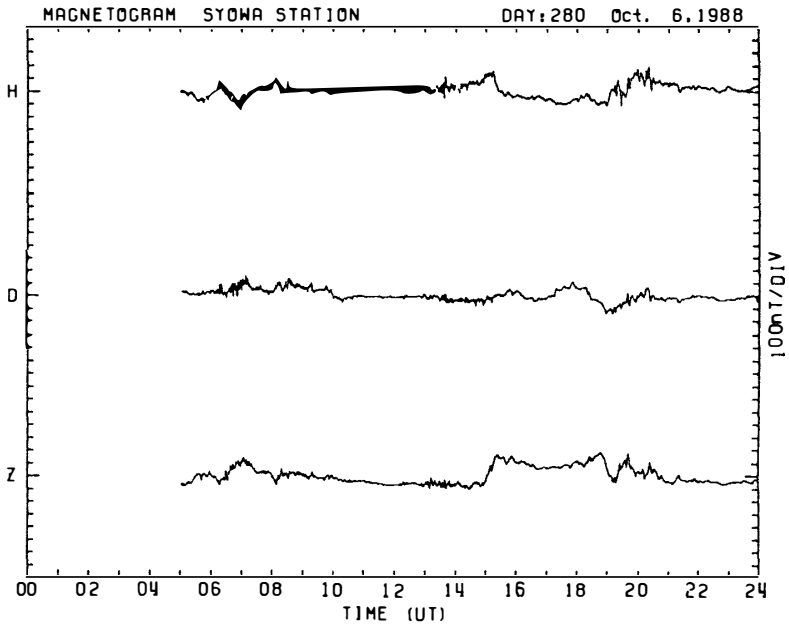
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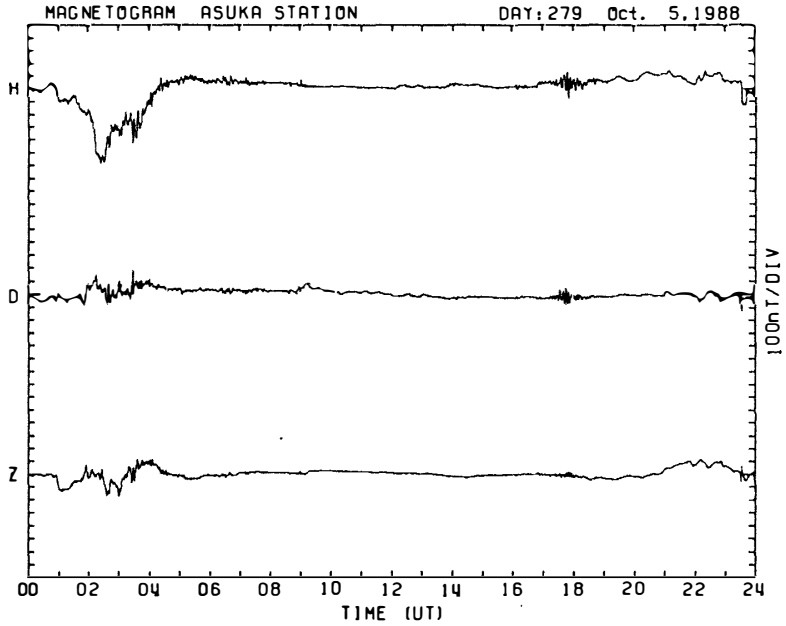
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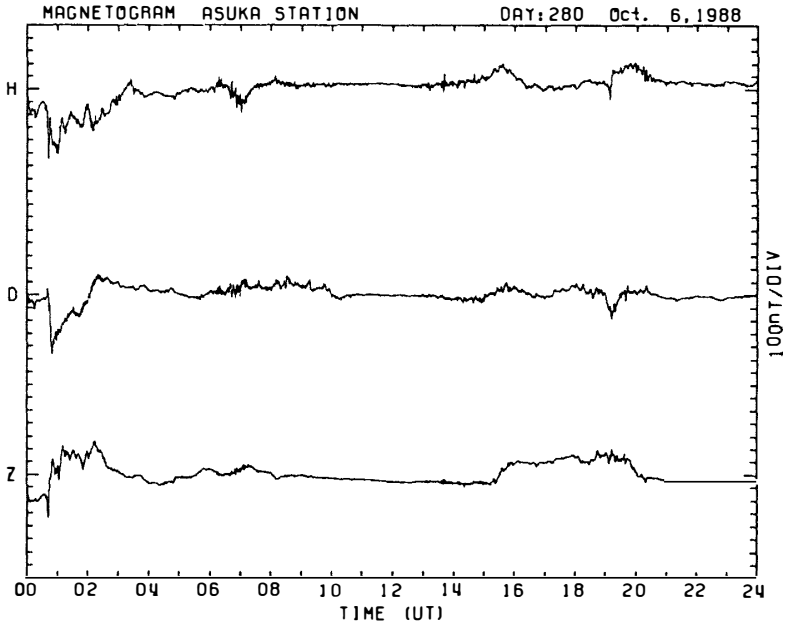
TIME (UT)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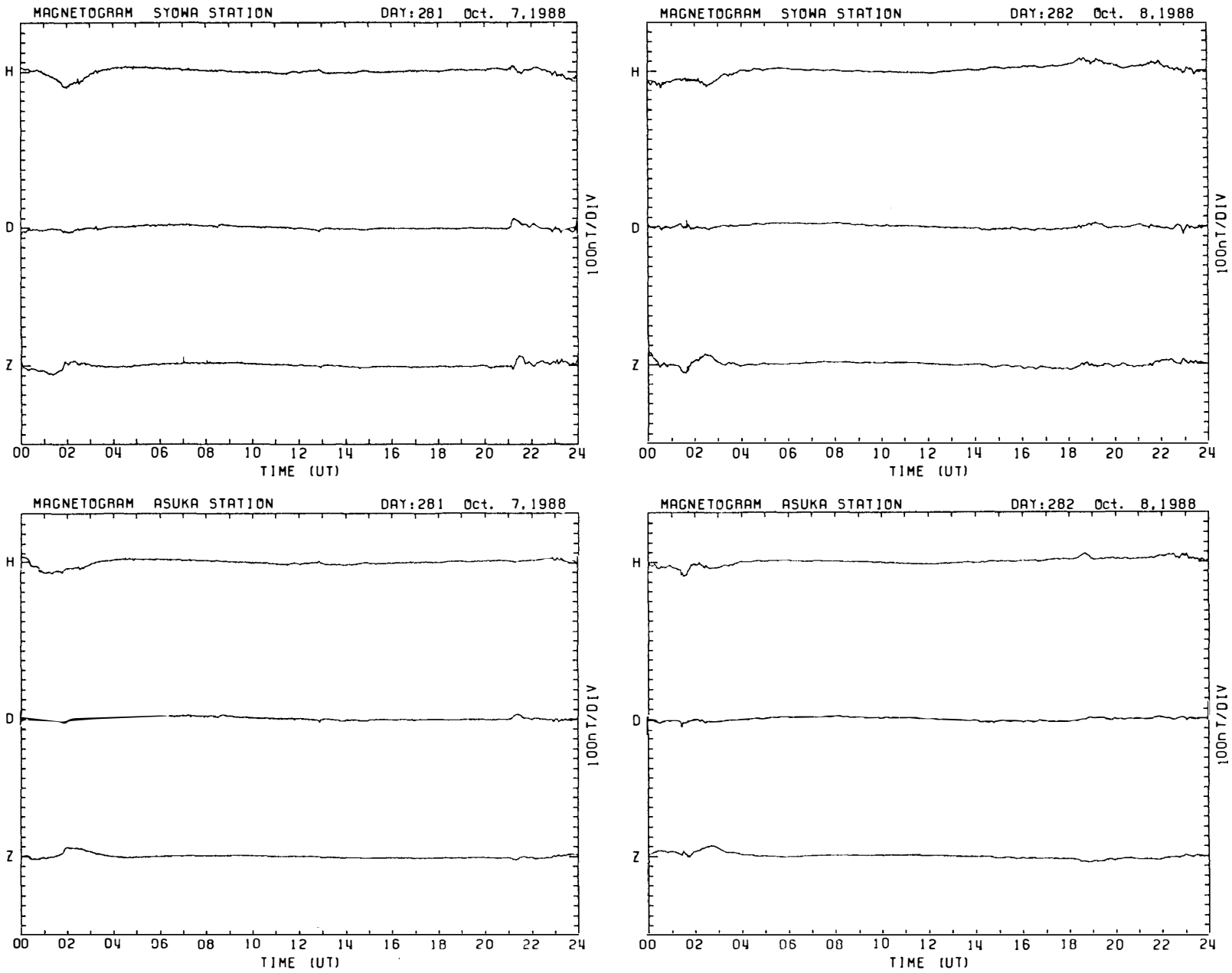
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MAGNETOGRAM ASUKA STATION DAY:281 Oct. 7,1988
MAGNETOGRAM ASUKA STATION DAY:282 Oct. 8,1988
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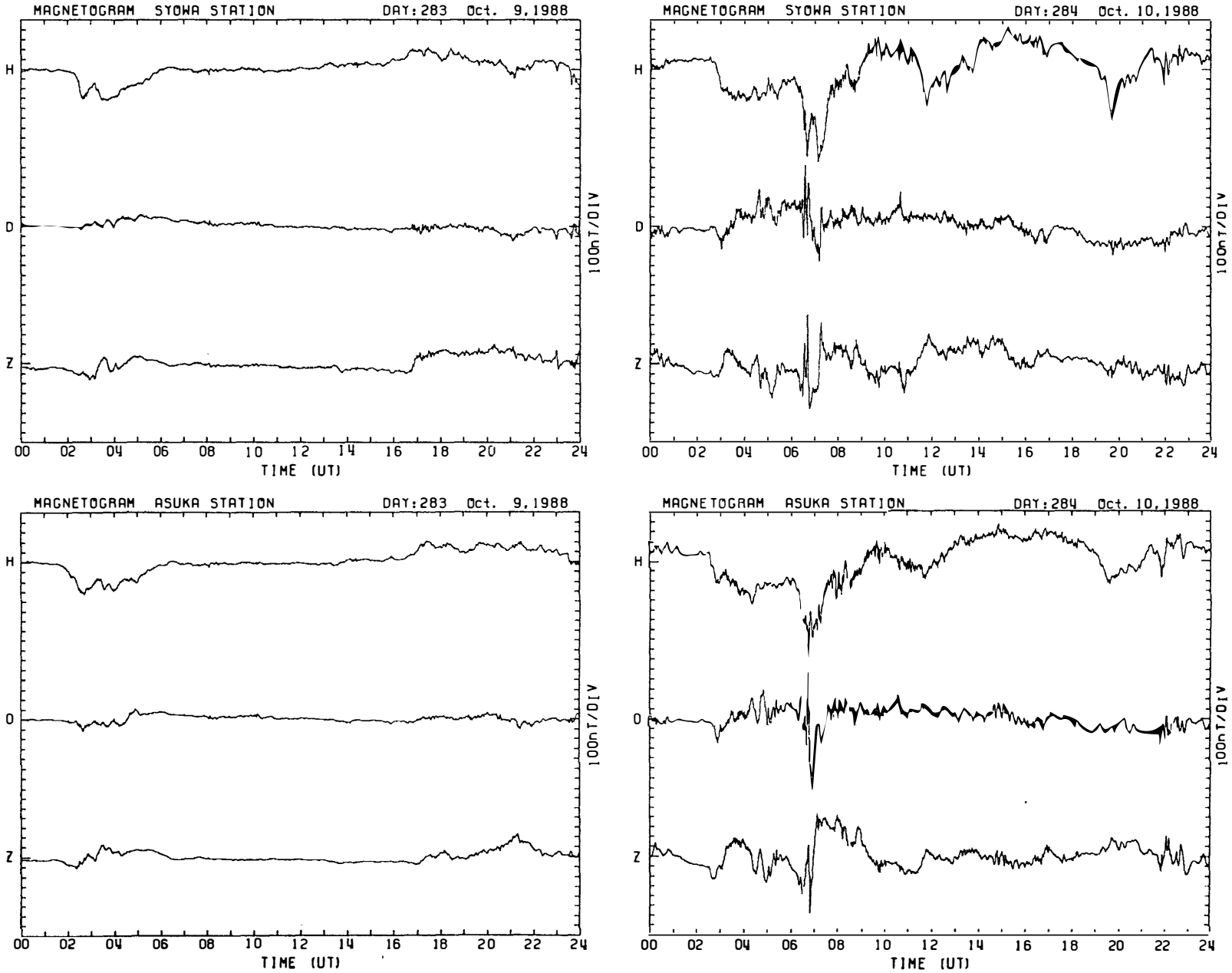
TIME (UT)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MAGNETOGRAM ASUKA STATION DAY:283 Oct. 9,1988
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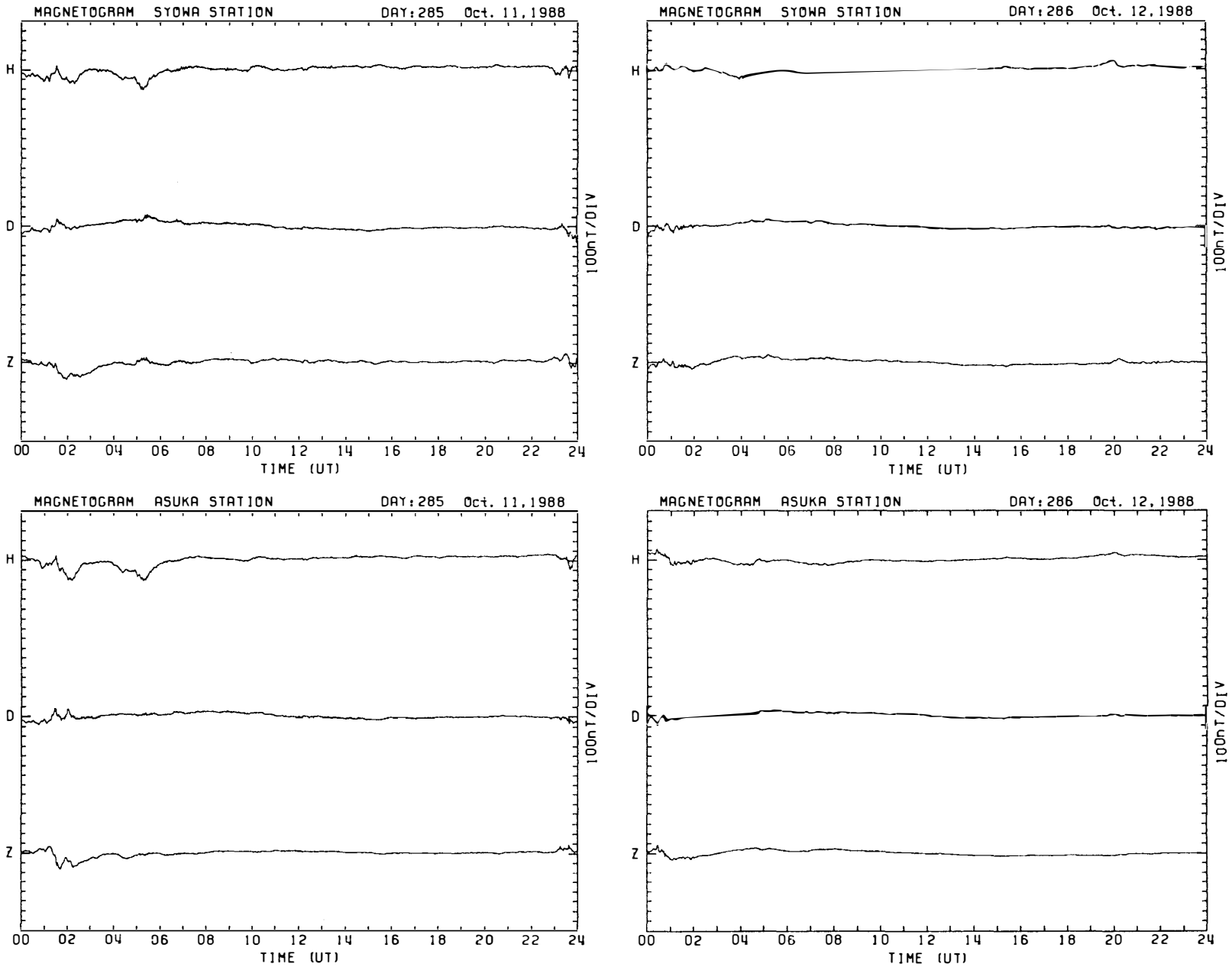
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MAGNETOGRAM ASUKA STATION DAY:285 Oct. 11,1988
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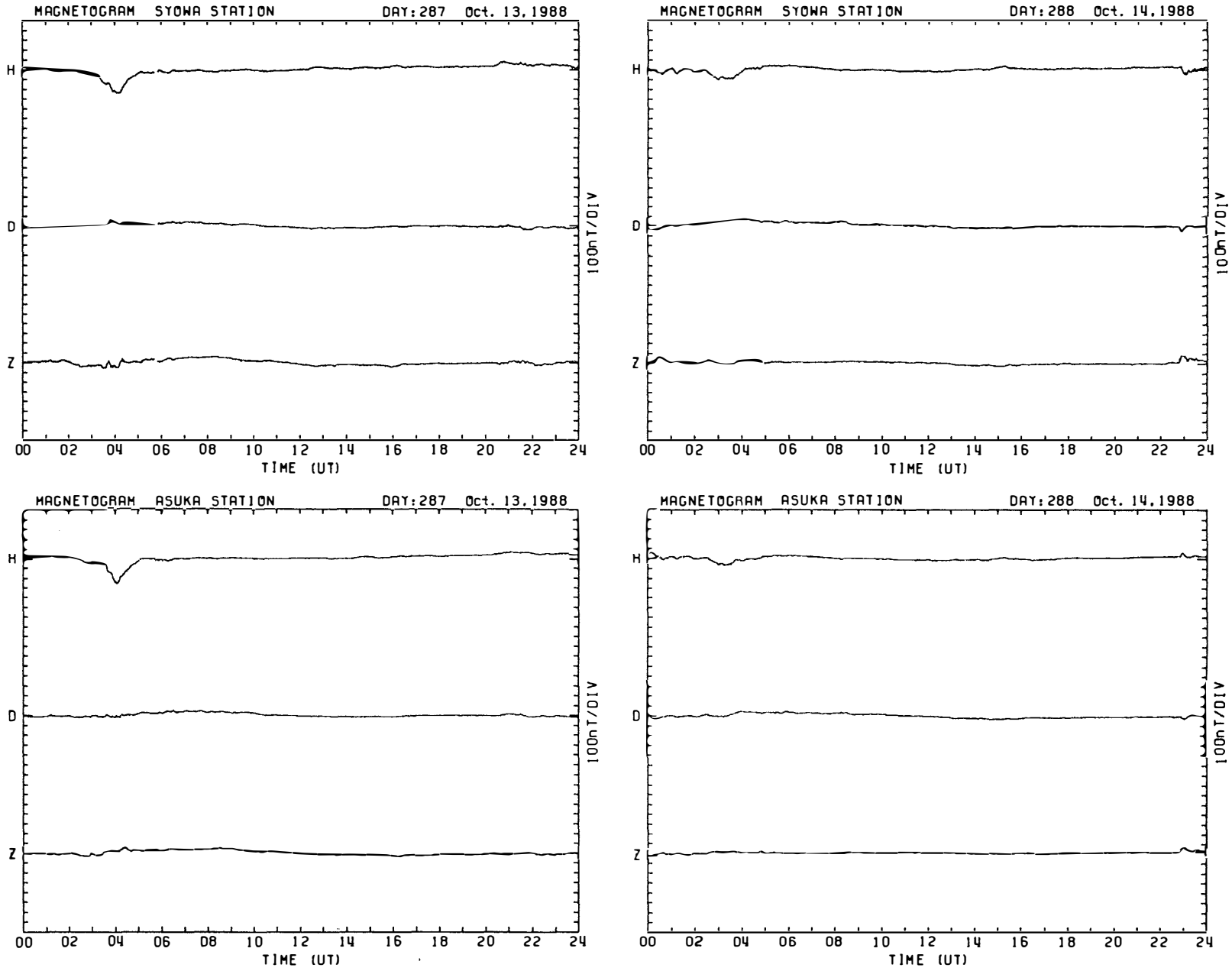
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MAGNETOGRAM ASUKA STATION DAY:287 Oct. 13,1988
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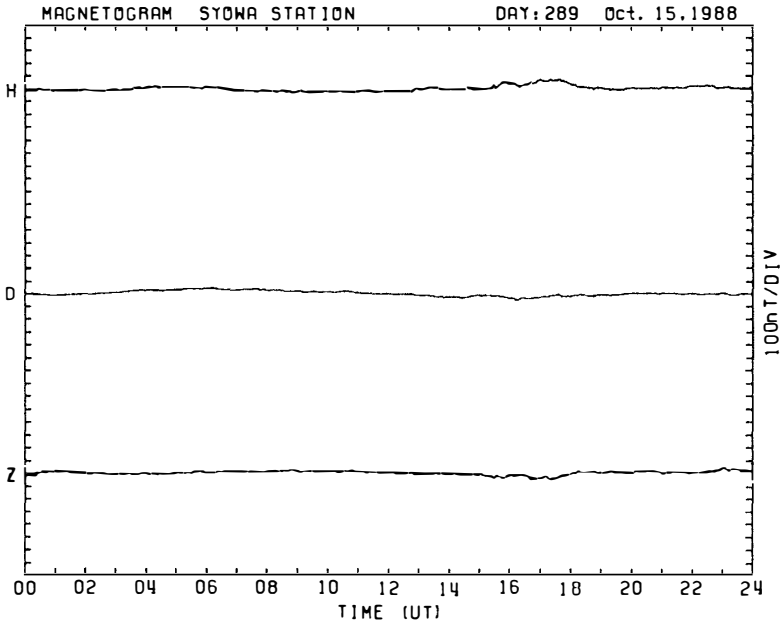
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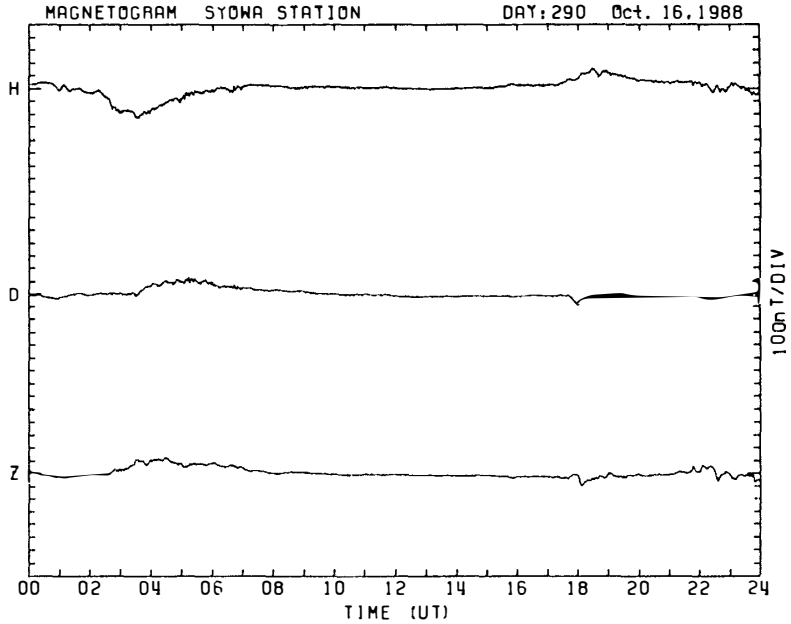
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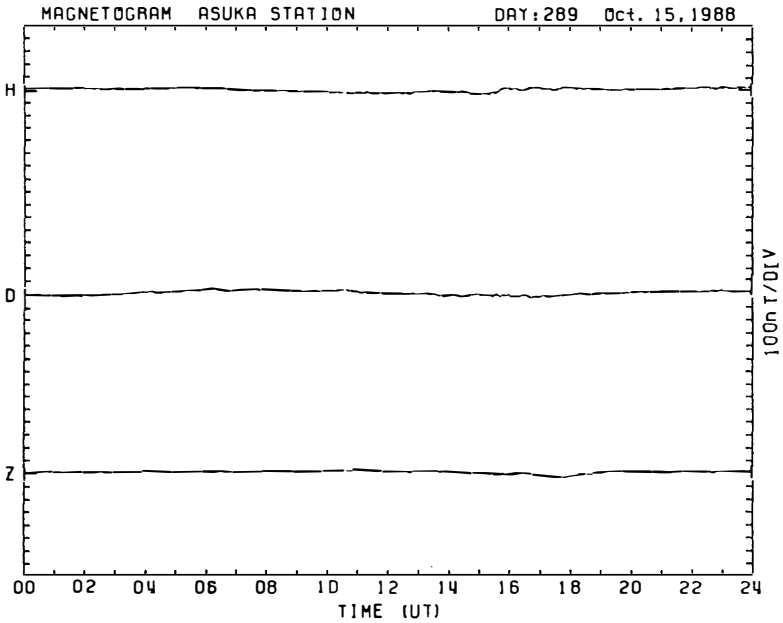
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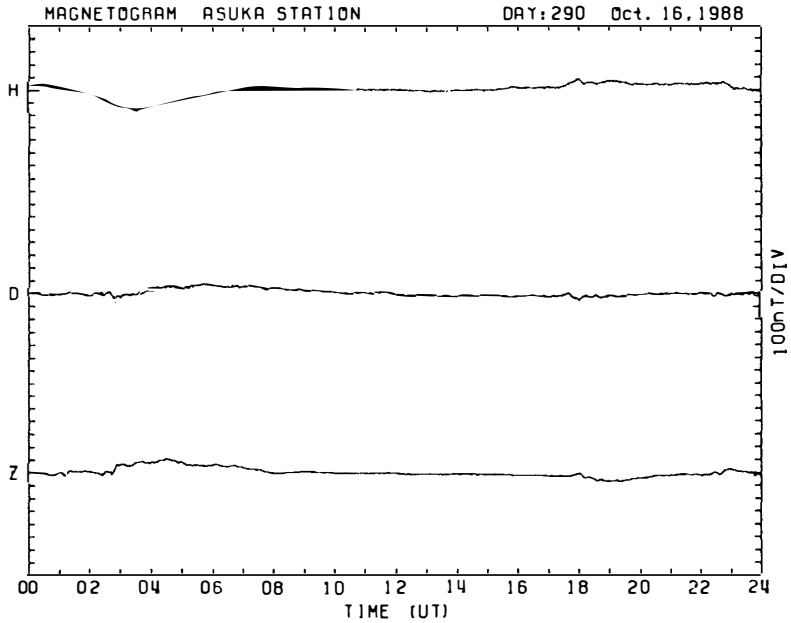
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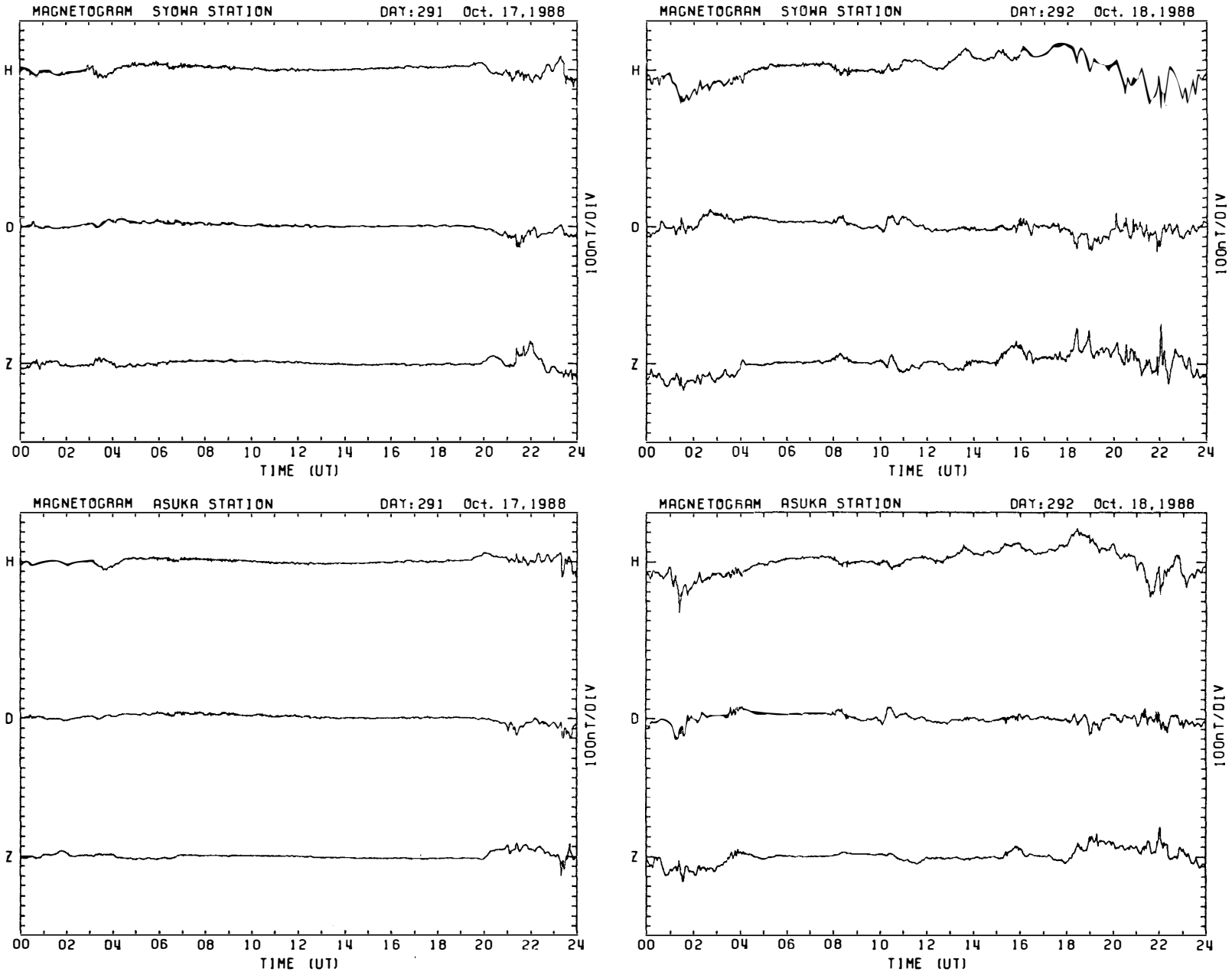
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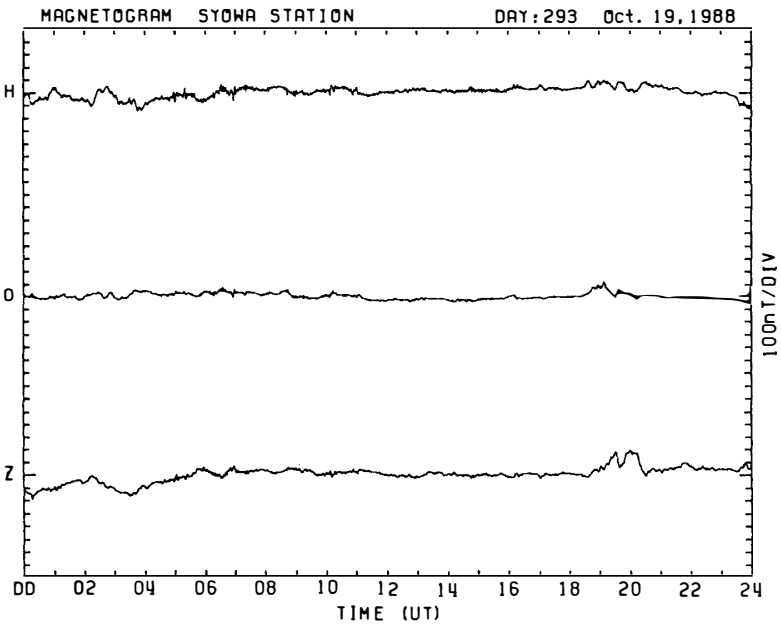
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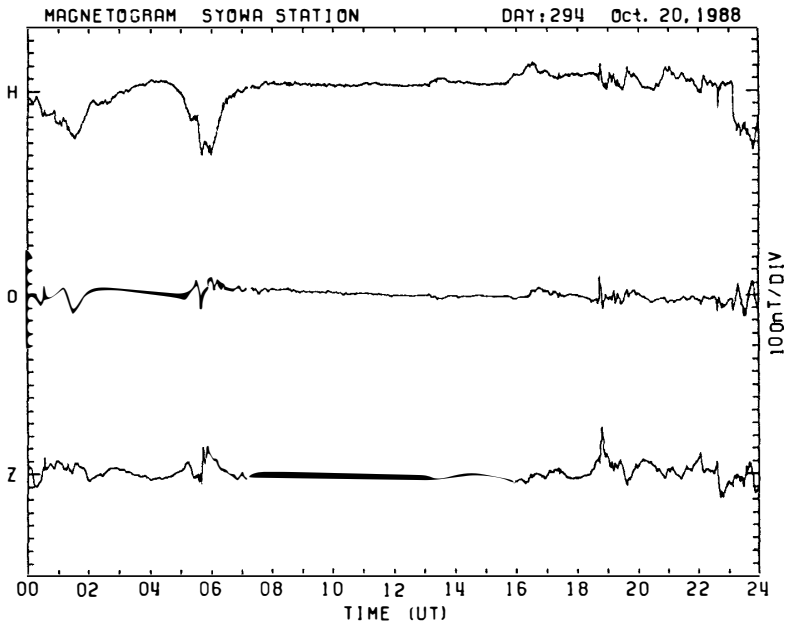
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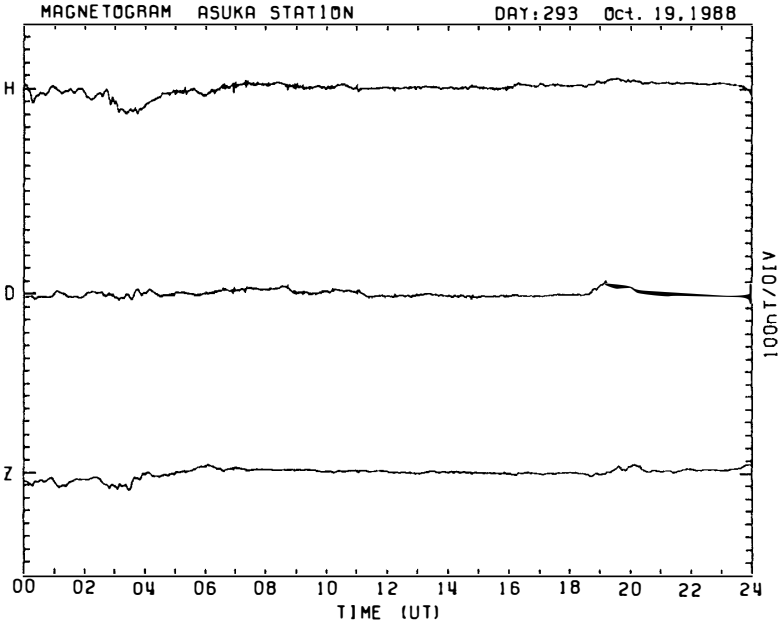
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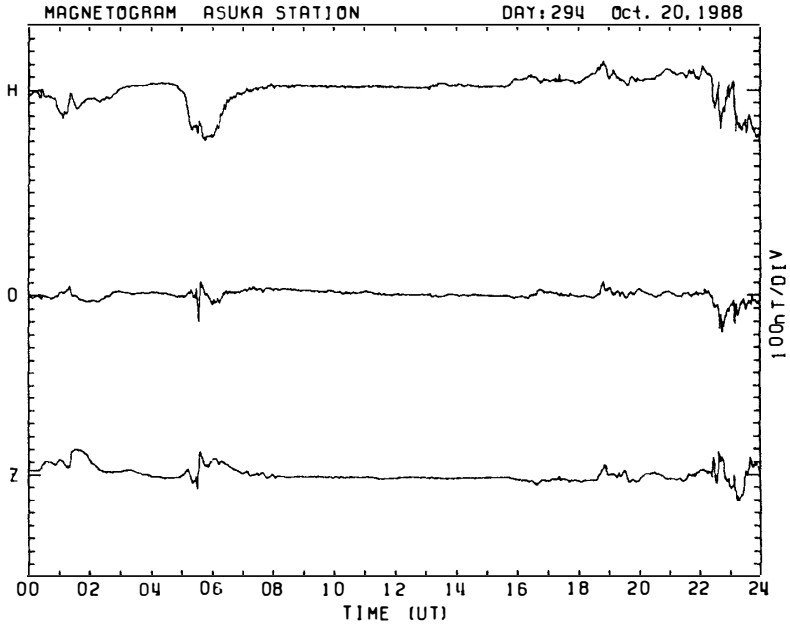
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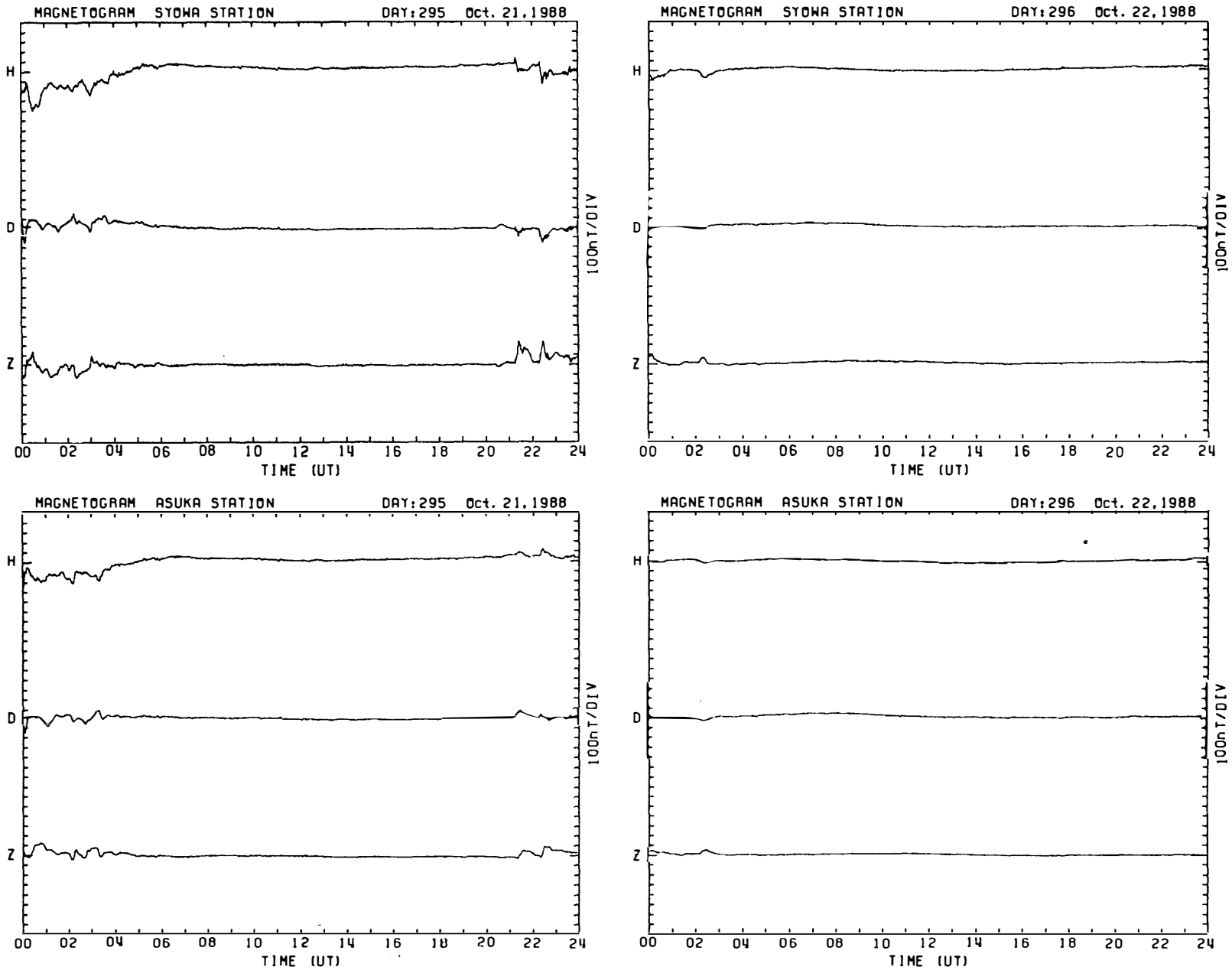
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MAGNETOGRAM ASUKA STATION DAY:295 Oct. 21,1988
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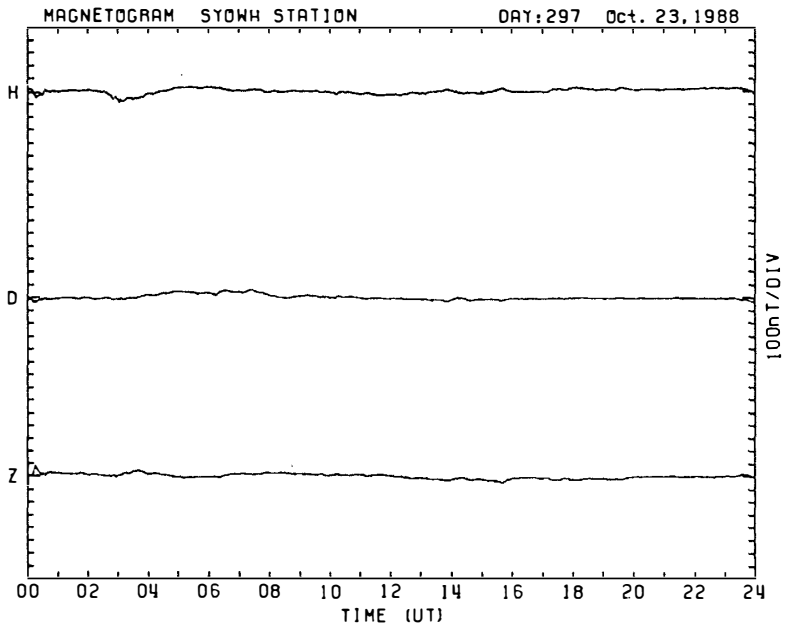
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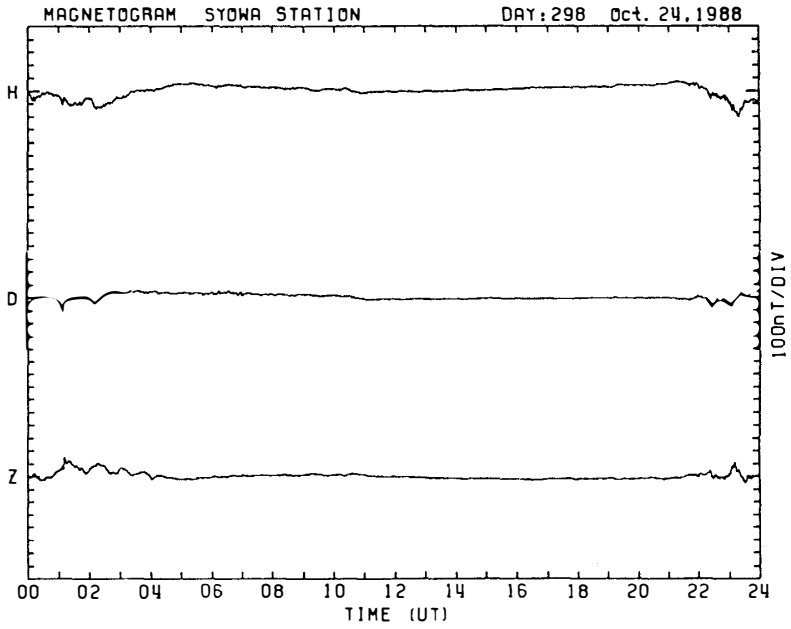
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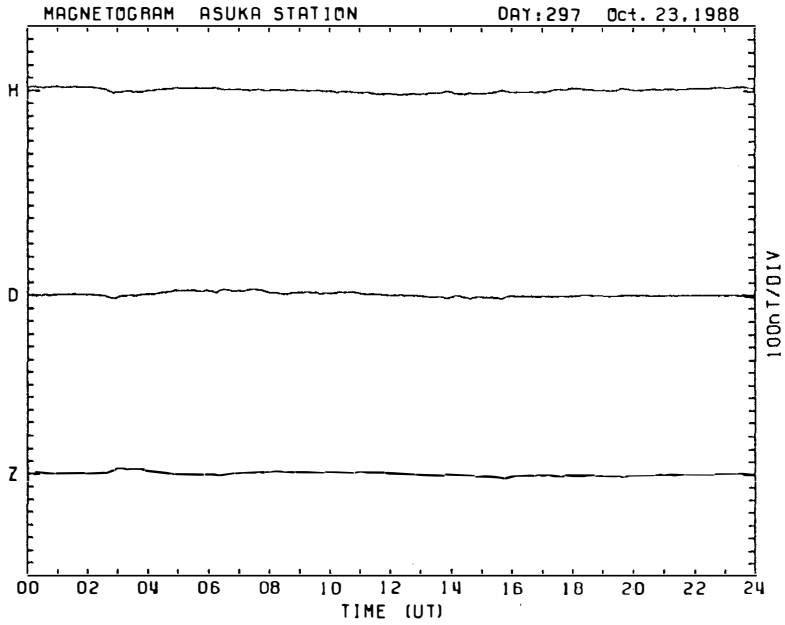
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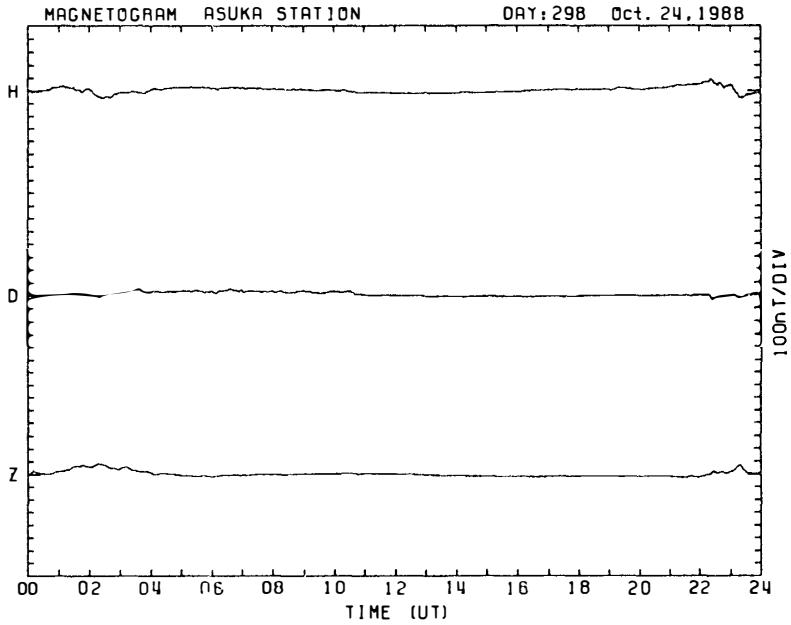
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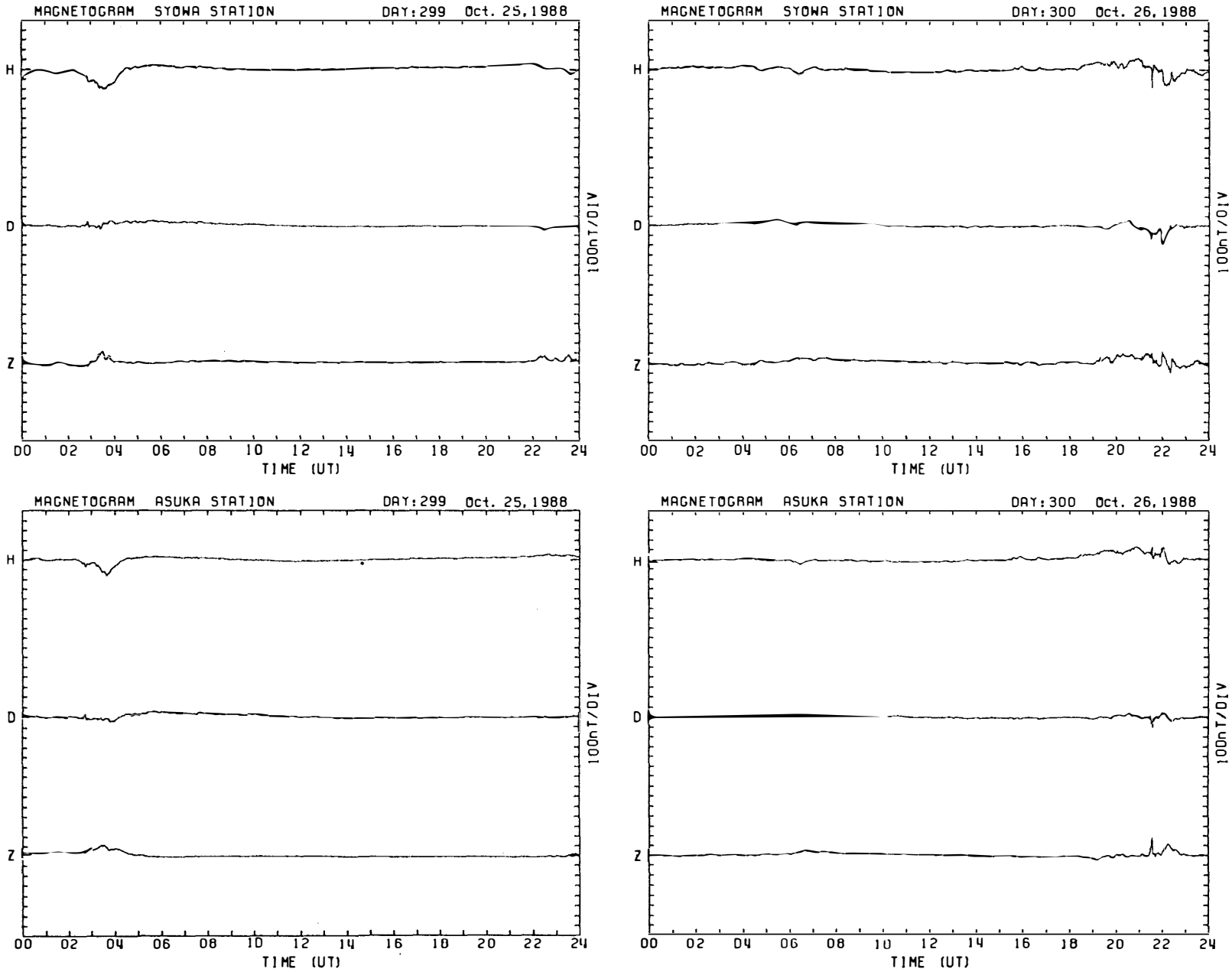
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MAGNETOGRAM ASUKA STATION DAY:299 Oct. 25,1988
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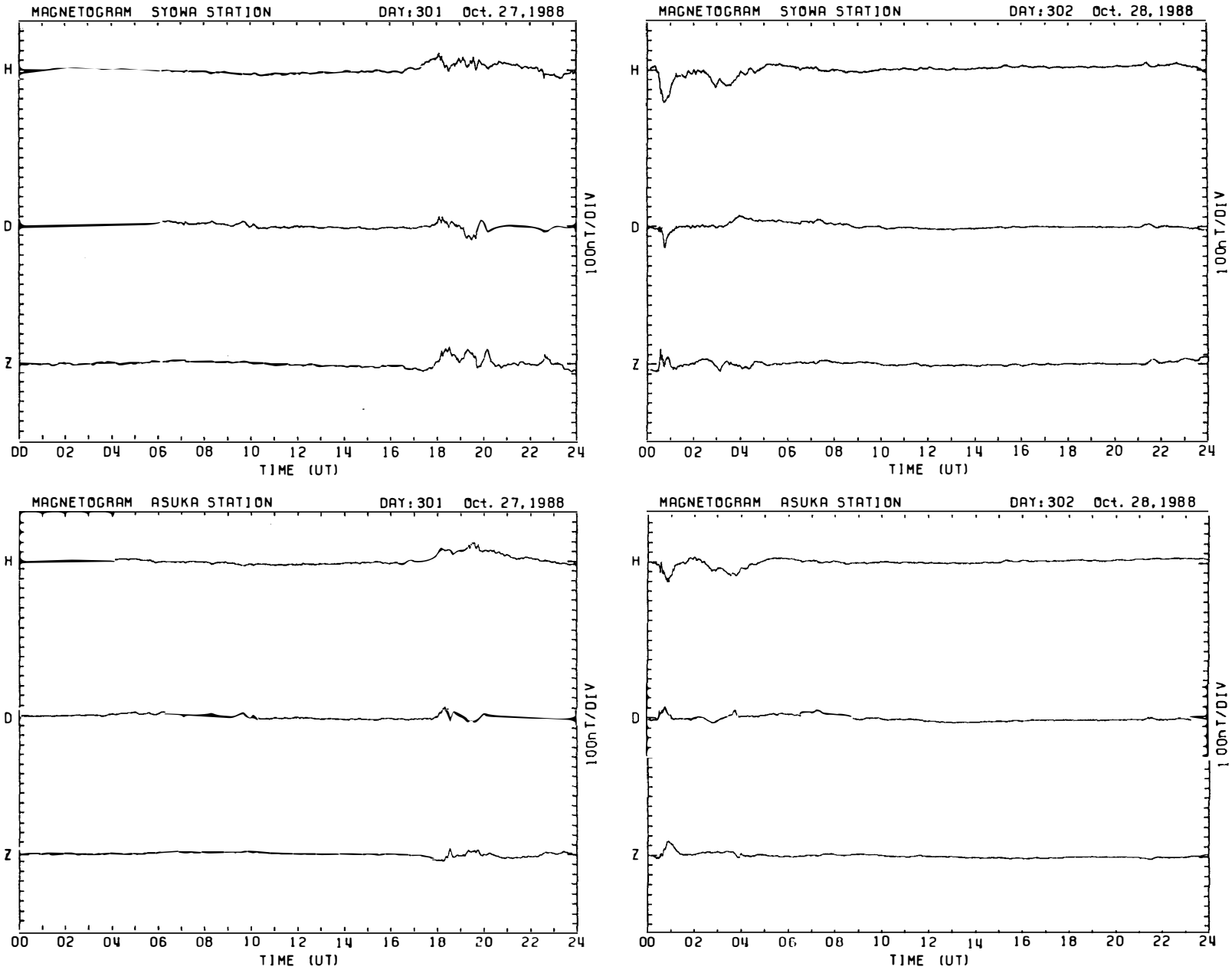
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MAGNETOGRAM ASUKA STATION DAY:301 Oct. 27,1988
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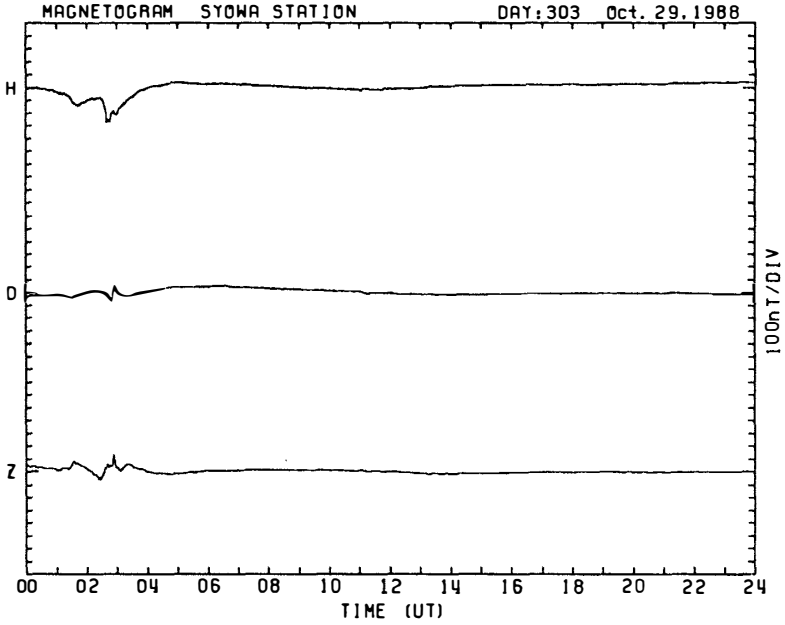
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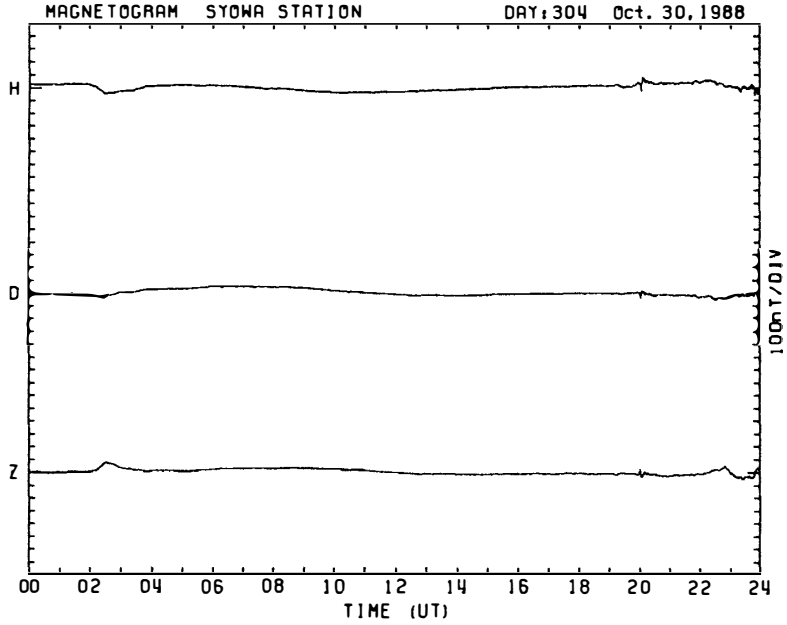
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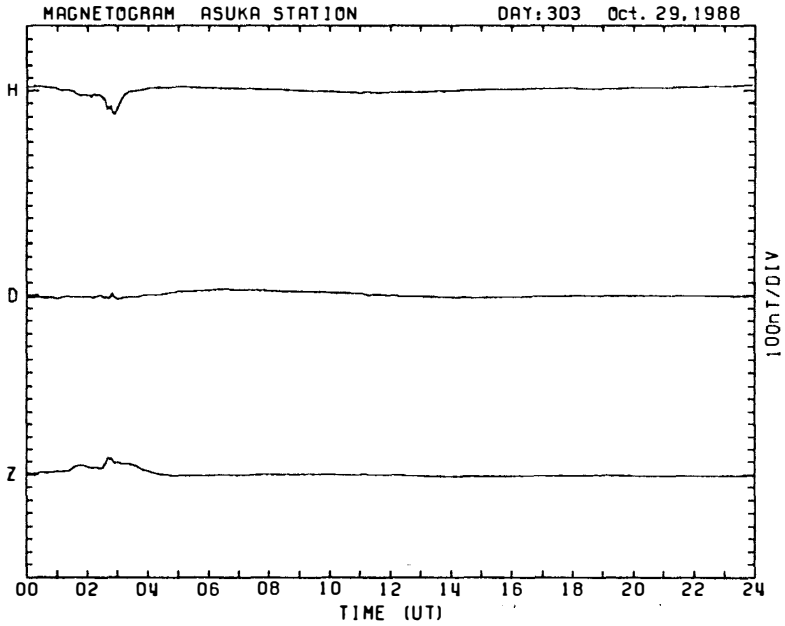
TIME (UT)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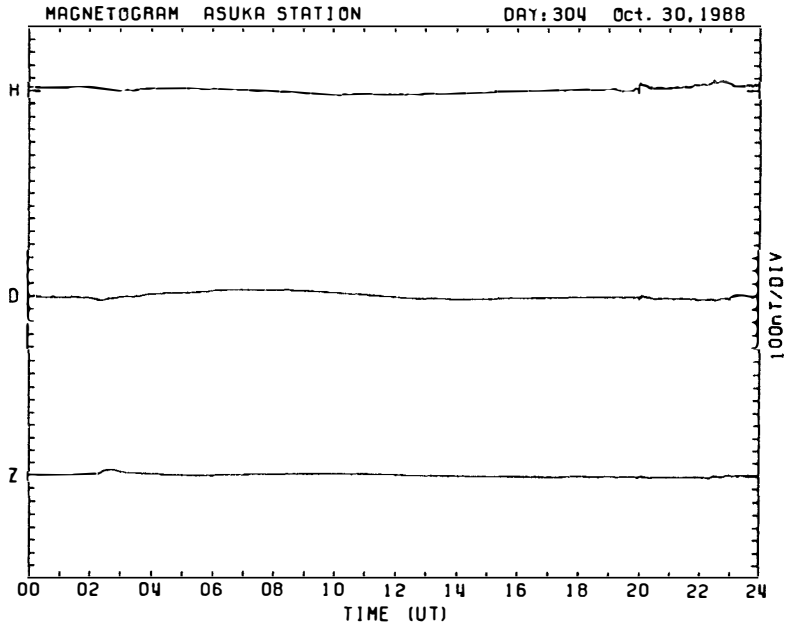
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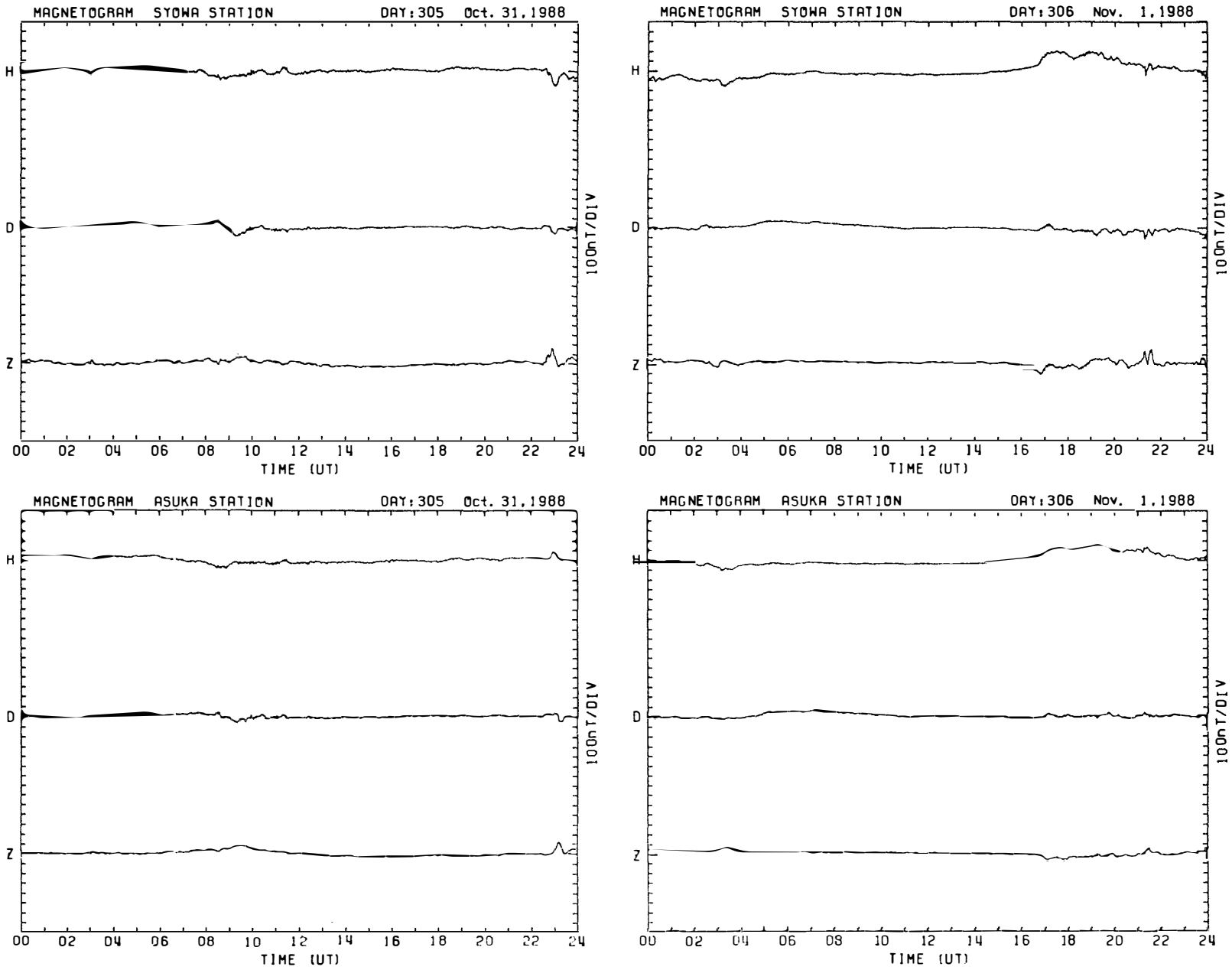
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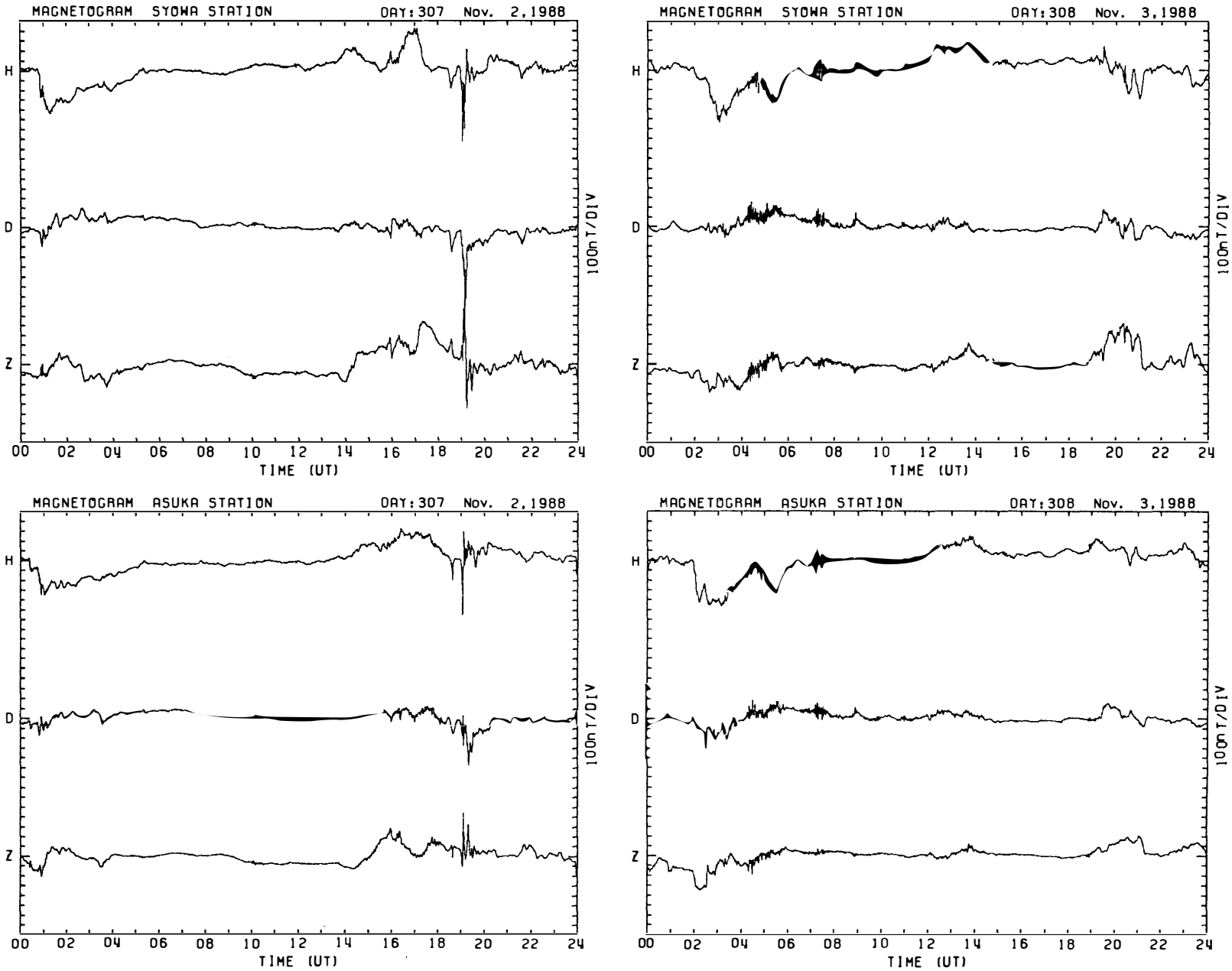
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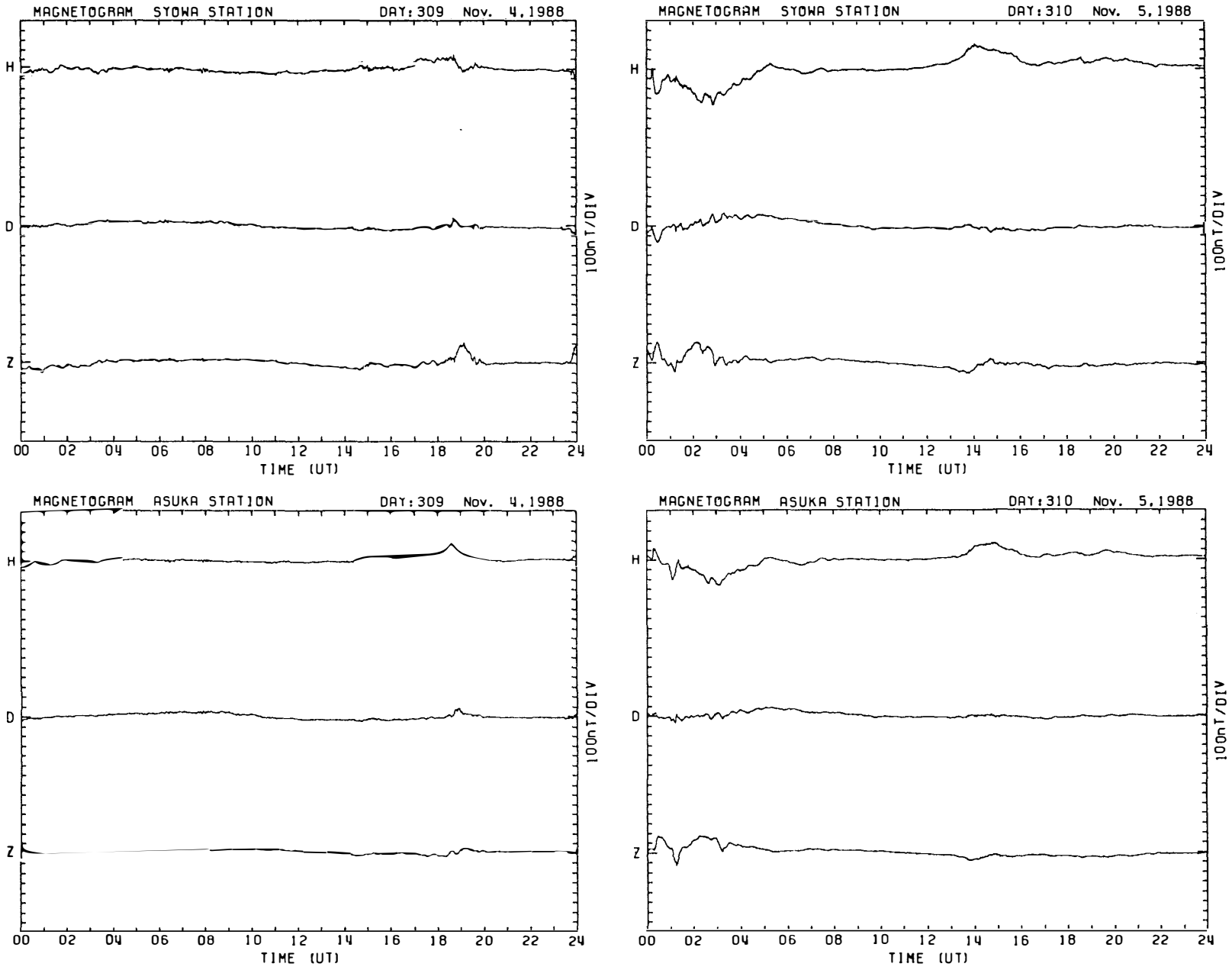
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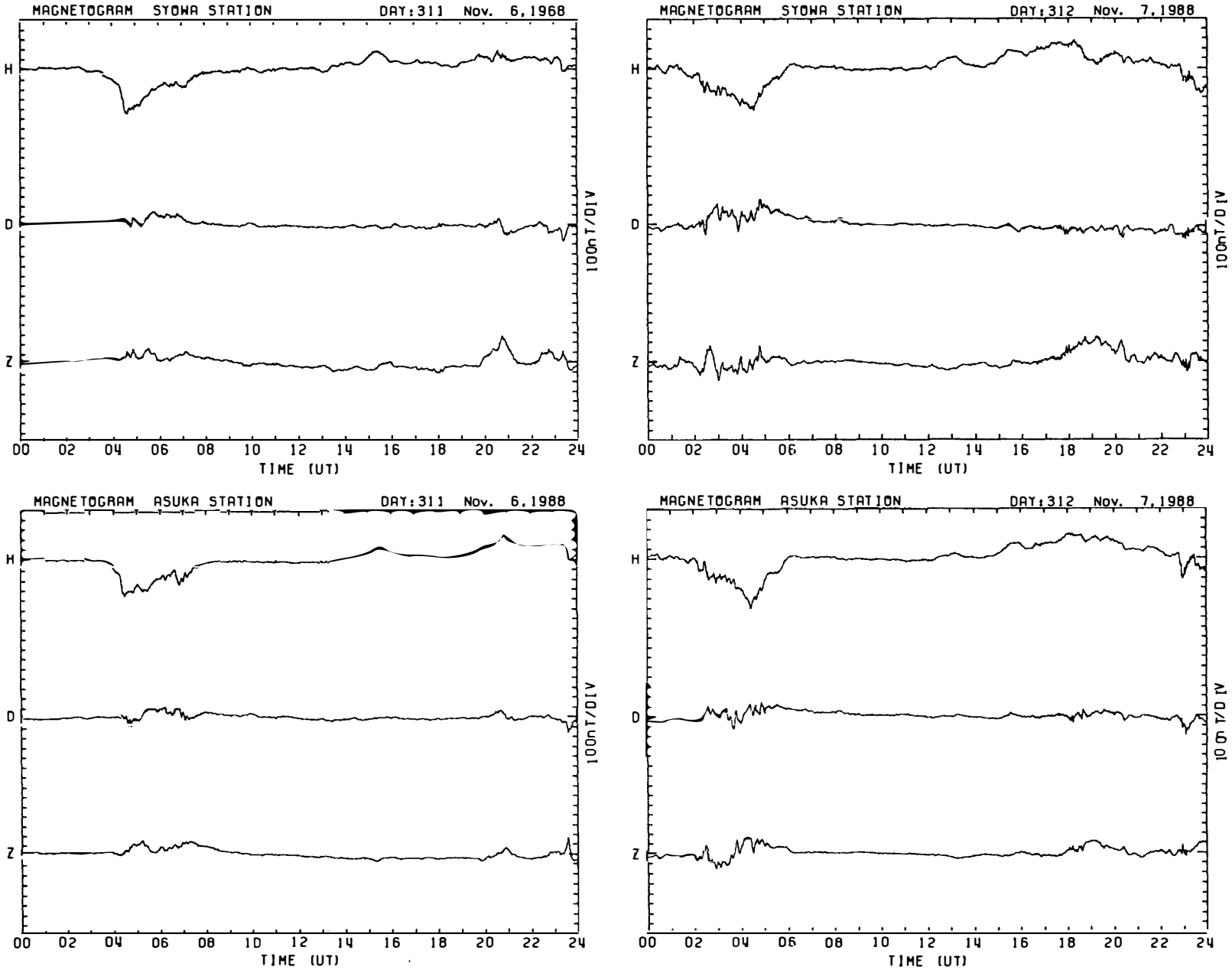
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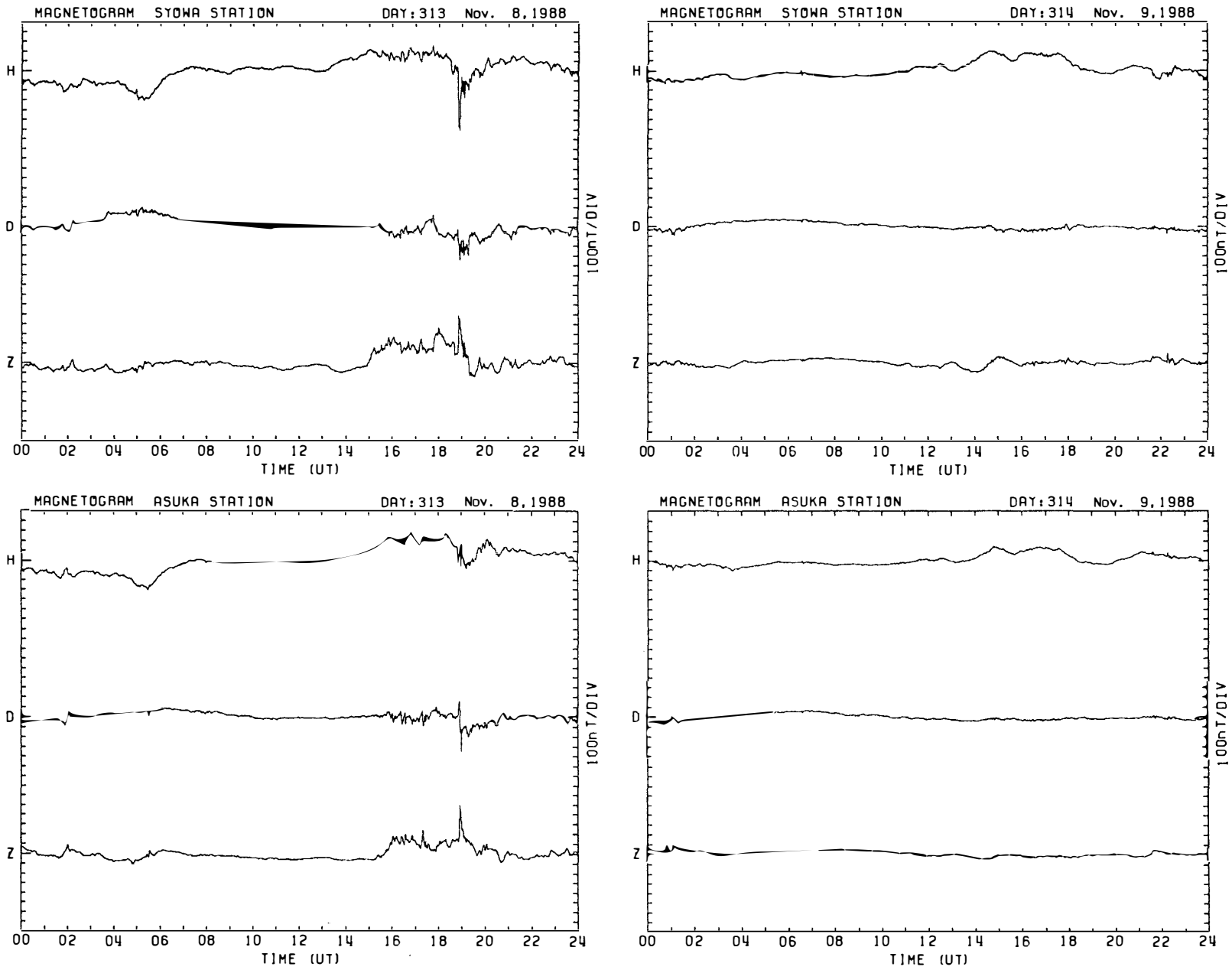
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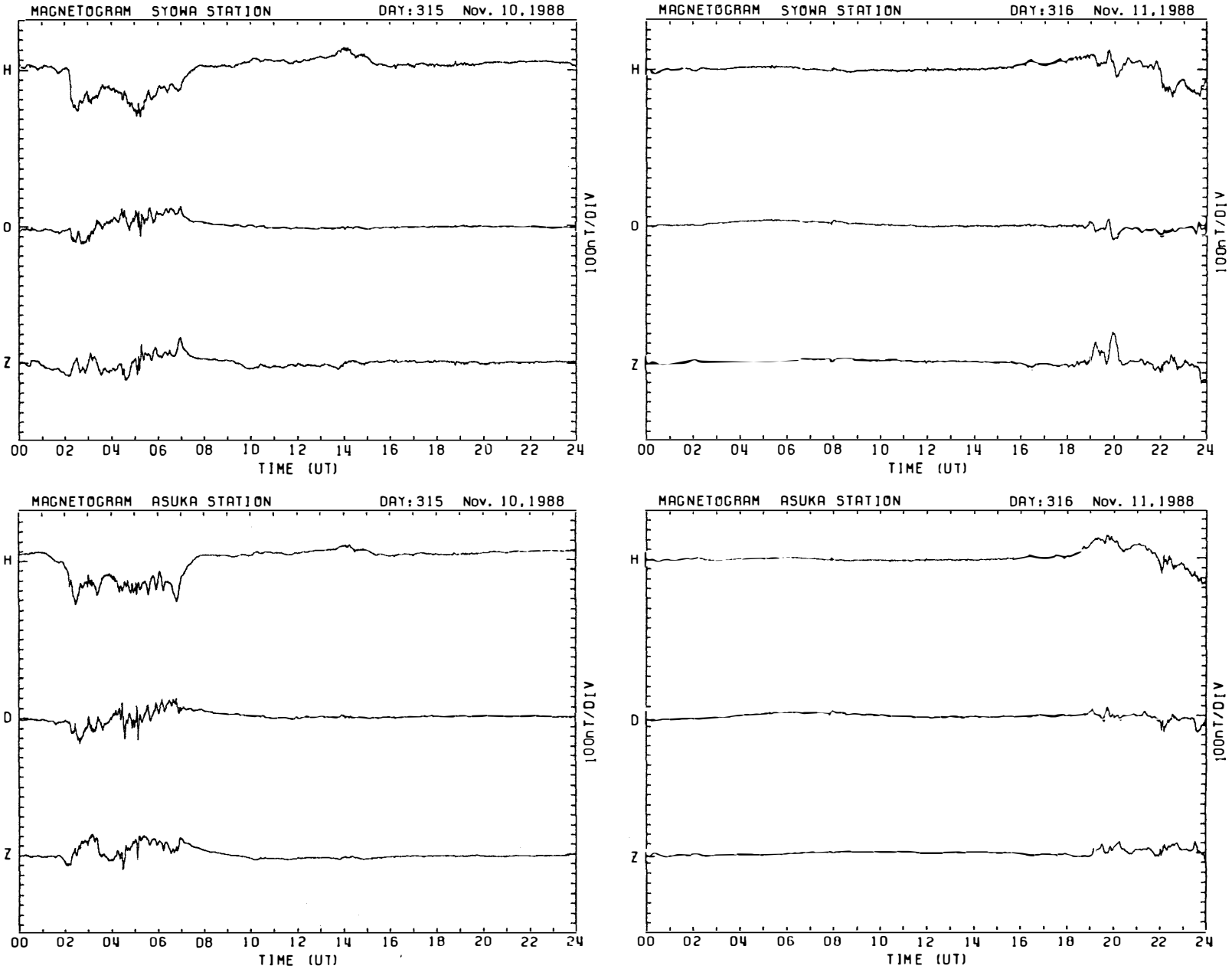
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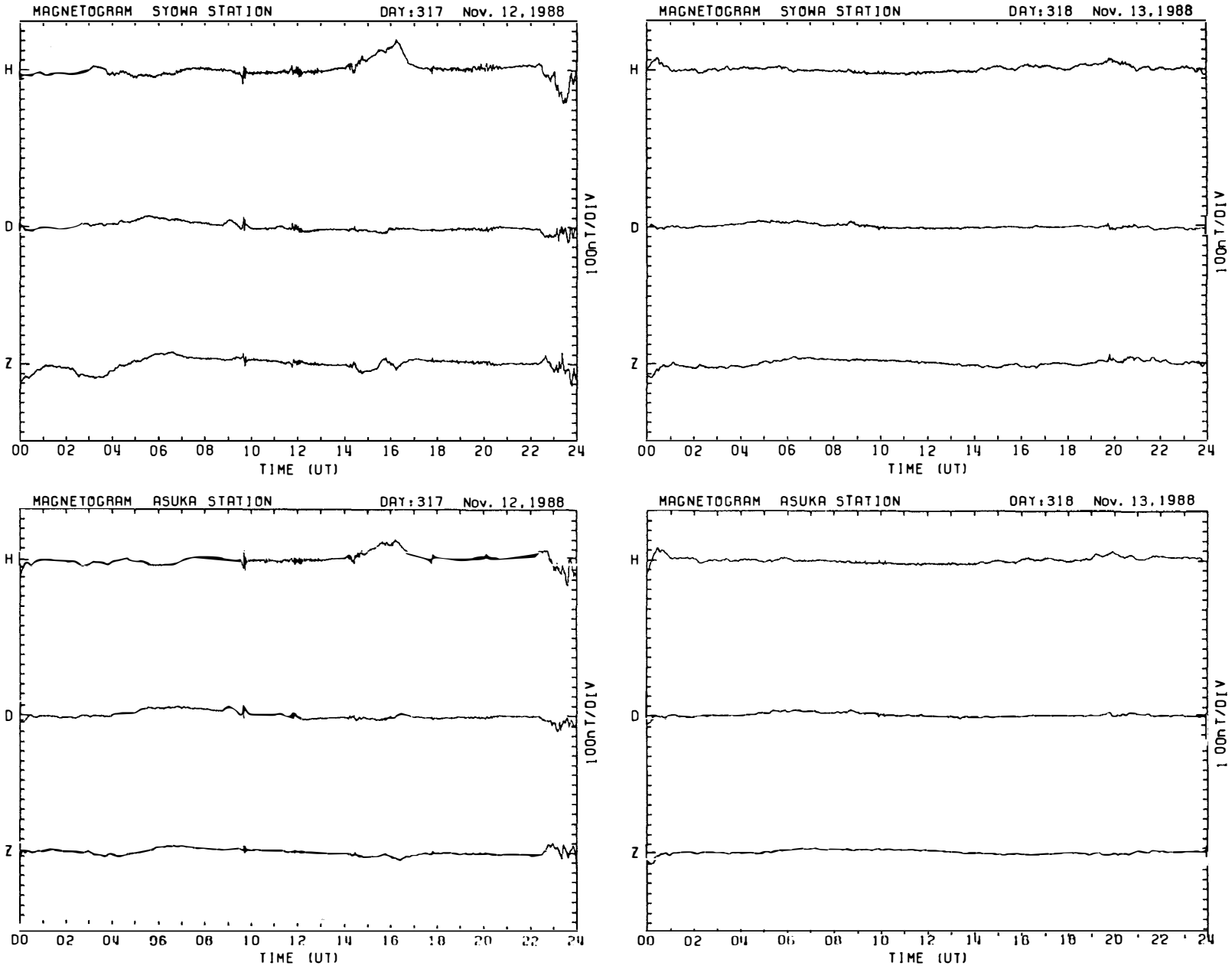
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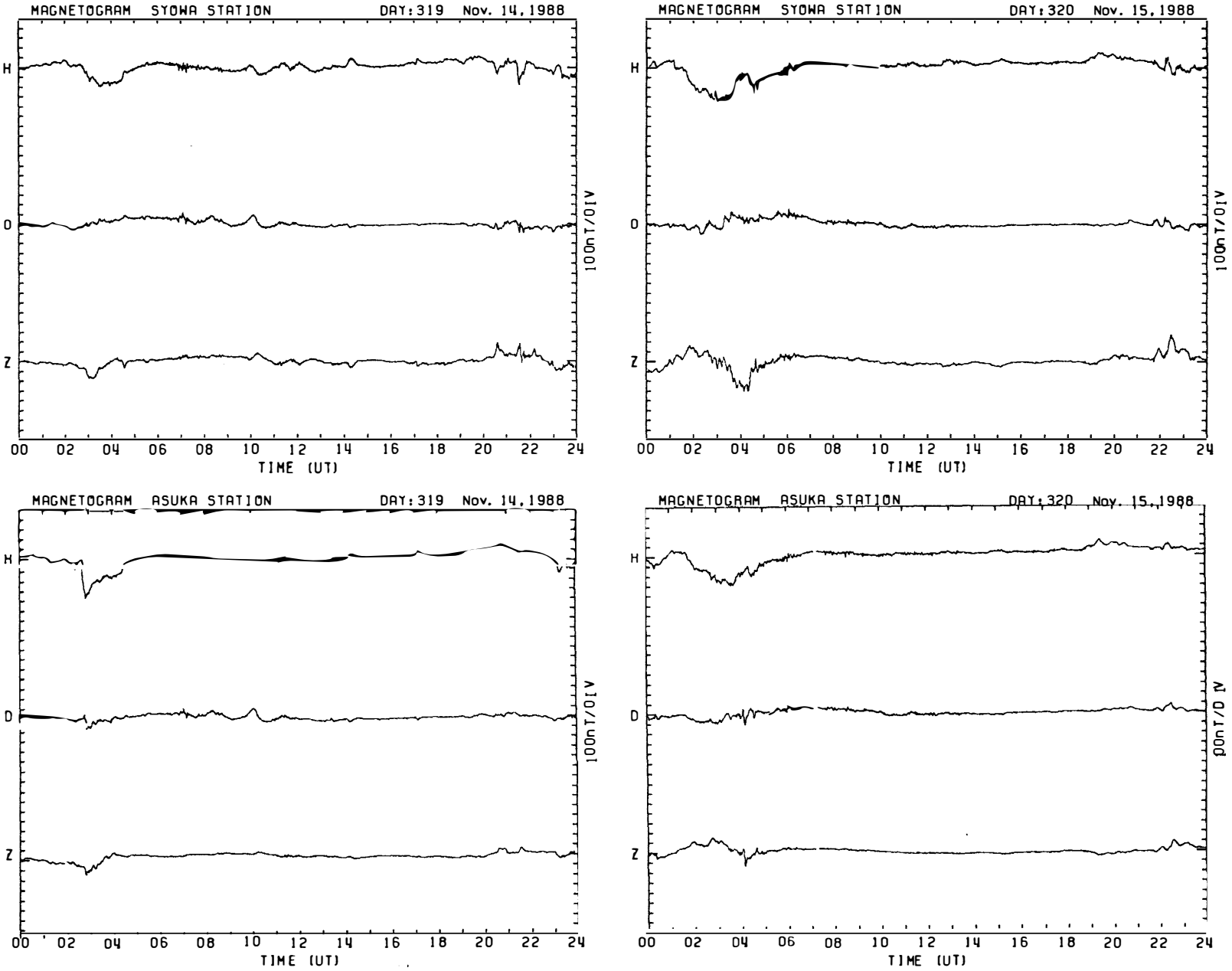
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MAGNETOGRAM ASUKA STATION DAY:319 Nov. 14,1988
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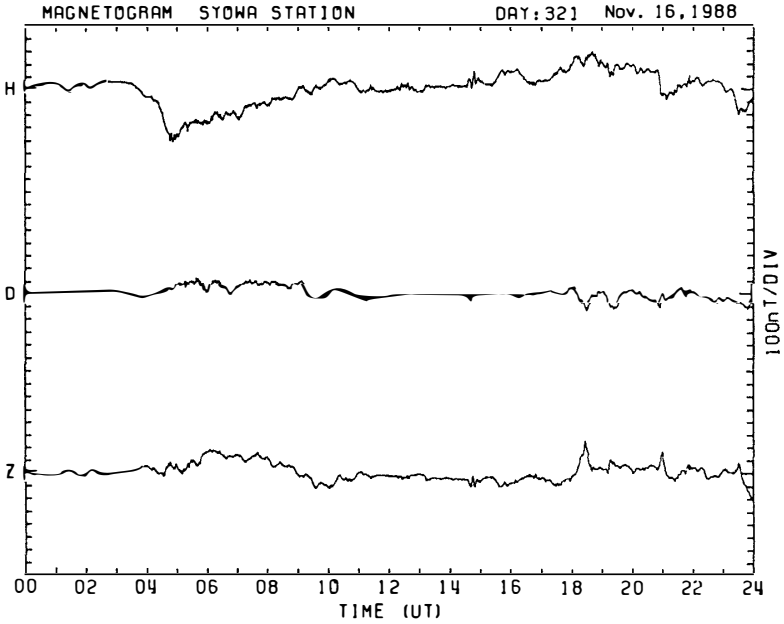
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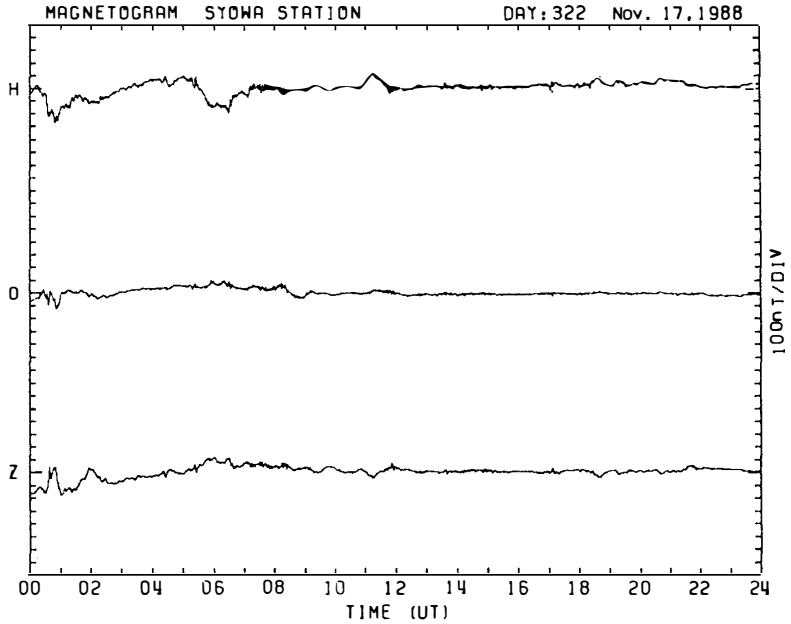
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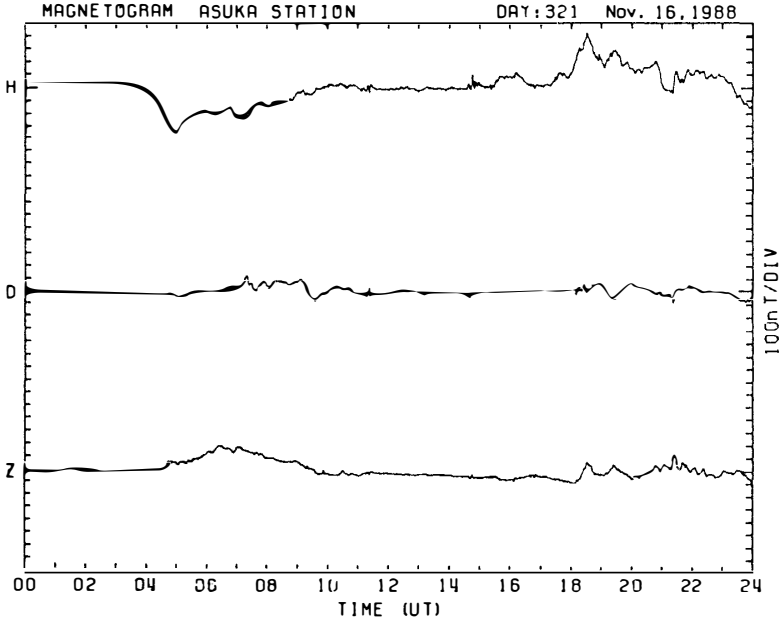
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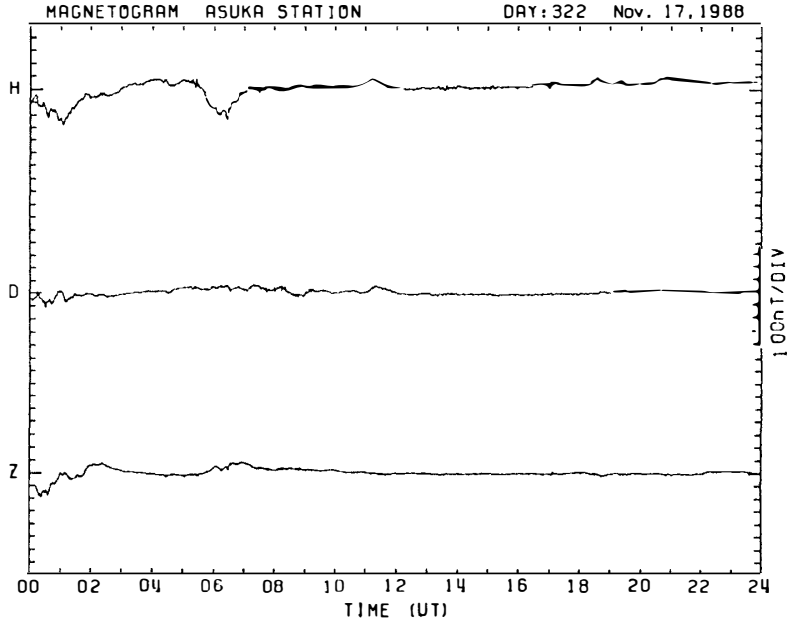
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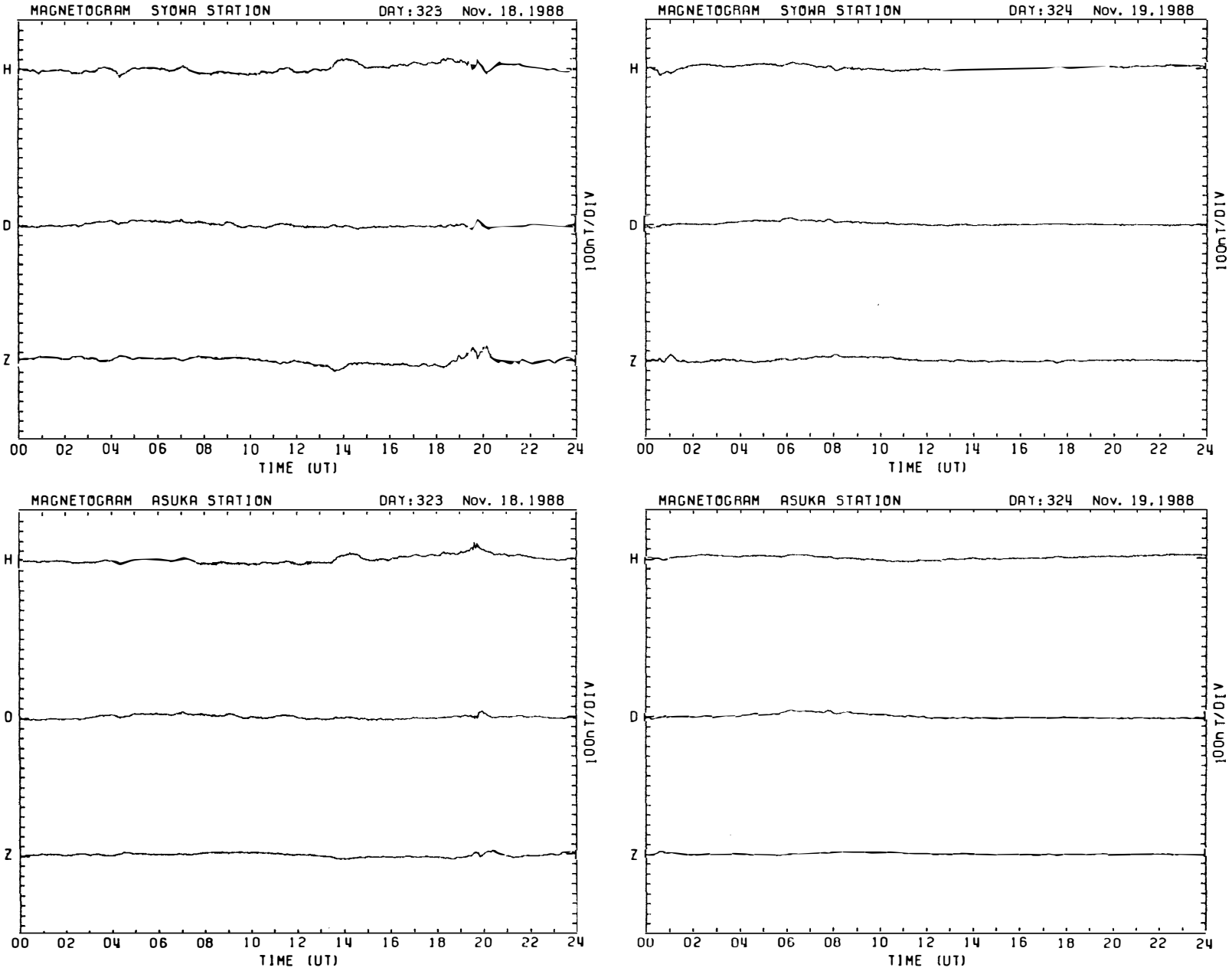
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MAGNETOGRAM ASUKA STATION DAY:323 Nov. 18,1988
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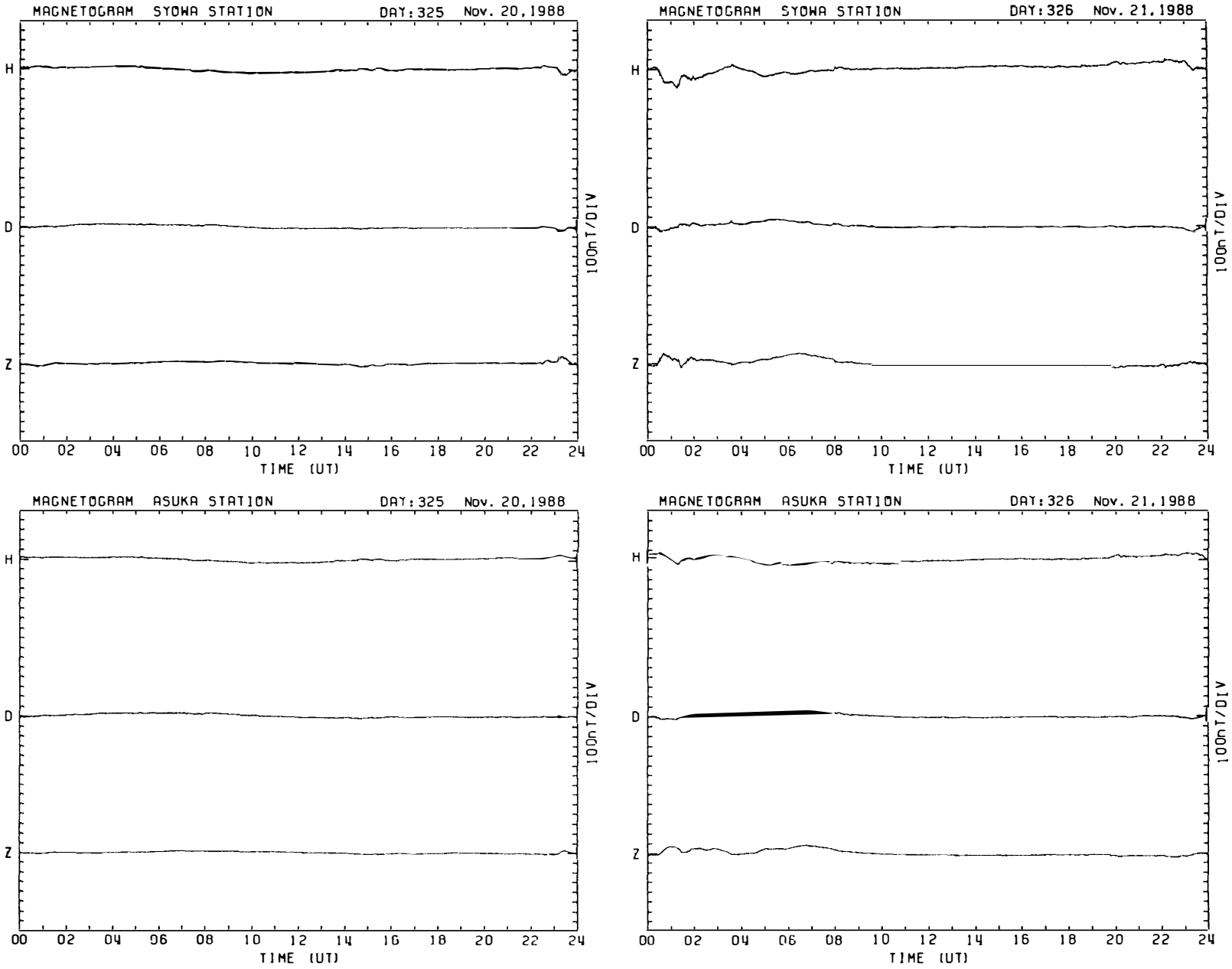
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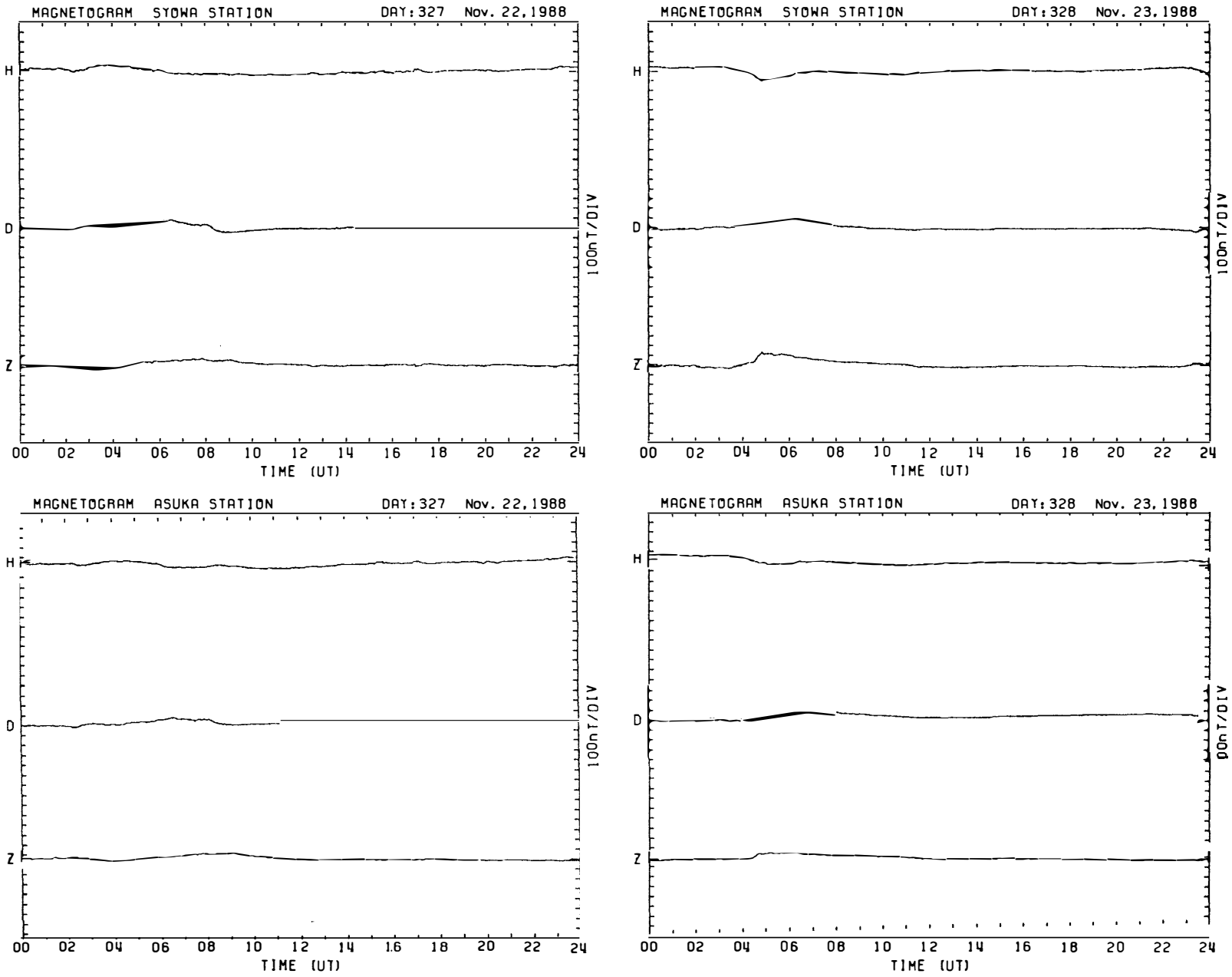
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TIME (UT)
MAGNETOGRAM STOWA STATION DAY:328 Nov. 23,1988
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TIME (UT)
MAGNETOGRAM ASUKA STATION DAY:327 Nov. 22,1988
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TIME (UT)
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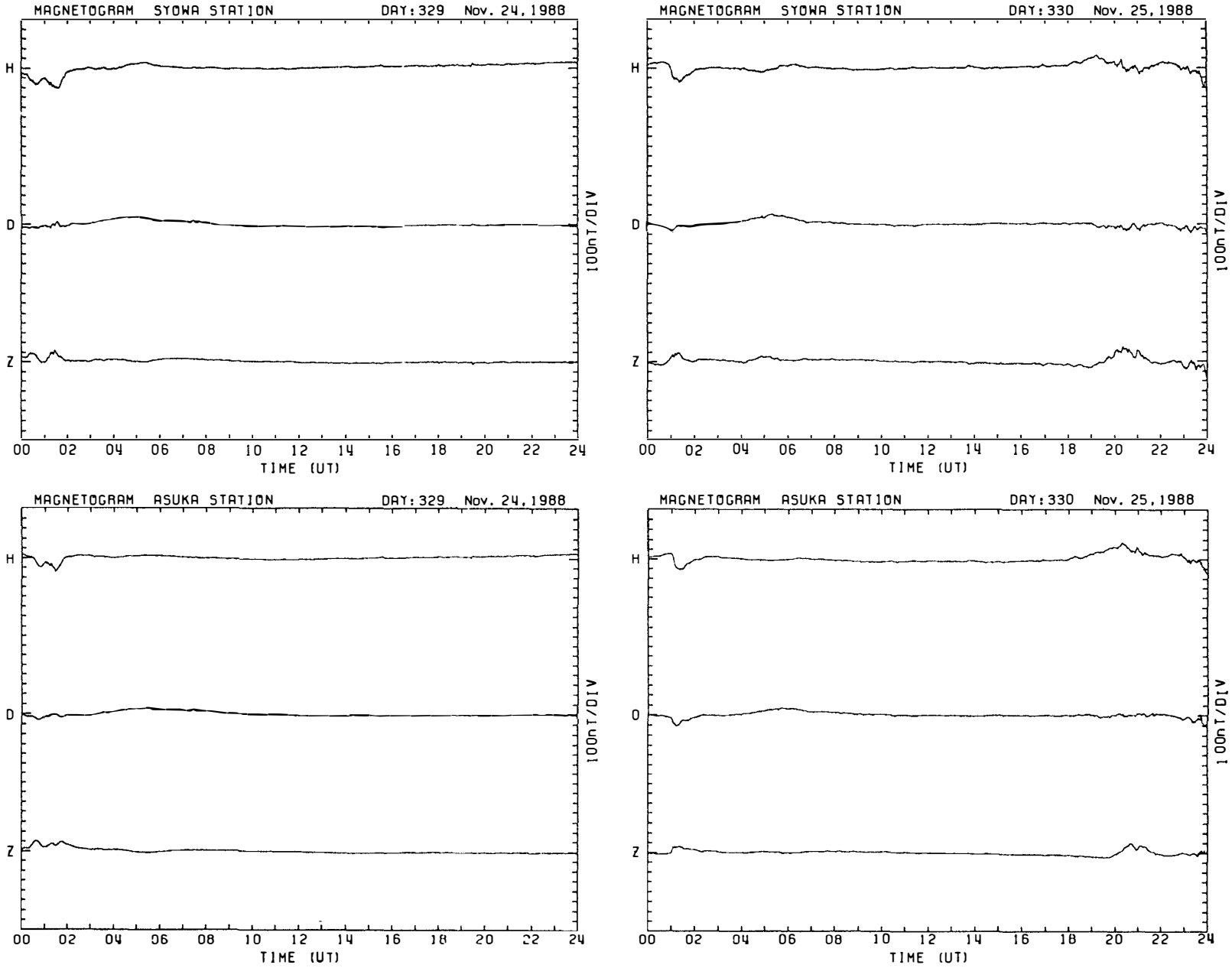
TIME (UT)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MAGNETOGRAM ASUKA STATION DAY:329 Nov. 24,1988
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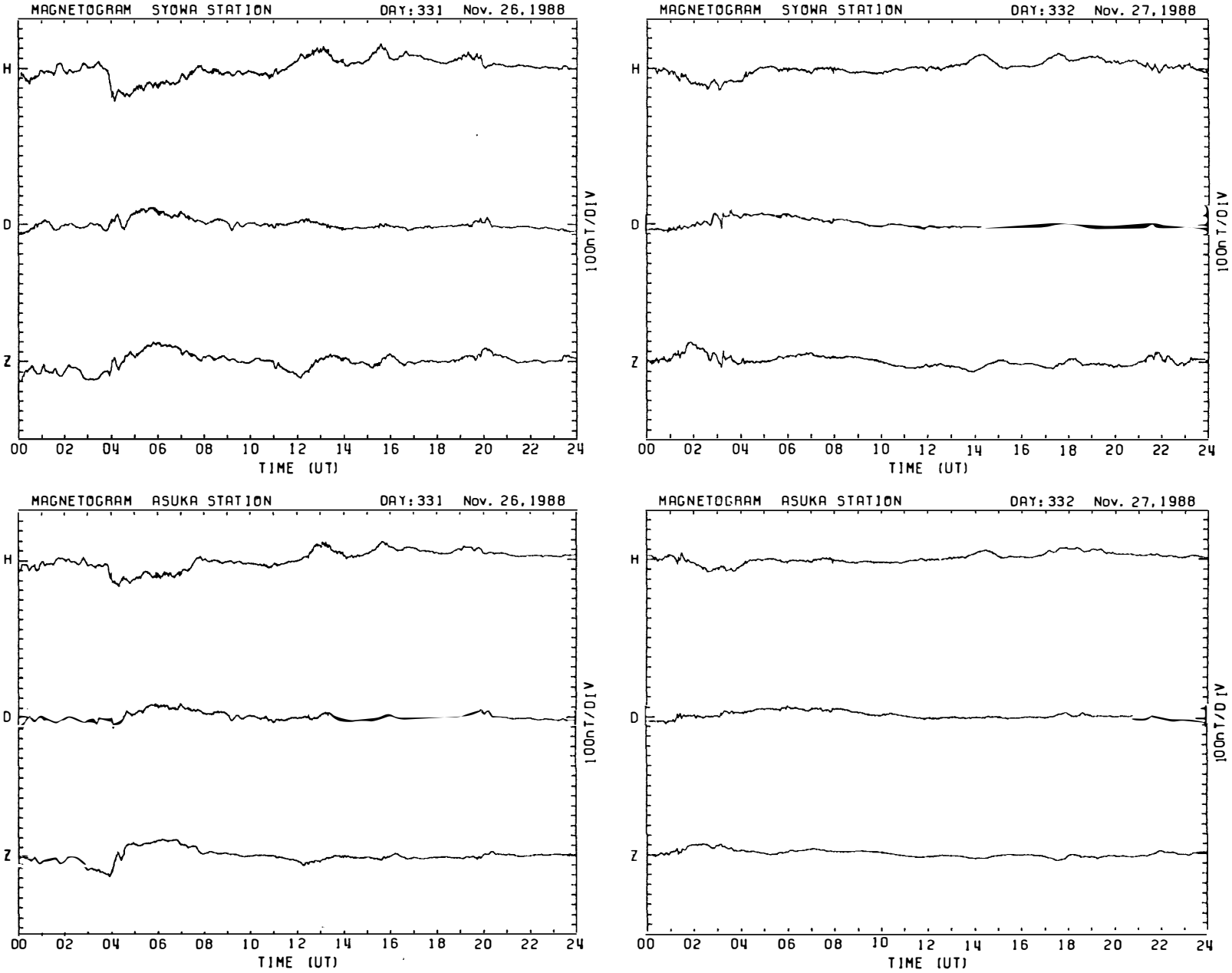
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MAGNETOGRAM ASUKA STATION DAY:331 Nov. 26,1988
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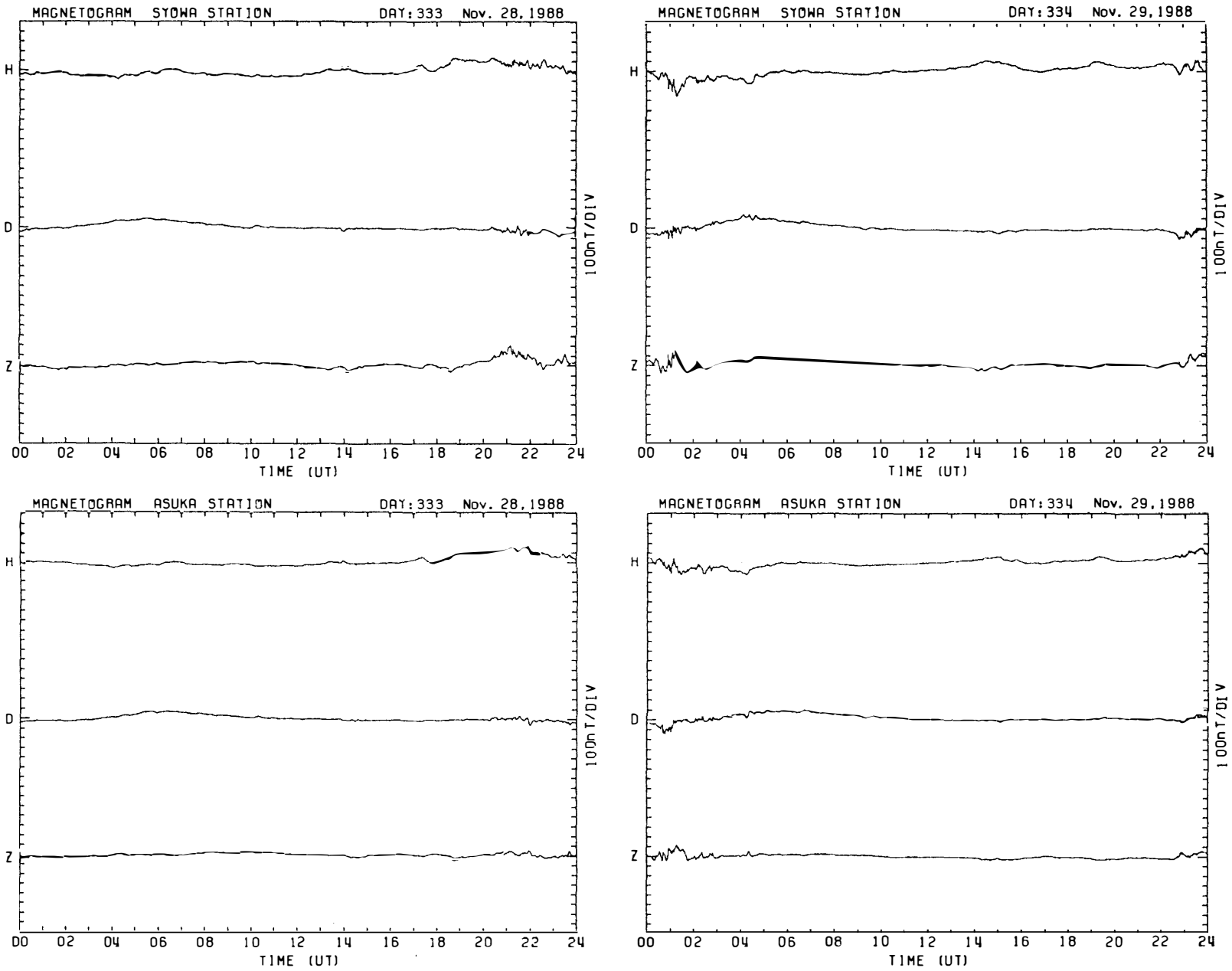
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MAGNETOGRAM ASUKA STATION DAY:333 Nov. 28,1988
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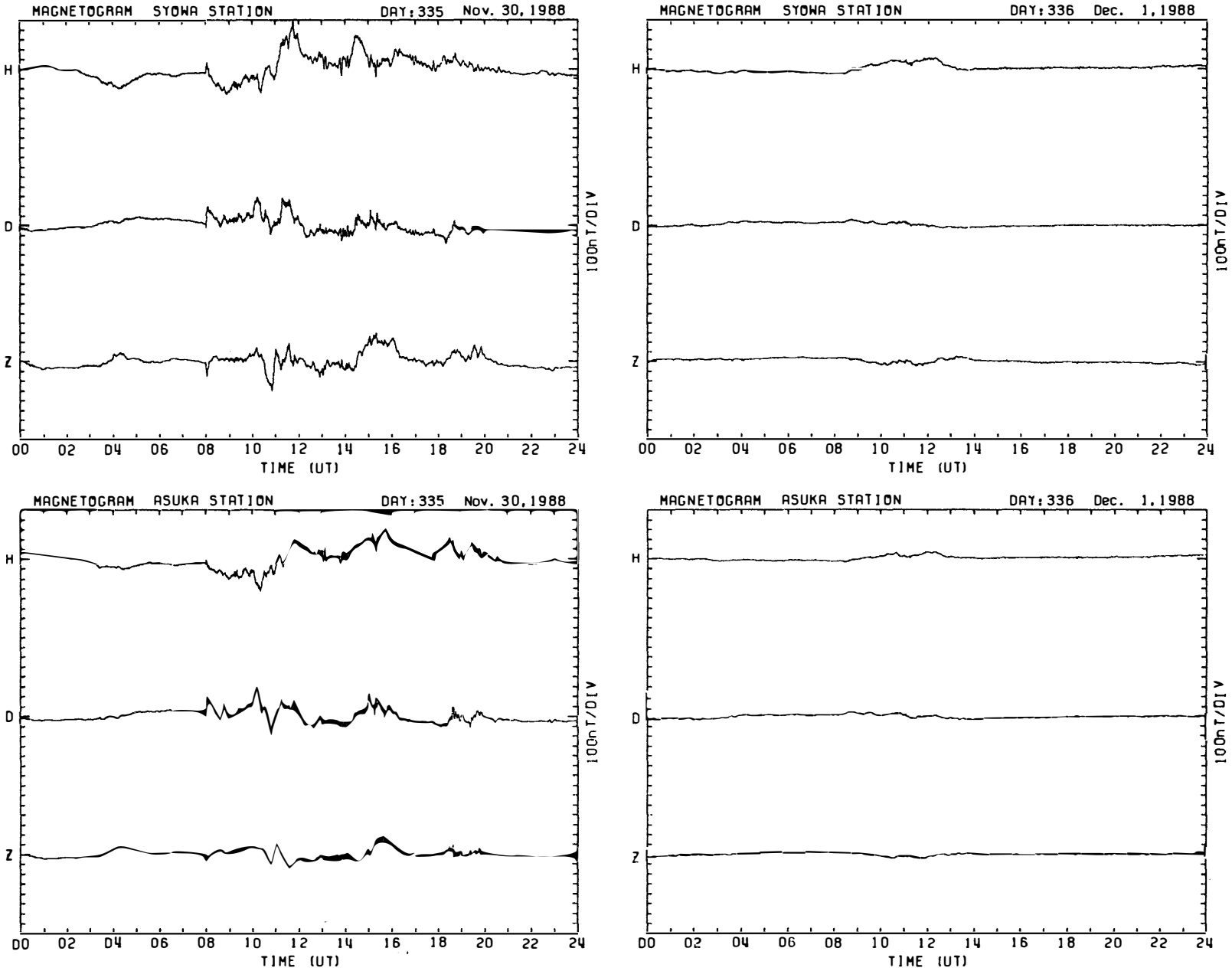
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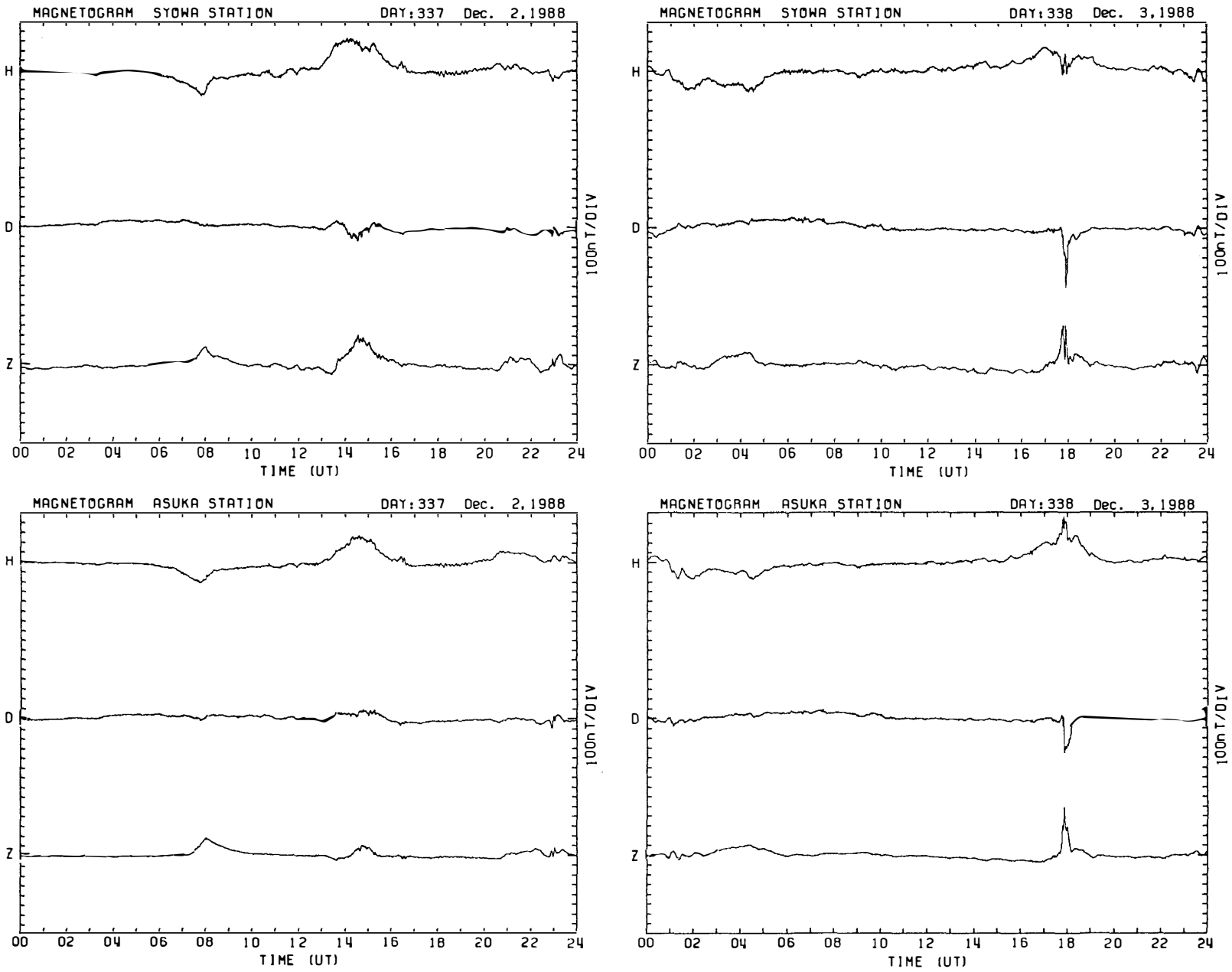
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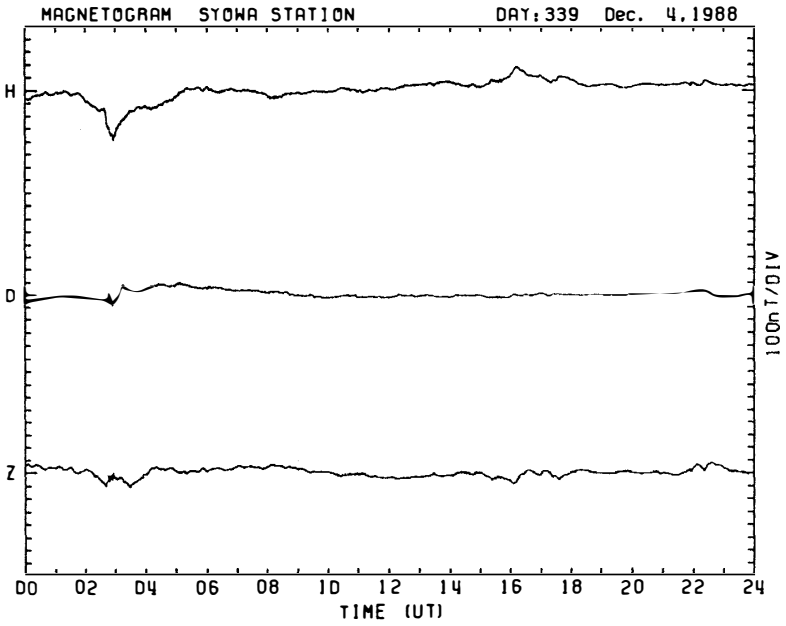
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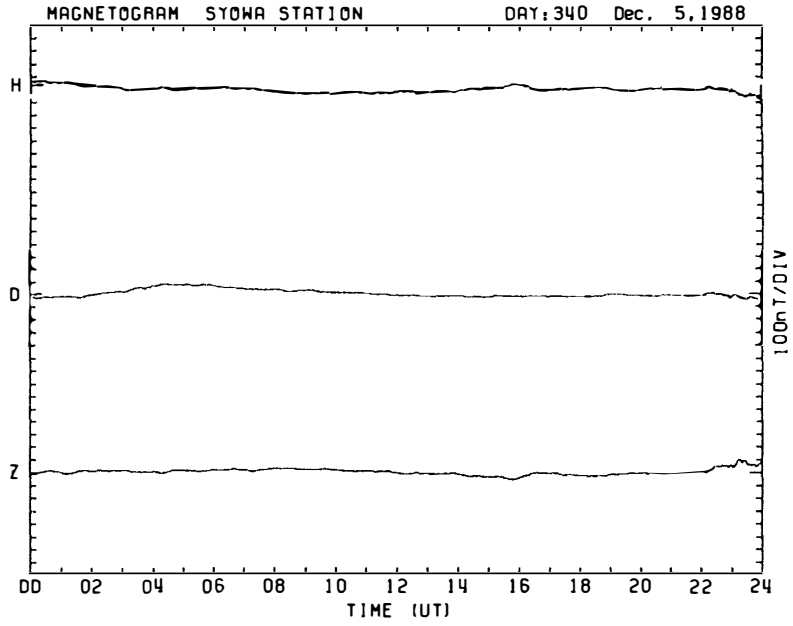
TIME (UT)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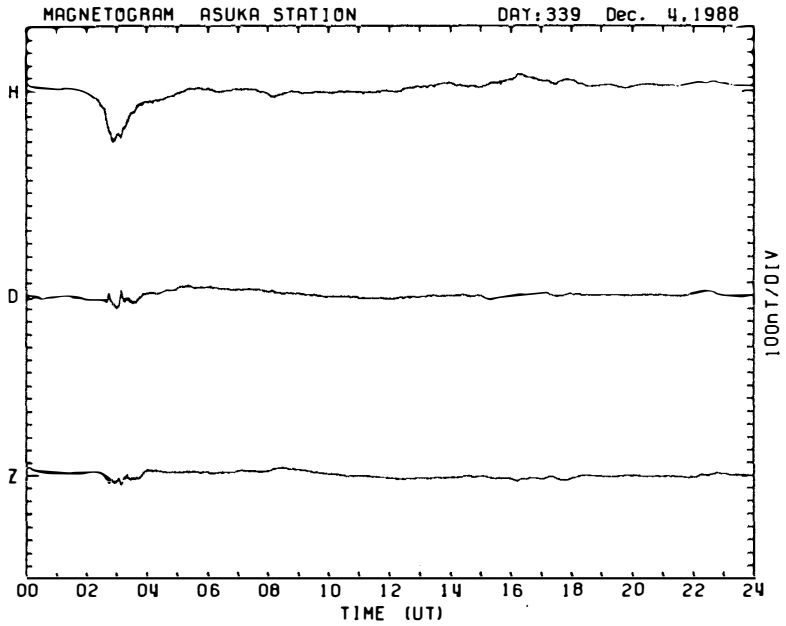
TIME (UT)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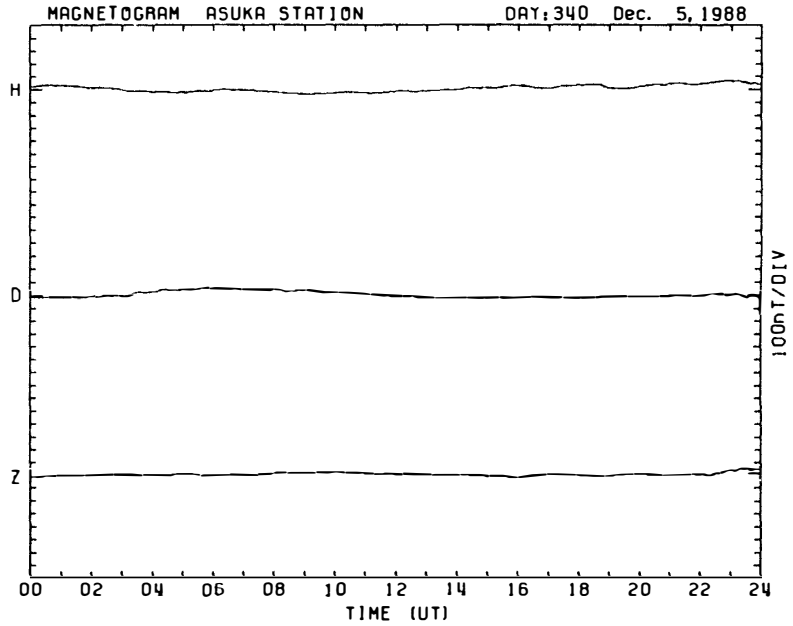
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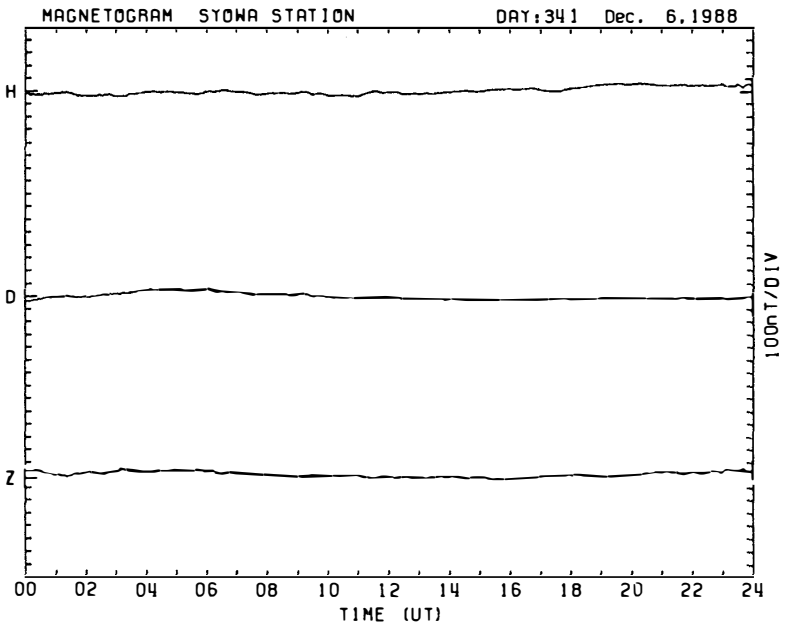
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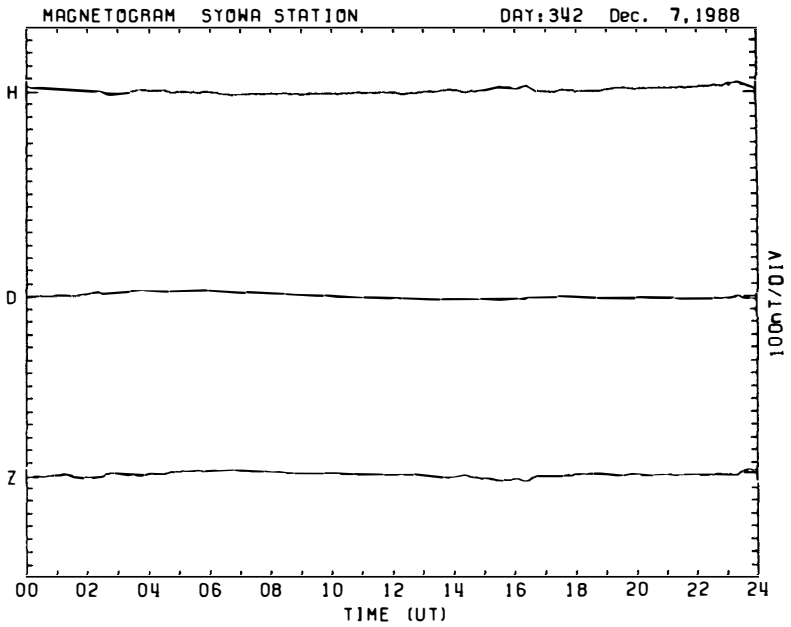
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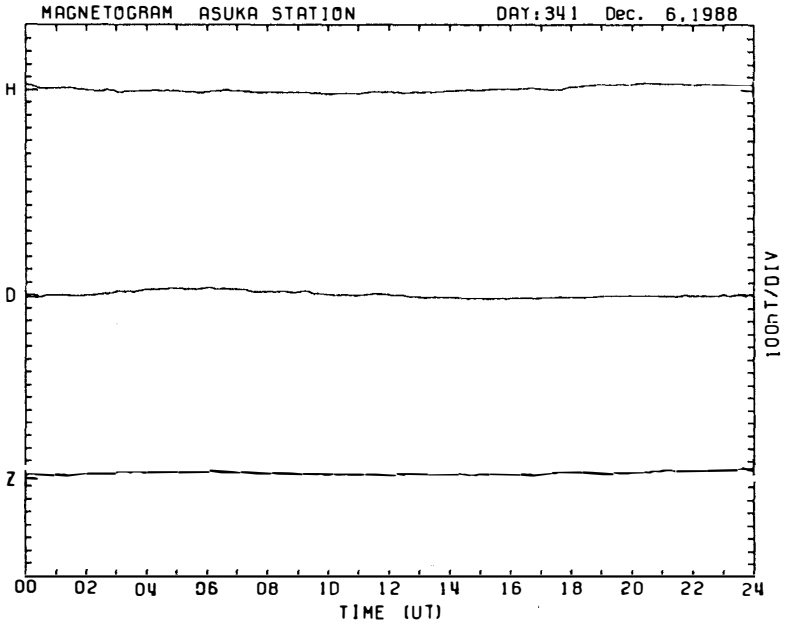
TIME (UT)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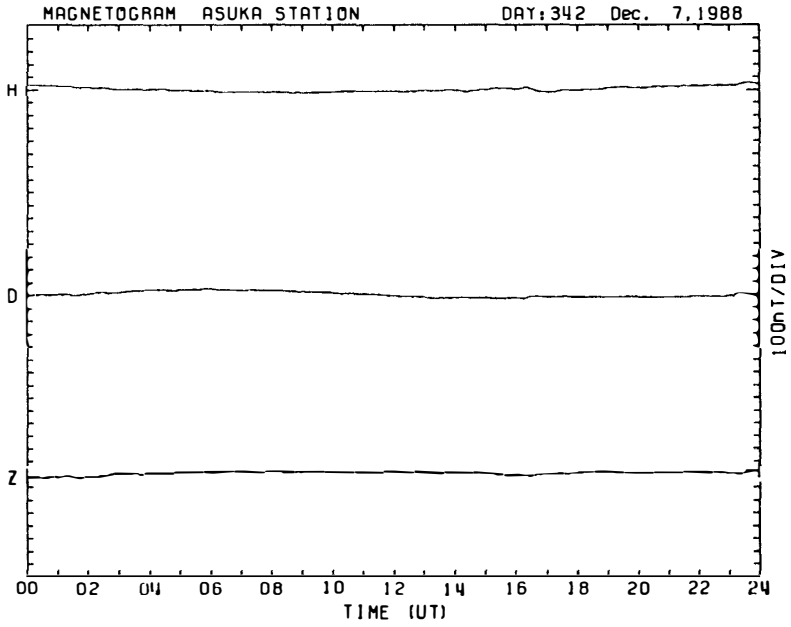
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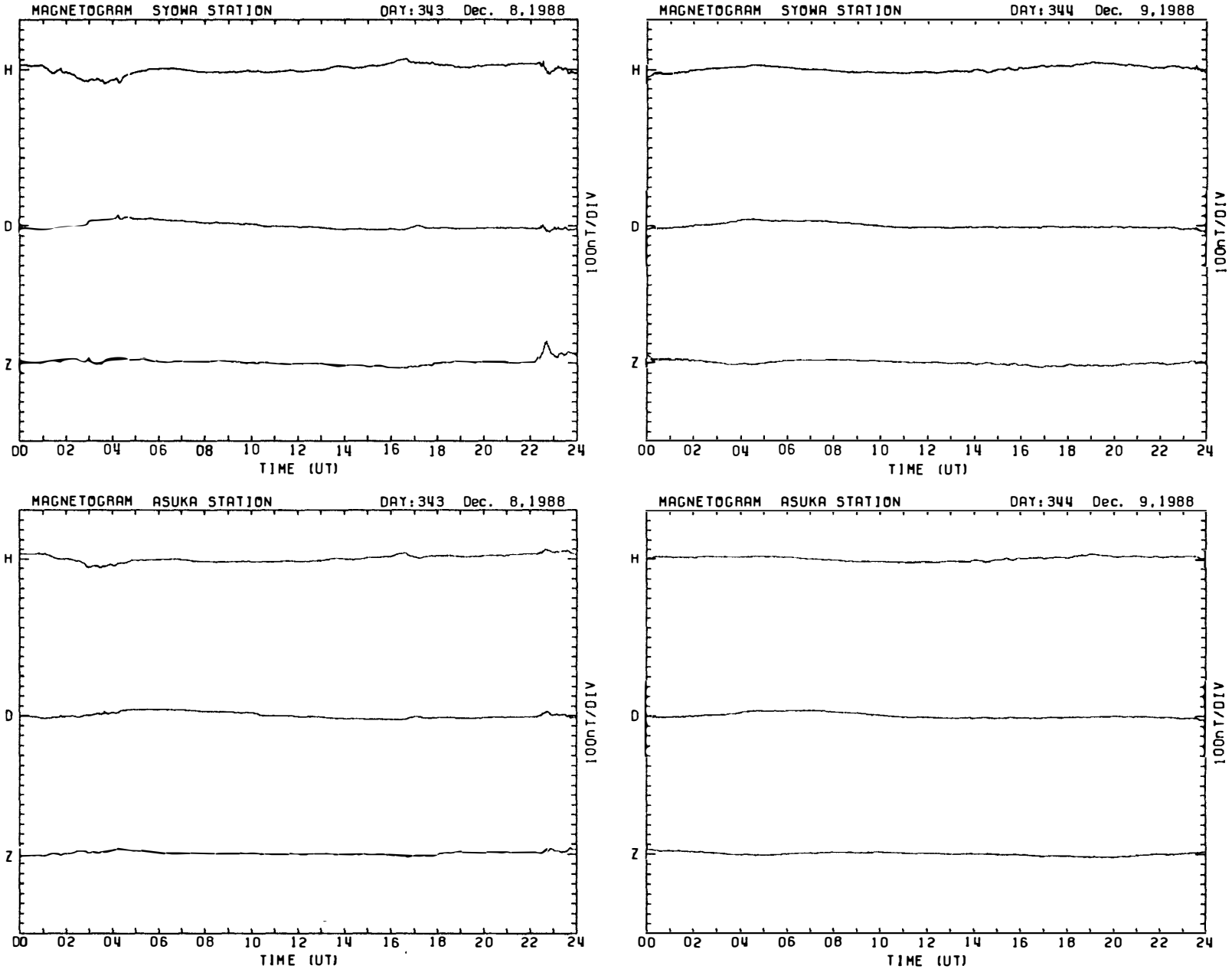
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MAGNETOGRAM ASUKA STATION DAY:343 Dec. 8,1988
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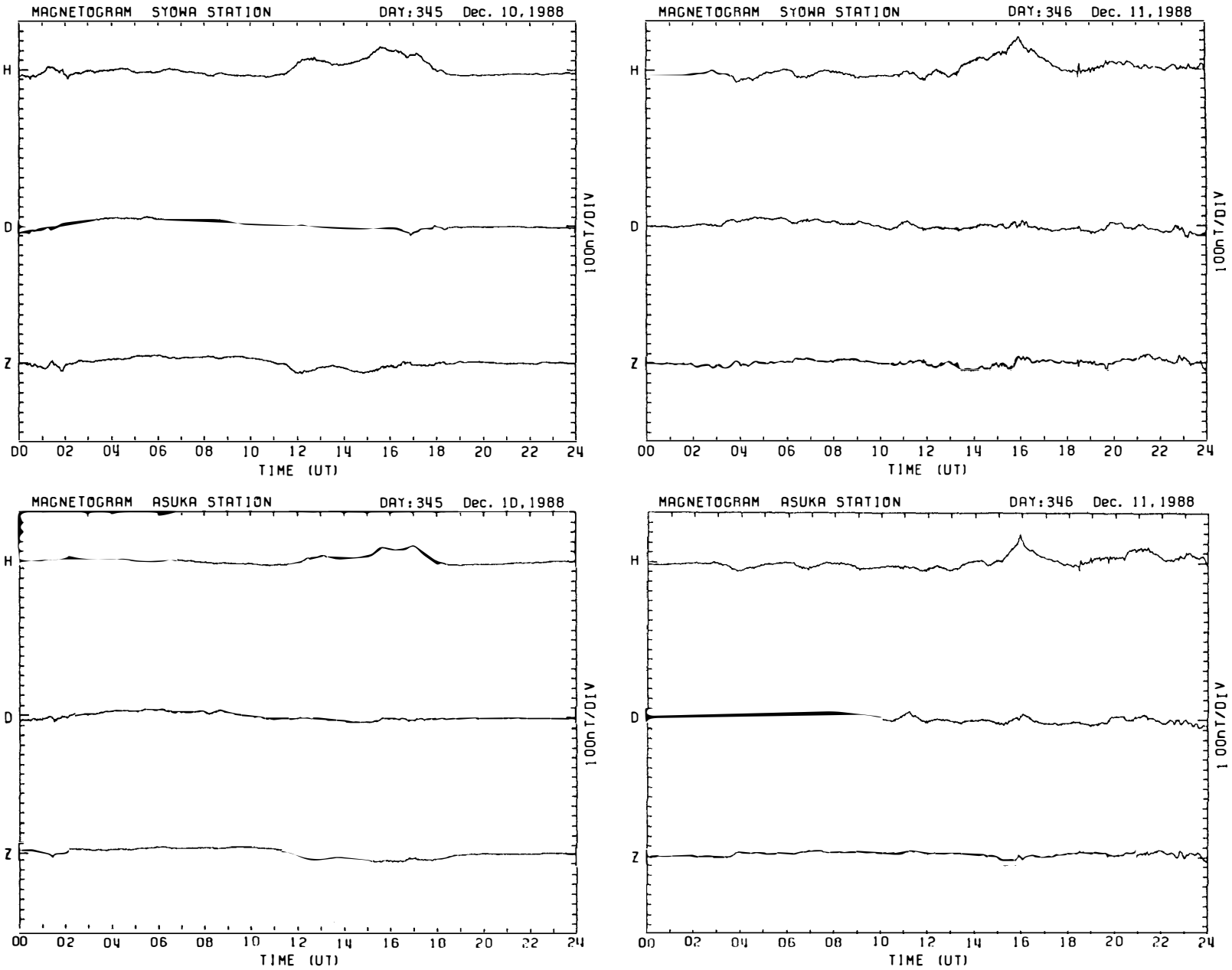
TIME (UT)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MAGNETOGRAM ASUKA STATION DAY:345 Dec. 10,1988
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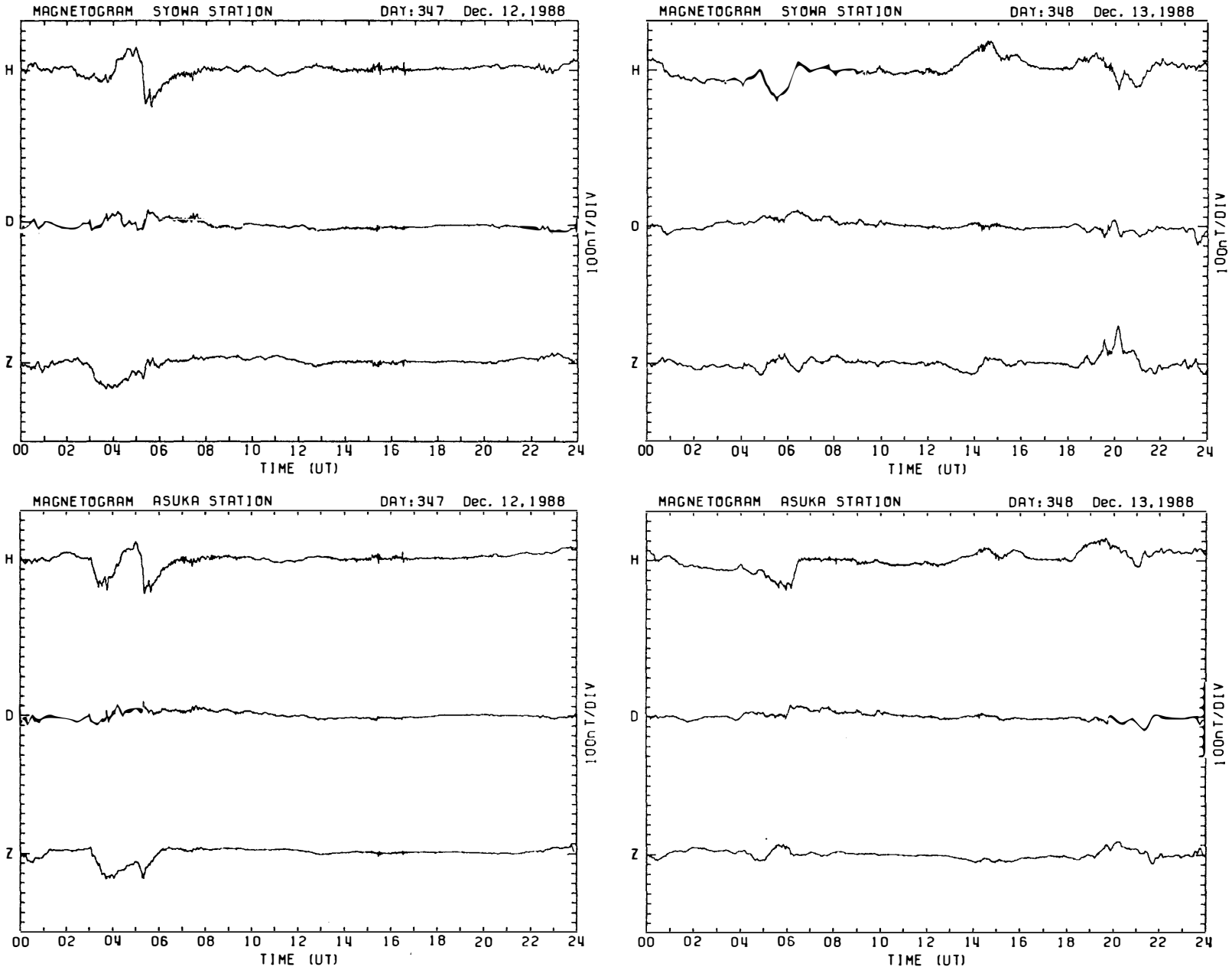
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MAGNETOGRAM ASUKA STATION DAY:347 Dec. 12,1988
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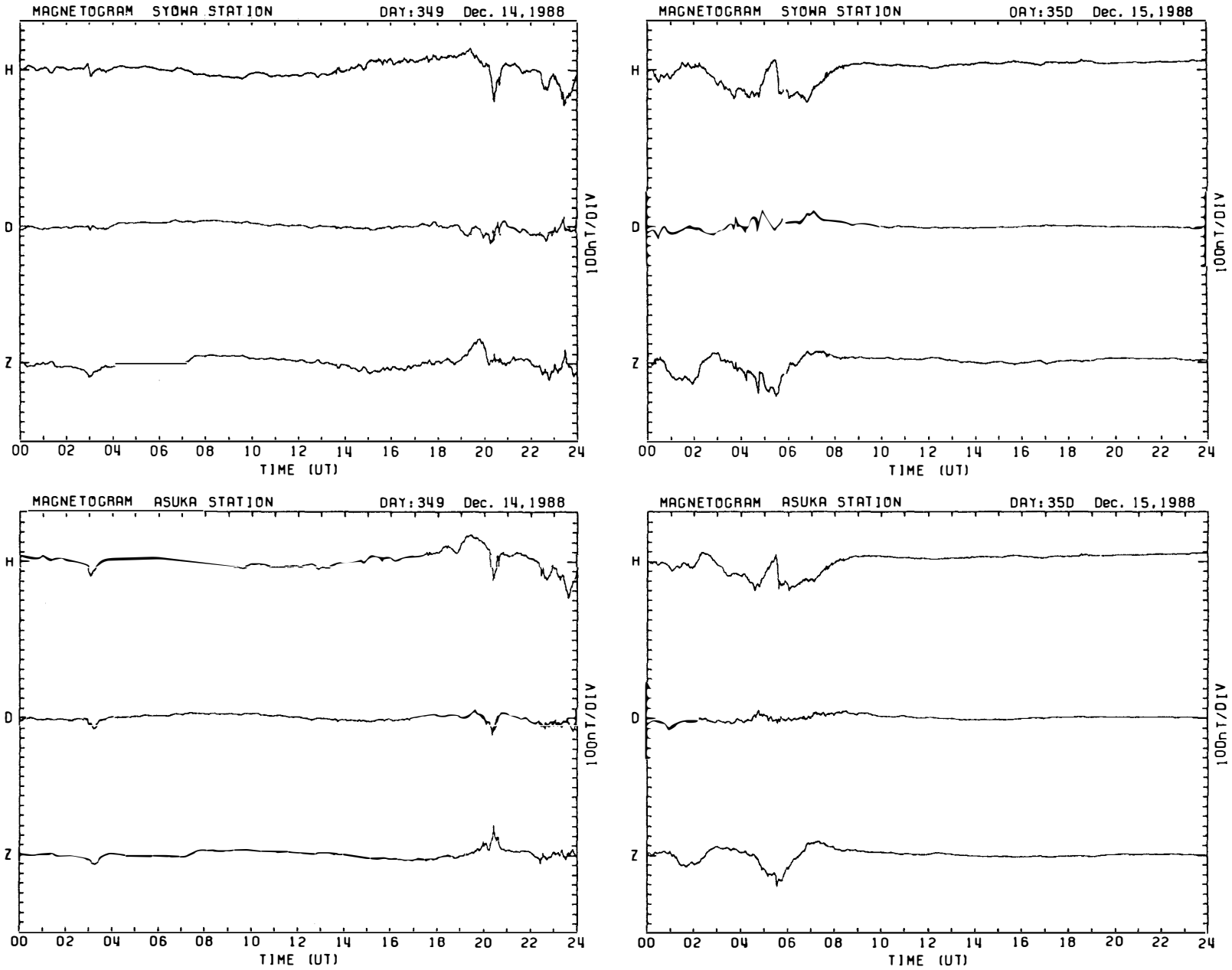
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MAGNETOGRAM ASUKA STATION DAY:349 Dec. 14,1988
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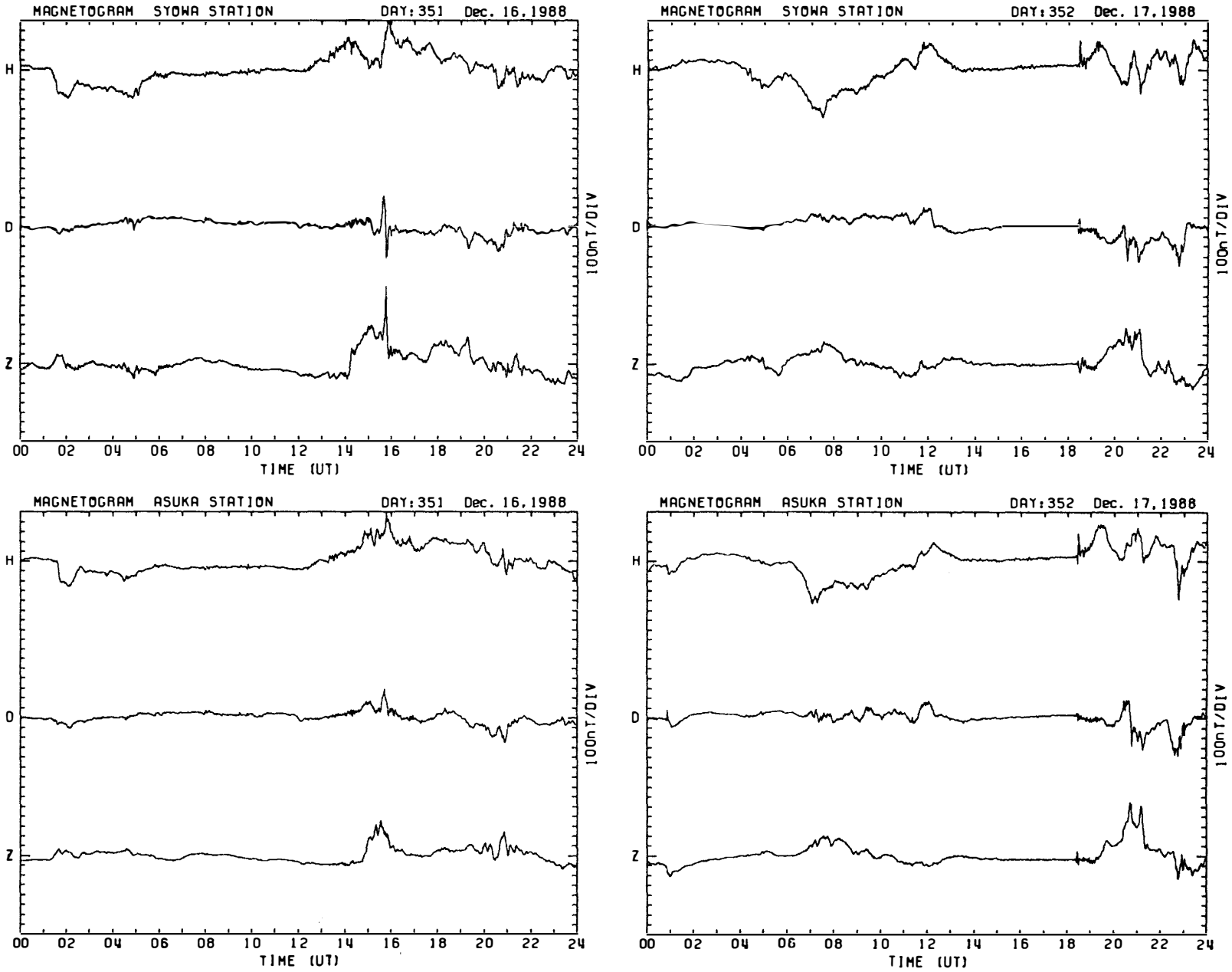
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MAGNETOGRAM ASUKA STATION DAY:351 Dec. 16,1988
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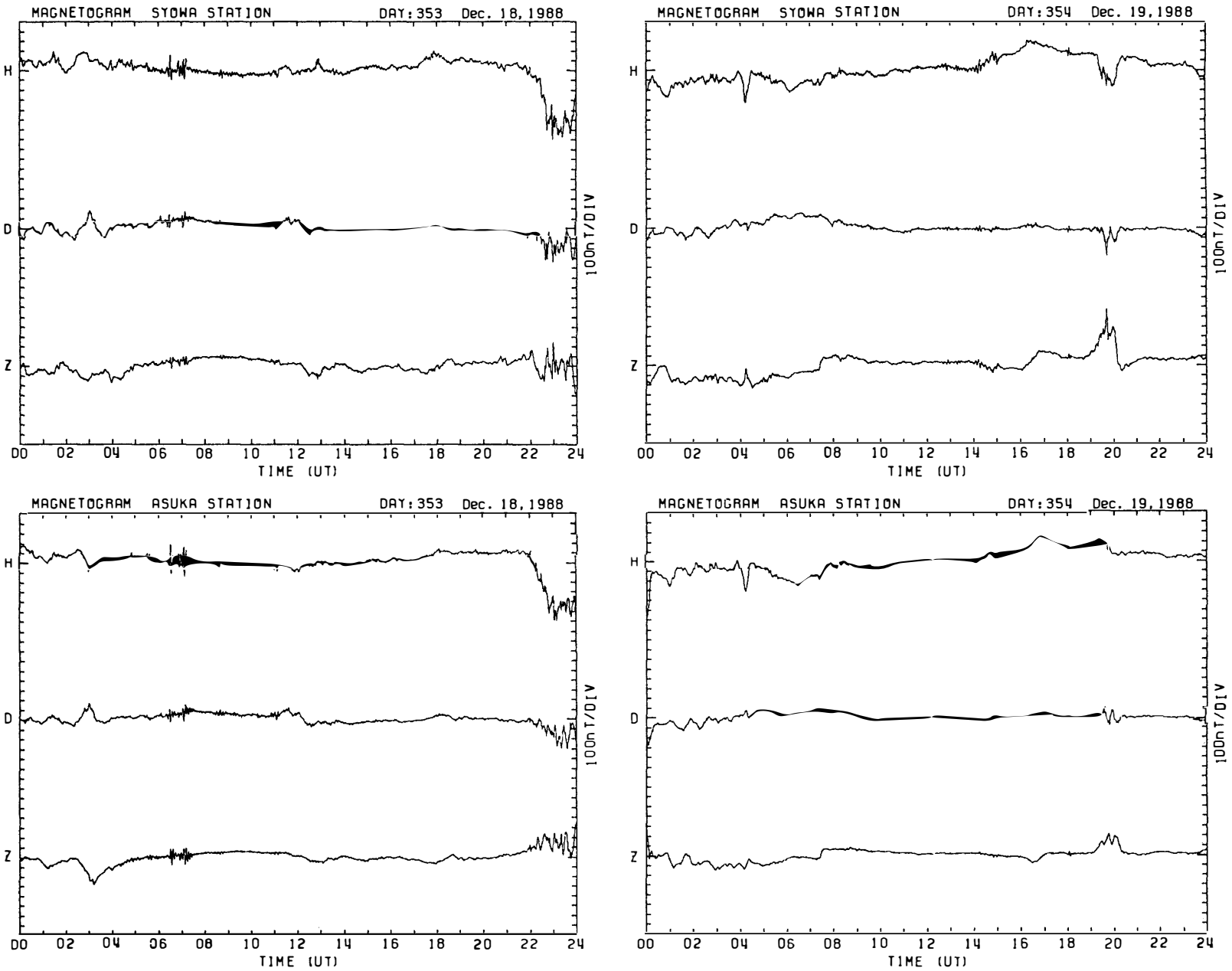
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MAGNETOGRAM ASUKA STATION DAY:353 Dec. 18,1988
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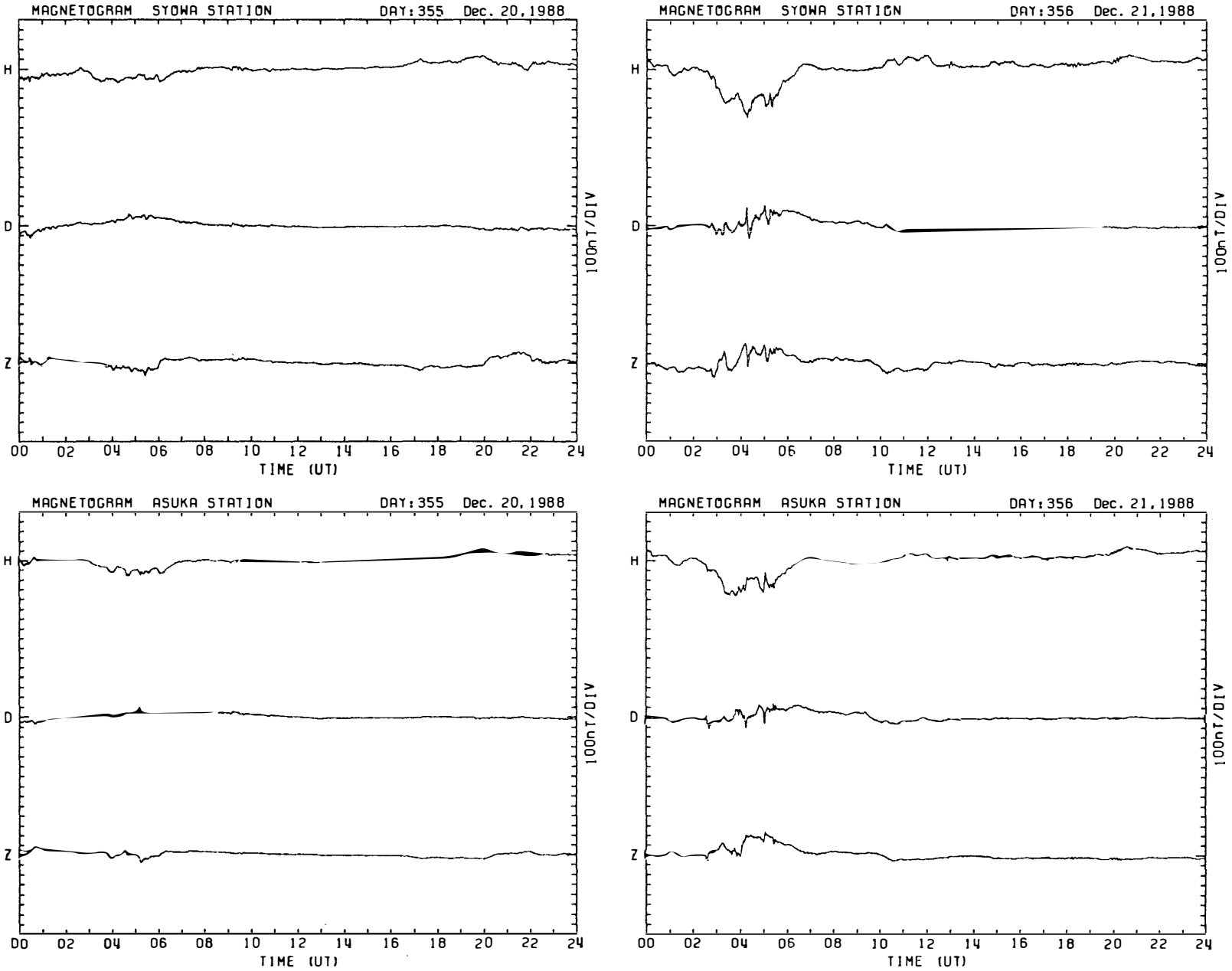
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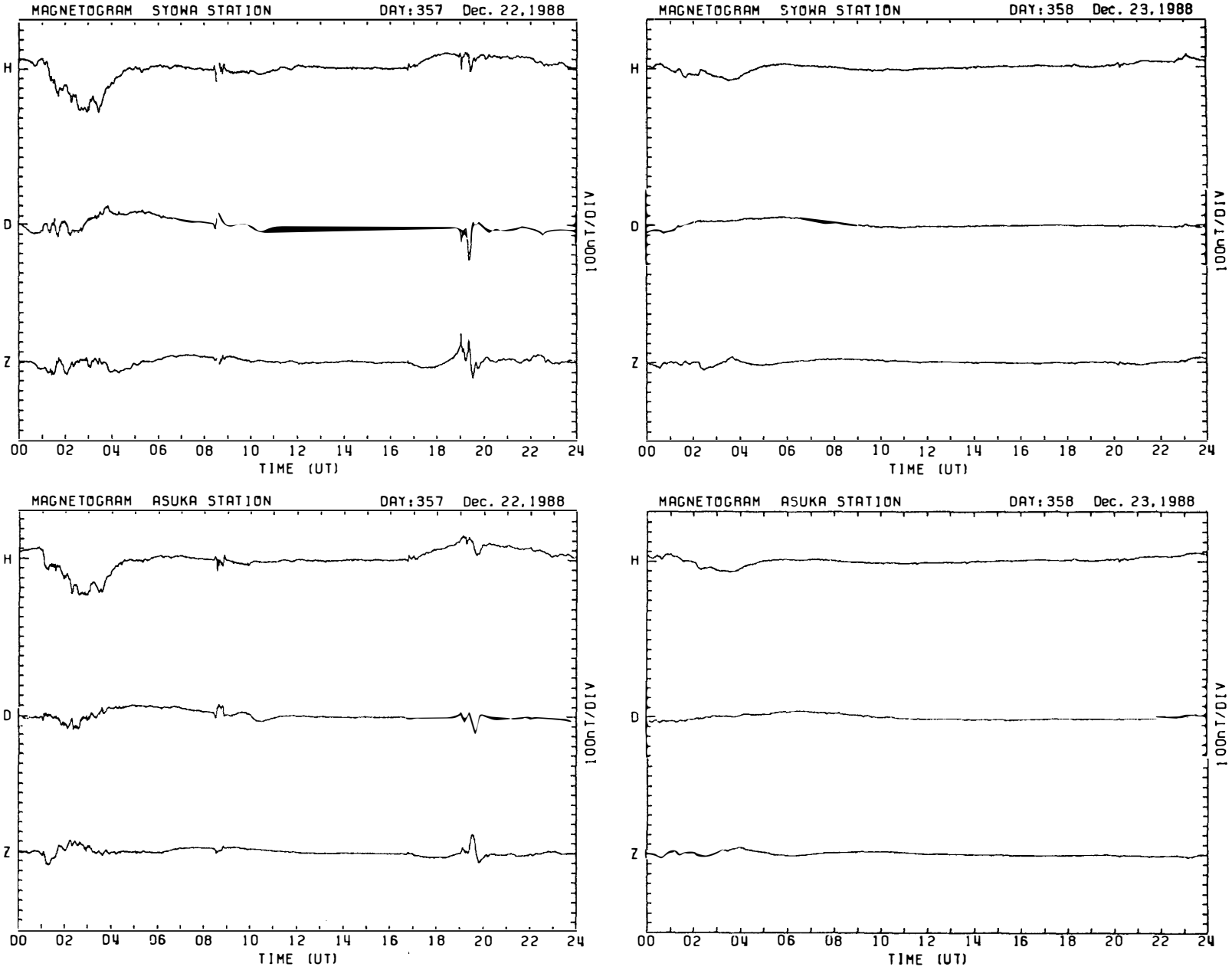
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MAGNETOGRAM ASUKA STATION DAY:357 Dec. 22,1988
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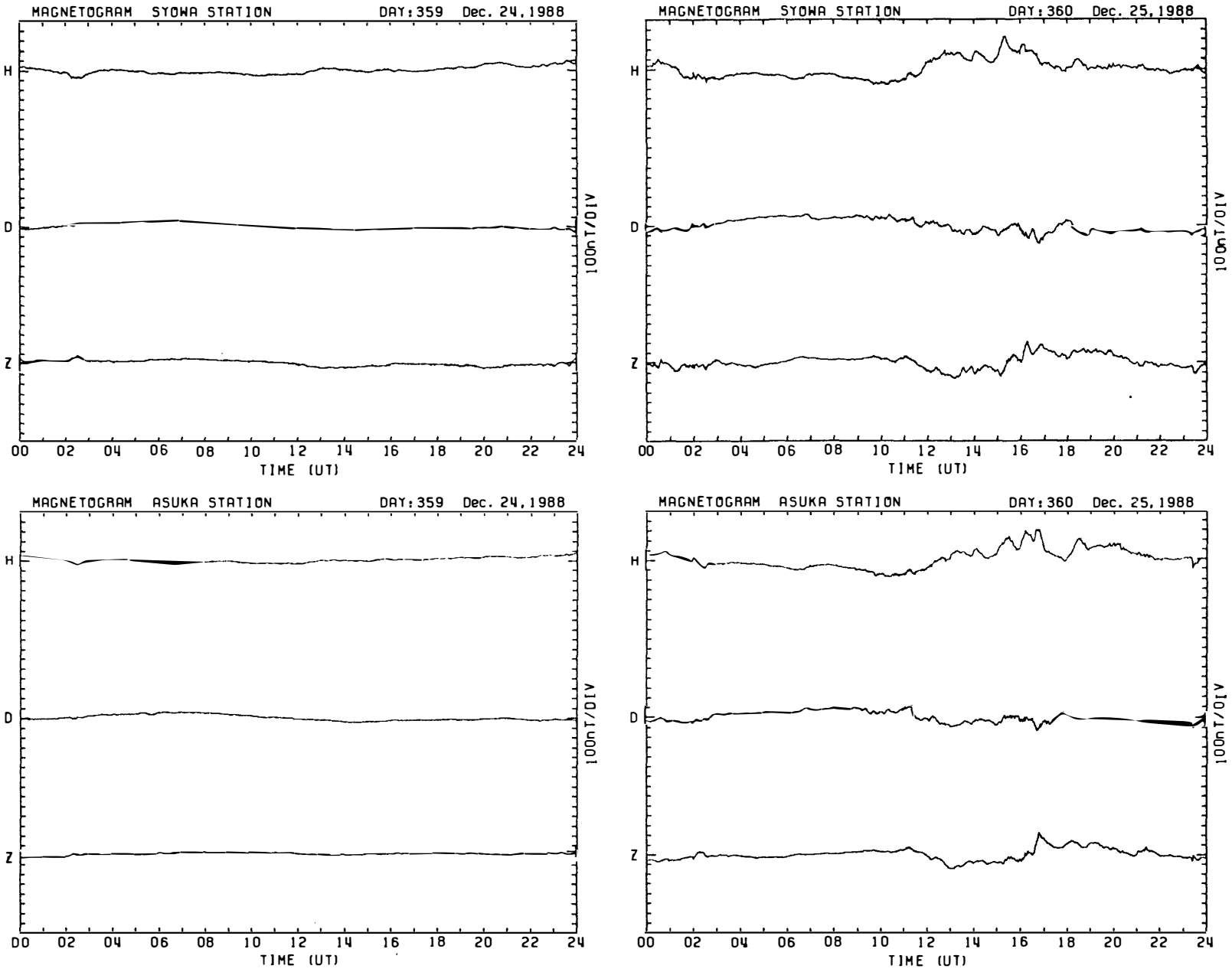
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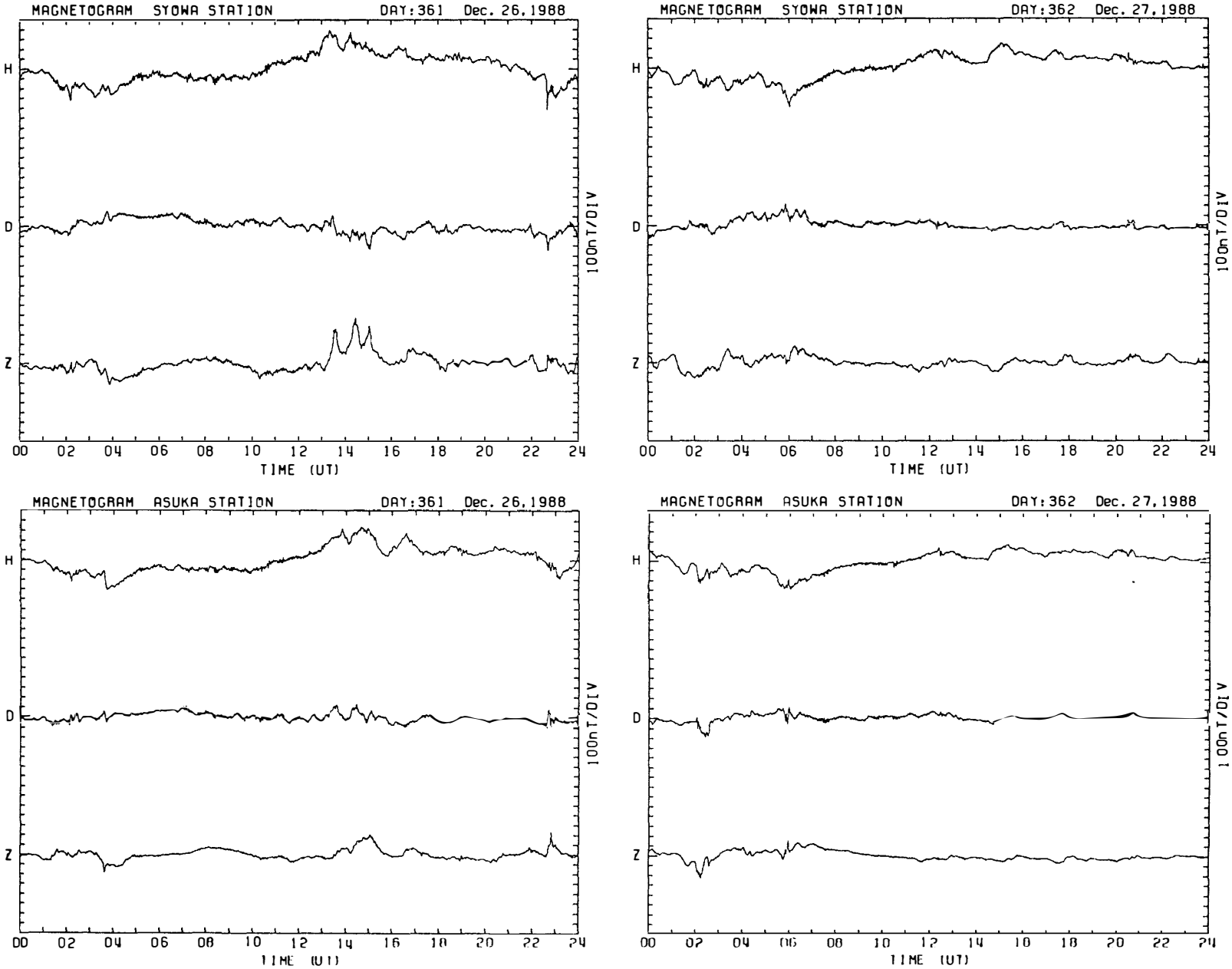
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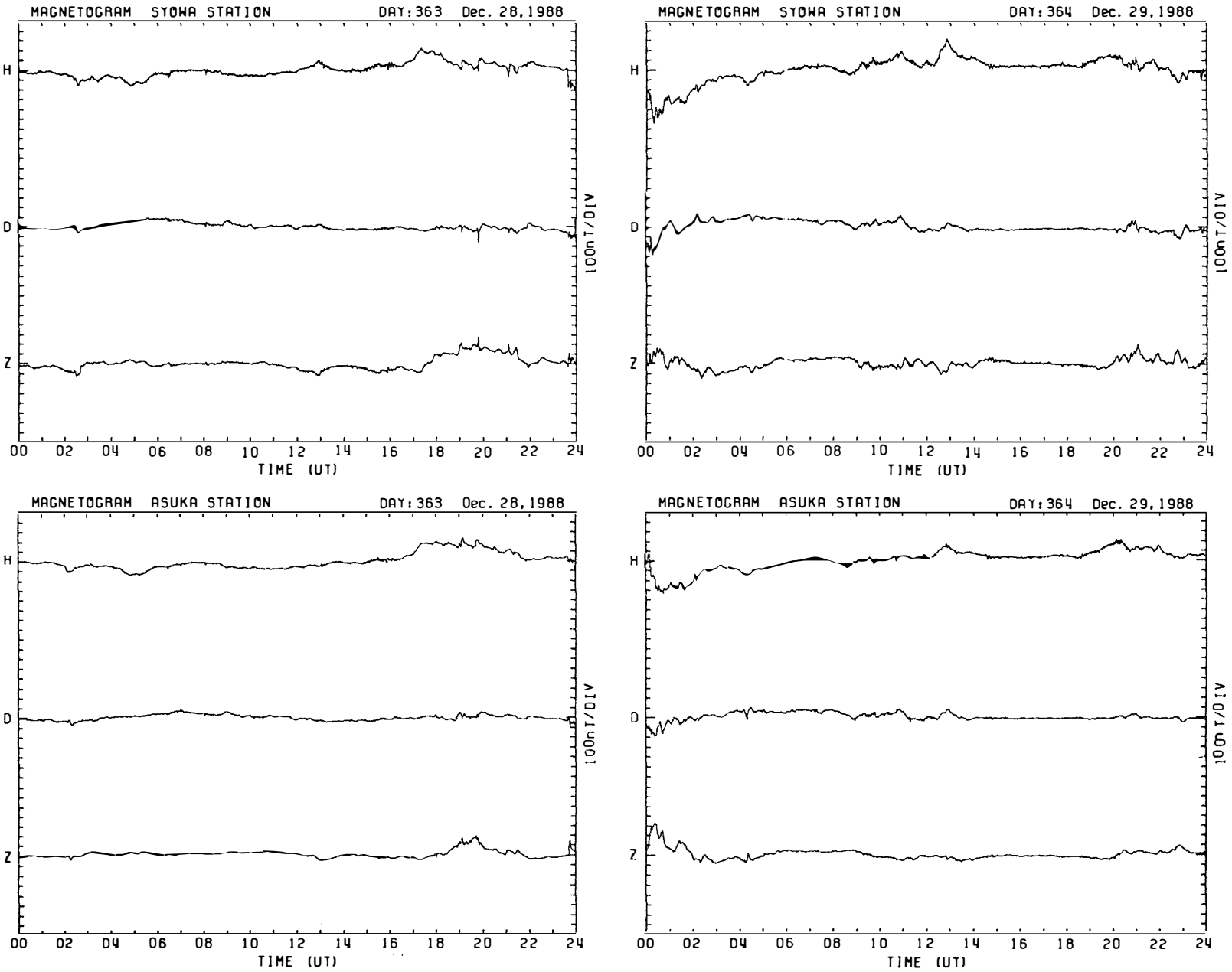
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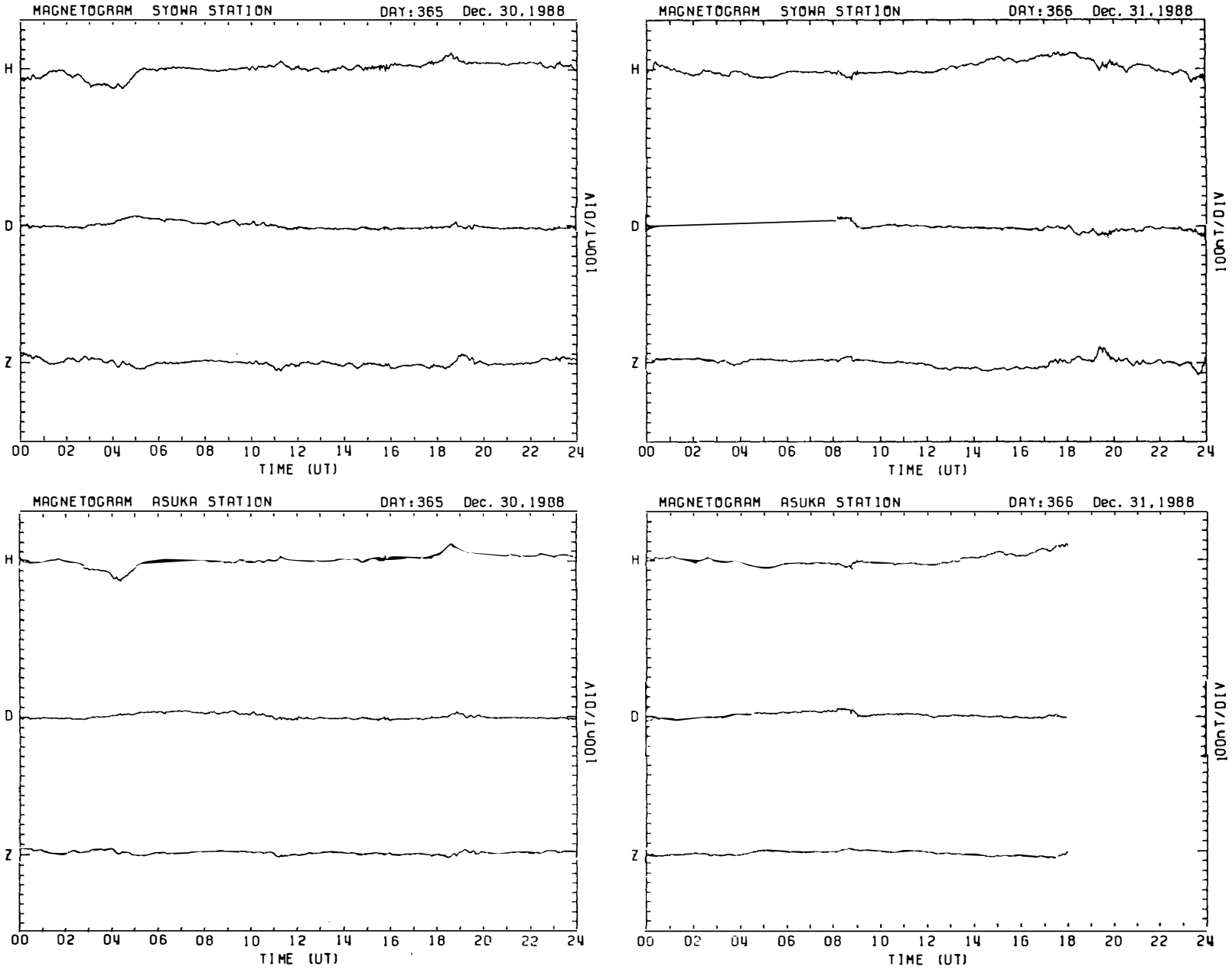
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