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Magnetic Results 2001

LERWICK, ESKDALEMUIR AND HARTLAND OBSERVATORIES
AND UK REPEAT STATIONS

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

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1. Introduction

This bulletin is a report of the measurements made between the 1st January and the 31st December 2001 at the UK geomagnetic observatories operated by the British Geological Survey (BGS) at Lerwick, Eskdalemuir and Hartland and at the repeat stations occupied during the year.

The three observatory sites are described, with notes of any changes made during the year. The Geomagnetic Automatic Unmanned Sampling System (GAUSS), which was developed by BGS staff (Turbitt *et al.*, 1999), was first installed in 1996 and became the definitive operating system for the three UK observatories from the 1st January 1997. A description of the GAUSS instruments is given and the method of collecting the data from each observatory, the quality control procedures and the method of reducing the data to absolute values are also outlined.

A brief description of the repeat station network is also given and the results of the observations made during 2001 are presented.

The presentation of the data in this bulletin is principally in graphical form, with complete sets of daily magnetograms derived from one-minute values, and plots of hourly and daily mean values for each observatory. The data are available in digital form on request (details are given in Section 7).

A general introduction and guide to the operation of magnetic observatories is the International Association of Geomagnetism and Aeronomy (IAGA) guide by Jankowski and Sucksdorff (1996).

2. Descriptions of the observatories

The locations of the UK geomagnetic observatories are shown on the map in Figure 1 and the co-ordinates of each are given in the table below.

Observatory		**Lerwick**	**Eskdalemuir**	**Hartland**
Geographic	**Latitude**	60° 08' N	55° 19' N	51° 00' N
	Longitude	358° 49' E	356° 48' E	355° 31' E
Geomagnetic	**Latitude**	62° 01' N	57° 51' N	53° 58' N
	Longitude	89° 08' E	83° 51' E	80° 13' E
Height above mean sea level		85 m	245 m	95 m

Geomagnetic co-ordinates given are relative to a geomagnetic pole position of 79° 33' N, 71° 34' W, computed from the tenth generation International Geomagnetic Reference Field (Macmillan and Maus, 2005) at epoch 2001.5.

The history of the current UK magnetic observatories, and of other observatories that have operated in the British Isles, is described by Robinson (1982).

2.1 LERWICK (SHETLAND ISLANDS, SCOTLAND)

Lerwick Observatory is situated on a ridge of high ground about 2.5 km to the south-west of the port of Lerwick. The surrounding countryside is moor land comprising peat bog, heather and rocky outcrops. The observatory is operated by the Meteorological Office as a meteorological station carrying out routine synoptic observations and upper-air measurements. Other work includes detection of thunderstorms, measurement of solar radiation, ozone and atmospheric pollution levels, and chemical sampling. BGS also uses Lerwick as a seismological station, recording data from a local three-component seismometer set and, via radio link, from the Shetland seismic array. Lerwick was established as a meteorological site in 1919 and geomagnetic measurements began in 1922. Responsibility for the magnetic observations passed from the Meteorological Office to BGS in 1968. No members of BGS staff are stationed at Lerwick.

Figure 2 is a site diagram of Lerwick Observatory. During 2001, no major changes were made to the observatory instruments. There were further intermittent communication problems during the year. In January maintenance was caried out on the ISDN connection and in October the power supply to the Terminal Adapter (TA) was replaced. Other routine maintenance was carried out on the observatory buildings and grounds.

2.2 ESKDALEMUIR (DUMFRIES & GALLOWAY, SCOTLAND)

Eskdalemuir Observatory is situated in the Southern Uplands of Scotland. It is on a rising shoulder of open moor land in the upper part of the valley of the river White Esk. It is surrounded by young conifer forests with hills rising to nearly 700 m to the north-west. The observatory is 100 km from Edinburgh and 25 km from the towns of Langholm and Lockerbie.

Eskdalemuir is a synoptic meteorological station involved in measurement of solar radiation, levels of atmospheric pollution, and in chemical sampling. The observatory operates a US standard seismograph and an International Deployment Accelerometer Program long-period sensor. BGS has a three-component seismometer set installed at the observatory and records data from four remote sites transmitted to the observatory by radio link. The observatory opened in 1908. It was built because of disruption to geomagnetic measurements at Kew Observatory (London) following the advent of electric tramcars at the beginning of the 20th century. BGS took over responsibility for magnetic observations from the Meteorological Office in 1968. There are two members of BGS staff stationed at the observatory. Mr W E Scott and Mrs M Scott were responsible for the maintenance of the observatory buildings and grounds during 2001.

Figure 3 is a site diagram of Eskdalemuir Observatory. During 2001, no major changes were made to the observatory instruments. A failure of the GAUSS data logger, PC1, occurred in February. It was reset, which solved the problem. In October the flooring in the underground chamber was replaced. The Uninterruptible Power Supply (UPS) and the system electronics were temporarily moved to allow this work to take place. Maintenance work was carried out on the heating in the variometer chanber in December. Other routine maintenance was carried out on the observatory buildings and grounds.

2.3 HARTLAND (DEVON, ENGLAND)

Hartland Observatory is situated on the north-west boundary of Hartland village. The site is the southern half of a large meadow, which slopes steeply northward into a wooded valley. The sea (Bristol Channel) is about 3 km to both the north and west of Hartland. BGS operates a three-component seismometer set and a LF microphone at the observatory, and data from two seismic outstations are transmitted to the observatory by radio link.

The observatory was purpose-built for magnetic work, and continuous operations began in 1957, the International Geophysical Year (IGY). Hartland is the successor to Abinger and Greenwich observatories. The moves from Greenwich to Abinger and then to Hartland were necessary as electrification of the railways progressed, making accurate geomagnetic measurements impossible in SE England. BGS took over control of Hartland Observatory, from the Royal Greenwich Observatory, in 1968. The observatory also houses an archive of material consisting of records of geomagnetic measurements and observatory yearbooks from all over the world. The only member of BGS staff stationed at Hartland in 2001 was Mr C R Pringle.

Figure 4 is a site diagram of Hartland Observatory. During 2001, no major changes were made to the observatory instruments. Routine maintenance was carried out on the observatory buildings and grounds throughout the year.

2.4 UK REPEAT STATION NETWORK

Geomagnetic measurements are made at a network of 51 repeat stations throughout the UK. The locations of these are shown as circles on the map in Figure 1, which for the sites occupied during 2001 are filled in black. Absolute measurements of *D*, *I* and *F* are performed at each repeat station every 4 to 6 years so that temporal and spatial changes to the magnetic field in the UK can be evaluated. Data from the repeat station network are supplemented with data from Lerwick, Eskdalemuir and Hartland and magnetic observations made in Ireland and France, and are used to compute a model of the geomagnetic field for the region of Great Britain. This model represents the field arising from sources in the Earth's core and does not include the effects of near-surface crustal sources and the time-varying sources external to the Earth's surface.

3. Instrumentation

3.1 OBSERVATORY ABSOLUTE OBSERVATIONS

At each observatory absolute measurements are made in a single absolute hut (see the site diagrams). Since 1st January 1990, absolute values of all geomagnetic elements are referred to a single standard pillar at each of the observatories. For continuity with previous records the differences between the new and old standards are quoted in the tables of annual mean values in the sense (new standard - old standard) for all elements of the geomagnetic field. Thus, annual mean values prior to 1990.5 can be referred to the new standard by adding the site difference to the old standard values. A detailed account of the change in absolute measurement reference is given by Kerridge and Clark (1991).

The instruments used at each observatory are given below.

	Fluxgate-Theodolite (Inventory Number)	Proton Magnetometer (from GAUSS)
Lerwick	ELSEC 810 (LER32)	Overhauser Effect Proton precession magnetometer (GEOMAG, SM90R)
Eskdalemuir	Bartington MAG 01H (ESK43)	Overhauser Effect Proton precession magnetometer (GEOMAG, SM90R)
Hartland	ELSEC 810 (HAD16)	Overhauser Effect Proton precession magnetometer (GEOMAG, SM90R)

In an ideal fluxgate-theodolite, the magnetic axis of the sensor core would be parallel to the optical axis of the telescope. However, this situation is impossible to achieve and small alignment errors called collimation errors are the result. These are systematic errors associated with each individual instrument and should remain roughly constant. With the telescope horizontal, δ is the collimation error about the vertical axis and ε is the collimation error about the horizontal axis, both expressed as angles. A third error, measured in nT, is the zero-field offset. This represents the output if the instrument was placed in a zero field and is due to permanent magnetisation of the core or to features of the electronics. The collimation and zero-field offset values calculated throughout the year are plotted to check that they remain reasonably constant. Departures from a long-term mean value may be caused by mechanical or electronic changes to the fluxgate-theodolite or by errors in recording the measurements. A full description of the fluxgate-theodolite is given in Kerridge (1988).

3.2 PRIMARY OBSERVATORY OPERATING SYSTEM - GAUSS

The essential components of GAUSS are: a triaxial linear-core fluxgate magnetometer (Model FGE-89) manufactured by the Danish Meteorological Institute (DMI); an Overhauser Effect proton precession magnetometer (GEOMAG, SM90R), with its sensor mounted at the centre of a set of dual axis Helmholtz coils; and a Global Positioning Satellite (GPS) receiver (Garmin GPS36). These instruments all operate under the control of two IBM compatible Personal Computers (PC1 and PC2). A block diagram of the GAUSS system is given in Figure 5.

Each GAUSS system is supported by a 500 VA Merlin-Gerin SX500 Uninterruptible Power Supply (UPS); this equipment has internal batteries capable of powering the system for one hour in the event of a mains failure. Each observatory also has a stand-by diesel generator designed to start automatically, within one minute of loss of mains power. In normal operation the UPS is only required to maintain mains power to the GAUSS system until the generator takes over.

3.2.1 Fluxgate variometer measurements

The fluxgate sensors are orientated to measure the variations in the horizontal (*H*) and vertical (*Z*) components of the magnetic field. The third is orientated perpendicular to these and measures variations that are proportional to the changes in declination (*D*). The fluxgate magnetometers, operating as variometers, provide an analogue output of ±10 Volts, which corresponds to a magnetic field change of ±5000 nT. Mounted orthogonally to one another, the sensors are in a single 20 cm cube marble block, which is located on a pier in a temperature-controlled variometer chamber. At Eskdalemuir this marble block is supported in a gimballed mounting, which provides magnetometer tilt correction. This automatic compensation is not carried out at Lerwick or Hartland. The temperature in the variometer chamber is controlled by a separate temperature sensor, which activates heaters when required. A full description of the

DMI fluxgate magnetometers is given in a DMI technical report (1997).

The rate at which the outputs from the three fluxgate sensors are sampled is one per second. These one-second values are then passed through a 61-point cosine filter to generate one-minute values of *H*, *D* and *Z* variations centred on the beginning of the minute.

3.2.2 PVM variometer measurements

The proton vector magnetometer (PVM) apparatus has been designed to measure absolute values of total intensity (*F*) as well as variations in *D* and Inclination (*I*). The apparatus used to make PVM measurements consists of a proton precession magnetometer (PPM) sensor mounted at the centre of two orthogonal sets of Helmholtz coils in a delta *D*/delta *I* ($\delta D/\delta I$) configuration. Currents are passed through the coils creating bias fields, the magnitude of which are measured in combination with the Earth's magnetic field. The coils are orientated initially so that one set provides a bias field approximately perpendicular to the geomagnetic field vector in the horizontal plane (δD), and the other provides a bias field approximately perpendicular to the geomagnetic field vector in the magnetic meridian (δI). If the resultant magnetic field is measured after applying the bias fields then vector algebra can be used to calculate the change in declination (δD) and the change in inclination (δI). These changes are relative to baseline values of declination and inclination (D_0 and I_0) determined by the directions of the magnetic axes of the coils. The values of D_0 and I_0 can be determined by comparing the PVM measurements with absolute observations. This technique is described in full by Alldredge (1960).

The proton magnetometer and associated coils are sited in a non-magnetic hut, which is within 50 m of the GAUSS control electronics. A magnetic field measurement is made every eight seconds, following a sampling sequence of:

i. without a bias field (F_1);
ii. with a current flowing in the δI coils to create a bias field positive in the direction of *I* (*I*+);
iii. with a current flowing in the opposite direction from that of *ii*. (*I*–);
iv. without a bias field (F_2);
v. with a current flowing in the δD coils to create a bias field positive in the direction of *D* (*D*+);
vi. with a current flowing in the opposite direction from that of *v*. (*D*–); and
vii. without a bias field (F_3).

The complete cycle of measurements takes 56 seconds. Using the results from the vector measurements quasi-absolute one-minute values of *D* and *I* are derived as well as absolute one-minute mean values of *F*.

Full PVM absolute observations would require a sequence of measurements to be made with the coils rotated into positions enabling errors due to imperfect alignment of the magnetic axes to be eliminated. The Helmholtz coils used at the UK observatories cannot be rotated, so the measurement is not error-free. If the mechanical stability of the coil system is good, and the pier on which it is mounted does not tilt, then the error should be (practically) constant. Comparisons of PVM results with measurements made by the fluxgate magnetometers have shown that this is not the case. Drifting can be observed in the PVM values, which means that they have not been used as a means for interpolating between absolute observations as originally designed. Instead, these measurements have been useful as an extra quality control check for the individual absolute observations and, if used over short term periods only, as an extra back-up system for the one-minute variometer data.

3.2.3 Data collection, control and communications

In routine operations the analogue outputs from the three channels of the fluxgate magnetometer and the two temperature sensors are sampled every second by a 20-bit analogue to digital converter (ADC). The temperature sensors measure the temperature in the variometer chamber and the hut housing the PVM apparatus. The control of this operation along with switching bias currents to the Helmholtz coils and sampling of the proton magnetometer is done by the embedded PC2. This PC has its operating system and all control and data collection software stored in erasable programmable read only memory (EPROM). Its operation is dedicated to sampling the fluxgate and proton magnetometers and transferring these data through serial communications to PC1, which computes the one-minute values, handles the data storage and provides operating status codes.

In designing GAUSS one of the main constraints was that all data input and sensor control functions should be carried out through standard serial or parallel PC ports (COM1, COM2 or LPT1). No specialised interface cards have been used in its design. This feature will allow, in the event of a system failure, the replacement of either PC1 or PC2 with any IBM compatible PC fitted with the correct number of standard ports.

PC1 controls all data collection, filtering and error checking operations along with the transmission of data from the observatory back to Edinburgh for analysis, dissemination to users and archiving. All system timing operations are controlled by the PC1 software clock, which is synchronised to GPS time using the information received through the Garmin GPS receiver. Time information is received and decoded every second by the GPS receiver and relayed serially through the COM2 port on PC1 to update or correct the PC1 processor clock. This timing information is also relayed serially, from PC1 to PC2, and used to control all data collection operations. Using this method of time synchronisation the sample timing and time stamping of the recorded data is maintained to an accuracy of ±100 ms.

The data are stored in files on the disk drive on PC1. Each file contains one day of time-stamped one-minute values of *H*, *D* and *Z* variations from the fluxgate magnetometer, two sets of temperature measurements and five PVM measurements in the sequence *I*+, *I*-, *D*+, *D*- and *F*. These files are maintained for 40 days on PC1, after which they are overwritten.

Communication between Murchison House in Edinburgh and GAUSS at Lerwick and Hartland observatories is provided by Integrated Services Digital Network (ISDN) connections on GAUSS and the data collection PC in Murchison House. The data from these two observatories are transferred every 4 minutes. A Local Area Network (LAN) is operational at Eskdalemuir, providing direct INTERNET access to the observatory from Murchison House. A Hitchhiker network device provides a link between GAUSS and the data collection PC in Murchison House and the data are transferred every 2 minutes. Normally, data retrieval is automatic, but facilities have been included to allow manual operator control of several functions. These permit the operator to extract any current data which have not been retrieved by an automatic call-up, retrieve historical data (up to 40 days old), replace GAUSS operating software or make adjustments to system configuration parameters (e.g. adjust fluxgate/ADC scaling factors).

3.2.4 Technical specifications summary

The specifications quoted here are those given by the manufacturers of the equipment.

DMI fluxgate magnetometer

Sensitivity	0.2 nT
Dynamic Range	±5000 nT (LER), ±4000 nT (ESK and HAD)
Temperature coefficient	< 0.25 nT/°C

GEOMAG SM90R Overhauser effect proton magnetometer

Resolution	0.01 nT
Accuracy	±0.1 nT
Measurement Range	10,000 - 90,000 nT

Garmin GPS receiver

Output code	NMEA standard coded messages
Output data rate	4800 baud
Output update rate	Once/second

Analogue to digital converter

Type	2 x Crystal CS5506
Resolution	20 bit (2^{20})
Number of channels	8
50Hz noise rejection	105 dB
Sampling rate	1 Hz (maximum 100/sec)
Scaling factor	approx. 52000 counts/volt (This depends on the calibration values of the fluxgate)

System clock

PC1 Real Time Clock	without GPS corrections >1 second/day with GPS corrections applied every second within ±100 ms of GPS time.

3.3 BACK-UP OBSERVATORY OPERATING SYSTEMS – FLARE *PLUS*

The back-up systems provide completely independent back-up data in the event of a total GAUSS failure. They are the Fluxgate Logging Automatic Recording Equipment incorporating a proton magnetometer (FLARE *Plus*), which was developed by BGS. The FLARE *Plus* system is based on a PC, which controls the data logging and communications. The measurements are made using two types of magnetometers: a triaxial linear-core fluxgate magnetometer (model FGE-89) manufactured by the DMI; and an Overhauser PPM (GEOMAG, SM90R). Two of the fluxgate sensors are orientated to measure the variations in *H* and *Z* and the third is orientated perpendicular to these and measures variations that are proportional to the changes in *D*. Measurements are made every 5 seconds and are filtered using a 19-point Gaussian filter to produce one-minute values centred exactly on the minute. The PPM is used to make measurements of *F* every minute, also on the minute. As with GAUSS, accurate timing of the data is maintained using a GPS receiver. The one-minute values are stored both in memory (up to 2 days) and on 3½" floppy disk (up to 40 days). The FLARE *Plus* system is described in more detail by Turbitt *et al* (1997) and a block diagram of the system is shown in Figure 6.

FLARE *Plus* data are retrieved to the BGS office in Edinburgh using a Multitech modem operating at speeds of up to 9600 baud with the data relayed through the public switched telephone network (PSTN). This is normally carried out at four selected times by the automatic data collection processor in Edinburgh, but as with GAUSS, facilities have been included to allow manual operator control of several functions, including immediate data retrieval in the event of the loss of GAUSS data.

3.4 REPEAT STATION SURVEY INSTRUMENTS

A series of absolute observations are carried out at each site using the instrumentation summarised below. Calibration checks of all survey instruments are carried out before and after each field session.

Repeat Station Instrumentation		
Instrument	**Function**	**Accuracy**
Wild GAK-1 north seeking gyro attachment for theodolite. Also Leica 530 twin GPS receivers	To acquire a horizontal circle reading for **true north** for measurement of *D*.	10 arc-seconds 10 arc-seconds
Bartington Mag-01 fluxgate magnetometer sensor mounted on Zeiss non-magnetic theodolite.	Detection of magnetic meridian in the horizontal plane for measurement of *D* and detection of magnetic field vector in the magnetic meridian for measurement of *I*.	~6 arc seconds
GEM GSM-19 Overhauser effect proton precession magnetometer.	Measurement of *F*.	0.2 nT

The proton precession magnetometer (PPM) logs absolute one-minute values at a location a few metres from the repeat station for the duration of the occupation. An accurate site difference between the station and the PPM site is obtained initially by running two PPMs concurrently for 5 minutes. An azimuth reading for true north is obtained from a gyro-theodolite combination mounted on a tripod. This process is fully described by Kerridge (1984b). The instrument is set up at the station inside a non-magnetic shelter for protection from the weather. Successive absolute observations of *D* and *I* are then made at least once an hour for 4–6 hours. These measurements are made using the fluxgate-theodolite. The procedure is described in detail in Kerridge (1984a). Accurate times for each reading and position are obtained from a portable Garmin GPS receiver.

3.5 CALIBRATION OF OBSERVATORY INSTRUMENTS

The physical measurements made by GAUSS are of the analogue voltage output from the fluxgate sensors and the precession frequency radiated by the polarised sample in the proton precession magnetometer. For calibration purposes these measurements can be split into three separate processes: calibration of the fluxgate magnetometer; calibration of the ADC module; and calibration of the proton magnetometer.

At all three observatories the same calibration procedures are followed and all the sensors and digitising equipment listed above are calibrated four times per year. All test equipment used in these calibrations is checked annually against National Physical Laboratory (NPL) standards. A file containing the relevant certificates for all observatory test equipment is maintained at

BGS, Edinburgh. The equipment used in these calibrations is a high resolution digital voltmeter (DVM), a precision 1000Ω manganin-wound resistor and a frequency source stabilised using the 198 kHz radio reference.

The calibrations were carried out routinely in 2001 during service visits to the observatories by Edinburgh based BGS staff. Lerwick instruments were serviced in June and October, Eskdalemuir instruments were serviced in May and November, and Hartland instruments were serviced in May, September and December.

3.5.1 Calibration of the fluxgate magnetometers

The scale values of the fluxgate sensors are calibrated by the manufacturer at the DMI. A regular check of the scale value of each sensor is carried out by measuring the current through the 1000 Ω resistor connected in series with the feedback coil of each sensor and then using the coil constant, provided by the manufacturer, to calculate the scale value. The object of the calibration is to check any drift, or change in the manufacturer's supplied scale values.

3.5.2 Calibration of the ADC

This unit is calibrated by disconnecting the fluxgate and applying a +5 Volt, zero Volt and a –5 Volt DC signal from a stabilised voltage source to each input of the ADC, respectively. This input voltage is measured using the calibrated DVM and the resultant digital counts are displayed on the PC1 monitor. The ADC conversion factor in Volts per count can then be calculated.

3.5.3 Calibration of the proton magnetometer

The proton magnetometer measures the frequency of emitted radiation from a sample of proton-enriched fluid. This is related to the ambient magnetic field by the proton gyromagnetic ratio. The conversion from frequency to magnetic field value carried out by the proton magnetometer is checked by irradiating the sensor with a signal of various frequencies derived from a stable frequency source. The stable source used to provide these frequencies is a 198 kHz signal transmitted from Droitwich. The long-term accuracy of this signal, quoted by NPL, is 1 part in 10^9; the short-term accuracy is 1 part in 10^{11}. All proton magnetometers operating at the UK magnetic observatories are calibrated using this method over a range of field values from 20,000 nT to 80,000 nT at three monthly intervals.

4. Observatory data processing

Data are retrieved to Edinburgh from the observatories by a dedicated IBM PS/2 PC. It can either be programmed to call the observatories automatically at predetermined times or it can be used to manually retrieve the data when required. The data are then transferred via a standard serial link to a Sun Workstation where they are stored in day files in raw binary format. The raw data are also stored on the data retrieval PC for 45 days, after which time they are overwritten.

Data processing is carried out automatically on the Sun workstation at ten minute intervals. The binary data files are first converted into ASCII, with the data sorted by Universal Time (UT). Subsequent data processing is carried out on these day files by a FORTRAN program, which uses subroutines to generate various data products and derivatives. Several quality control routines are also carried out to identify possible errors. The overall control of the automatic data processing jobs are carried out by UNIX C-Shell scripts, which are executed by the UNIX clock daemon command, *cron*.

The data products generated automatically each day shortly after midnight are:

- *HDZ* fluxgate magnetograms;
- *HDZ* PVM magnetograms;
- Plots comparing *F*, *D, H* and *Z* measurements made from the three systems;
- Formatted lists of one-minute values;
- Hourly mean values of each geomagnetic component;
- Hourly standard deviations in *X* and *Y*;
- Hourly and daily ranges in each geomagnetic component;
- Daily mean values;
- *K* indices; and,
- Forecasts of geomagnetic activity for up to 27 days ahead.

The final check on the quality of the data is the responsibility of the operator in Edinburgh who examines the magnetograms and comparison plots each day. Any erroneous values, undetected by the automatic quality control procedures, will be identified at this stage. If required, data from the back-up system or the PVM measurements can be used to replace any erroneous values or fill any gaps in the GAUSS fluxgate data, after which the main daily data processing procedure is repeated.

At all three observatories there were no periods during 2001 when the GAUSS and back-up variometers and the GAUSS PVM measurements all failed simultaneously. Consequently, the time-series of one-minute values are complete throughout the year.

The scientific and commercial demand for rapid access to UK observatory data and data products has continued to increase and further development of the automatic data processing procedures and quality control standards has been carried out to help meet these requirements. Data products are transferred to academic and commercial users worldwide by electronic mail. Established in 1987, the Geomagnetism Information and Forecast Service (GIFS), provides free, "user-friendly" access to the data sets, and is available on the world-wide web (*www.geomag.bgs.ac.uk/on_line_gifs.html*). Some of the data sets on GIFS derived from UK observatory data are updated hourly while others are updated daily.

At the end of each month, a monthly bulletin is issued for each observatory to present the preliminary magnetic results obtained during the month and record the quality control procedures undertaken to maintain the standard of these results. The results included in these bulletins are: magnetograms; hourly and daily mean plots; monthly mean values; lists of rapid variations; *K* and *aa* indices; and the forecasts of magnetic and solar activity. The quality control records included are: the results of absolute observations and the associated collimation errors; PVM–fluxgate comparisons; plots of the baselines applied to the variometer measurements; and a diary giving details of any changes made during the month at the observatory. The baseline values allocated to the variometer data are also reviewed each month and definitive monthly mean values are published around 6 months in arrears.

At the end of each year the baseline values are finalised to give absolute values, the details of which are given in Section 5. The results obtained from these definitive absolute values are described in Section 6 of this text and presented in the final results section.

5. Correction of data to absolute values

The GAUSS fluxgate magnetometers only monitor accurately variations in the components of the geomagnetic field, they do not measure the absolute magnitudes of the components. Absolute measurements of the field are made typically once a week. As described in Section 3.1, *D* and *I* are determined using a fluxgate sensor mounted on a theodolite and *F* is measured using a proton precession magnetometer. The absolute observations are used in conjunction with the GAUSS variometer measurements to derive baselines and produce a continuous record of the absolute values of the geomagnetic field elements as if they had been measured at the observatory reference pillar.

The baselines allocated for each observatory for 2001 are shown in Figures 7-9. (The results for each observatory are discussed in more detail below.) The baselines are derived by comparing the fluxgate measurements with absolute measurements taken simultaneously. In each of the figures, the top panel shows the comparison between the absolute measurements and the fluxgate measurements for *H* (plotted in the sense absolute − fluxgate). The second panel shows the same for *D*, in which East is represented by positive values, and the next panel shows the same for *Z*. In these absolute − fluxgate comparison panels, the symbols represent the observed values and the full line shows the adopted baselines. The adopted baselines are derived from piecewise polynomial fits to the observed values computed using the method of least squares. In deriving the baselines the observations made towards the end of the previous year and at the start of the following year were used, but are not shown in the plots. This ensures that unrealistic discontinuities are not introduced at the year boundaries. Daily mean differences between the measured absolute *F* and the *F* computed from the baseline corrected *H* and *Z* values are plotted in the third panel from the bottom (plotted in the sense measured − derived). The bottom two panels show the daily mean temperature in the fluxgate chamber and the daily mean temperature in the hut housing the PVM apparatus, which follows changes in the outside temperature.

5.1 LERWICK

Absolute measurements were made weekly by Meteorological Office staff based in Lerwick and were supplemented by measurements made by Edinburgh based BGS staff during service visits to the observatory. These are plotted in Figure 7 as the observed baselines, that is, with the variometer values subtracted. The clusters of measurements made within a few days indicate the dates of service visits.

The ranges of the allocated baselines during the year were 4.8 nT for *H*, 0.98 minutes of arc for *D* and 1.8 nT for *Z* and there were no significant baseline steps during the year.

The table below lists the root mean squared (*rms*) differences of the observed baseline corrections from the allocated values. The *rms* differences for 1999 and 2000 are also listed. The number of observations used for each component is given in brackets.

Year	H(nT)	D(min)	Z(nT)
1999	0.90 (56)	0.17 (61)	0.46 (59)
2000	0.76 (48)	0.15 (45)	0.30 (47)
2001	0.84 (46)	0.18 (48)	0.29 (45)

5.2 ESKDALEMUIR

Absolute observation measurements were made weekly by the resident BGS staff at the observatory and supplemented by measurements made by Edinburgh based BGS staff during visits to the observatory. These are plotted in Figure 8 as the observed baselines, that is, with the variometer values subtracted.

The ranges of the allocated baselines during the year were 2.6 nT for *H*, 0.61 minutes of arc for *D* and 1.5 nT for *Z* and there were no significant baseline steps during the year.

The table below lists the root mean squared (*rms*) differences of the observed baseline corrections from the allocated values. The *rms* differences for 1999 and 2000 are also listed. The number of observations used for each component in each year is given in brackets.

Year	H(nT)	D(min)	Z(nT)
1999	1.05 (86)	0.22 (92)	0.44 (86)
2000	0.54 (68)	0.24 (67)	0.40 (76)
2001	0.82 (85)	0.27 (88)	0.34 (87)

5.3 HARTLAND

Absolute observation measurements were made weekly by the resident BGS staff at Hartland Observatory. These are plotted in Figure 9 as the observed baselines, i.e. with the variometer values subtracted.

The ranges of the allocated baselines during the year were 3.8 nT for *H*, 0.61 minutes of arc for *D* and 3.9 nT for *Z* and there were no significant baseline steps during the year.

The table below lists the *rms* differences of the observed zero-field corrections from the allocated values. The *rms* differences for 1999 and 2000 are also listed. The number of observations used for each element in each year is given in brackets.

Year	H(nT)	D(min)	Z(nT)
1999	0.45 (96)	0.09 (93)	0.30 (96)
2000	0.44 (89)	0.09 (90)	0.35 (89)
2001	0.36 (83)	0.10 (84)	0.28 (83)

6. Presentation of observatory results

The data are organised by observatory in the order Lerwick, Eskdalemuir and Hartland. The following sub-sections summarise the results presented for each observatory.

6.1 ONE-MINUTE VALUES

The one-minute values of *H*, *D* and *Z* are centred at the beginning of the minute. These are plotted in daily magnetograms of *H*, *D* and *Z*. They are organised as 16 to a page, the data for days 1 to 16 of each month on one page, and the data for the remaining days of the month on the facing page. The *D* trace is plotted positive (east) upwards. The absolute level in each plot is indicated by the value shown to the left of the plots, in degrees for *D* and in nanoteslas for *H* and *Z*, which have been set to equal the relevant monthly mean values. The magnetogram scale values, shown to the right of the plots, are varied (by multiples of two) where necessary, and when changes are made this is indicated at the top of the magnetogram. This accounts for the occasional discontinuities in the traces at day boundaries.

6.2 HOURLY MEAN VALUES

Hourly mean values, centred on the UT half-hour, are computed from the one-minute values unless there are more than six one-minute values missing. The hourly mean data are plotted at a constant scale in 27-day batches, according to the Bartels rotation number. These plots show a number of features of geomagnetic field variations including diurnal variation, and seasonal changes in its magnitude, and periods of geomagnetic disturbance. By plotting the data in 27-day batches, recurrent solar driven disturbances are highlighted. Changes due to secular variation at the UK observatories over the course of a year are small compared to diurnal variations and disturbances. However, the gradual drift eastward in D is discernible in the plots.

6.3 DAILY MEAN, MINIMUM AND MAXIMUM VALUES

Daily mean values and the daily maximum and minimum values are calculated from the one-minute values. Daily means are not computed if there are more than 144 one-minute values (2 hours and 24 minutes) missing. In the plots of daily mean values, secular variation is quite clear in *H*, *D*, *Z* and *F* as shorter period variations are attenuated by the averaging. The reference values shown on the left sides of the daily mean plots are the annual mean values. The black shading indicates when the daily mean was less than the annual mean; the white part indicates when the daily mean was greater. The plots of daily maximum and minimum values are also plotted. These are shaded black and white relative to the daily means.

6.4 MONTHLY MEAN VALUES

Monthly mean values are calculated from the daily mean values. Monthly means are not computed if there are more than three missing daily values. At each stage of processing, the mean values of the remaining geomagnetic elements are calculated from the corresponding mean values of *H*, *D* and *Z*. Annual mean values are also calculated from the daily mean values uless there are more than 36 missing daily values. The monthly mean and annual mean values for all the geomagnetic elements are tabulated. Declination and inclination are expressed in degrees and decimal minutes of arc, the units of all the other elements are nanoteslas. Monthly and annual mean values are also calculated for the five international quiet days and the five international disturbed days in each month.

6.5 INDICES

The *K* index summarises geomagnetic activity at an observatory by assigning a code, an integer from 0 to 9, to each 3-hour UT interval. The index values are determined from the ranges in *H* and *D* (scaled into nT), with allowance made for the regular diurnal variation. The method for computing *K* indices is described by Clark (1992). The *K* index has a Local Time and seasonal dependence associated with the geographic and geomagnetic co-ordinates of the observatory. The complete sets of *K* indices for each of the UK observatories are tabulated throughout the year.

A summary of the occurrence of each *K* index in 2001 is given below (there were no intervals of missing *K* indices at any of the three UK observatories).

	K Index									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
LER	**672**	**921**	**715**	**358**	**129**	**59**	**31**	**19**	**9**	**7**
ESK	**491**	**826**	**734**	**553**	**216**	**59**	**22**	**9**	**6**	**4**
HAD	**307**	**834**	**830**	**573**	**259**	**81**	**26**	**8**	**2**	**0**

A number of 3-hour geomagnetic indices are computed by combining *K* indices from networks of observatories to characterise global activity levels and to eliminate Local Time and seasonal effects. *K* indices from each of the three UK observatories are used in deriving the planetary geomagnetic activity indices *Kp*, *Kn* and *Km*, sanctioned by the International Association of Geomagnetism and Aeronomy (IAGA). The *K* indices from Hartland are combined with those from Canberra observatory, Australia, which is approximately antipodal to Hartland, to produce the 3-hourly *aa* and daily *Aa* index. *Aa* is another planetary or global activity index. The *aa* indices for 2001 have been computed in Edinburgh and the daily (*Aa*), monthly and annual mean values are listed following the tables of *K* indices for Hartland. (Definitive values of the indices recognised by IAGA are published by the International Service for Geomagnetic Indices, St. Maur, France.) The derivation of the geomagnetic activity indices mentioned here is described in detail by Mayaud (1980).

6.6 RAPID VARIATIONS

The scaling of rapid variations is performed according to the guidelines given in the Provisional Atlas of Rapid Variations (IAGA, 1961). Occurrences of Solar Flare Effects (SFEs), Sudden Impulses (SIs) and Storm Sudden Commencements (SSCs) are given along with the time, amplitude and quality of the event.

6.7 ANNUAL MEAN VALUES

The annual mean values at each observatory since operations began are tabulated. Declination and inclination are expressed in degrees and decimal minutes of arc; the units of all the other elements are nanoteslas. Plots of the annual mean values of *H*, *D*, *Z* and *F* and of first differences of the annual means, representing secular variation at the observatories are presented. In the case of Hartland, annual mean values from Abinger Observatory for 1925.5-56.5 have been included in the table. The plots for Hartland also include the values from Abinger, taking into account the site differences between the two observatories determined during 1957 when both observatories operated simultaneously.

7. Repeat station network results

During 2001, observations were made at 11 repeat stations, the results for which are tabulated below. During the year there was an outbreak of foot and mouth disease, thus sites chosen were based on areas of the country that were free from the disease. The values are reduced to a quiet level at the time of occupation using observatory data. The results of the modelling work for 2001 are shown in Figures 10 and 11. The data collection and processing are described in Carrigan (2002) and the modelling work is similar to that described in Macmillan and Carrigan (2002).

	Code	Date	Latitude	Longitude	Declination	Inclination	Total intensity
Stornoway	SWY	31/07/01	58° 12′ 37″ N	6° 23′ 43″ W	8° 02′ 36″	71° 27′ 56″	50117.9 nT
Fort Augustus	FOR	02/08/01	57° 08′ 27″N	4° 41′ 00″ W	5° 55′ 16″	70° 45′ 29″	50016.8 nT
Cromer	CRO	28/08/01	52° 48′ 45″ N	1° 13′ 29″ E	2° 50′ 37″	67° 35′ 27″	48711.4 nT
Dunwich Heath	DUN	29/08/01	52° 15′ 17″ N	1° 37′ 16″ E	2° 30′ 41″	67° 09′ 05″	48576.2 nT
Ashridge	ASH	30/08/01	51° 46′ 57″ N	0° 35′ 22″ W	3° 21′ 47″	66° 49′ 19″	48479.5 nT
Boat of Garten	BOG	04/09/01	57° 15′ 27″ N	3° 42′ 59″ W	6° 07′ 20″	70° 43′ 45″	49901.6 nT
Thurso	THU	05/09/01	58° 35′ 17″ N	3° 30′ 02″ W	5° 46′ 16″	71° 39′ 18″	50165.5 nT
Leckmelm	LEC	06/09/01	57° 51′ 44″ N	5° 05′ 39″ W	6° 40′ 39″	71° 10′ 40″	50222.9 nT
Crianlarich	CRI	02/10/01	56° 24′ 11″ N	4° 37′ 37″ W	6° 05′ 56″	70° 03′ 13″	49514.1 nT
Crail	CRA	03/10/01	56° 17′ 28″ N	2° 37′ 33″ W	4° 58′ 57″	70° 04′ 26″	49578.2 nT
Inverkeilor	INV	13/11/01	56° 37′ 43″ N	2° 32′ 07″ W	4° 54′ 58″	70° 26′ 25″	49827.0 nT

8. Data availability

One-minute mean values of geomagnetic elements at each of the UK observatories are available in digital form from 1983 onwards. Hourly mean values are available in digital form for Lerwick (1926–present), Eskdalemuir (1911–present), Abinger (1926–57) and Hartland (1957–present). *K* indices from the current UK observatories are available in digital form from 1954 onwards. In its role as the World Data Centre C1 for Geomagnetism, the BGS also holds a selection of hourly mean values and annual mean values from observatories worldwide. Digital data can be transferred directly by electronic mail or *ftp* over the Internet. Up-to-date UK observatory hourly mean values, *K* indices, global geomagnetic indices and geomagnetic activity forecasts are also available on the BGS geomagnetism web site.

For more information contact:

Geomagnetism	☏:	+44 (0) 131 667 1000
British Geological Survey	Fax:	+44 (0) 131 650 0265
Murchison House	Email:	ecla@bgs.ac.uk
West Mains Road	Internet:	www.geomag.bgs.ac.uk
Edinburgh EH9 3LA, UK		

9. BGS staff working in geomagnetism during 2001

Edinburgh	
Manager (Band 3)	Dr D J Kerridge
PA	Mrs M Milne
PRES	Dr T D G Clark
	J C Riddick
SSO	S M Flower
	Dr S Macmillan
	Dr A W P Thomson
HSO	J G Carrigan
	E Clarke
	T J Harris
	V B F Lesur *
	C W Turbitt
SO	S J Reay *
	D W Wallis *
	K W Wyse *
ASO	P White *
Eskdalemuir	
Craftsman	W E Scott
Cleaner	Mrs M Scott
Hartland	
PGS E	C R Pringle

* Dr Vincent Lesur joined BGS in April 2001
Mrs Pamela White resigned from BGS in May 2001
Miss Sarah Reay joined BGS in August 2001
Mr Dirk Wallis joined BGS in September 2001
Mr Keith Wyse joined BGS on a temporary contract in September 2001

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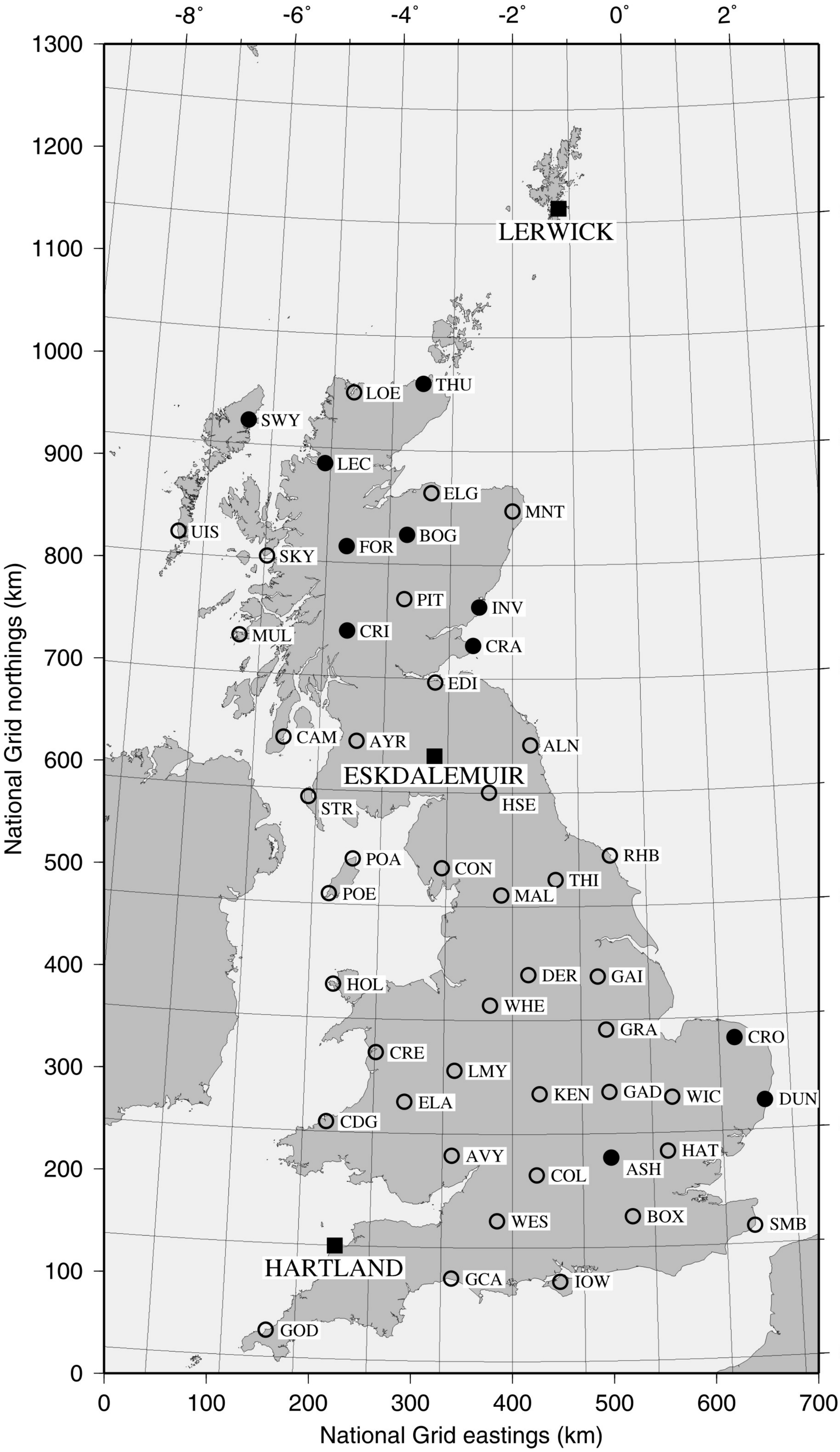
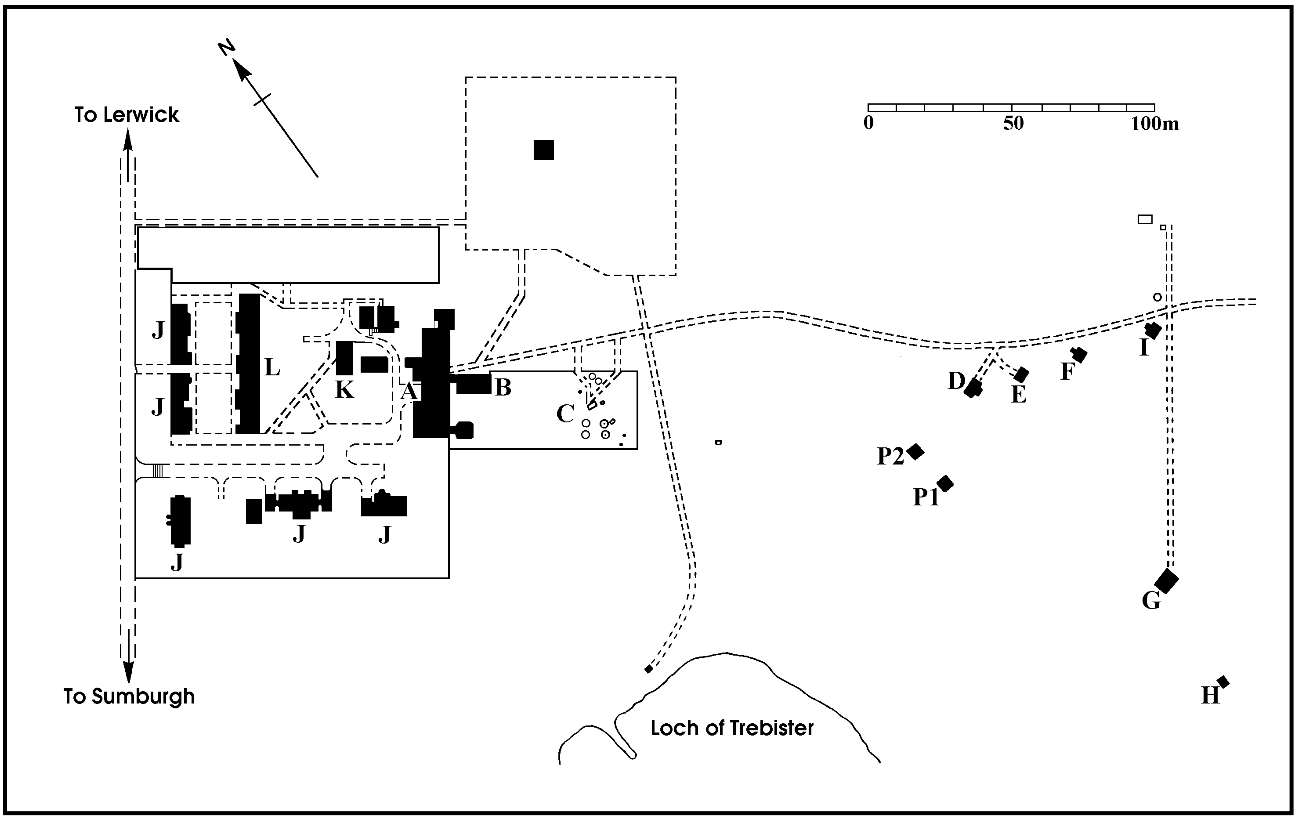


Figure 1. Location of the UK magnetic observatories (squares) and repeat stations (circles)

Lerwick Observatory



Observatory Layout

A	Main observatory building
B	BGS office, seismic recorders
C	Meteorological instrument enclosure
D	Absolute hut
E	Instrument hut
F	Variometer house
G	West hut
H	Azimuth mark
I	Back-up fluxgate data logger & MUTEST transmitter
J	Staff houses
K	Standby generator
L	Staff hostel
P1	Unused proton magnetometer
P2	GAUSS proton magnetometer & $\delta D/\delta I$ coils

Instrument Deployment

Absolute Hut
PVM (used as PPM for F measurements and QC)
D/I fluxgate theodolite

The fixed mark (azimuth 8º 38' 02" E of S) is viewed through a sliding panel in the hut door.

Instrument Hut
GAUSS logger
Uninterruptible power supply (UPS)

Variometer House
GAUSS fluxgate sensor (*HDZ*)
FLARE*plus* (backup) fluxgate sensors (*HDZ*)

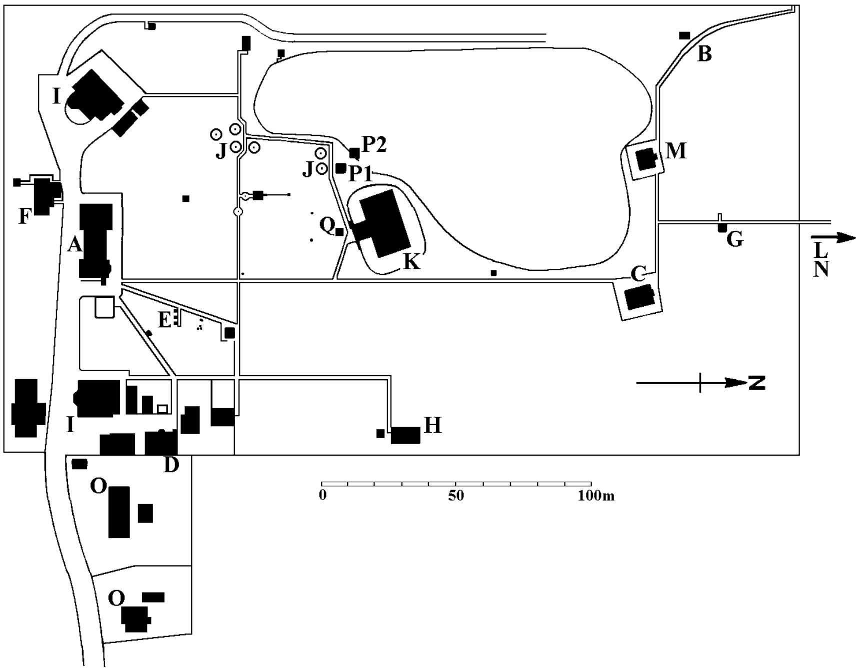
The variometer house is constructed from non-magnetic concrete and has internal dimensions of 4.9 by 3 meters. The roof is semi-circular in cross section. The temperature of the house is controlled to a diurnal range of ±1ºC. The meridian at the time of construction is defined on the north and south walls.

West Hut
Remote fluxgate magnetometer transmitting via METEOSAT.

Previous descriptions
The observatory is described by Harper (1950) and Tyldesley (1971).

Figure 2. Lerwick Observatory site diagram

Eskdalemuir Observatory



Observatory Layout

A	Main observatory building
B	Atmospheric pollution sampling
C	East absolute hut
D	Garage and standby generator
E	Meteorological instruments
F	Seismic laboratory, seismic recorders, offices, electronics laboratory
G	Hut G
H	Non-magnetic laboratory
I	Staff accommodation
J	Rain gauges
K	Underground variometer chamber
L	Seismic vault containing remote fluxgate (280 metres from boundary wall)
M	West absolute hut
N	Chemical sampling (Warren Spring Laboratory) (75 metres from boundary wall)
O	Private houses – formerly staff housing
P1	GAUSS proton magnetometer & $\delta D/\delta I$ coils
P2	Unused proton magnetometer
Q	METEOSAT transmitter

Instrument Deployment

Underground Variometer Chamber
GAUSS fluxgate sensor (*HDZ*)
FLARE*plus* (backup) fluxgate sensors (*HDZ*) transmitting to METEOSAT

The variometer chamber comprises two separate rooms inside a domed chamber covered with a thick layer of earth. The instruments are situated below ground level. The inside temperature is controlled to a diurnal range of ±0.5ºC. The instrument room was created by extending the former porch back into the stairwell and entrance. Standby batteries are kept in a compartment under the floor. The entrance to the room is protected by an external porch.

Hut G
PVM electronics, digital clock and printer to record total field values during absolute observations.

East Absolute Hut
PVM (used as PPM for F measurements and QC)
D/I fluxgate theodolite
The fixed mark (azimuth 8º 12' 35" W of S) is viewed through a shutter on the south wall.

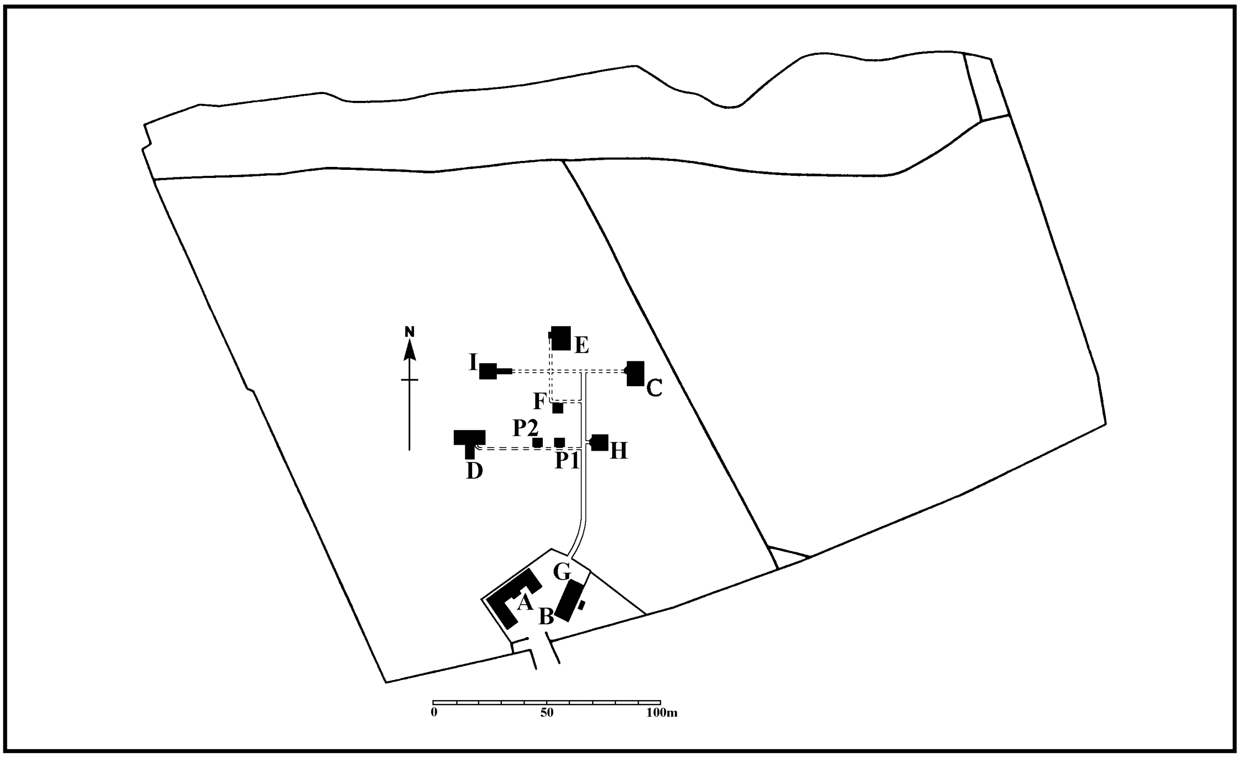
The Non-Magnetic Laboratory
The laboratory is used for instrument development and testing. It contains a sensor room with three piers and a larger room with a single pier.

West Absolute Hut
The hut contains three instrument piers. The fixed mark (azimuth 4º 36' 08" W of S) is viewed from the central pillar through a shutter on the south wall.

Previous descriptions
The observatory is described by Crichton (1950) and Blackwell (1958).

Figure 3. Eskdalemuir Observatory site diagram

Hartland Observatory



Observatory Layout

A	Main observatory building
B	Caretakers house
C	Absolute hut
D	Non-magnetic laboratory
E	Variometer house
F	Instrument hut
G	Garage
H	Test hut 2
I	Test hut 1
P1	Unused proton magnetometer
P2	Unused proton magnetometer & $\delta D/\delta I$ coils

Instrument Deployment

Absolute Hut
PVM (used only as PPM for F measurements)
D/I fluxgate theodolite
The fixed mark (azimuth 11º 27' 54" E of N) is viewed through a window in the north wall.

Variometer House
GAUSS fluxgate sensors (*HDZ*)
The variometer house comprises an entrance porch and a main room, which contains two separate internal rooms, each divided into three compartments. The temperature is controlled to a diurnal range of ±0.5ºC. Two cable ducts connect the variometer house to the instrument hut.

The Non-Magnetic Laboratory
GAUSS proton magnetometer & $\delta D/\delta I$ coils (PVM)
FLARE*plus* (backup) fluxgate sensors (*HDZ*) transmitting to METEOSAT
Fluxgate system transmitting to the GOES satellite.

The laboratory was built in 1972 to provide accommodation for a rubidium-vapour magnetometer digital recording system. It comprises an instrument room and a sensor room with five instrument piers.

Instrument Hut
GAUSS logger
Standby batteries
Uninterruptible power supply (UPS)

Test Hut 1
Low field facility (LFF) comprising an orthogonal coil system of dimension ~2m and its power supply. The system consists of a pair of vertical-axis square coils and two pairs of horizontal-axis square coils for creating fields parallel and normal to the meridian.

Test Hut 2
Auxiliary measurement position. The fixed mark (azimuth 12º 52' 08" E of N) is viewed through a window in the north wall from the north-east theodolite position.

Previous descriptions
The observatory is discussed in Finch (1960) and Reader (1997).

Figure 4. Hartland Observatory site diagram

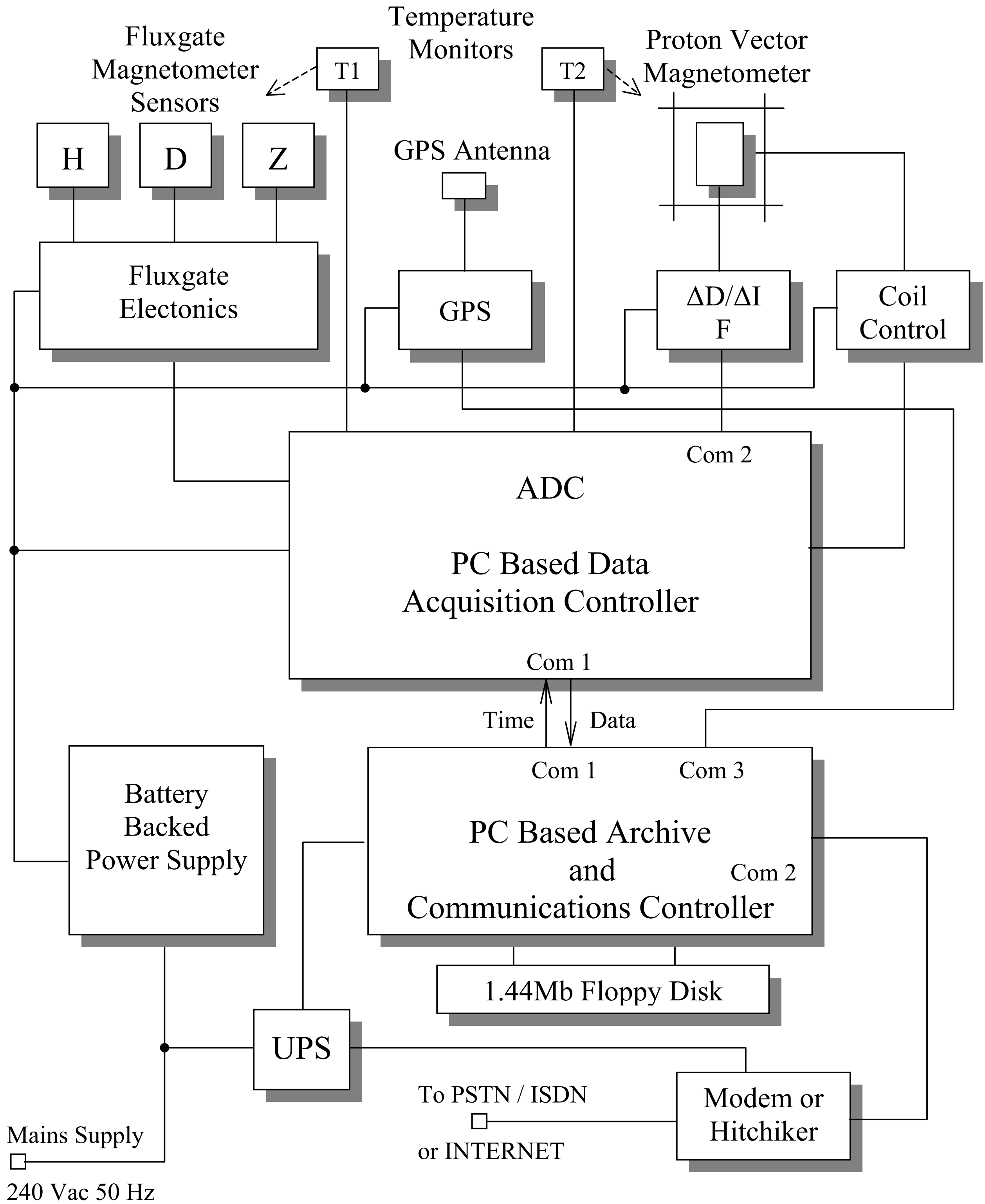


Figure 5. **Block diagram of GAUSS**

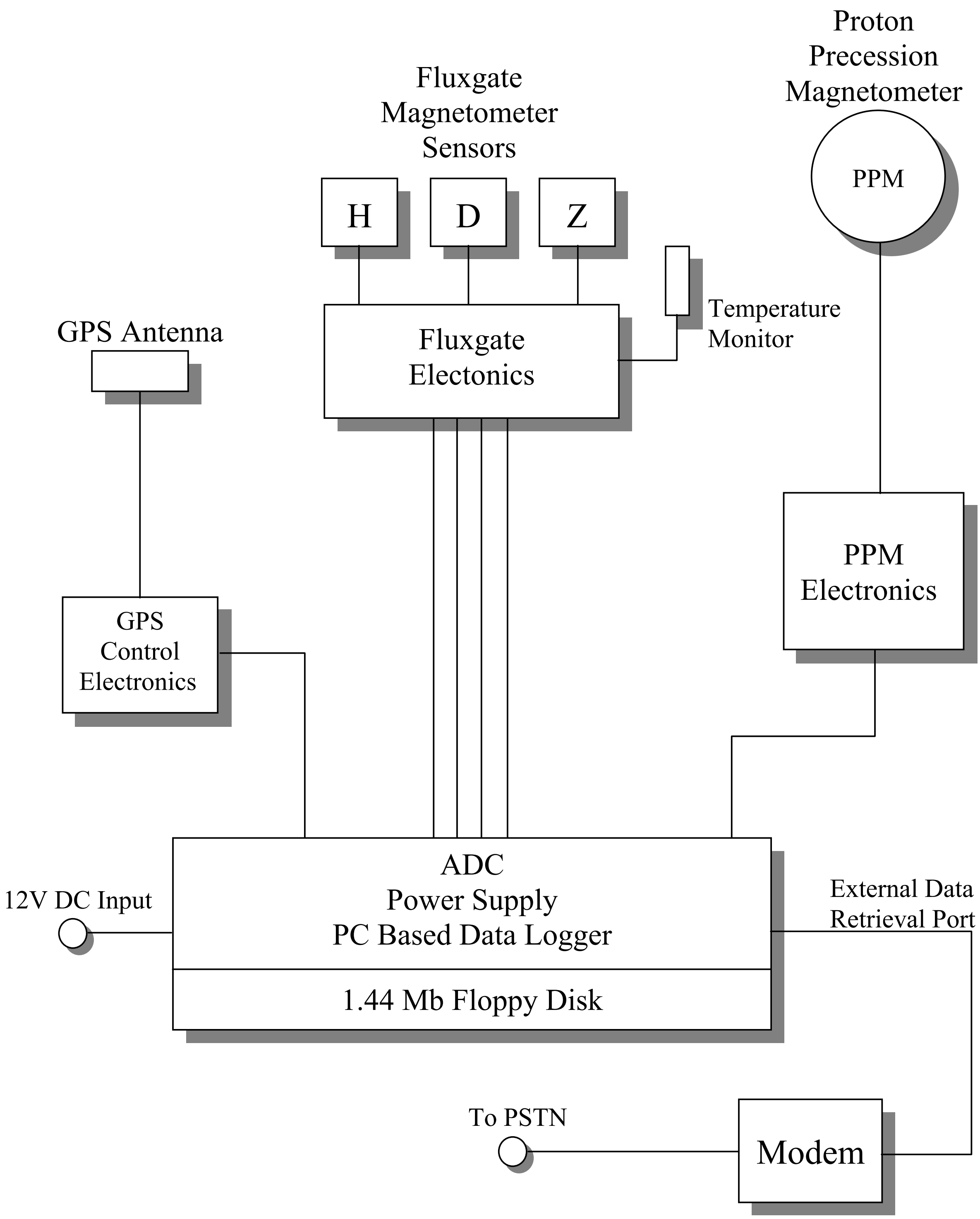


Figure 6. Block diagram of the FLARE *plus* backup system

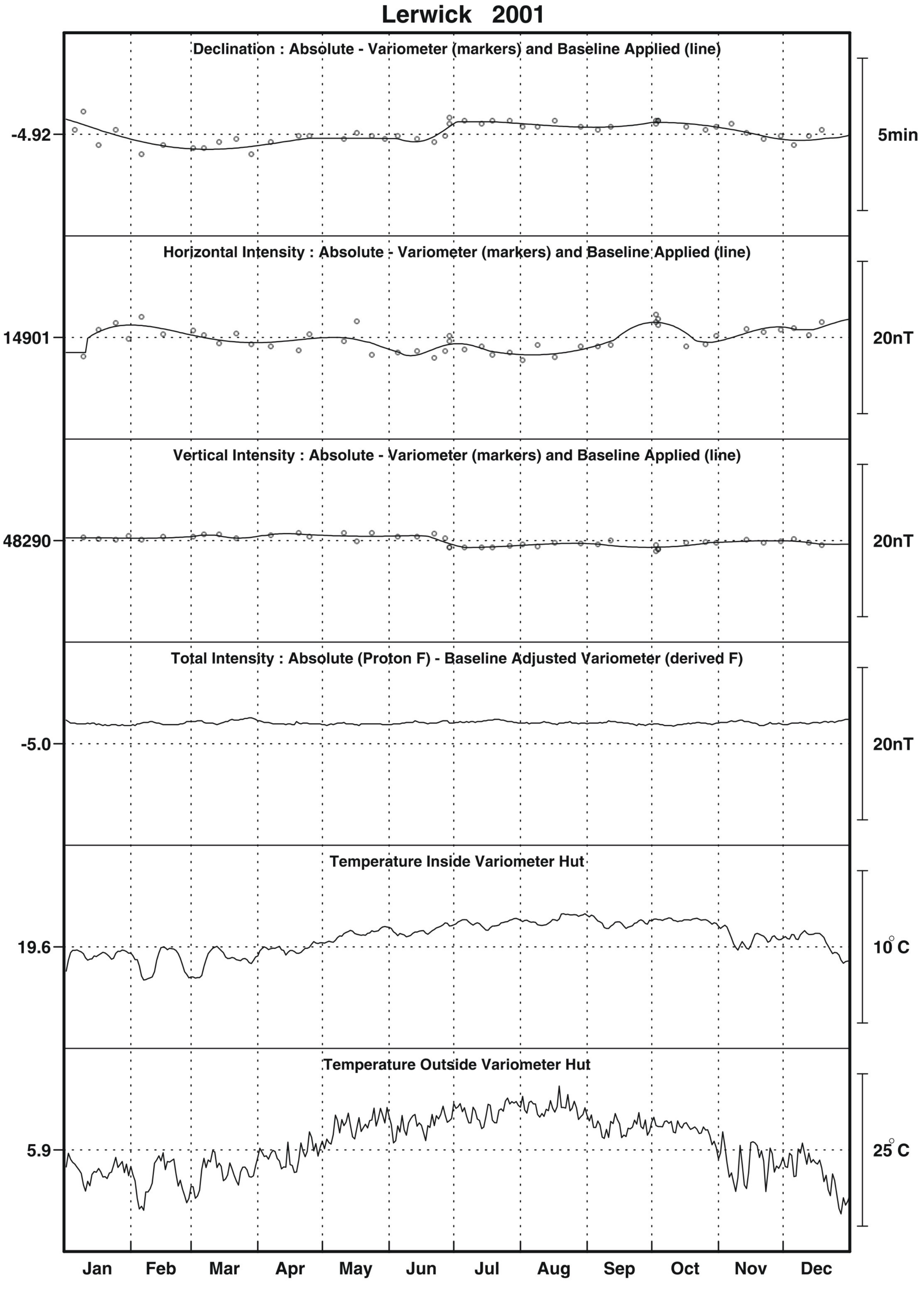


Figure 7. Observed and allocated baselines at Lerwick

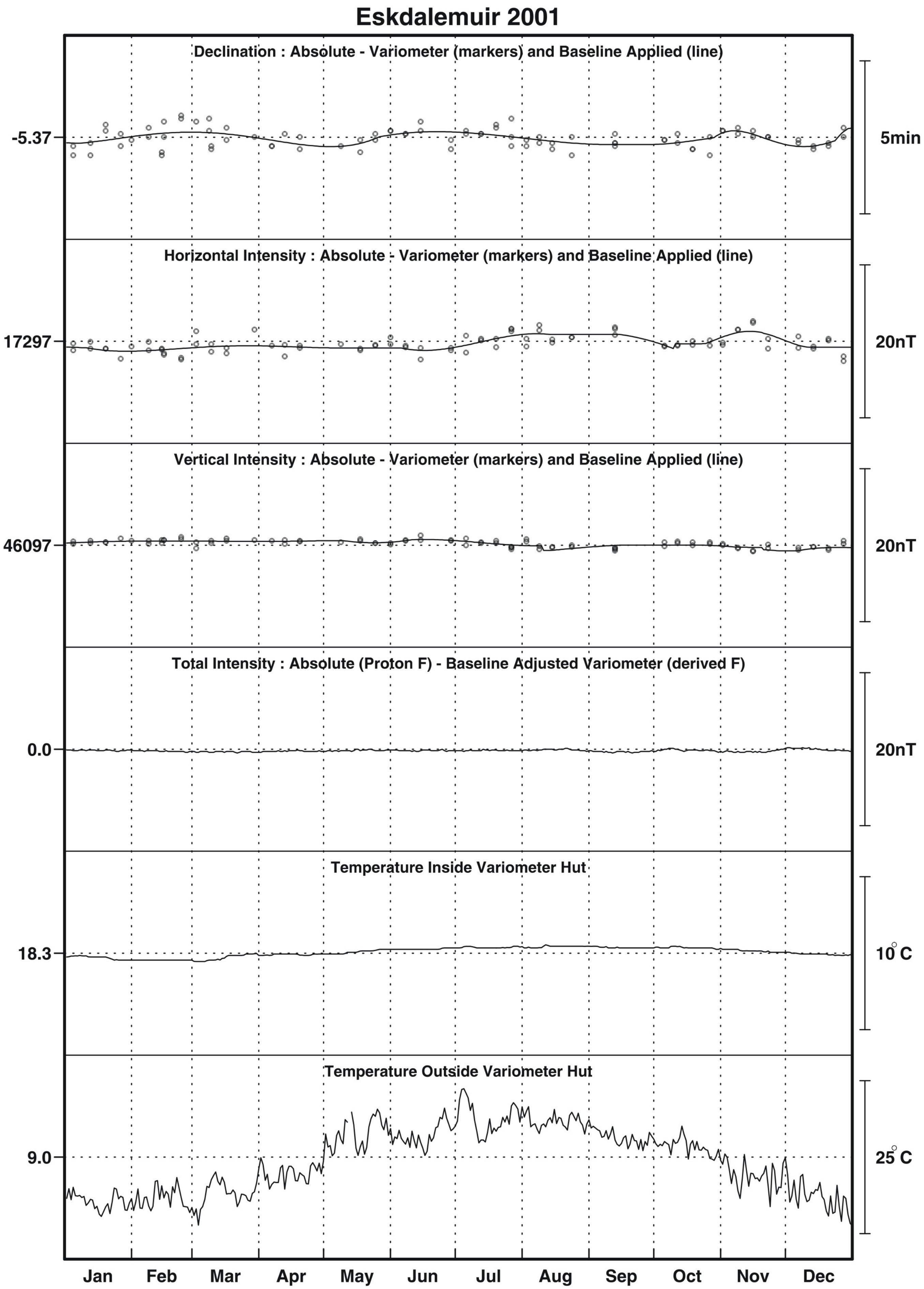


Figure 8. Observed and allocated baselines at Eskdalemuir

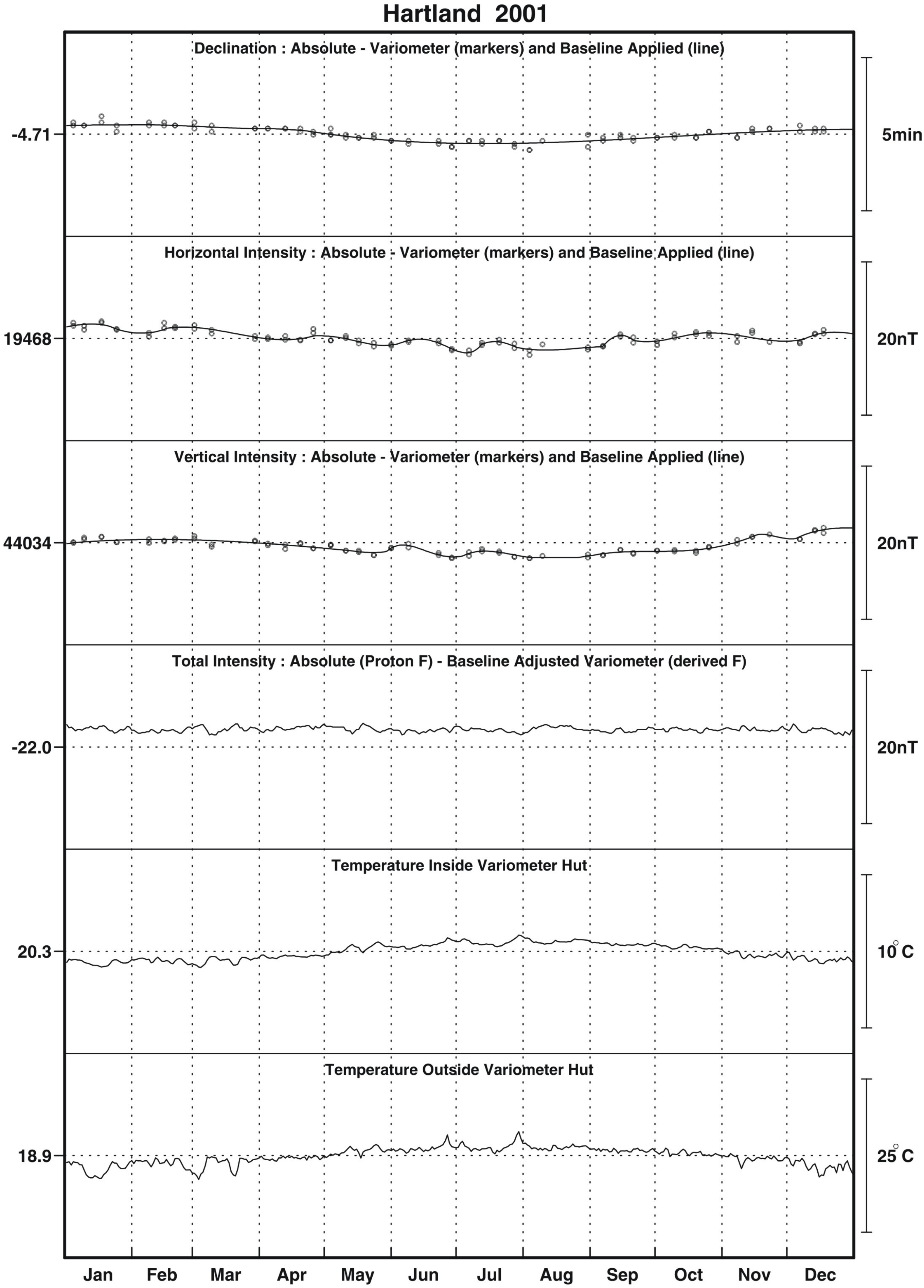


Figure 9. Observed and allocated baselines at Hartland

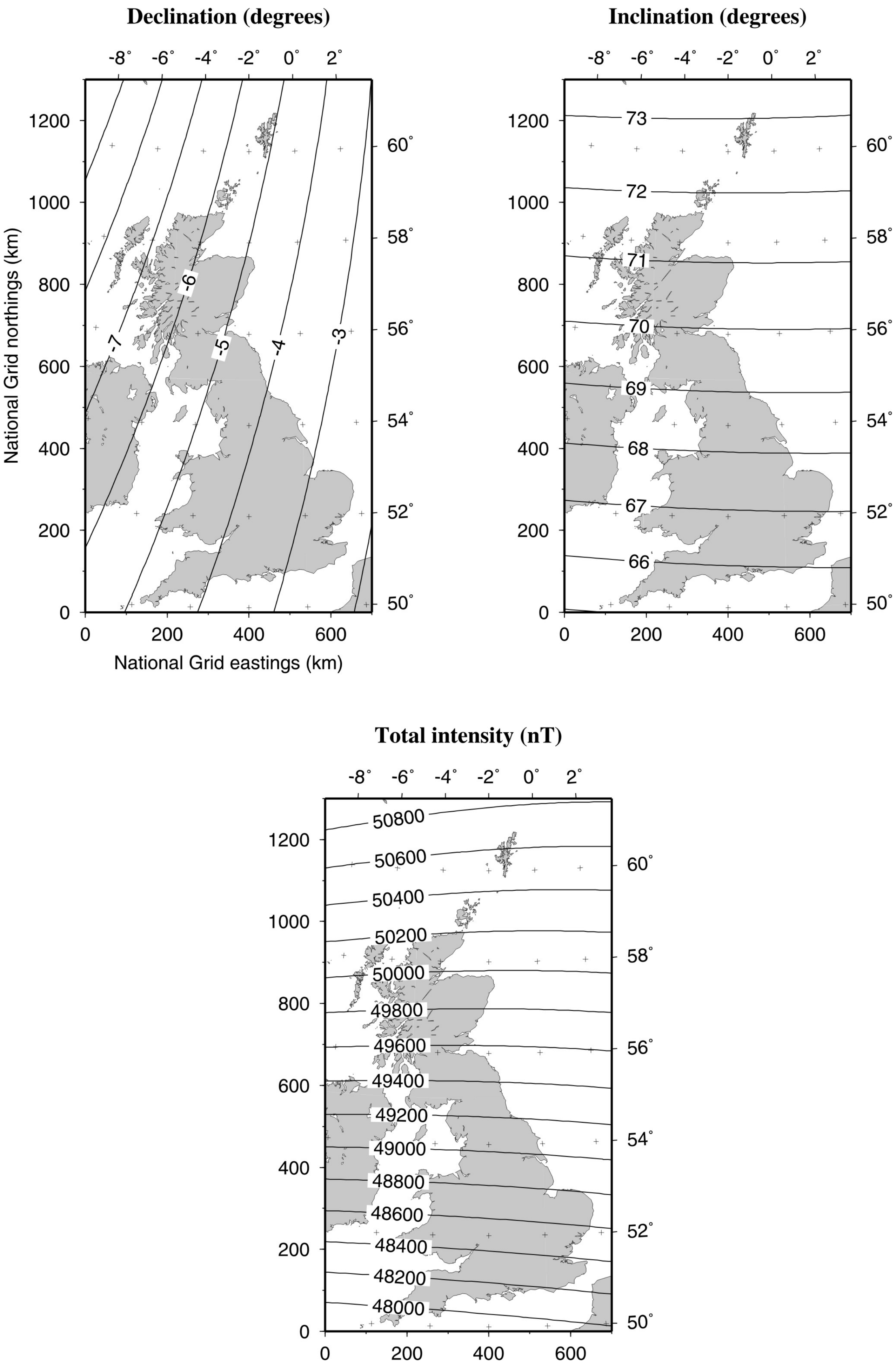


Figure 10. Declination, inclination and total intensity at 2001.5

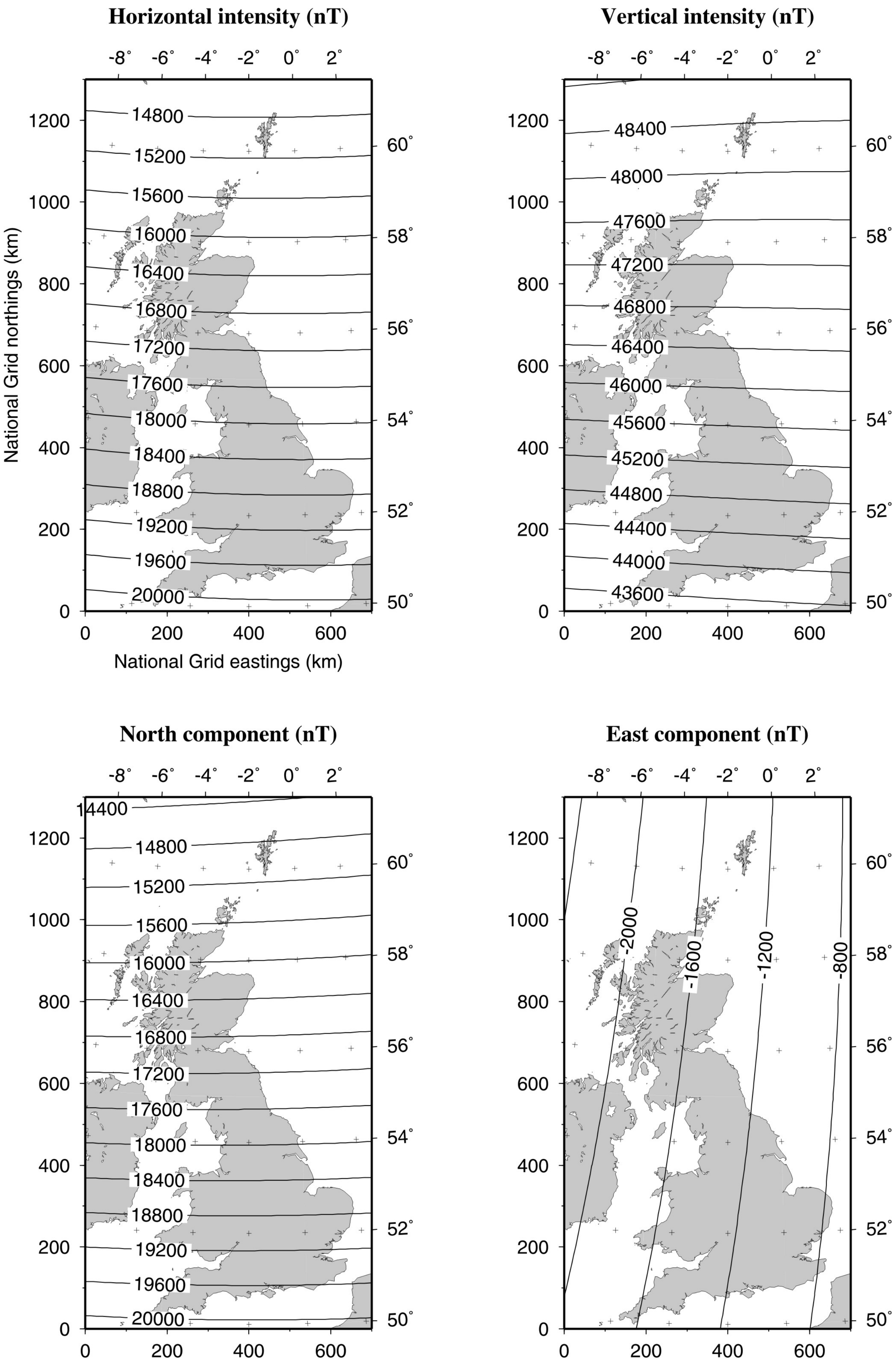
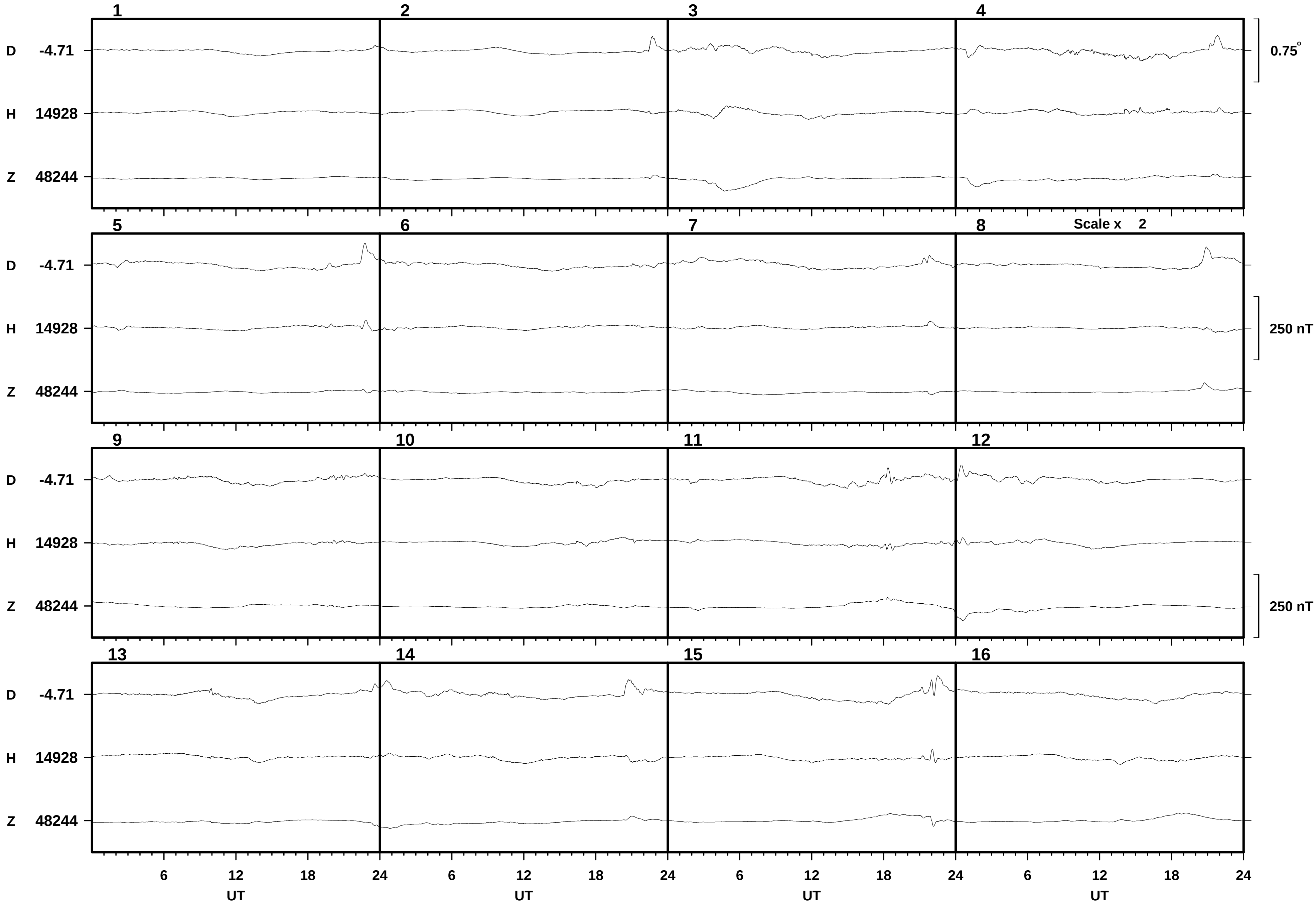


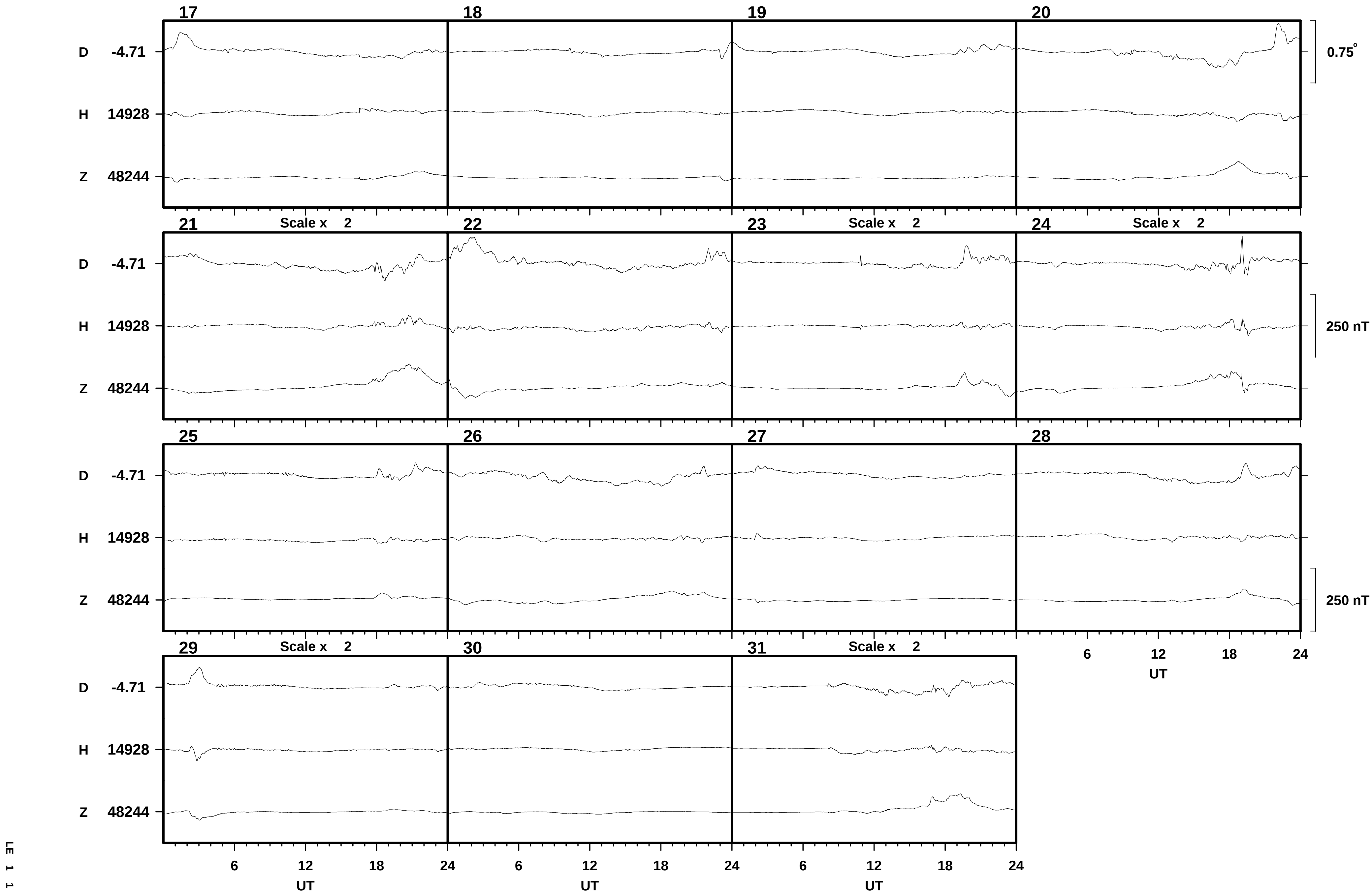
Figure 11. Horizontal, vertical, northerly and easterly intensities at 2001.5

Lerwick Observatory Results 2001

Lerwick January 2001



LE 1 1


17
18
19
20
D -4.71
H 14928
Z 48244
0.75°
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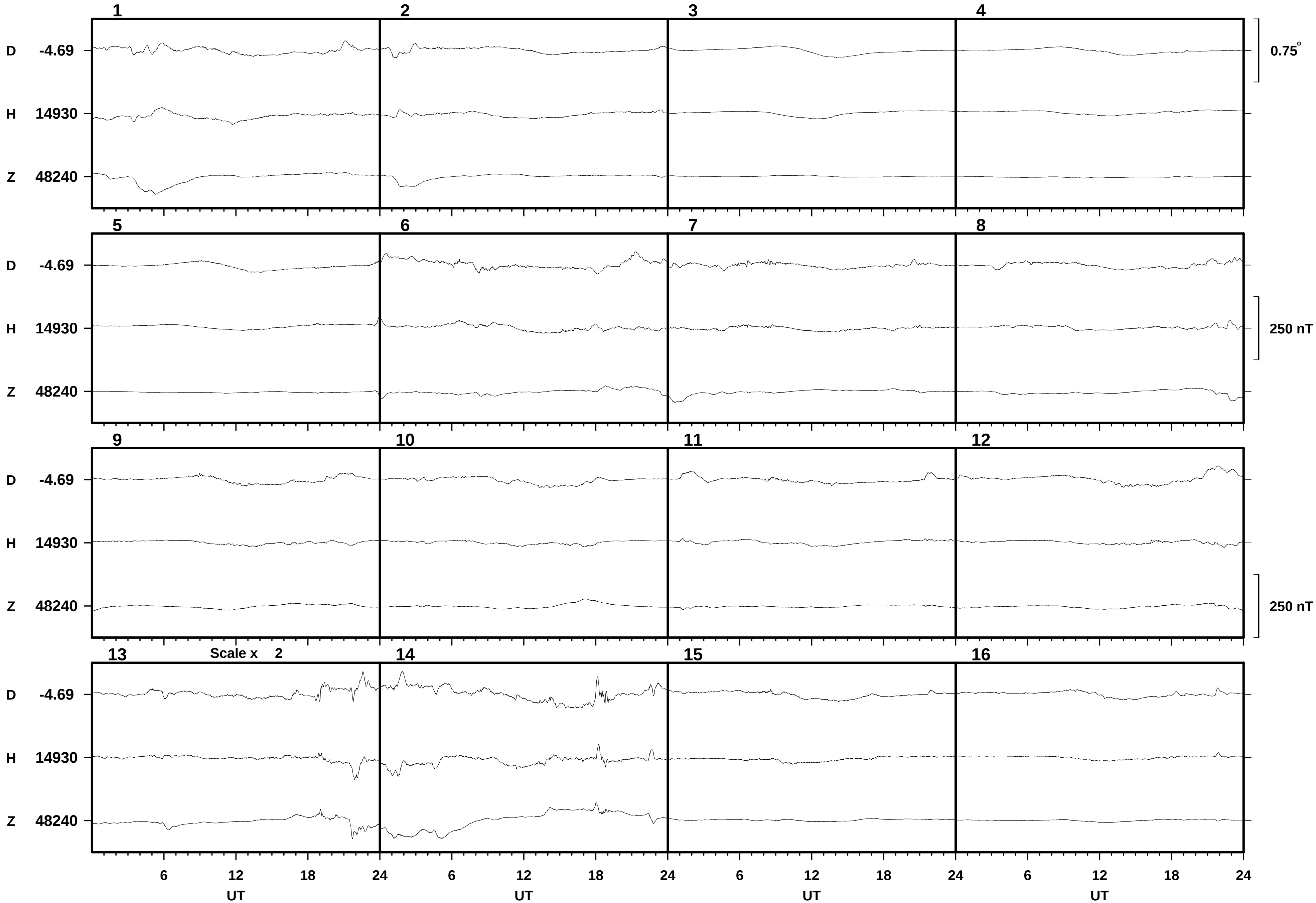
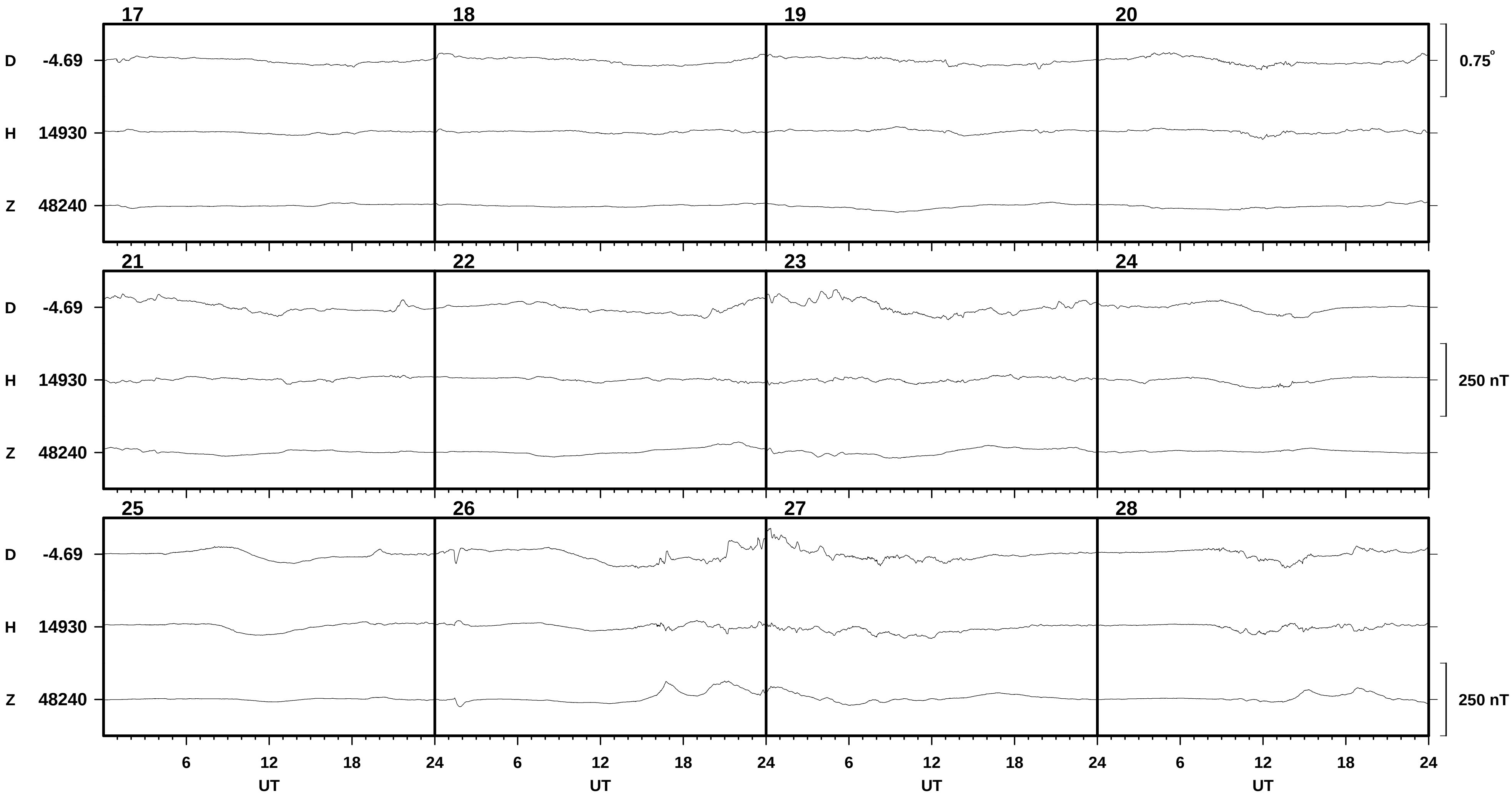
Scale x 2
22
23
Scale x 2
24
Scale x 2
250 nT
25
26
27
28
250 nT
29
Scale x 2
30
31
Scale x 2
6
12
18
24
UT
LE 1 1

Lerwick February 2001



LE 2 1


17
18
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21
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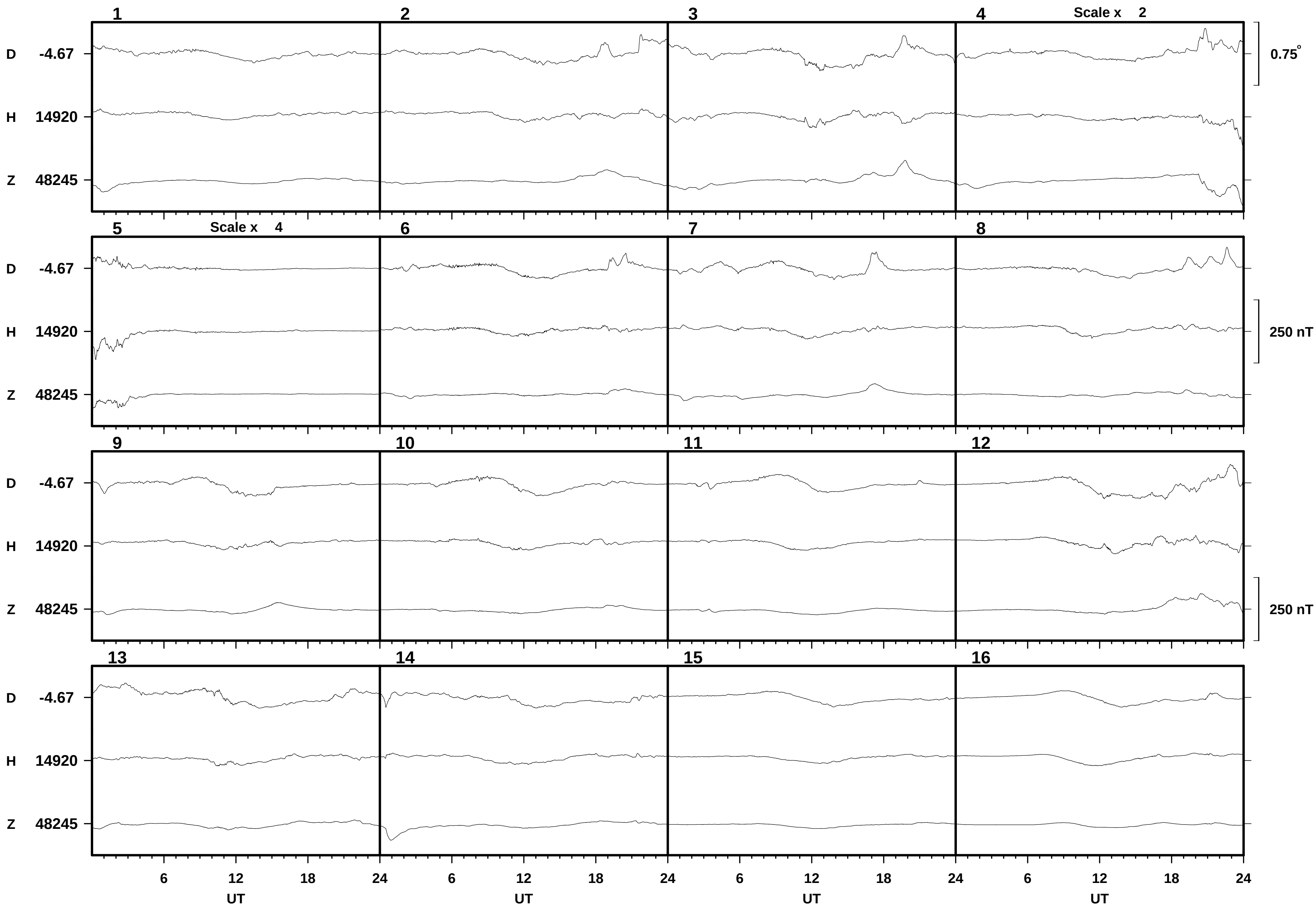
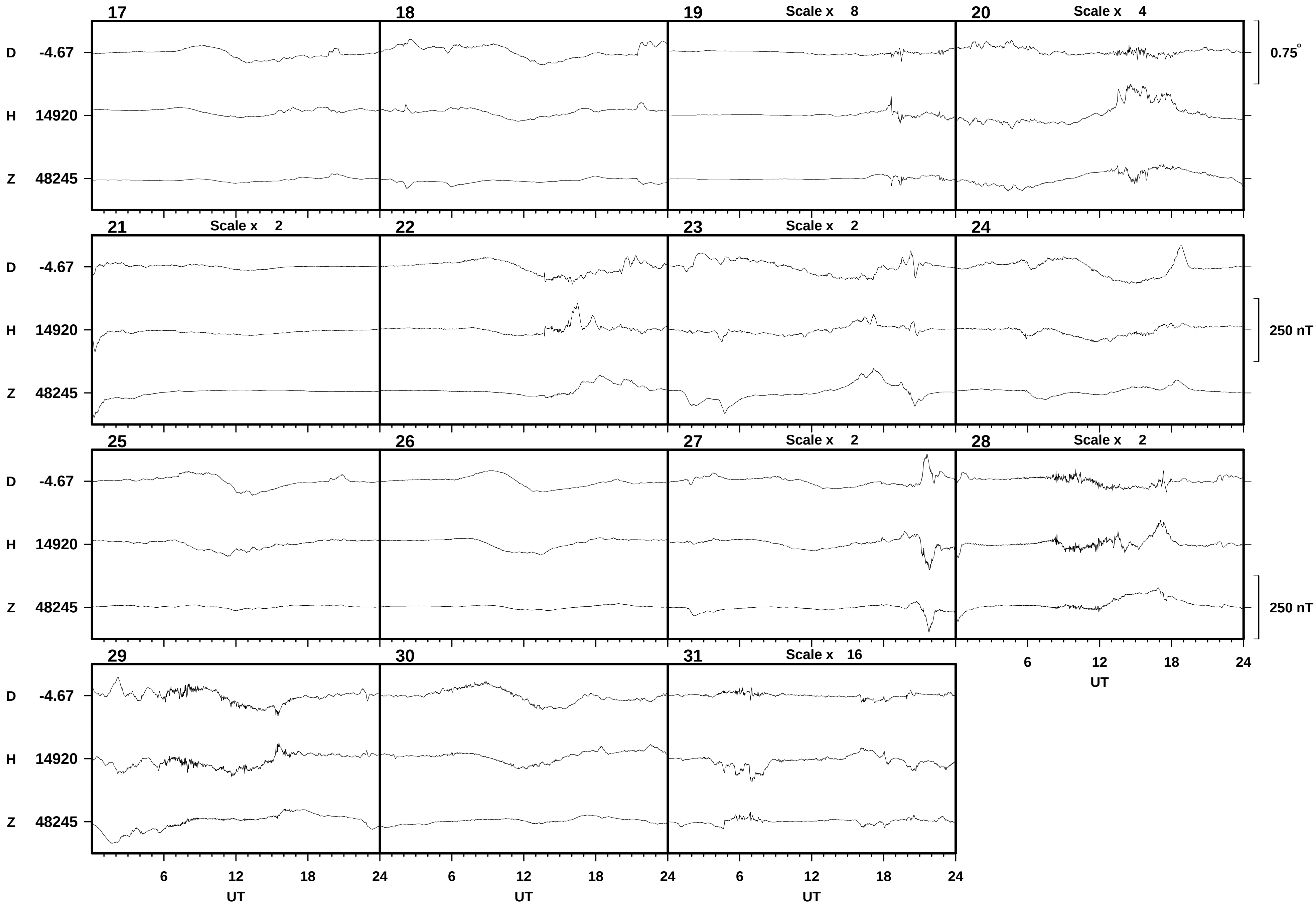
23
24
25
26
27
28
D -4.69
H 14930
Z 48240
0.75°
250 nT
250 nT
6
12
18
24
UT

LE 2 1

Lerwick March 2001



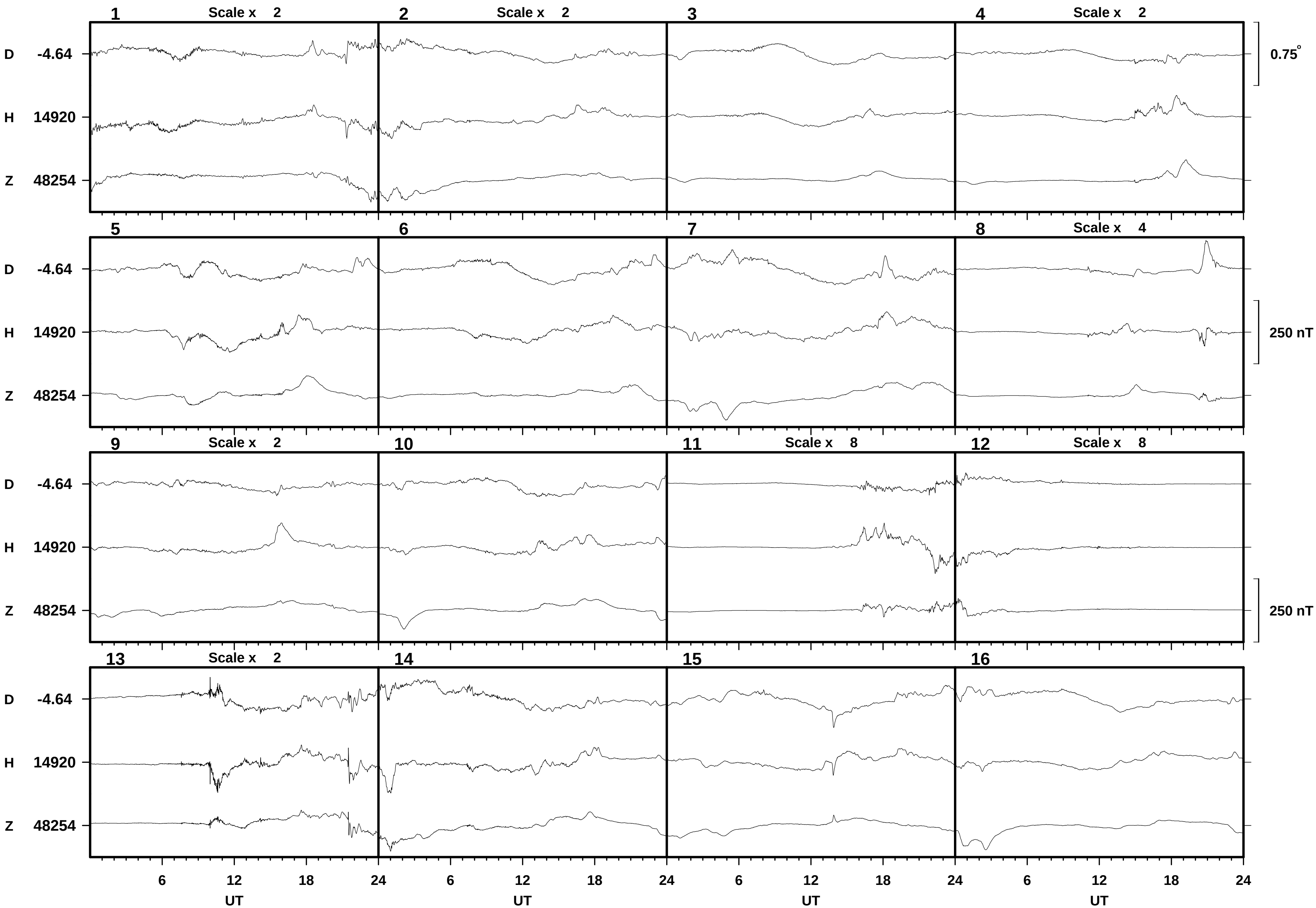
LE 3 1



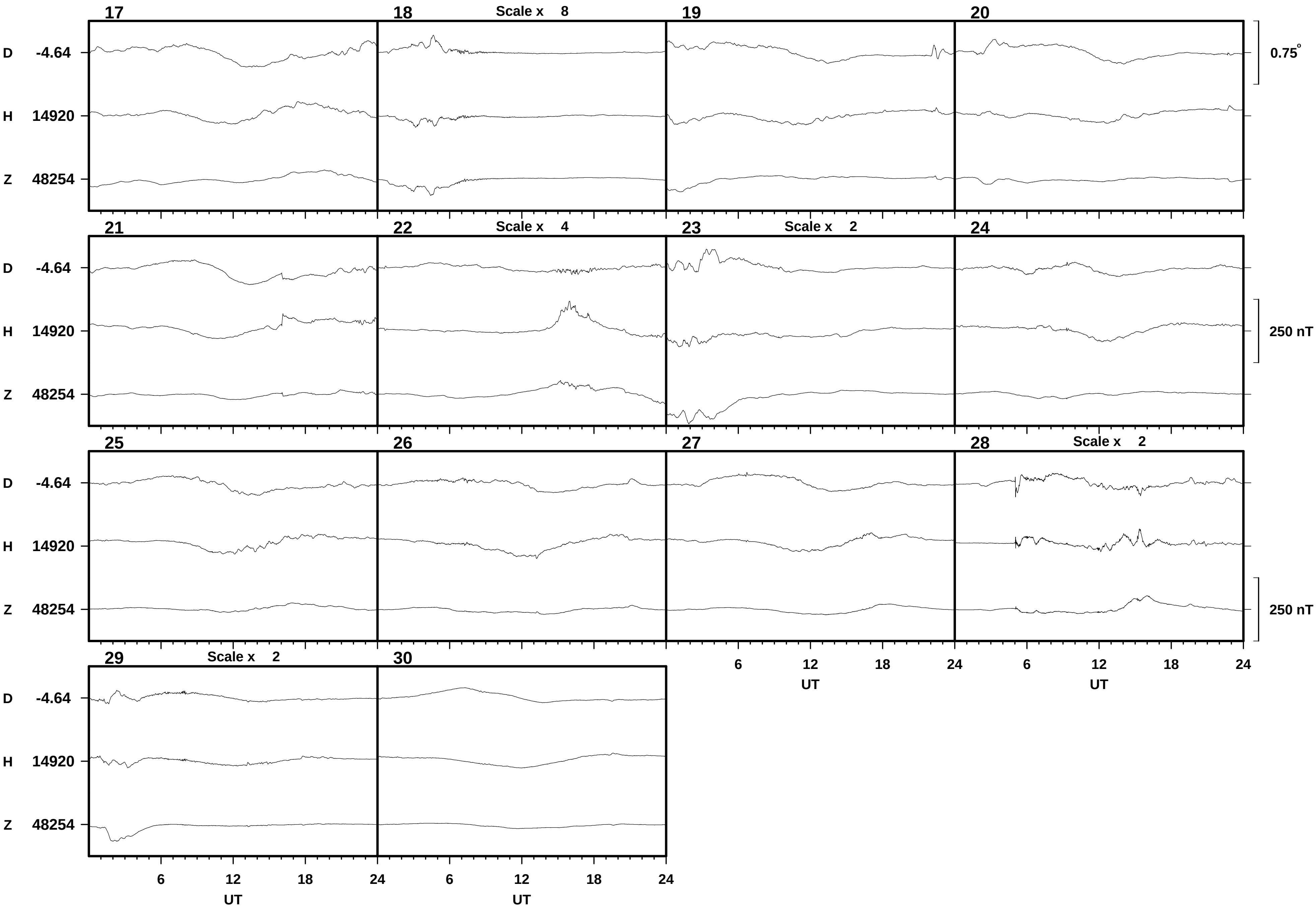
17
18
19 Scale x 8
20 Scale x 4
21 Scale x 2
22
23 Scale x 2
24
25
26
27 Scale x 2
28 Scale x 2
29
30
31 Scale x 16
D -4.67
H 14920
Z 48245
0.75°
250 nT
250 nT
6
12
18
24
UT

LE 3 1

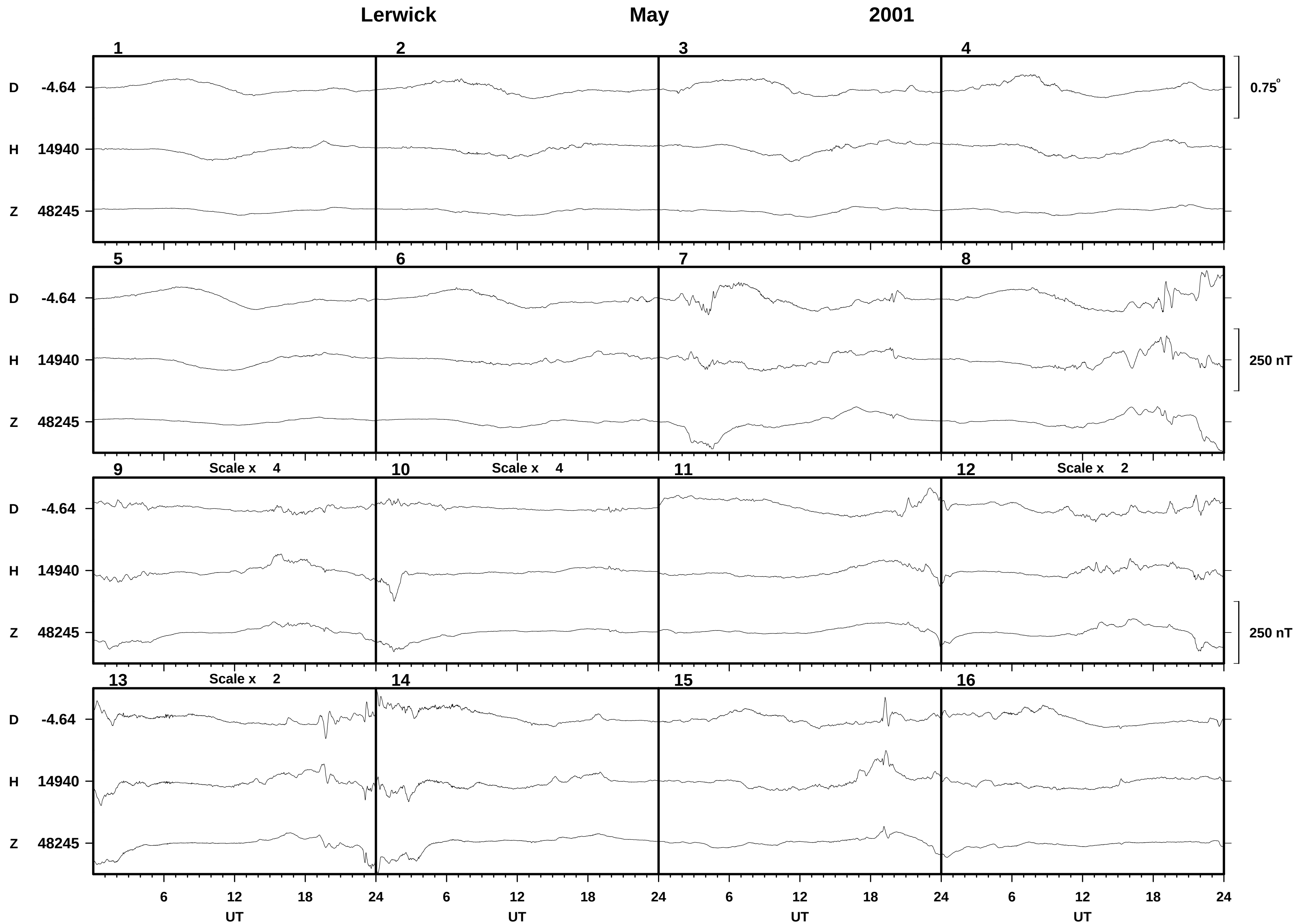
Lerwick April 2001



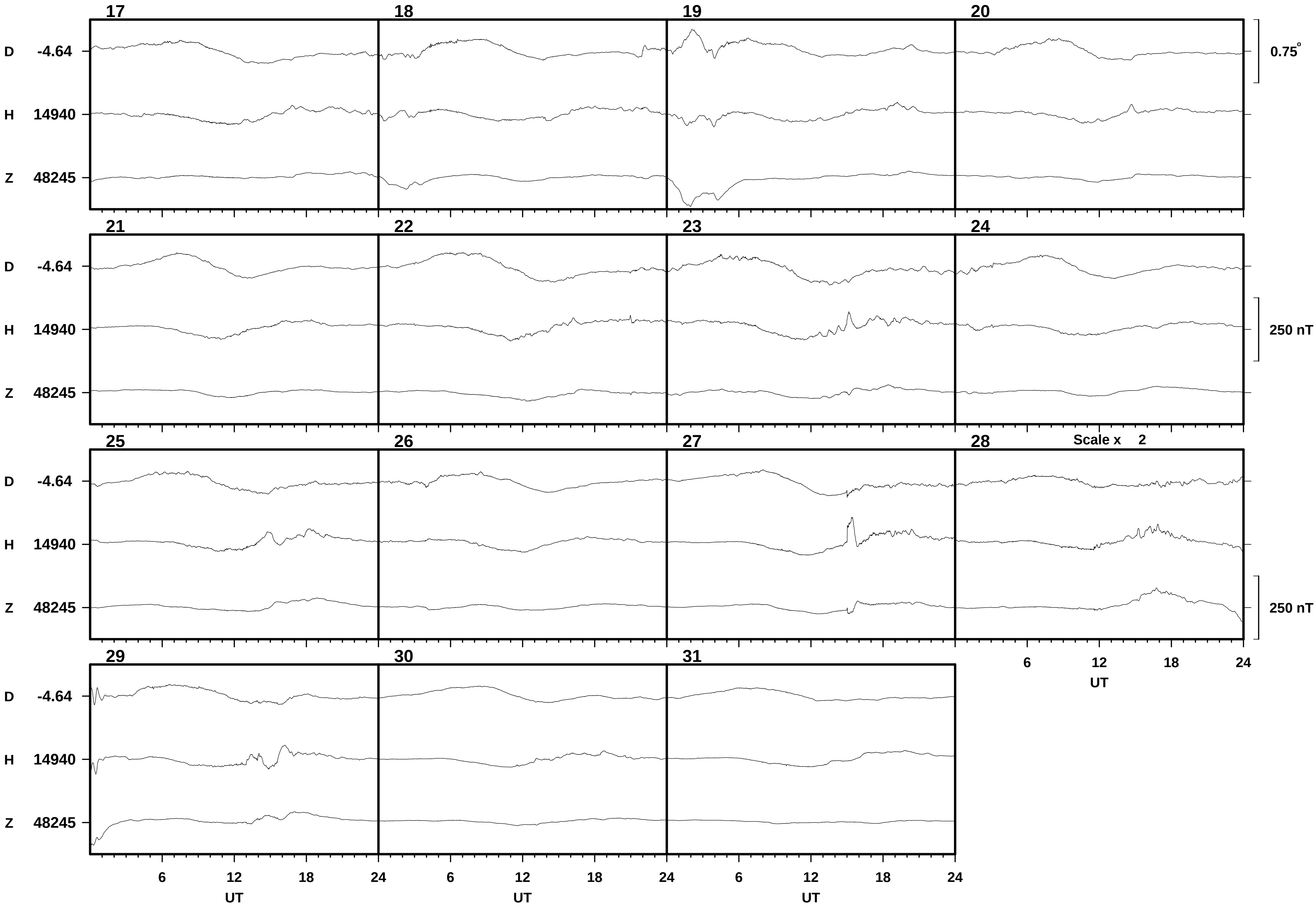
LE 4 1


17
18
Scale x 8
19
20
21
22
Scale x 4
23
Scale x 2
24
25
26
27
28
Scale x 2
29
Scale x 2
30
D -4.64
H 14920
Z 48254
0.75°
250 nT
250 nT
6
12
18
24
UT

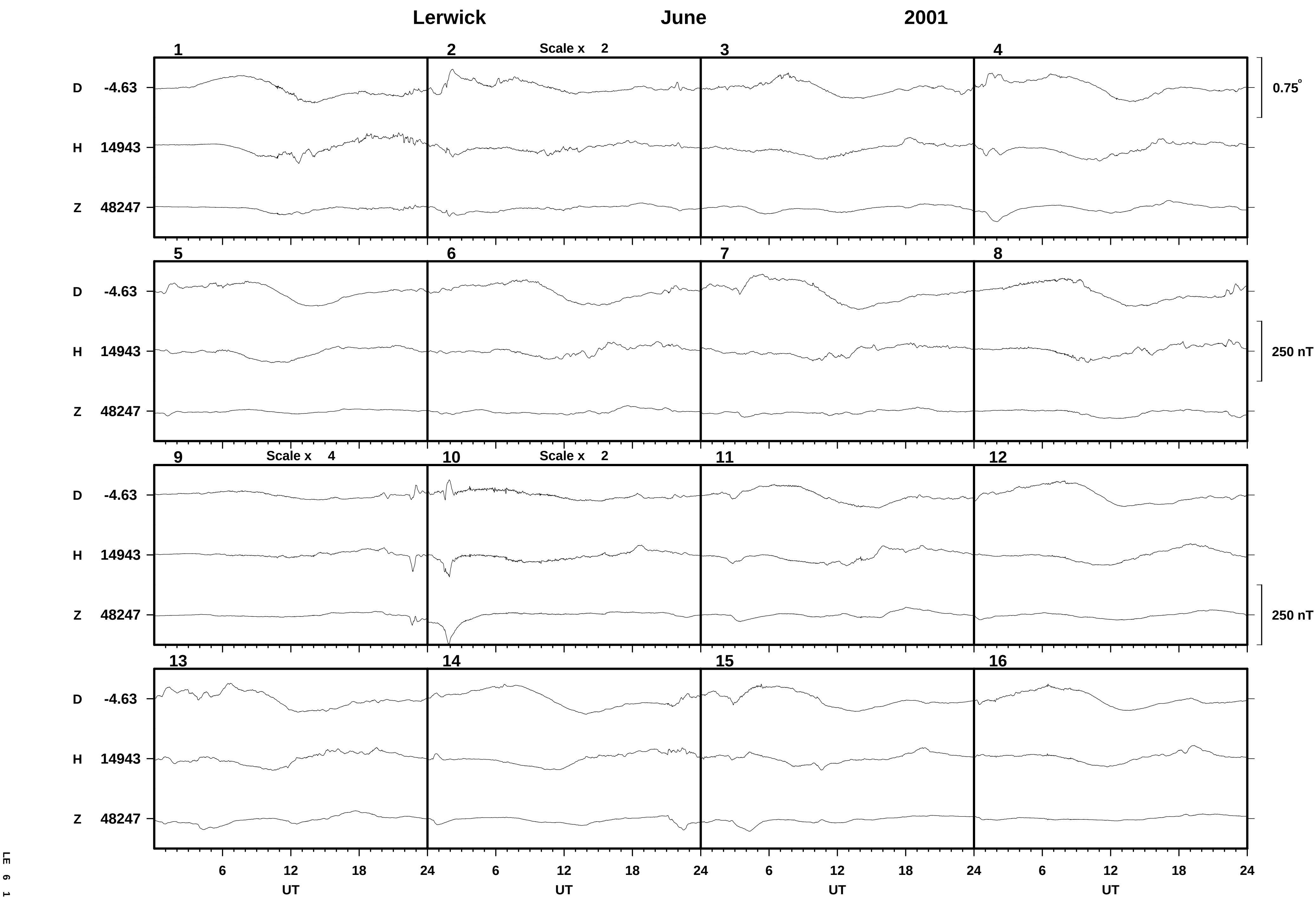
LE 4 1

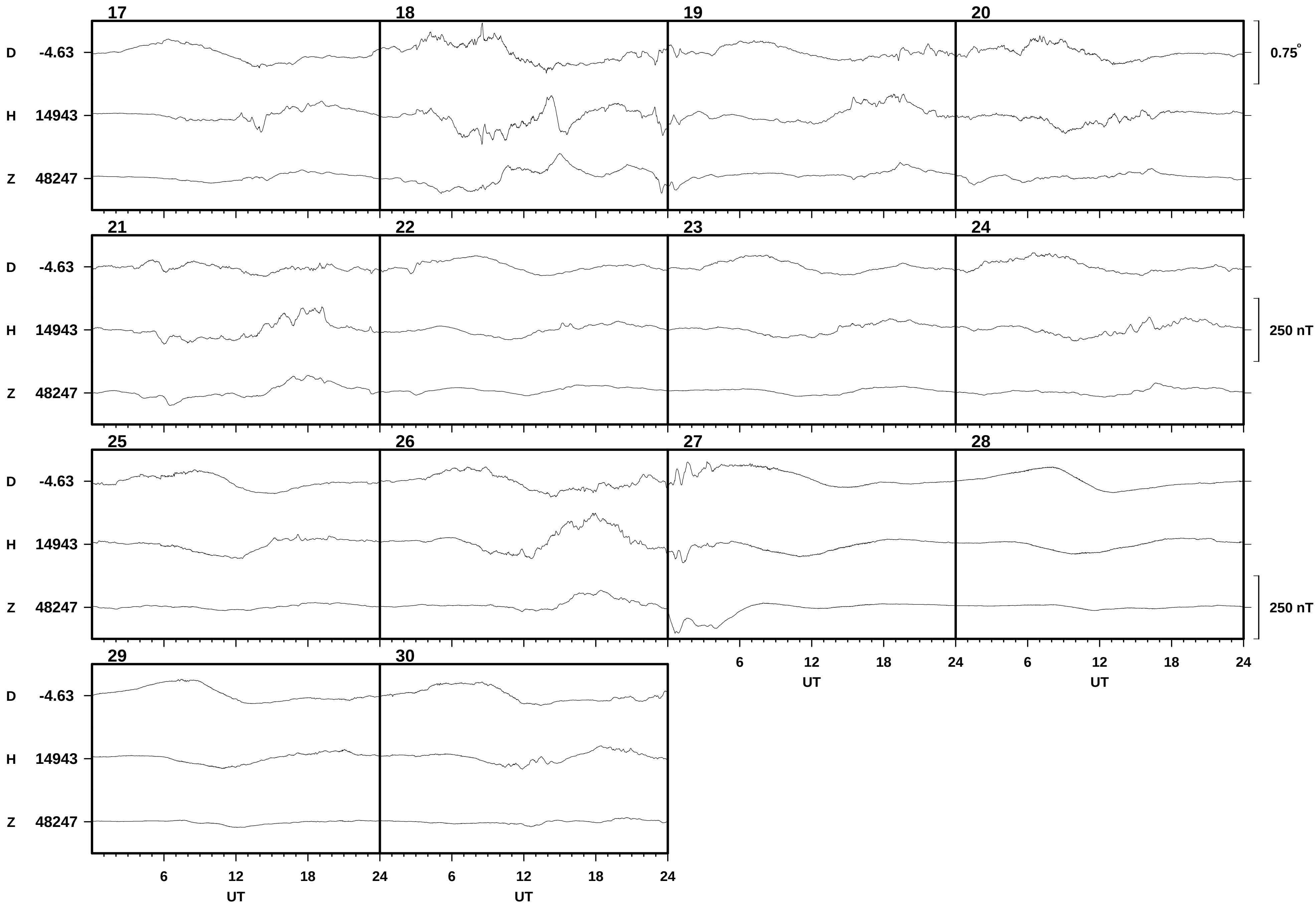

Lerwick May 2001
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Scale x 4
Scale x 4
Scale x 2
Scale x 2
D -4.64
H 14940
Z 48245
0.75°
250 nT
250 nT
6
12
18
24
UT

LE 5 1


17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
D -4.64
H 14940
Z 48245
0.75°
250 nT
Scale x 2
250 nT
6
12
18
24
UT

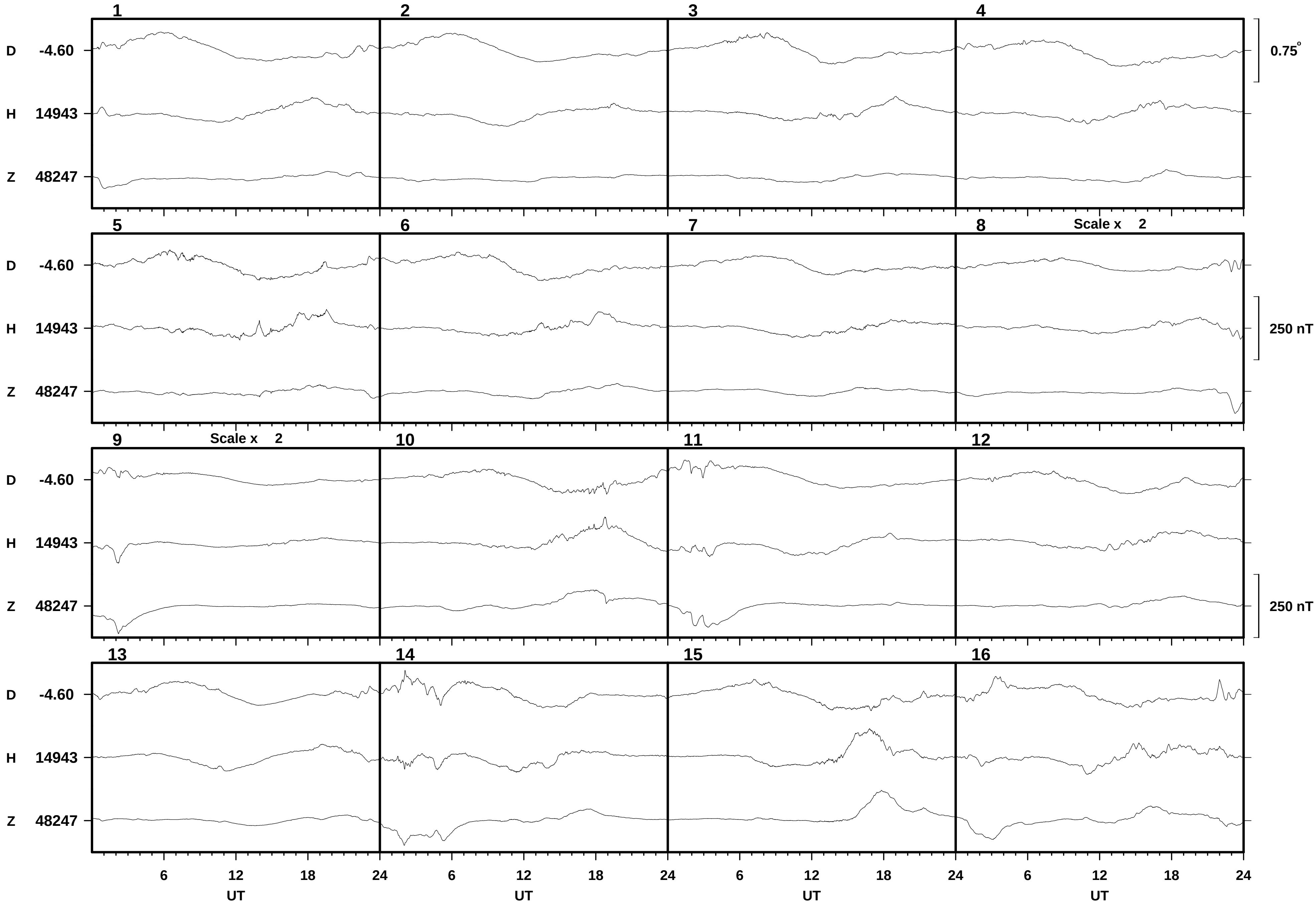
LE 5 1


Lerwick June 2001
1
2
Scale x 2
3
4
D -4.63
H 14943
Z 48247
0.75°
5
6
7
8
250 nT
9
Scale x 4
10
Scale x 2
11
12
250 nT
13
14
15
16
6 12 18 24
UT
LE 6 1

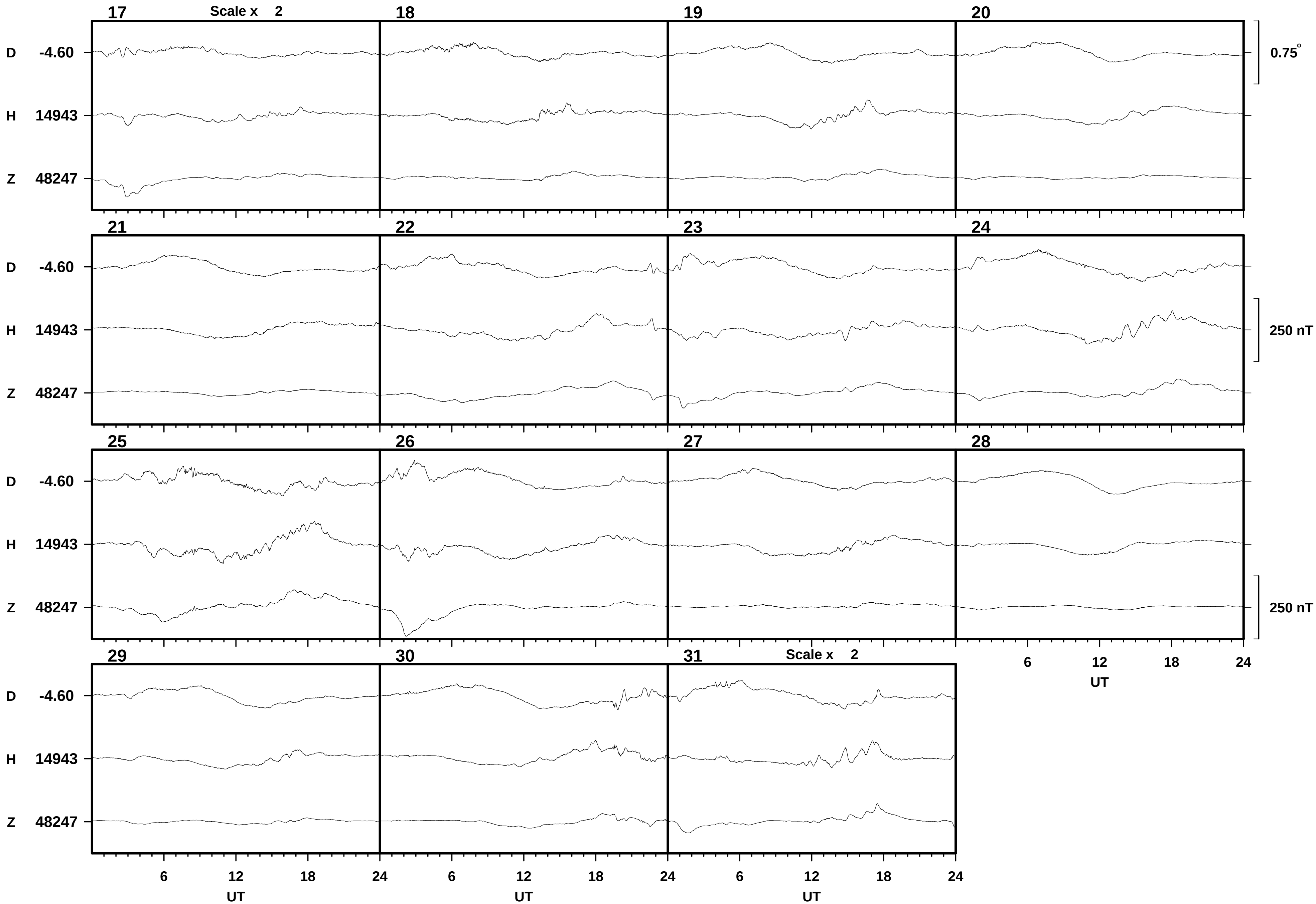

17
18
19
20
21
22
23
24
25
26
27
28
29
30
D -4.63
H 14943
Z 48247
0.75°
250 nT
250 nT
6
12
18
24
UT

LE 6 1

Lerwick July 2001

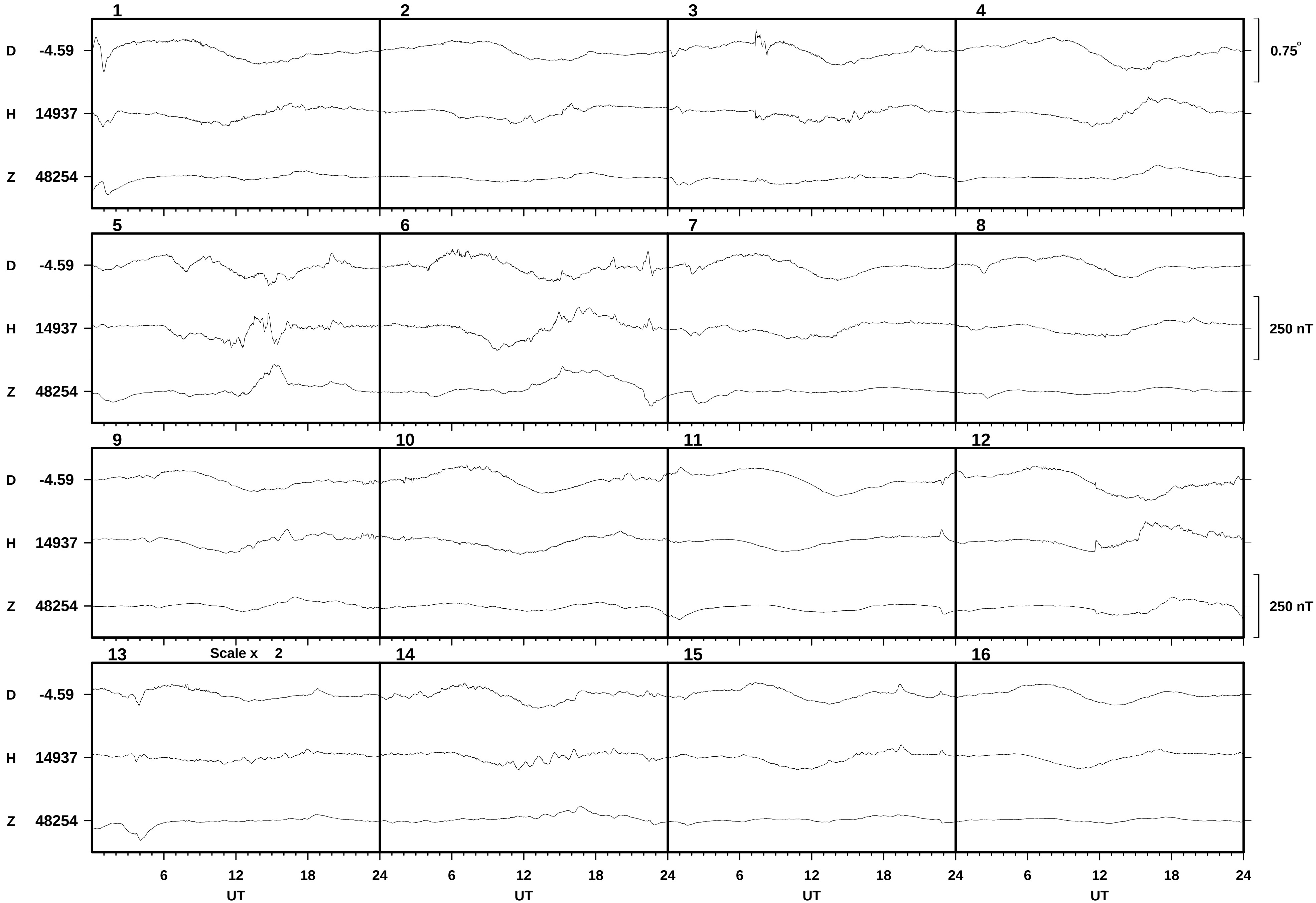


LE 7 1

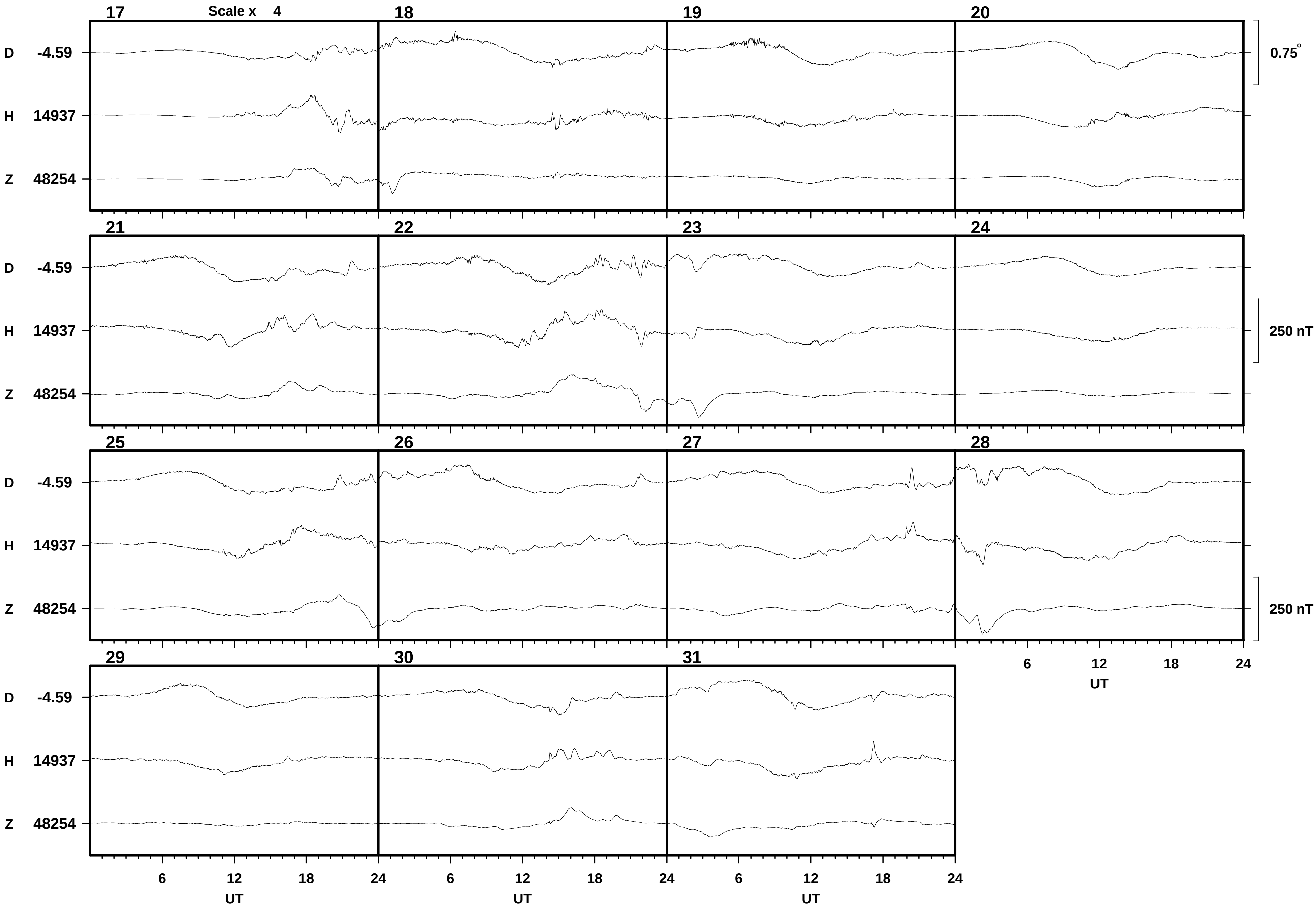

17
Scale x 2
18
19
20
0.75°
D -4.60
H 14943
Z 48247
21
22
23
24
250 nT
25
26
27
28
29
30
31
Scale x 2
6
12
18
24
UT

LE 7 1

Lerwick August 2001

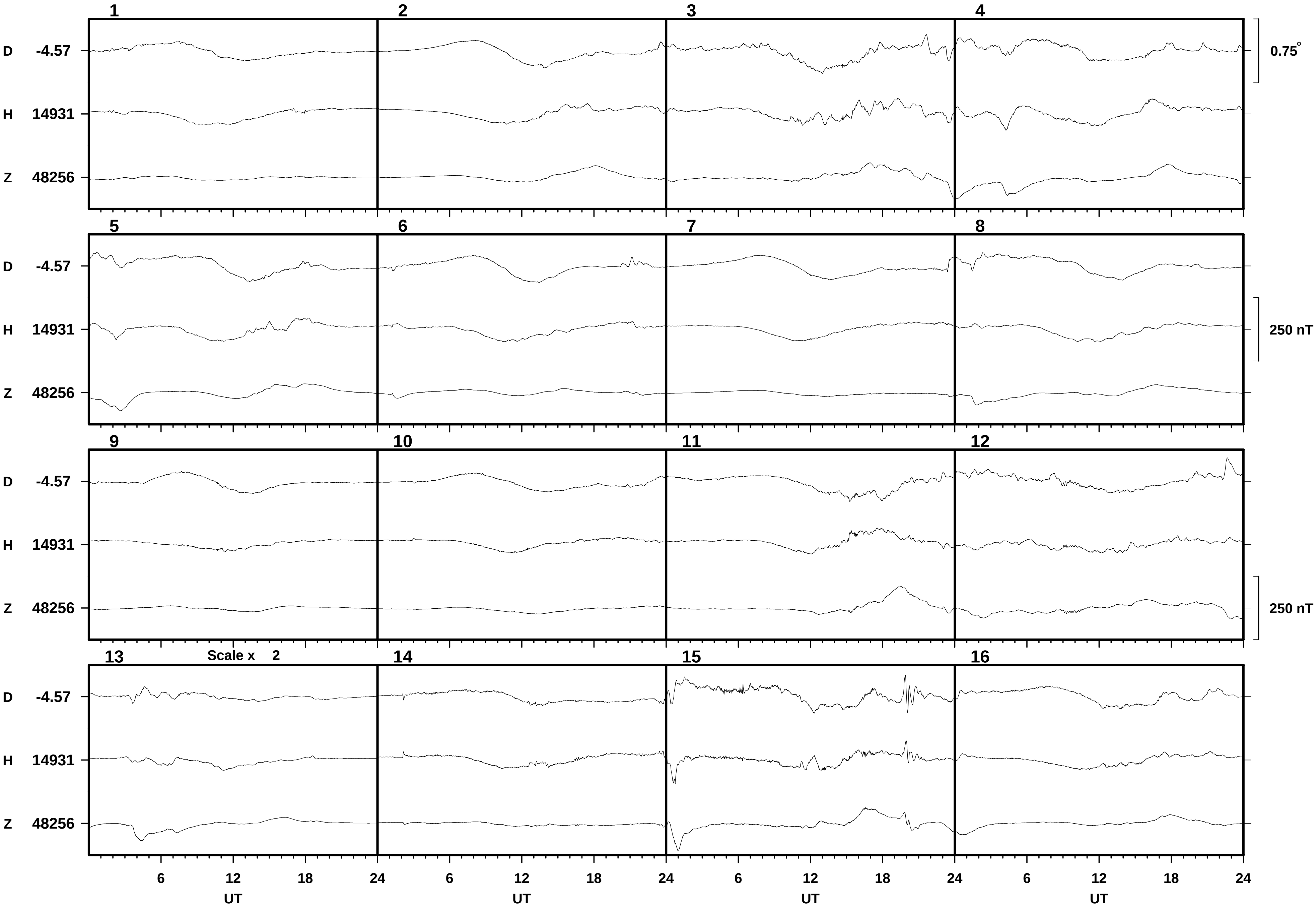


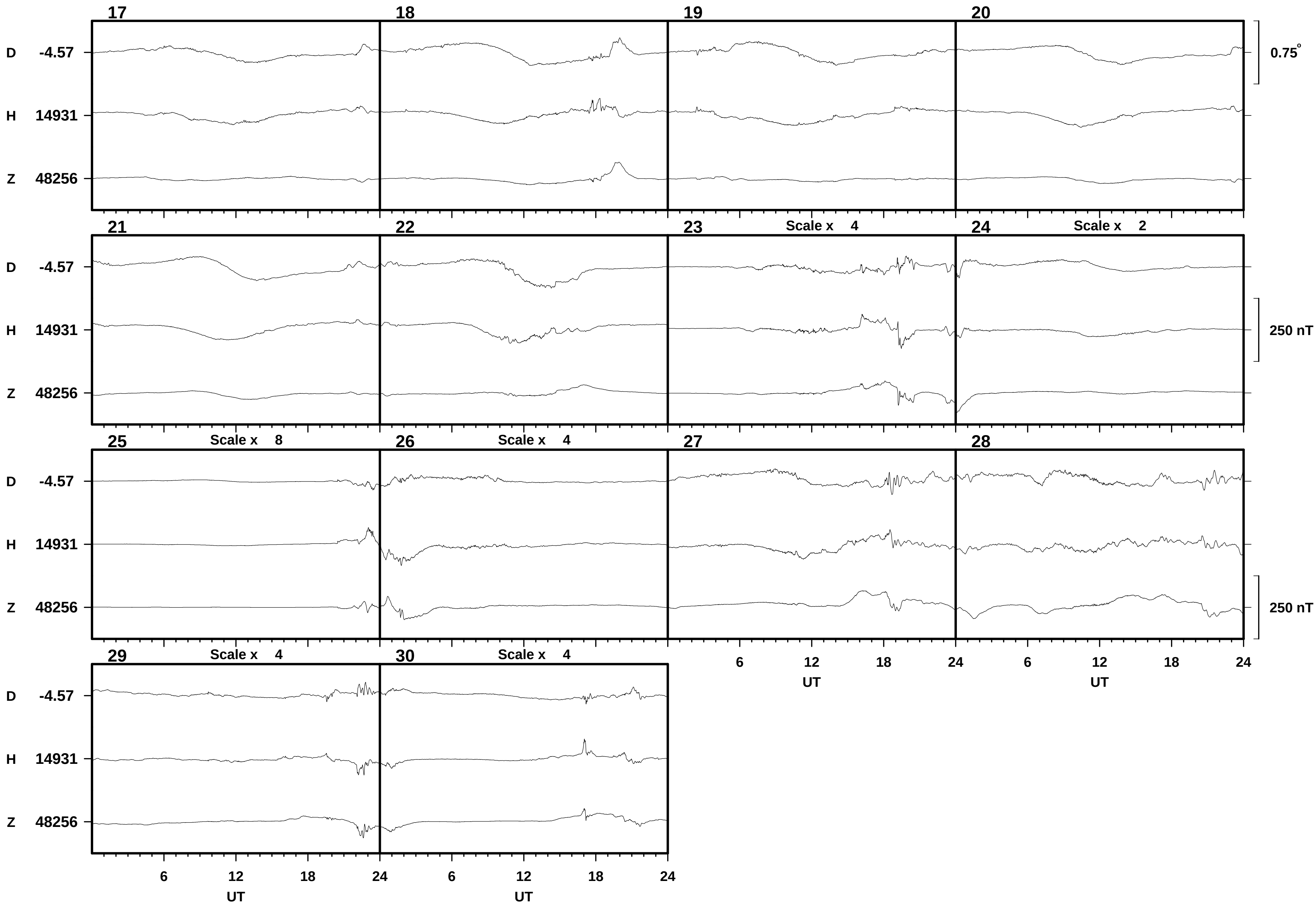
LE 8 1


Scale x 4
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
D -4.59
H 14937
Z 48254
0.75°
250 nT
250 nT
6
12
18
24
UT

LE 8 1

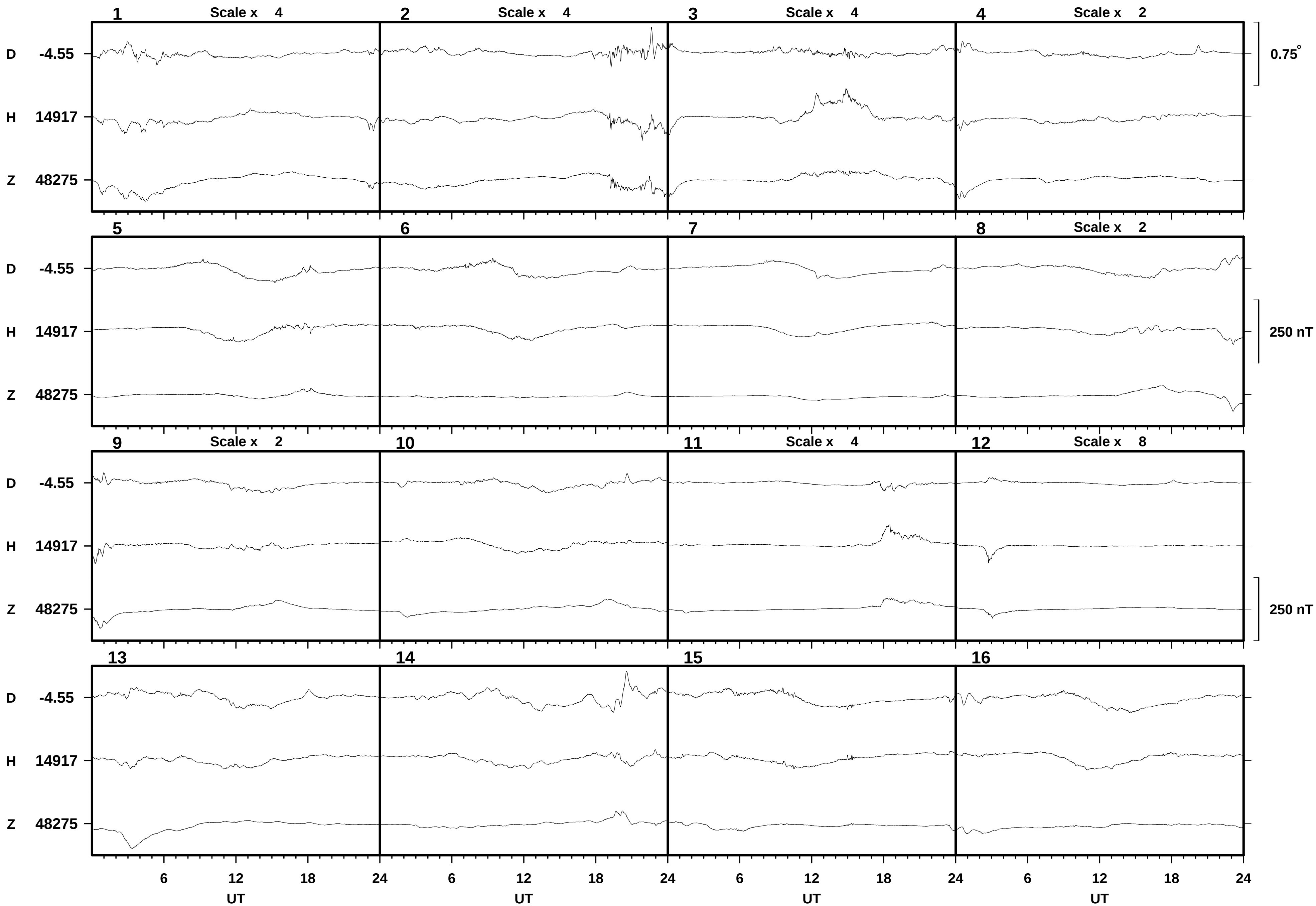
Lerwick September 2001



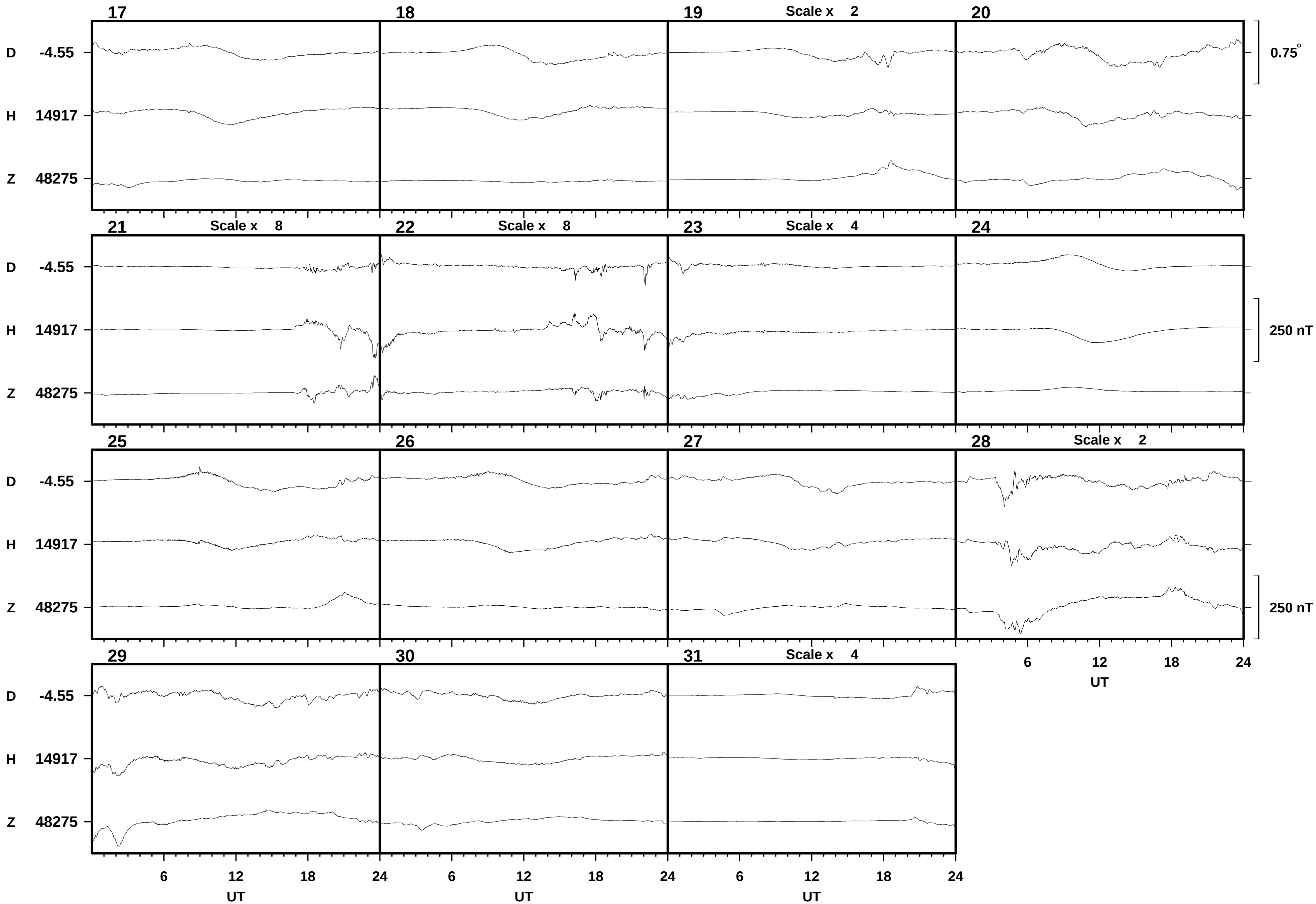

17
18
19
20
21
22
23
Scale x 4
24
Scale x 2
25
Scale x 8
26
Scale x 4
27
28
29
Scale x 4
30
Scale x 4
D -4.57
H 14931
Z 48256
0.75°
250 nT
250 nT
6
12
18
24
UT

LE 9 1

Lerwick October 2001

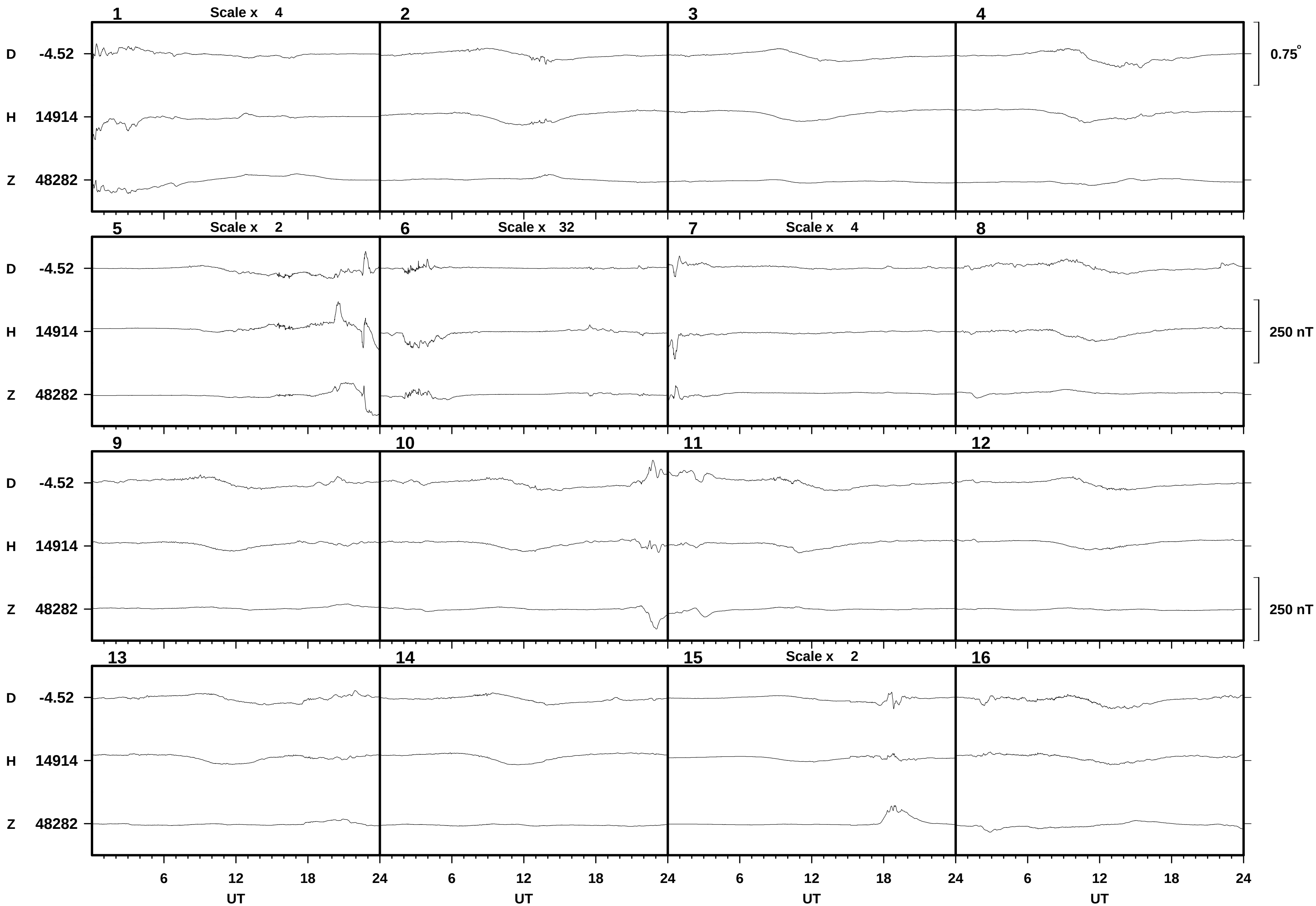


LE 10 1

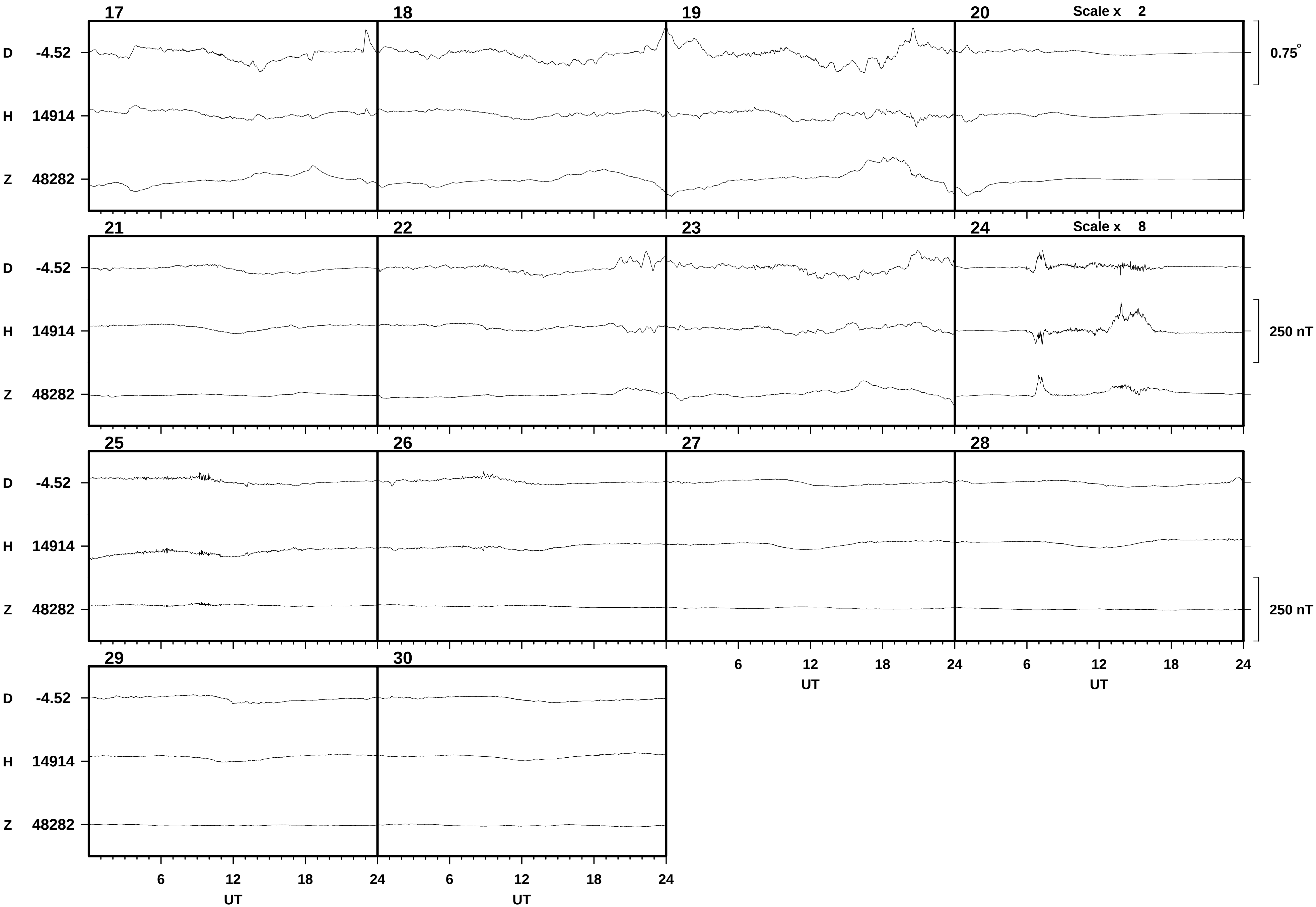

17
18
19
Scale x 2
20
21
Scale x 8
22
Scale x 8
23
Scale x 4
24
25
26
27
28
Scale x 2
29
30
31
Scale x 4
D -4.55
H 14917
Z 48275
0.75°
250 nT
250 nT
6
12
18
24
UT

LE 10 1

Lerwick November 2001



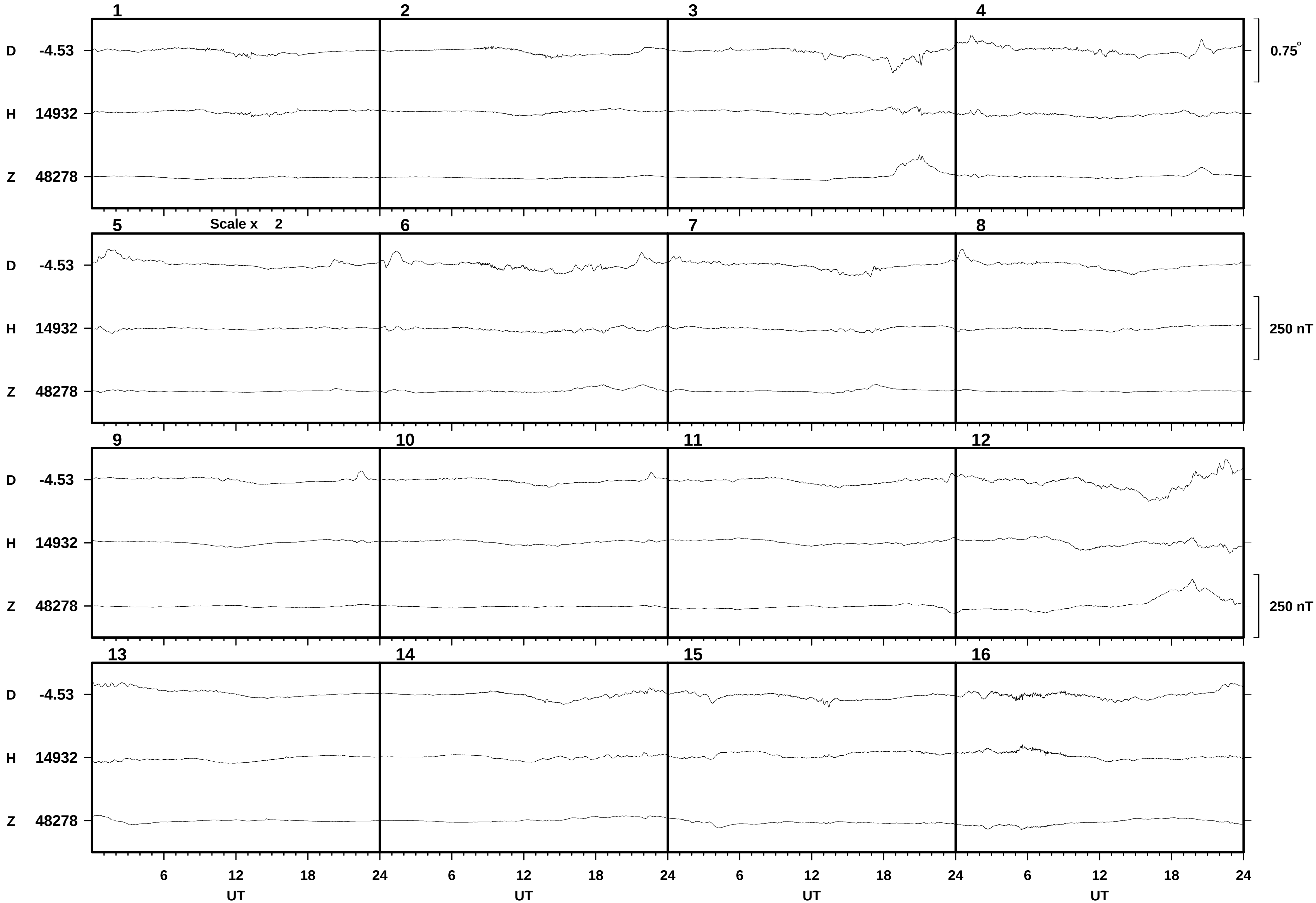
LE 11 1



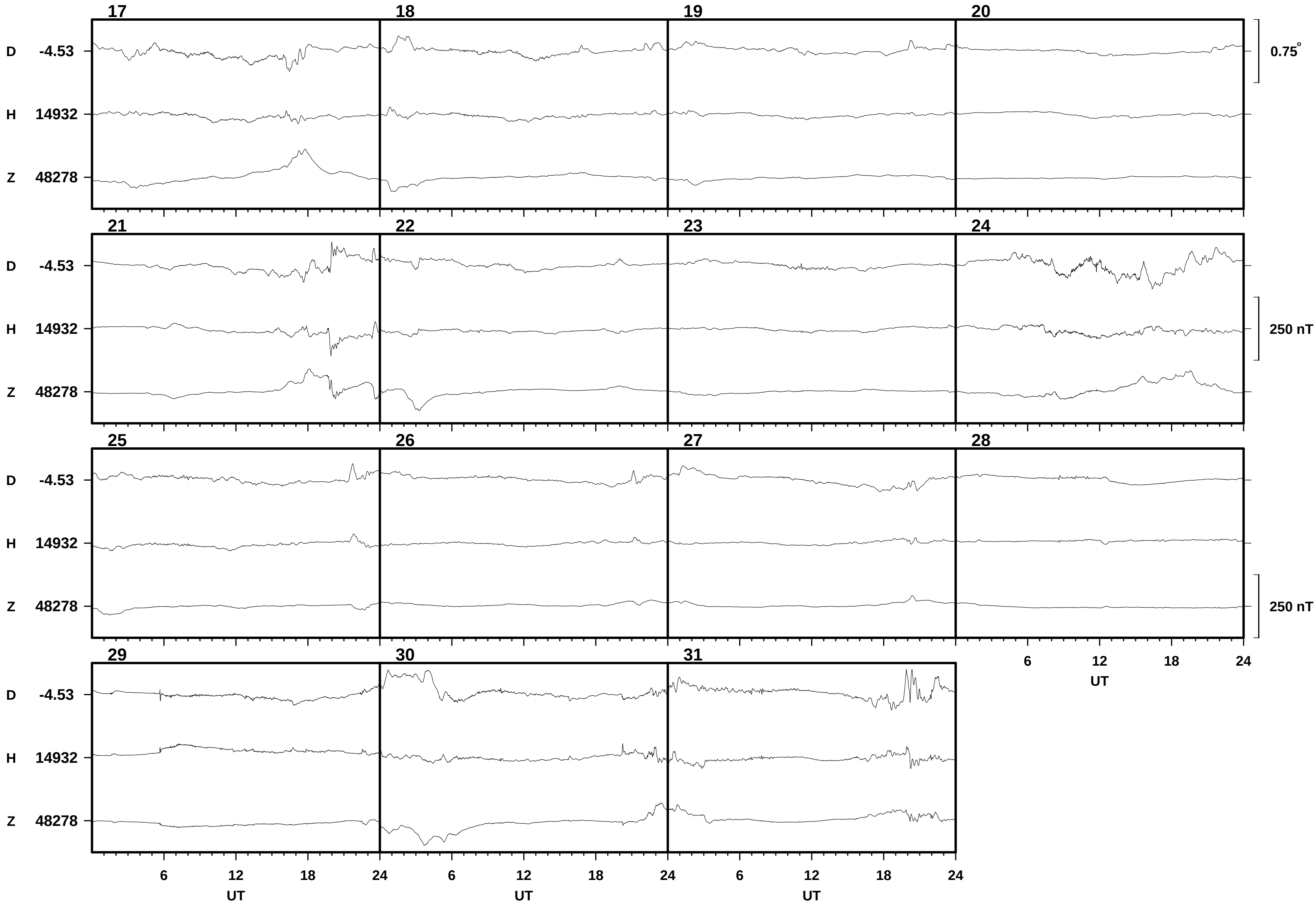
17
18
19
20
Scale x 2
21
22
23
24
Scale x 8
25
26
27
28
29
30
D -4.52
H 14914
Z 48282
0.75°
250 nT
250 nT
6
12
18
24
UT

LE 11 1

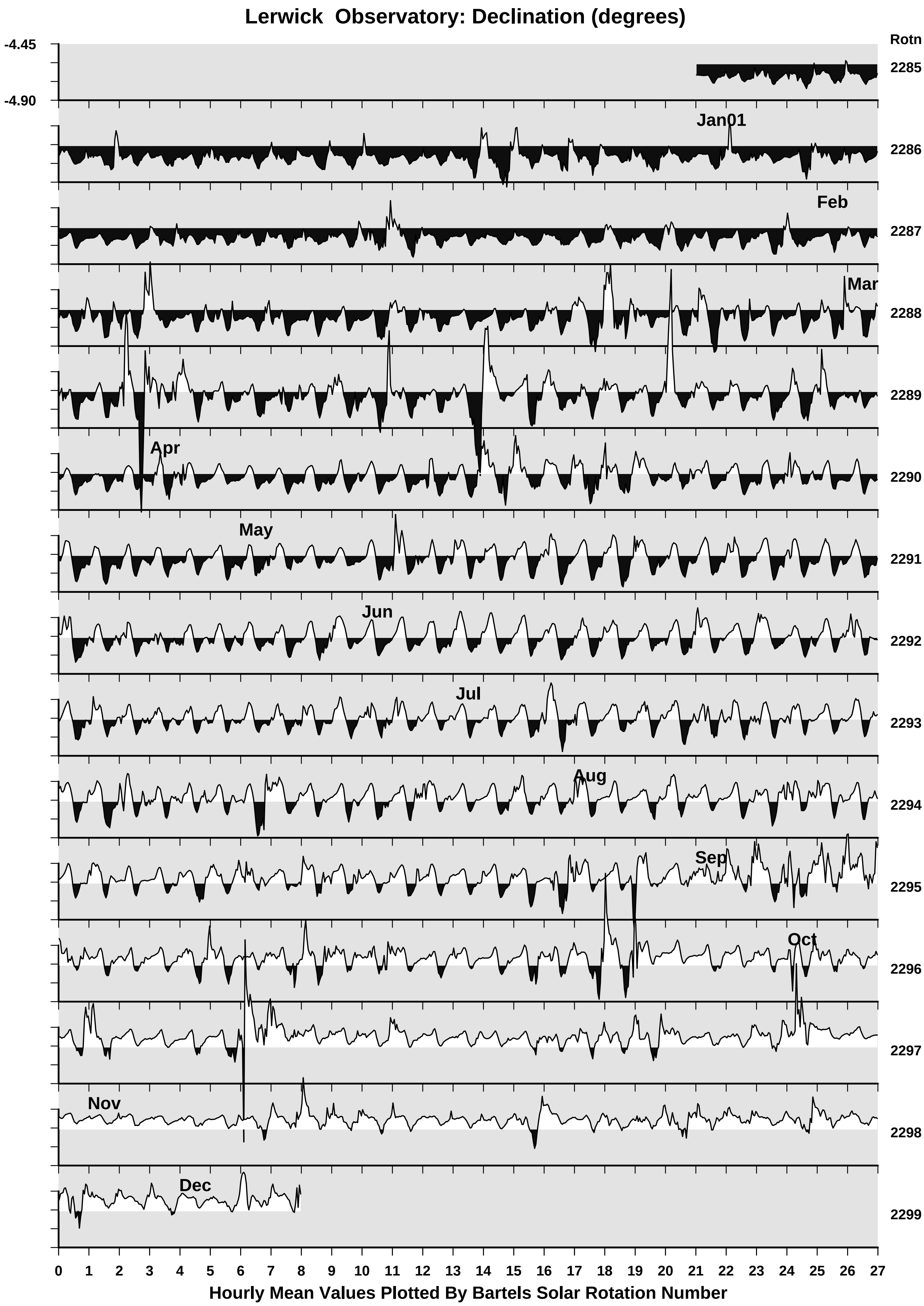
Lerwick December 2001



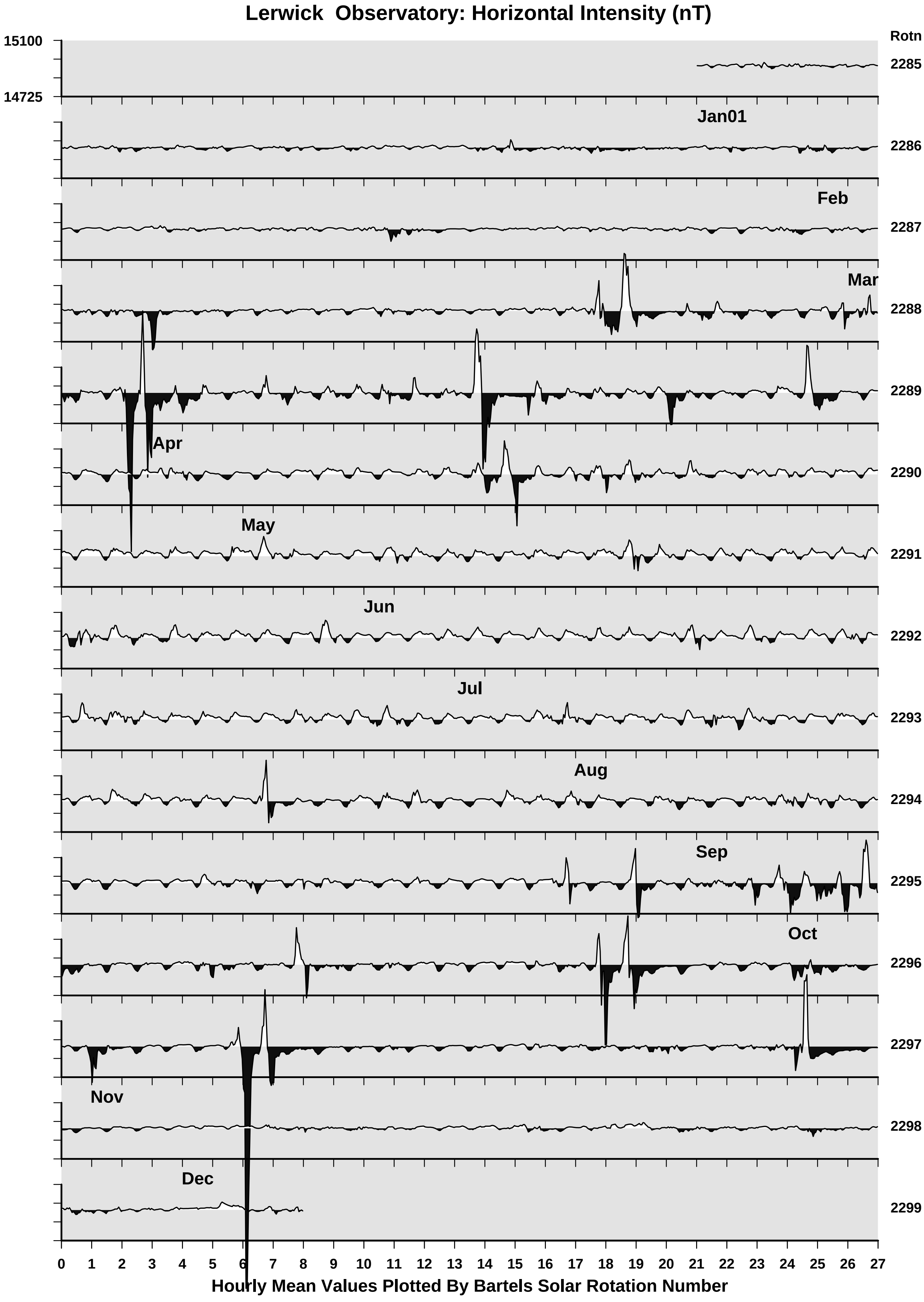
LE 12 1


17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
D -4.53
H 14932
Z 48278
0.75°
250 nT
250 nT
6
12
18
24
UT

LE 12 1

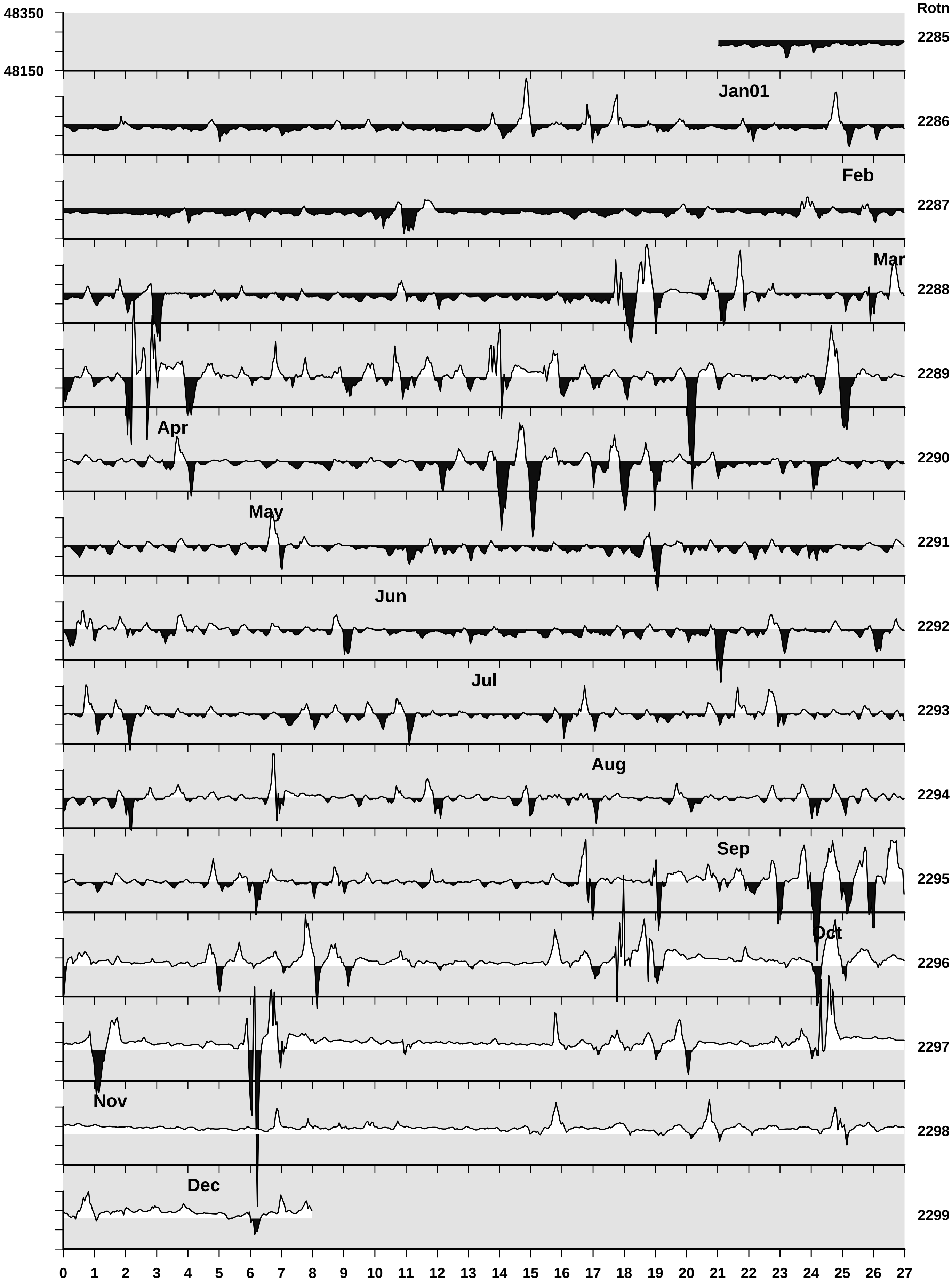


Lerwick Observatory: Declination (degrees)
-4.45
-4.90
Rotn
2285
2286
2287
2288
2289
2290
2291
2292
2293
2294
2295
2296
2297
2298
2299
Jan01
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
Hourly Mean Values Plotted By Bartels Solar Rotation Number

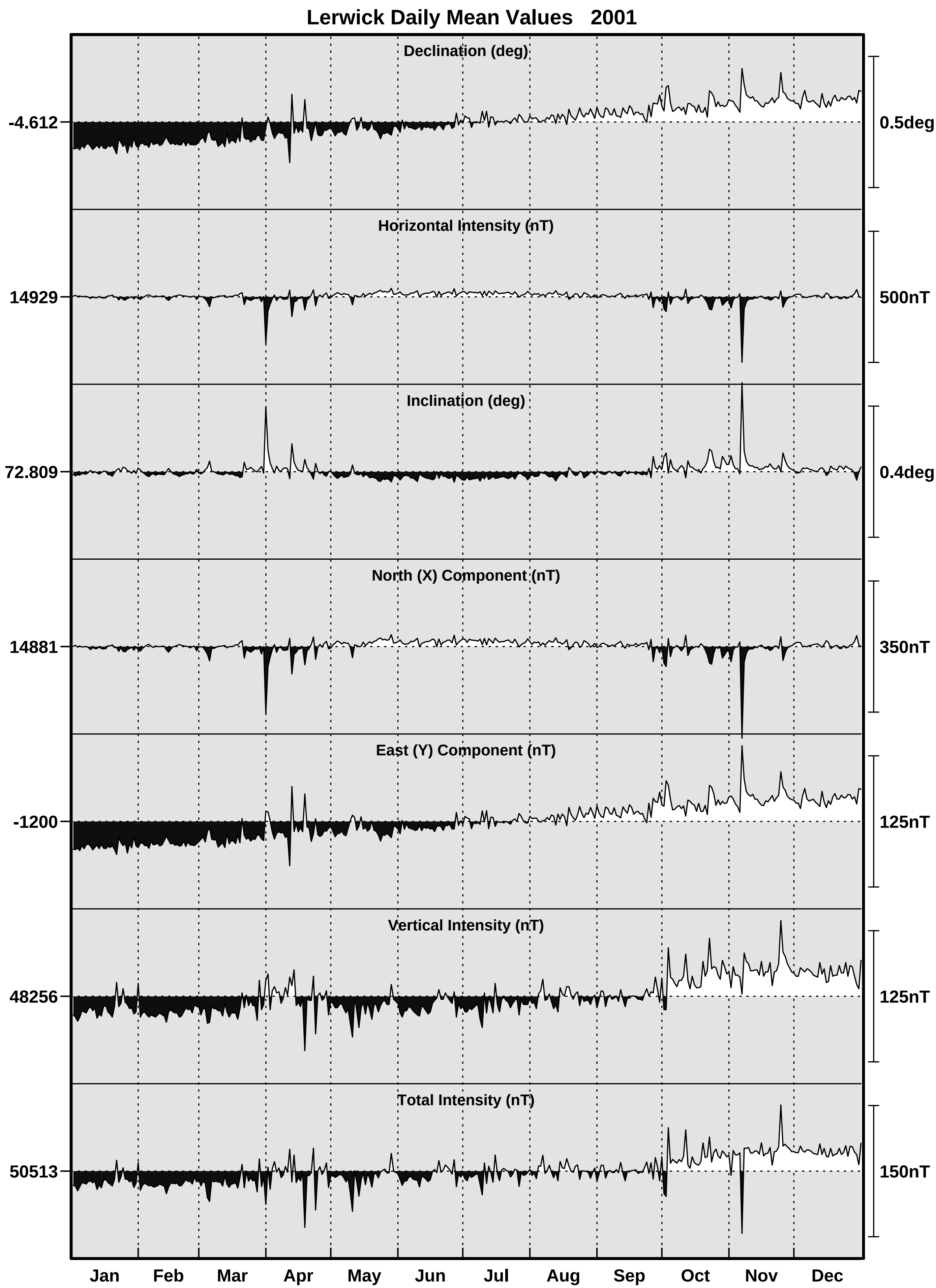


Lerwick Observatory: Horizontal Intensity (nT)
15100
14725
Rotn
2285
2286
2287
2288
2289
2290
2291
2292
2293
2294
2295
2296
2297
2298
2299
Jan01
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted By Bartels Solar Rotation Number

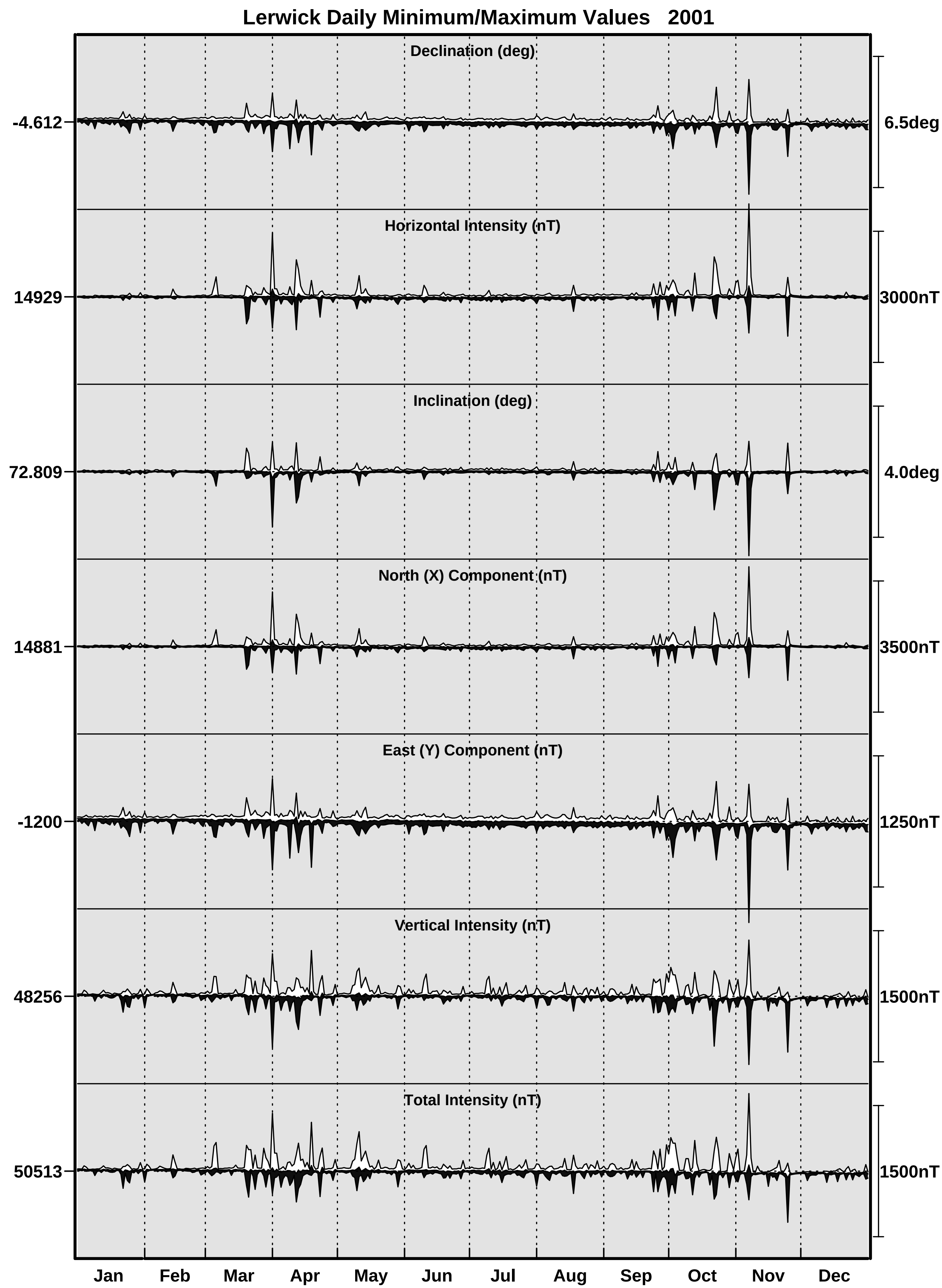
Lerwick Observatory: Vertical Intensity (nT)



Hourly Mean Values Plotted By Bartels Solar Rotation Number



Lerwick Daily Mean Values 2001
Declination (deg)
-4.612
0.5deg
Horizontal Intensity (nT)
14929
500nT
Inclination (deg)
72.809
0.4deg
North (X) Component (nT)
14881
350nT
East (Y) Component (nT)
-1200
125nT
Vertical Intensity (nT)
48256
125nT
Total Intensity (nT)
50513
150nT
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



Lerwick Daily Minimum/Maximum Values 2001
Declination (deg)
-4.612
6.5deg
Horizontal Intensity (nT)
14929
3000nT
Inclination (deg)
72.809
4.0deg
North (X) Component (nT)
14881
3500nT
East (Y) Component (nT)
-1200
1250nT
Vertical Intensity (nT)
48256
1500nT
Total Intensity (nT)
50513
1500nT
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Monthly Mean Values for Lerwick 2001

Month	D	H	I	X	Y	Z	F

Based on All Days

Month	D	H	I	X	Y	Z	F
January	-4° 42.3′	14928 nT	72° 48.4′	14877 nT	-1224 nT	48244 nT	50501 nT
February	-4° 41.6′	14930 nT	72° 48.2′	14880 nT	-1222 nT	48240 nT	50497 nT
March	-4° 40.5′	14920 nT	72° 48.9′	14870 nT	-1216 nT	48245 nT	50499 nT
April	-4° 38.6′	14920 nT	72° 49.1′	14871 nT	-1208 nT	48254 nT	50509 nT
May	-4° 38.4′	14940 nT	72° 47.6′	14891 nT	-1208 nT	48245 nT	50505 nT
June	-4° 37.7′	14943 nT	72° 47.5′	14894 nT	-1206 nT	48247 nT	50508 nT
July	-4° 36.3′	14943 nT	72° 47.5′	14895 nT	-1200 nT	48247 nT	50509 nT
August	-4° 35.5′	14937 nT	72° 48.0′	14889 nT	-1196 nT	48254 nT	50513 nT
September	-4° 34.3′	14931 nT	72° 48.5′	14883 nT	-1190 nT	48256 nT	50514 nT
October	-4° 32.8′	14917 nT	72° 49.8′	14870 nT	-1183 nT	48275 nT	50527 nT
November	-4° 31.3′	14914 nT	72° 50.1′	14867 nT	-1176 nT	48282 nT	50533 nT
December	-4° 31.7′	14932 nT	72° 48.8′	14885 nT	-1179 nT	48278 nT	50535 nT
Annual	**-4° 36.7′**	**14929 nT**	**72° 48.5′**	**14881 nT**	**-1200 nT**	**48256 nT**	**50512 nT**

International quiet day means

Month	D	H	I	X	Y	Z	F
January	-4° 42.5′	14932 nT	72° 48.0′	14882 nT	-1226 nT	48239 nT	50497 nT
February	-4° 41.9′	14933 nT	72° 48.0′	14883 nT	-1223 nT	48240 nT	50498 nT
March	-4° 41.1′	14932 nT	72° 48.1′	14882 nT	-1220 nT	48241 nT	50499 nT
April	-4° 38.8′	14929 nT	72° 48.5′	14880 nT	-1210 nT	48255 nT	50511 nT
May	-4° 38.4′	14940 nT	72° 47.7′	14891 nT	-1208 nT	48249 nT	50509 nT
June	-4° 37.2′	14943 nT	72° 47.5′	14895 nT	-1204 nT	48250 nT	50511 nT
July	-4° 36.4′	14943 nT	72° 47.5′	14894 nT	-1200 nT	48248 nT	50509 nT
August	-4° 35.1′	14935 nT	72° 48.1′	14888 nT	-1194 nT	48253 nT	50512 nT
September	-4° 35.2′	14934 nT	72° 48.2′	14886 nT	-1194 nT	48255 nT	50513 nT
October	-4° 32.7′	14925 nT	72° 49.1′	14878 nT	-1183 nT	48271 nT	50526 nT
November	-4° 32.1′	14928 nT	72° 49.1′	14881 nT	-1180 nT	48280 nT	50535 nT
December	-4° 31.8′	14932 nT	72° 48.8′	14885 nT	-1179 nT	48276 nT	50532 nT
Annual	**-4° 36.9′**	**14934 nT**	**72° 48.2′**	**14885 nT**	**-1202 nT**	**48255 nT**	**50513 nT**

International disturbed day means

Month	D	H	I	X	Y	Z	F
January	-4° 42.1′	14924 nT	72° 48.9′	14874 nT	-1223 nT	48258 nT	50513 nT
February	-4° 41.0′	14924 nT	72° 48.6′	14874 nT	-1219 nT	48240 nT	50496 nT
March	-4° 39.0′	14897 nT	72° 50.7′	14848 nT	-1208 nT	48258 nT	50505 nT
April	-4° 37.3′	14904 nT	72° 50.2′	14855 nT	-1201 nT	48256 nT	50505 nT
May	-4° 37.7′	14930 nT	72° 48.1′	14882 nT	-1205 nT	48236 nT	50494 nT
June	-4° 37.7′	14938 nT	72° 47.7′	14889 nT	-1205 nT	48244 nT	50504 nT
July	-4° 36.4′	14943 nT	72° 47.4′	14895 nT	-1200 nT	48246 nT	50508 nT
August	-4° 36.1′	14940 nT	72° 47.9′	14892 nT	-1199 nT	48260 nT	50519 nT
September	-4° 33.2′	14920 nT	72° 49.2′	14873 nT	-1184 nT	48260 nT	50514 nT
October	-4° 31.3′	14899 nT	72° 50.9′	14852 nT	-1175 nT	48276 nT	50523 nT
November	-4° 28.4′	14864 nT	72° 53.4′	14819 nT	-1159 nT	48287 nT	50523 nT
December	-4° 31.2′	14926 nT	72° 49.3′	14879 nT	-1176 nT	48282 nT	50536 nT
Annual	**-4° 36.0′**	**14917 nT**	**72° 49.4′**	**14869 nT**	**-1196 nT**	**48259 nT**	**50512 nT**

Lerwick Observatory K Indices 2001

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0000 0001	1321 1022	2110 1111	5443 3345	0000 1120	1012 3223	2111 1122	4112 1211	1111 1200	6644 4425	6531 4310	0001 2200
2	1000 1003	3100 0101	1011 1233	5422 3432	0111 1100	5334 3233	1100 1021	0111 2310	0000 2212	4443 3467	0010 2000	0000 1111
3	2321 1000	0000 1000	2112 3233	2111 1212	2102 1212	1121 1222	0110 2221	2142 2312	1122 3333	6245 6734	0000 0000	0101 2133
4	2121 2213	0000 0000	2221 2255	2111 4451	1121 1222	3011 1211	1101 1211	1111 2222	3421 2322	4222 3332	0001 1200	2211 2131
5	2000 0013	0000 0012	6432 1201	1133 3433	0000 0110	2110 0111	2221 3332	2133 4432	3111 3320	1001 2320	0001 2356	4201 1132
6	1000 0001	3121 1232	2111 2132	1122 3232	0011 2111	1111 2222	1011 2331	2322 4323	1111 1112	1112 2011	9963 5877	3111 1223
7	1100 0003	1120 0021	1321 1320	3322 2333	3421 2231	2312 2221	1101 1210	2211 2111	0001 1113	0000 2101	7312 2122	2100 1201
8	1101 1254	0211 0112	1011 1133	2123 5376	1012 3444	1012 2222	1221 1335	3110 1121	3101 2110	1211 3324	1111 1001	3111 1100
9	1011 1111	0011 1122	2011 2200	2232 2522	5432 4555	2223 4346	5210 1211	0100 2322	0101 1100	5223 3301	0011 1121	0001 0002
10	0000 0211	0101 1210	0111 1120	2111 3223	7432 2442	5222 2332	0101 2332	2111 1022	1000 1122	1011 1221	1101 1113	0000 1002
11	1000 1232	2111 1002	1211 1011	2112 3789	2010 0124	2201 2321	3301 1121	2100 1013	1000 2332	2110 2554	2101 0100	0000 1012
12	3221 0000	1000 1122	0011 3233	7644 3200	4233 4434	2110 1111	1111 2222	2113 2332	2222 2123	7632 3343	1001 0000	1111 2233
13	0012 2002	2332 2345	2212 1112	0126 4546	5321 3355	2221 2221	2201 0022	3422 3432	2433 2120	2322 2321	0000 1112	1100 0000
14	2211 1032	3322 3343	3111 1111	4322 3332	4321 1221	2010 1212	3412 3211	2212 3222	2111 2112	0222 2243	0000 0010	0000 1112
15	0001 1123	1011 0101	0000 1000	2220 4222	1111 2342	3312 1120	0011 3332	1110 2222	4223 3342	1212 2202	0000 1240	2201 2001
16	0000 2111	0000 1012	0000 0102	3210 2222	2221 0212	2010 0121	3212 4323	0100 0111	2101 2222	2011 1111	2111 1101	2221 1111
17	3100 0111	1000 0010	0001 1221	1210 2222	1100 1221	1010 3222	4422 3321	1102 3576	0110 1112	2010 1000	2211 2123	3322 2421
18	0001 1003	1000 0001	2211 1122	6753 2223	2210 2112	2343 4424	1211 3311	3220 3332	1100 1331	0000 1110	2201 1224	3111 2202
19	2000 0012	1000 1010	2112 3586	2211 1003	3310 1121	3211 2333	1112 2321	0122 1220	2211 1121	0001 2442	3212 2343	2101 0131
20	0011 1224	0101 2112	4545 7663	2201 2101	1111 3110	2232 3201	1111 2210	0002 2211	0101 1002	1222 2212	3231 0000	1000 1001
21	2212 2344	2111 1102	5211 1000	1101 2322	1001 1110	1322 2342	1101 1111	0113 4333	1000 1102	2101 1689	0000 1100	0021 2343
22	3211 1213	0010 0121	0000 2433	2322 5653	1111 2221	2110 1211	2221 2333	0123 4344	1012 2210	8434 6788	1111 2123	2211 1020
23	1103 2253	2211 1212	4422 3453	4422 2211	1211 3322	1101 2211	3211 3321	3221 2111	0233 4575	6332 1100	1112 2233	1102 1101
24	2201 3353	1110 1100	1321 2230	1212 2111	2101 0111	2111 2322	2212 3431	0000 1100	4111 1210	0000 0000	3376 8833	1233 3433
25	1100 0123	0000 0010	0112 2121	1011 2222	1111 3320	1210 2210	1333 3342	0102 2433	0111 1247	0021 1121	0122 1100	2111 1103
26	1122 1222	3000 0323	0011 1010	0111 2122	1210 1001	0122 4343	3311 2121	2122 1223	6534 2221	0011 0112	1021 0000	1001 0023
27	2100 1000	3222 1100	3312 1346	1111 1211	0011 1421	3210 0100	1111 2211	1111 2333	0112 2232	1101 2000	0000 0000	2100 1222
28	0001 2132	0001 2121	4144 5533	2533 5533	2223 3433	0000 0001	1000 1100	4321 2220	2232 2233	2543 4443	0000 0001	1010 1001
29	4411 0022		3333 2323	4421 2220	3100 3411	0000 0111	1211 2210	0011 1200	3223 2356	3212 2222	1001 1000	2211 1212
30	1100 0000		2121 2323	0000 0010	0000 2121	1112 2222	0011 2232	0111 3321	5211 3655	2211 1102	0000 0000	3421 1133
31	0022 3343		5995 6797		0000 1110		4332 5533	2222 1421		1000 2256		3210 0243

SIs and SSCs

Day	Month	UT		Type	Quality	H(nT)	D(min)	Z(nT)
10	01	16	20	SSC*	C	9.6	0.95	3.0
13	01	09	45	SSC*	B	-8.4	2.54	-2.6
17	01	16	30	SSC*	A	19.5	-1.50	-6.9
23	01	10	47	SSC*	A	-15.7	11.02	-7.5
31	01	08	04	SSC*	A	6.6	3.96	-6.9
12	02	16	13	SSC*	C	13.9	-1.39	3.0
03	03	11	20	SSC*	B	20.1	-4.92	-7.4
19	03	11	14	SSC*	B	15.3	2.63	-3.6
19	03	18	34	SI*	A	-542.1	-35.40	-225.0
22	03	13	41	SSC*	A	32.3	-5.80	-8.0
27	03	17	46	SSC	B	36.8	-2.81	-10.4
31	03	00	52	SSC	C	49.2	-10.20	-87.6
31	03	06	50	SI*	B	-267.6	-83.33	-188.2
31	03	16	02	SI*	B	131.1	-78.33	-523.9
04	04	14	54	SSC*	A	57.5	-6.63	-23.3
08	04	11	01	SSC*	B	-42.9	8.82	18.8
11	04	13	43	SSC*	B	34.4	-2.09	2.4
13	04	07	34	SSC*	B	-32.6	-3.73/+4.1	-8.1/+11.0
13	04	09	57	SI	A	-176.5	29.91	65.7
13	04	21	27	SI*	B	-227.2	-16.35	-182.7
18	04	00	47	SSC	C	21.3	-4.20	-21.3
21	04	16	01	SSC*	A	48.5	-4.58	-14.8
28	04	05	00	SSC*	A	+49.0/-89.3	-28.6	20.7
27	05	14	57	SSC*	A	59.8	-5.09	-18.5
07	06	09	48	SSC	C	-4.6	1.83	-2.1/+1.9
11	06	14	01	SI*	B	-16.6	0.72	-4.2
18	06	02	59	SSC	B	11.5	-3.34	-2.7
17	07	06	03	SSC*	C	-1.1	1.68	-
20	07	07	04	SI*	C	-2.0	1.48	-1.6
31	07	03	53	SSC	C	-4.8	4.91	3.6
03	08	07	15	SSC*	A	-25.4	9.23	-3.3
12	08	11	34	SSC*	A	40.3	-4.6	-14.5
17	08	11	03	SSC*	A	21.9	3.11	-5.5
21	08	14	47	SI*	C	-4.8	0.27	-3.2
23	08	05	55	SSC*	C	-6.2	1.46	-
27	08	19	51	SSC	B	48.8	-1.85	-15.0
30	08	14	10	SSC*	B	29.2	-3.35	4.6
14	09	02	04	SSC*	A	21.6	-3.33	-5.8
22	09	14	34	SI	C	-16.3	3.74	1.9
23	09	07	50	SSC*	C	-14.0	1.78	-
25	09	20	25	SSC*	A	68.0	7.98	-31.4
29	09	09	38	SSC*	A	-3.9	5.29	-4.7

Notes

A * indicates that the principal impulse was preceded by a smaller reversed impulse.

The quality of the event is classified as follows :

A = very distinct
B = fair, ordinary, but unmistakable
C = doubtful

The amplitudes given are for the first chief movement of the event.

SIs and SSCs

Day	Month	UT		Type	Quality	H(nT)	D(min)	Z(nT)
11	10	17	00	SSC*	A	45.6	2.64	6.6
21	10	16	47	SSC*	A	64.4	-8.16	24.3
22	10	21	57	SI	A	-64.74	-62.64	-276.8
25	10	08	59	SI	B	8.6	-2.8	-1.6
28	10	03	18	SSC	A	12.3	-5.18	-2.3
31	10	13	48	SI	B	17.1	-3.87	0.8
05	11	02	49	SI	C	2.5	-0.37	-
06	11	01	52	SSC	A	-356.8	-27.79	-173.5
15	11	15	09	SSC	A	14.6	-1.98	-5.3
19	11	18	14	SSC	C	20.7	2.76	-12.1
24	11	05	55	SSC*	A	-41.2	-14.58	23.5
30	11	18	24	SSC*	B	5.9	0.57	-2.4
29	12	05	38	SSC	A	21.6	-8.21	-9.3
30	12	20	10	SSC	A	42.2	-2.21	-14.0

Notes

A * indicates that the principal impulse was preceded by a smaller reversed impulse.
The quality of the event is classified as follows :

A = very distinct
B = fair, ordinary, but unmistakable
C = doubtful

The amplitudes given are for the first chief movement of the event.

SFEs

Day	Month	Universal Time Start		Maximum		End		H(nT)	D(min)	Z(nT)
08	03	11	15	11	20	11	30	-11.8	0.56	3.0
17	03	09	25	09	30	09	40	2.5	-0.94	-1.5
15	04	13	45	13	52	14	06	-47.0	-46.9	25.6
26	04	13	08	13	12	13	24	-13.2	-	5.5
31	08	10	30	10	47	11	04	-22.4	-3.32	5.3
13	12	14	26	14	31	14	50	-2.7	-0.78	4.8

Notes

The amplitudes given are for the chief movement of the event.

Annual Values of Geomagnetic Elements

Lerwick

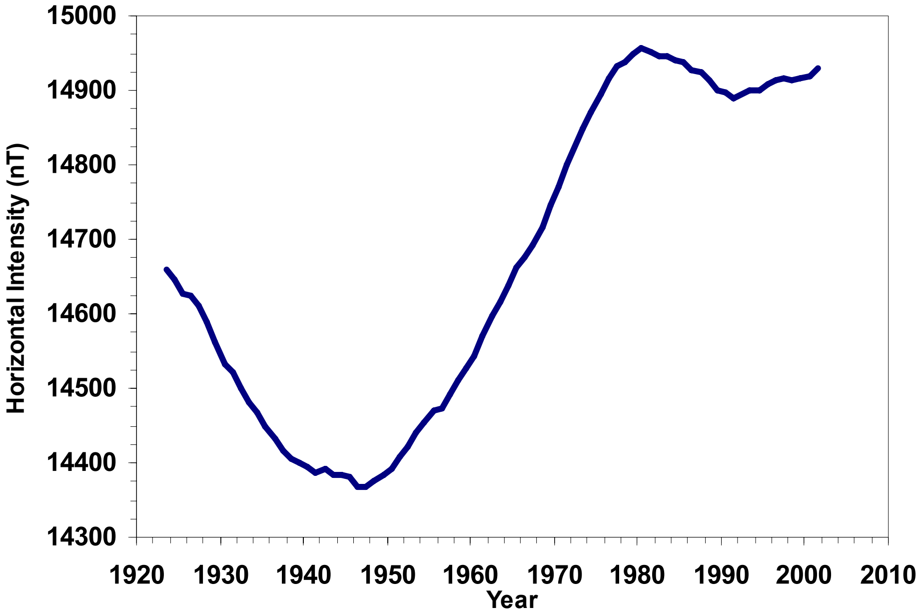
Year	D	H	I	X	Y	Z	F
1923.5	-15 40.3	14655	72 33.7	14111	-3959	46655	48902
1924.5	-15 26.5	14642	72 35.7	14113	-3899	46708	48950
1925.5	-15 13.5	14621	72 37.2	14108	-3840	46713	48948
1926.5	-14 58.6	14618	72 37.1	14121	-3778	46699	48933
1927.5	-14 45.7	14607	72 38.1	14125	-3722	46713	48944
1928.5	-14 32.9	14585	72 39.4	14117	-3664	46702	48926
1929.5	-14 19.4	14556	72 40.3	14104	-3601	46651	48869
1930.5	-14 7.0	14527	72 41.6	14088	-3543	46624	48835
1931.5	-13 55.4	14517	72 42.3	14090	-3493	46623	48830
1932.5	-13 41.9	14495	72 43.5	14083	-3433	46608	48809
1933.5	-13 29.8	14477	72 44.6	14077	-3379	46605	48802
Note 1	0 0.0	0	0 3.0	0	0	144	138
1934.5	-13 17.7	14462	72 48.0	14074	-3326	46716	48903
1935.5	-13 5.3	14445	72 49.4	14070	-3271	46730	48911
1936.5	-12 53.6	14428	72 51.2	14064	-3220	46763	48938
1937.5	-12 42.4	14411	72 52.8	14058	-3170	46785	48955
1938.5	-12 31.6	14401	72 54.0	14058	-3123	46809	48974
1939.5	-12 21.4	14394	72 54.9	14061	-3080	46833	48995
1940.5	-12 11.1	14389	72 55.8	14065	-3037	46860	49019
1941.5	-12 1.0	14382	72 56.8	14067	-2994	46884	49040
1942.5	-11 52.5	14386	72 56.8	14078	-2960	46899	49056
1943.5	-11 43.5	14378	72 57.8	14078	-2922	46919	49073
1944.5	-11 35.1	14380	72 58.1	14087	-2888	46940	49093
1945.5	-11 26.3	14376	72 58.8	14090	-2851	46963	49114
1946.5	-11 17.1	14363	73 0.2	14085	-2811	46989	49135
1947.5	-11 8.7	14363	73 0.5	14092	-2776	47002	49148
1948.5	-11 0.9	14371	73 0.1	14106	-2746	47009	49157
1949.5	-10 53.1	14378	73 0.2	14119	-2715	47037	49185
1950.5	-10 45.5	14388	72 59.5	14135	-2686	47039	49190
1951.5	-10 37.7	14402	72 59.1	14155	-2656	47061	49215
1952.5	-10 29.9	14417	72 58.6	14176	-2627	47087	49245
1953.5	-10 22.8	14435	72 57.8	14199	-2601	47106	49268
1954.5	-10 15.6	14450	72 57.3	14219	-2574	47129	49294
1955.5	-10 9.2	14464	72 56.9	14237	-2550	47156	49324
1956.5	-10 2.8	14469	72 57.3	14247	-2524	47191	49359
1957.5	-9 57.5	14486	72 56.8	14268	-2505	47225	49397
1958.5	-9 52.7	14507	72 55.8	14292	-2489	47246	49423
1959.5	-9 48.1	14523	72 55.3	14311	-2472	47271	49452
1960.5	-9 43.4	14538	72 54.9	14329	-2455	47299	49483
1961.5	-9 39.1	14565	72 53.5	14359	-2442	47318	49509
1962.5	-9 33.3	14591	72 52.1	14389	-2422	47336	49534
1963.5	-9 28.5	14610	72 51.3	14411	-2405	47359	49561
1964.5	-9 24.4	14634	72 50.2	14437	-2392	47382	49590
1965.5	-9 21.1	14656	72 49.2	14461	-2382	47403	49617
1966.5	-9 17.8	14672	72 48.7	14479	-2370	47431	49648
1967.5	-9 14.2	14688	72 48.3	14498	-2358	47464	49685
1968.5	-9 12.1	14712	72 47.4	14523	-2353	47496	49722
1969.5	-9 10.3	14740	72 46.2	14552	-2349	47531	49764
1970.5	-9 7.9	14766	72 45.4	14579	-2343	47573	49812
1971.5	-9 5.2	14796	72 44.1	14610	-2337	47607	49853
1972.5	-8 59.5	14820	72 43.3	14638	-2316	47646	49898
1973.5	-8 53.6	14844	72 42.4	14666	-2295	47680	49937
1974.5	-8 46.5	14866	72 41.8	14692	-2268	47719	49981
1975.5	-8 38.4	14890	72 40.9	14721	-2237	47753	50021
1976.5	-8 29.9	14911	72 40.1	14747	-2204	47780	50053
1977.5	-8 20.9	14927	72 39.5	14769	-2167	47803	50079
1978.5	-8 10.1	14933	72 39.8	14782	-2122	47835	50112
1979.5	-8 0.3	14944	72 39.3	14798	-2081	47850	50129
1980.5	-7 50.4	14952	72 39.0	14812	-2039	47858	50139
1981.5	-7 40.9	14946	72 39.7	14812	-1998	47875	50154
1982.5	-7 31.6	14940	72 40.4	14812	-1957	47890	50166
1983.5	-7 22.6	14942	72 40.4	14818	-1918	47895	50172
1984.5	-7 13.4	14936	72 40.9	14818	-1878	47902	50177
1985.5	-7 5.5	14933	72 41.3	14819	-1844	47913	50186
1986.5	-6 58.4	14921	72 42.5	14811	-1811	47931	50200

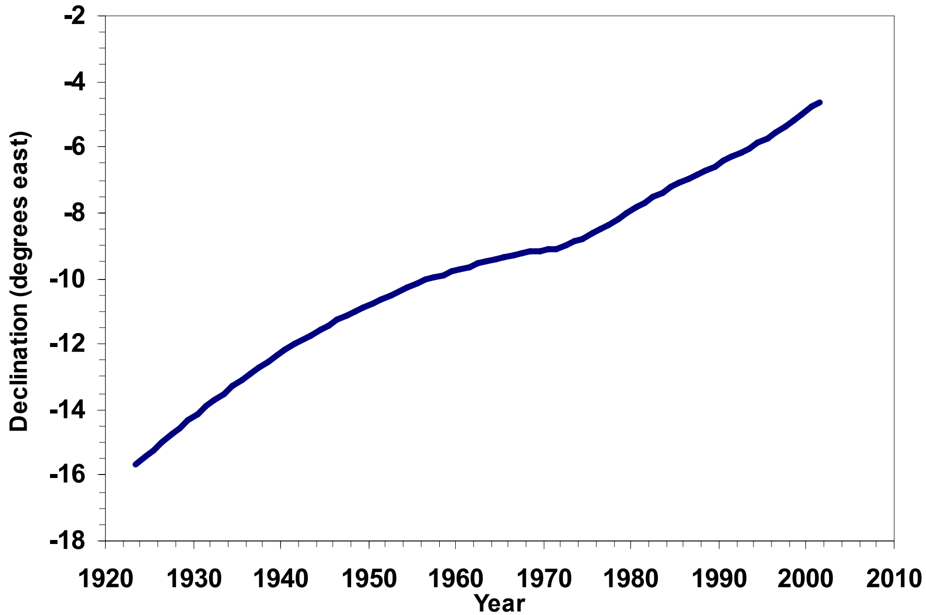
Year	D	H	I	X	Y	Z	F
1987.5	-6 50.3	14918	72 43.0	14812	-1776	47944	50211
1988.5	-6 42.2	14908	72 44.1	14806	-1740	47968	50231
1989.5	-6 34.1	14894	72 45.6	14796	-1704	47995	50253
Note 2	0 0.0	5	0 -0.5	5	-1	-8	-6
1990.5	-6 26.6	14898	72 45.4	14804	-1672	48001	50260
1991.5	-6 19.0	14890	72 46.4	14800	-1638	48021	50277
1992.5	-6 11.3	14894	72 46.3	14807	-1606	48033	50289
1993.5	-6 2.3	14899	72 46.2	14816	-1567	48044	50301
1994.5	-5 52.7	14899	72 46.6	14821	-1526	48063	50319
1995.5	-5 43.2	14907	72 46.5	14833	-1486	48080	50338
Note 3	0 0.0	0	0 0.5	0	0	8	6
1996.5	-5 32.6	14914	72 46.5	14844	-1441	48103	50362
1997.5	-5 21.6	14919	72 46.7	14854	-1393	48130	50389
1998.5	-5 9.6	14913	72 47.7	14853	-1341	48164	50420
1999.5	-4 58.5	14917	72 48.1	14860	-1293	48190	50446
2000.5	-4 47.3	14919	72 48.6	14867	-1246	48227	50482
2001.5	-4 36.7	14929	72 48.5	14881	-1200	48256	50512

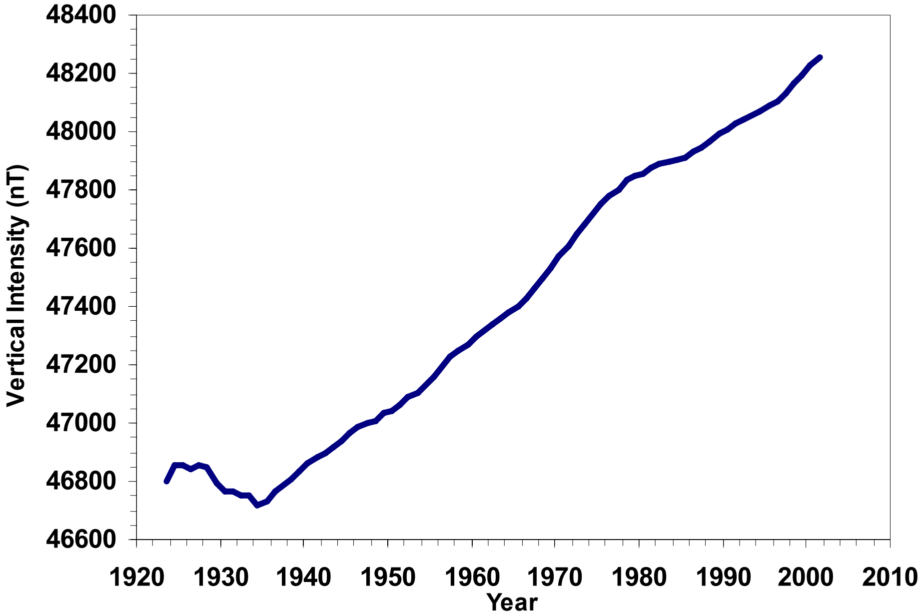
1 Site differences 1 Jan 1934 (new value - old value)
2 Site differences 1 Jan 1990 (new value - old value)
3 Site differences 1 Jan 1996 (new value - old value)

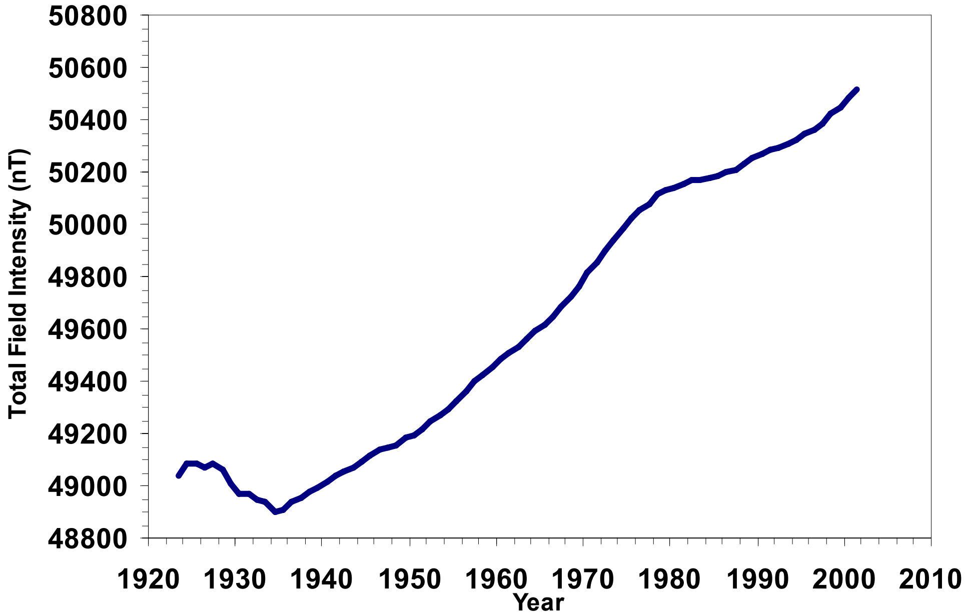
D and I are given in degrees and decimal minutes
All other elements are in nanoteslas

Annual Mean Values at Lerwick

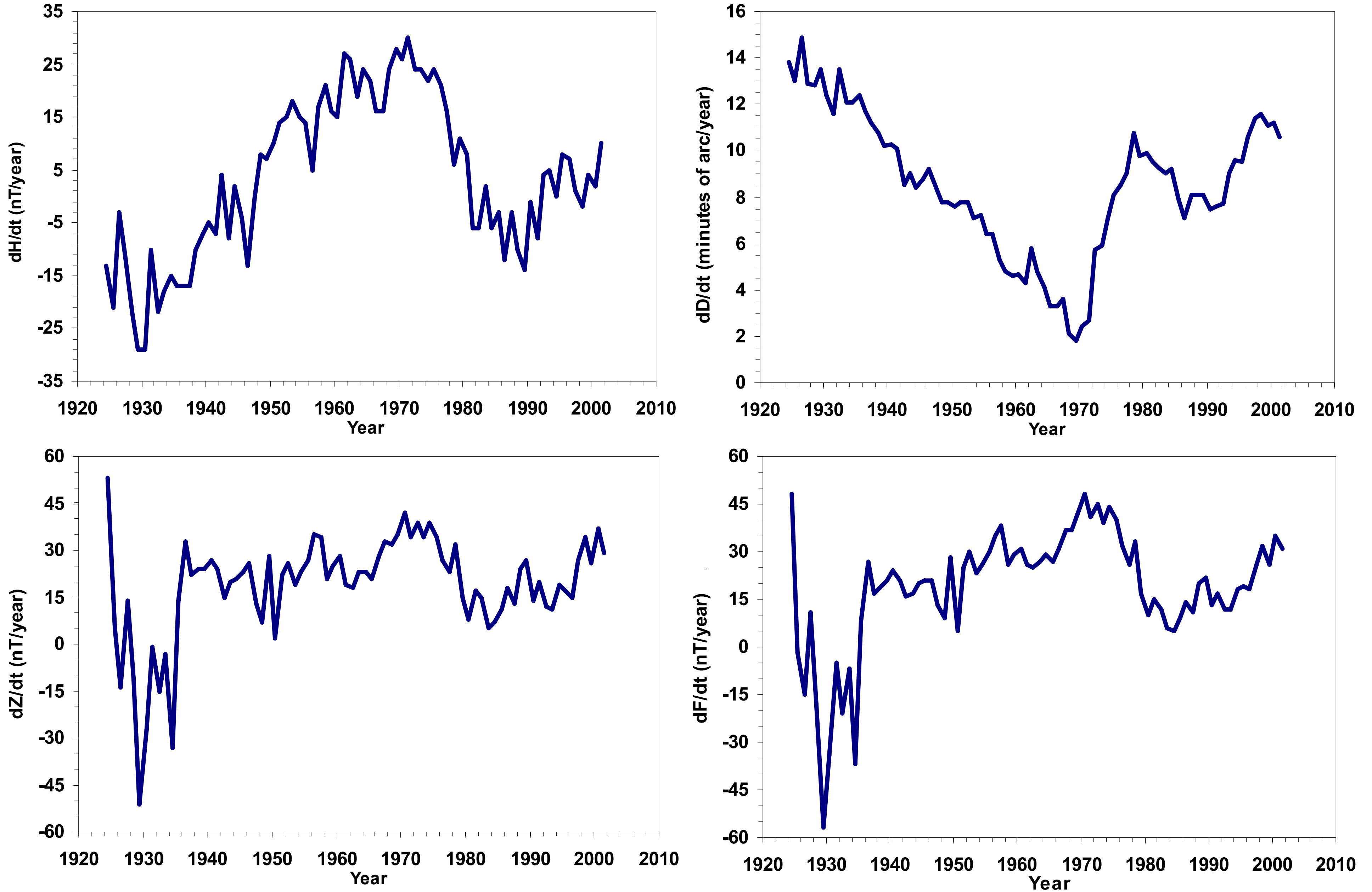




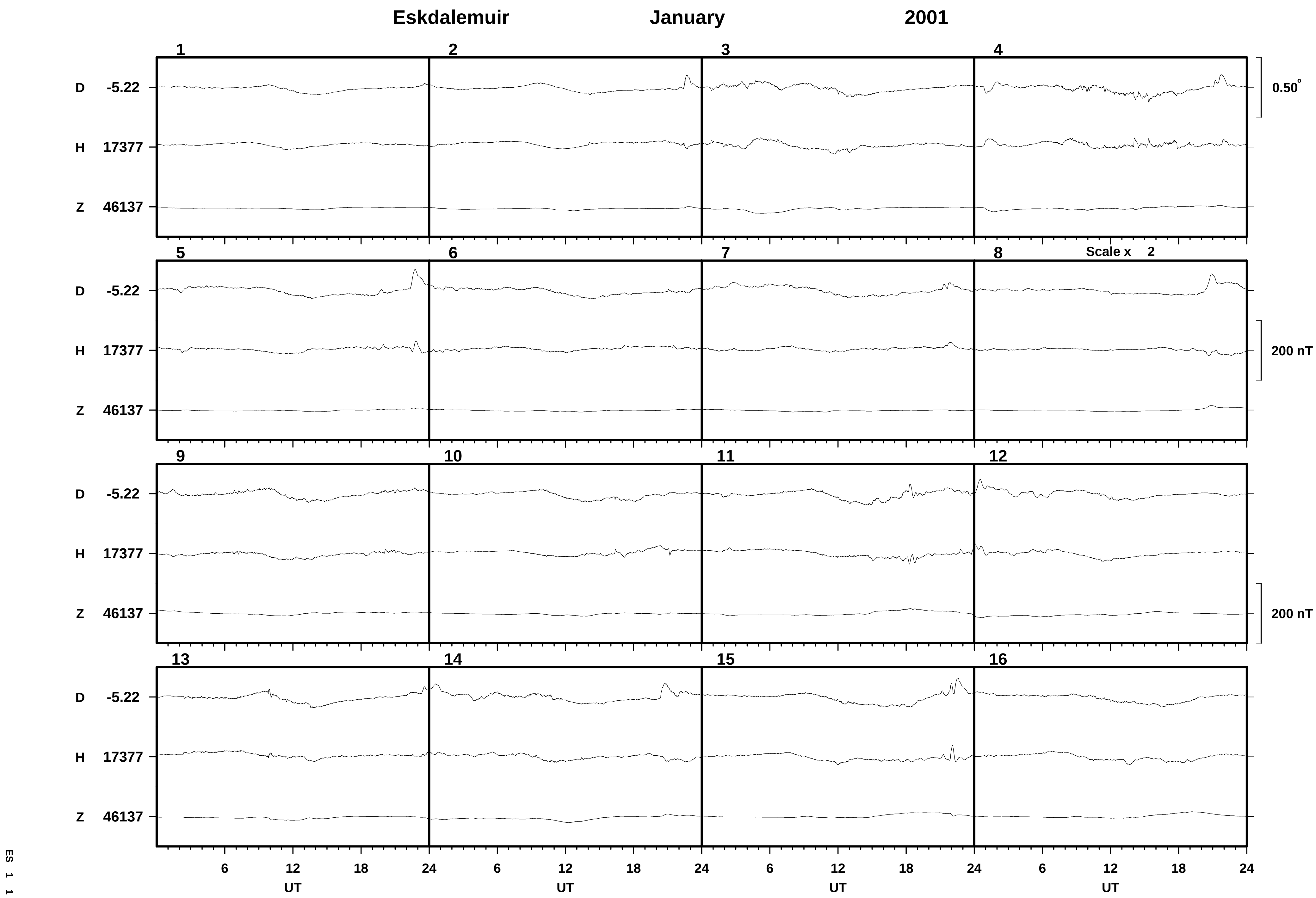




Rate of Change of Annual Mean Values at Lerwick



Eskdalemuir Observatory Results 2001



Eskdalemuir January 2001
1
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D -5.22
H 17377
Z 46137
0.50°
Scale x 2
200 nT
200 nT
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18
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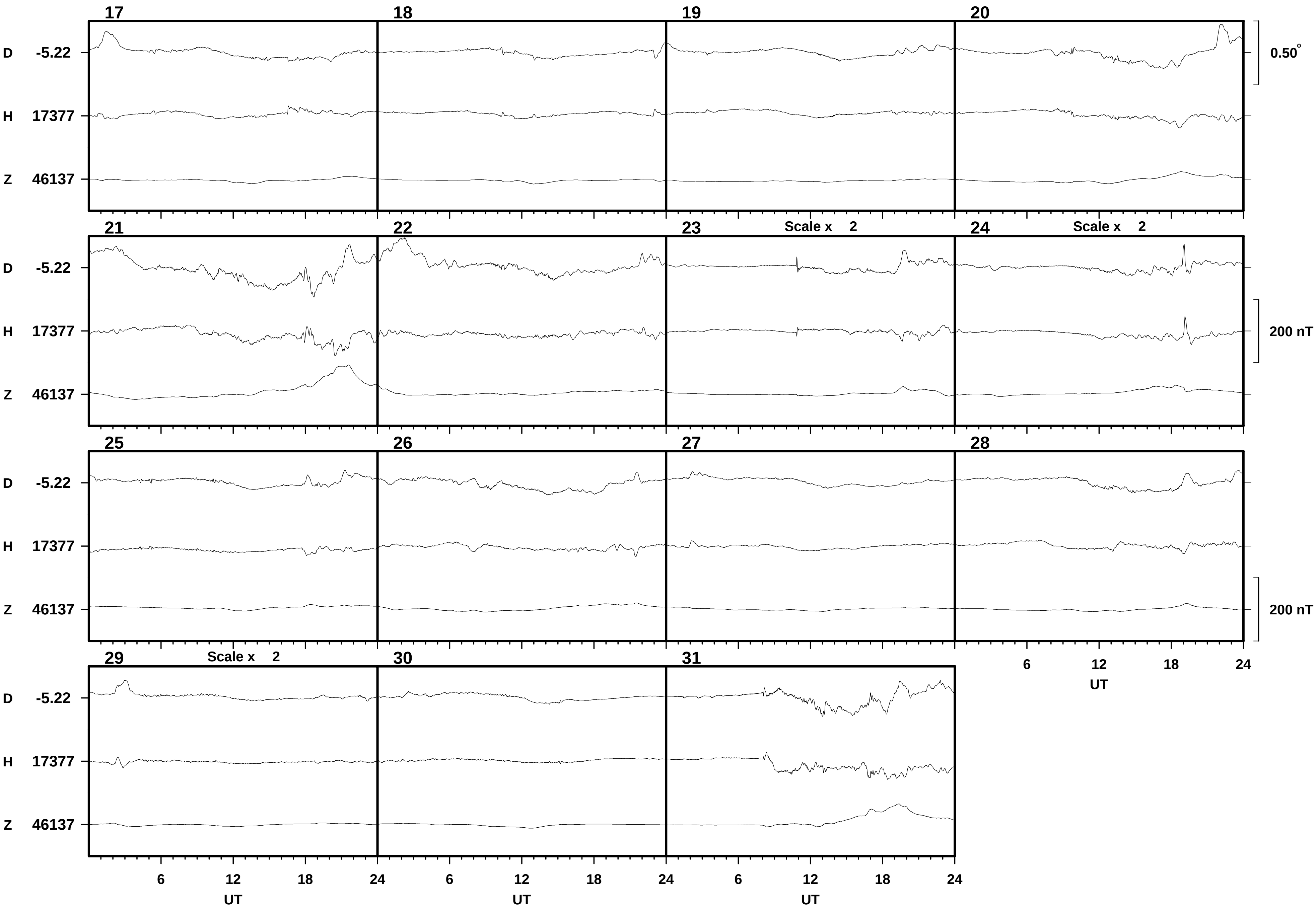
UT
ES 1 1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Scale x 2
Scale x 2
Scale x 2
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H 17377
Z 46137
0.50°
200 nT
200 nT
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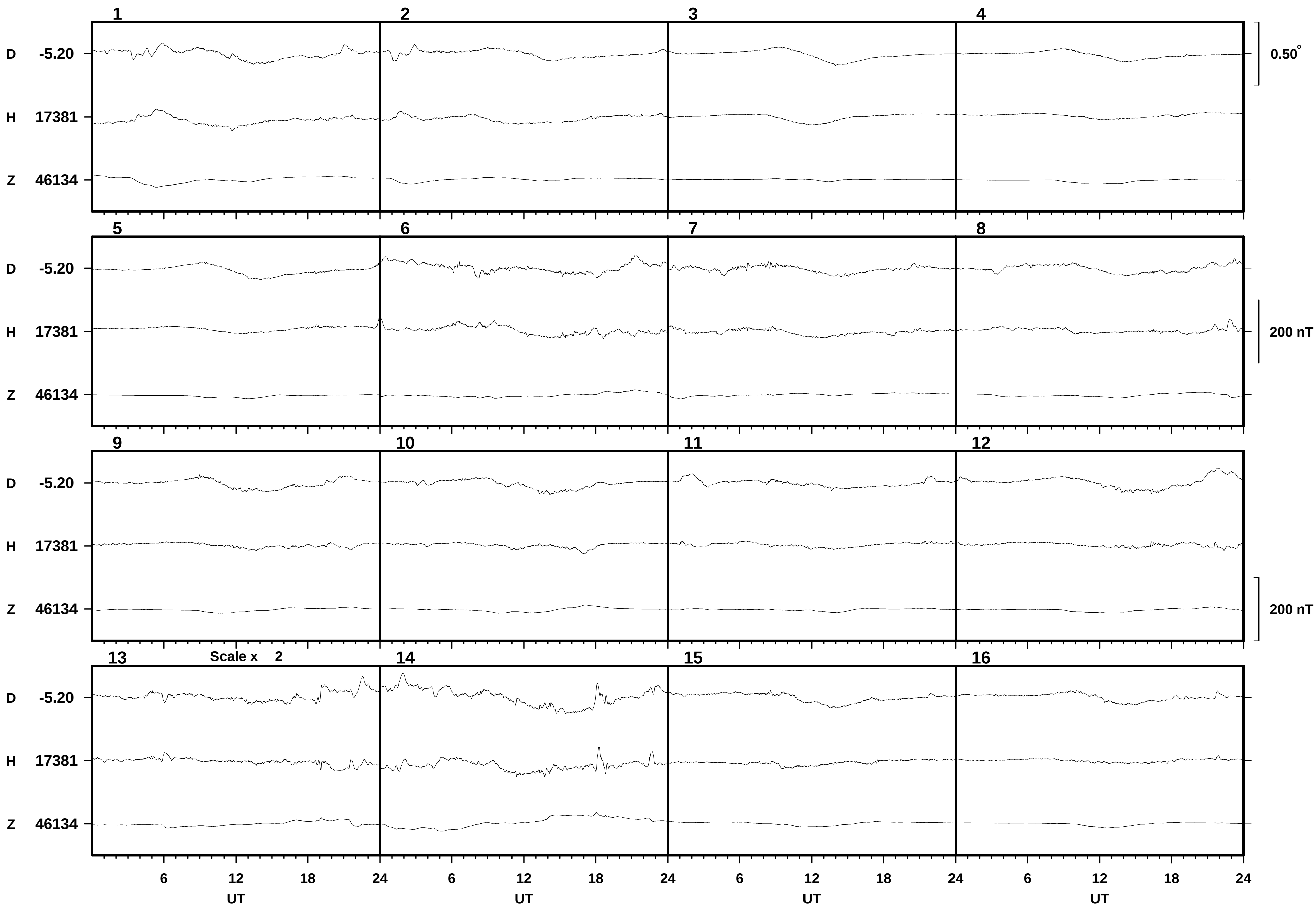
UT
ES 1 1

Eskdalemuir February 2001



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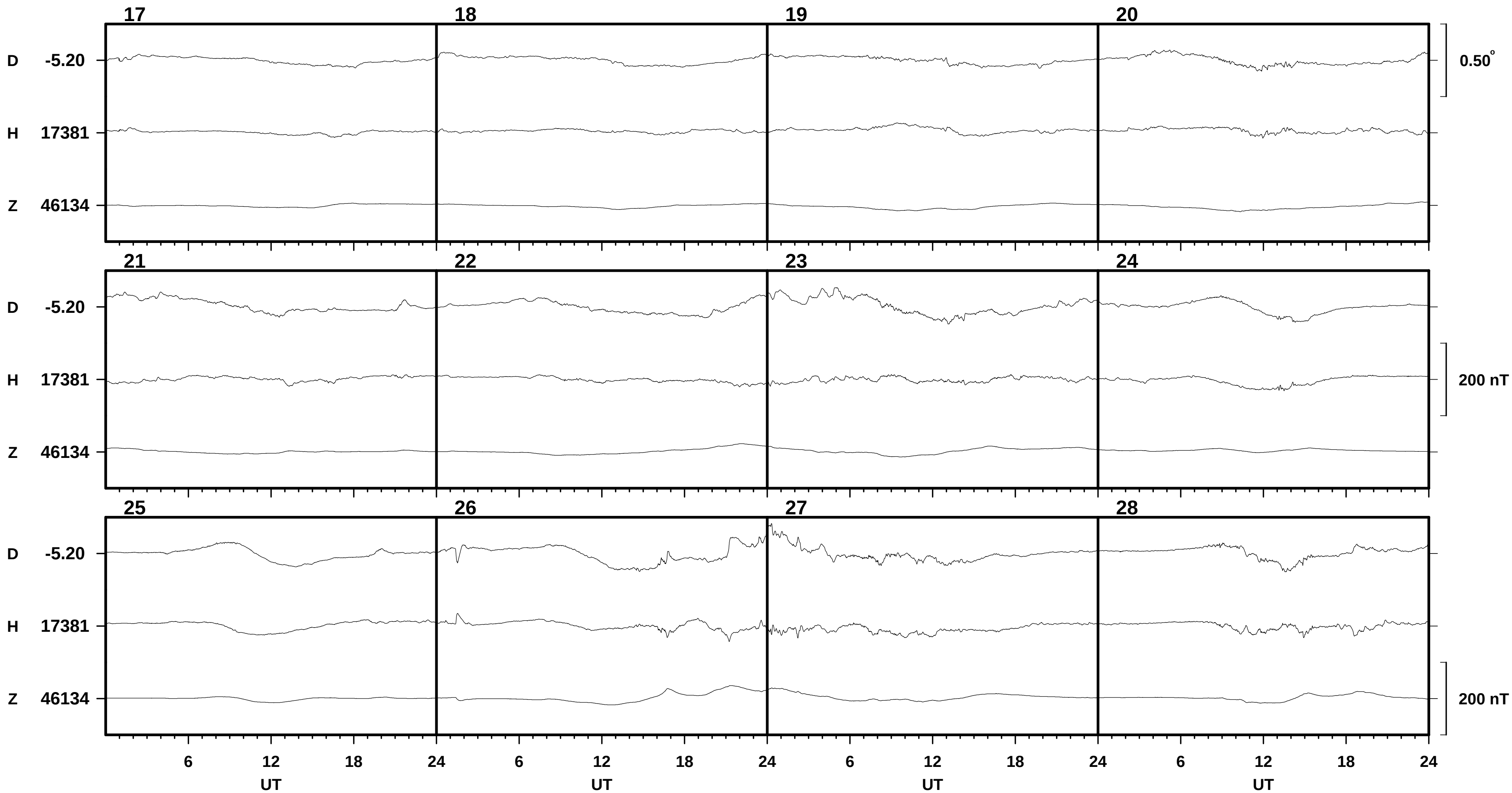

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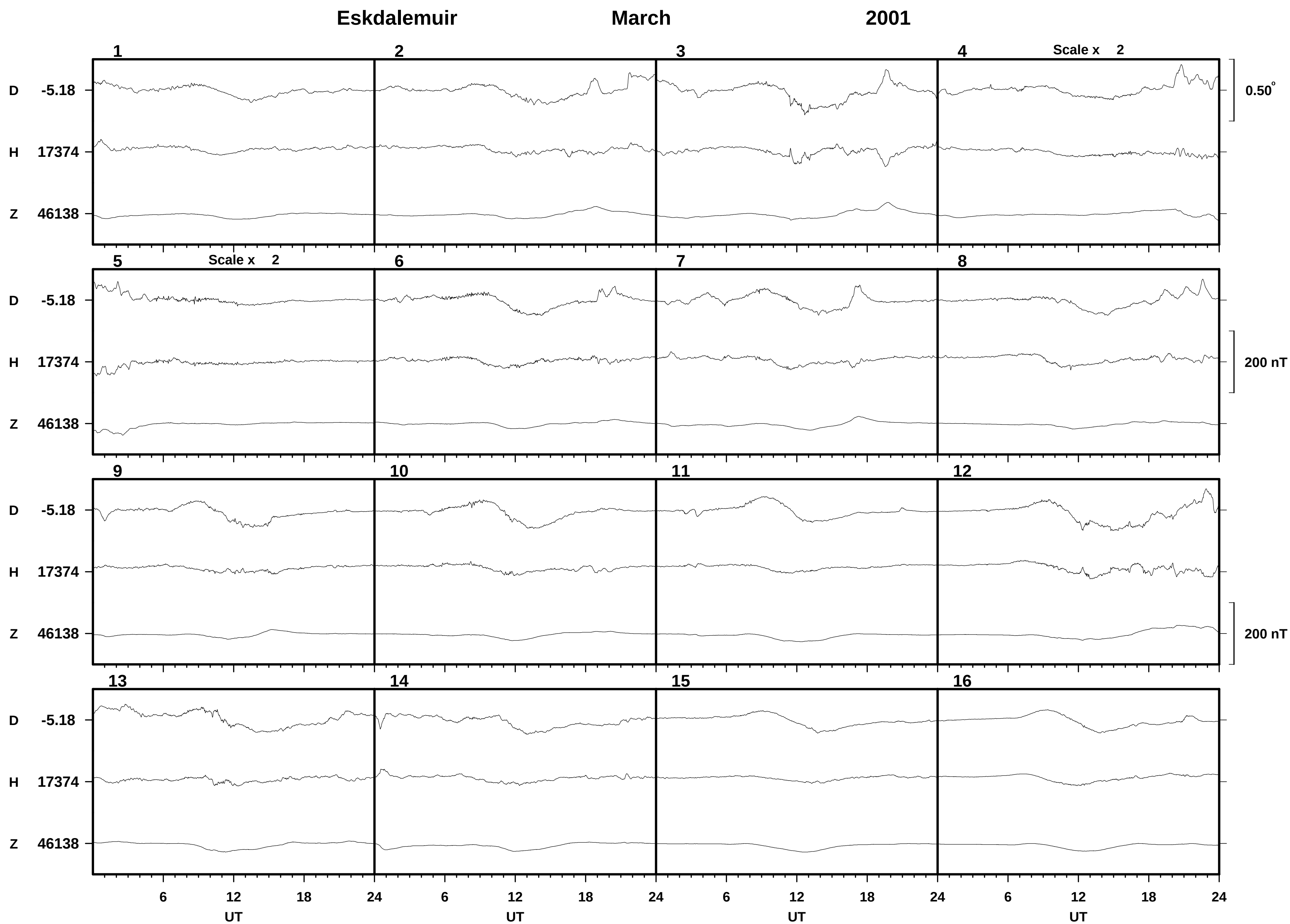
UT

ES 2 1



Eskdalemuir
March
2001
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Scale x 2
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D -5.18
H 17374
Z 46138
D -5.18
H 17374
Z 46138
D -5.18
H 17374
Z 46138
D -5.18
H 17374
Z 46138
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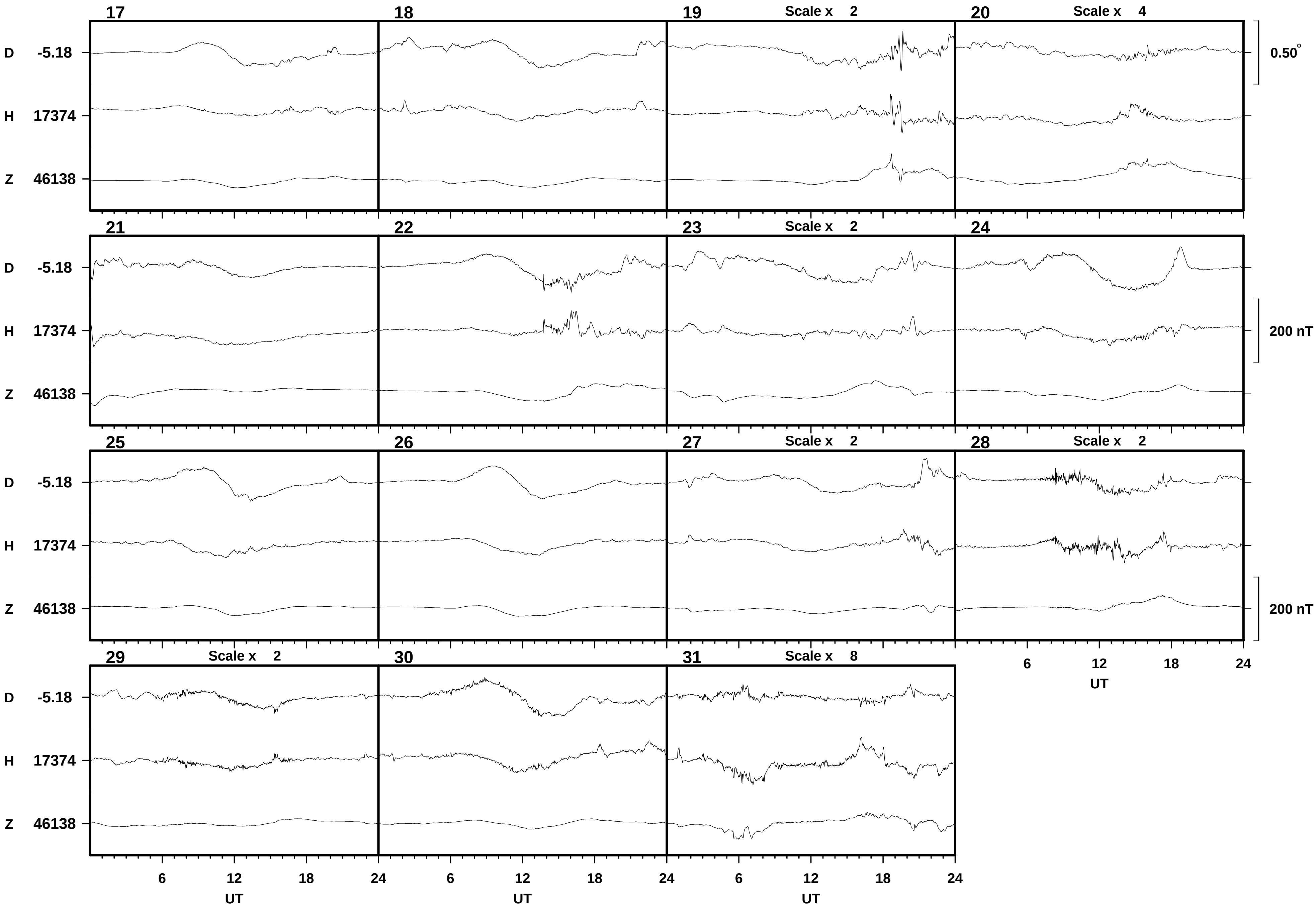
ES 3 1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Scale x 4
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Scale x 2
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200 nT
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Scale x 2
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Scale x 2
200 nT
29
Scale x 2
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Z 46138
6
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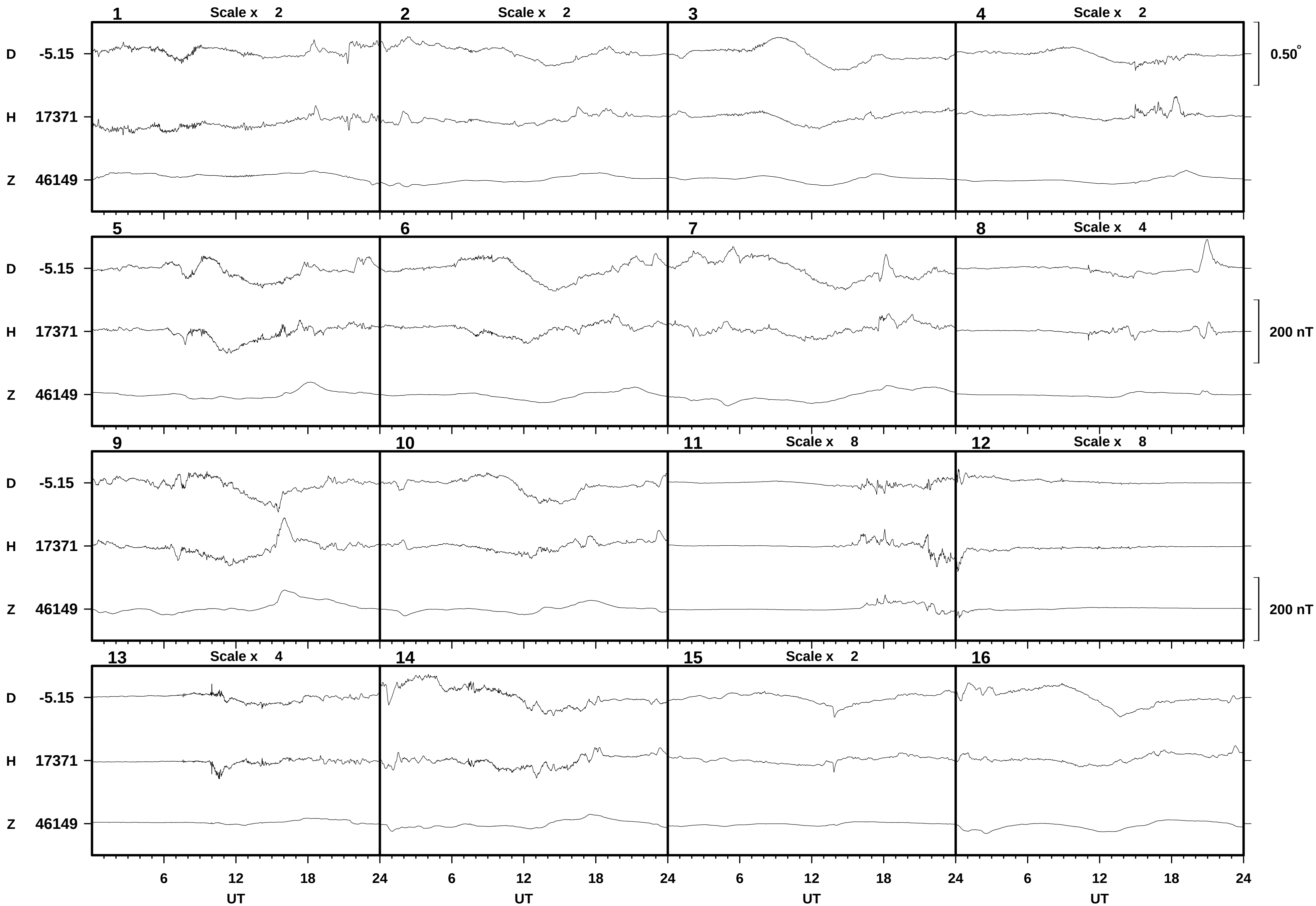
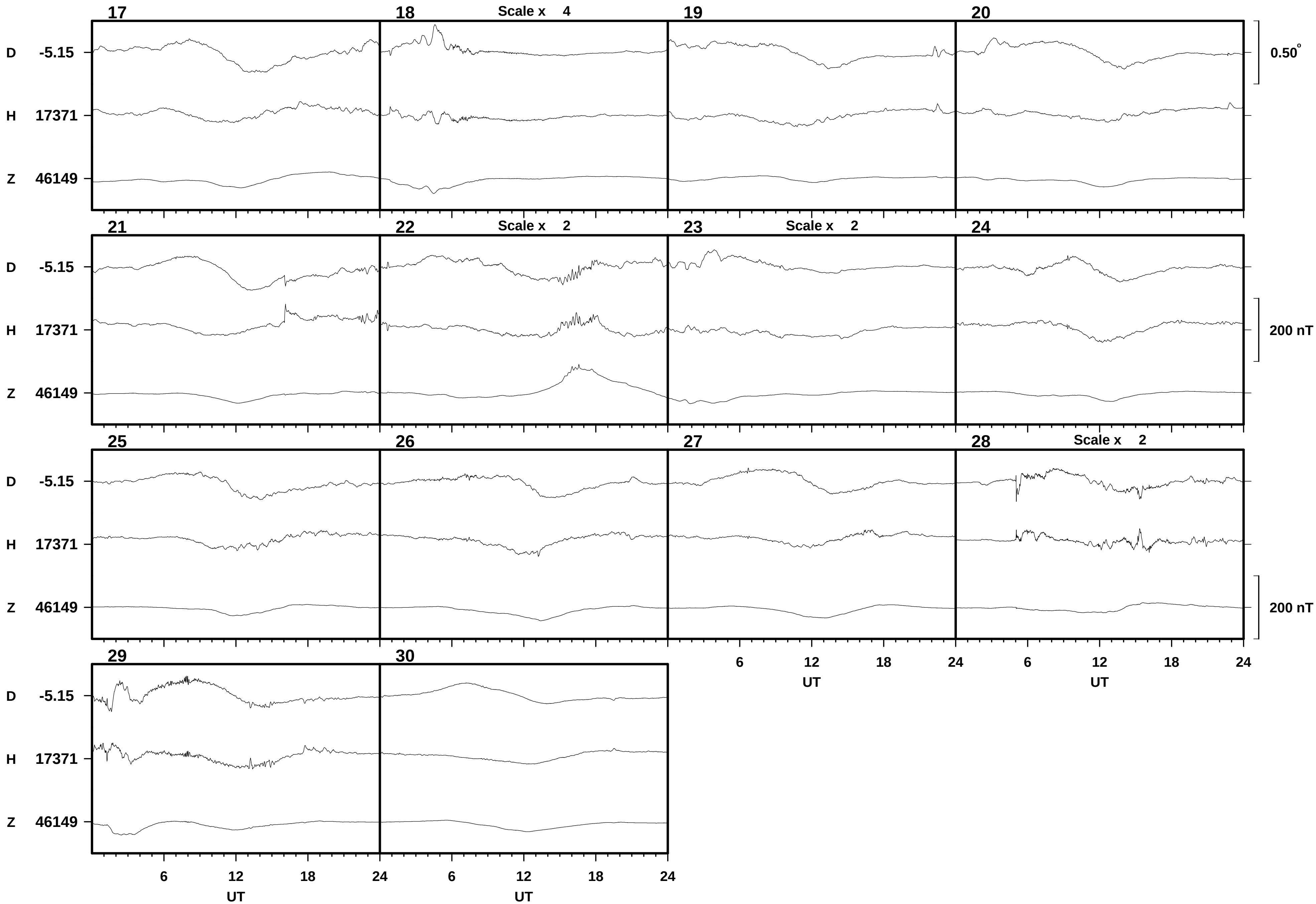
18
24
UT

ES 3 1

Eskdalemuir April 2001



ES 4 1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Scale x 2
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Scale x 2
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28
Scale x 2
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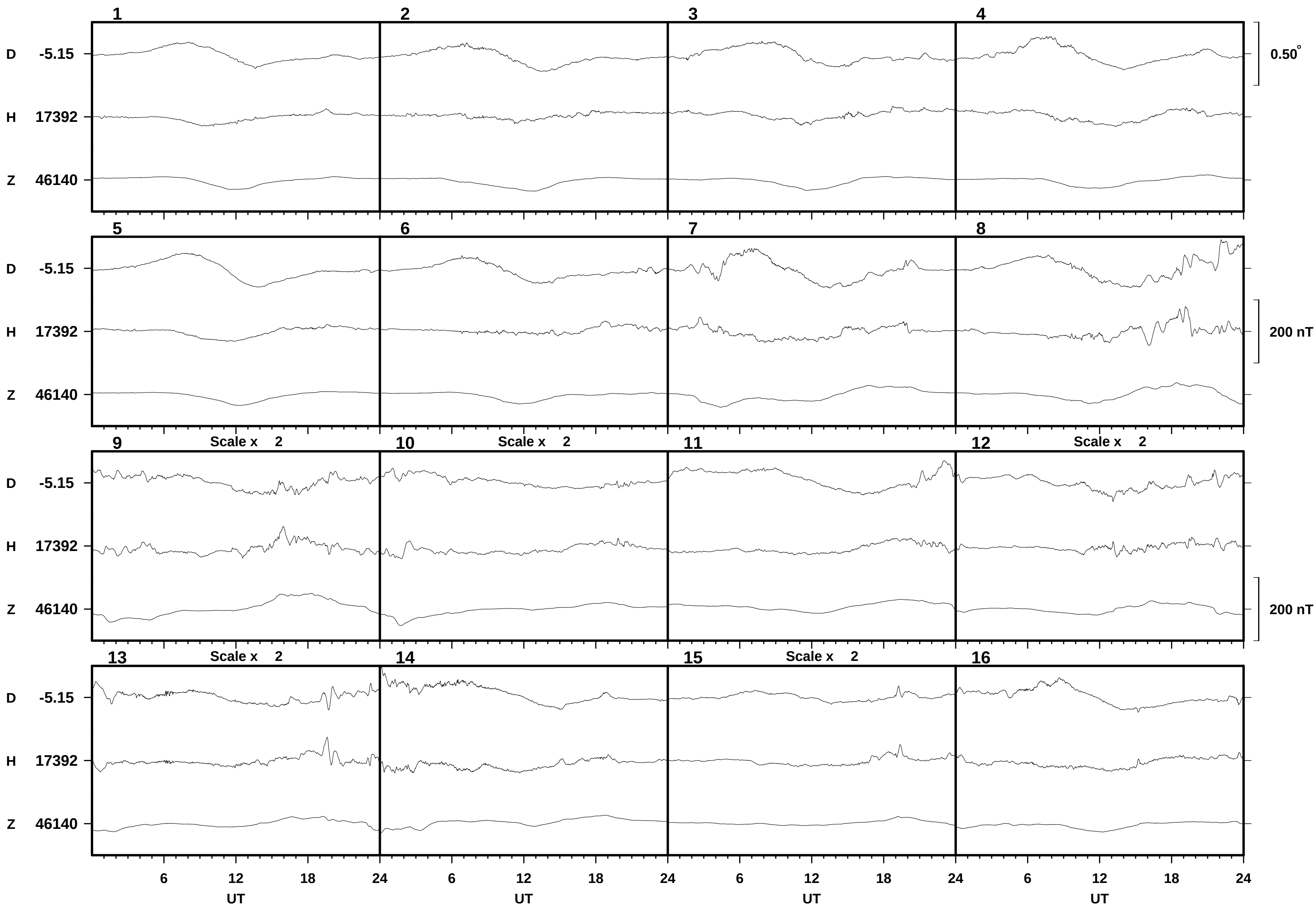
D -5.15
H 17371
Z 46149
0.50°
200 nT
200 nT
6
12
18
24
UT

ES 4 1

Eskdalemuir May 2001



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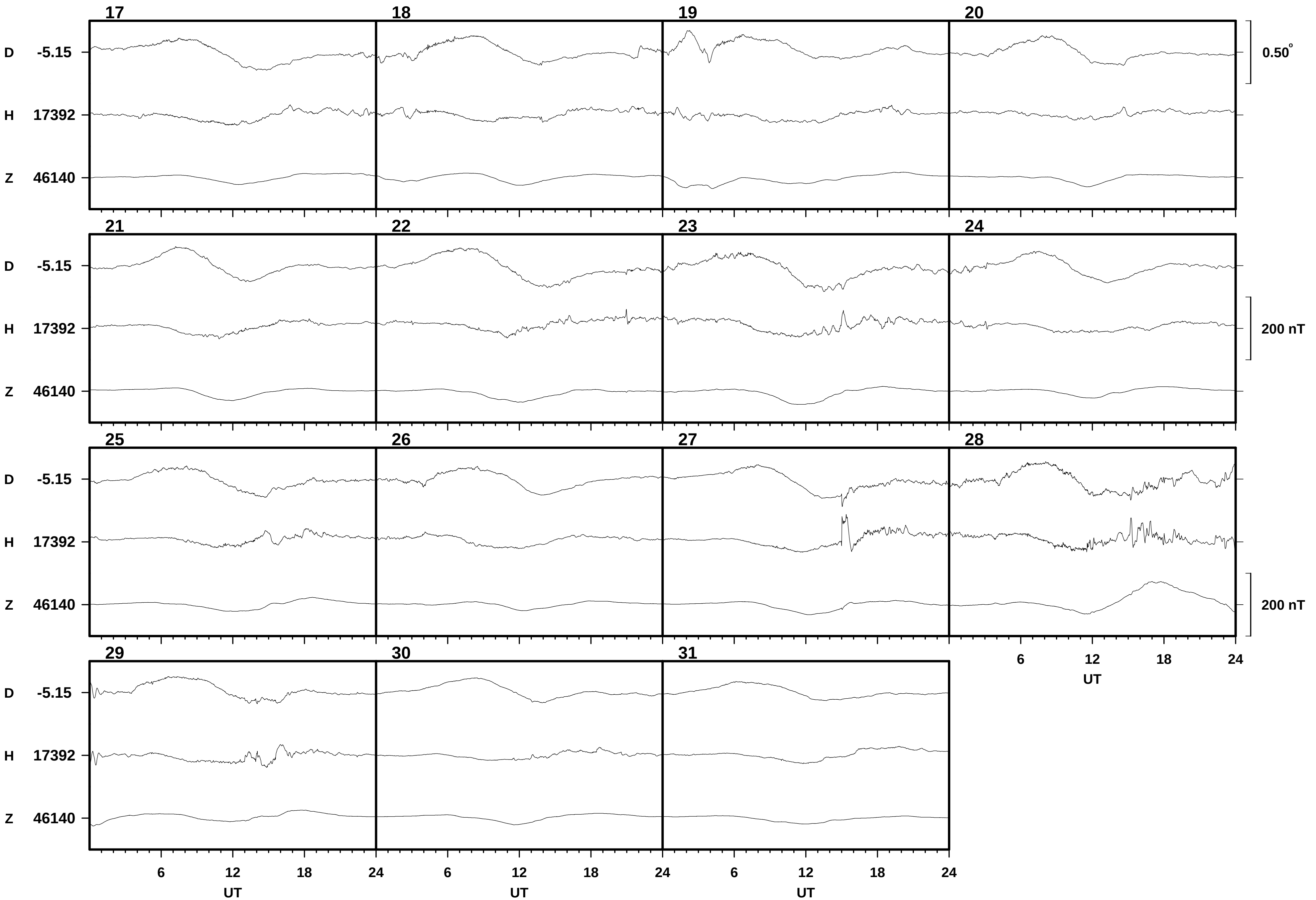
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D -5.15
H 17392
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0.50°
200 nT
200 nT
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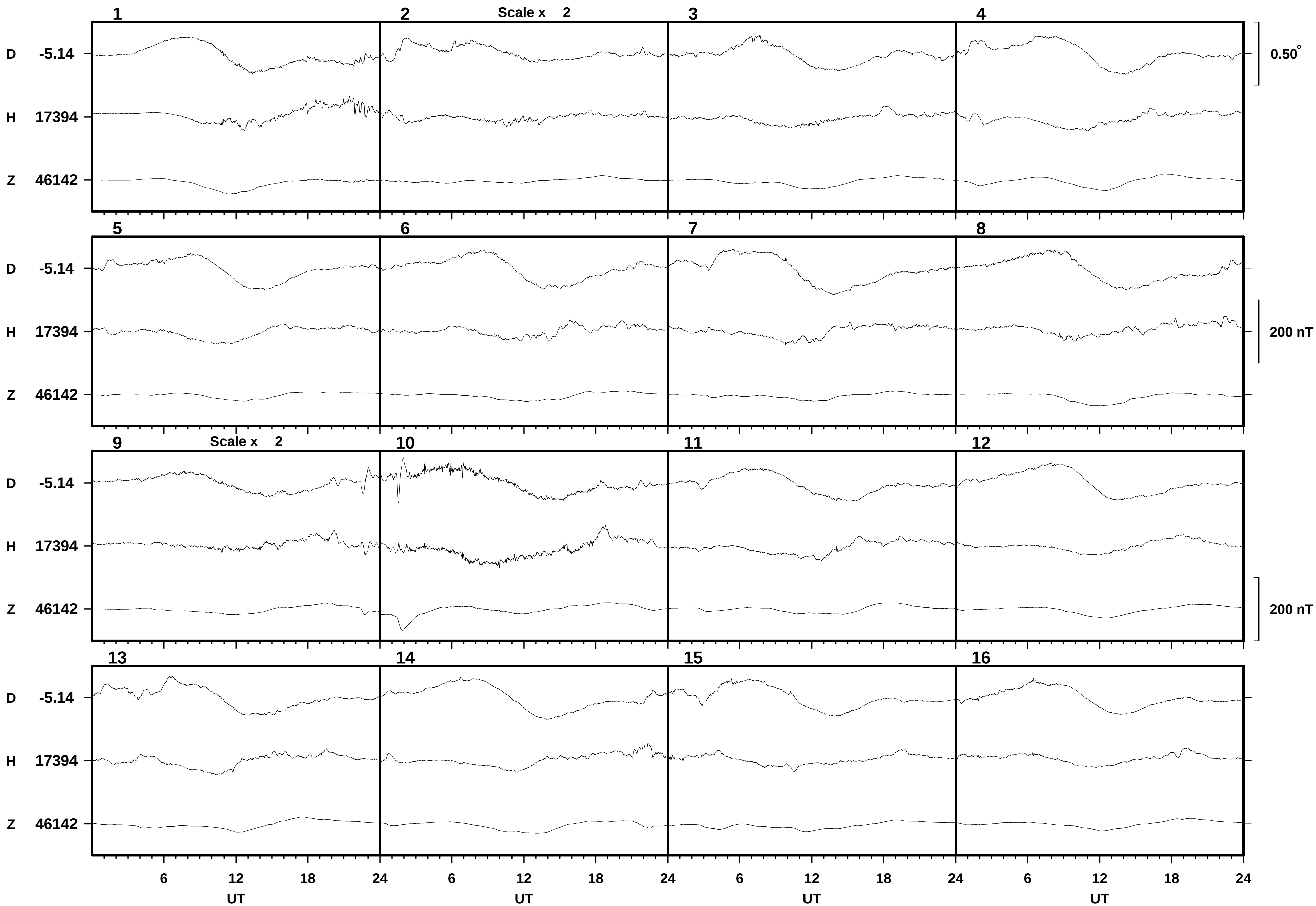
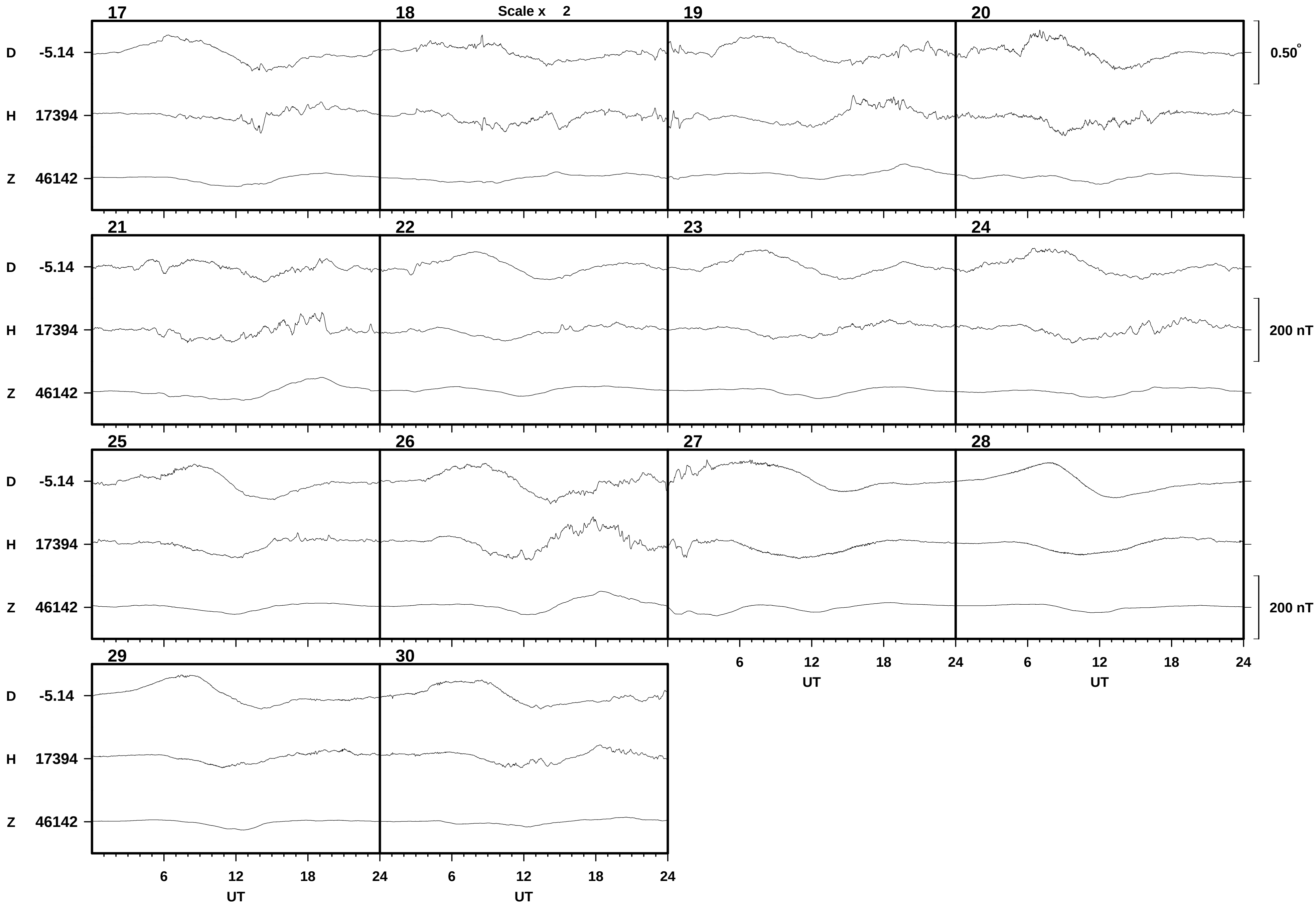
12
18
24
UT

ES 5 1

Eskdalemuir June 2001



ES 6 1


Scale x 2
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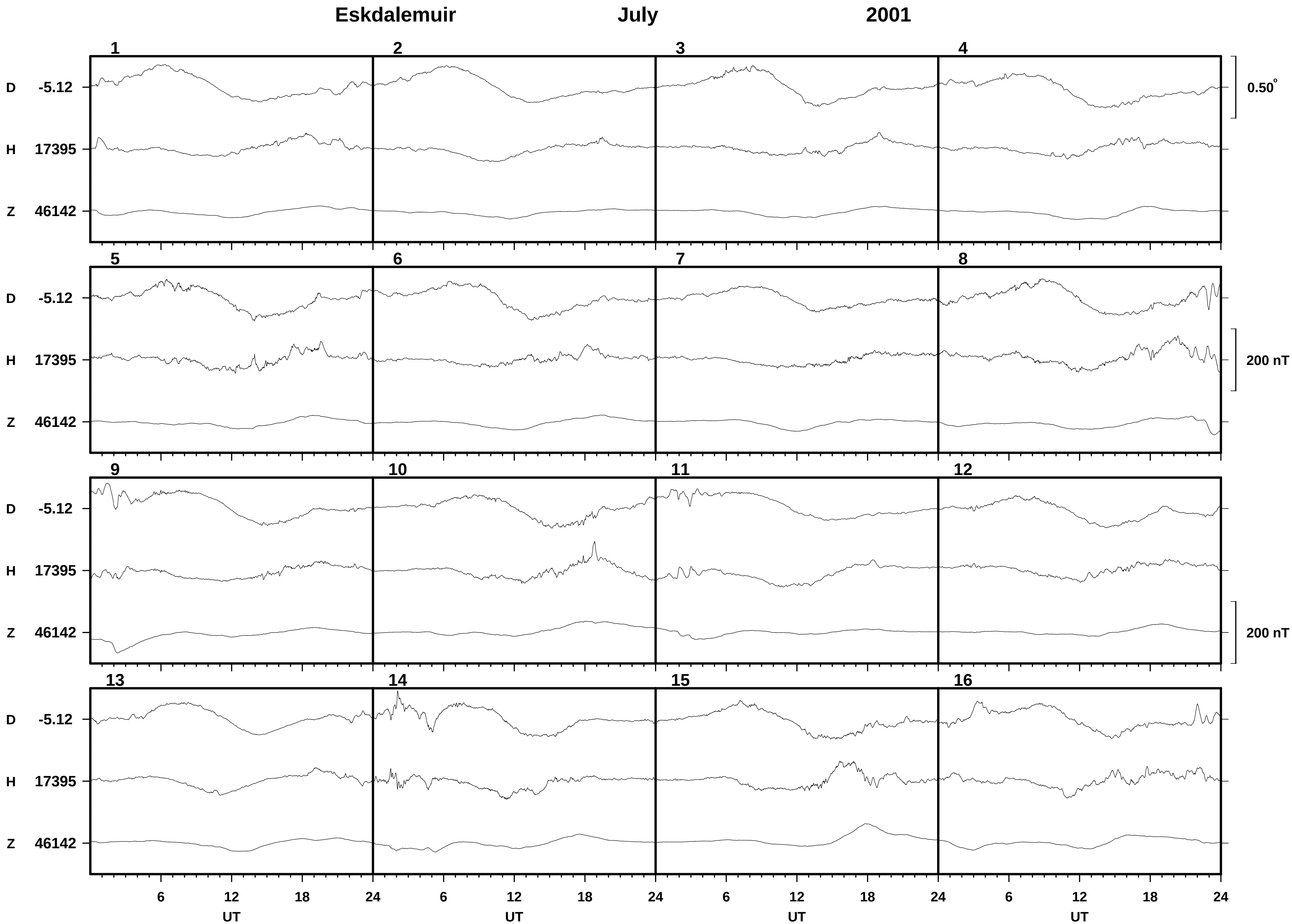
D -5.14
H 17394
Z 46142
0.50°
200 nT
200 nT
6
12
18
24
UT



Eskdalemuir
July
2001
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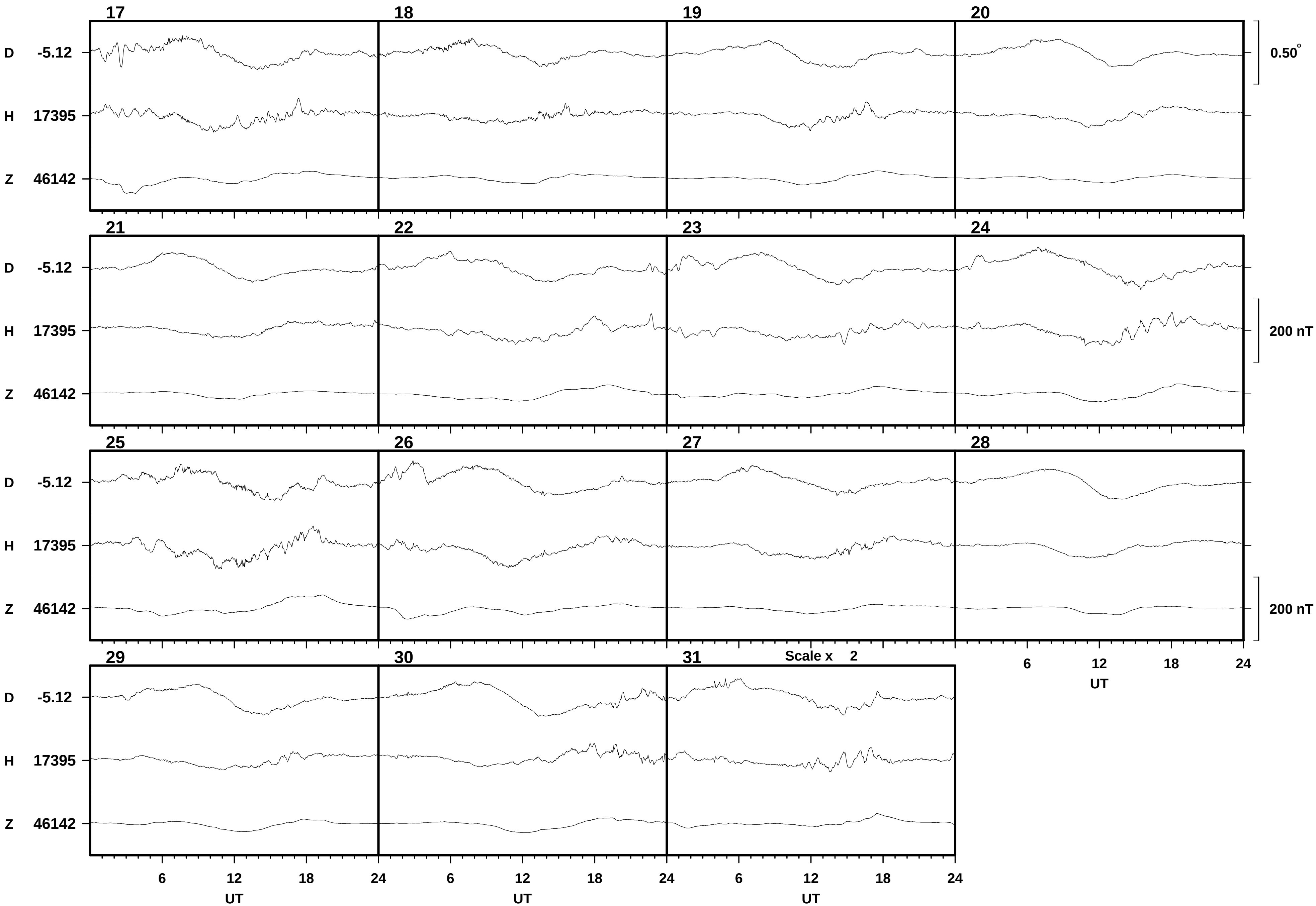
16
D -5.12
H 17395
Z 46142
0.50°
200 nT
200 nT
6
12
18
24
UT

ES 7 1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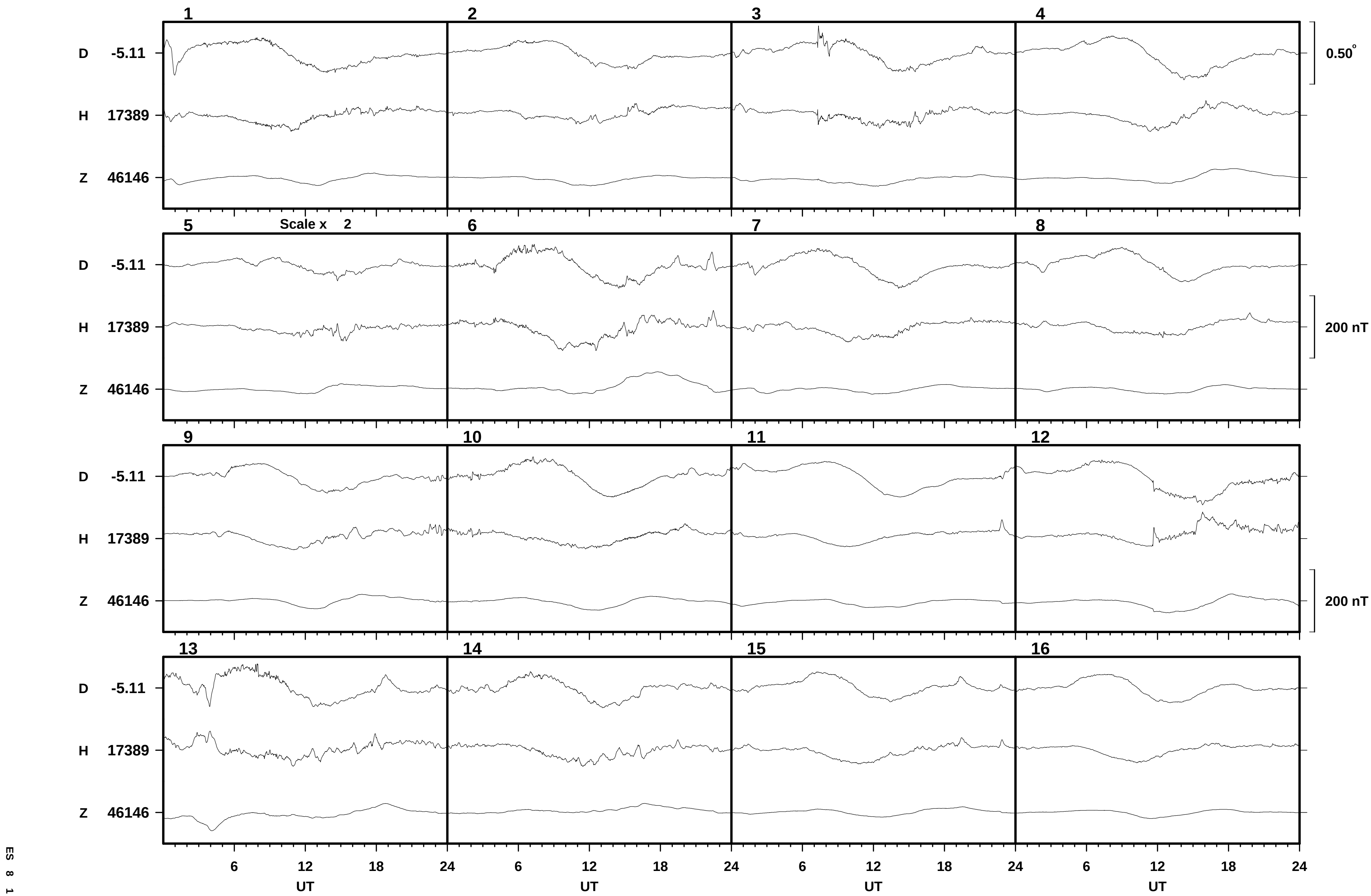
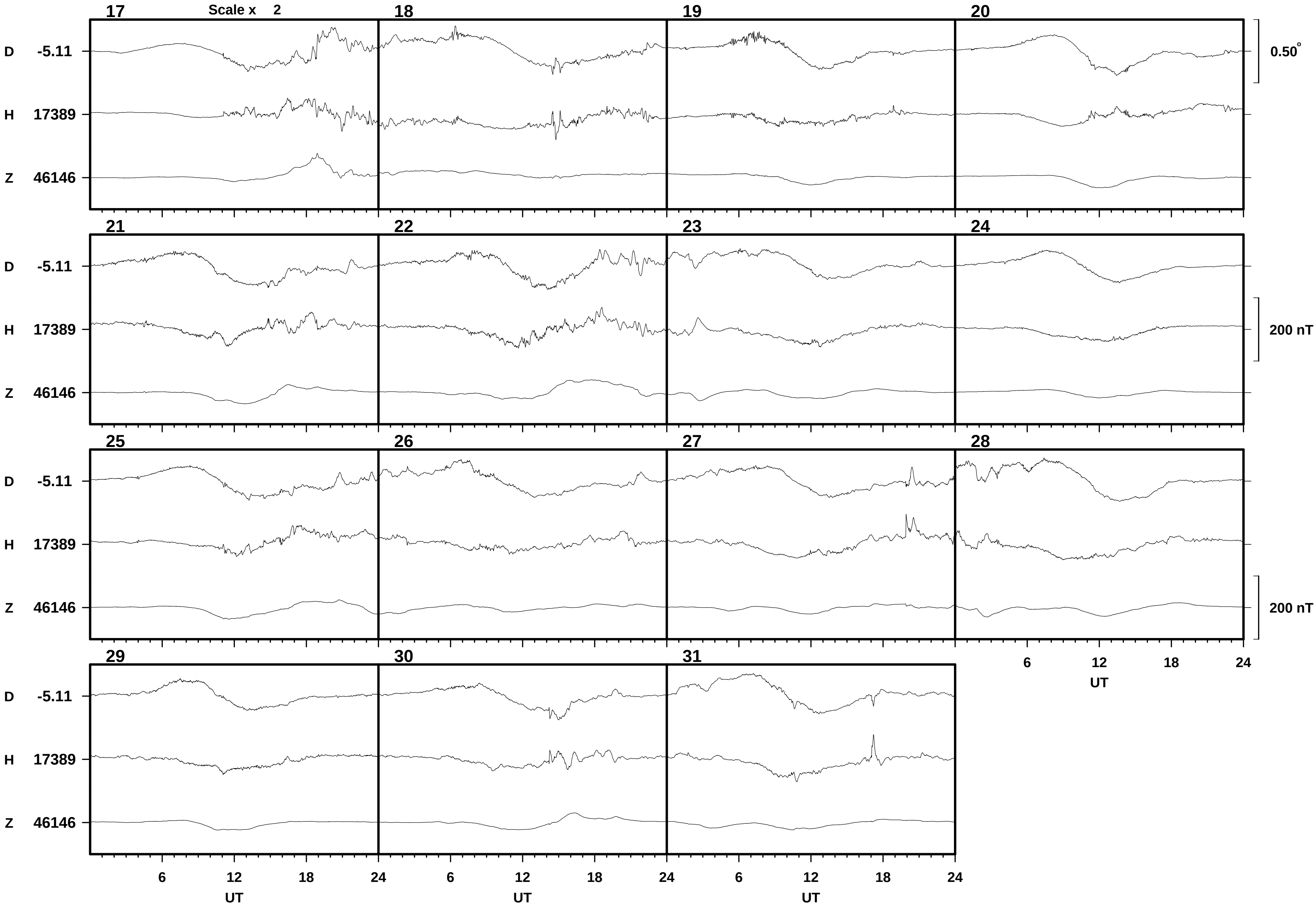
31
D -5.12
H 17395
Z 46142
0.50°
200 nT
200 nT
Scale x 2
6
12
18
24
UT

ES 7 1

Eskdalemuir August 2001

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Scale x 2
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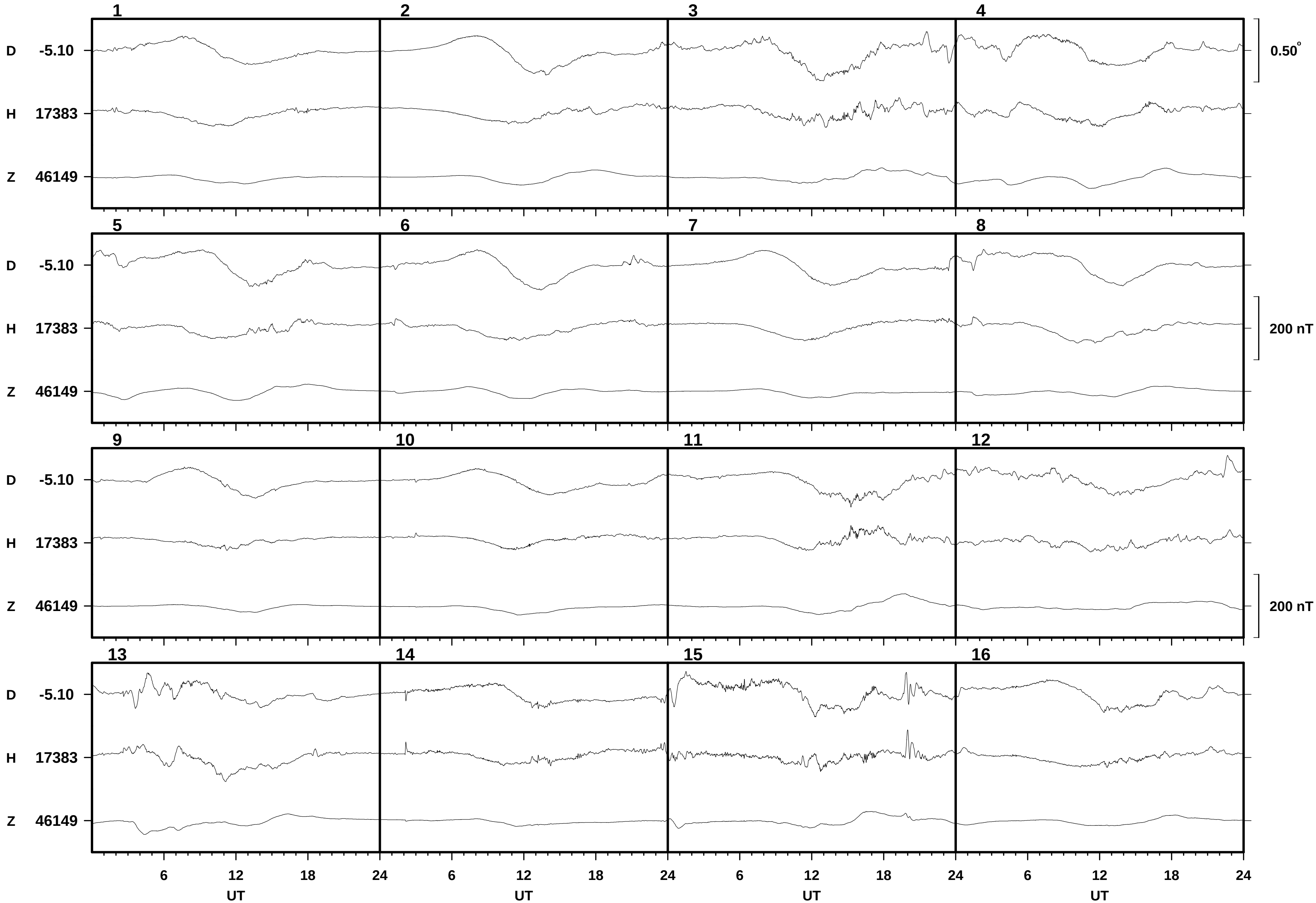
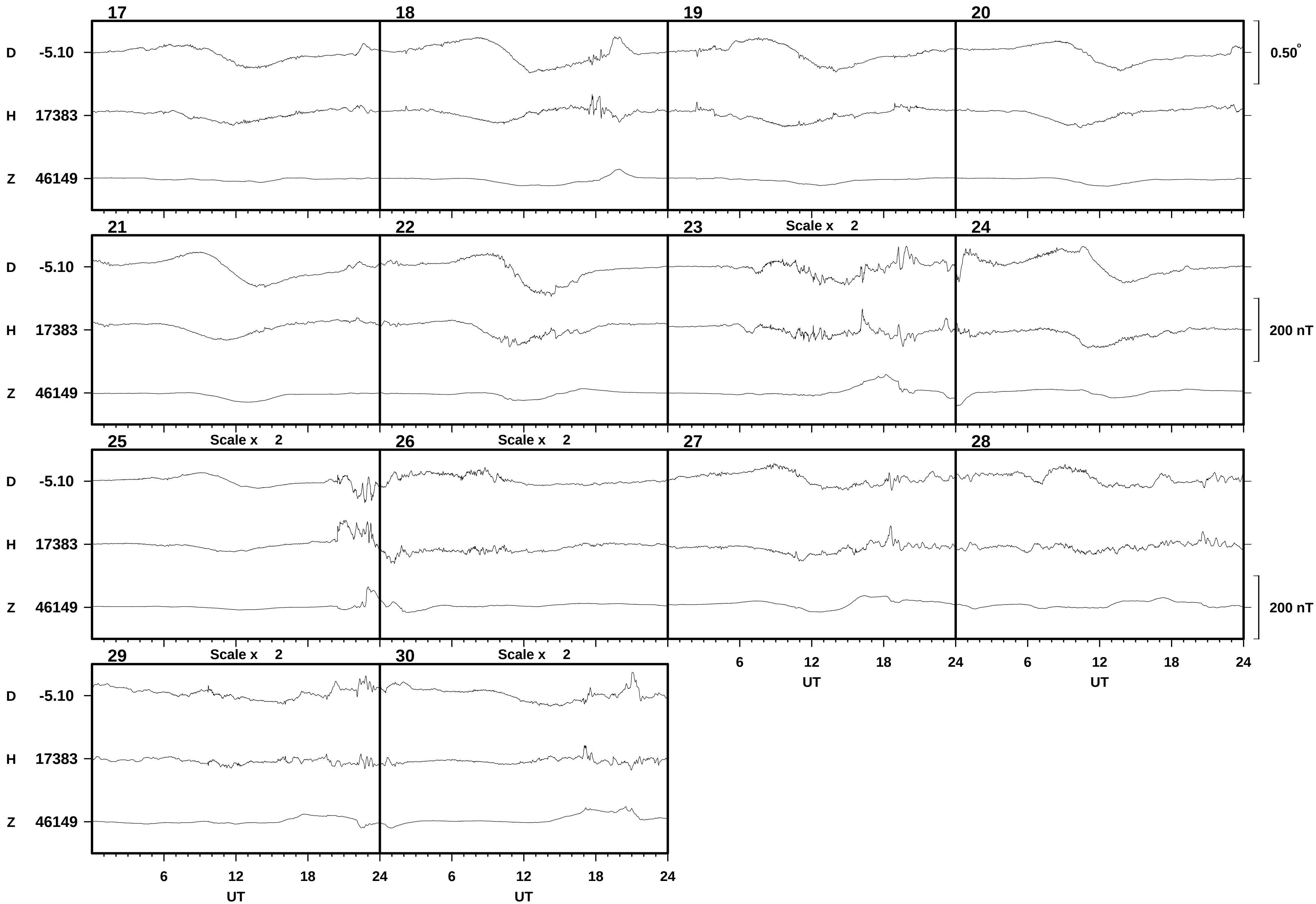
H 17389
Z 46146
0.50°
200 nT
200 nT
6 12 18 24
UT

ES 8 1

Eskdalemuir September 2001



ES 9 1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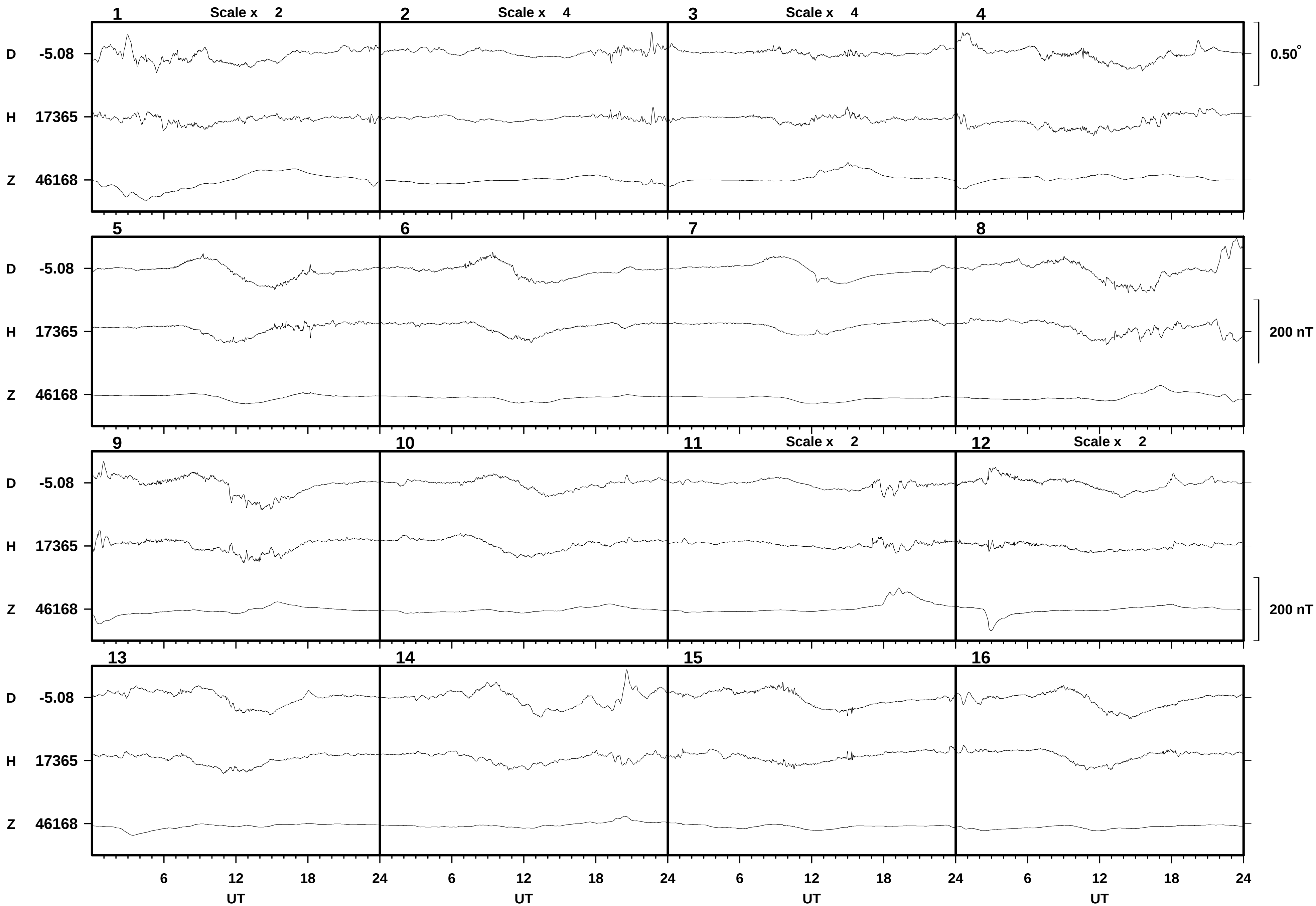
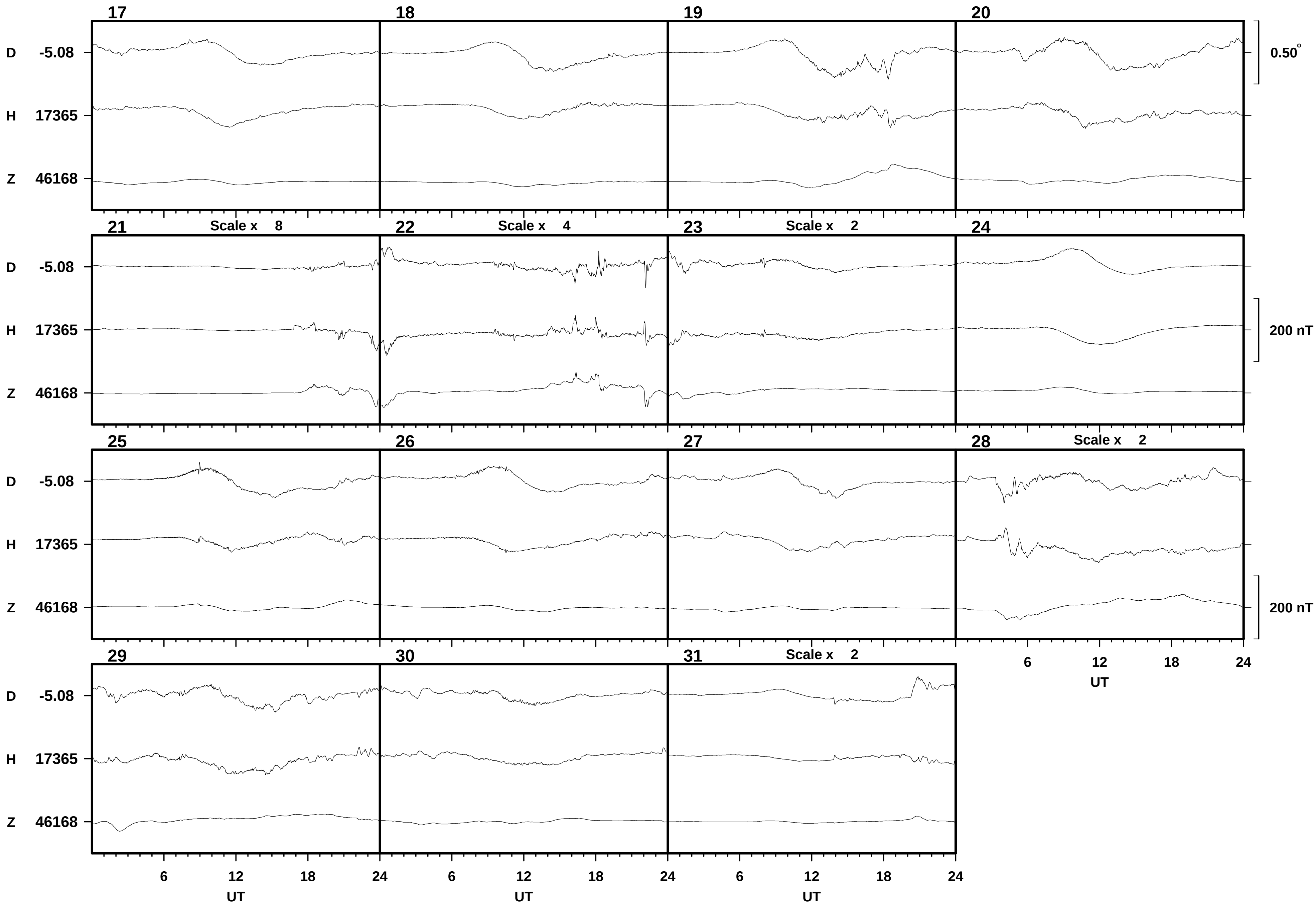
D -5.10
H 17383
Z 46149
Scale x 2
0.50°
200 nT
6
12
18
24
UT

ES 9 1

Eskdalemuir October 2001

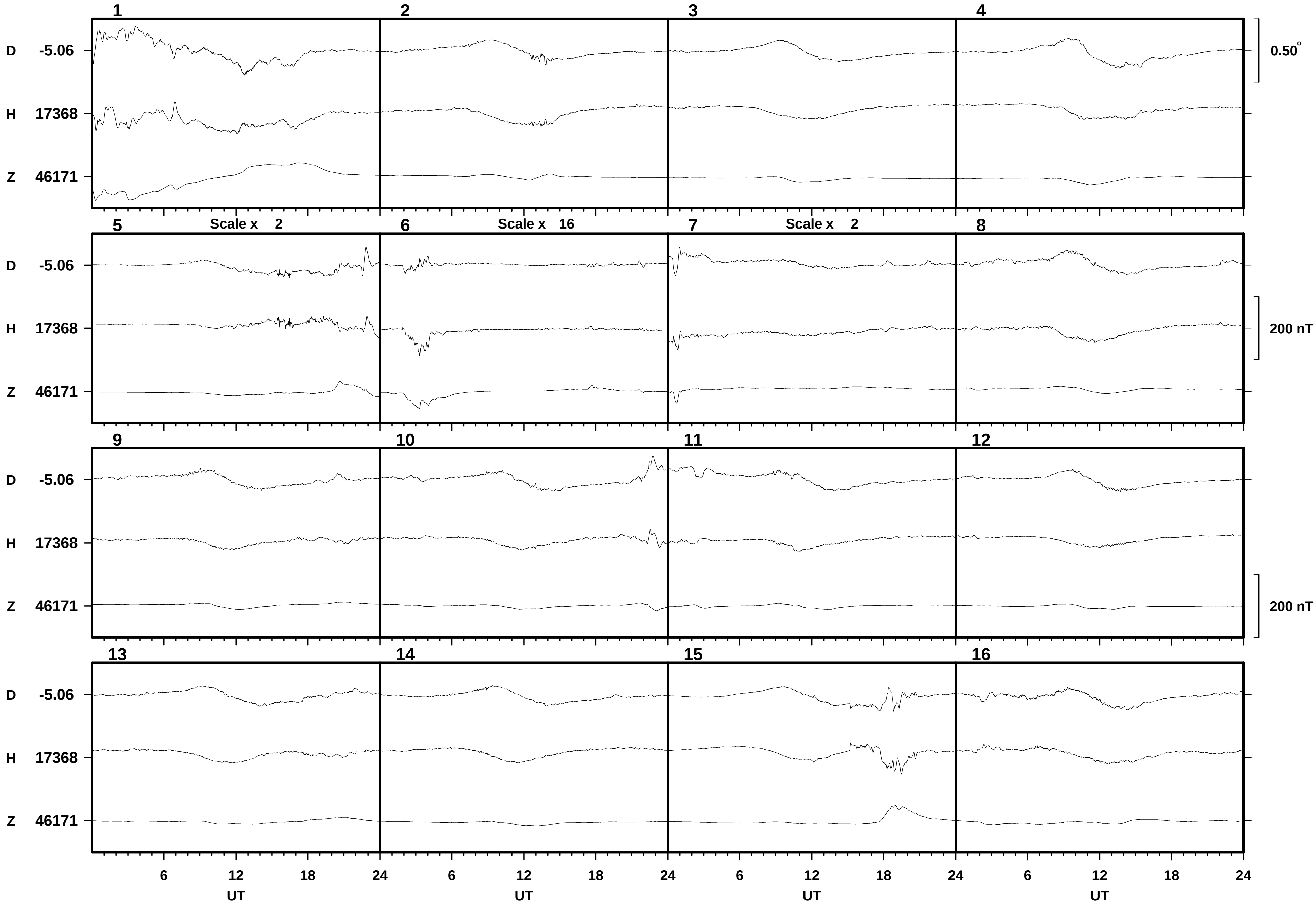


ES 10 1

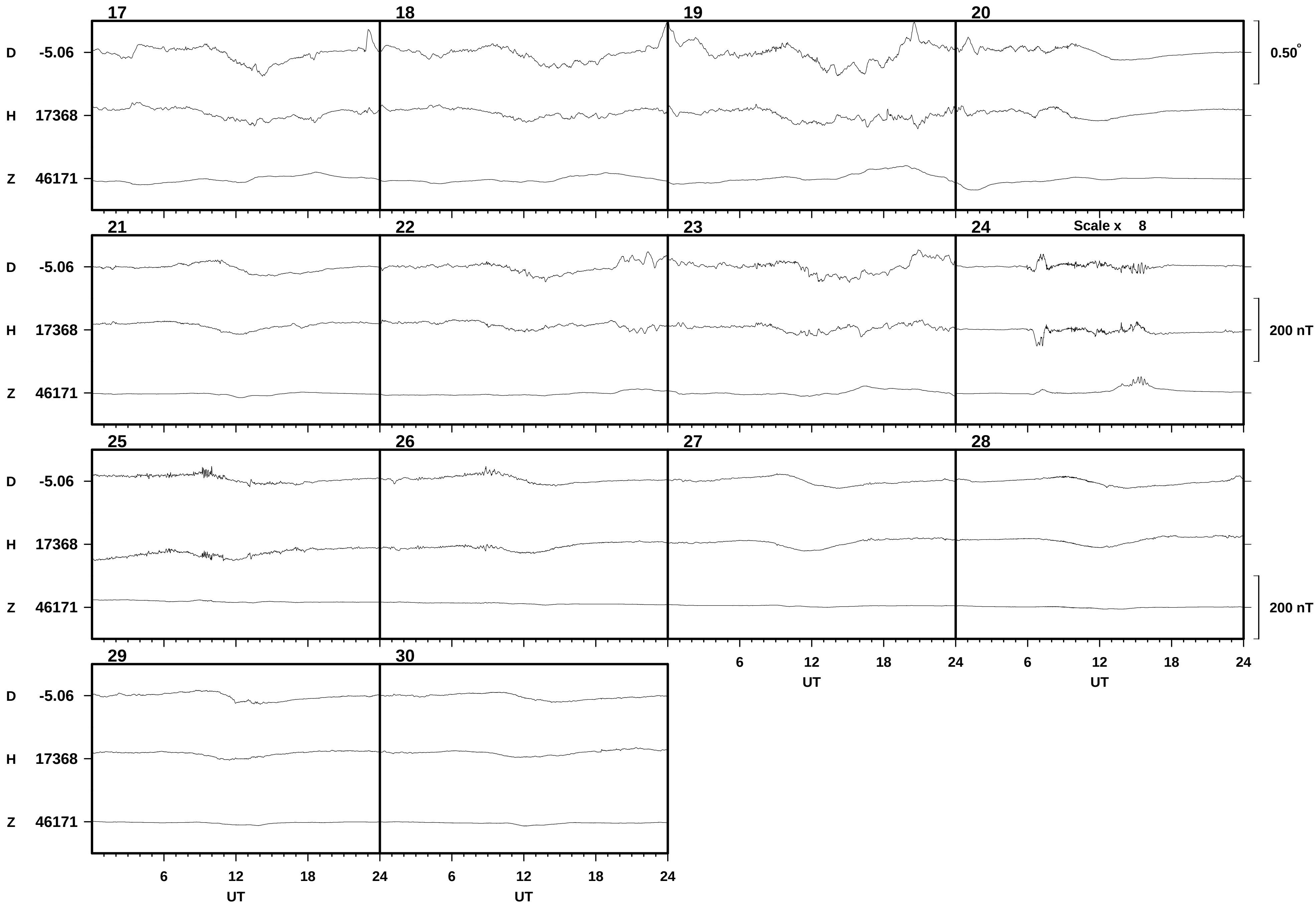

17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
D -5.08
H 17365
Z 46168
0.50°
200 nT
200 nT
Scale x 8
Scale x 4
Scale x 2
Scale x 2
Scale x 2
6
12
18
24
UT

ES 10 1

Eskdalemuir November 2001



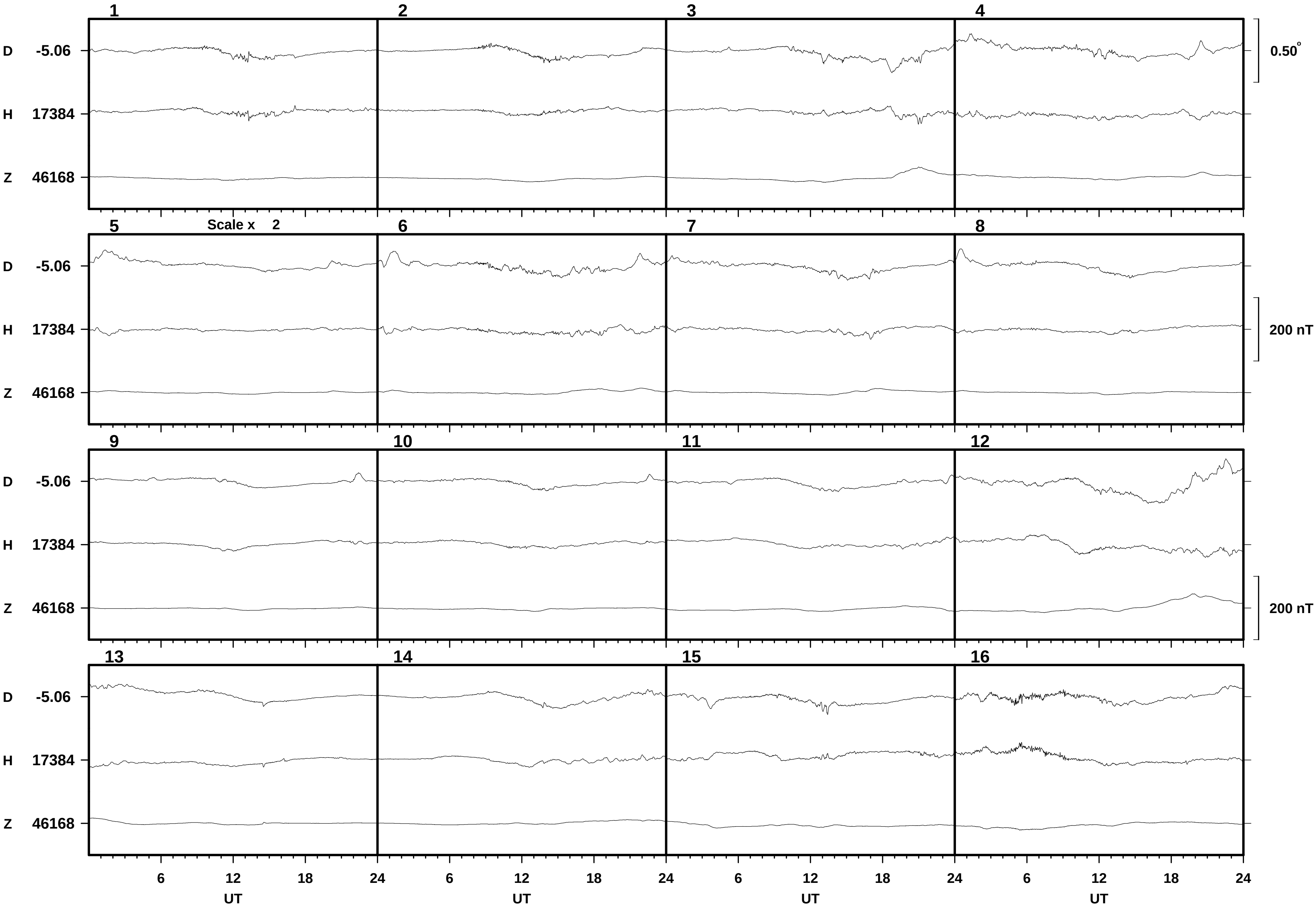
ES 11 1



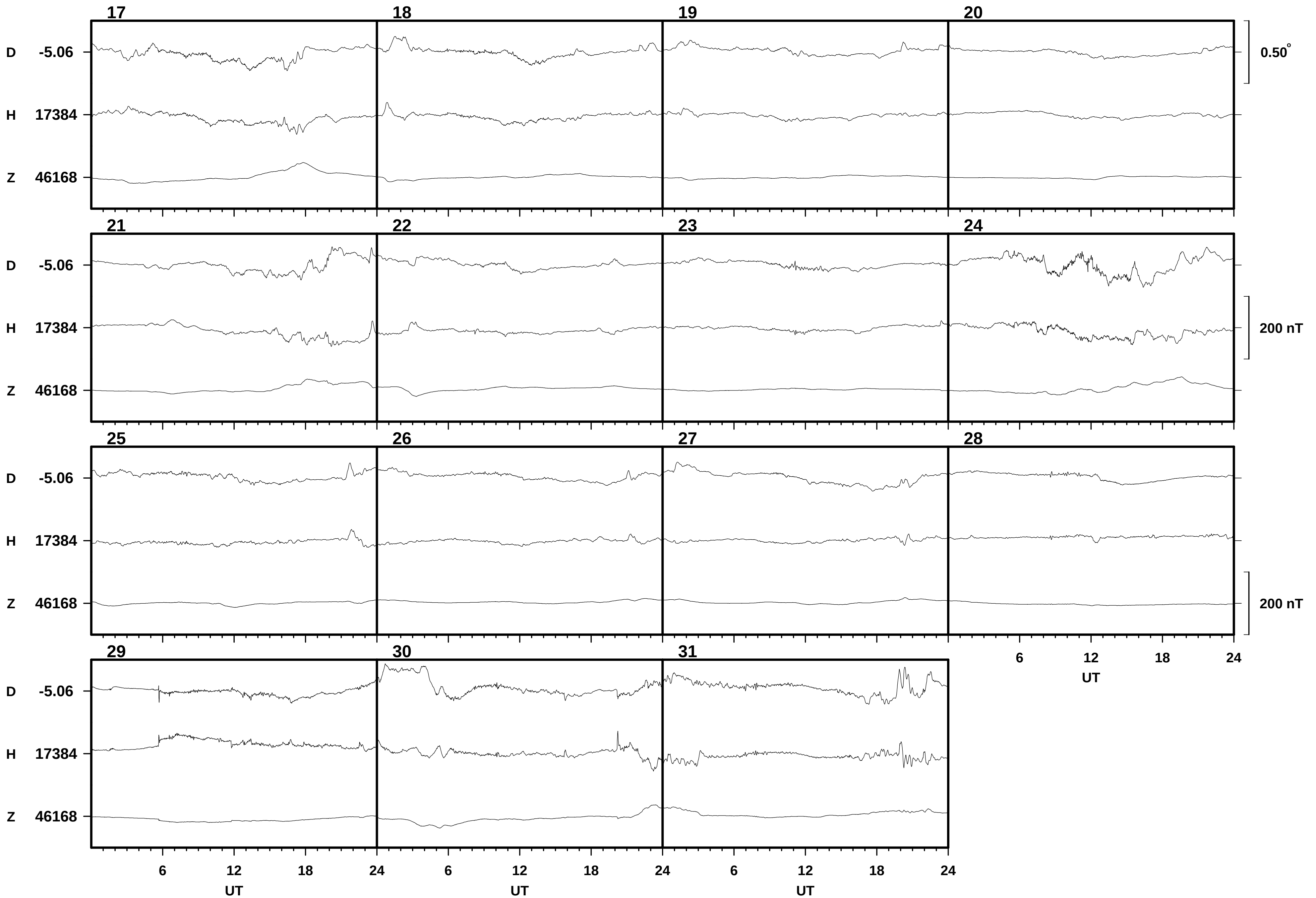
17
18
19
20
21
22
23
24
25
26
27
28
29
30
D -5.06
H 17368
Z 46171
0.50°
Scale x 8
200 nT
200 nT
6
12
18
24
UT

ES 11 1

Eskdalemuir December 2001

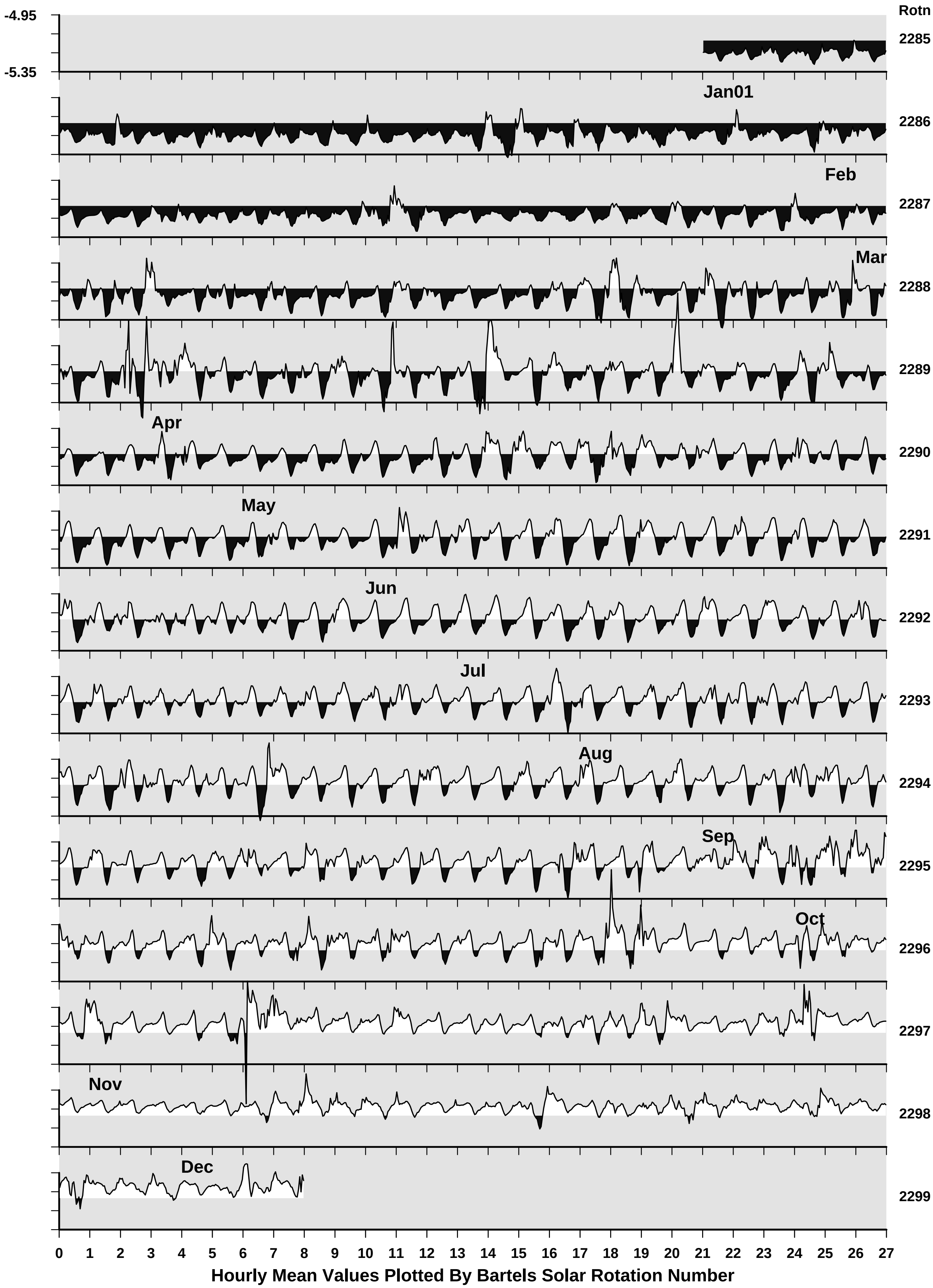


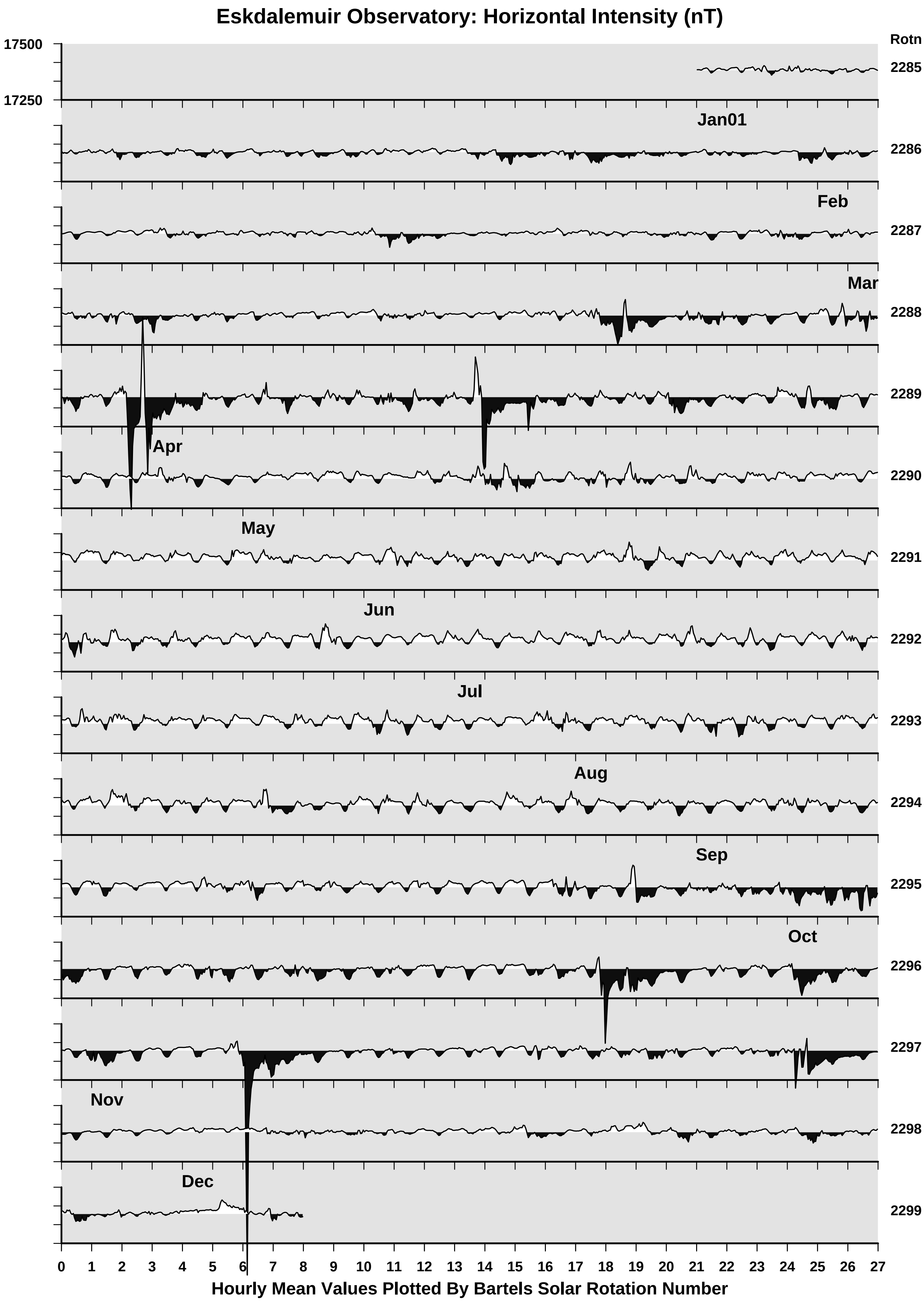
ES 12 1


17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
D -5.06
H 17384
Z 46168
0.50°
200 nT
200 nT
6
12
18
24
UT

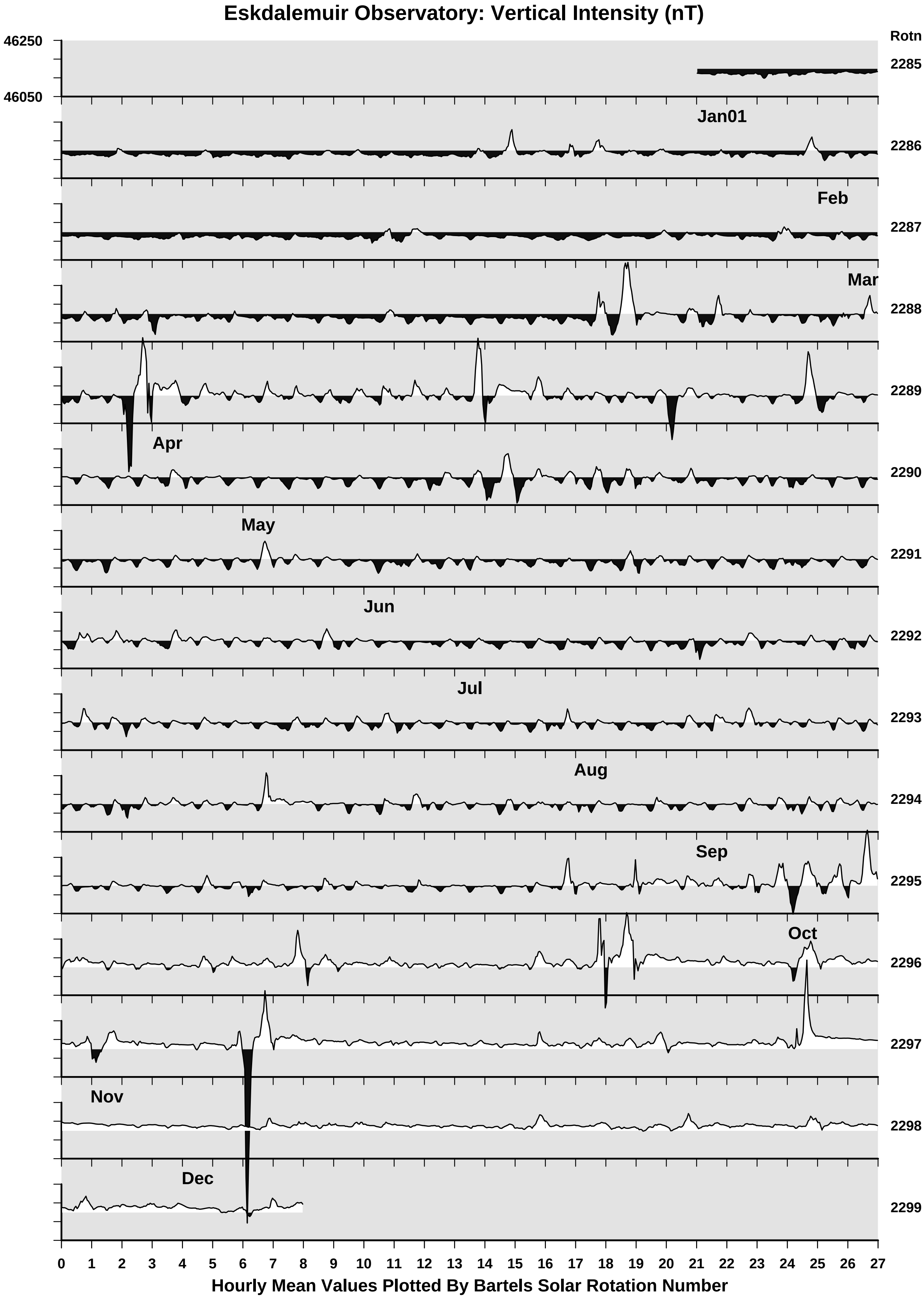
ES 12 1

Eskdalemuir Observatory: Declination (degrees)

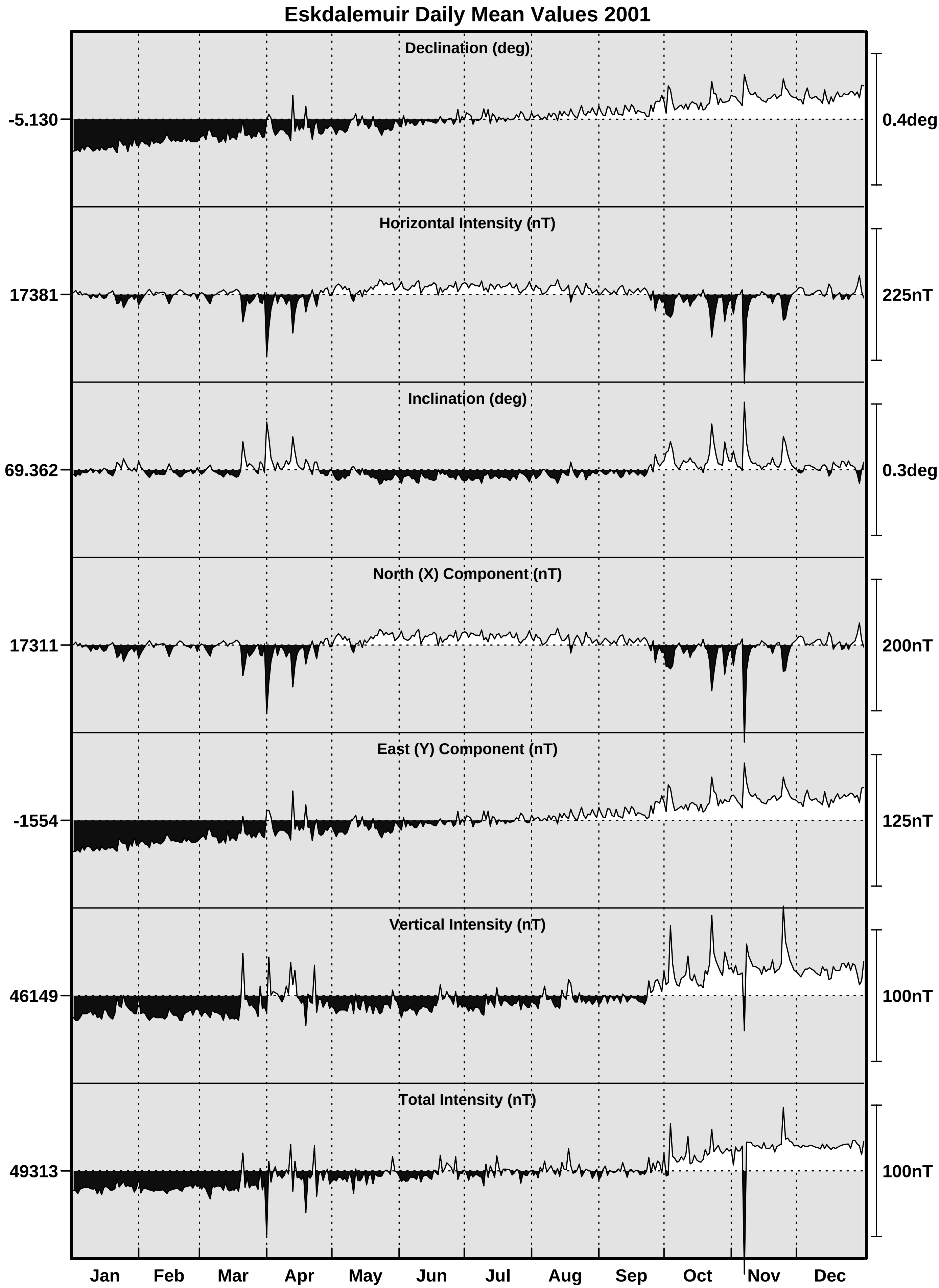


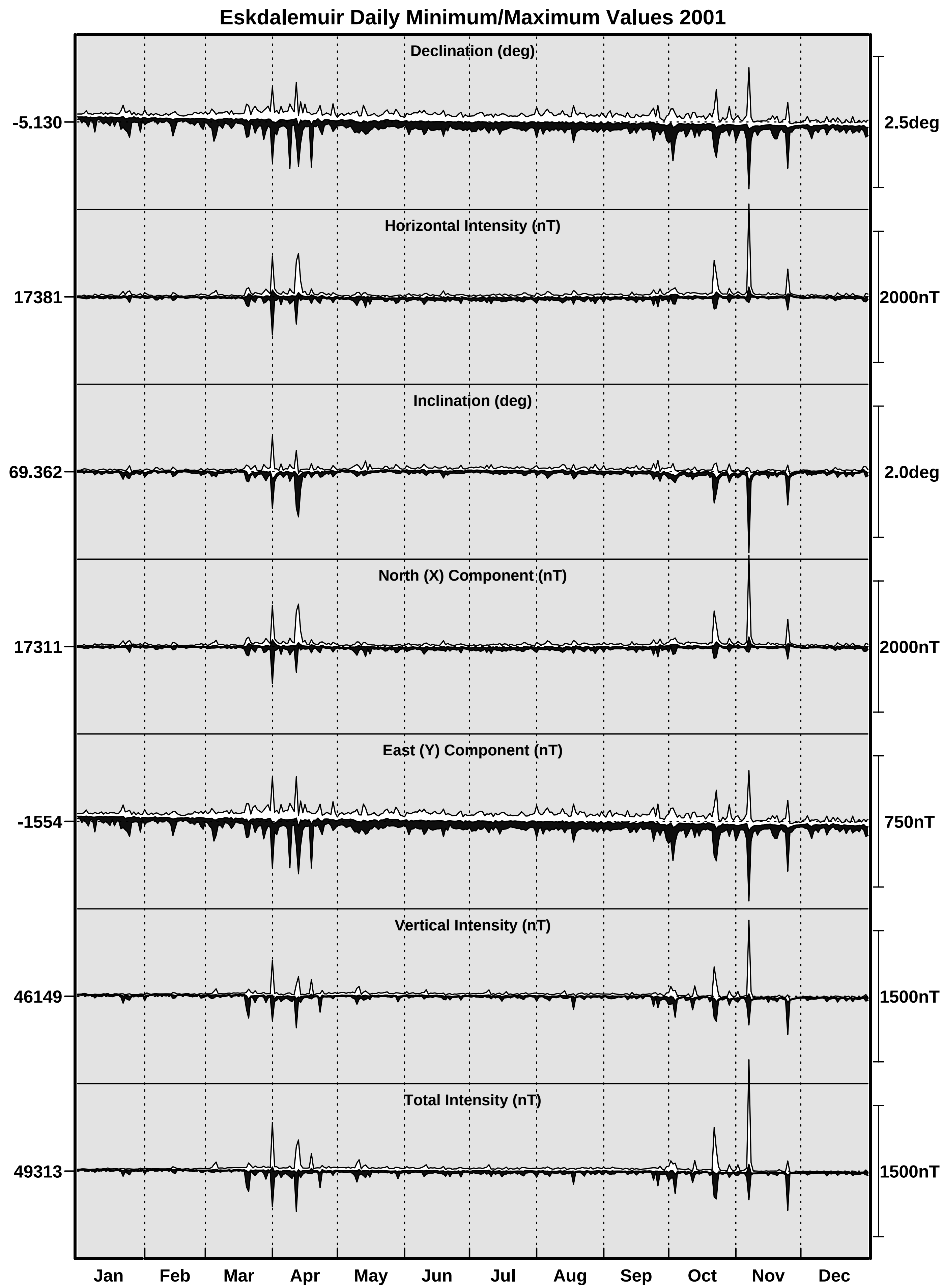


Eskdalemuir Observatory: Horizontal Intensity (nT)
17500
17250
Rotn
2285
2286
2287
2288
2289
2290
2291
2292
2293
2294
2295
2296
2297
2298
2299
Jan01
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
Hourly Mean Values Plotted By Bartels Solar Rotation Number



Eskdalemuir Observatory: Vertical Intensity (nT)
46250
46050
Rotn
2285
Jan01
2286
Feb
2287
Mar
2288
2289
Apr
2290
May
2291
Jun
2292
Jul
2293
Aug
2294
Sep
2295
Oct
2296
2297
Nov
2298
Dec
2299
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted By Bartels Solar Rotation Number


Eskdalemuir Daily Mean Values 2001
Declination (deg)
-5.130
0.4deg
Horizontal Intensity (nT)
17381
225nT
Inclination (deg)
69.362
0.3deg
North (X) Component (nT)
17311
200nT
East (Y) Component (nT)
-1554
125nT
Vertical Intensity (nT)
46149
100nT
Total Intensity (nT)
49313
100nT
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



Eskdalemuir Daily Minimum/Maximum Values 2001
Declination (deg)
-5.130
2.5deg
Horizontal Intensity (nT)
17381
2000nT
Inclination (deg)
69.362
2.0deg
North (X) Component (nT)
17311
2000nT
East (Y) Component (nT)
-1554
750nT
Vertical Intensity (nT)
46149
1500nT
Total Intensity (nT)
49313
1500nT
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Monthly Mean Values for Eskdalemuir 2001

Based on All Days

Month	D	H	I	X	Y	Z	F
January	-5° 12.9′	17377 nT	69° 21.7′	17305 nT	-1580 nT	46137 nT	49300 nT
February	-5° 11.8′	17381 nT	69° 21.4′	17309 nT	-1574 nT	46134 nT	49300 nT
March	-5° 10.7′	17374 nT	69° 22.0′	17303 nT	-1568 nT	46138 nT	49301 nT
April	-5° 9.3′	17371 nT	69° 22.4′	17300 nT	-1561 nT	46149 nT	49310 nT
May	-5° 9.0′	17392 nT	69° 20.8′	17321 nT	-1561 nT	46140 nT	49309 nT
June	-5° 8.1′	17394 nT	69° 20.7′	17324 nT	-1557 nT	46142 nT	49311 nT
July	-5° 7.4′	17395 nT	69° 20.7′	17325 nT	-1554 nT	46142 nT	49312 nT
August	-5° 6.9′	17389 nT	69° 21.1′	17320 nT	-1550 nT	46146 nT	49314 nT
September	-5° 6.0′	17383 nT	69° 21.6′	17314 nT	-1545 nT	46149 nT	49315 nT
October	-5° 4.7′	17365 nT	69° 23.3′	17297 nT	-1537 nT	46168 nT	49326 nT
November	-5° 3.4′	17368 nT	69° 23.2′	17300 nT	-1531 nT	46171 nT	49330 nT
December	-5° 3.5′	17384 nT	69° 22.0′	17316 nT	-1533 nT	46168 nT	49332 nT
Annual	**-5° 7.8′**	**17381 nT**	**69° 21.7′**	**17311 nT**	**-1554 nT**	**46149 nT**	**49313 nT**

International quiet day means

Month	D	H	I	X	Y	Z	F
January	-5° 13.1′	17384 nT	69° 21.1′	17312 nT	-1581 nT	46133 nT	49299 nT
February	-5° 12.0′	17384 nT	69° 21.2′	17312 nT	-1576 nT	46133 nT	49300 nT
March	-5° 11.1′	17386 nT	69° 21.0′	17315 nT	-1571 nT	46133 nT	49300 nT
April	-5° 9.7′	17381 nT	69° 21.6′	17311 nT	-1564 nT	46145 nT	49310 nT
May	-5° 9.1′	17392 nT	69° 20.8′	17322 nT	-1562 nT	46140 nT	49309 nT
June	-5° 7.8′	17394 nT	69° 20.7′	17325 nT	-1555 nT	46144 nT	49314 nT
July	-5° 7.6′	17395 nT	69° 20.6′	17326 nT	-1554 nT	46141 nT	49311 nT
August	-5° 6.7′	17389 nT	69° 21.1′	17320 nT	-1549 nT	46145 nT	49312 nT
September	-5° 6.9′	17389 nT	69° 21.2′	17319 nT	-1550 nT	46145 nT	49313 nT
October	-5° 4.7′	17377 nT	69° 22.3′	17309 nT	-1538 nT	46162 nT	49324 nT
November	-5° 3.9′	17382 nT	69° 22.2′	17314 nT	-1535 nT	46169 nT	49333 nT
December	-5° 3.6′	17385 nT	69° 21.9′	17317 nT	-1533 nT	46166 nT	49331 nT
Annual	**-5° 8.0′**	**17386 nT**	**69° 21.3′**	**17317 nT**	**-1556 nT**	**46146 nT**	**49313 nT**

International disturbed day means

Month	D	H	I	X	Y	Z	F
January	-5° 12.5′	17367 nT	69° 22.6′	17295 nT	-1576 nT	46145 nT	49304 nT
February	-5° 11.3′	17375 nT	69° 21.8′	17304 nT	-1571 nT	46136 nT	49299 nT
March	-5° 9.4′	17345 nT	69° 24.2′	17274 nT	-1559 nT	46152 nT	49303 nT
April	-5° 8.1′	17352 nT	69° 23.7′	17283 nT	-1553 nT	46155 nT	49309 nT
May	-5° 8.5′	17383 nT	69° 21.4′	17313 nT	-1558 nT	46142 nT	49308 nT
June	-5° 7.9′	17390 nT	69° 21.0′	17320 nT	-1556 nT	46142 nT	49310 nT
July	-5° 7.4′	17395 nT	69° 20.7′	17325 nT	-1553 nT	46143 nT	49313 nT
August	-5° 7.0′	17389 nT	69° 21.2′	17320 nT	-1551 nT	46151 nT	49319 nT
September	-5° 5.0′	17371 nT	69° 22.6′	17303 nT	-1539 nT	46157 nT	49318 nT
October	-5° 3.3′	17340 nT	69° 25.2′	17272 nT	-1528 nT	46180 nT	49328 nT
November	-5° 1.7′	17324 nT	69° 26.1′	17257 nT	-1518 nT	46174 nT	49317 nT
December	-5° 2.9′	17376 nT	69° 22.6′	17308 nT	-1529 nT	46171 nT	49332 nT
Annual	**-5° 7.1′**	**17367 nT**	**69° 22.8′**	**17298 nT**	**-1549 nT**	**46154 nT**	**49313 nT**

Eskdalemuir Observatory K Indices 2001

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0000 0001	1332 1122	3110 1111	4443 3345	1000 1020	0002 3334	3211 1233	4112 2222	2100 1200	5544 3434	4441 3321	0012 3311
2	1000 1113	3210 1101	1111 2233	4323 3432	1111 1210	5334 3333	1100 1120	1112 2310	0001 2312	4443 2456	0010 2001	1011 2111
3	2322 2111	0000 1000	2214 3343	2111 2322	2111 2222	1121 2232	1221 3231	3142 2323	2123 3434	4245 6644	1000 1000	0101 3233
4	3022 3323	0000 1000	3331 2354	2121 5452	1221 1222	3112 2322	1212 2321	1202 3332	3322 2322	4233 2332	0013 2200	2212 2132
5	2000 1023	0000 1013	4432 2212	1133 3333	0000 0111	2110 1111	2232 4432	2233 4533	3110 2330	1002 3331	0012 3445	4212 2232
6	1000 0101	3132 1333	2111 2131	1122 3333	0011 2122	1111 3322	1011 2332	2422 4433	2111 1112	1123 2121	9954 5666	3112 2233
7	1101 0112	2220 1121	2311 1421	3332 2342	3421 3230	2303 3222	1101 1221	3212 2221	0000 1113	0000 2102	5311 2223	2101 2211
8	2111 1254	0211 0123	1012 1133	2125 6576	1012 3444	1122 2333	2222 2344	3111 2221	3111 2110	2212 3324	1221 1101	3111 1000
9	2011 1021	0011 1122	3112 2210	2233 3432	4433 4543	2223 4445	4310 2322	1201 2323	0112 2000	4224 3311	1011 1122	0001 1002
10	0000 1222	1101 2210	0122 1220	3112 3313	5432 2333	5333 2332	0111 3442	2121 1132	1101 1111	2111 2221	1101 1113	0000 1002
11	1000 1233	2111 1002	1211 1011	2111 3779	2111 1123	3201 3331	3300 2221	2000 0113	1001 3342	3211 2443	2112 1100	0100 1122
12	3221 0000	1000 1222	0011 3334	8544 4311	3233 4444	2110 1111	2211 3222	1114 2433	2232 3233	4432 3443	1001 1000	2212 2233
13	1112 2102	3332 3344	3213 1112	1136 4454	5322 3464	2222 2331	2202 0123	3433 3432	3443 2230	2233 2321	0100 1112	1100 1100
14	2221 1032	3323 3343	3111 1112	4333 3432	4321 2221	3010 2323	4412 3311	2222 3332	3111 3213	1233 2343	0010 1010	0000 2222
15	0001 2113	1022 1101	0000 1000	2321 4232	1122 2443	3312 1120	0121 3432	2110 2232	4233 3443	3212 2212	0000 2441	2211 3112
16	0011 2211	0001 1112	0000 1111	3211 2223	3221 1212	2120 0230	3313 4433	1100 1111	2101 3233	3111 2121	2111 1101	2322 2112
17	3100 1222	1000 0110	0000 1222	2211 2222	1211 2322	0111 4321	4332 3422	1003 4565	0111 1102	2011 1101	2311 3233	3322 2331
18	0002 1013	1000 1111	3210 1223	5653 2233	3211 2223	3344 5534	1222 3321	3230 4333	1101 2442	0000 1110	2211 3224	3111 2212
19	1100 1022	1011 2110	2114 4465	3211 1013	4311 2121	3312 2333	1112 3321	0233 2230	3212 2121	0001 2341	4223 3353	3112 1231
20	0022 2234	1101 2121	4444 6634	3201 2102	1111 3221	2333 3312	1111 2210	0003 3222	1101 2112	1333 2222	3231 0000	1001 1112
21	2213 3344	2111 2202	4121 0000	1100 2423	0001 1121	1332 3443	1111 1112	1213 4333	1000 1102	3211 2578	1011 1200	0122 2344
22	3322 2223	0011 1112	0001 3433	3333 4554	1112 2332	2100 1221	2221 2433	1123 4344	2113 3210	6335 5667	1111 2133	3222 2020
23	1104 3354	2221 2212	4424 3453	3332 2321	2211 3432	1111 2221	3311 3332	3221 2111	0244 4554	5332 2111	2223 3343	1102 1112
24	2202 3353	1100 2100	1331 2330	1221 1111	2201 1211	2212 2322	2212 4432	0101 2100	4112 2211	0000 0000	3486 7734	2234 4433
25	1111 1233	0000 0011	0112 2121	1011 2222	1111 3321	1210 3321	2334 4432	0102 3433	0111 1156	0023 1232	1223 2210	2212 1103
26	2132 1223	3000 1333	0000 2010	0121 2222	1210 0111	1112 4443	3312 2122	3232 1333	5344 2222	0011 1122	1122 1000	2001 1123
27	2100 1100	3322 2110	3312 2445	1111 1220	0000 2532	3210 0000	0121 2321	1212 2343	0112 2342	1201 2110	0000 0100	2101 1232
28	0011 3232	0012 3231	3245 5523	3544 4543	2223 3434	0000 0011	1000 1100	3331 2221	2233 2333	3643 4334	0000 1001	1011 2102
29	4411 1022		3343 3423	4321 3420	3200 3421	0001 1112	1211 2310	1112 1210	3224 3444	3222 2323	1001 1000	1322 2223
30	1100 1100		2222 3333	0000 0010	0001 2121	1112 2332	1011 2333	0112 3330	3112 3555	2211 1102	1000 0011	3432 2244
31	0033 3343		7885 6897		0000 1111		4333 5533	2223 1422		1000 3354		3321 1244

SIs and SSCs

Day	Month	UT		Type	Quality	H(nT)	D(min)	Z(nT)
10	01	16	20	SSC	C	12.0	1.22	-1.2
13	01	09	45	SSC*	B	-10.1	2.10	0.5
17	01	16	30	SSC*	A	27.6	-1.79	-2.0
23	01	10	47	SSC*	A	-28.2	9.37	1.7
31	01	08	04	SSC*	A	9.2	2.89	-1.4
12	02	16	13	SSC*	C	16.8	-1.84	0.8
03	03	11	20	SSC*	B	24.9	-3.87	-3.3
19	03	11	13	SSC*	B	-10.9	1.94	-
22	03	13	41	SSC*	A	44.2	-7.71	-4.2
27	03	17	46	SSC	B	45.4	-3.77	-2.3
31	03	00	52	SSC	B	169.5	-9.45	-32.5
04	04	14	54	SSC*	A	88.7	-8.85	-8.1
08	04	11	01	SSC*	A	-79.0	7.82	-6.9
11	04	13	43	SSC*	B	35.8	-4.04	-1.8
13	04	07	34	SSC*	B	-34.9	-3.81/+4.82	2.3
13	04	09	56	SI*	A	-145.1/151.2	23.0	-13.2
18	04	00	46	SSC*	B	91.2	-9.45	-15.5
21	04	16	00	SSC*	B	58.9	-5.21	-4.2
28	04	05	00	SSC*	A	63.1	-24.93	-9.5
27	05	14	57	SSC*	A	93.1	-6.11	-5.0
07	06	09	47	SSC*	C	-6.9	1.23	-
11	06	14	01	SI*	C	-19.8	0.91	1.0
18	06	02	59	SSC	B	27.7	-3.57	-3.6
17	07	06	03	SSC*	C	-2.9	1.85	1.3
20	07	07	04	SI*	C	-4.1	1.35	-
31	07	03	53	SSC	C	-25.7	4.96	4.3
03	08	07	15	SSC*	A	-31.4	7.6	2.1
12	08	11	34	SSC*	A	55.3	-4.32	-9.3
17	08	11	03	SSC*	A	24.6	2.4	-5.0
21	08	14	47	SI*	C	-8.7	0.44	1.4
23	08	05	55	SSC*	C	-7.8	1.40	1.4
27	08	19	51	SSC	B	68.8	-2.3	-6.4
30	08	14	10	SSC*	B	34.8	-4.12	-2.0
14	09	02	04	SSC*	A	37.9	-4.80	9.5
22	09	14	34	SI	C	-25.4	3.77	2.6
23	09	07	50	SSC*	C	-13.5	1.97	1.9
25	09	20	25	SSC*	A	92.0	5.92	-11.4
29	09	09	38	SSC*	A	77.9	4.73	1.5

Notes

A * indicates that the principal impulse was preceded by a smaller reversed impulse.
The quality of the event is classified as follows :

A = very distinct
B = fair, ordinary, but unmistakable
C = doubtful

The amplitudes given are for the first chief movement of the event.

SIs and SSCs

Day	Month	UT		Type	Quality	H(nT)	D(min)	Z(nT)
11	10	17	00	SSC*	A	52.1	-3.73	-2.2
21	10	16	47	SSC*	A	81.2	-9.52	-5.8
25	10	08	50	SI	B	12.6	-2.43	-1.6
28	10	03	18	SSC	A	12.8	-5.25	-2.4
31	10	13	48	SI	B	27.1	-4.48	-3.2
05	11	02	48	SI	C	3.9	-0.50	-
06	11	01	52	SSC	A	103.5	-25.96	-25.4
15	11	15	09	SSC	A	20.6	-2.42	-3.0
19	11	18	14	SSC	C	26.4	1.30	-3.0
24	11	05	55	SSC*	A	-24.6	-14.21	3.7
30	11	18	24	SSC*	B	8.3	-0.42/+0.45	-
29	12	05	38	SSC	A	35.6	-8.04	-4.8
30	12	20	10	SSC	A	51.3	-2.44	-6.0

Notes

A * indicates that the principal impulse was preceded by a smaller reversed impulse.
The quality of the event is classified as follows :

A = very distinct
B = fair, ordinary, but unmistakable
C = doubtful

The amplitudes given are for the first chief movement of the event.

SFEs

Day	Month	Universal Time Start		Universal Time Maximum		Universal Time End		H(nT)	D(min)	Z(nT)
08	03	11	15	11	20	11	30	-16.2	1.14	-
17	03	09	24	09	31	09	39	3.7	-0.83	-1.2
15	04	13	45	13	50	14	06	-58.7	-9.49	1.3
31	08	10	30	10	47	11	04	-30.2	-2.38	4.8
13	12	14	25	14	31	14	50	-11.3	-1.89	5.2

Notes

The amplitudes given are for the chief movement of the event.

Annual Values of Geomagnetic Elements

Eskdalemuir

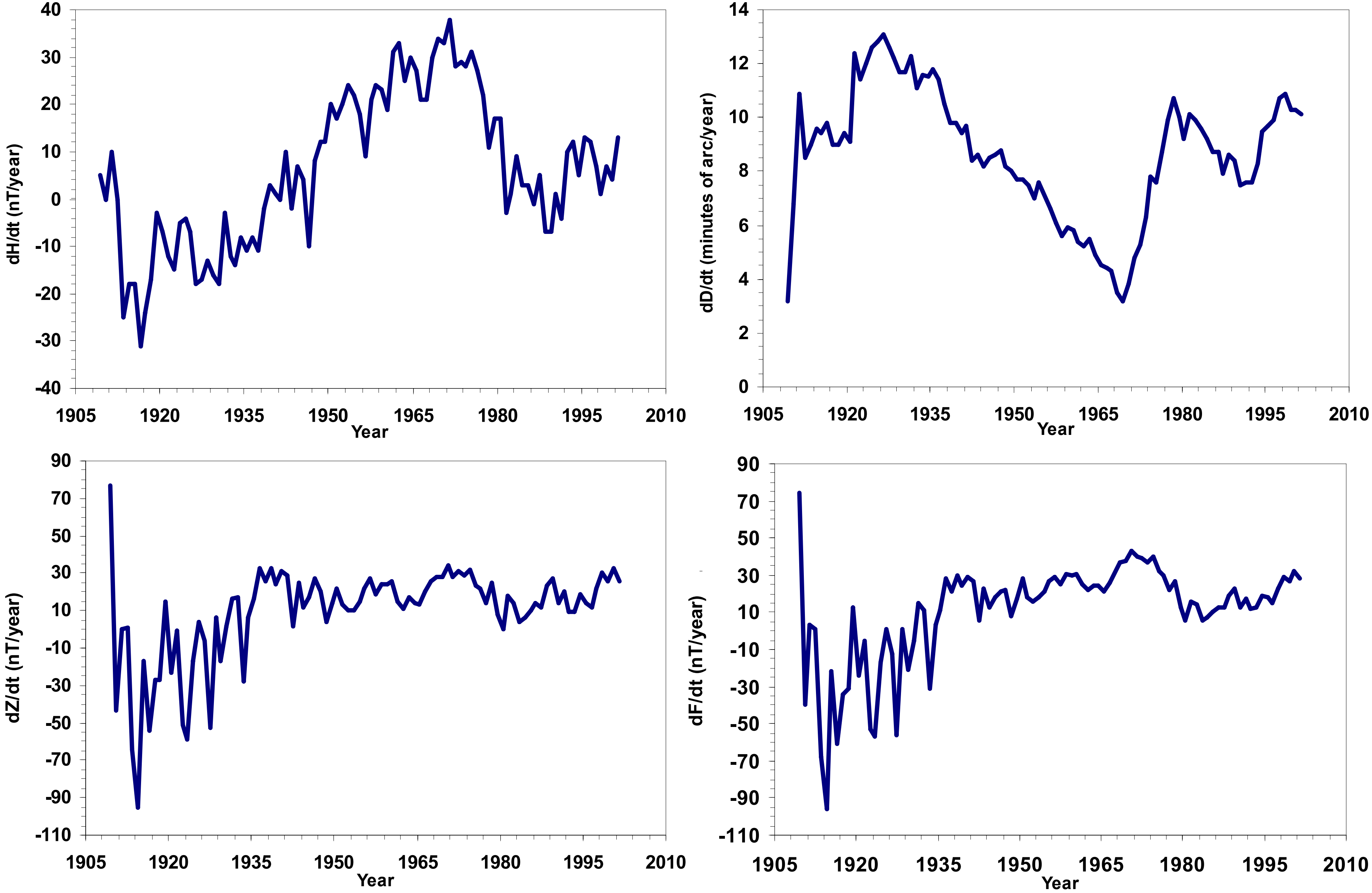
Year	D		H	I		X	Y	Z	F
1908.5	-18	33.3	16821	69	37.3	15947	-5353	45283	48306
1909.5	-18	30.1	16826	69	38.9	15956	-5339	45360	48380
1910.5	-18	23.3	16826	69	37.8	15967	-5308	45317	48340
1911.5	-18	12.4	16836	69	37.1	15993	-5260	45317	48343
1912.5	-18	3.9	16836	69	37.2	16006	-5221	45318	48344
1913.5	-17	54.9	16811	69	37.3	15996	-5171	45254	48276
1914.5	-17	45.3	16793	69	36.1	15993	-5121	45159	48180
1915.5	-17	35.9	16775	69	36.9	15990	-5072	45142	48158
1916.5	-17	26.1	16744	69	37.6	15975	-5017	45088	48097
1917.5	-17	17.1	16720	69	38.6	15965	-4968	45061	48063
1918.5	-17	8.1	16703	69	39.0	15962	-4921	45034	48032
1919.5	-16	58.7	16700	69	39.6	15972	-4877	45049	48045
1920.5	-16	49.6	16693	69	39.5	15978	-4832	45026	48021
1921.5	-16	37.2	16681	69	40.3	15984	-4771	45025	48016
1922.5	-16	25.8	16666	69	40.0	15985	-4714	44974	47963
1923.5	-16	13.8	16661	69	38.8	15997	-4657	44915	47906
1924.5	-16	1.2	16657	69	38.7	16010	-4597	44898	47889
1925.5	-15	48.4	16650	69	39.3	16020	-4535	44902	47890
1926.5	-15	35.3	16632	69	40.3	16020	-4469	44896	47878
1927.5	-15	22.7	16615	69	40.2	16020	-4406	44843	47822
1928.5	-15	10.5	16602	69	41.2	16024	-4346	44849	47823
1929.5	-14	58.8	16586	69	41.9	16022	-4287	44832	47802
1930.5	-14	47.1	16568	69	43.2	16019	-4228	44834	47797
1931.5	-14	34.8	16565	69	43.7	16032	-4170	44850	47812
1932.5	-14	23.7	16553	69	45.0	16033	-4115	44867	47823
1933.5	-14	12.1	16539	69	45.2	16033	-4058	44839	47792
1934.5	-14	0.6	16531	69	45.9	16039	-4002	44845	47795
1935.5	-13	48.8	16520	69	47.0	16042	-3944	44861	47806
1936.5	-13	37.4	16512	69	48.4	16047	-3889	44894	47834
1937.5	-13	26.9	16501	69	49.8	16049	-3837	44920	47855
1938.5	-13	17.1	16499	69	50.7	16057	-3791	44953	47885
1939.5	-13	7.3	16502	69	51.1	16071	-3746	44977	47909
1940.5	-12	57.9	16503	69	51.8	16082	-3703	45008	47938
1941.5	-12	48.2	16503	69	52.5	16093	-3657	45037	47965
1942.5	-12	39.8	16513	69	51.9	16111	-3620	45039	47971
1943.5	-12	31.2	16511	69	52.7	16118	-3579	45064	47994
1944.5	-12	23.0	16518	69	52.5	16134	-3542	45076	48007
1945.5	-12	14.5	16522	69	52.6	16146	-3503	45093	48025
1946.5	-12	5.9	16512	69	54.0	16145	-3461	45120	48046
1947.5	-11	57.1	16520	69	53.9	16162	-3421	45140	48068
1948.5	-11	48.9	16532	69	53.2	16182	-3385	45144	48076
1949.5	-11	40.9	16544	69	52.8	16201	-3350	45158	48093
1950.5	-11	33.2	16564	69	52.0	16228	-3317	45180	48121
1951.5	-11	25.5	16581	69	51.1	16252	-3284	45193	48139
1952.5	-11	18.0	16601	69	50.0	16279	-3253	45203	48155
1953.5	-11	11.0	16625	69	48.7	16309	-3224	45213	48173
1954.5	-11	3.4	16647	69	47.6	16338	-3193	45228	48194
1955.5	-10	56.3	16665	69	46.9	16362	-3162	45250	48221
1956.5	-10	49.7	16674	69	47.0	16377	-3132	45277	48250
1957.5	-10	43.6	16695	69	46.0	16403	-3107	45296	48275
1958.5	-10	38.0	16719	69	45.0	16432	-3085	45320	48306
1959.5	-10	32.1	16742	69	44.1	16460	-3061	45344	48336
1960.5	-10	26.3	16761	69	43.5	16484	-3037	45370	48367
1961.5	-10	20.9	16792	69	41.8	16519	-3016	45385	48392
1962.5	-10	15.7	16825	69	39.8	16556	-2997	45396	48414
1963.5	-10	10.2	16850	69	38.6	16585	-2975	45413	48438
1964.5	-10	5.3	16880	69	36.9	16619	-2957	45427	48462
1965.5	-10	0.8	16907	69	35.5	16649	-2940	45440	48483
1966.5	-9	56.4	16928	69	34.6	16674	-2922	45460	48509
1967.5	-9	52.1	16949	69	33.8	16698	-2905	45486	48541
1968.5	-9	48.6	16979	69	32.5	16731	-2893	45514	48578
1969.5	-9	45.4	17013	69	31.0	16767	-2883	45542	48616
1970.5	-9	41.6	17046	69	29.6	16803	-2870	45576	48659
1971.5	-9	36.8	17084	69	27.8	16844	-2853	45604	48699
1972.5	-9	31.5	17112	69	26.7	16876	-2832	45635	48738

Year	D		H	I		X	Y	Z	F
1973.5	-9	25.2	17141	69	25.5	16910	-2805	45664	48775
1974.5	-9	17.4	17169	69	24.5	16944	-2772	45696	48815
1975.5	-9	9.8	17200	69	23.0	16981	-2739	45719	48847
1976.5	-9	1.1	17227	69	21.8	17014	-2700	45741	48877
1977.5	-8	51.2	17249	69	20.6	17044	-2655	45755	48899
1978.5	-8	40.5	17260	69	20.5	17063	-2603	45780	48926
1979.5	-8	30.5	17277	69	19.6	17087	-2556	45788	48939
1980.5	-8	21.3	17294	69	18.5	17110	-2513	45788	48945
1981.5	-8	11.2	17291	69	19.2	17114	-2462	45806	48961
1982.5	-8	1.3	17292	69	19.4	17123	-2413	45820	48975
1983.5	-7	51.7	17301	69	18.9	17138	-2366	45824	48981
1984.5	-7	42.5	17304	69	18.9	17147	-2321	45830	48988
1985.5	-7	33.8	17307	69	18.9	17156	-2278	45840	48998
1986.5	-7	25.1	17306	69	19.4	17161	-2234	45854	49011
1987.5	-7	17.2	17311	69	19.3	17171	-2196	45866	49024
1988.5	-7	8.6	17304	69	20.4	17170	-2152	45889	49043
1989.5	-7	0.2	17297	69	21.5	17168	-2109	45916	49066
Note 1	0	0.0	11	0	-0.2	11	-1	22	25
1990.5	-6	52.7	17309	69	21.6	17184	-2073	45952	49104
1991.5	-6	45.1	17305	69	22.3	17185	-2034	45972	49121
1992.5	-6	37.5	17315	69	21.9	17199	-1998	45981	49133
1993.5	-6	29.2	17327	69	21.3	17216	-1957	45990	49146
Note 2	0	0.0	-8	0	0.0	-8	1	-23	-24
1994.5	-6	19.7	17324	69	21.4	17218	-1910	45986	49141
1995.5	-6	10.0	17337	69	20.9	17237	-1862	46000	49159
1996.5	-6	0.1	17349	69	20.5	17254	-1814	46012	49174
1997.5	-5	49.4	17356	69	20.5	17266	-1761	46034	49197
1998.5	-5	38.5	17357	69	21.2	17273	-1707	46064	49226
1999.5	-5	28.2	17364	69	21.4	17285	-1655	46090	49253
2000.5	-5	17.9	17368	69	22.0	17294	-1604	46123	49285
2001.5	-5	7.8	17381	69	21.7	17311	-1554	46149	49313

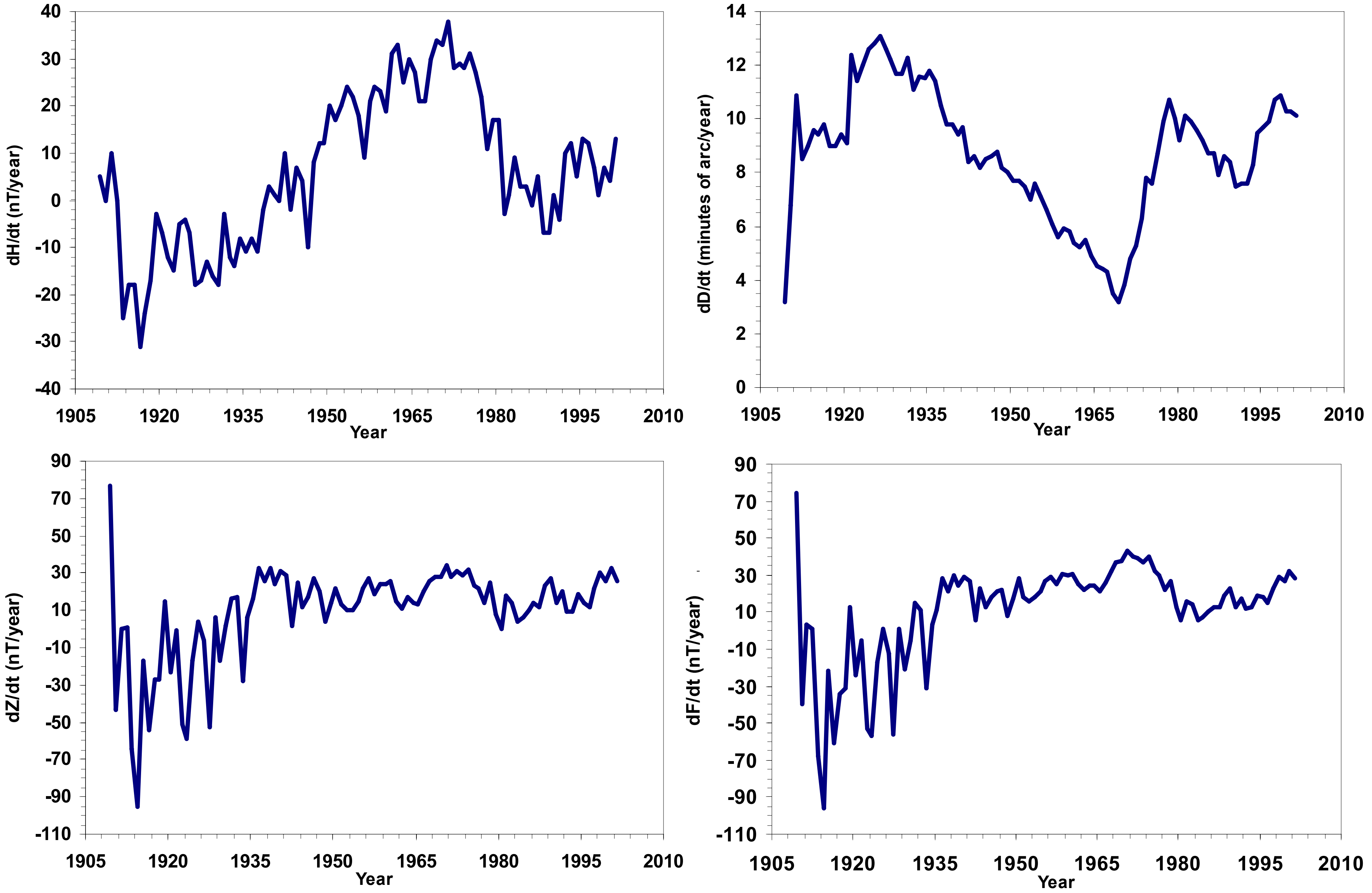
1 Site differences 1 Jan 1990 (new value - old value)
2 Site differences 1 Jan 1994 (new value - old value)

D and I are given in degrees and decimal minutes
All other elements are in nanoteslas

Annual Mean Values at Eskdalemuir

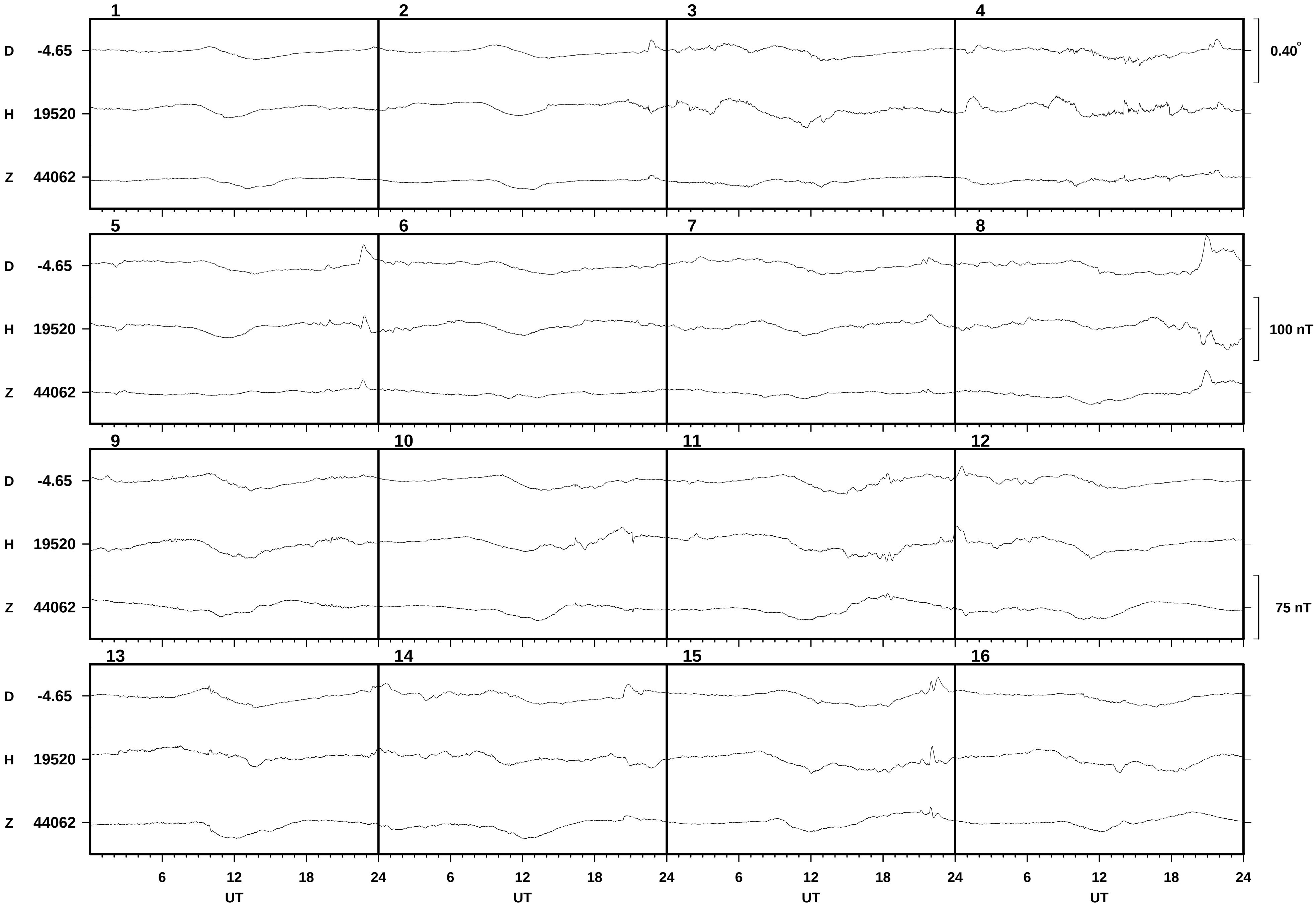


Rate of Change of Annual Mean Values at Eskdalemuir

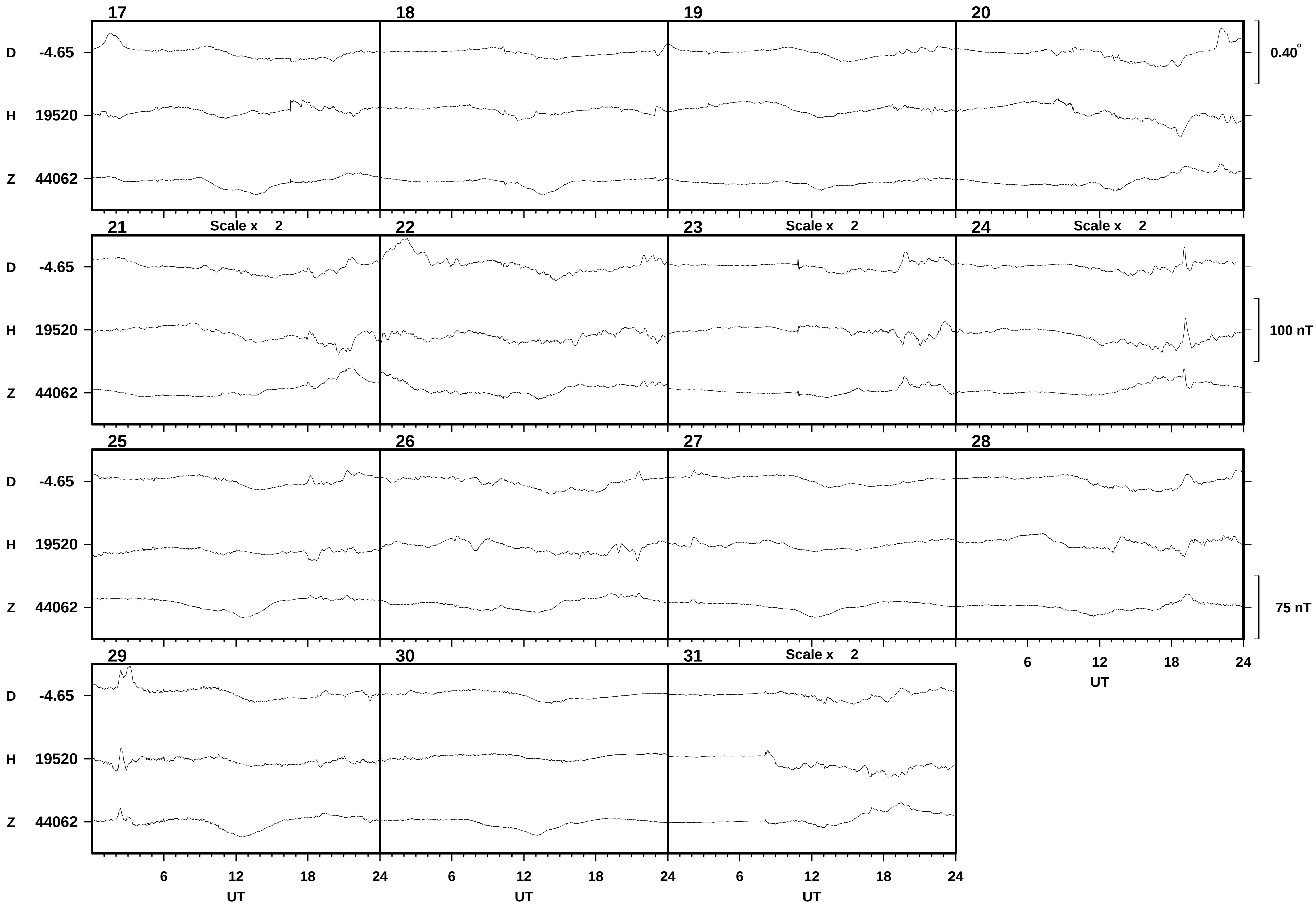


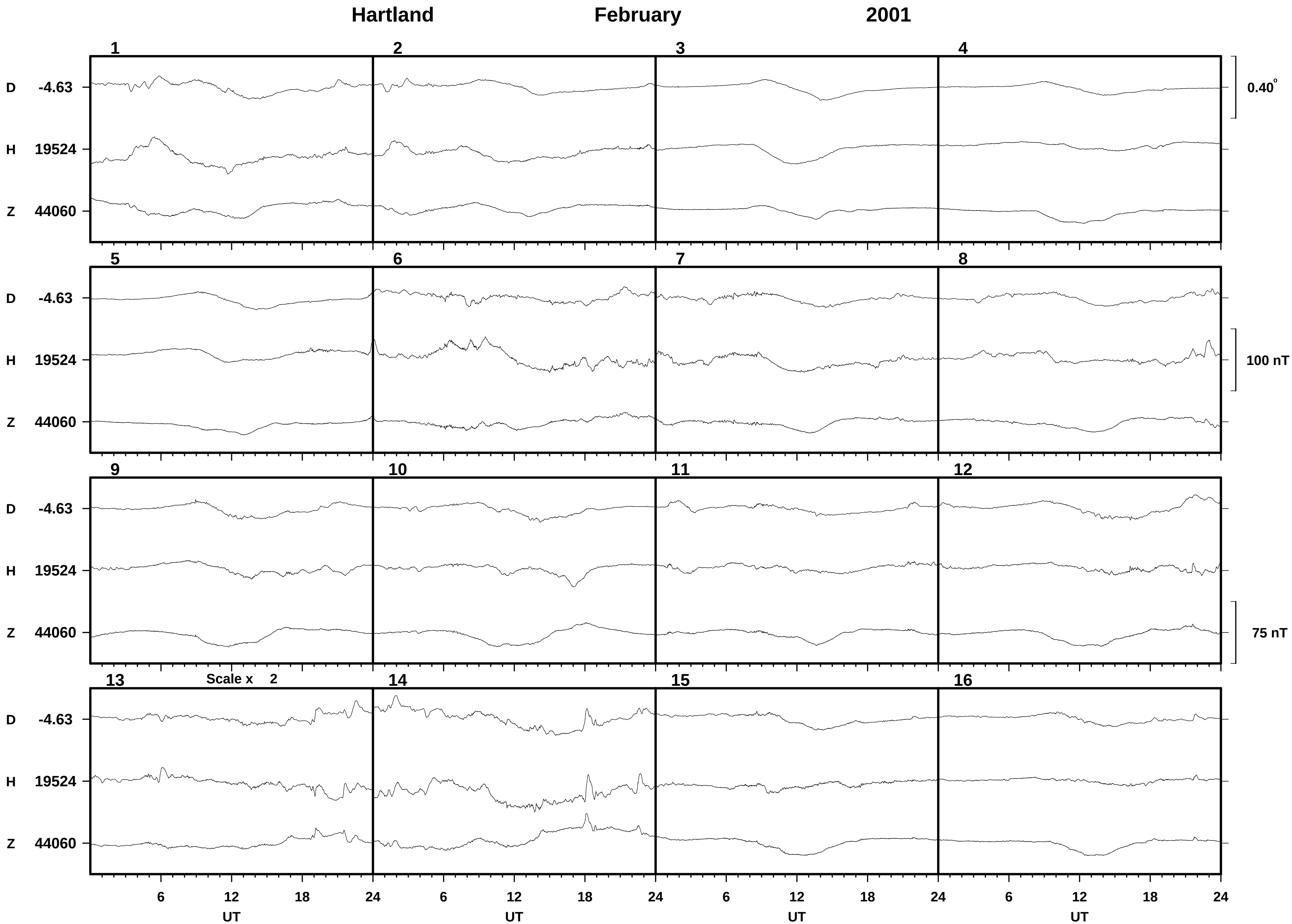
Hartland Observatory Results 2001

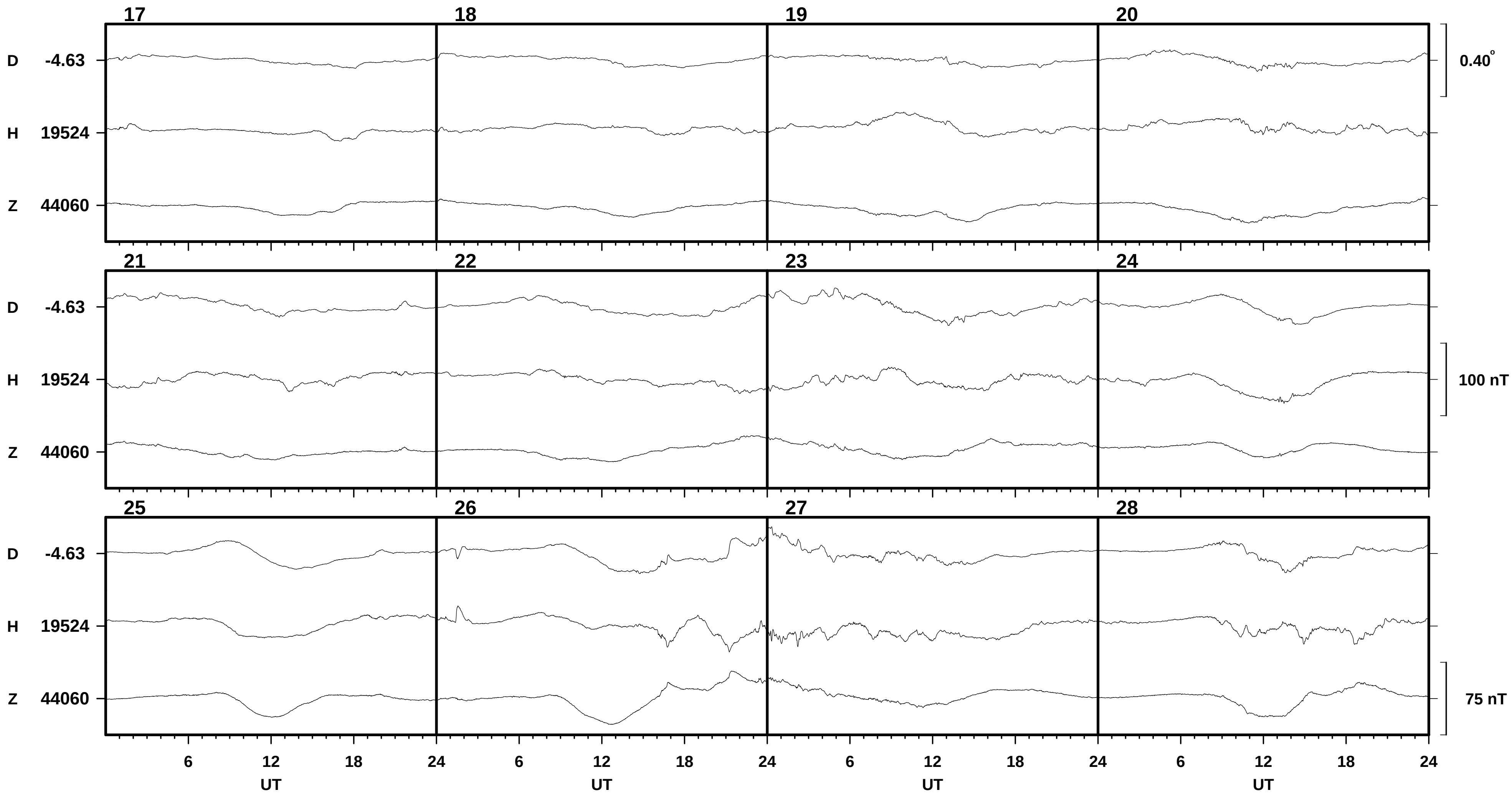
Hartland January 2001



HA 1 1


17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
D -4.65
H 19520
Z 44062
0.40°
100 nT
75 nT
Scale x 2
6
12
18
24
UT
HA 1 1


Hartland
February
2001
1
2
3
4
5
6
7
8
9
10
11
12
13
Scale x 2
14
15
16
D -4.63
H 19524
Z 44060
0.40°
100 nT
75 nT
6
12
18
24
UT
HA 2 1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18
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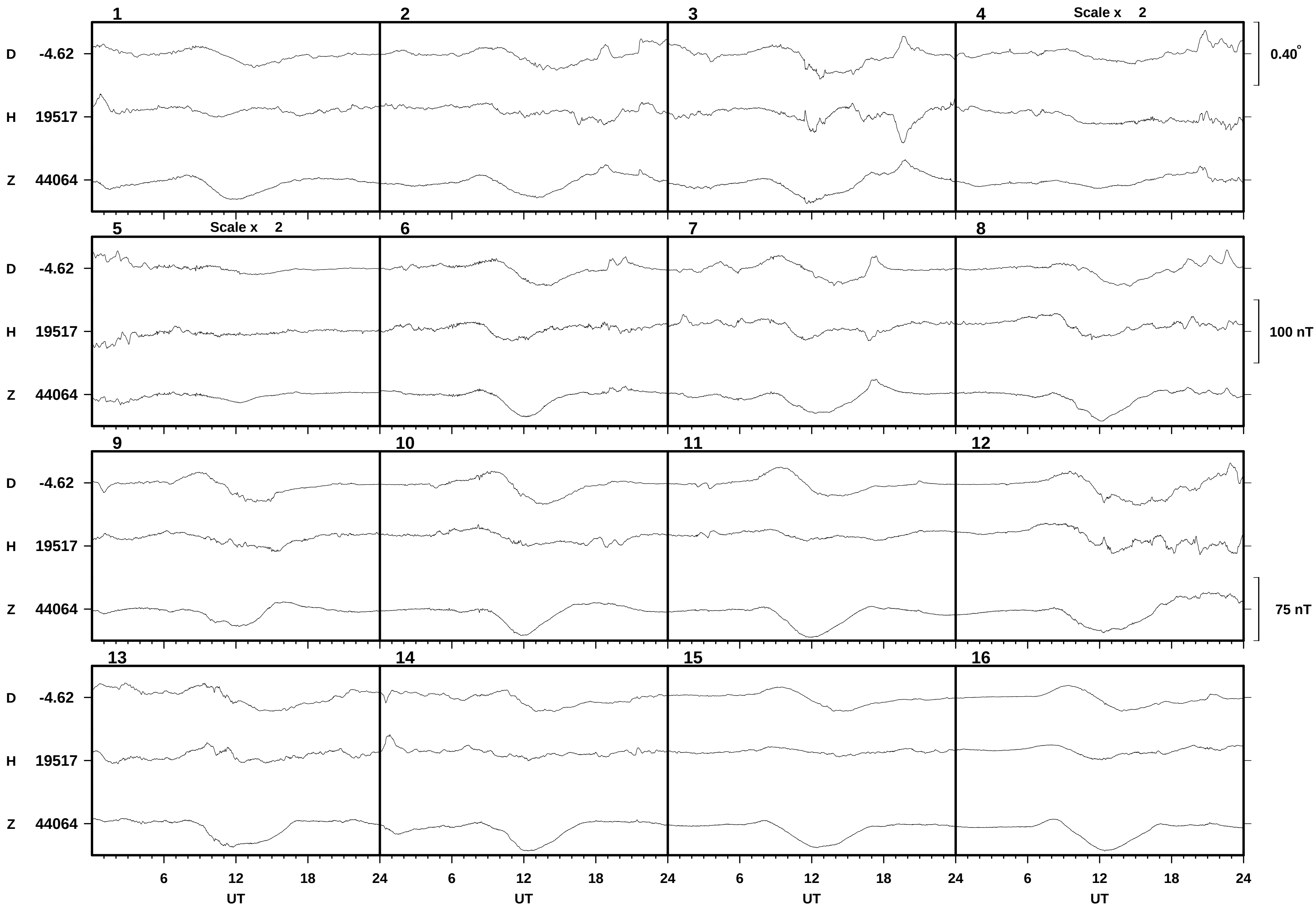
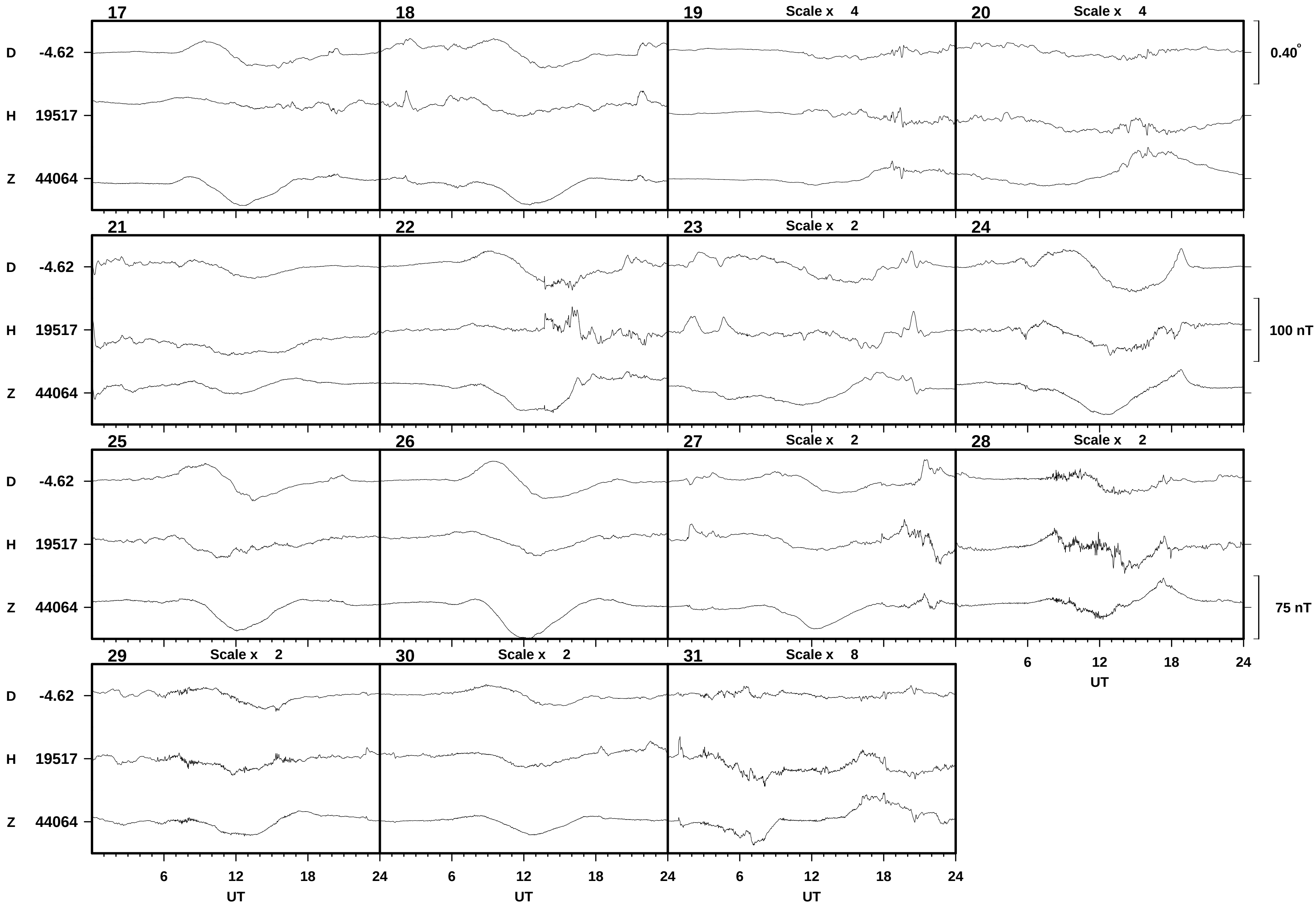
21
22
23
24
25
26
27
28
D
-4.63
H
19524
Z
44060
0.40°
100 nT
75 nT
6
12
18
24
UT

HA 2 1

Hartland March 2001



HA 3 1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18
19
Scale x 4
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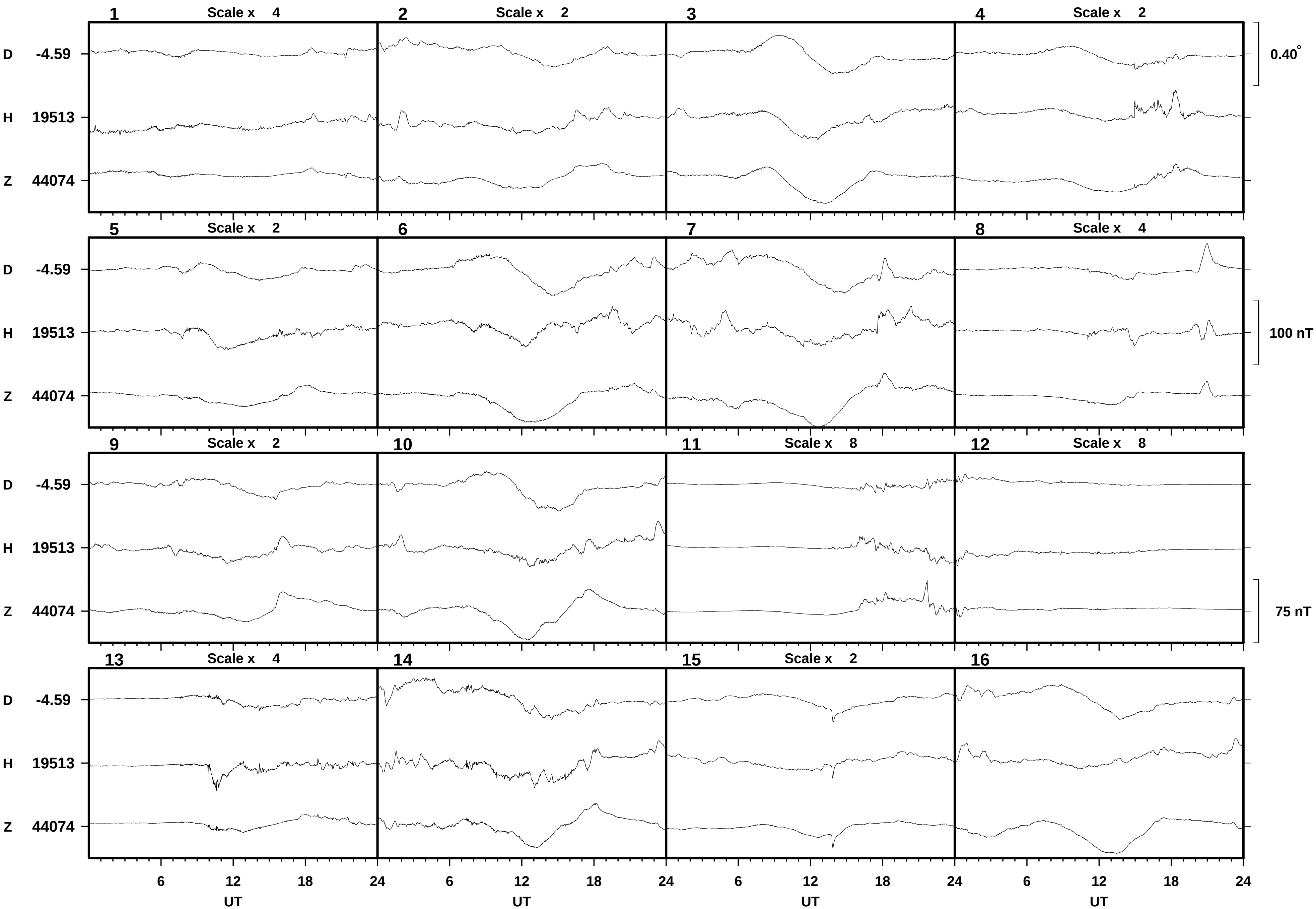
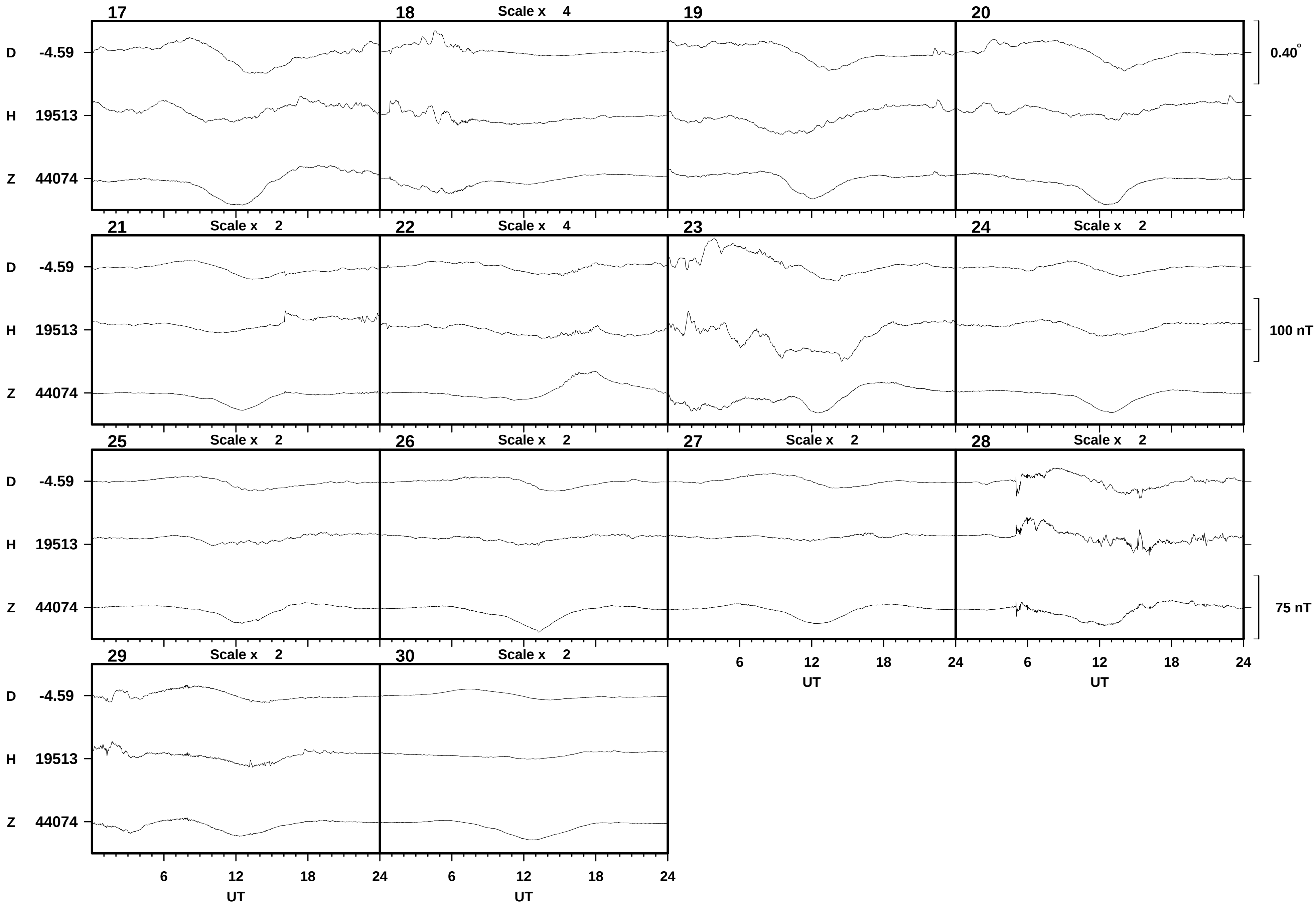
Scale x 4
21
22
23
Scale x 2
24
25
26
27
Scale x 2
28
Scale x 2
29
Scale x 2
30
Scale x 2
31
Scale x 8
D -4.62
H 19517
Z 44064
0.40°
100 nT
75 nT
6
12
18
24
UT
HA 3 1

Hartland April 2001



HA 4 1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18
Scale x 4
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Scale x 2
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Scale x 4
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24
Scale x 2
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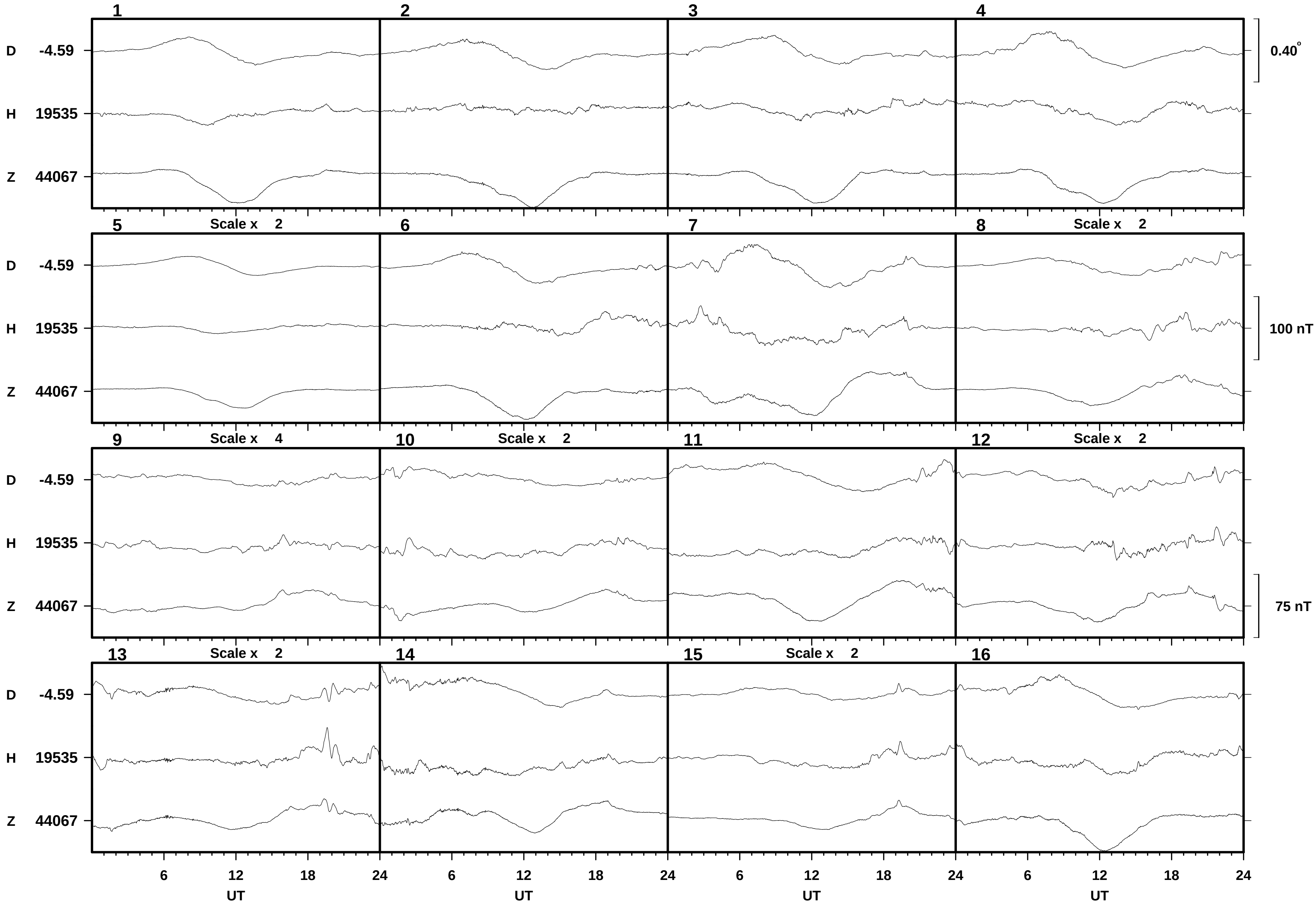
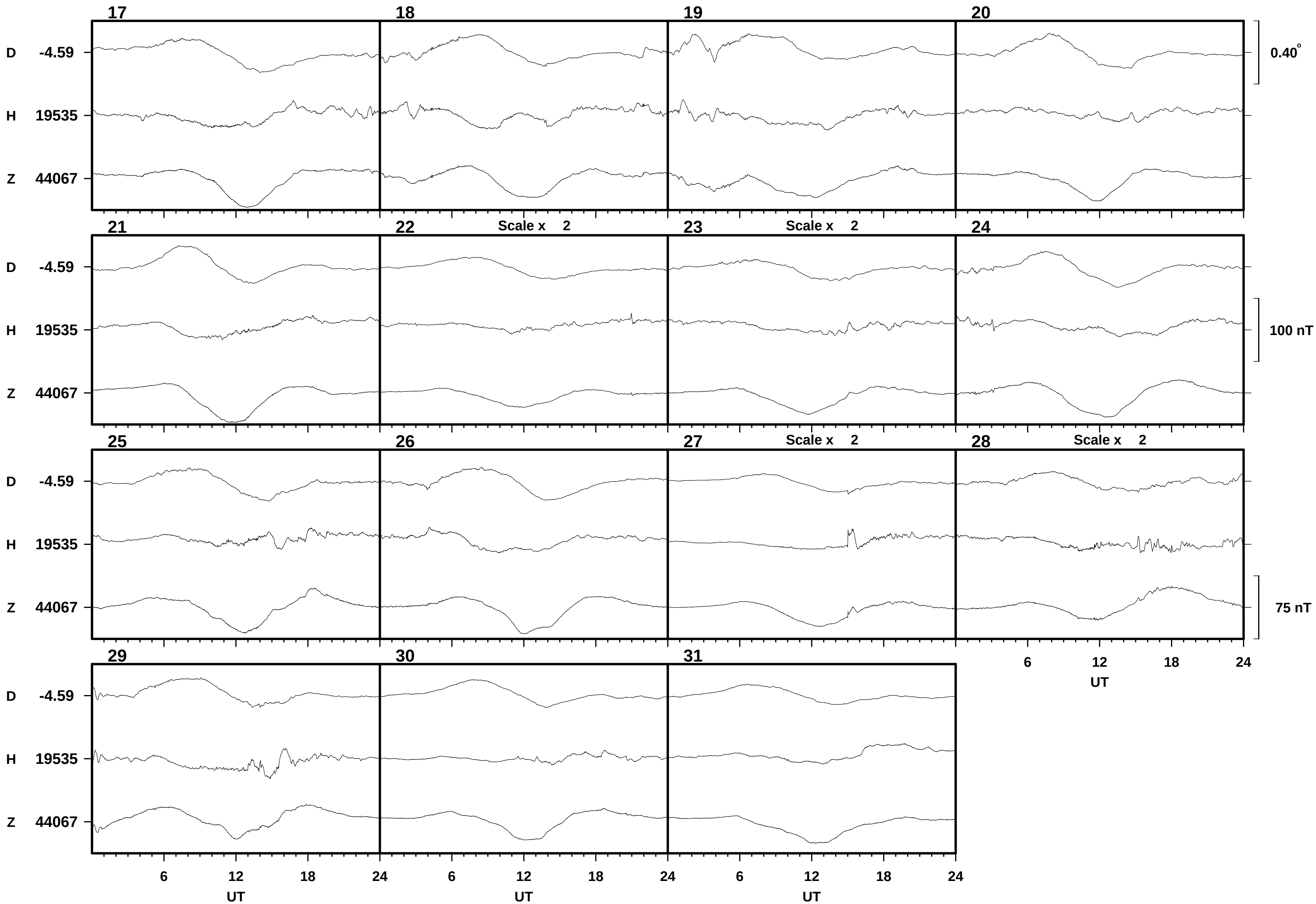
Scale x 2
26
Scale x 2
27
Scale x 2
28
Scale x 2
29
Scale x 2
30
Scale x 2
D -4.59
H 19513
Z 44074
0.40°
100 nT
75 nT
6
12
18
24
UT

HA 4 1

Hartland May 2001



HA 5 1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18
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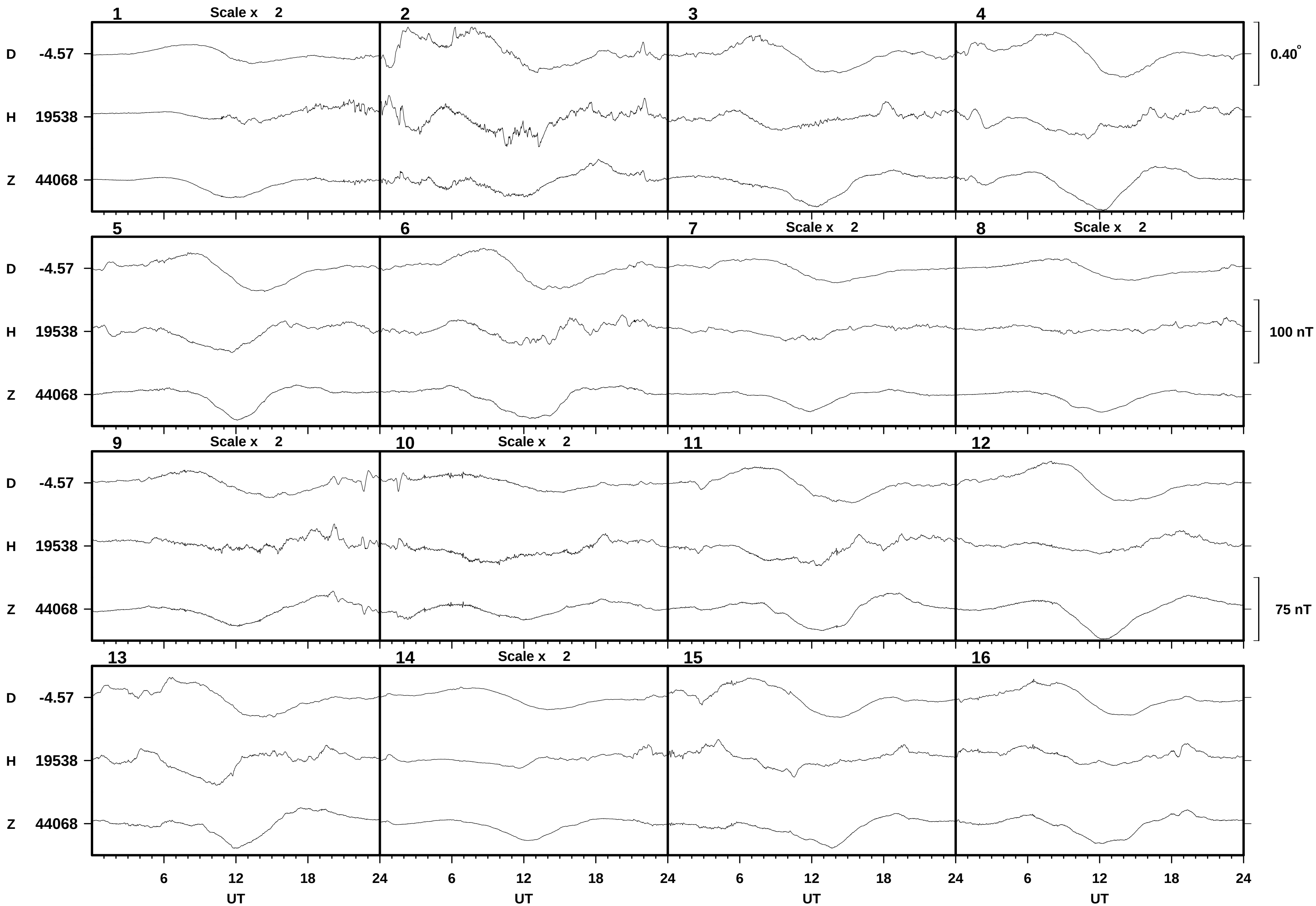
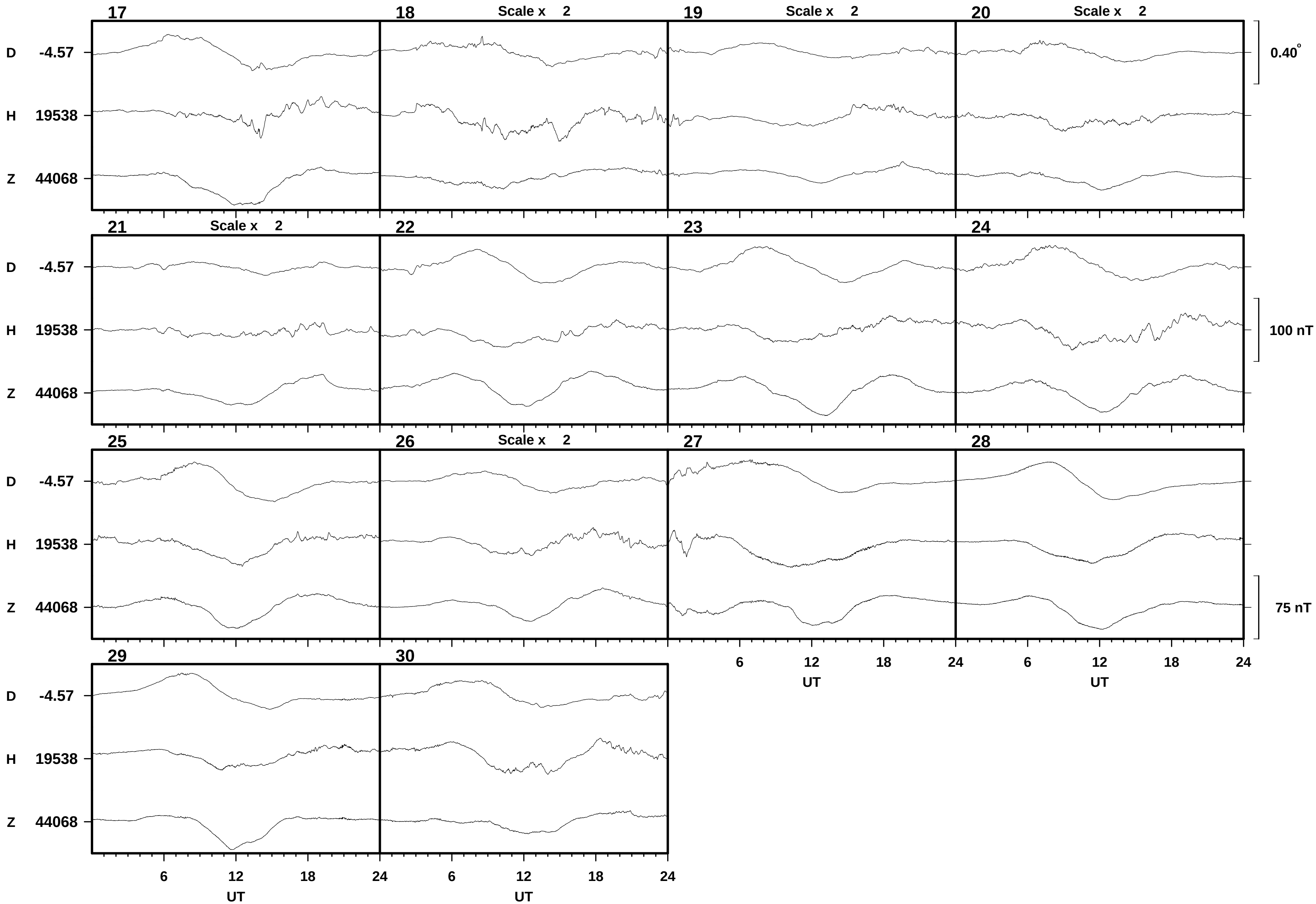
Scale x 2
23
Scale x 2
24
25
26
27
Scale x 2
28
Scale x 2
29
30
31
D -4.59
H 19535
Z 44067
0.40°
100 nT
75 nT
6
12
18
24
UT

HA 5 1

Hartland June 2001



HA 6 1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18
Scale x 2
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Scale x 2
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Scale x 2
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Scale x 2
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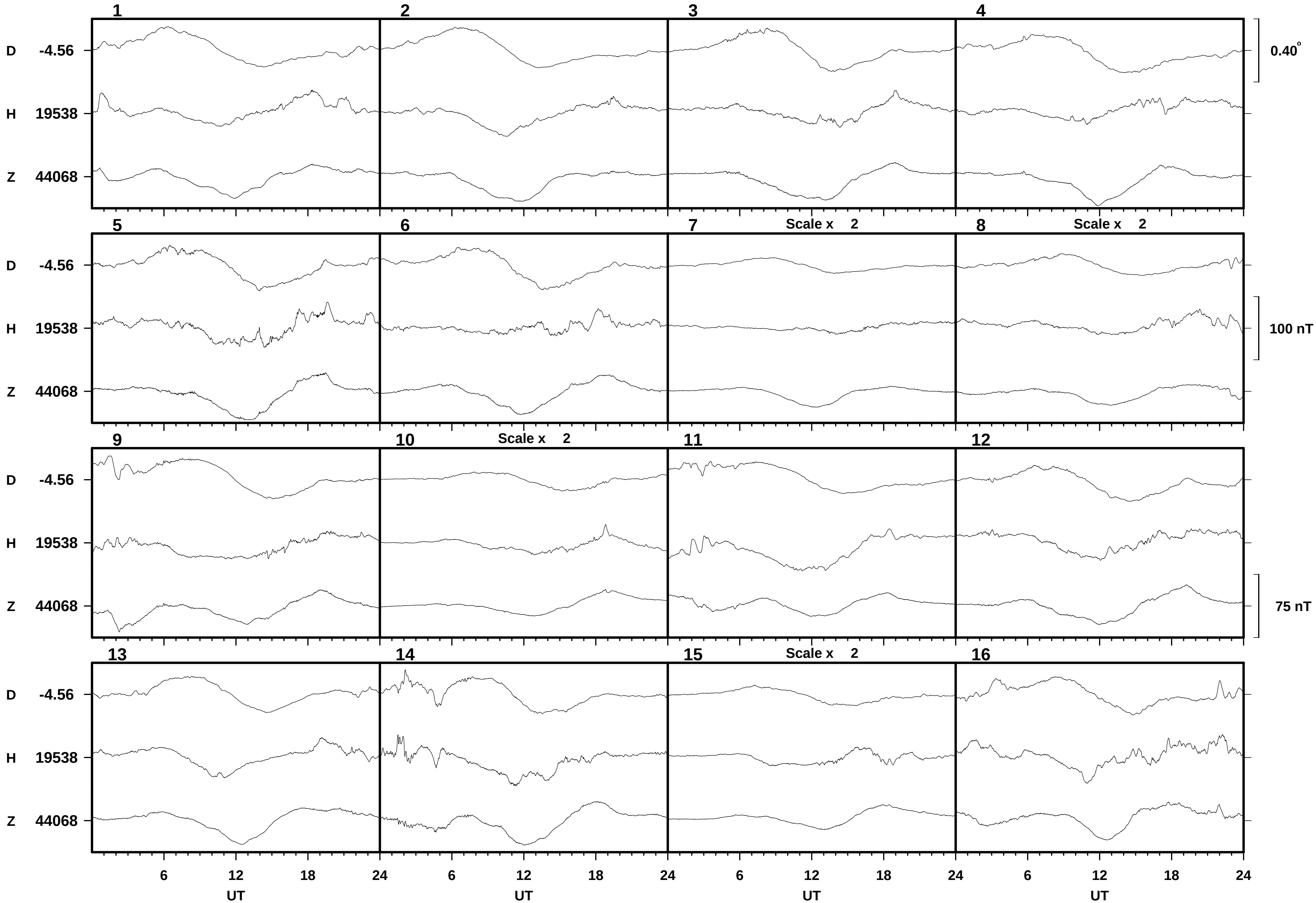
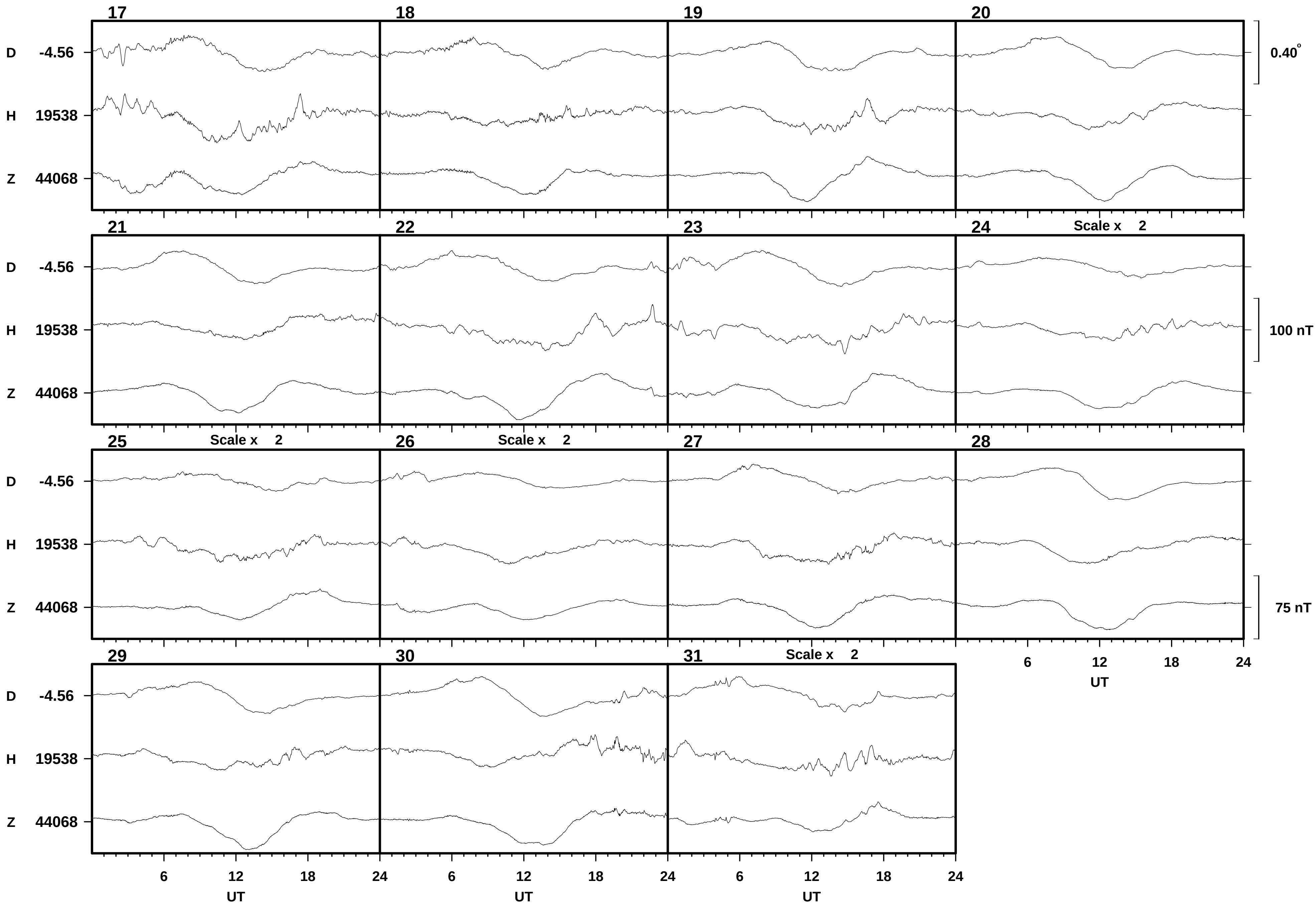
24
25
26
Scale x 2
27
28
29
30
D -4.57
H 19538
Z 44068
0.40°
100 nT
75 nT
6
12
18
24
UT

HA 6 1

Hartland July 2001



HA 7 1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25
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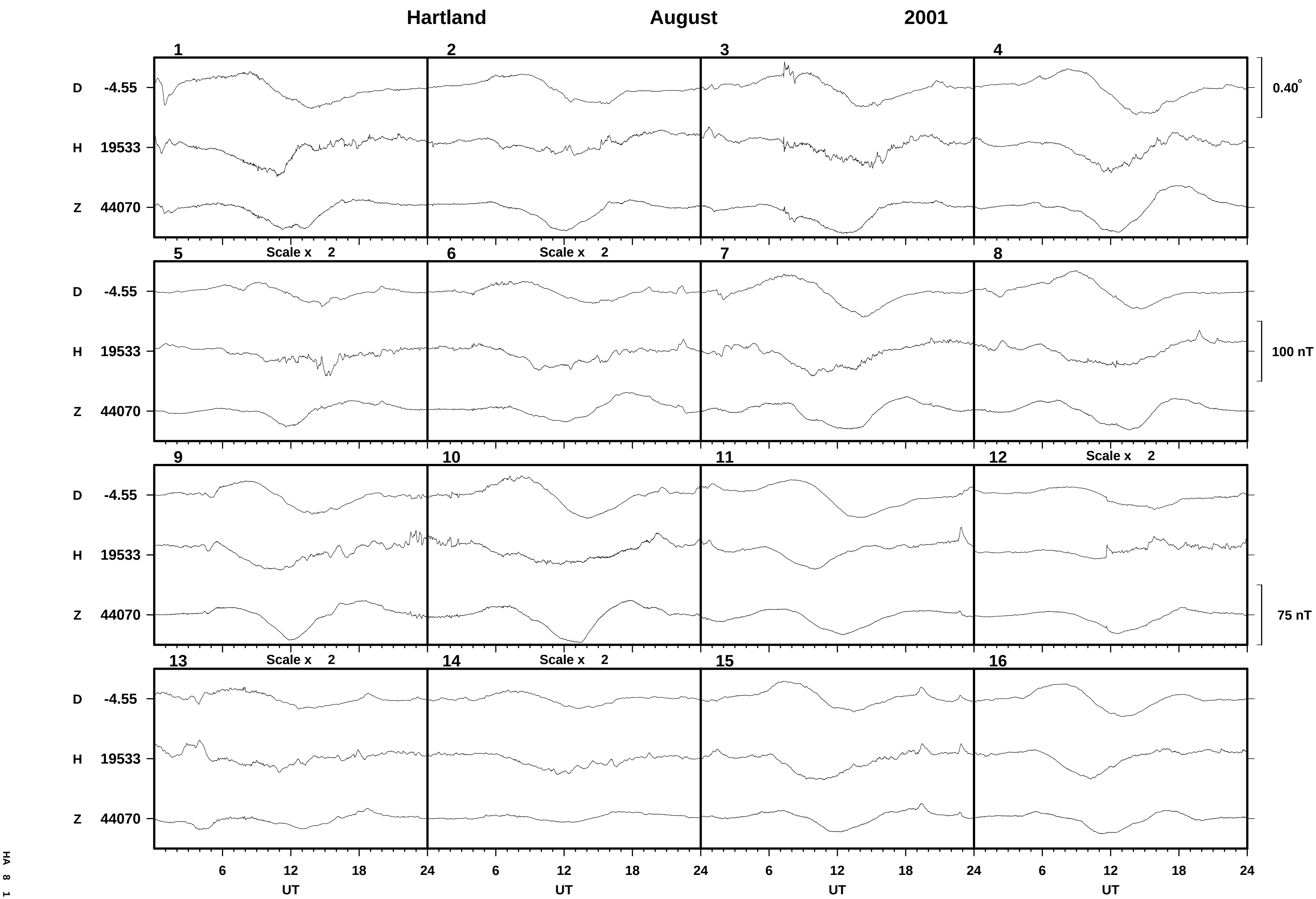
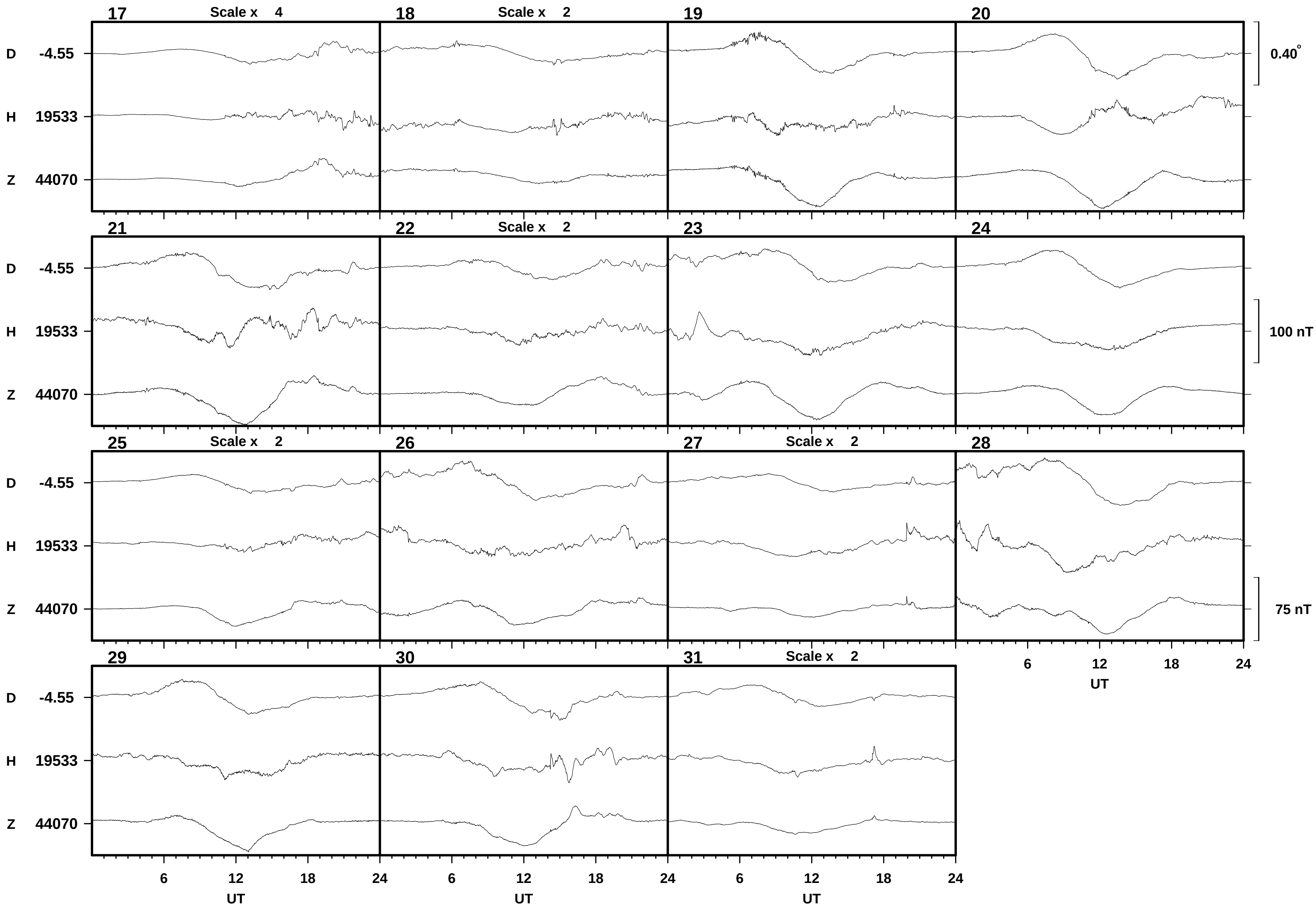
27
28
29
30
31
D -4.56
H 19538
Z 44068
Scale x 2
0.40°
100 nT
75 nT
6
12
18
24
UT

HA 7 1


Hartland August 2001
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Scale x 2
D -4.55
H 19533
Z 44070
0.40°
100 nT
75 nT
6 12 18 24
UT
HA 8 1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Scale x 4
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Scale x 2
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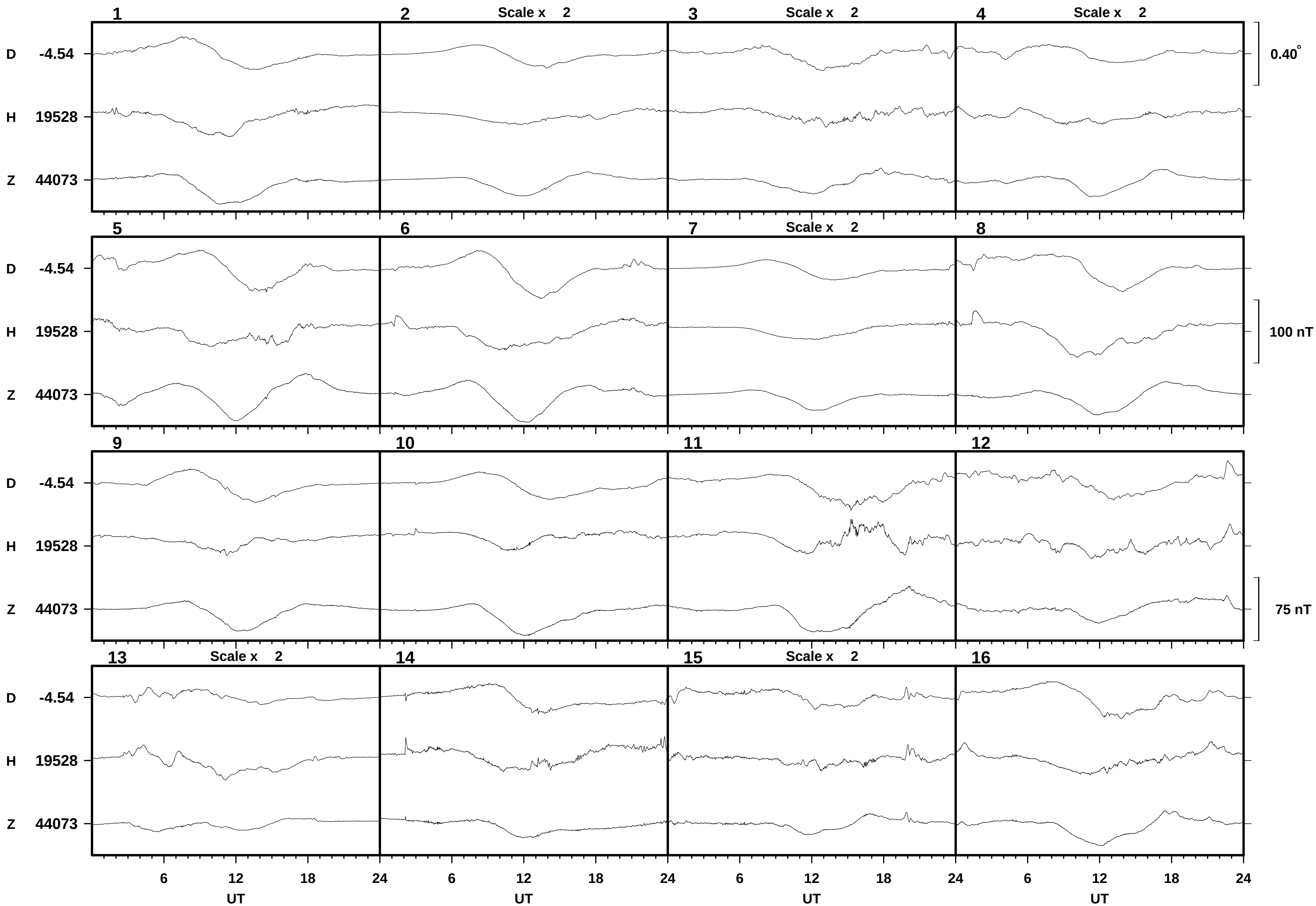
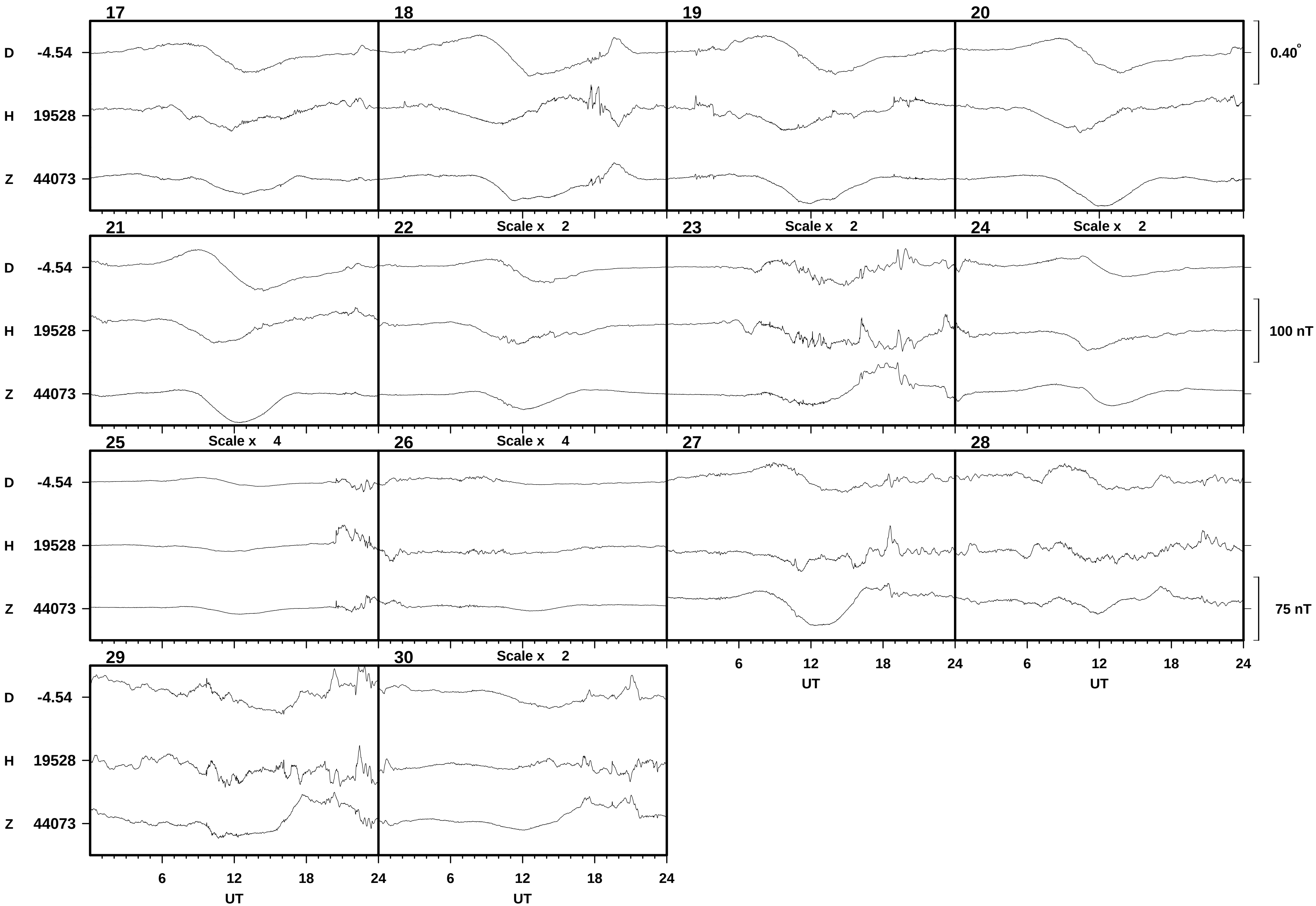
21
22
Scale x 2
23
24
25
Scale x 2
26
27
Scale x 2
28
29
30
31
Scale x 2
D -4.55
H 19533
Z 44070
0.40°
100 nT
75 nT
6
12
18
24
UT

HA 8 1

Hartland September 2001



HA 9 1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18
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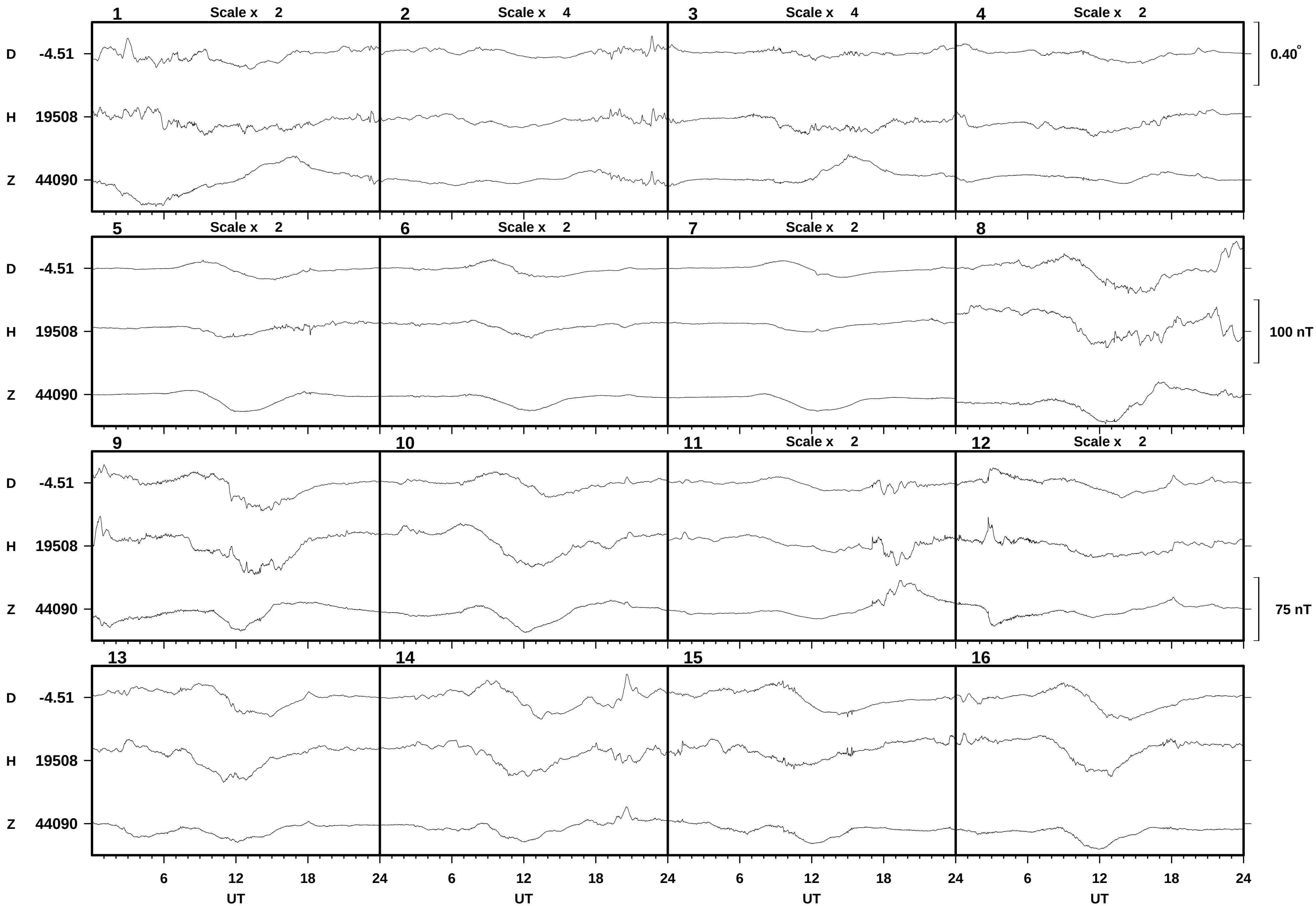
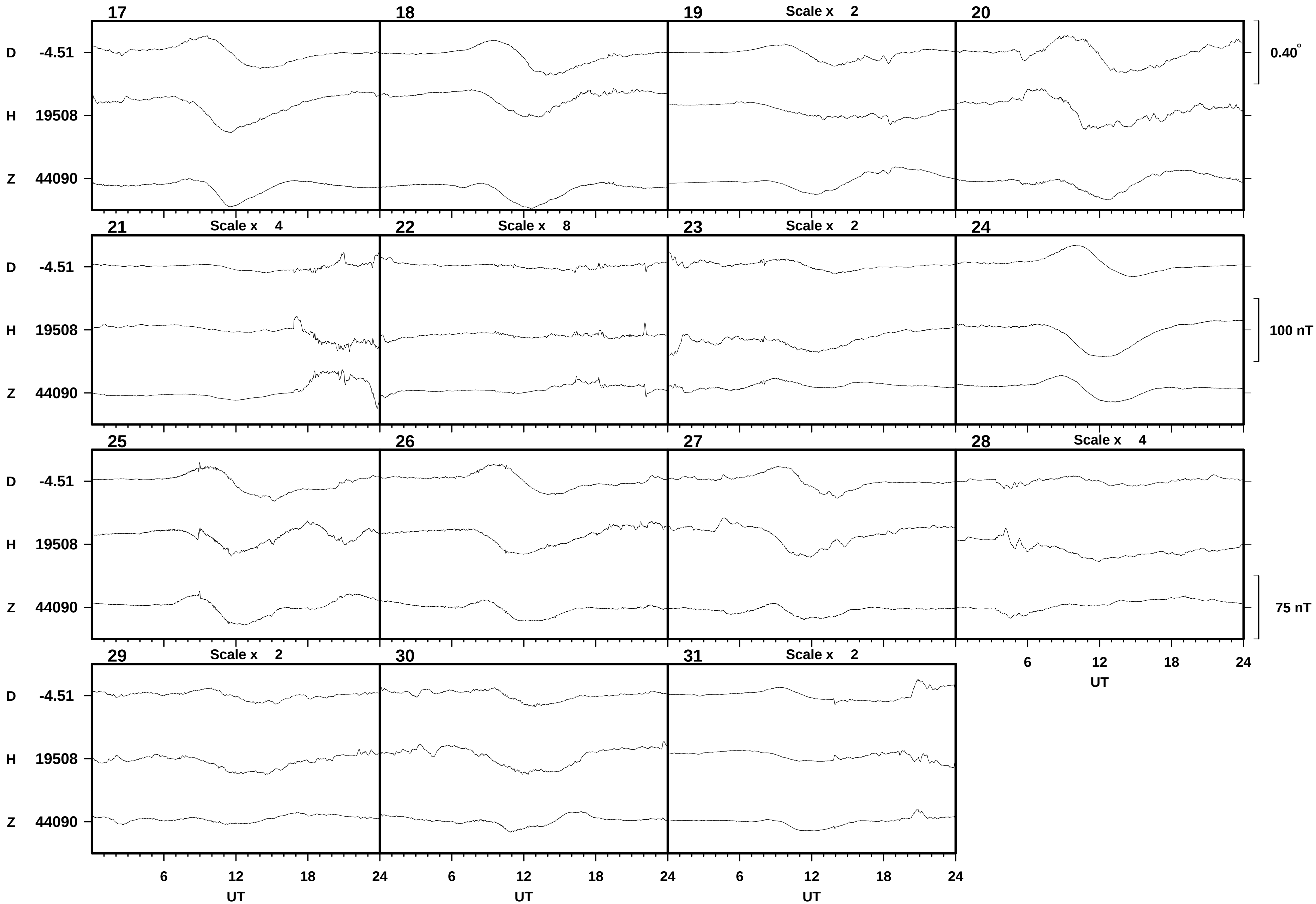
23
24
25
26
27
28
29
30
D -4.54
H 19528
Z 44073
0.40°
100 nT
75 nT
Scale x 2
Scale x 4
6
12
18
24
UT

HA 9 1

Hartland October 2001



HA 10 1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18
19
Scale x 2
20
21
Scale x 4
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Scale x 8
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Scale x 2
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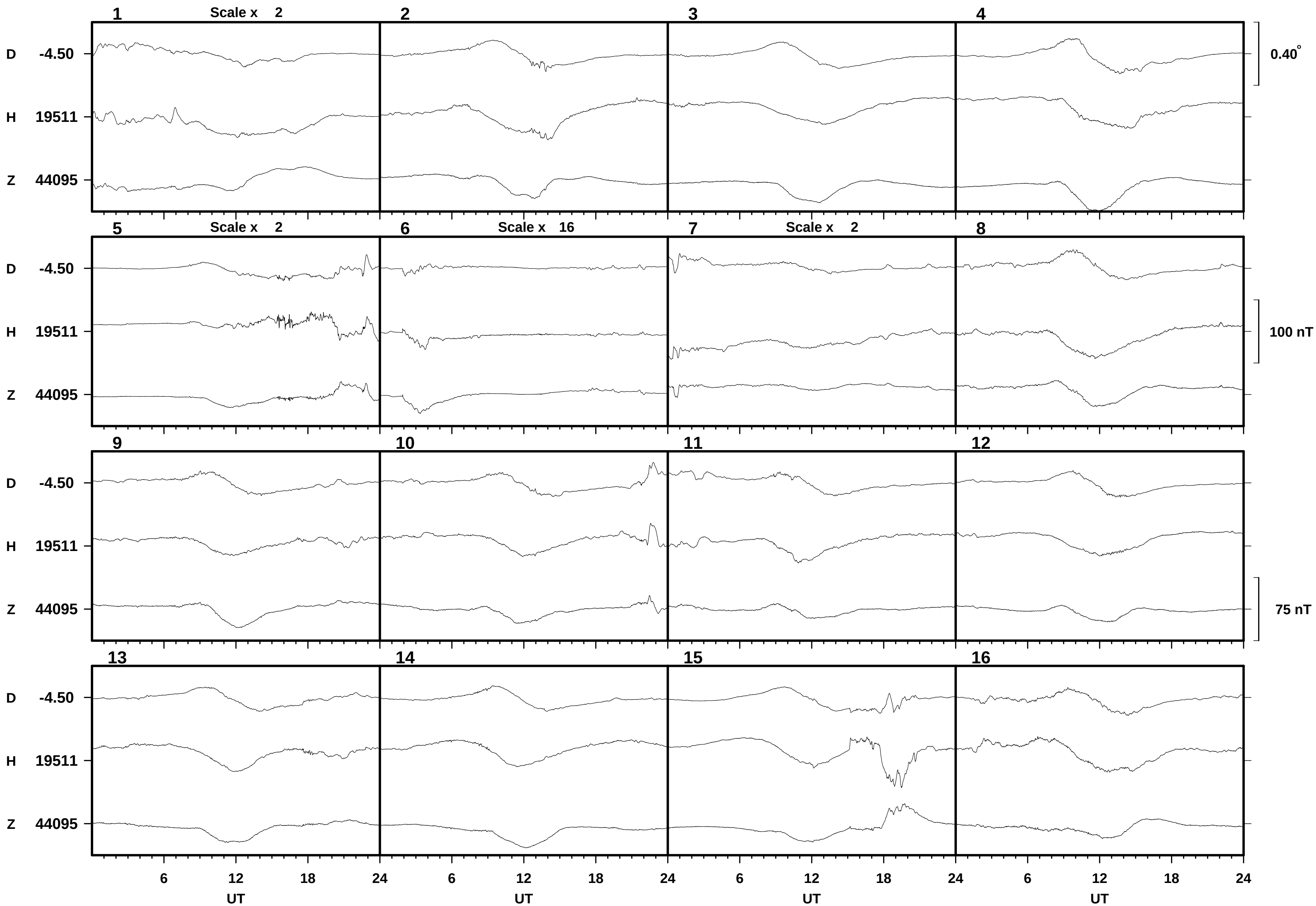
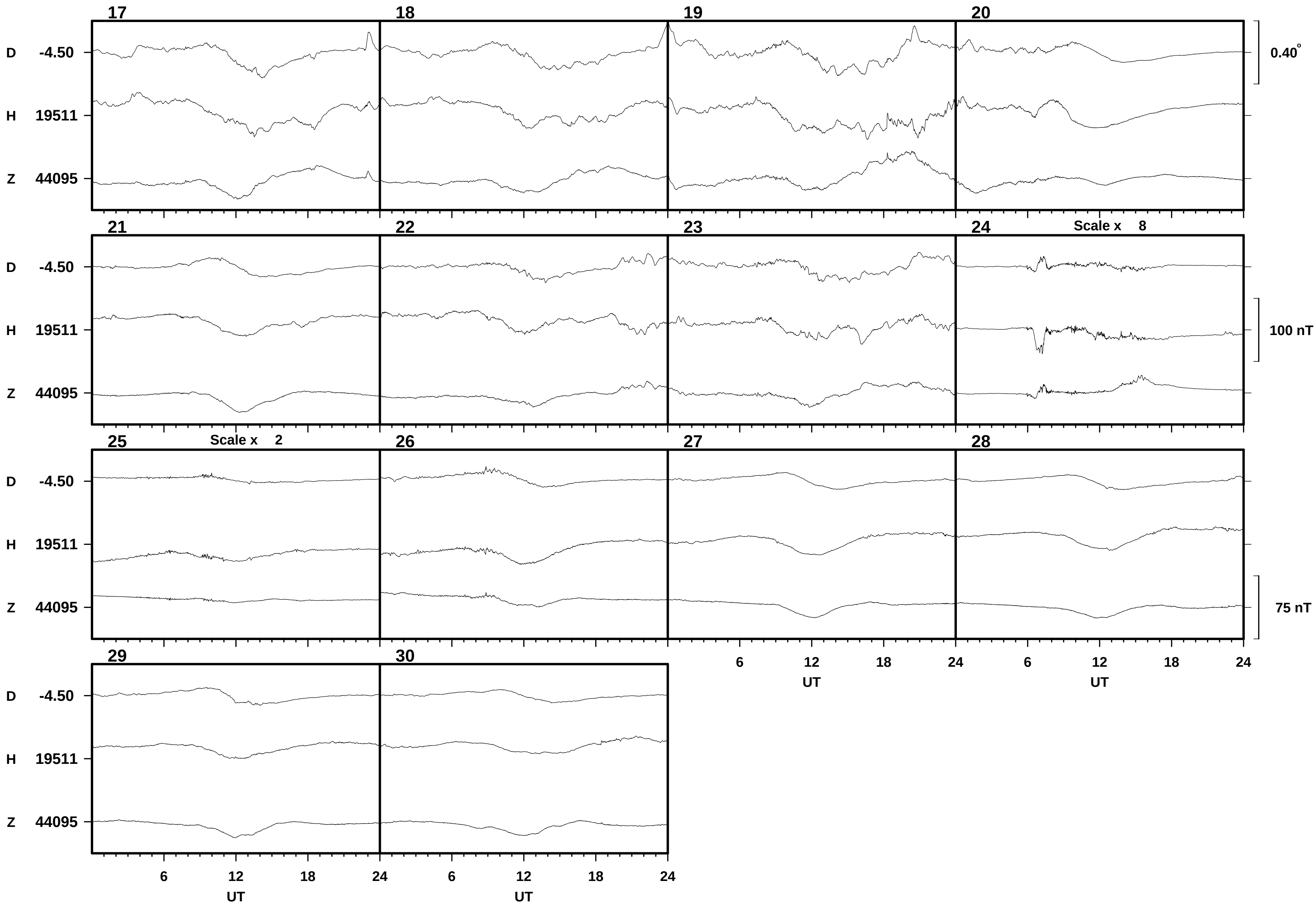
25
26
27
28
Scale x 4
29
Scale x 2
30
31
Scale x 2
D -4.51
H 19508
Z 44090
0.40°
100 nT
75 nT
6
12
18
24
UT

HA 10 1

Hartland November 2001



HA 11 1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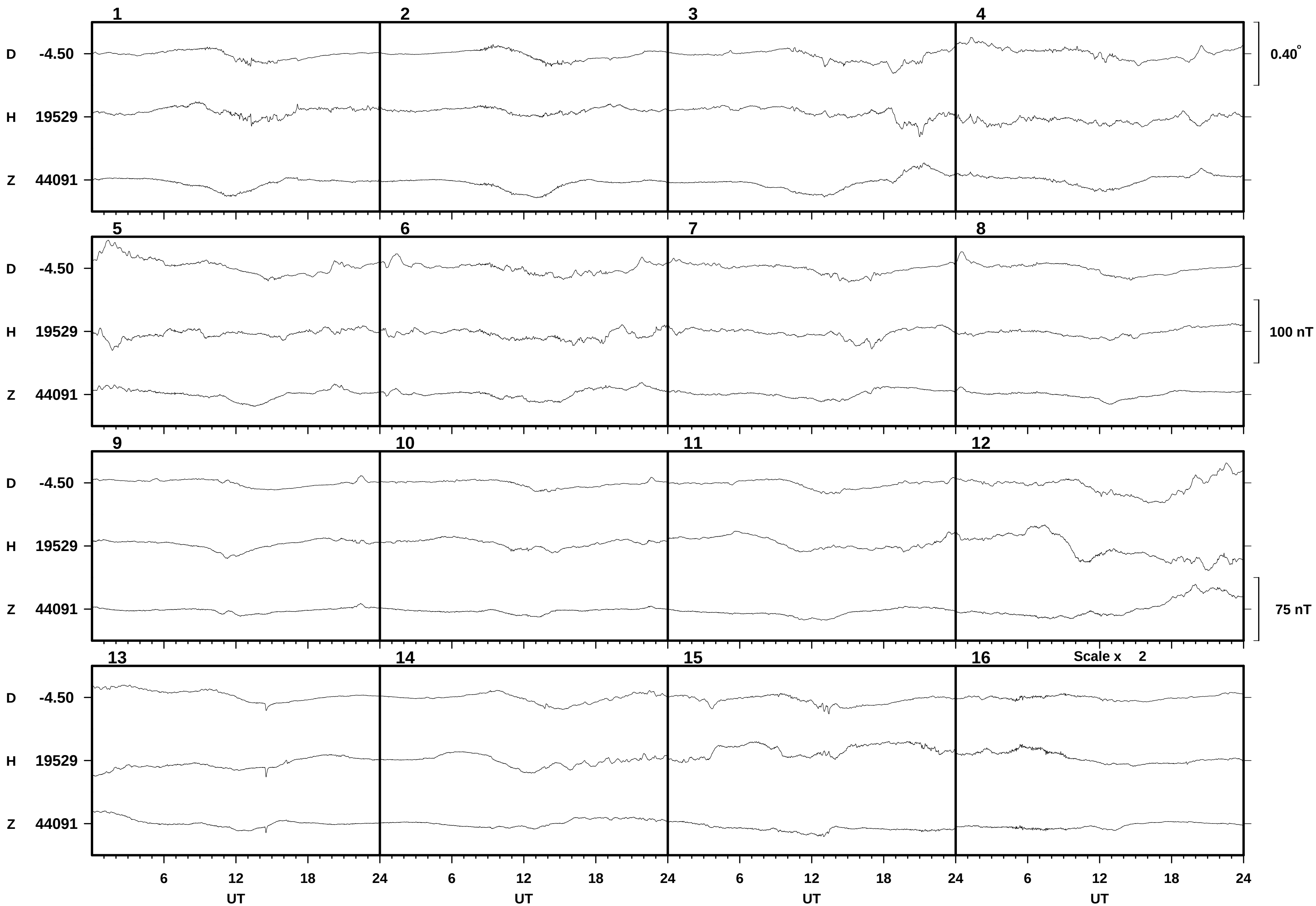
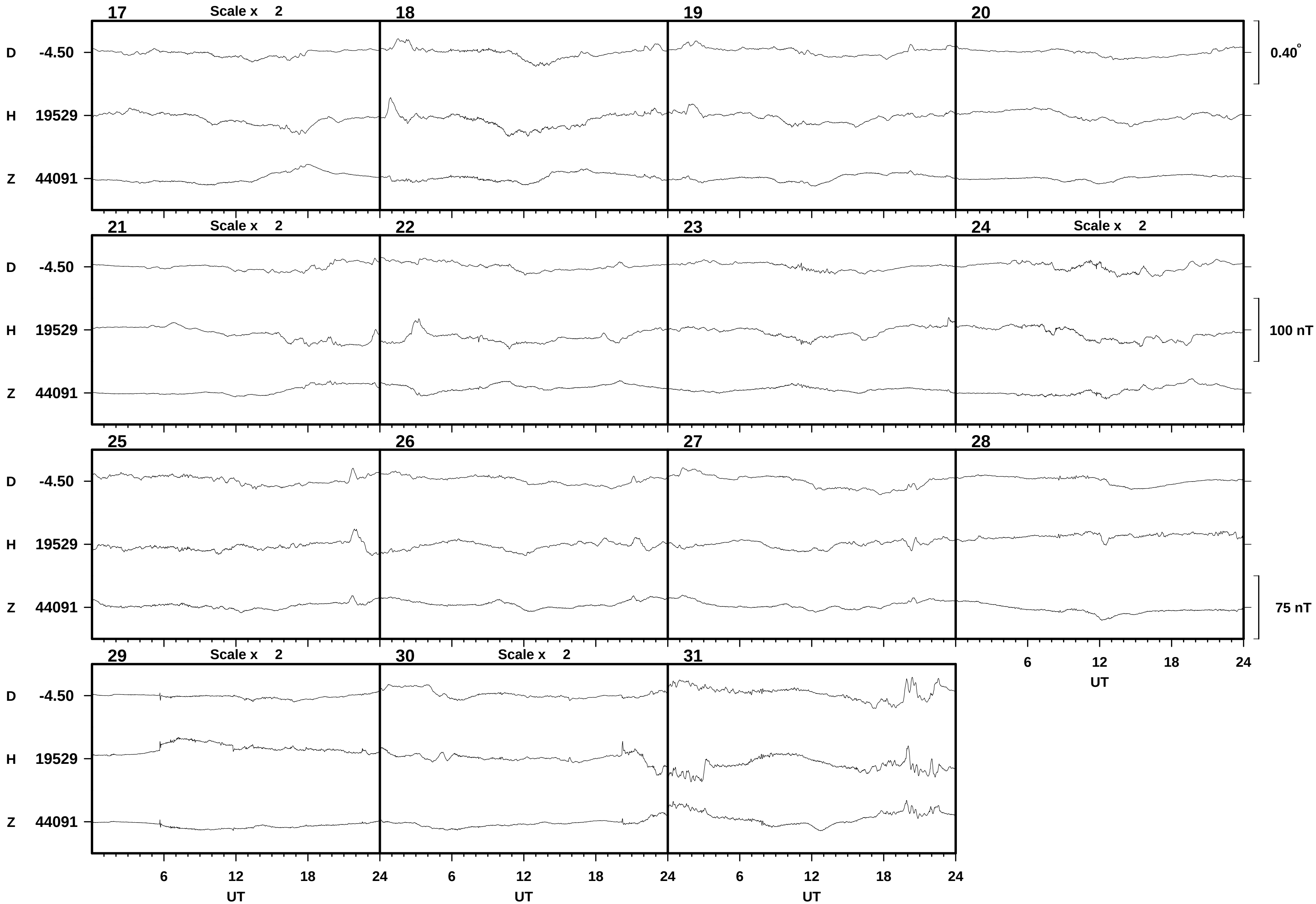
18
19
20
21
22
23
24
Scale x 8
25
Scale x 2
26
27
28
29
30
D -4.50
H 19511
Z 44095
0.40°
100 nT
75 nT
6
12
18
24
UT
HA 11 1

Hartland December 2001



HA 12 1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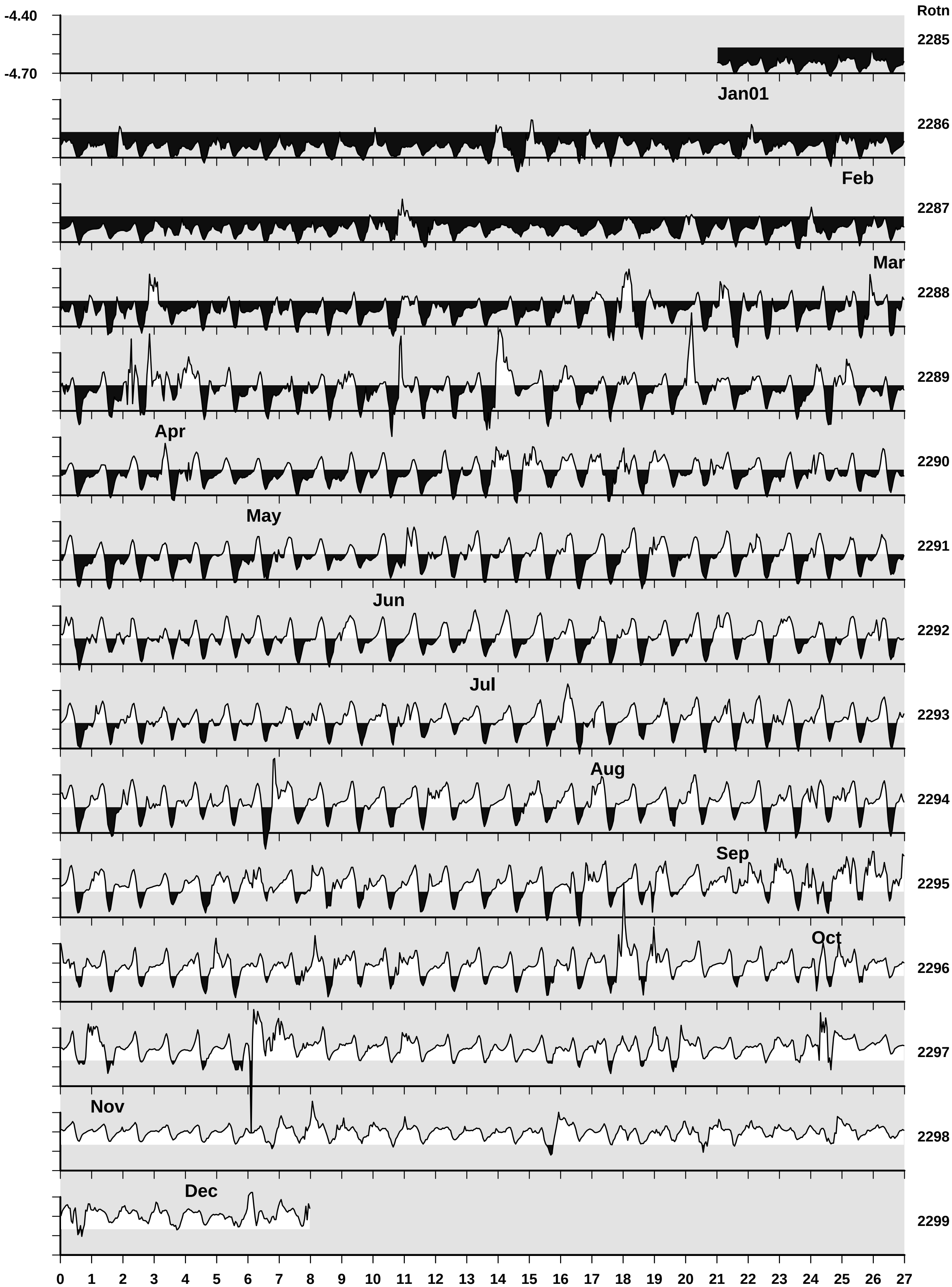
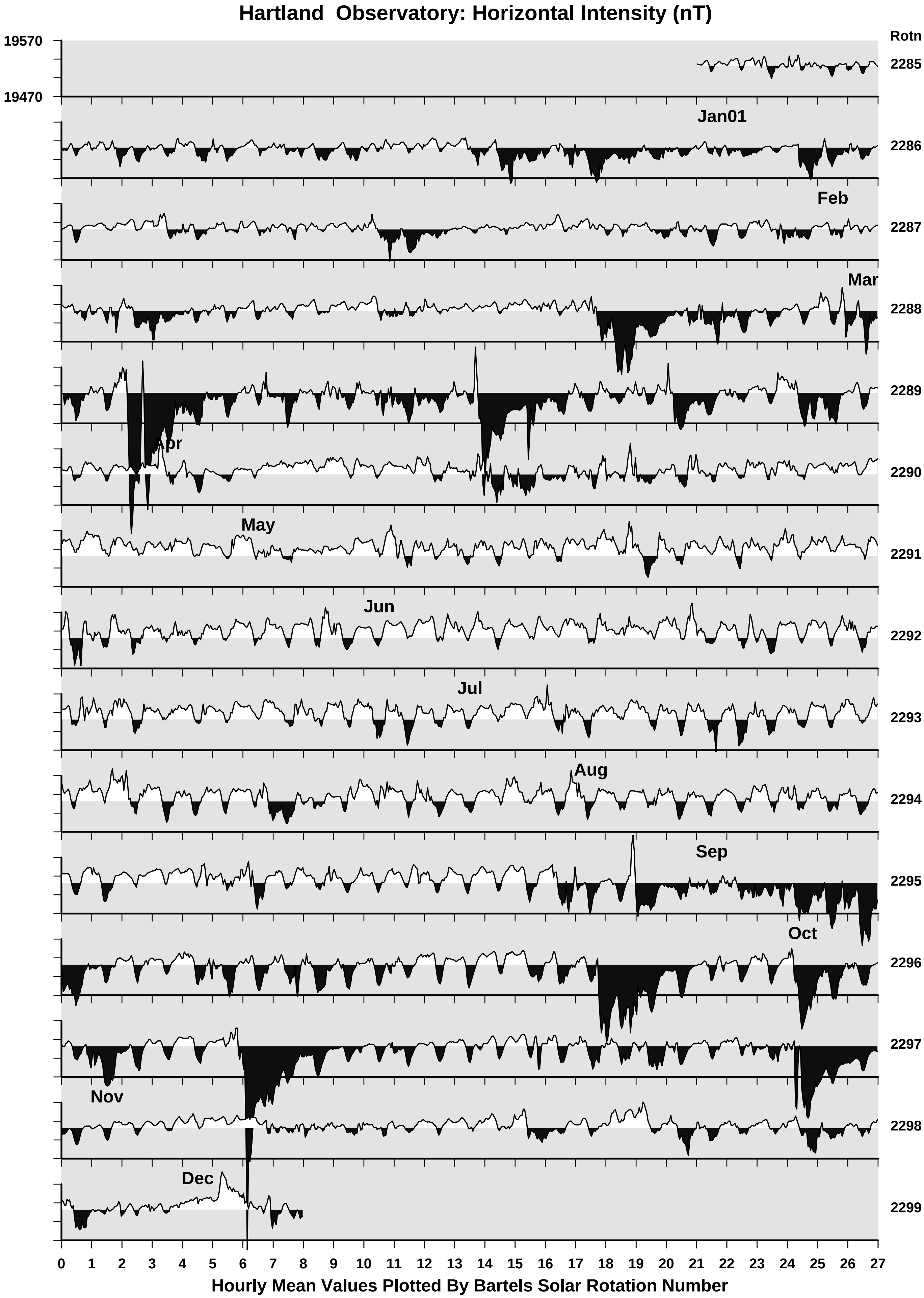
Scale x 2
18
19
20
21
Scale x 2
22
23
24
Scale x 2
25
26
27
28
29
Scale x 2
30
Scale x 2
31
D -4.50
H 19529
Z 44091
0.40°
100 nT
75 nT
6
12
18
24
UT

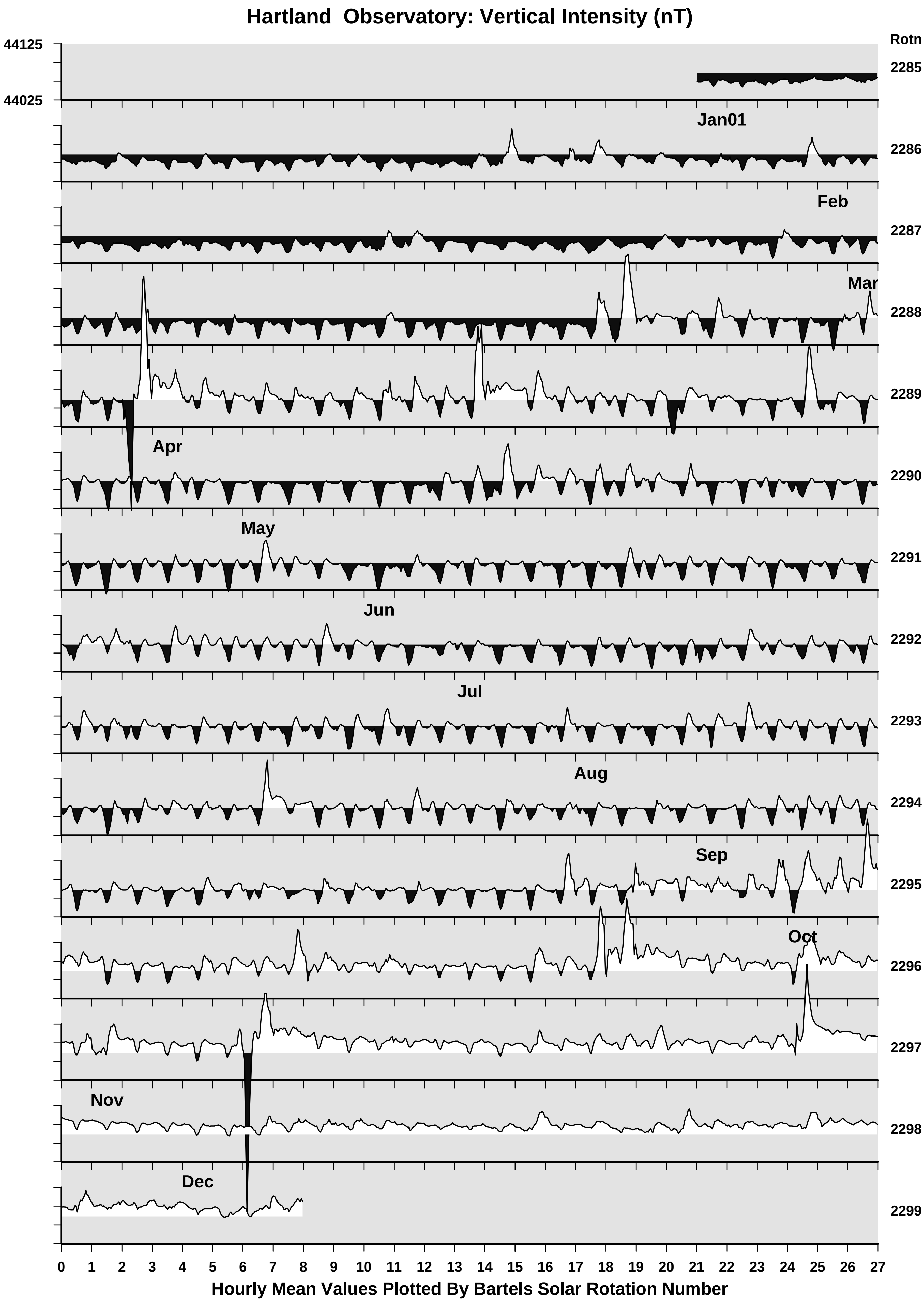
HA 12 1

Hartland Observatory: Declination (degrees)

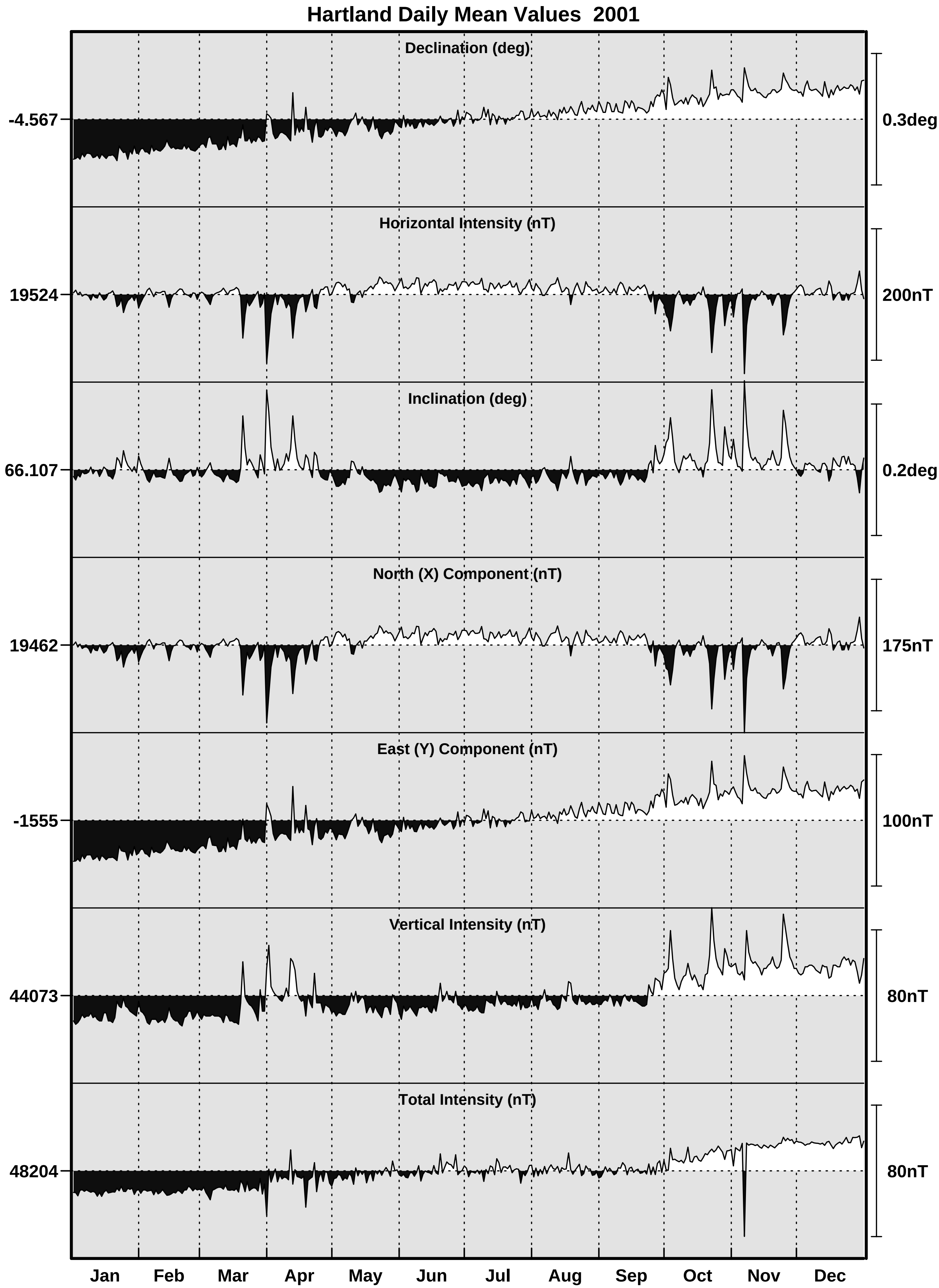




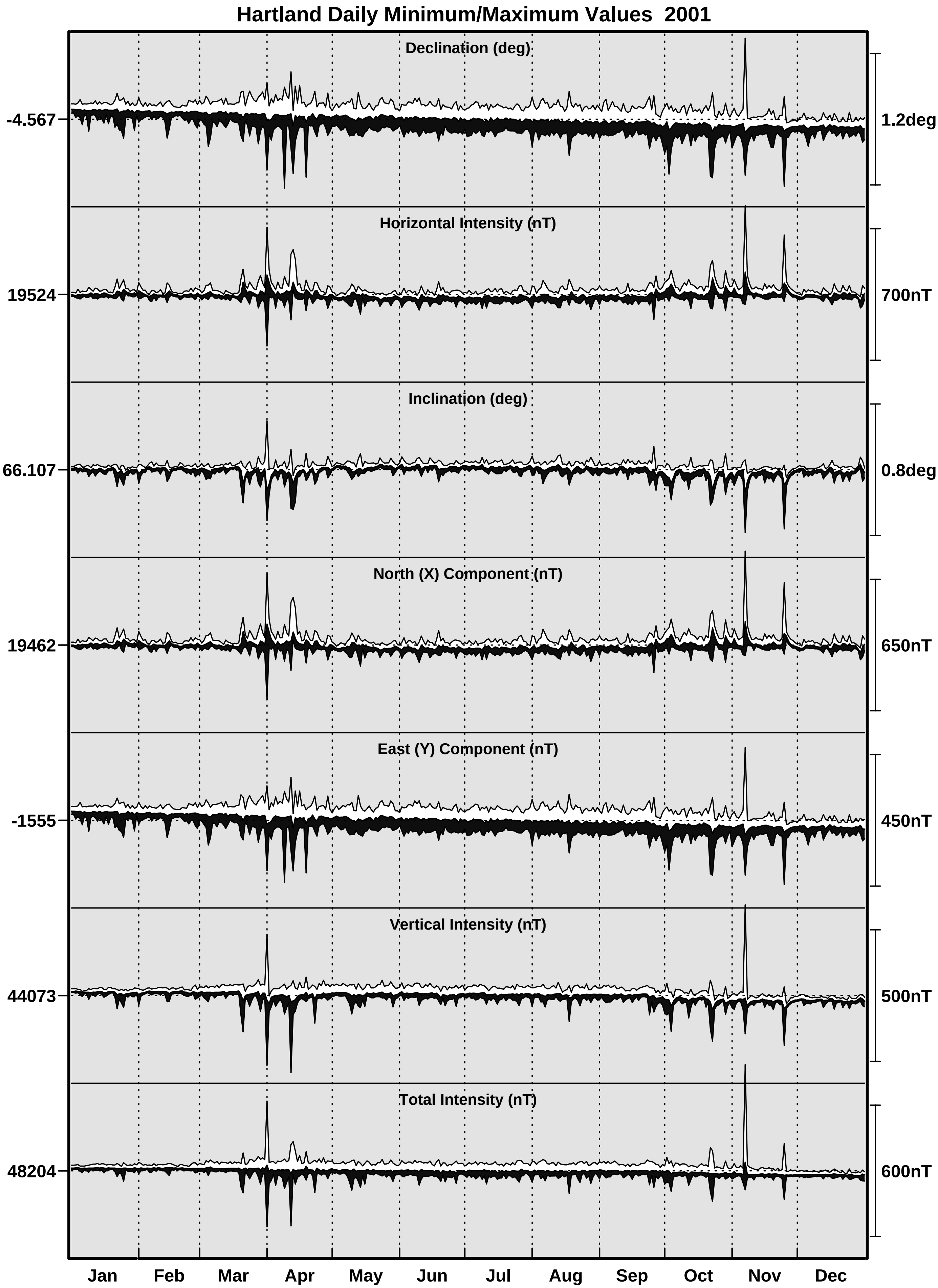
Hartland Observatory: Horizontal Intensity (nT)
19570
19470
Rotn
2285
2286
2287
2288
2289
2290
2291
2292
2293
2294
2295
2296
2297
2298
2299
Jan01
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted By Bartels Solar Rotation Number



Hartland Observatory: Vertical Intensity (nT)
44125
44025
Rotn
2285
2286
2287
2288
2289
2290
2291
2292
2293
2294
2295
2296
2297
2298
2299
Jan01
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted By Bartels Solar Rotation Number



Hartland Daily Mean Values 2001
Declination (deg)
-4.567
0.3deg
Horizontal Intensity (nT)
19524
200nT
Inclination (deg)
66.107
0.2deg
North (X) Component (nT)
19462
175nT
East (Y) Component (nT)
-1555
100nT
Vertical Intensity (nT)
44073
80nT
Total Intensity (nT)
48204
80nT
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Hartland Daily Minimum/Maximum Values 2001
Declination (deg)
-4.567
1.2deg
Horizontal Intensity (nT)
19524
700nT
Inclination (deg)
66.107
0.8deg
North (X) Component (nT)
19462
650nT
East (Y) Component (nT)
-1555
450nT
Vertical Intensity (nT)
44073
500nT
Total Intensity (nT)
48204
600nT
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Monthly Mean Values for Hartland 2001

Based on all days

Month	D	H	I	X	Y	Z	F
January	-4° 38.9′	19520 nT	66° 6.4′	19455 nT	-1582 nT	44062 nT	48192 nT
February	-4° 38.0′	19524 nT	66° 6.0′	19461 nT	-1577 nT	44060 nT	48192 nT
March	-4° 37.0′	19517 nT	66° 6.6′	19453 nT	-1571 nT	44064 nT	48193 nT
April	-4° 35.4′	19513 nT	66° 7.2′	19450 nT	-1561 nT	44074 nT	48201 nT
May	-4° 35.2′	19535 nT	66° 5.5′	19472 nT	-1562 nT	44067 nT	48202 nT
June	-4° 34.5′	19538 nT	66° 5.3′	19476 nT	-1558 nT	44068 nT	48205 nT
July	-4° 33.7′	19538 nT	66° 5.4′	19476 nT	-1554 nT	44068 nT	48205 nT
August	-4° 33.0′	19533 nT	66° 5.8′	19471 nT	-1549 nT	44070 nT	48205 nT
September	-4° 32.2′	19528 nT	66° 6.2′	19467 nT	-1544 nT	44073 nT	48205 nT
October	-4° 30.9′	19508 nT	66° 7.9′	19448 nT	-1536 nT	44090 nT	48213 nT
November	-4° 30.0′	19511 nT	66° 7.9′	19451 nT	-1531 nT	44095 nT	48218 nT
December	-4° 29.9′	19529 nT	66° 6.6′	19468 nT	-1532 nT	44091 nT	48222 nT
Annual	**-4° 34.0′**	**19524 nT**	**66° 6.4′**	**19462 nT**	**-1555 nT**	**44073 nT**	**48204 nT**

International quiet day means

Month	D	H	I	X	Y	Z	F
January	-4° 39.1′	19527 nT	66° 5.8′	19463 nT	-1584 nT	44058 nT	48192 nT
February	-4° 38.3′	19528 nT	66° 5.8′	19464 nT	-1579 nT	44059 nT	48192 nT
March	-4° 37.4′	19531 nT	66° 5.5′	19468 nT	-1574 nT	44058 nT	48193 nT
April	-4° 35.7′	19525 nT	66° 6.2′	19463 nT	-1564 nT	44069 nT	48200 nT
May	-4° 35.2′	19538 nT	66° 5.3′	19475 nT	-1562 nT	44064 nT	48202 nT
June	-4° 34.2′	19539 nT	66° 5.4′	19476 nT	-1557 nT	44069 nT	48206 nT
July	-4° 33.9′	19539 nT	66° 5.2′	19477 nT	-1555 nT	44066 nT	48204 nT
August	-4° 32.9′	19533 nT	66° 5.7′	19471 nT	-1549 nT	44069 nT	48204 nT
September	-4° 32.9′	19534 nT	66° 5.6′	19473 nT	-1549 nT	44068 nT	48204 nT
October	-4° 31.0′	19523 nT	66° 6.8′	19463 nT	-1537 nT	44084 nT	48214 nT
November	-4° 30.3′	19526 nT	66° 6.8′	19465 nT	-1534 nT	44091 nT	48221 nT
December	-4° 29.9′	19530 nT	66° 6.5′	19470 nT	-1532 nT	44089 nT	48221 nT
Annual	**-4° 34.2′**	**19531 nT**	**66° 5.9′**	**19469 nT**	**-1556 nT**	**44070 nT**	**48204 nT**

International disturbed day means

Month	D	H	I	X	Y	Z	F
January	-4° 38.6′	19508 nT	66° 7.3′	19444 nT	-1579 nT	44068 nT	48193 nT
February	-4° 37.6′	19518 nT	66° 6.5′	19455 nT	-1574 nT	44062 nT	48192 nT
March	-4° 35.6′	19482 nT	66° 9.4′	19419 nT	-1560 nT	44080 nT	48193 nT
April	-4° 34.4′	19494 nT	66° 8.7′	19432 nT	-1554 nT	44083 nT	48200 nT
May	-4° 34.6′	19524 nT	66° 6.4′	19462 nT	-1558 nT	44072 nT	48203 nT
June	-4° 34.3′	19533 nT	66° 5.7′	19471 nT	-1557 nT	44068 nT	48204 nT
July	-4° 33.5′	19538 nT	66° 5.4′	19476 nT	-1553 nT	44069 nT	48206 nT
August	-4° 33.0′	19530 nT	66° 6.1′	19468 nT	-1550 nT	44074 nT	48207 nT
September	-4° 31.2′	19514 nT	66° 7.3′	19453 nT	-1538 nT	44080 nT	48206 nT
October	-4° 29.7′	19477 nT	66° 10.4′	19417 nT	-1526 nT	44103 nT	48212 nT
November	-4° 28.6′	19468 nT	66° 10.9′	19409 nT	-1520 nT	44102 nT	48207 nT
December	-4° 29.6′	19519 nT	66° 7.3′	19459 nT	-1529 nT	44093 nT	48220 nT
Annual	**-4° 33.4′**	**19509 nT**	**66° 7.6′**	**19447 nT**	**-1550 nT**	**44080 nT**	**48204 nT**

Hartland Observatory K Indices 2001

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0001 0011	2332 2132	3110 1212	4443 3345	1001 1121	0002 3434	3221 1233	4122 3222	2111 1210	5645 3433	4342 3332	1123 2311
2	1100 1023	3210 1111	1111 2333	4334 3432	1121 1210	5434 4333	2211 1121	1112 2311	0001 2222	4453 2456	1011 3101	1012 2211
3	3322 2111	0010 1100	2214 4342	2111 1222	1111 1222	2221 1232	1221 3231	3142 3422	2132 3434	5345 5445	1000 1000	0211 3243
4	3132 3323	0000 0010	3333 2354	2321 4452	1221 1122	3212 2322	1212 1322	1212 2222	4433 2432	4233 2432	0023 2210	3223 3232
5	2001 1124	0001 1113	4432 2212	1234 3433	0000 0111	2211 1211	2332 3433	2233 4532	3210 3330	1112 1341	0023 3455	4212 2232
6	1110 1101	3232 1333	2221 2231	1123 3333	0011 2122	1111 3332	1121 3332	2423 4434	2111 1113	1133 2121	8754 4566	3212 2333
7	2211 1113	3220 1121	2311 2421	3432 2443	3421 3330	2412 2232	1111 1221	3212 2121	0111 1113	0010 2102	5323 2223	2211 2312
8	2212 2254	0212 0123	1122 1133	2124 6577	1122 3444	1122 1333	2321 1444	3211 2131	3211 2110	2232 3435	2222 1111	3111 2110
9	2111 1021	1022 2222	3122 2210	2333 3433	3433 4553	1223 3445	4210 2222	1311 2323	1112 2100	4224 3421	1121 1122	0101 1012
10	0001 1222	1212 2320	0223 1220	3221 2423	4432 3433	5333 2332	0111 2442	2221 1122	1101 1111	2221 2231	1112 2124	0011 2012
11	2001 2333	3221 2012	1211 1111	3122 4667	3111 0123	3211 2331	3301 2220	2100 1113	1100 3342	3211 2453	2212 2100	1100 2122
12	3221 1101	1010 2223	0013 3334	6544 3321	3233 4444	2110 1111	2221 2223	1114 2433	2232 3224	5433 3443	1011 2100	3223 3244
13	1122 2102	3442 3455	3223 2112	1236 5554	5322 3464	3322 2231	2211 0133	4533 3332	3444 3320	2233 2331	1111 1122	1101 2100
14	3221 1133	3333 3343	3222 1112	4332 3432	4220 1221	3011 2224	4412 3211	2322 4322	3111 2223	1233 3353	1011 1010	0101 2222
15	1001 2223	1122 1201	0000 1101	3321 5322	2122 2444	3312 1120	0121 3442	2111 1232	5333 3443	3322 2212	0001 2441	2312 3112
16	0011 3222	0001 1122	0000 1112	3211 2223	3221 1212	2121 1130	3203 2433	1101 1111	2111 3333	3122 3122	3222 2211	3332 2222
17	3111 2222	1000 0220	0011 1232	2211 1212	1211 2223	0120 4321	4332 3422	1003 4465	0121 1212	2111 1101	3323 3243	3323 3441
18	0012 2013	1010 1111	3221 1223	5652 2223	3211 2223	2344 5544	2221 2321	3231 4333	2111 2342	1000 2220	2222 3224	4112 2212
19	1100 1122	1011 2121	2214 4565	2211 1012	4411 1121	3311 1333	1112 2431	0233 2220	3222 2131	0102 3341	4333 4354	3212 1231
20	0022 2234	1112 2222	4453 5545	3211 2102	1111 2221	3333 3312	1111 2210	0112 3222	1102 2112	1333 2223	3232 1000	1011 2112
21	2223 3454	2211 2212	4221 0111	1110 2423	1111 1121	1332 2443	1211 1112	1223 3433	1000 1112	3211 2566	1011 1210	0122 2444
22	4322 3223	1111 1112	1011 4433	3334 3554	2112 3232	3210 1221	2221 2433	1224 3344	2123 3210	6335 4656	1212 3233	3322 2121
23	2104 3355	3322 2222	4434 3553	3333 2321	2221 3332	1210 2221	3311 3332	4321 2111	0244 4555	5332 2111	2223 3343	1212 2212
24	3212 3353	1111 2200	1331 2340	1332 1111	2211 1111	1222 2322	3332 4432	0101 1100	4123 3221	0001 0000	3486 6524	2244 4443
25	1111 1132	0011 0021	1123 2221	1012 2222	1111 2321	1210 1221	2344 3432	0112 3333	0221 1166	0133 1333	1223 2211	2212 2114
26	2233 1223	3011 1344	0010 1011	1121 2222	1210 0111	1123 4443	4421 2122	3232 1233	5244 2222	0111 1122	2122 1001	2111 2123
27	2110 2111	3332 2210	4332 2345	1111 1220	0110 2432	4210 1100	0221 2221	1212 2243	1122 2342	1311 2110	1000 0101	3111 2232
28	1111 3232	0013 3332	3145 5523	2543 4543	2223 3434	0000 1011	1000 1111	4332 2221	2233 2333	3644 4344	0000 1011	1011 3112
29	4411 1123		3344 3423	4321 3420	3211 3421	0011 1112	2211 2321	1212 2211	3334 3444	3223 2323	1012 2000	2423 3323
30	2100 1100		2232 3333	1000 0010	0000 2221	1111 3232	1121 2233	0212 3431	4211 3555	2211 1102	1000 0011	3432 2345
31	0143 3443		7775 6676		0000 1111		4443 5533	2223 1422		1011 3354		3321 1344

DAILY Aa INDICES 2001

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	7	17	11	51	5	18	14	19	8	66	32	19
2	10	10	17	37	9	38	9	11	10	69	12	12
3	20	5	29	12	14	12	16	23	30	79	4	20
4	26	4	38	34	13	16	12	11	29	32	11	22
5	12	8	24	33	4	9	22	30	16	17	36	17
6	10	31	12	28	9	14	15	42	11	16	152	23
7	11	13	16	34	25	18	9	13	7	7	27	15
8	24	13	14	98	30	15	24	13	10	35	12	11
9	11	12	14	33	55	36	15	17	8	32	10	7
10	11	12	13	22	36	33	20	11	6	17	15	11
11	16	13	7	100	11	21	11	8	20	39	10	12
12	13	12	23	46	47	10	14	25	25	60	7	30
13	14	49	17	72	46	20	10	35	32	20	8	8
14	17	30	15	34	19	16	22	22	17	27	8	13
15	15	12	4	26	29	13	21	10	37	18	21	20
16	14	8	6	16	15	13	21	5	17	20	18	28
17	15	6	11	11	14	13	27	52	14	7	29	27
18	13	6	15	56	15	62	15	26	21	7	21	18
19	9	12	57	10	19	20	16	18	18	22	38	17
20	23	16	89	14	9	24	9	12	10	21	12	10
21	39	14	13	17	7	24	9	24	8	72	8	27
22	26	10	23	52	13	9	18	33	20	99	14	15
23	37	21	49	27	15	8	23	16	62	24	26	16
24	35	9	27	13	9	13	29	5	18	3	145	46
25	11	6	13	12	11	10	44	18	50	19	17	16
26	22	20	6	13	6	28	27	25	38	9	9	12
27	9	21	41	8	14	11	17	20	20	10	7	12
28	20	22	56	55	26	3	8	20	27	60	6	14
29	22		33	22	16	5	18	12	49	29	7	41
30	7		24	3	6	13	15	20	43	11	4	43
31	38		216		4		51	22		25		26
Monthly Mean Values	**18.0**	**14.7**	**30.2**	**33.0**	**17.8**	**18.2**	**18.7**	**19.9**	**22.6**	**31.4**	**24.2**	**19.5**

Yearly Mean Value for 2001 = 22.4

SIs and SSCs

Day	Month	UT		Type	Quality	H(nT)	D(min)	Z(nT)
10	01	16	20	SSC*	C	8.1	1.97	-4.2
13	01	09	45	SSC*	B	-4.3	1.11	1.7
17	01	16	30	SSC*	A	18.5	-1.04	4.3
23	01	10	47	SSC*	A	-12.4	5.34	4.4
31	01	08	04	SSC*	A	9.2	1.83	5.1
12	02	16	13	SSC*	C	9.3	-1.11	1.0
03	03	11	20	SSC*	B	16.5	-2.59	-4.4
19	03	11	13	SSC*	B	10.5	1.32	1.9
22	03	13	41	SSC*	A	24.7	-4.91	-5.8
27	03	17	46	SSC	B	28.1	-2.05	4.1
31	03	00	52	SSC	A	185.1	-4.77	32.3
04	04	14	54	SSC*	A	54.0	-5.10	+8.2/-9.1
08	04	11	01	SSC*	B	-27.9	3.04/-2.48	-9.9
11	04	13	44	SSC*	B	20.5	-2.46	-
13	04	07	34	SSC*	B	-14.1	-2.28/2.72	-1.6
13	04	09	56	SI*	B	-74.4/72.3	10.76	16.6
18	04	00	46	SSC*	B	71.8	-4.73	9.5
21	04	16	00	SSC*	B	35.1	-2.90	4.4
28	04	05	00	SSC*	A	35.2	-14.70	-37.2
27	05	14	57	SSC*	A	55.9	-1.93	15.2
07	06	09	47	SSC*	C	-3.4	0.52	-
11	06	14	00	SI*	C	-11.4	0.68	-2.4/+2.4
18	06	02	59	SSC*	B	21.5	-2.06	+2.9/-2.7
17	07	06	03	SSC*	C	0.5	1.42	2.9
20	07	07	04	SI*	C	-1.0	0.88	1.6
31	07	03	53	SSC	C	-17.8	2.49	1.4
03	08	07	15	SSC*	A	-14.0	4.24	4.2
12	08	11	34	SSC*	A	42.2	-2.97	4.1
17	08	11	03	SSC*	A	18.5	0.99	2.9
21	08	14	47	SI*	C	-6.2	0.7	-1.1
23	08	05	55	SSC*	C	-4.1	0.71	1.6
27	08	19	51	SSC	B	55.2	0.66	16.9
30	08	14	10	SSC*	B	19.9	-2.39	2.8
14	09	02	04	SSC*	A	26.5	-2.16	3.1
22	09	14	34	SI	C	-14.5	2.29	0.8
23	09	07	50	SSC*	C	-8.5	1.11	2.3
25	09	20	25	SSC*	A	77.9	5.81	30.3
29	09	09	38	SSC*	A	-3.8	2.71	3.7

Notes

A * indicates that the principal impulse was preceded by a smaller reversed impulse.

The quality of the event is classified as follows :

- A = very distinct
- B = fair, ordinary, but unmistakable
- C = doubtful

The amplitudes given are for the first chief movement of the event.

SIs and SSCs

Day	Month	UT		Type	Quality	H(nT)	D(min)	Z(nT)
11	10	17	00	SSC*	A	37.3	-1.94	10.4
21	10	16	47	SSC*	A	66.5	-5.83	14.9
25	10	08	50	SI	B	9.8	-1.48	-1.6
28	10	03	18	SSC	A	6.3	-3.46	-5.6
31	10	13	48	SI	B	14.6	-3.74	-4.7
05	11	02	49	SI	C	2.2	-0.30	-1.2
06	11	01	52	SSC	A	98.6	-17.17	-40.3
15	11	15	08	SSC	A	18.2	-1.42	-3.1
19	11	18	14	SSC	C	18.8	1.30	8.3
24	11	05	55	SSC*	A	-38.8	-10.18	-29.4
30	11	18	24	SSC*	B	5.9	0.27	1.6
29	12	05	38	SSC	A	24.1	-5.61	-17.7
30	12	20	10	SSC	A	37.6	-1.72	9.5

Notes

A * indicates that the principal impulse was preceded by a smaller reversed impulse.
The quality of the event is classified as follows :

A = very distinct
B = fair, ordinary, but unmistakable
C = doubtful

The amplitudes given are for the first chief movement of the event.

SFEs

Day	Month	Universal Time						H(nT)	D(min)	Z(nT)
		Start		Maximum		End				
08	03	11	15	11	20	11	25	-9.4	0.39	-3.0
17	03	09	24	09	32	09	40	2.2	-0.53	-
15	04	13	45	13	51	14	07	-37.2	-8.91	-30.5
26	04	13	08	13	14	13	23	-5.6	-	-5.1
31	08	10	30	10	47	11	04	-19.6	-1.56	-2.6
13	12	14	25	14	30	14	41	-14.9	-2.55	-6.5

Notes

The amplitudes given are for the chief movement of the event.

Annual Values of Geomagnetic Elements

Abinger

Year	D	H	I	X	Y	Z	F
1925.5	-13 22.7	18597	66 35.2	18092	-4303	42946	46800
1926.5	-13 10.4	18581	66 36.3	18092	-4234	42947	46794
1927.5	-12 58.4	18575	66 36.2	18101	-4170	42932	46778
1928.5	-12 47.0	18564	66 37.2	18104	-4108	42941	46782
1929.5	-12 35.8	18555	66 37.2	18108	-4047	42918	46758
1930.5	-12 24.6	18542	66 38.2	18109	-3985	42924	46757
1931.5	-12 13.7	18543	66 38.1	18122	-3928	42923	46757
1932.5	-12 2.6	18536	66 39.1	18128	-3868	42940	46770
1933.5	-11 51.7	18532	66 39.4	18136	-3809	42942	46770
1934.5	-11 41.1	18533	66 39.7	18149	-3754	42955	46782
1935.5	-11 30.3	18527	66 40.9	18155	-3695	42981	46805
1936.5	-11 20.0	18524	66 41.8	18163	-3640	43007	46827
1937.5	-11 10.4	18522	66 42.7	18171	-3589	43031	46848
1938.5	-11 1.4	18522	66 43.2	18180	-3542	43050	46865
1939.5	-10 51.9	18528	66 43.5	18196	-3492	43074	46890
1940.5	-10 43.0	18533	66 43.9	18210	-3446	43099	46915
1941.5	-10 33.8	18539	66 44.3	18225	-3399	43128	46944
1942.5	-10 24.8	18554	66 43.9	18248	-3354	43146	46966
1943.5	-10 16.2	18556	66 44.5	18259	-3308	43172	46991
1944.5	-10 7.8	18566	66 44.3	18277	-3265	43189	47010
1945.5	-9 59.5	18573	66 44.3	18291	-3223	43207	47030
1946.5	-9 51.1	18569	66 45.4	18295	-3177	43235	47054
1947.5	-9 43.1	18577	66 45.2	18310	-3136	43246	47067
1948.5	-9 35.4	18593	66 44.4	18333	-3098	43255	47082
1949.5	-9 27.5	18607	66 44.0	18354	-3058	43273	47104
1950.5	-9 19.7	18628	66 43.0	18382	-3019	43288	47126
1951.5	-9 12.2	18648	66 42.1	18408	-2983	43305	47149
1952.5	-9 4.7	18670	66 41.0	18436	-2946	43316	47168
1953.5	-8 57.5	18695	66 39.5	18467	-2911	43321	47183
1954.5	-8 50.9	18720	66 38.1	18497	-2879	43332	47203
1955.5	-8 43.6	18738	66 37.4	18521	-2843	43348	47225
1956.5	-8 36.8	18750	66 37.4	18539	-2808	43376	47255
1957.1	-8 32.9	18755	66 37.6	18547	-2788	43394	47274

Hartland

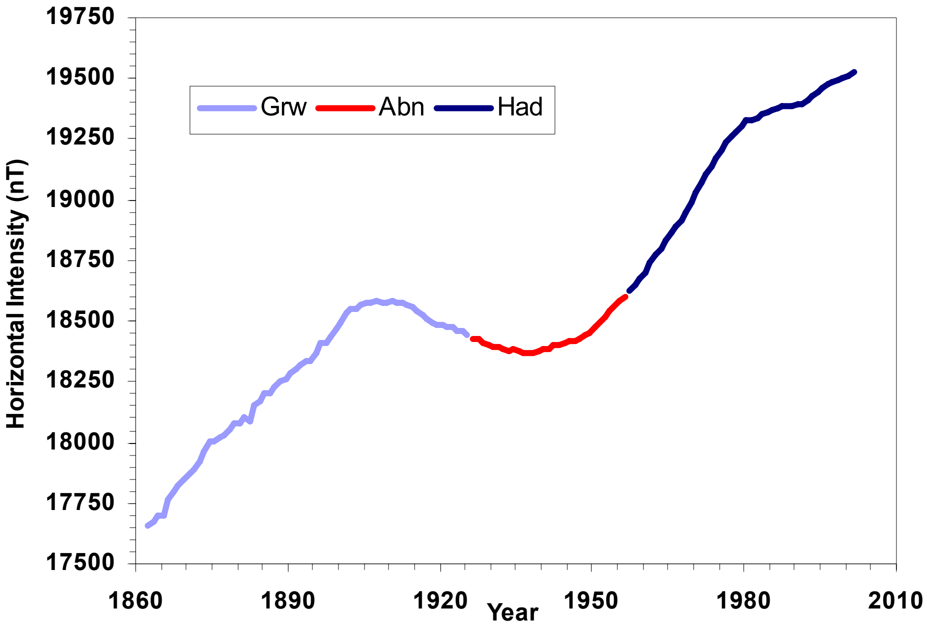
Note 1	-1 -46.6	-146	0 11.4	-247	-542	56	-6
1957.5	-10 17.2	18627	66 47.7	18328	-3326	43451	47275
1958.5	-10 11.0	18655	66 46.3	18361	-3298	43465	47299
1959.5	-10 5.0	18681	66 45.1	18392	-3271	43484	47327
1960.5	-9 58.8	18707	66 43.9	18424	-3242	43504	47356
1961.5	-9 53.0	18744	66 41.7	18466	-3217	43512	47378
1962.5	-9 46.9	18779	66 39.5	18506	-3190	43517	47396
1963.5	-9 40.6	18807	66 37.9	18539	-3161	43528	47417
1964.5	-9 35.2	18840	66 36.0	18577	-3138	43535	47437
1965.5	-9 30.1	18872	66 34.0	18613	-3115	43540	47454
1966.5	-9 25.1	18897	66 32.7	18642	-3092	43554	47477
1967.5	-9 20.3	18923	66 31.5	18672	-3071	43573	47505
1968.5	-9 15.5	18956	66 29.9	18709	-3050	43592	47535
1969.5	-9 11.1	18994	66 27.9	18750	-3032	43611	47568
1970.5	-9 6.5	19033	66 26.1	18793	-3013	43636	47606
1971.5	-9 1.1	19075	66 23.8	18839	-2990	43655	47640
1972.5	-8 55.3	19110	66 22.1	18879	-2964	43676	47674
1973.5	-8 48.2	19144	66 20.5	18918	-2930	43697	47707
1974.5	-8 40.4	19175	66 19.1	18956	-2892	43719	47739
1975.5	-8 32.3	19212	66 17.0	18999	-2852	43733	47767
1976.5	-8 23.1	19240	66 15.7	19034	-2806	43749	47793
1977.5	-8 13.7	19271	66 13.9	19073	-2758	43758	47813
1978.5	-8 03.6	19286	66 13.3	19095	-2704	43773	47833
1979.5	-7 53.5	19309	66 12.0	19127	-2651	43778	47847
Note 2	0 0.0	0	0 -0.2	0	0	-6	-5
1980.5	-7 43.8	19330	66 10.3	19154	-2600	43768	47846
1981.5	-7 33.9	19335	66 10.2	19167	-2546	43777	47857
1982.5	-7 24.7	19342	66 10.1	19180	-2495	43787	47869
1983.5	-7 15.1	19358	66 9.0	19203	-2443	43787	47876

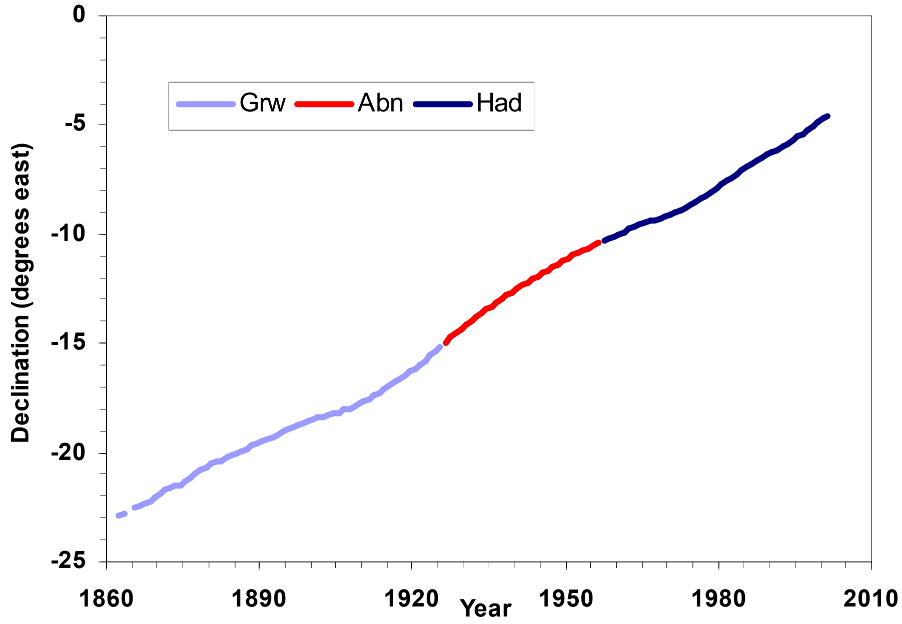
Year	D		H	I		X	Y	Z	F
1984.5	-7	5.5	19366	66	8.6	19218	-2391	43791	47882
1985.5	-6	56.1	19379	66	7.9	19237	-2340	43796	47892
1986.5	-6	47.3	19383	66	8.0	19247	-2291	43807	47904
1987.5	-6	39.2	19395	66	7.4	19264	-2247	43817	47918
1988.5	-6	30.7	19393	66	8.2	19267	-2199	43838	47936
1989.5	-6	22.9	19389	66	9.1	19269	-2155	43862	47956
Note 3	0	0.0	-6	0	1.1	-6	1	23	19
1990.5	-6	15.0	19395	66	9.7	19280	-2111	43896	47990
1991.5	-6	7.1	19398	66	10.0	19288	-2067	43912	48006
1992.5	-5	59.7	19413	66	9.3	19307	-2028	43920	48019
1993.5	-5	51.2	19429	66	8.4	19328	-1981	43928	48033
1994.5	-5	42.2	19440	66	8.1	19344	-1932	43942	48050
1995.5	-5	33.2	19457	66	7.3	19366	-1883	43951	48065
1996.5	-5	23.4	19475	66	6.4	19389	-1829	43960	48081
1997.5	-5	13.4	19485	66	6.2	19404	-1774	43979	48102
1998.5	-5	3.0	19490	66	6.7	19414	-1715	44004	48127
1999.5	-4	53.3	19500	66	6.6	19429	-1661	44024	48149
2000.5	-4	43.6	19508	66	6.9	19441	-1607	44051	48178
2001.5	-4	34.0	19524	66	6.4	19462	-1555	44073	48204

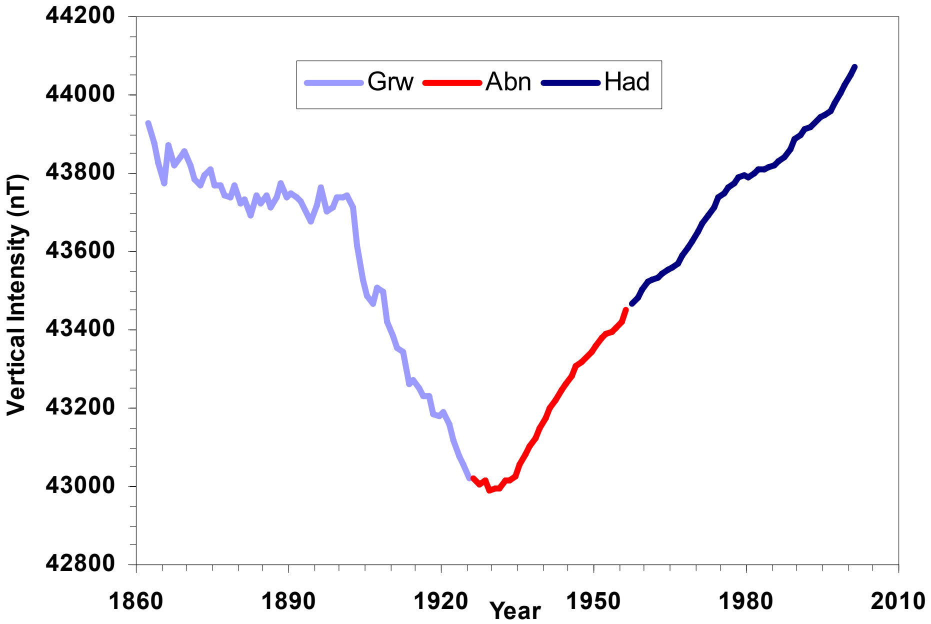
1 Site differences 1 Jan 1957 (Hartland value - Abinger value)
2 Site differences 1 Jan 1980 (new value - old value)
3 Site differences 1 Jan 1990 (new value - old value)

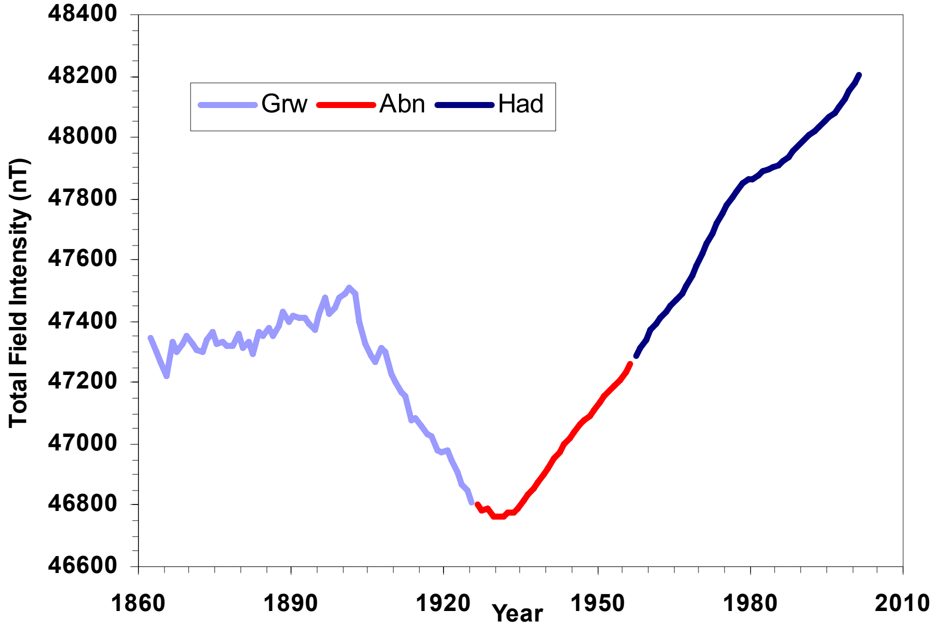
D and I are given in degrees and decimal minutes
All other elements are in nanoteslas

Annual Mean Values at Hartland

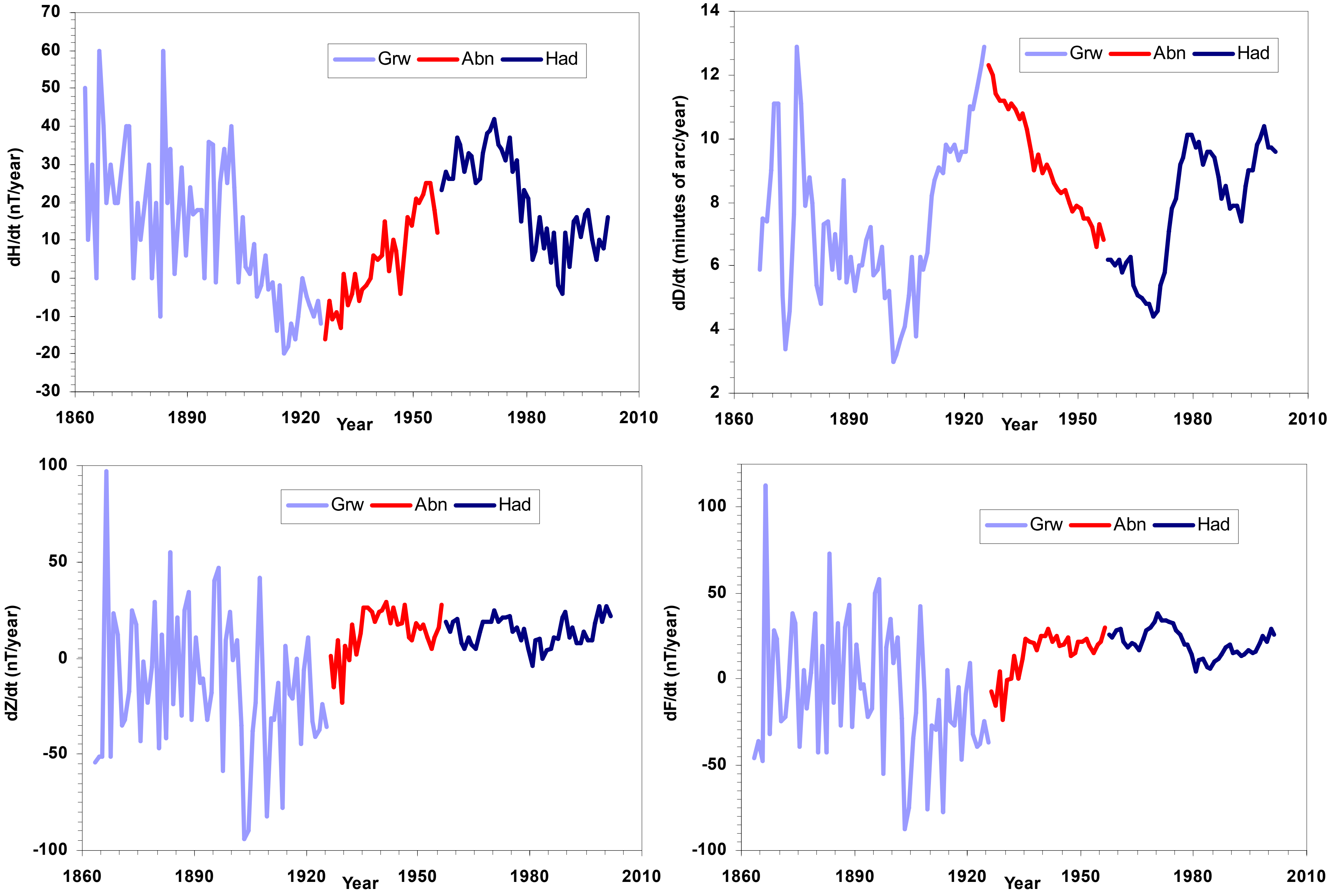








Rate of Change of Annual Mean Values at Hartland



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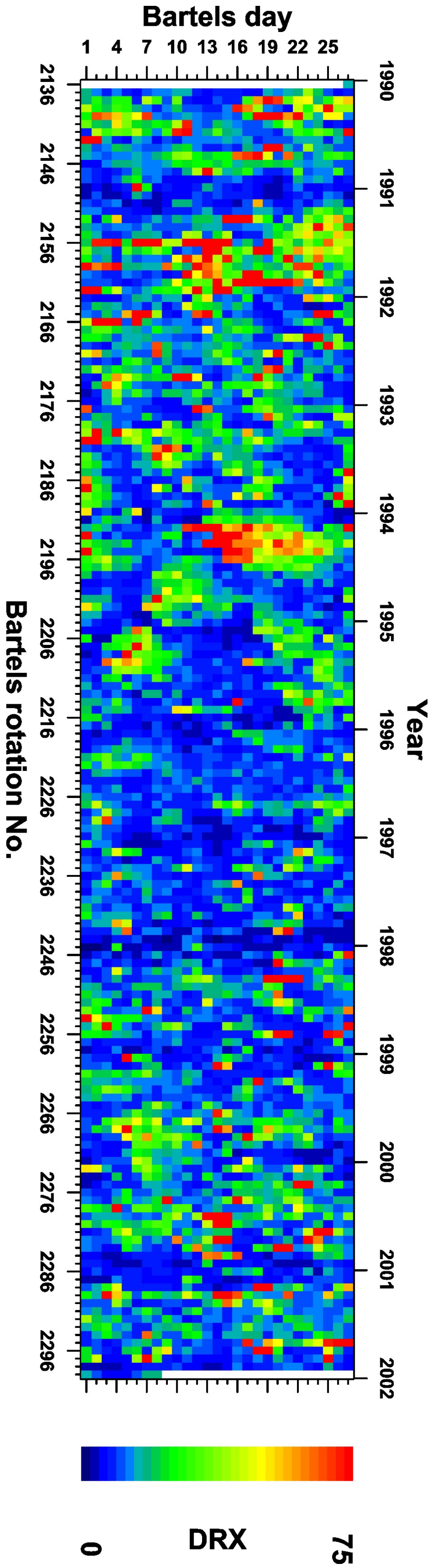
Front cover photograph
Removal of the old ARGOS fluxgates from the variometer chamber at Lerwick Observatory
(Photograph by E.Clarke, 3rd May 2002)

Back cover plot
The daily geomagnetic index DRX from Lerwick Observatory plotted by Bartels rotation for the years 1990-2001 (inclusive)



GEOMAGNETIC BULLETINS

1. Hartland Observatory magnetic results 1965, 1966 and 1967
2. Magnetic results 1968 Eskdalemuir, Hartland and Lerwick observatories
3. Magnetic results 1969 Eskdalemuir, Hartland and Lerwick observatories
4. Magnetic results 1970 Eskdalemuir, Hartland and Lerwick observatories
5. Magnetic results 1971 Eskdalemuir, Hartland and Lerwick observatories
6. Annual mean values of the geomagnetic elements since 1941
7. Magnetic results 1972 Eskdalemuir, Hartland and Lerwick observatories
8. Spherical harmonic models of the geomagnetic field
9. Magnetic results 1973-77 Eskdalemuir, Hartland and Lerwick observatories
10. Annual mean values of the geomagnetic elements
11. Magnetic results 1978-79 Eskdalemuir, Hartland and Lerwick observatories
12. A bibliographic guide to the production of local and regional magnetic charts
13. Magnetic results 1980 Eskdalemuir, Hartland and Lerwick observatories
14. Magnetic results 1981 Eskdalemuir, Hartland and Lerwick observatories
15. Magnetic results 1982 Eskdalemuir, Hartland and Lerwick observatories
16. Magnetic results 1983, 1984 Eskdalemuir, Hartland and Lerwick observatories
17. Magnetic results 1985 Eskdalemuir, Hartland and Lerwick observatories
18. Magnetic results 1986 Eskdalemuir, Hartland and Lerwick observatories
19. Magnetic results 1987-89 Lerwick, Eskdalemuir and Hartland observatories
20. Magnetic results 1990 Lerwick, Eskdalemuir and Hartland observatories
21. Magnetic results 1991 Lerwick, Eskdalemuir and Hartland observatories
22. Magnetic results 1992 Lerwick, Eskdalemuir and Hartland observatories
23. Magnetic results 1993 Lerwick, Eskdalemuir and Hartland observatories
24. Magnetic results 1994 Lerwick, Eskdalemuir and Hartland observatories
25. Magnetic results 1995 Lerwick, Eskdalemuir and Hartland observatories
26. Magnetic results 1996 Lerwick, Eskdalemuir and Hartland observatories
27. Magnetic results 1997 Lerwick, Eskdalemuir and Hartland observatories
28. Magnetic results 1998 Lerwick, Eskdalemuir and Hartland observatories
29. Magnetic results 1999: Lerwick, Eskdalemuir and Hartland observatories and UK repeat stations
30. Magnetic results 2000: Lerwick, Eskdalemuir and Hartland observatories and UK repeat stations