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Magnetic Results 2002

LERWICK, ESKDALEMUIR AND HARTLAND OBSERVATORIES
AND UK REPEAT STATIONS

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

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Magnetic Results 2002 : Lerwick, Eskdalemuir and Hartland Observatories and UK Repeat Stations

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LIST OF CONTENTS

Figures 19

Lerwick observatory results 2002 31

Eskdalemuir observatory results 2002 71

Hartland observatory results 2002 111

1. Introduction

This bulletin is a report of the measurements made between the 1st January and the 31st December 2002 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. New observatory systems were under development during 2002, in preparation for a new definitive operating system from January 2003. Although the GAUSS operations continued independently of this work, there were a few changes required to accommodate the new systems. Brief notes on these changes and their affects are included in Sections 2, 3 and 5.

A brief description of the repeat station network is also given and the results of the observations made during 2002 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. Geomagnetic co-ordinates given are relative to a geomagnetic pole position of 79° 32' N, 71° 33' W, computed from the tenth generation International Geomagnetic Reference Field (Macmillan and Maus, 2005) at epoch 2002.5.

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° 52' N	53° 58' N
	Longitude	89° 08' E	83° 50' E	80° 12' E
Height above mean sea level		85 m	245 m	95 m

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. Some instrument location changes were required during the year to accommodate the development of the new observatory systems. An updated site diagram will be available in the next annual bulletin. In May the router for remote access and data collection was replaced following a failure due to overheating. In August the GAUSS proton vector magnetomer (PVM), described in section 3.2.2, was removed. In November new paths were layed, providing better access routes to the instrument housing. 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 2002.

Figure 3 is a site diagram of Eskdalemuir Observatory. Some instrument location changes were required during the year to accommodate the development of the new observatory systems. An updated site diagram will be available in the next annual bulletin. Renovations to the underground chamber porch roof were carried out in July. In September the GAUSS proton vector magnetomer (PVM), described in section 3.2.2, was removed. In October the fluxgate power supply was replaced with the power supply for the new observatory system. 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 2002 was Mr C R Pringle.

Figure 4 is a site diagram of Hartland Observatory. Some instrument location changes were required during the year to accommodate the development of the new observatory systems. An updated site diagram will be available in the next annual bulletin. In September the GAUSS proton vector magnetometer (PVM), described in section 3.2.2, was removed. Also in September, modifications were made to the GAUSS electronics and a new analogue to digital converter (ADC) box was installed. The ADC box was subsequently discovered to have a faulty calibration switch and was replaced in October. The fluxgate power supply was also replaced in October, with the power supply for the new observatory system. Other routine maintenance was carried out on the observatory buildings and grounds.

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 2002 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). Figure 5 shows a block diagram of the GAUSS system.

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.
With new alternative observatory systems now operating, there was no longer a requirement for the PVM measurements as an extra back-up and quality control check. Additionally the proton magnetometers were required for use in the new observatory systems. Thus, data collection from the PVM systems were switched off during the year and the *F* measurements from the PPM logged by the new systems. This change was made on 29th August at Lerwick, on 2nd Setptember at Hartland and on 9th September at Eskdalemuir.

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.	To acquire a horizontal circle reading for **true north** for measurement of *D*.	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 2002 during service visits to the observatories by Edinburgh based BGS staff. Lerwick instruments were serviced in January, May, August and December, Eskdalemuir instruments were serviced in March and August, and Hartland instruments were serviced in March, June, September and October.

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 2002 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 2002 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 and other visits to the observatory. These are plotted in Figure 7 as the observed baselines, that is, with the variometer values subtracted. Any clusters of measurements made within a few days indicate the dates of BGS staff measurements.

The following baseline steps were observed during the year.

Original Date of Step	Reason for Step	Revised Date (day) (i.e. from 00:00 UT)	*H* (nT)	*D* (′)	*Z* (nT)
03-12-02	service visit, installation of new electronics on GAUSS & realignment of fluxgate sensors	03-12-02 (337)	–15.0 *	35.70 *	4.1

* Steps reduced to –4.0nT and 1.0′ for *H* and *D* respectively to fit on the plotting panel of the allocated baselines in Figure 7.

The ranges of the allocated baselines during the year, not including the realignment of the fluxgate sensors and changes to the electronics, were 4.9 nT for *H*, 1.26 minutes of arc for *D* and 2.9 nT for *Z*.

The table below lists the root mean squared (*rms*) differences of the observed baseline corrections from the allocated values. The *rms* differences for 2000 and 2001 are also listed. The number of observations used for each component is given in brackets.

Year	H(nT)		D(min)		Z(nT)	
2000	0.76	(48)	0.15	(45)	0.30	(47)
2001	0.84	(46)	0.18	(48)	0.29	(45)
2002	1.17	(74)	0.38	(69)	0.40	(74)

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 following baseline steps were observed during the year.

Original Date of Step	Reason for Step	Revised Date (day) (i.e. from 00:00 UT)	*H* (nT)	*D* (′)	*Z* (nT)
14-03-02	service visit	14-03-02 (73)	1.0	0.24	1.2
28-06-02	Unknown	28-06-02 (179)	0.5	-	-
30-07-02	electrical storm	31-07-02 (212)	–0.8	-	-
13-09-02	Unknown	14-09-02 (257)	0.6	-	-
27-09-02	Unknown	28-09-02 (271)	–0.9	-	–0.2
03-10-02	change of GAUSS power supply and realignment of fluxgate sensors	03-10-02 (276)	-	24.30 *	126.8 *

* Steps reduced to 1.0′ and 4.0nT for *D* and *Z* respectively to fit on the plotting panel of the allocated baselines in Figure 8.

The ranges of the allocated baselines during the year, not including the realignment of the fluxgate sensors and changes to the electronics, were 4.5 nT for *H*, 1.45 minutes of arc for *D* and 2.4 nT for *Z* .

The table below lists the root mean squared (*rms*) differences of the observed baseline corrections from the allocated values. The *rms* differences for 2000 and 2001 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)
2000	0.54 (68)	0.24 (67)	0.40 (76)
2001	0.82 (85)	0.27 (88)	0.34 (87)
2002	1.16 (106)	0.26 (115)	0.52 (104)

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 following baseline steps were observed during the year.

Original Date of Step	Reason for Step	Revised Date (day) (i.e. from 00:00 UT)	*H* (nT)	*D* (′)	*Z* (nT)
04-03-02	service visit	05-03-02 (64)	1.0	-	0.7
06-06-02	service visit and change to the UPS	07-06-02 (158)	-	-	0.7
02-09-02 & 03-09-02	service visit and changes made to GAUSS electronics and ADC box.	03-09-02 (246)	3.1	0.40	1.9
01-10-02 03-10-02	electronics, ADC box and power supply were replaced and fluxgate sensors realigned	01-10-02 (274)	23.8 *	11.39 *	97.9 *

* Steps reduced to 4.0nT, 1.0′ and 4.0nT for *H*, *D* and *Z* respectively to fit on the plotting panel of the allocated baselines in Figure 7.

The ranges of the allocated baselines during the year, not including the steps caused by the realignment of the fluxgate sensors and changes to the electronics, were 2.4 nT for *H*, 0.60 minutes of arc for *D* and 3.1 nT for *Z*.

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)	
2000	0.44	(89)	0.09	(90)	0.35	(89)
2001	0.36	(83)	0.10	(84)	0.28	(83)
2002	0.41	(87)	0.09	(89)	0.26	(86)

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 2002 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	502	911	773	467	161	54	30	14	8	0
ESK	343	752	787	706	260	50	14	8	0	0
HAD	192	782	794	719	329	83	16	5	0	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 2002, observations were made at 15 repeat stations, the results for which are tabulated below. The values are reduced to a quiet level at the time of occupation using observatory data. The results of the modelling work for 2002 are shown in Figures 10 and 11. The data collection and processing are described in Carrigan (2003) and the modelling work is similar to that described in Macmillan and Carrigan (2003).

	Code	Date	Latitude	Longitude	Declination	Inclination	Total intensity
Elan Village	ELA	22/05/02	52° 16’ 38” N	3° 33’ 25” W	-4º 11’ 29”	67º 07’ 32”	48596.8 nT
Long Mynd	LMY	23/05/02	52° 33’ 18” N	2° 51’ 00” W	-4º 05’ 52”	67º 21’ 33”	48569.5 nT
Skye	SKY	22/07/02	57° 01’ 46” N	5° 57’ 44” W	-6º 53’ 38”	70º 51’ 40”	49744.2 nT
South Uist	SUI	24/07/02	57º 11’ 24” N	7º 24’ 48” W	-8º 19’ 09”	70º 59’ 39”	49653.7 nT
Mull	MUL	26/07/02	56º 19’ 10” N	6º 19’ 31”W	-7º 49’ 05”	70º 07’ 23”	50103.5 nT
Great Addington	GAD	06/08/02	52º 22’ 00” N	0º 36’ 16” W	-3º 13’ 38”	67º 12’ 04”	48539.9 nT
Coleshill	COL	07/08/02	51º 38’ 27” N	1º 39’ 27” W	-3º 02’ 51”	66º 42’ 31”	48546.4 nT
Abergavenny	AVY	08/08/02	51º 48’ 36” N	2º 52’ 09” W	-3º 58’ 56”	66º 44’ 07”	48487.5 nT
Port Erin	POE	21/08/02	54º 05’ 36” N	4º 45’ 09” W	-5º 04’ 08”	68º 34’ 18”	49010.4 nT
Point of Ayre	POA	22/08/02	54º 24’ 07” N	4º 24’ 43” W	-5º 02’ 24”	68º 48’ 36”	49059.7 nT
Campbeltown	CAM	04/09/02	55º 26’ 55” N	5º 32’ 55” W	-5º 56’ 38”	69º 28’ 40”	49435.2 nT
Ayr	AYR	05/09/02	55º 26’ 13” N	4º 25’ 15” W	-5º 23’ 58”	69º 27’ 13”	49373.0 nT
Stranraer	STR	06/09/02	54º 56’ 08” N	5º 07’ 07” W	-5º 43’ 49”	69º 06’ 10”	49259.4 nT
Isle of Wight	IOW	18/09/02	50º 42’ 14” N	1º 20’ 30” W	-3º 00’ 41”	65º 47’ 37”	48148.0 nT
Westbury	WES	19/09/02	51º 14’ 12” N	2º 13’ 10” W	-3º 31’ 08”	66º 10’ 39”	48285.4 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:

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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 2002

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	O Baillie *
Eskdalemuir	
Craftsman	W E Scott
Cleaner	Mrs M Scott
Hartland	
PGS E	C R Pringle

* Mr Dirk Wallis resigned from BGS in June 2002
Mr Keith Wyse's temporary contract ended in July 2002
Mrs Orsi Baillie joined BGS in October 2002
Dr Toby Clark resigned from BGS in October 2002

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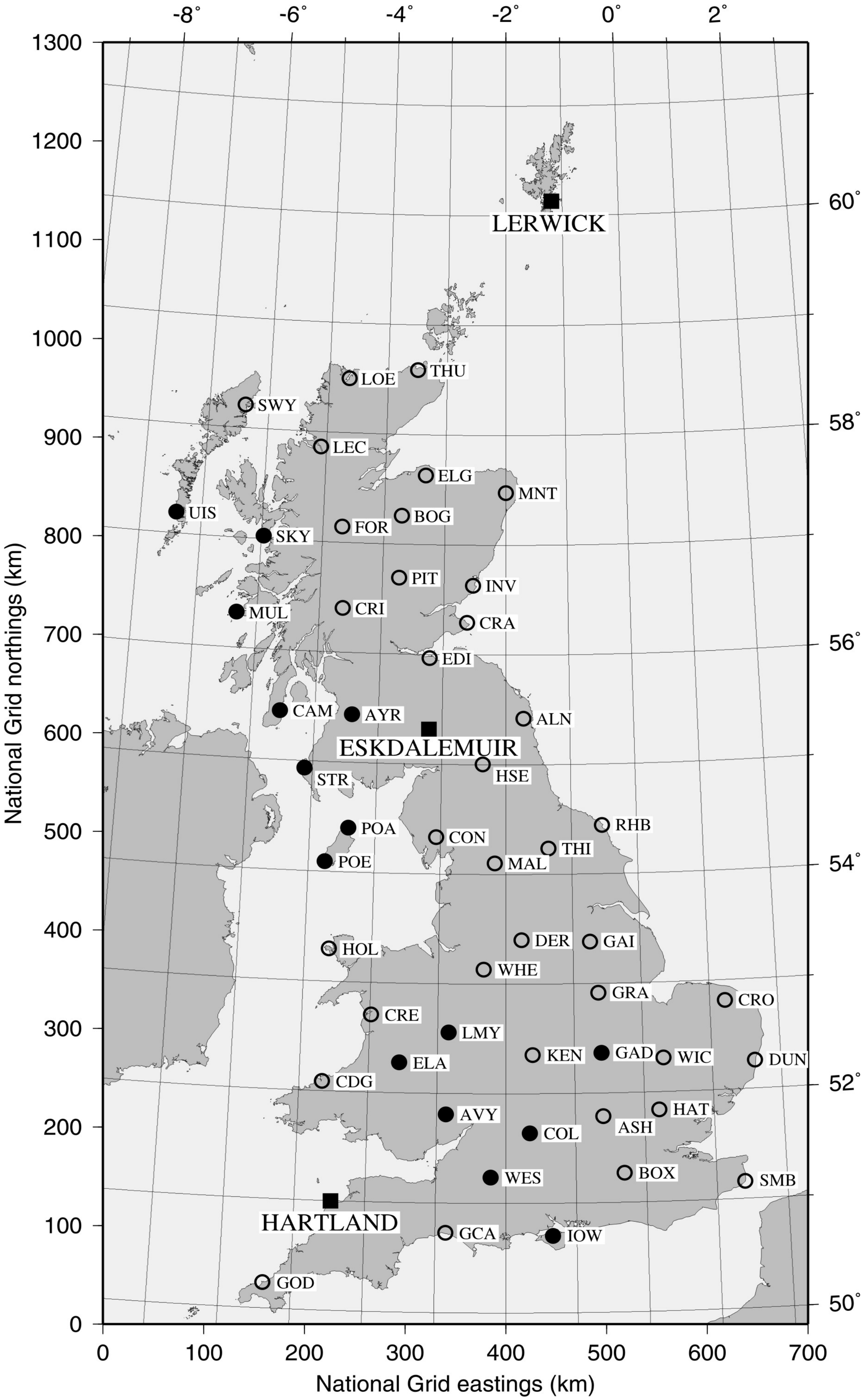
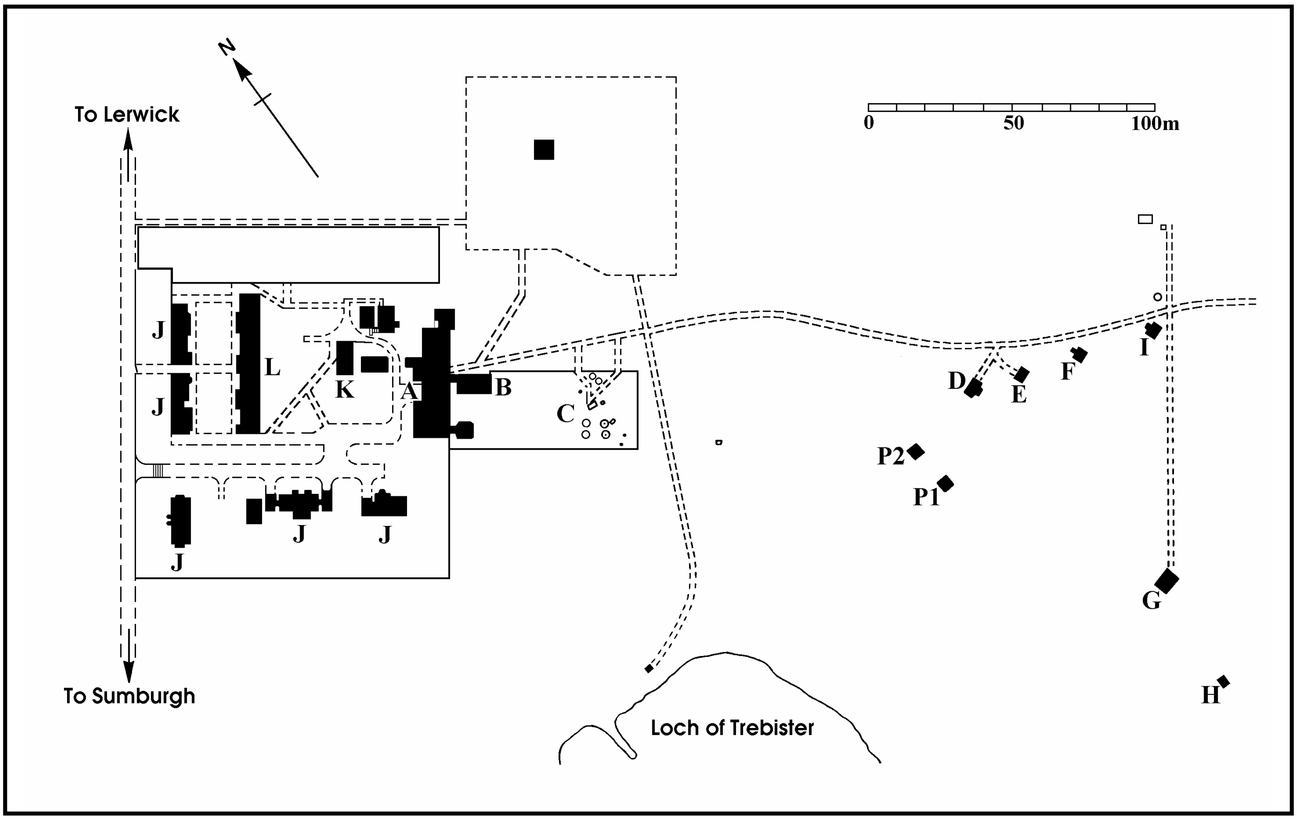


Figure 1. Location of the UK magnetic observatories (squares) and repeat stations (circles)

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*)

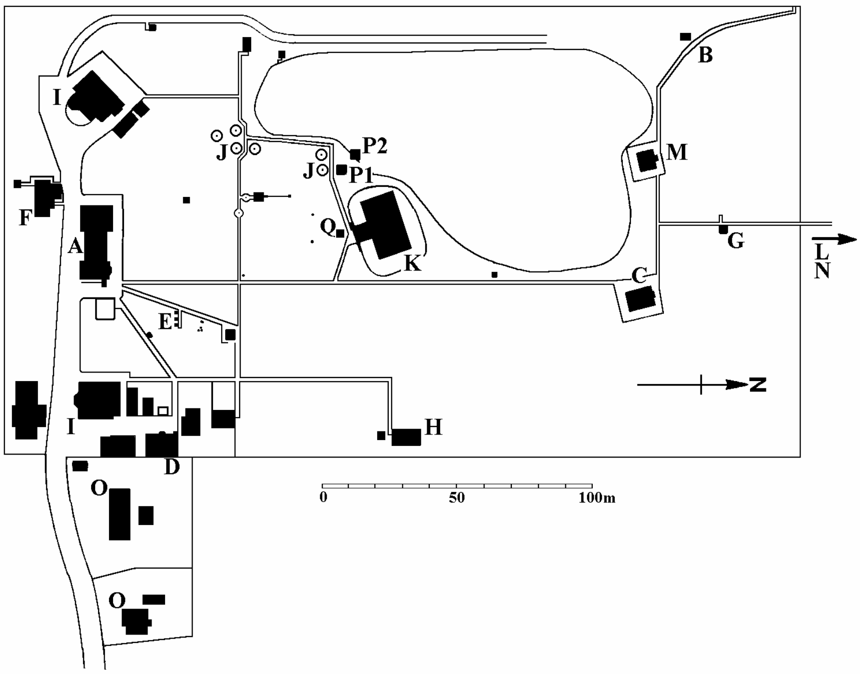
The variometer house is constructed from non-magnetic concrete and has internal dimensions of 4.9 by 3 meters. The roof is semi-circular in cross section. The temperature of the house is controlled to a diurnal range of ±1ºC. The meridian at the time of construction is defined on the north and south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

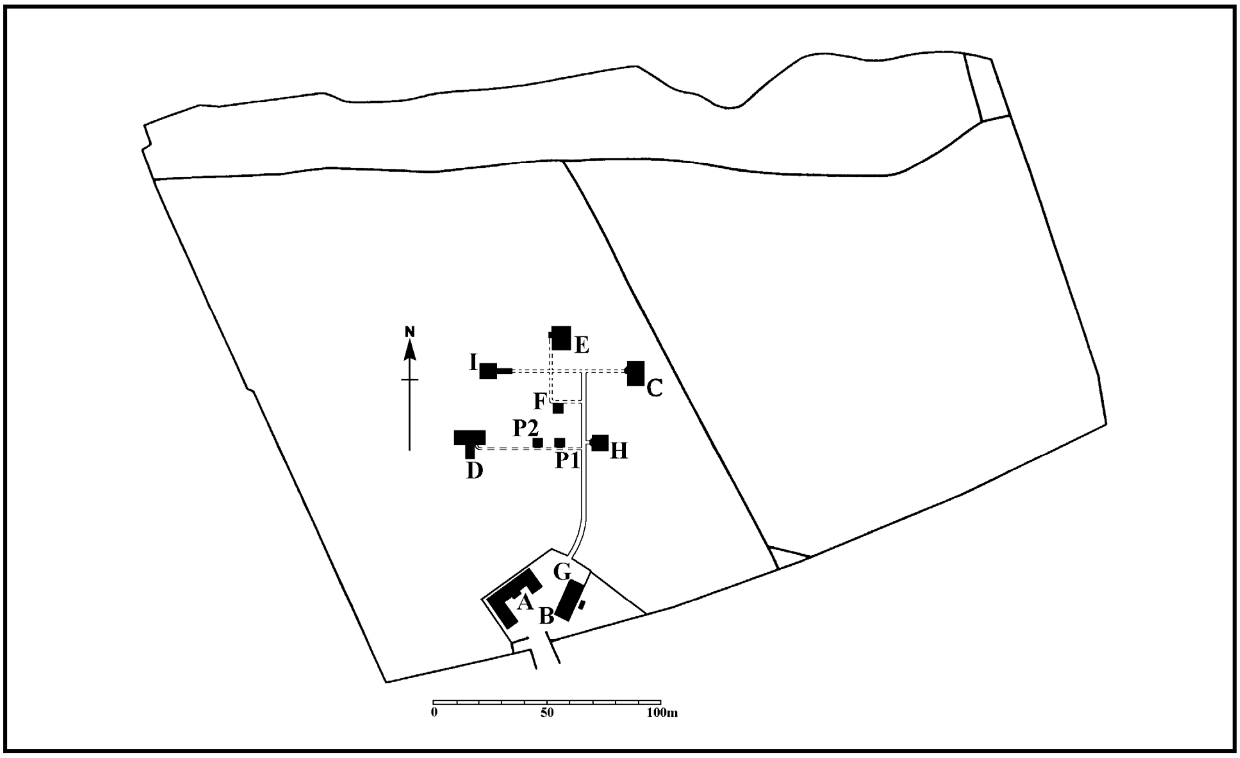
The Non-Magnetic Laboratory
The laboratory is used for instrument development and testing. It contains a sensor room with three piers and a larger room with a single pier.

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

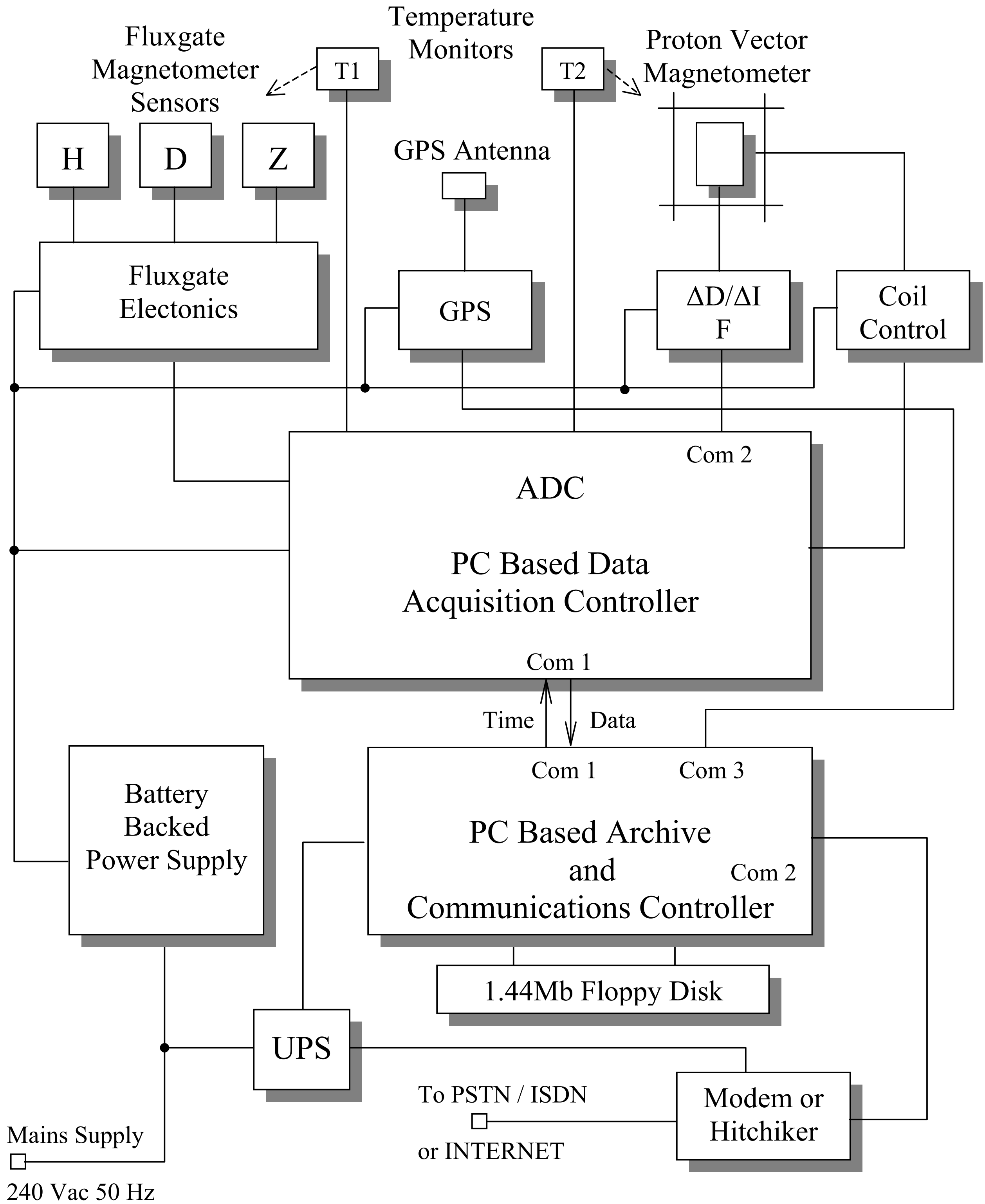


Figure 5. **Block diagram of GAUSS**

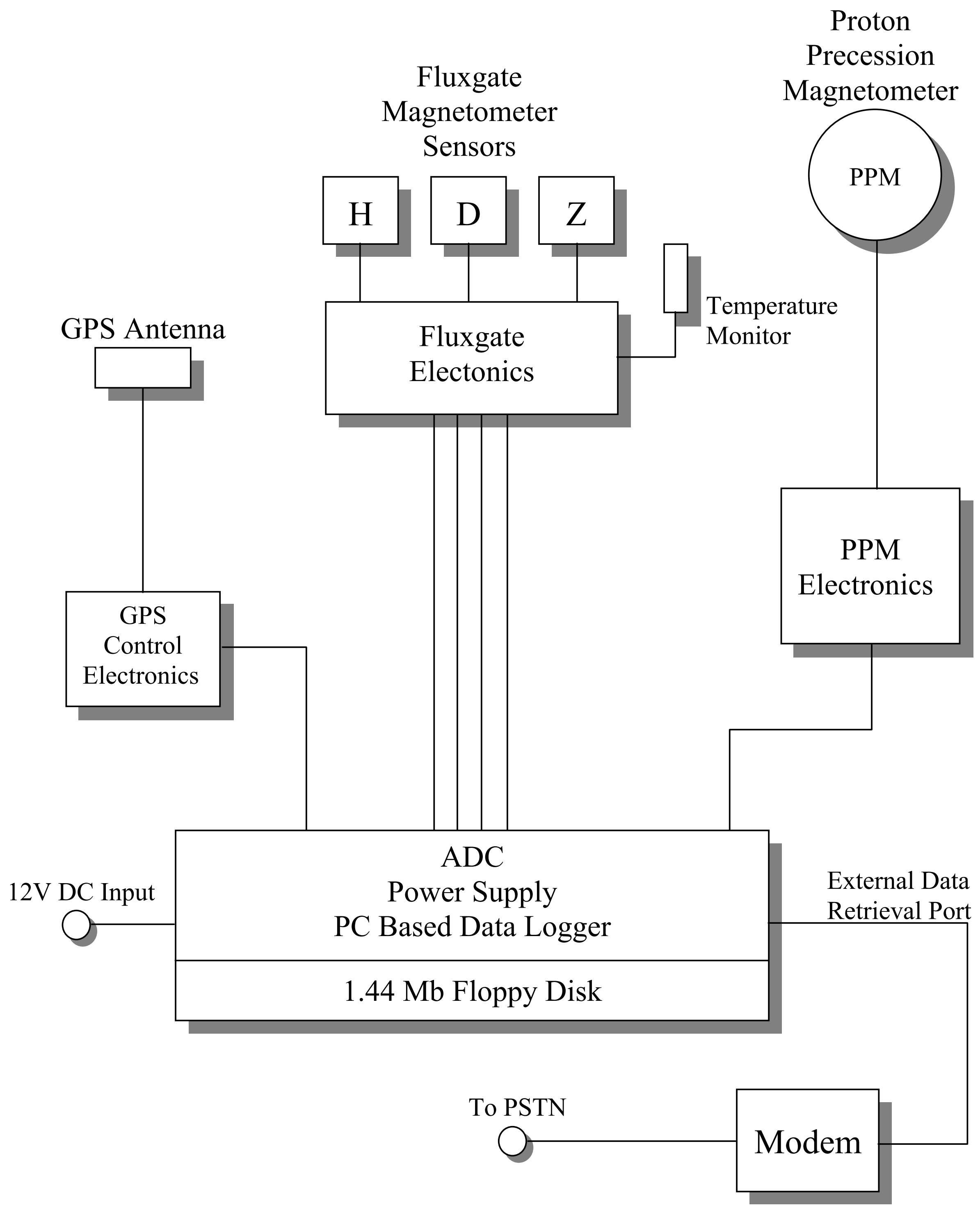


Figure 6. **Block diagram of the FLARE *plus* backup system**

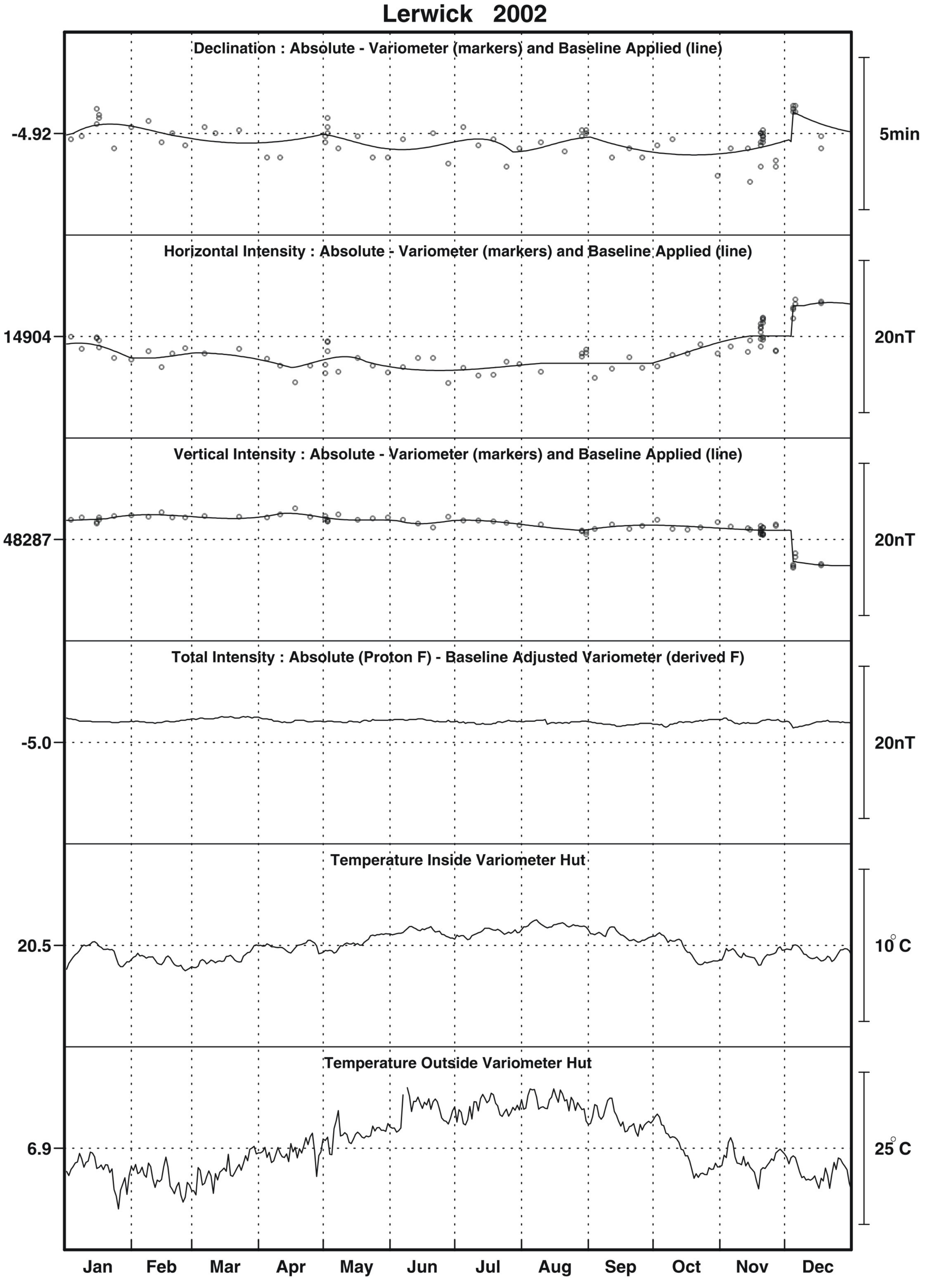


Figure 7. Observed and allocated baselines at Lerwick

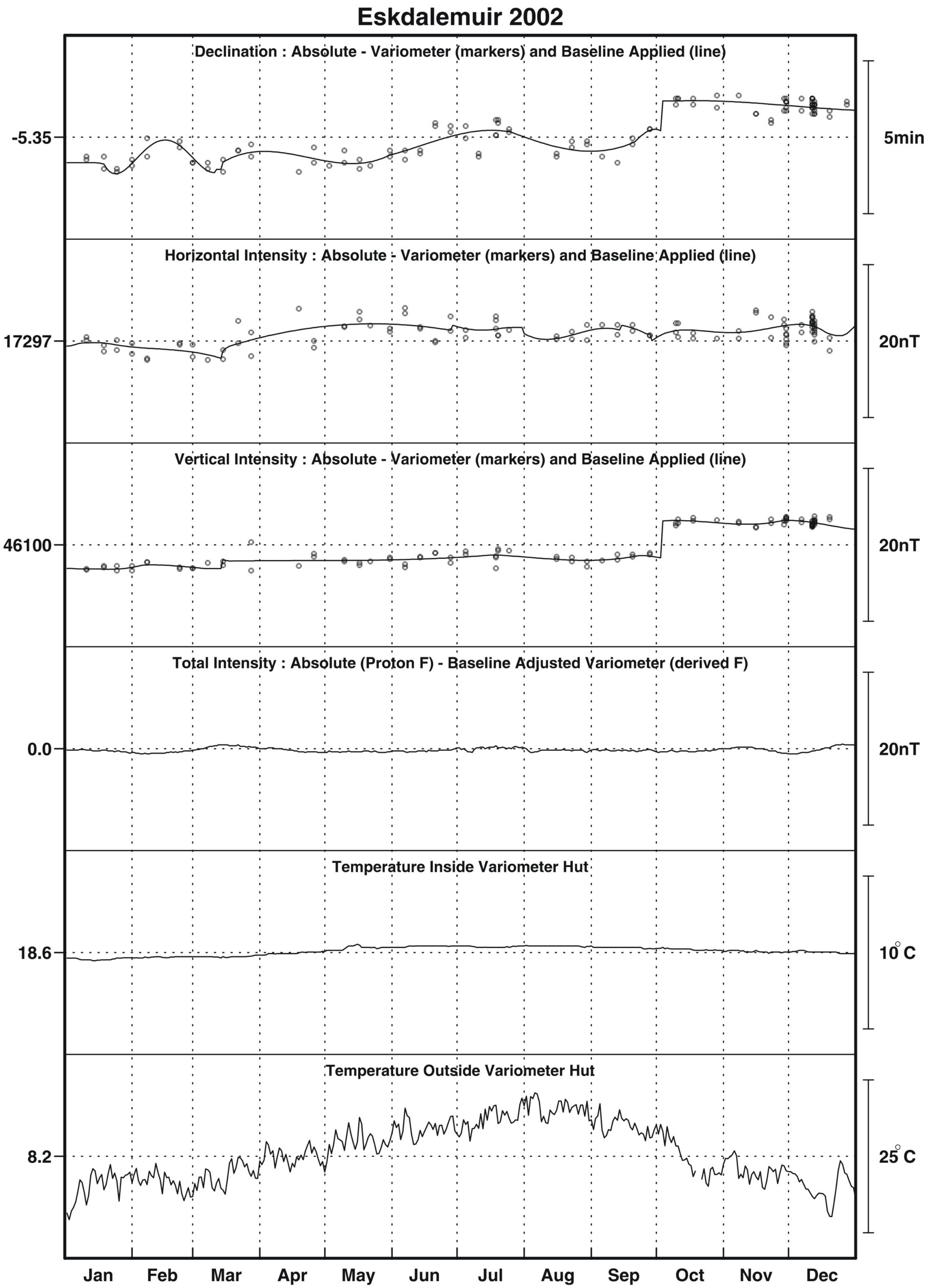


Figure 8. Observed and allocated baselines at Eskdalemuir

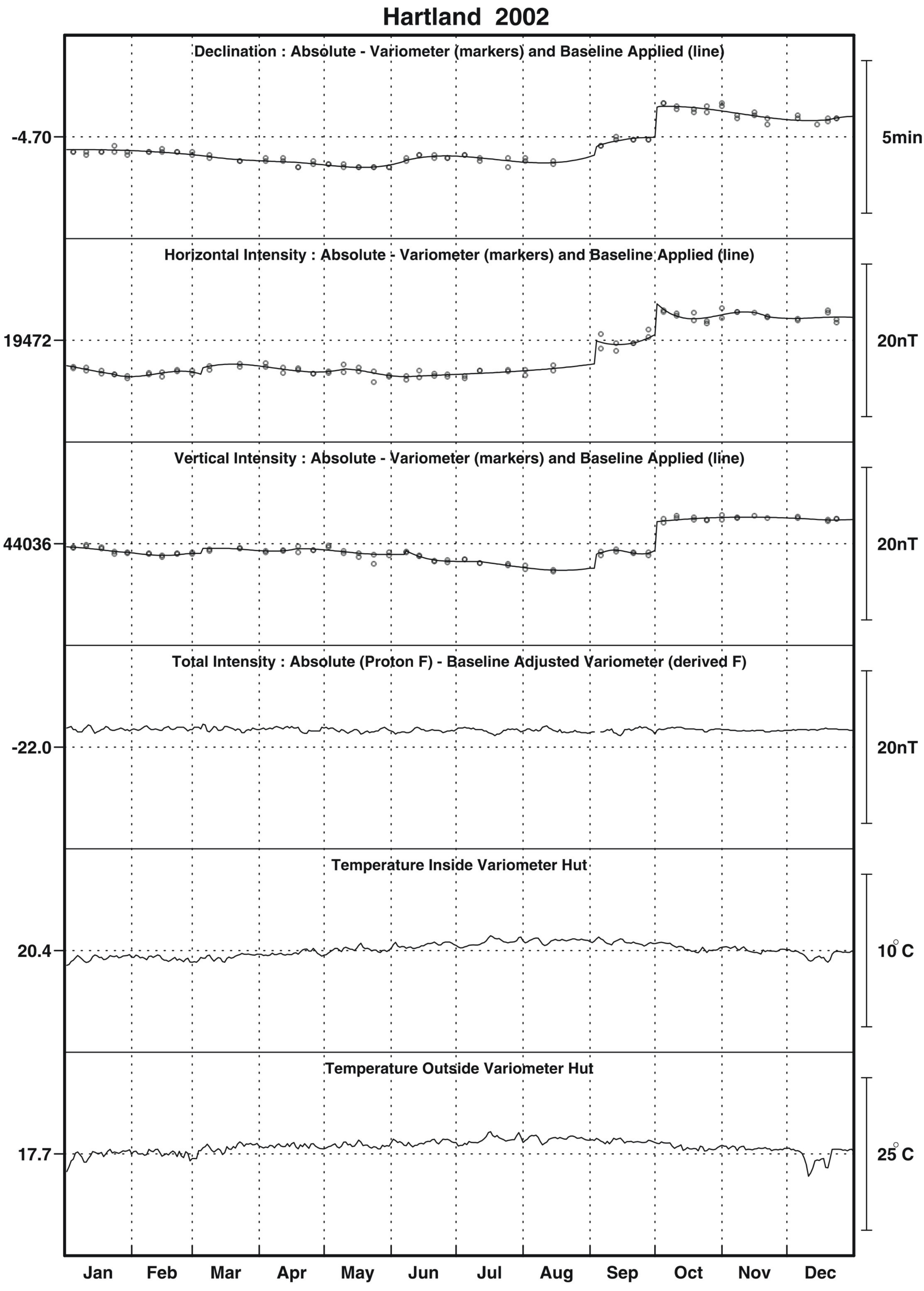


Figure 9. Observed and allocated baselines at Hartland

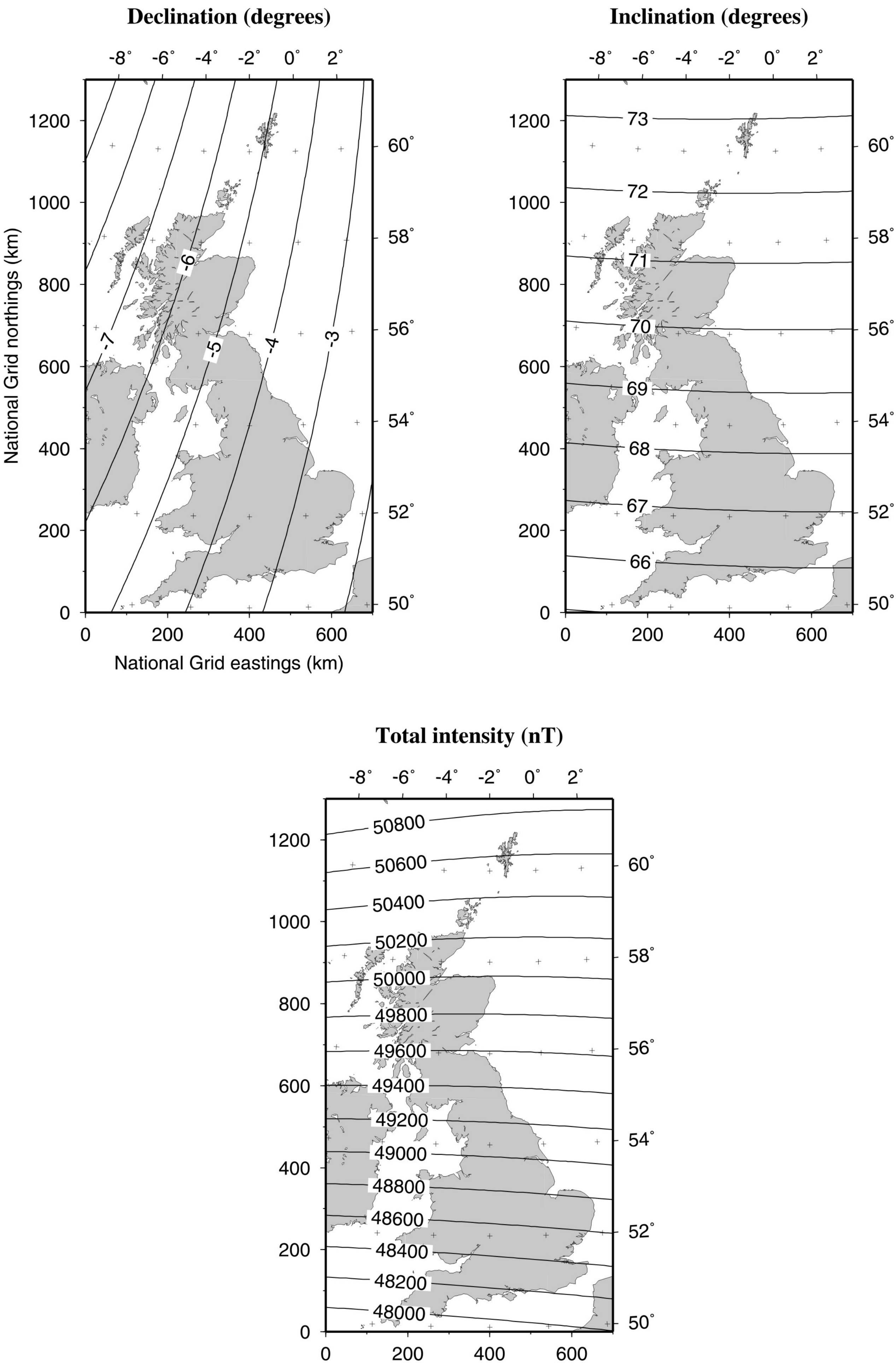


Figure 10. Declination, inclination and total intensity at 2002.5

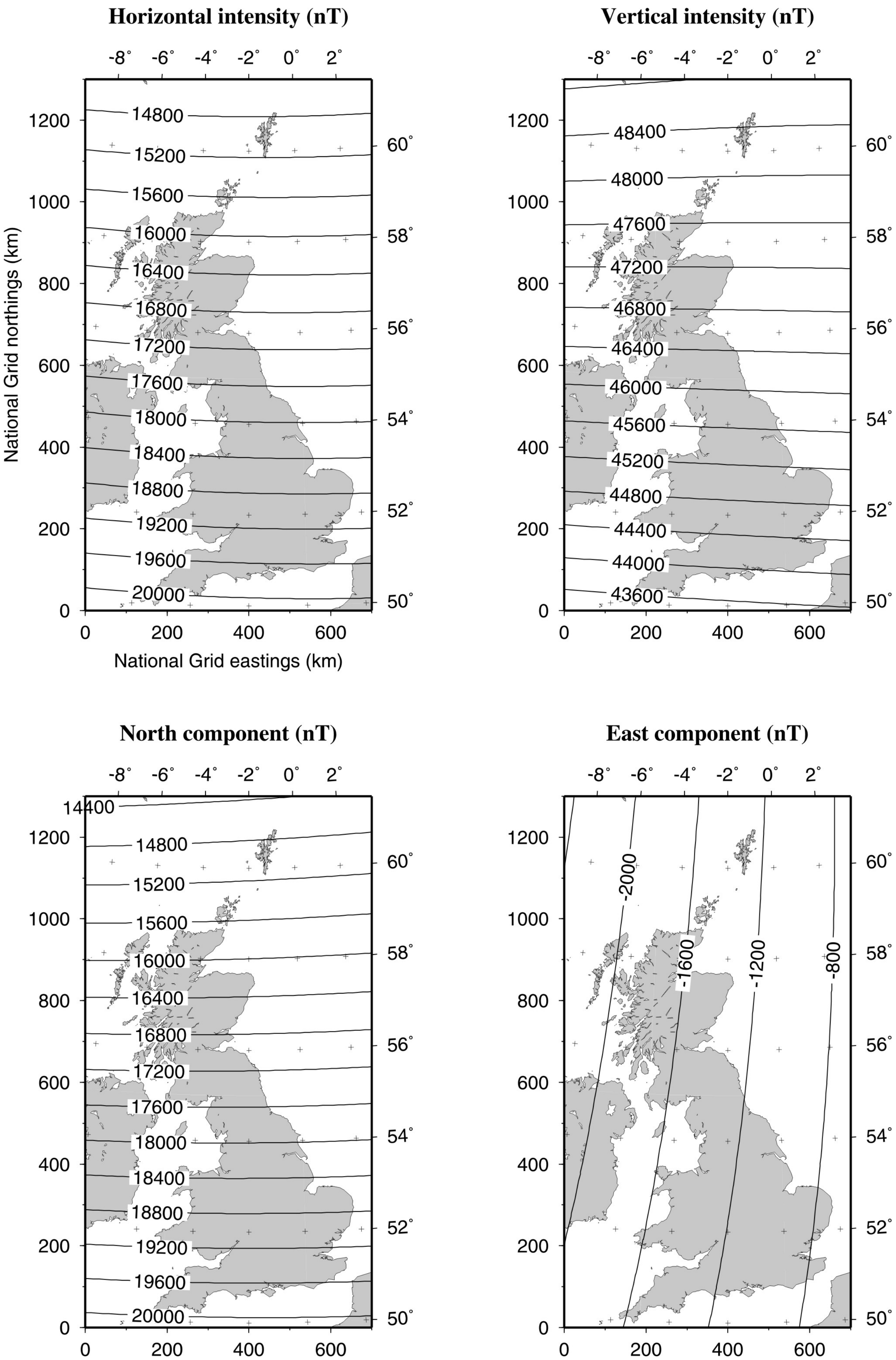
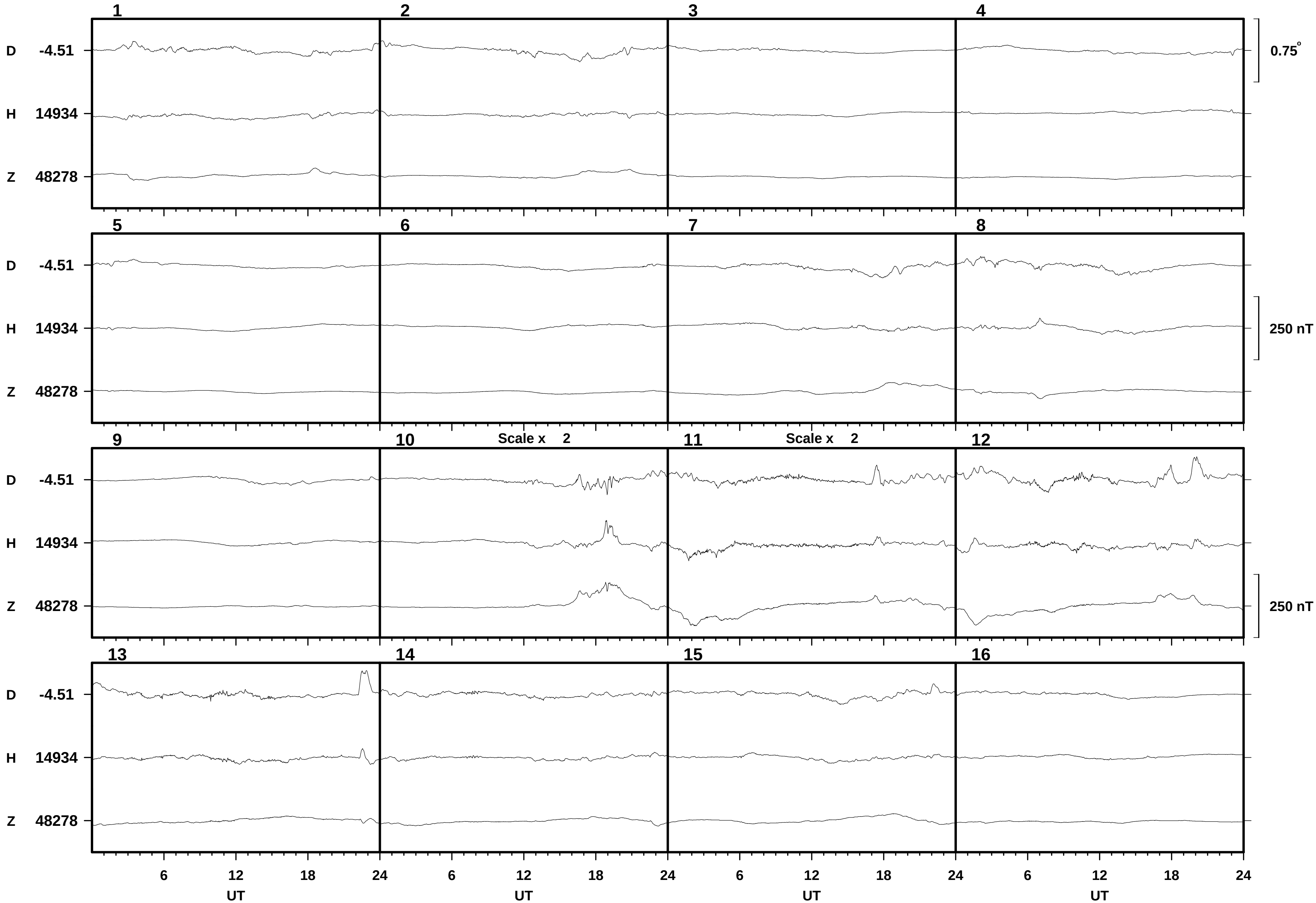


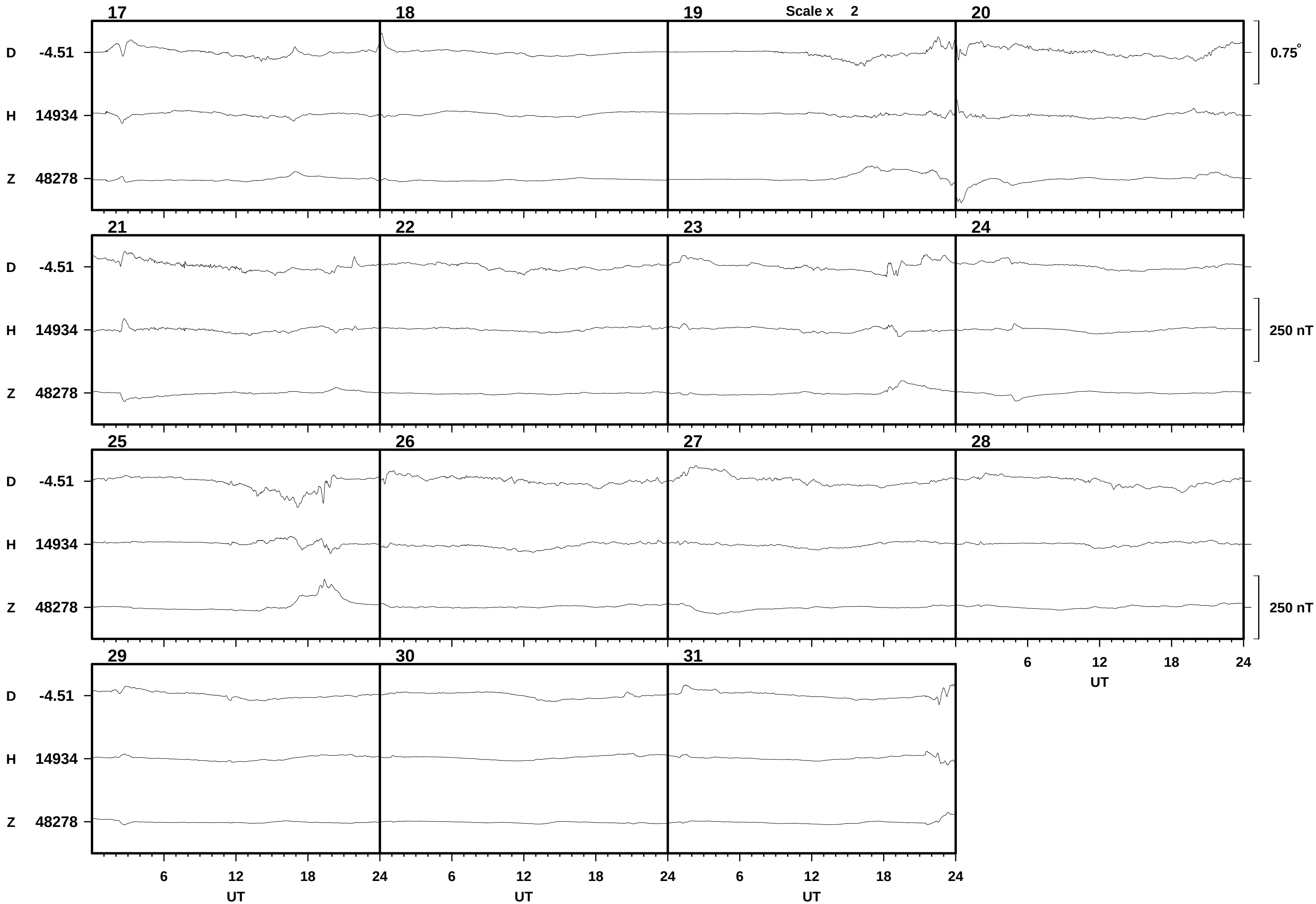
Figure 11. Horizontal, vertical, northerly and easterly intensities at 2002.5

Lerwick Observatory Results 2002

Lerwick January 2002



LE 1 2



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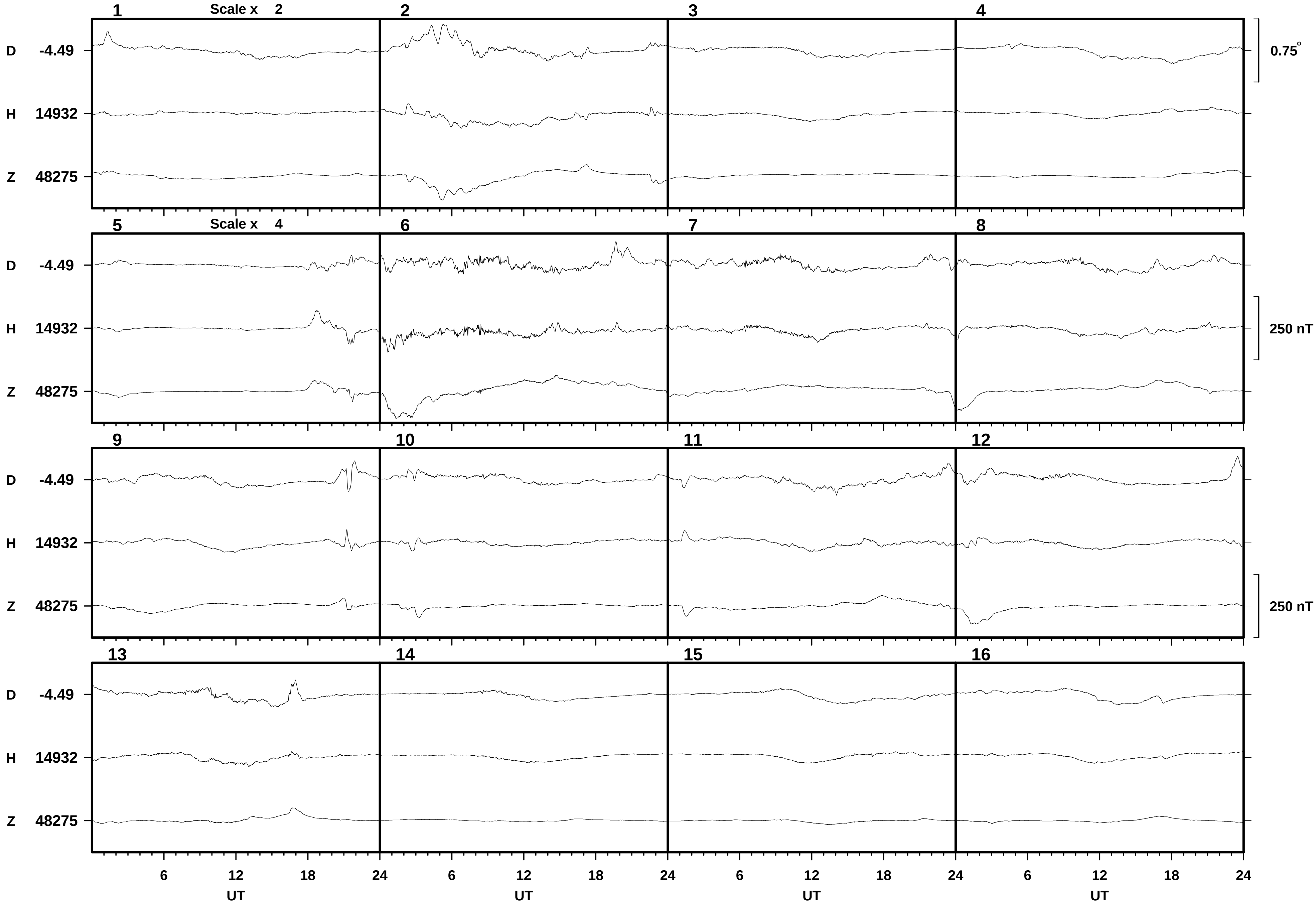
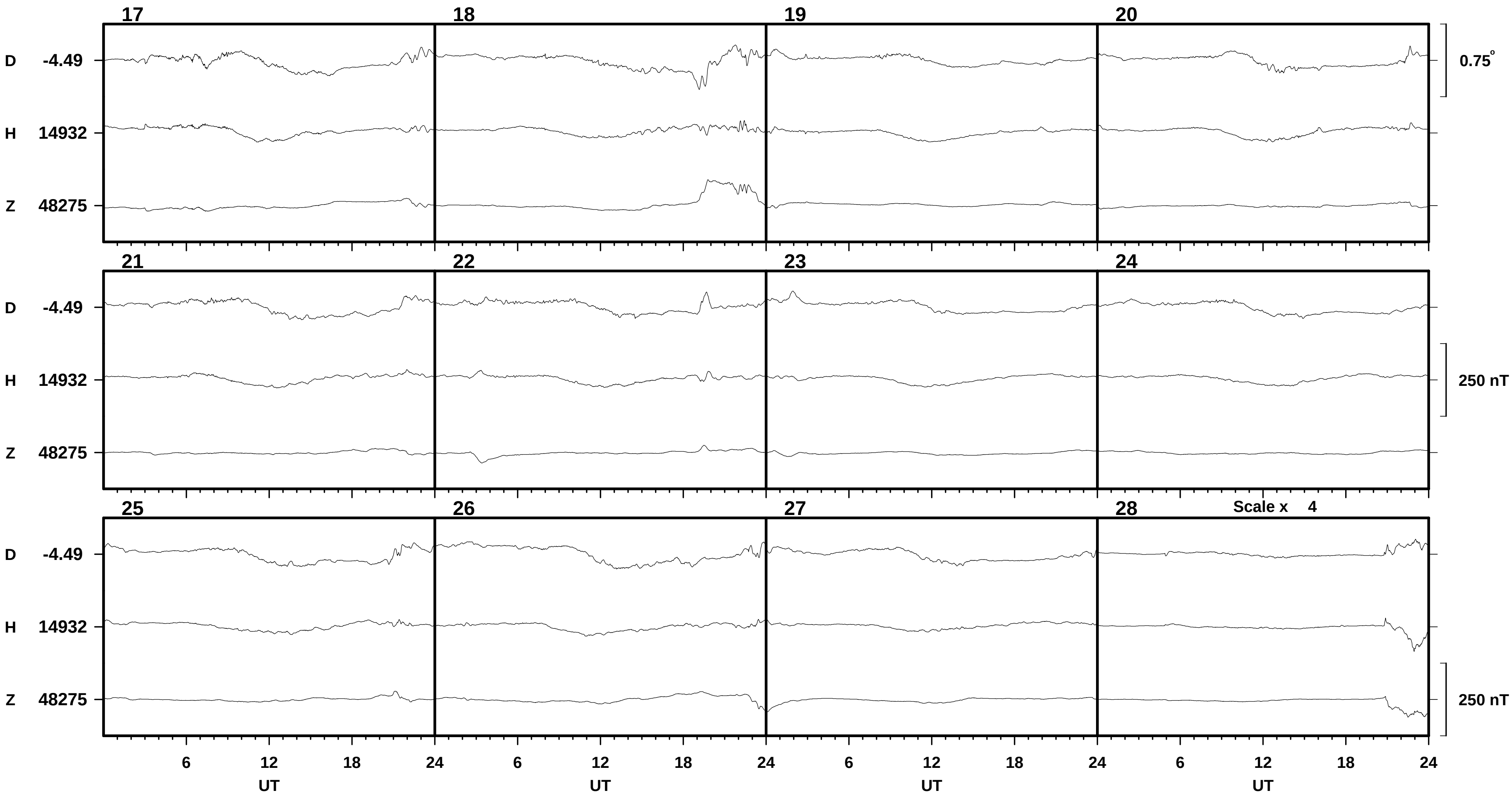
18
19
20
Scale x 2
D -4.51
H 14934
Z 48278
0.75°
21
22
23
24
250 nT
25
26
27
28
250 nT
29
30
31
6 12 18 24
UT

LE 1 2

Lerwick February 2002



LE 2 2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H 14932
Z 48275
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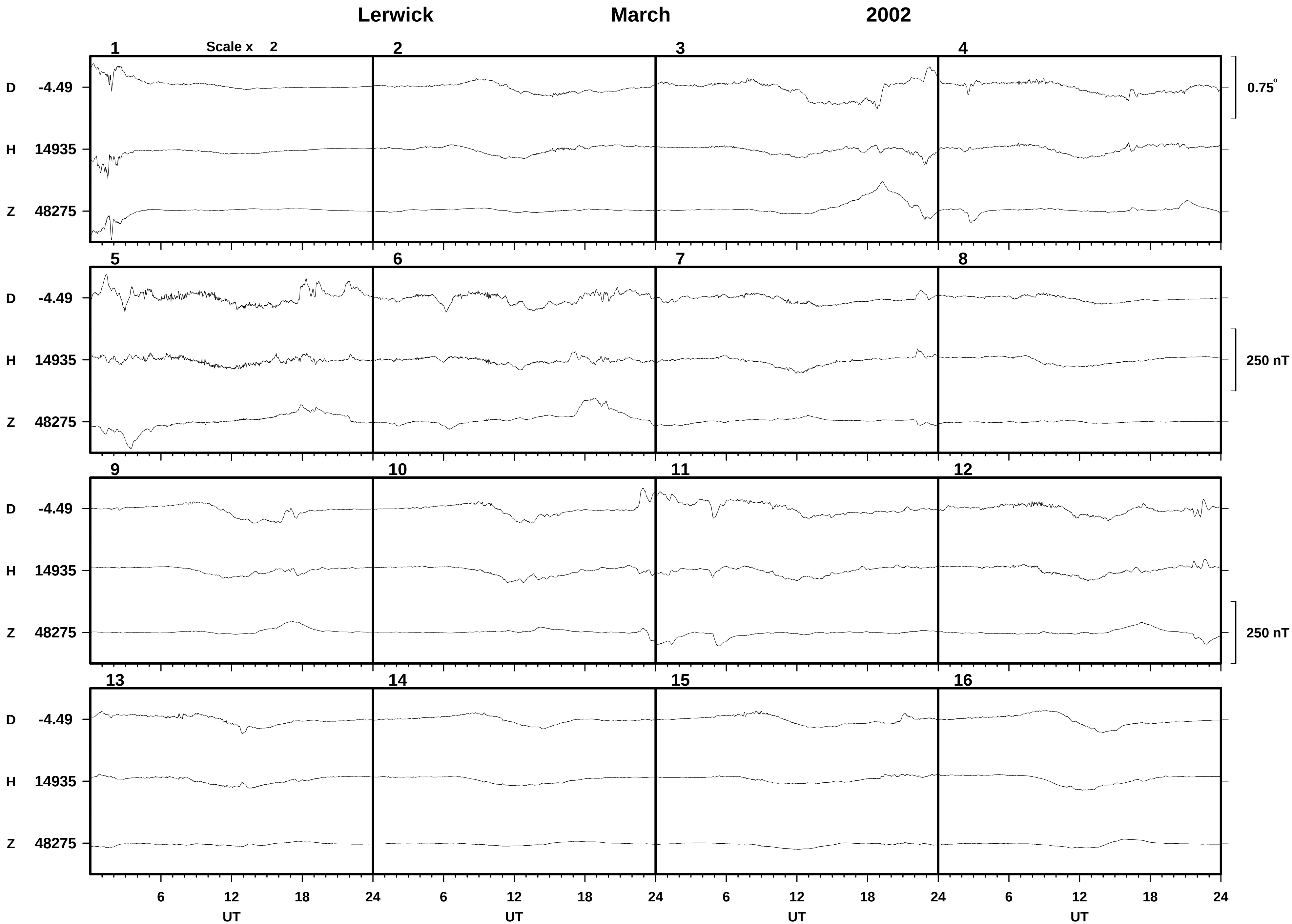
Scale x 4
250 nT
6 12 18 24
UT

LE 2 2



Lerwick
March
2002
Scale x 2
1
2
3
4
5
6
7
8
9
10
11
12
13
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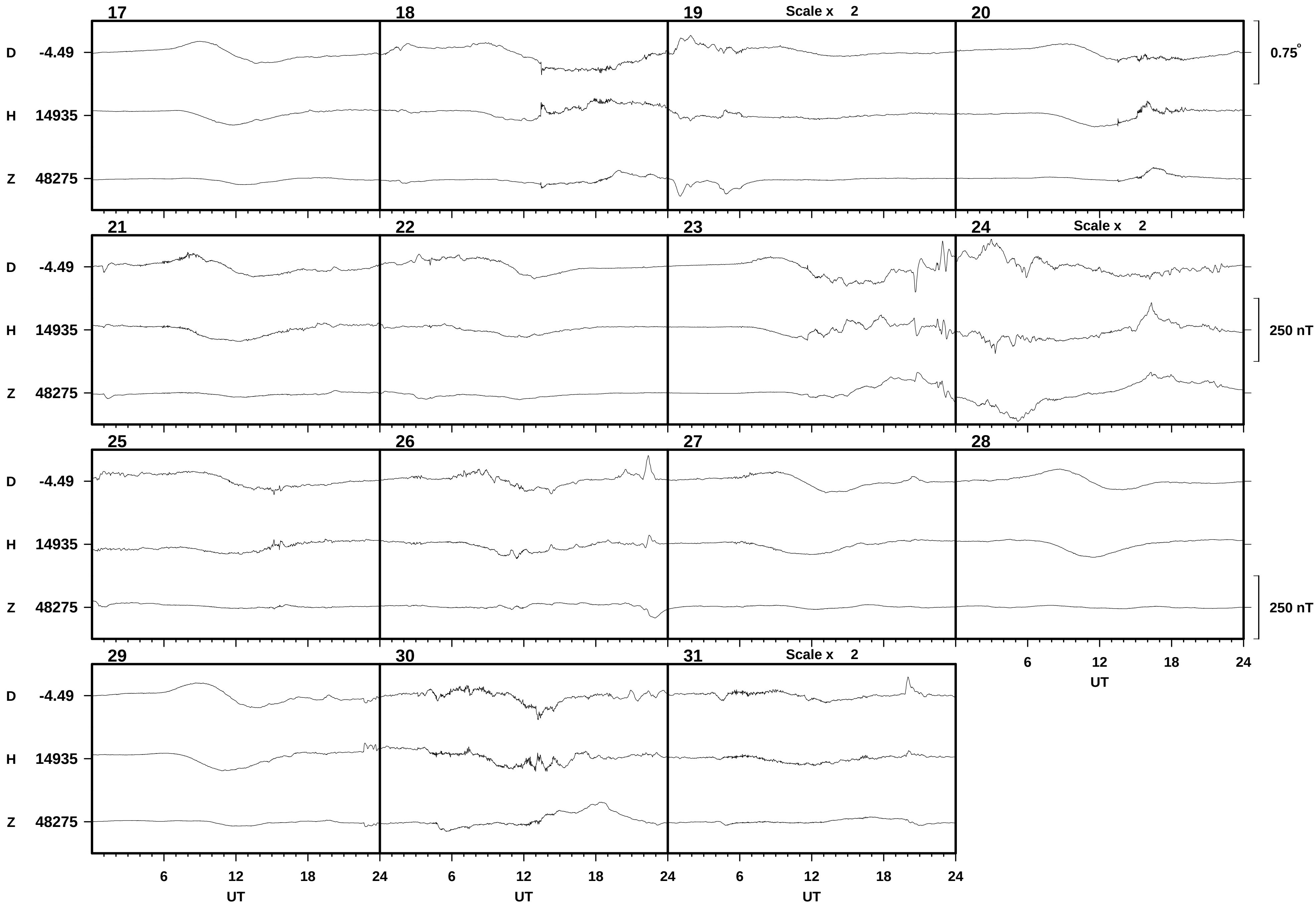
16
D -4.49
H 14935
Z 48275
0.75°
250 nT
250 nT
6
12
18
24
UT

LE 3 2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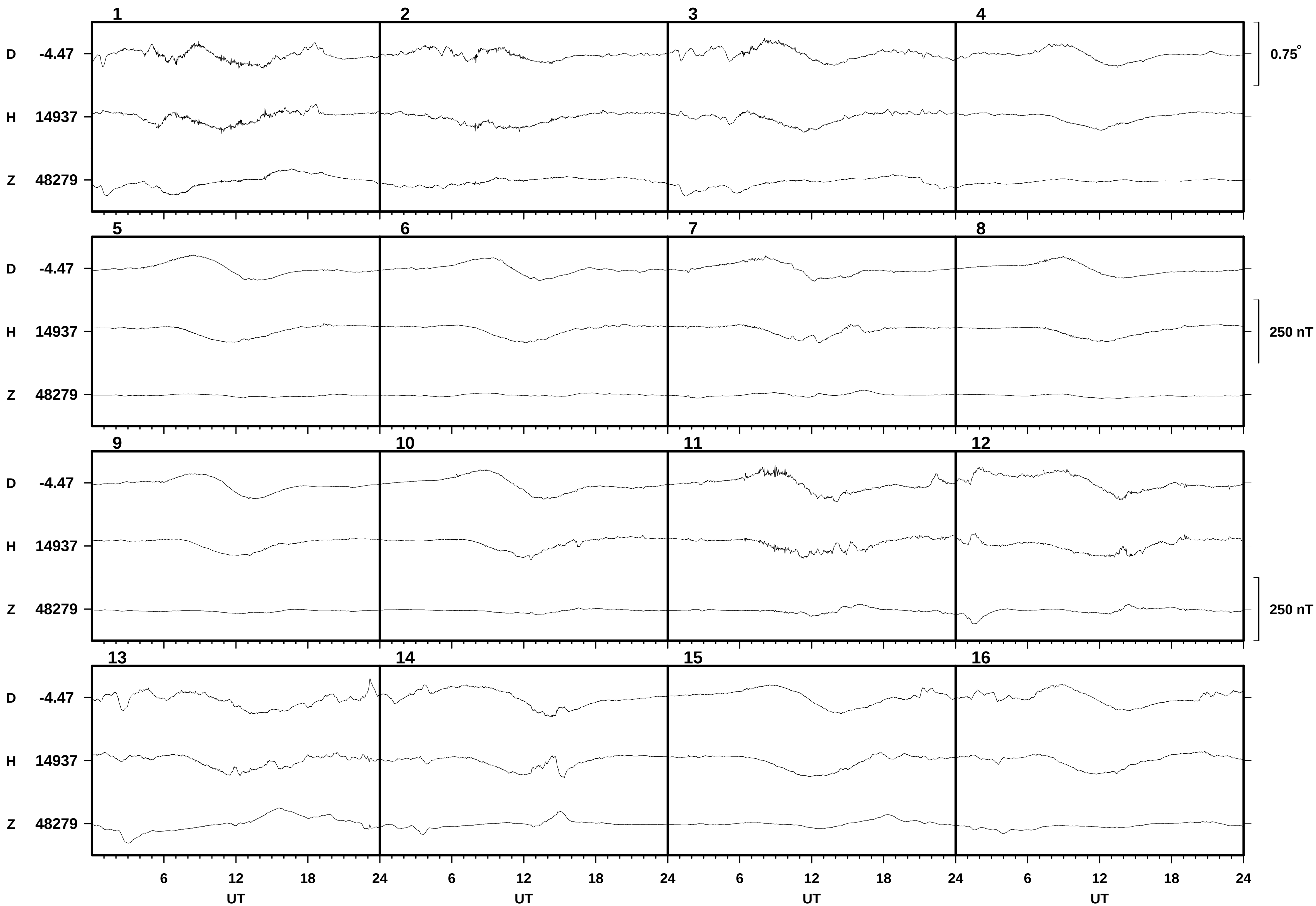
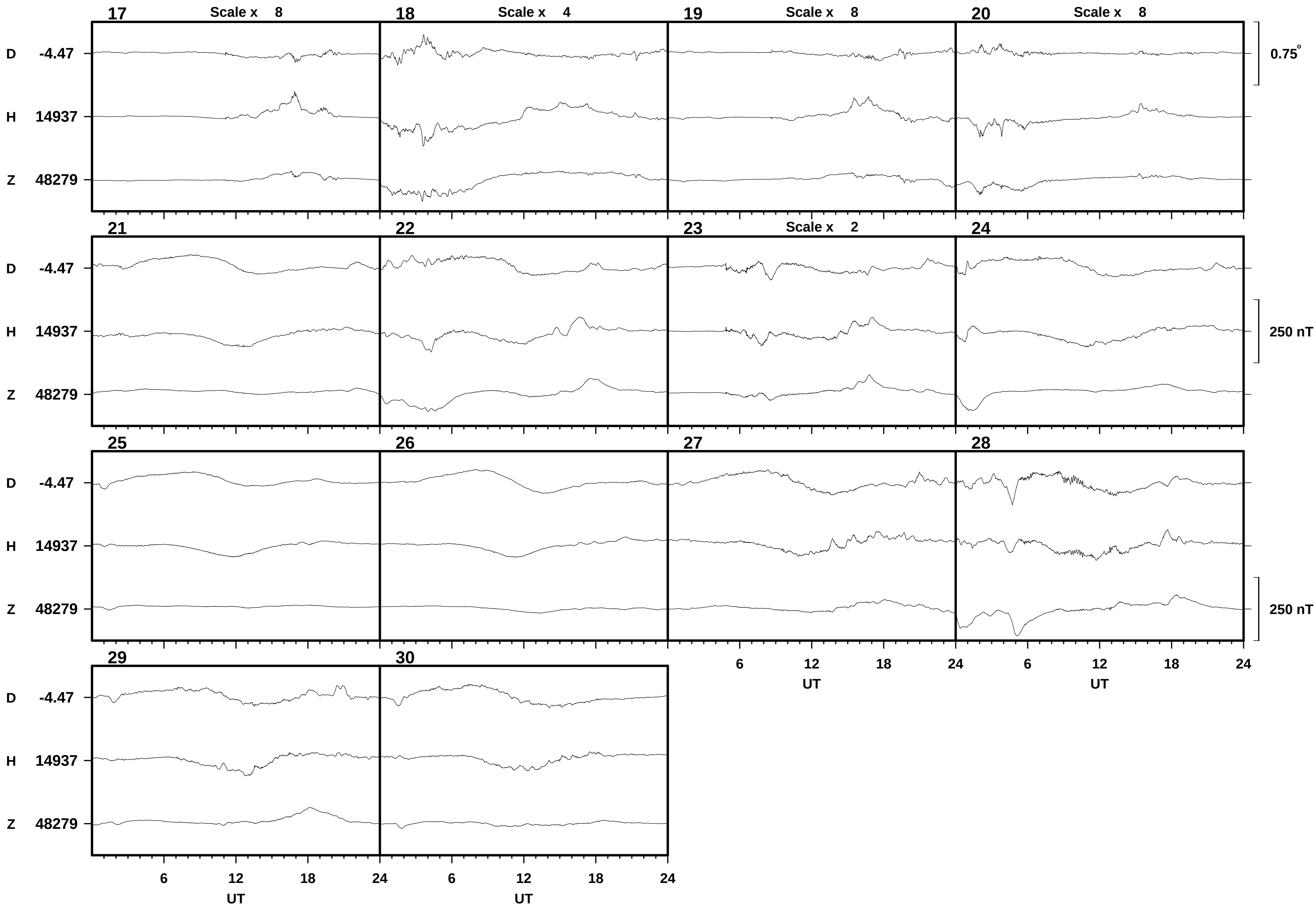
18
19
20
Scale x 2
D -4.49
H 14935
Z 48275
0.75°
21
22
23
24
Scale x 2
250 nT
25
26
27
28
250 nT
29
30
31
Scale x 2
6
12
18
24
UT

LE 3 2

Lerwick April 2002




17
Scale x 8
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Scale x 4
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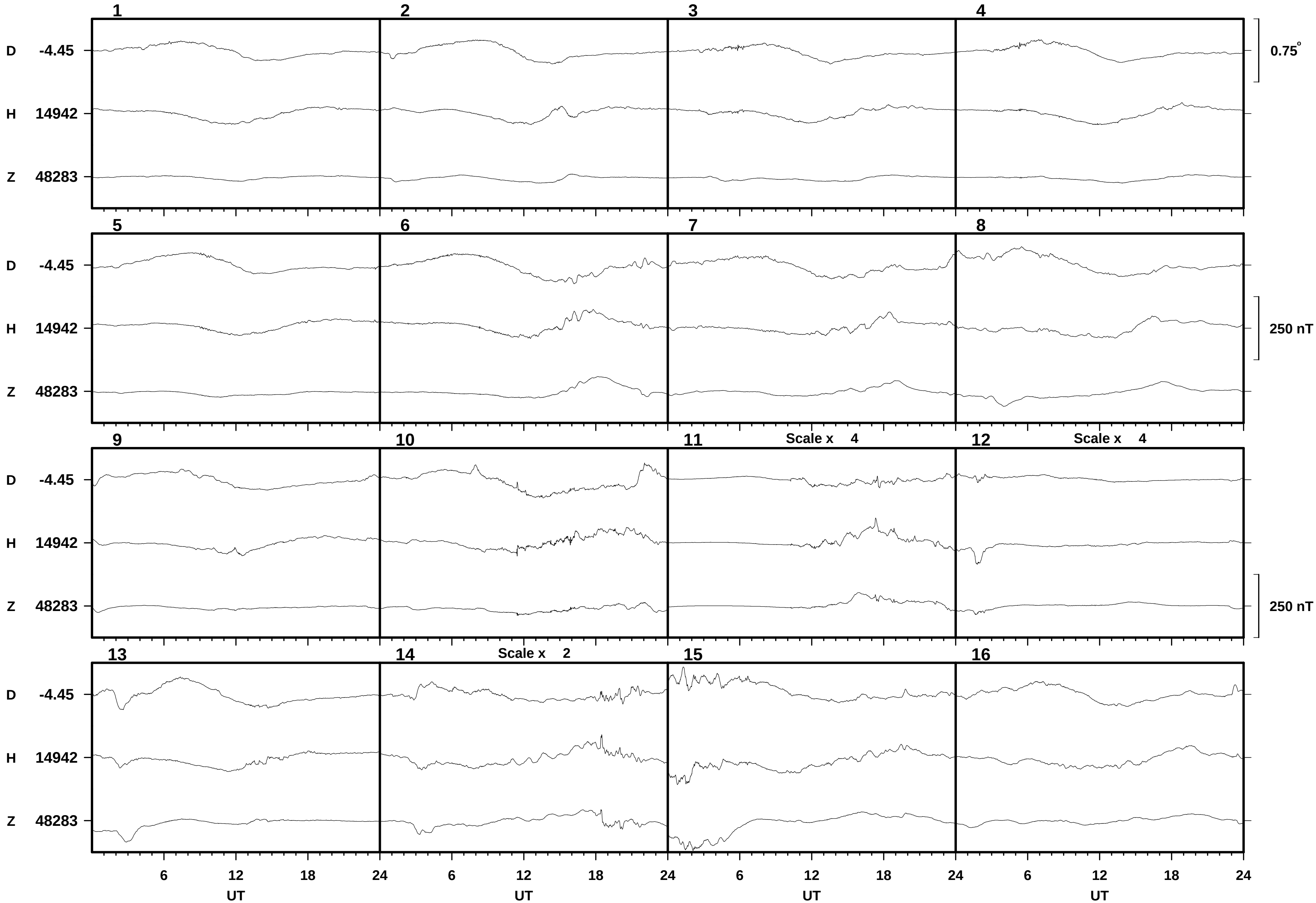
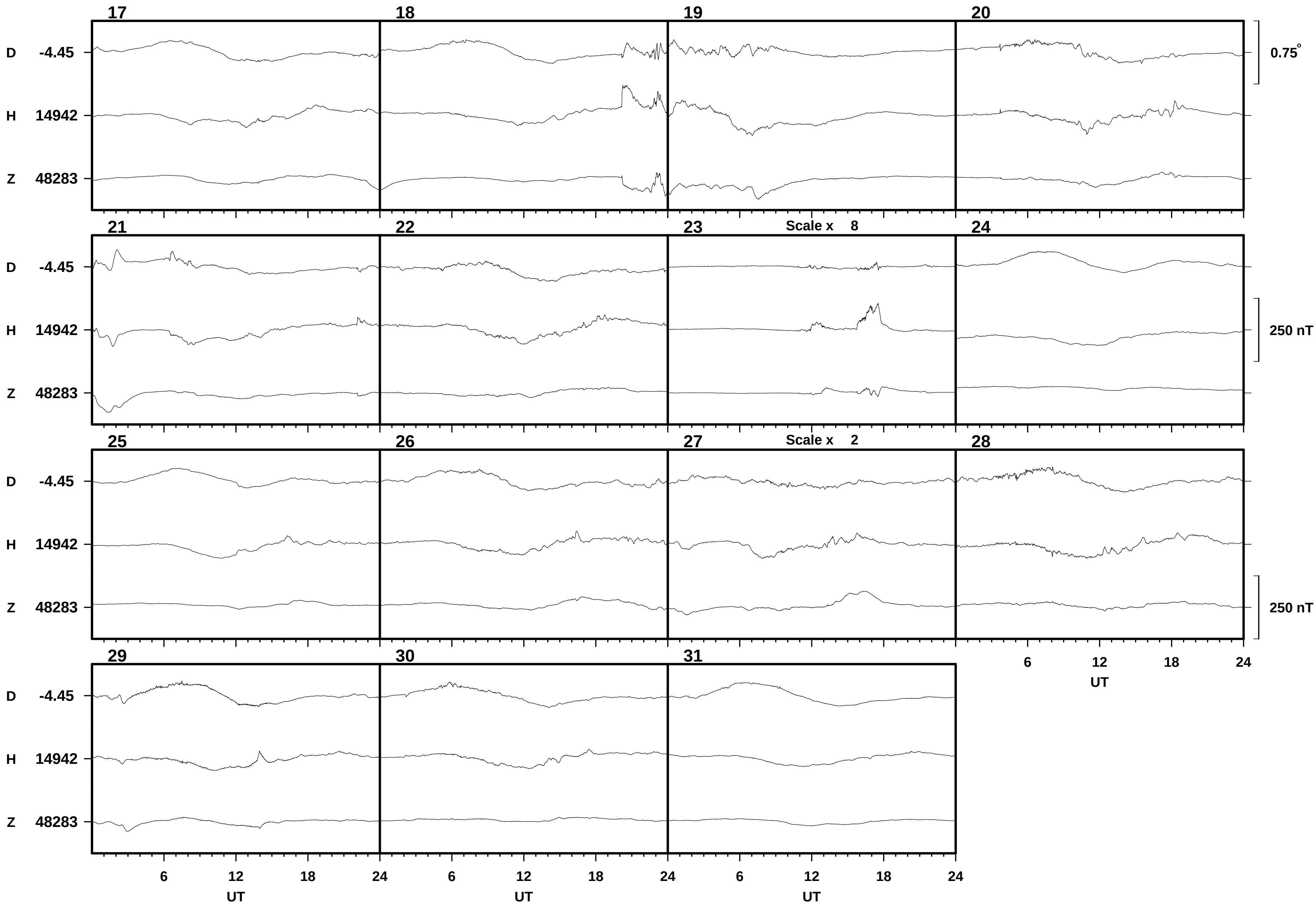
Scale x 8
20
Scale x 8
21
22
23
Scale x 2
24
25
26
27
28
29
30
D -4.47
H 14937
Z 48279
0.75°
250 nT
250 nT
6
12
18
24
UT

LE 4 2

Lerwick May 2002



LE 5 2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18
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21
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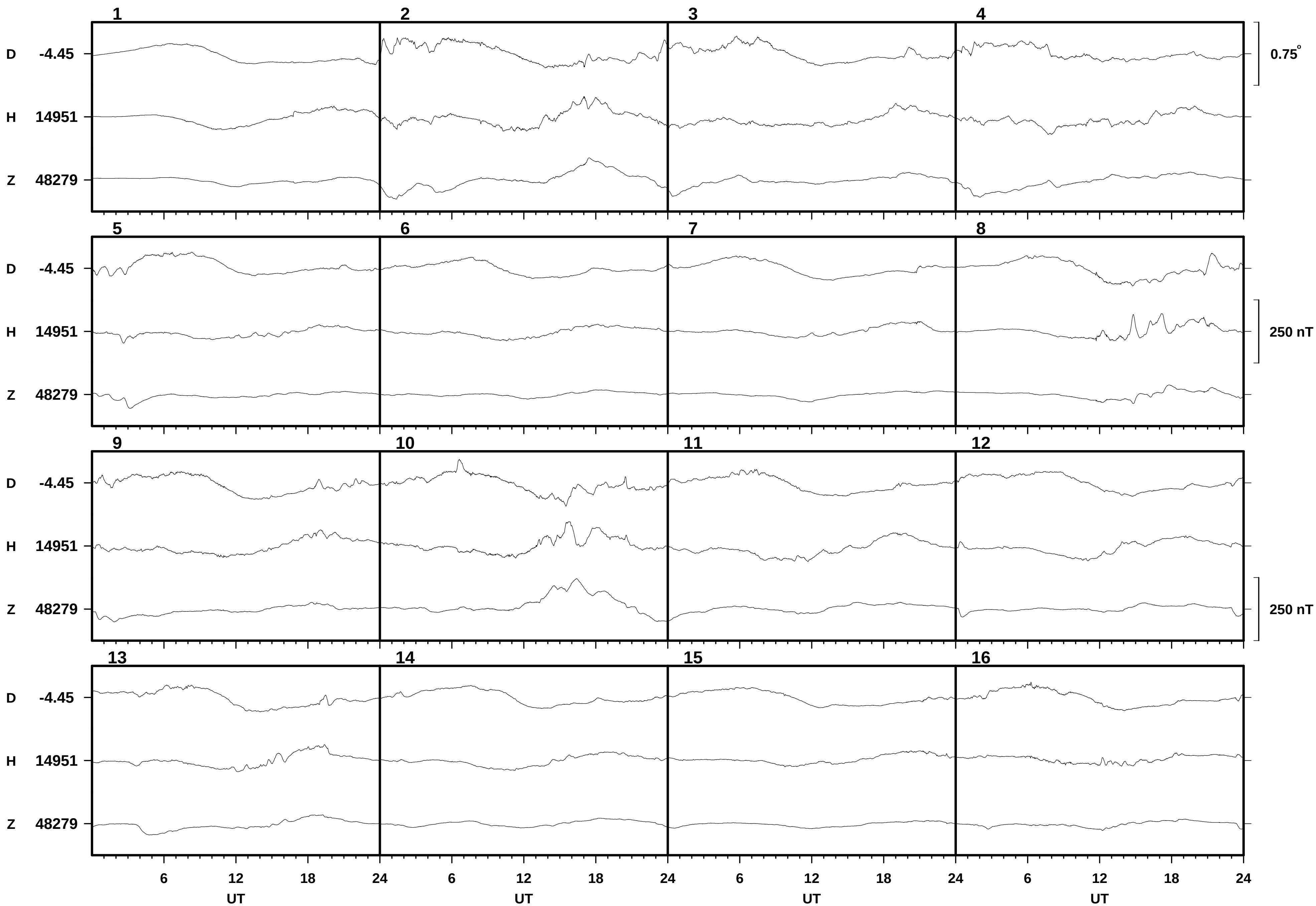
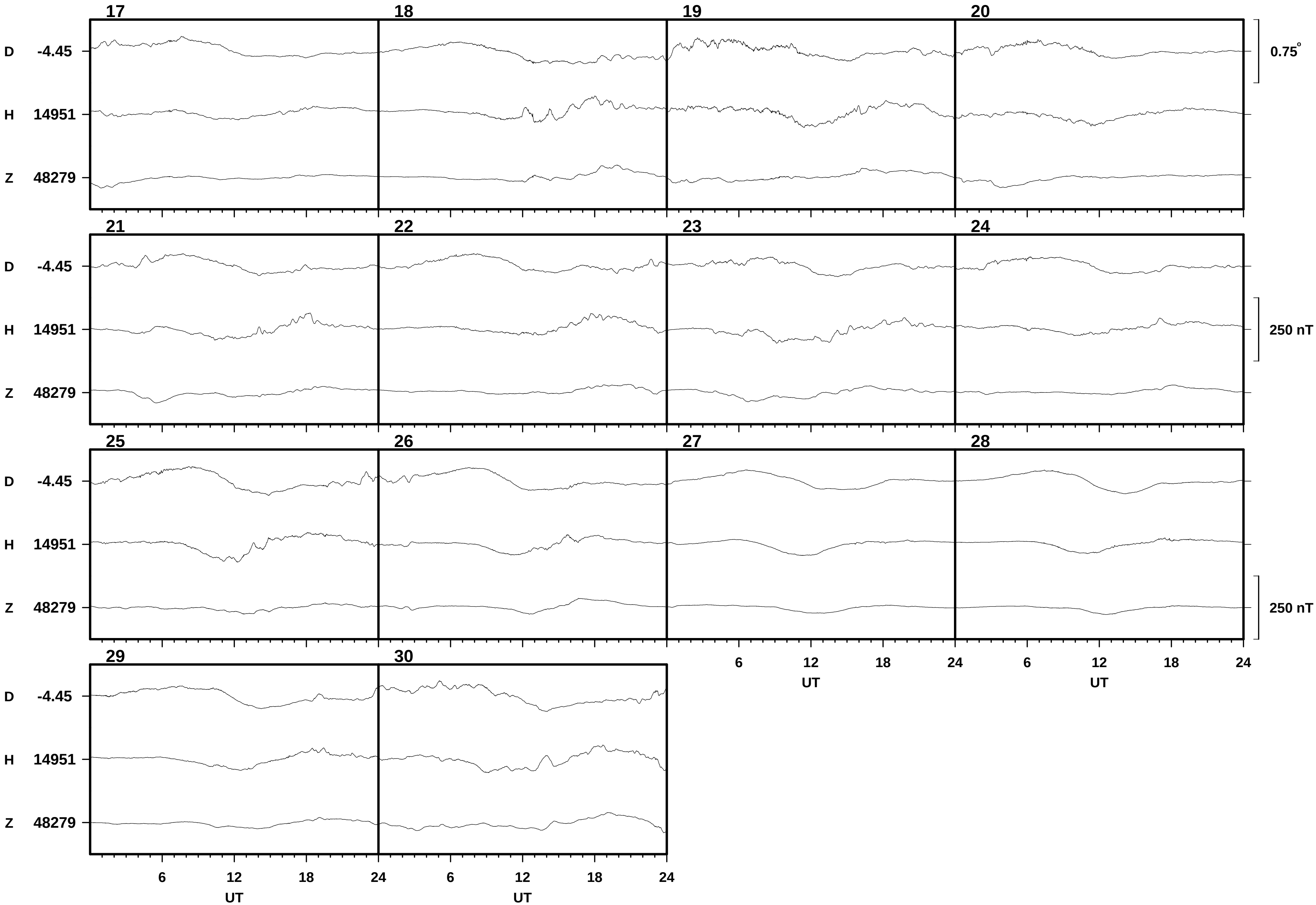
23
24
25
26
27
28
29
30
31
D -4.45
H 14942
Z 48283
0.75°
250 nT
250 nT
Scale x 8
Scale x 2
6
12
18
24
UT

Lerwick June 2002



LE 6 2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18
19
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21
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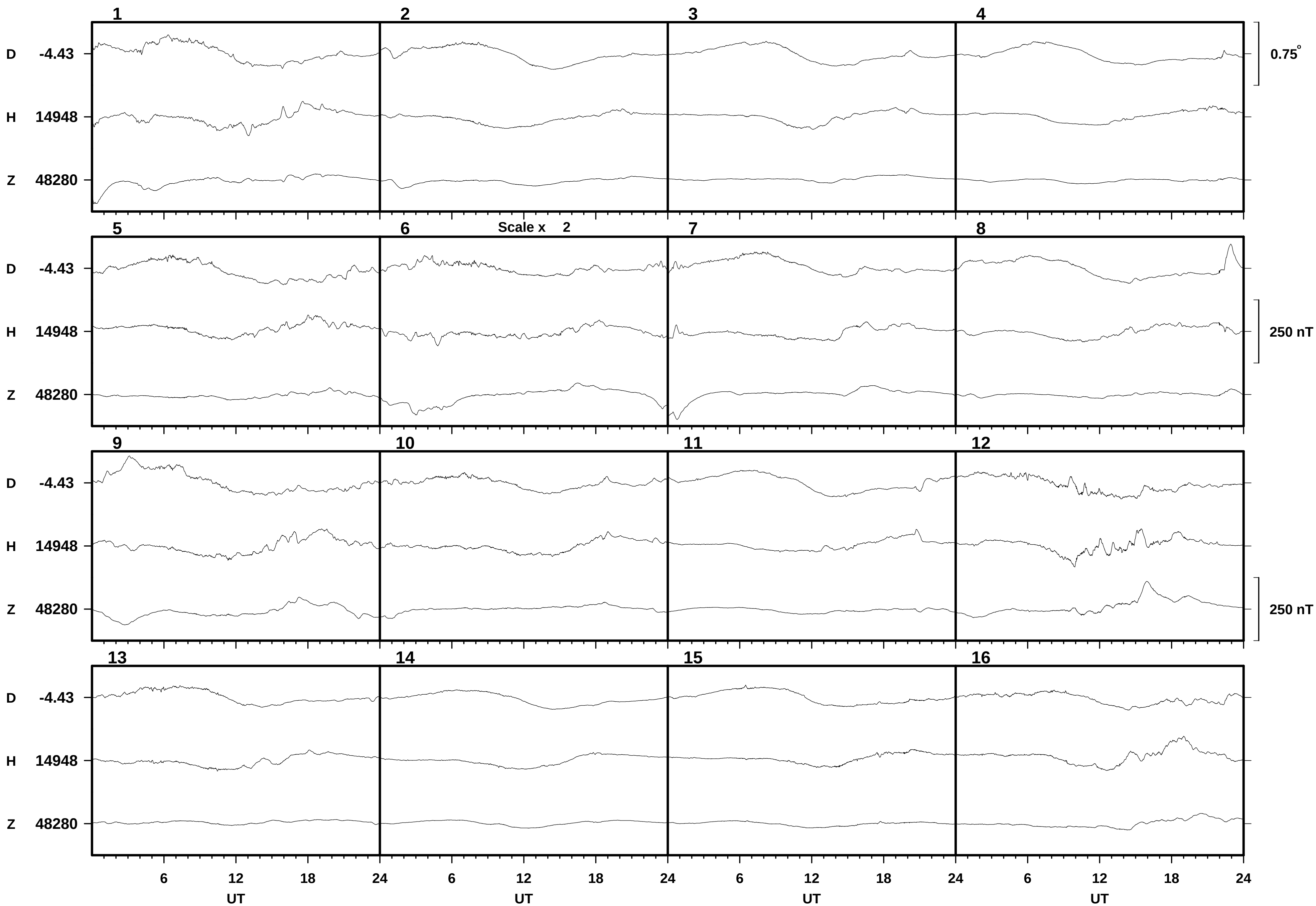
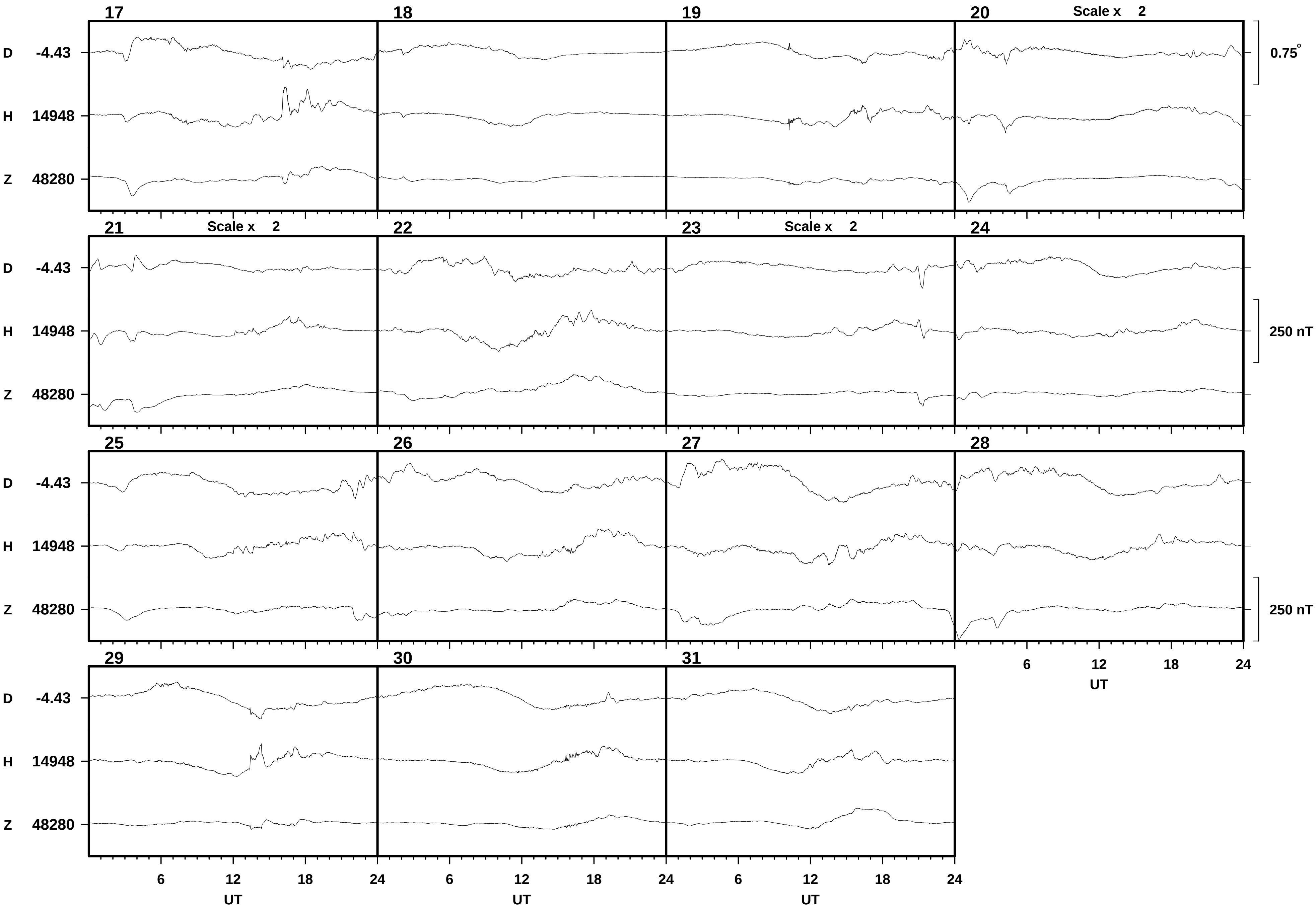
24
25
26
27
28
29
30
D -4.45
H 14951
Z 48279
0.75°
250 nT
250 nT
6
12
18
24
UT

LE 6 2

Lerwick July 2002



LE 7 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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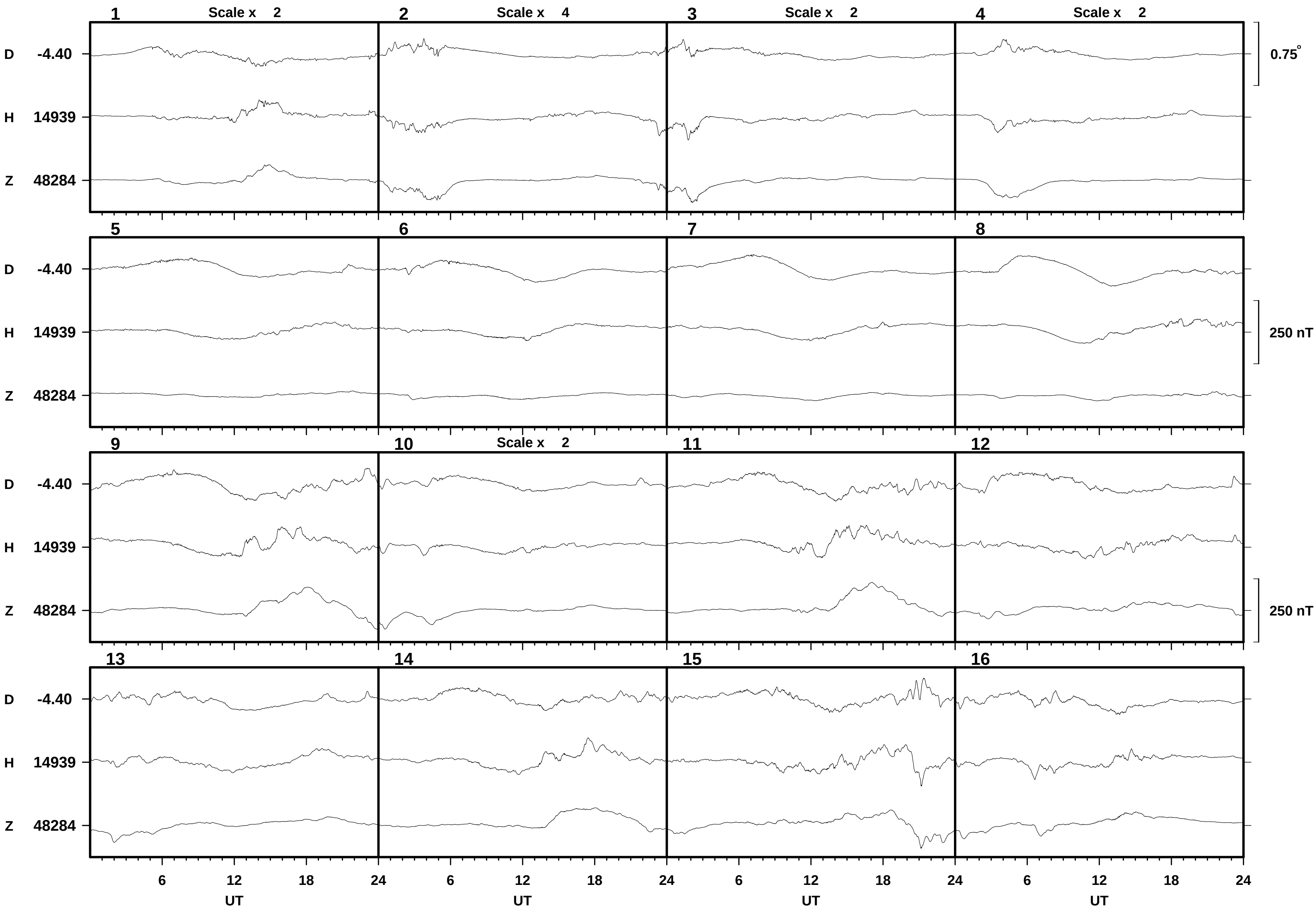
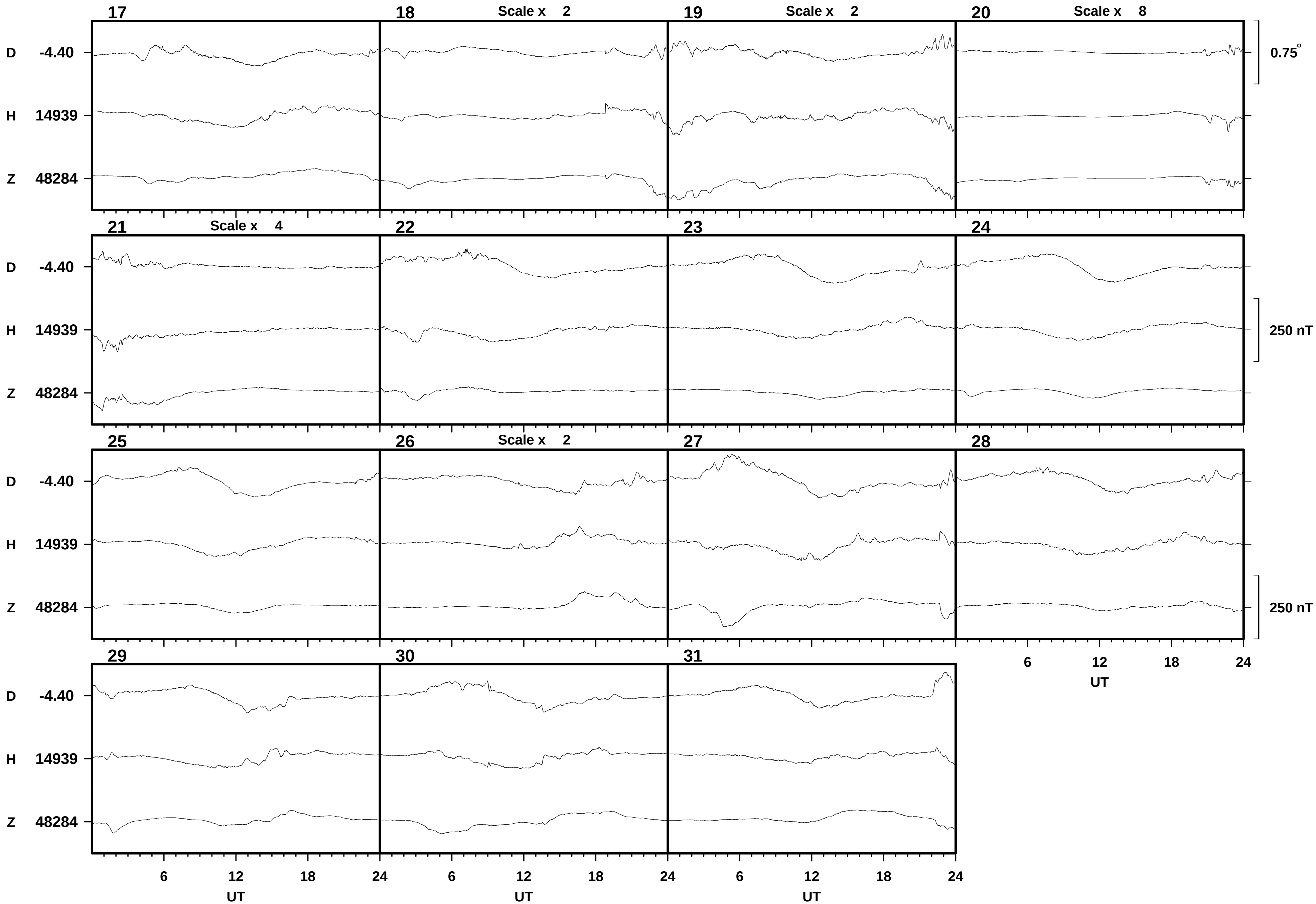
25
26
27
28
29
30
31
D -4.43
H 14948
Z 48280
0.75°
250 nT
250 nT
6
12
18
24
UT

LE 7 2

Lerwick August 2002

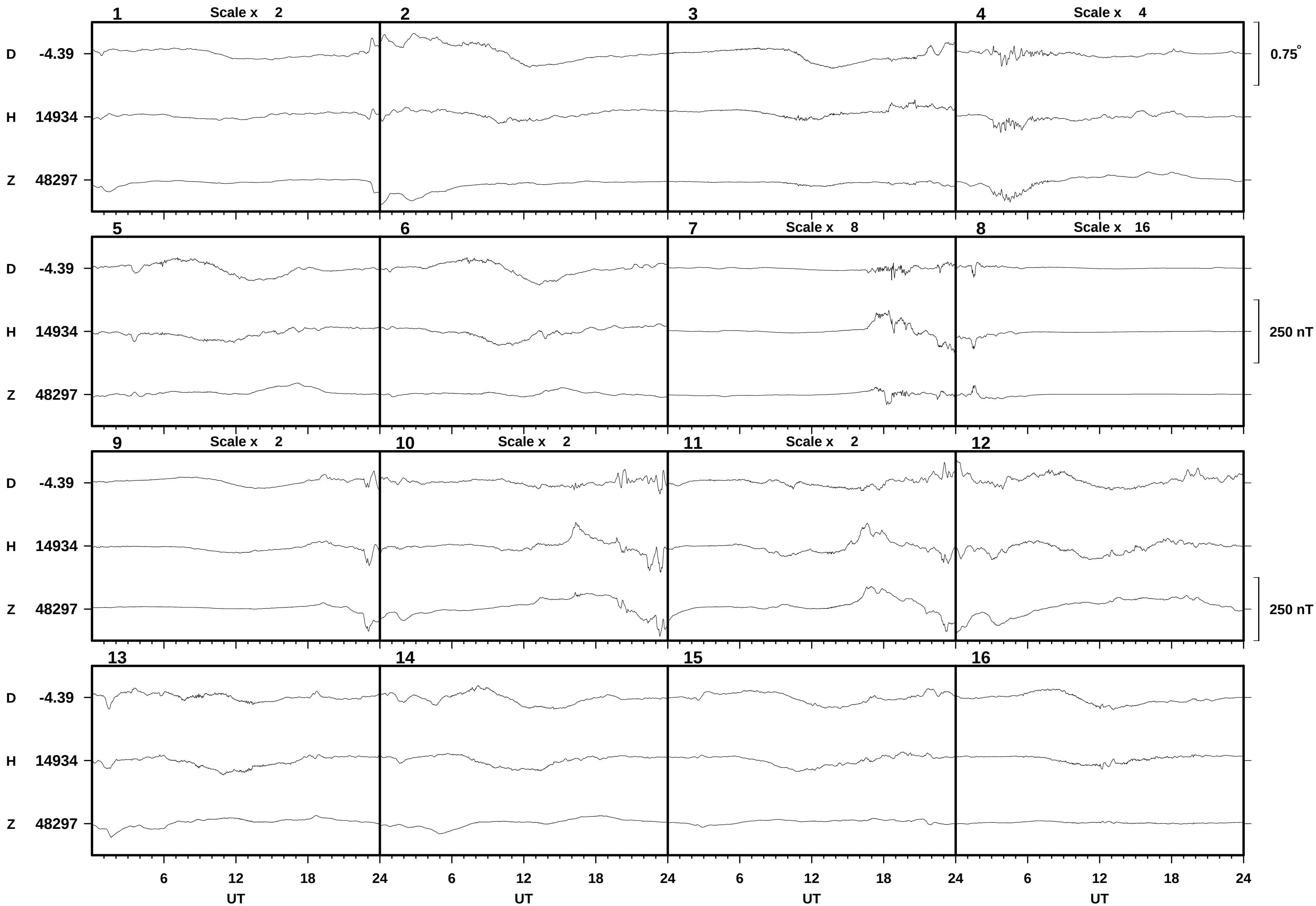


LE 8 2

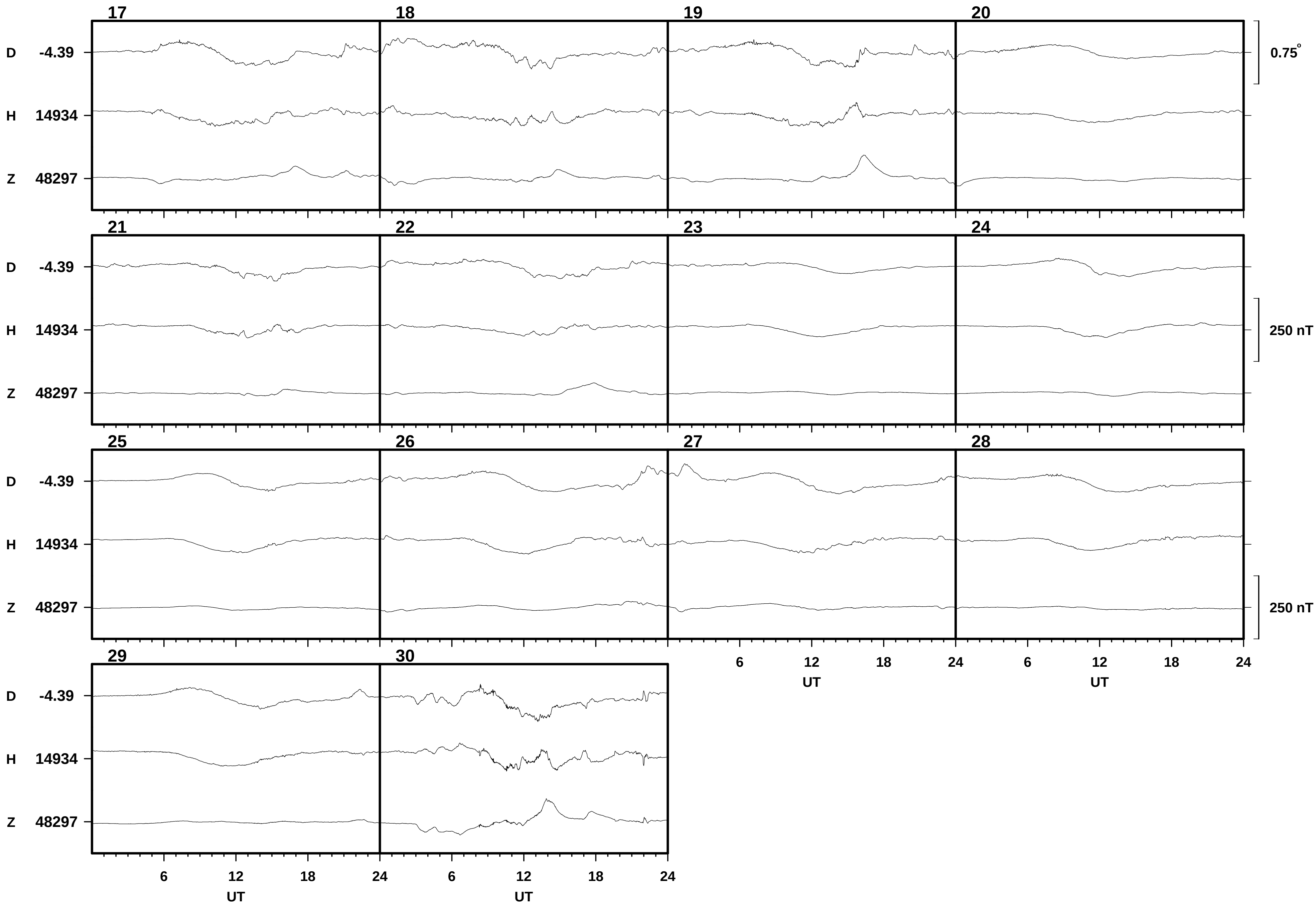

17
18
Scale x 2
19
Scale x 2
20
Scale x 8
0.75°
21
Scale x 4
22
23
24
250 nT
25
26
Scale x 2
27
28
250 nT
29
30
31
D -4.40
H 14939
Z 48284
6
12
18
24
UT

LE 8 2

Lerwick September 2002



LE 9 2


17
18
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21
22
23
24
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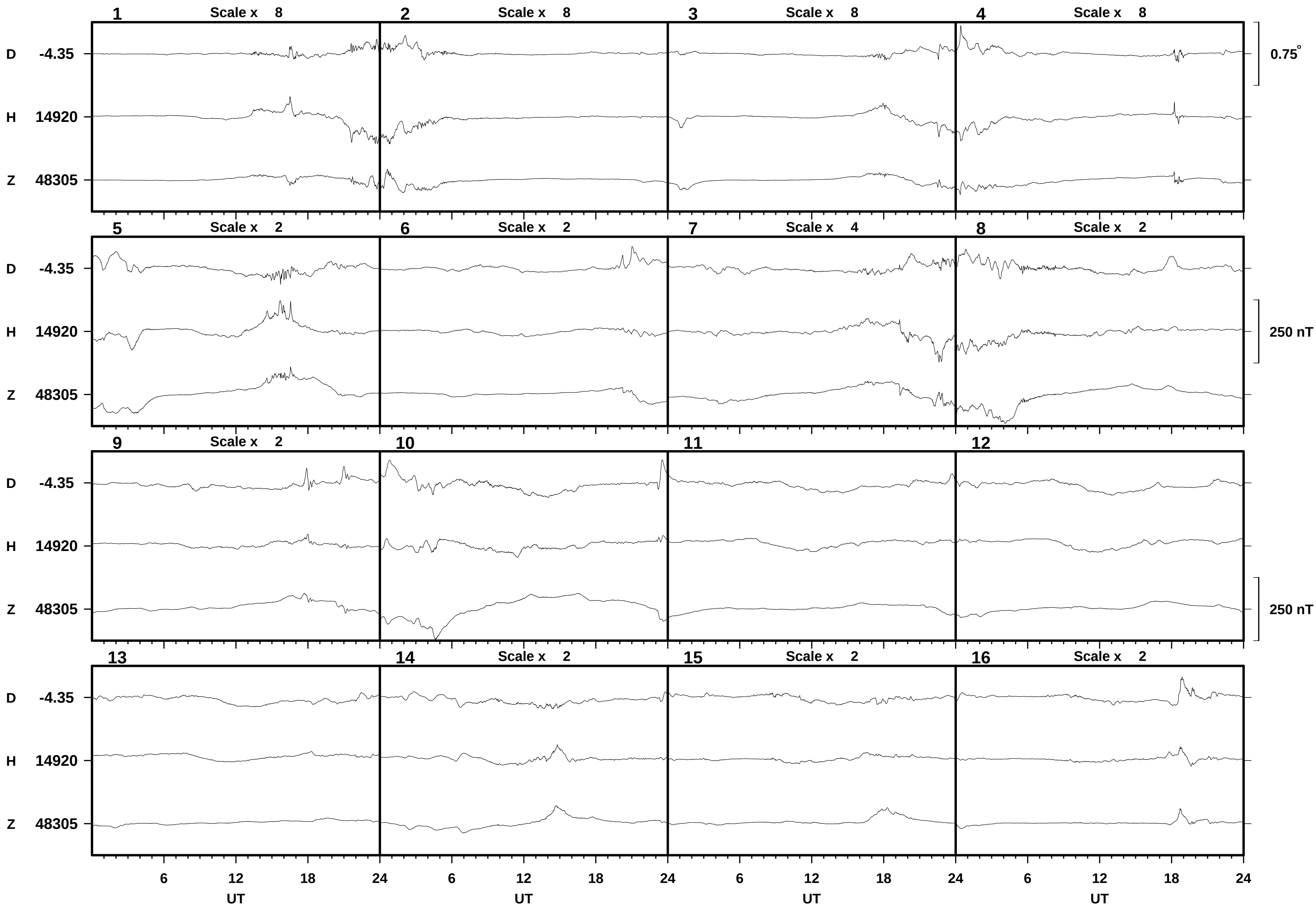
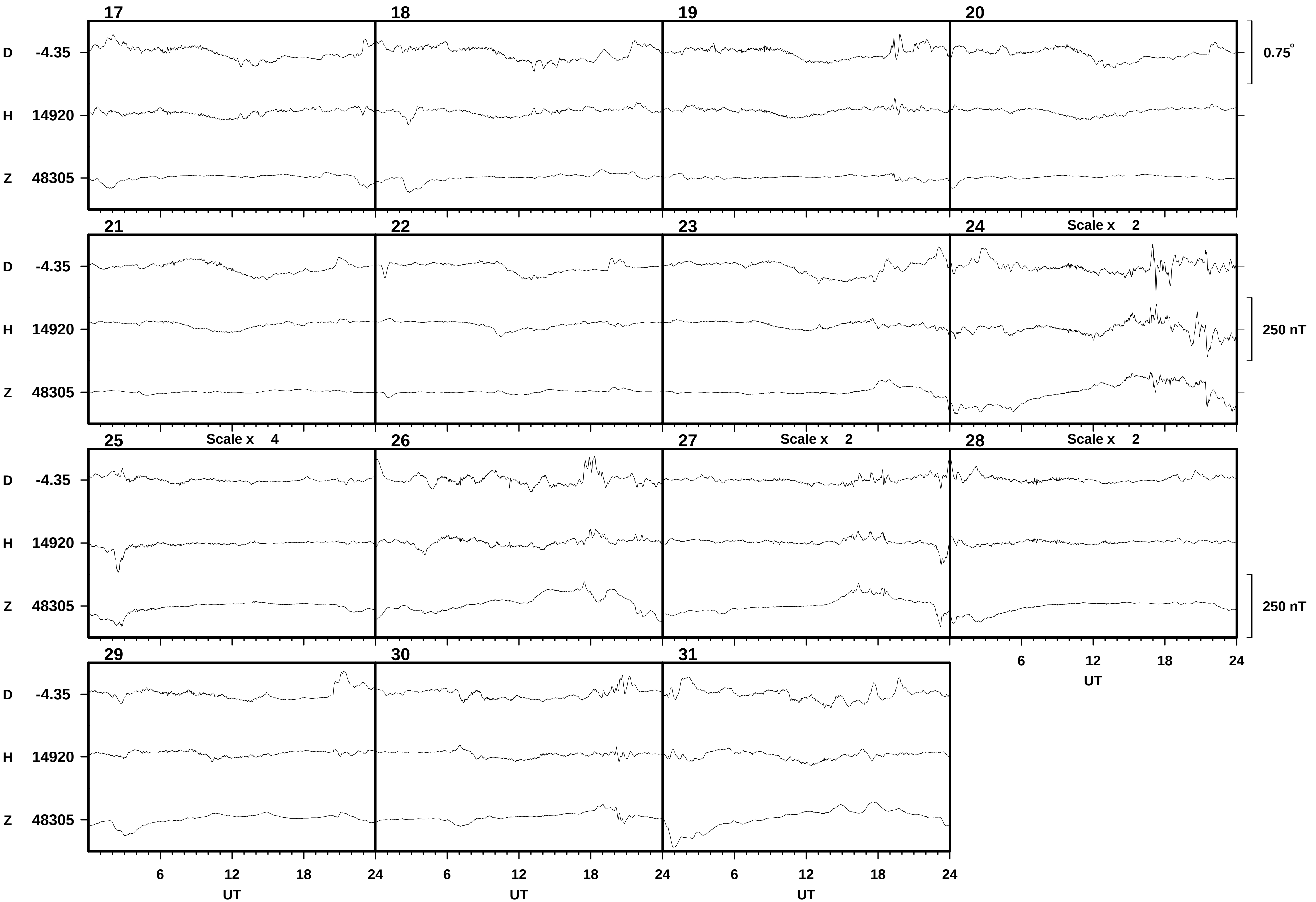
26
27
28
29
30
D -4.39
H 14934
Z 48297
0.75°
250 nT
250 nT
6
12
18
24
UT
LE 9 2

Lerwick October 2002



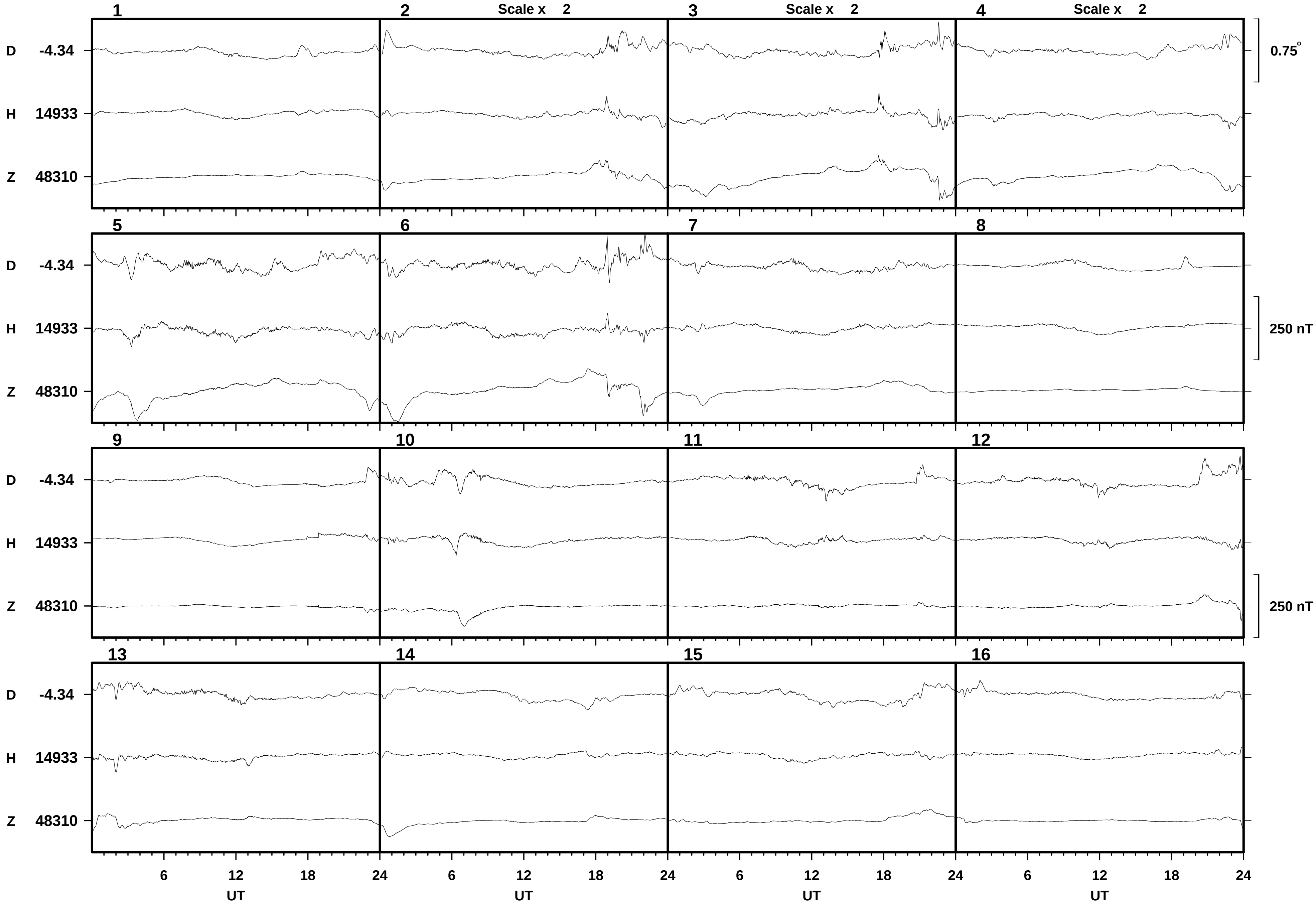
LE 10 2

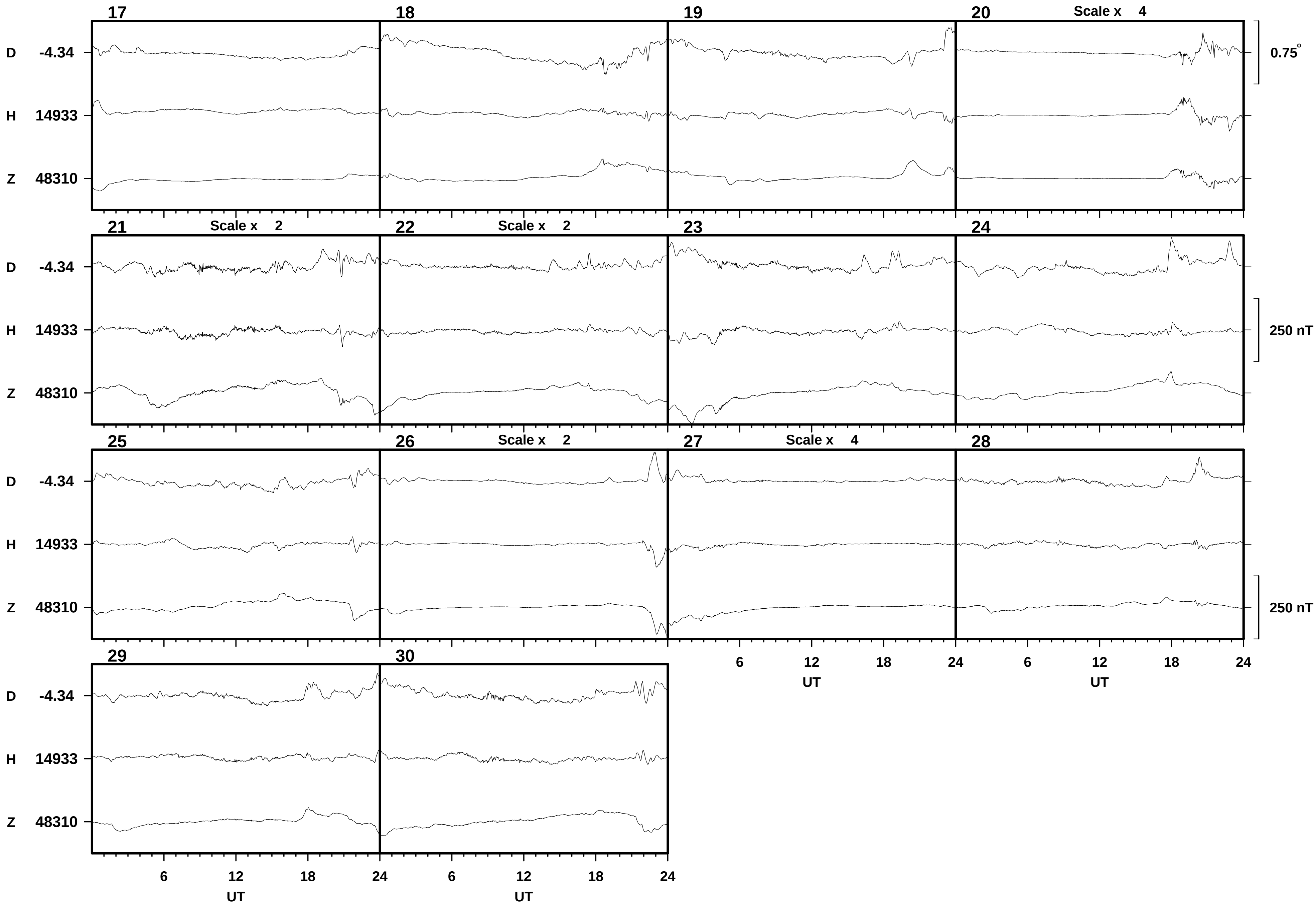


17
18
19
20
21
22
23
24
Scale x 2
25
Scale x 4
26
27
Scale x 2
28
Scale x 2
29
30
31
D -4.35
H 14920
Z 48305
0.75°
250 nT
250 nT
6 12 18 24
UT

LE 10 2

Lerwick November 2002

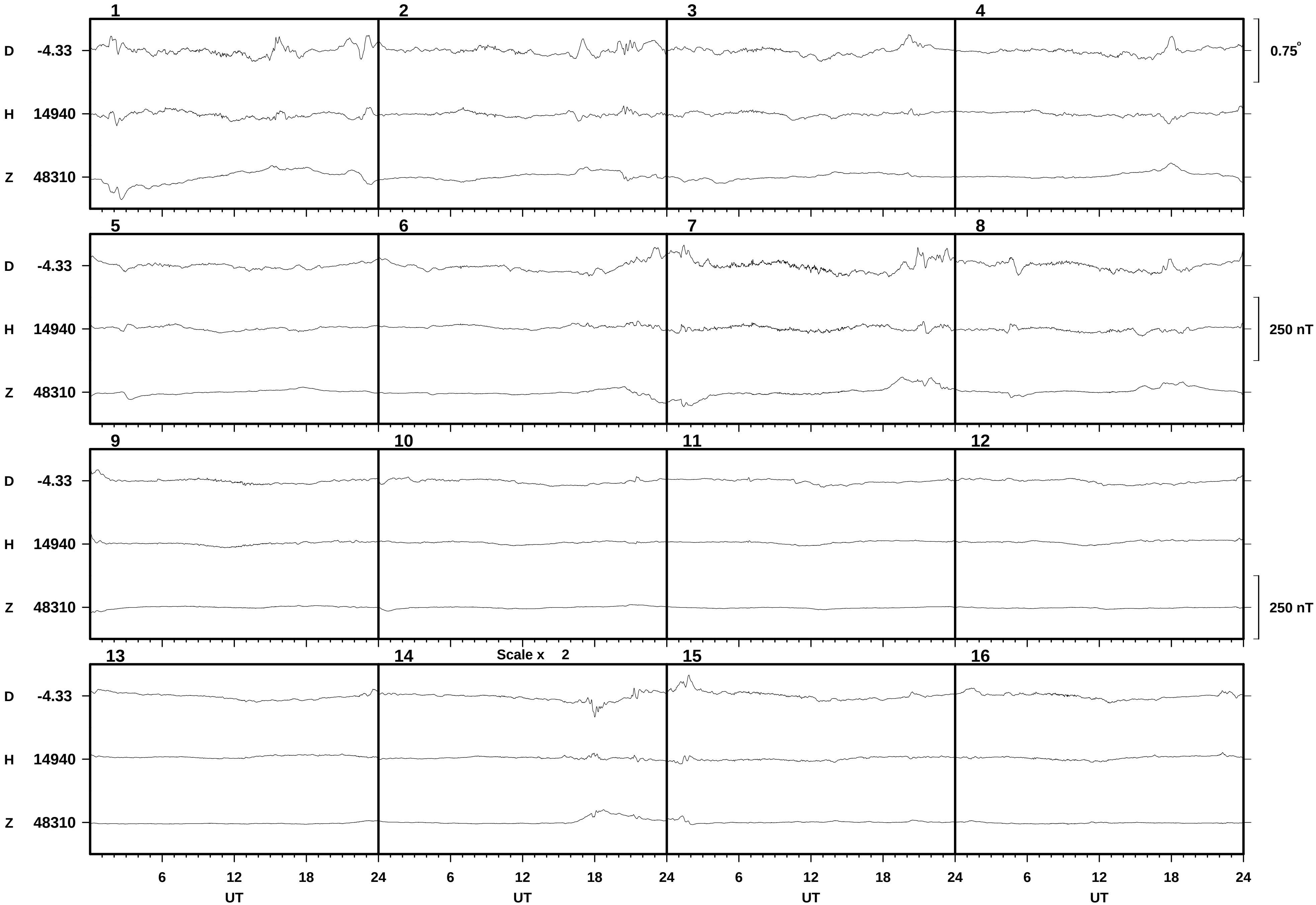




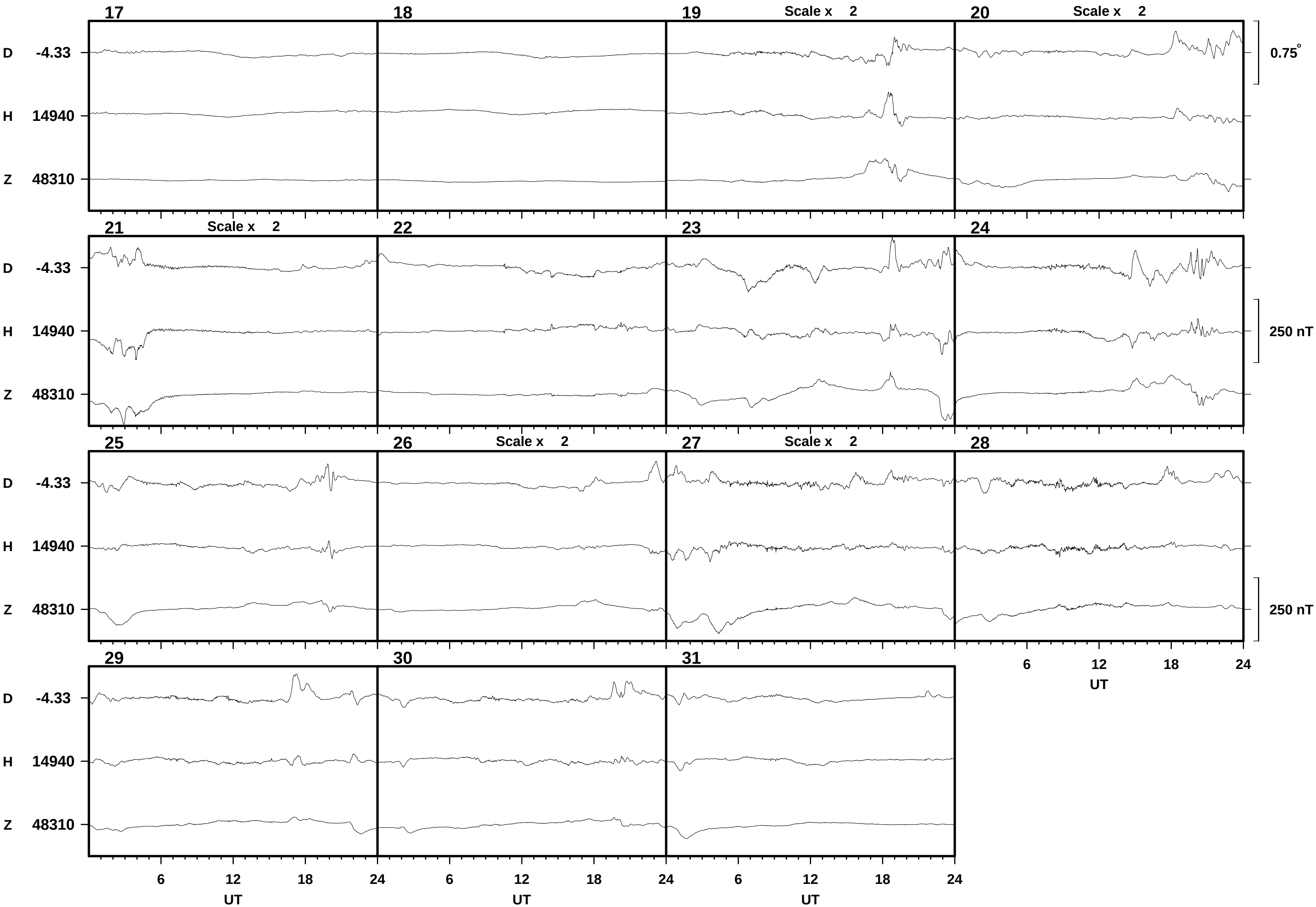
17
18
19
20
Scale x 4
21
Scale x 2
22
Scale x 2
23
24
25
26
Scale x 2
27
Scale x 4
28
29
30
D -4.34
H 14933
Z 48310
0.75°
250 nT
250 nT
6 12 18 24
UT

LE 11 2

Lerwick December 2002



LE 12 2


17
18
19
Scale x 2
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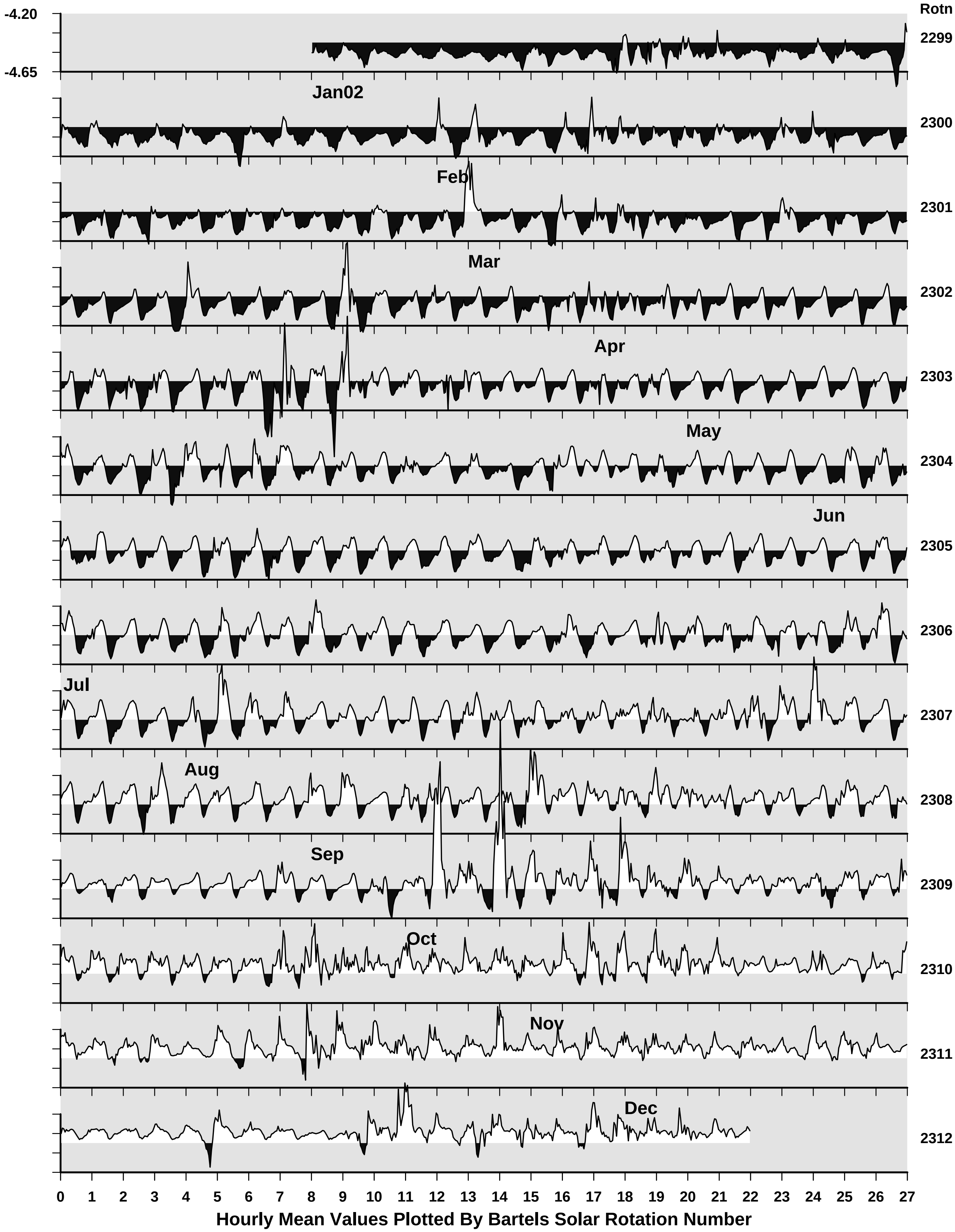
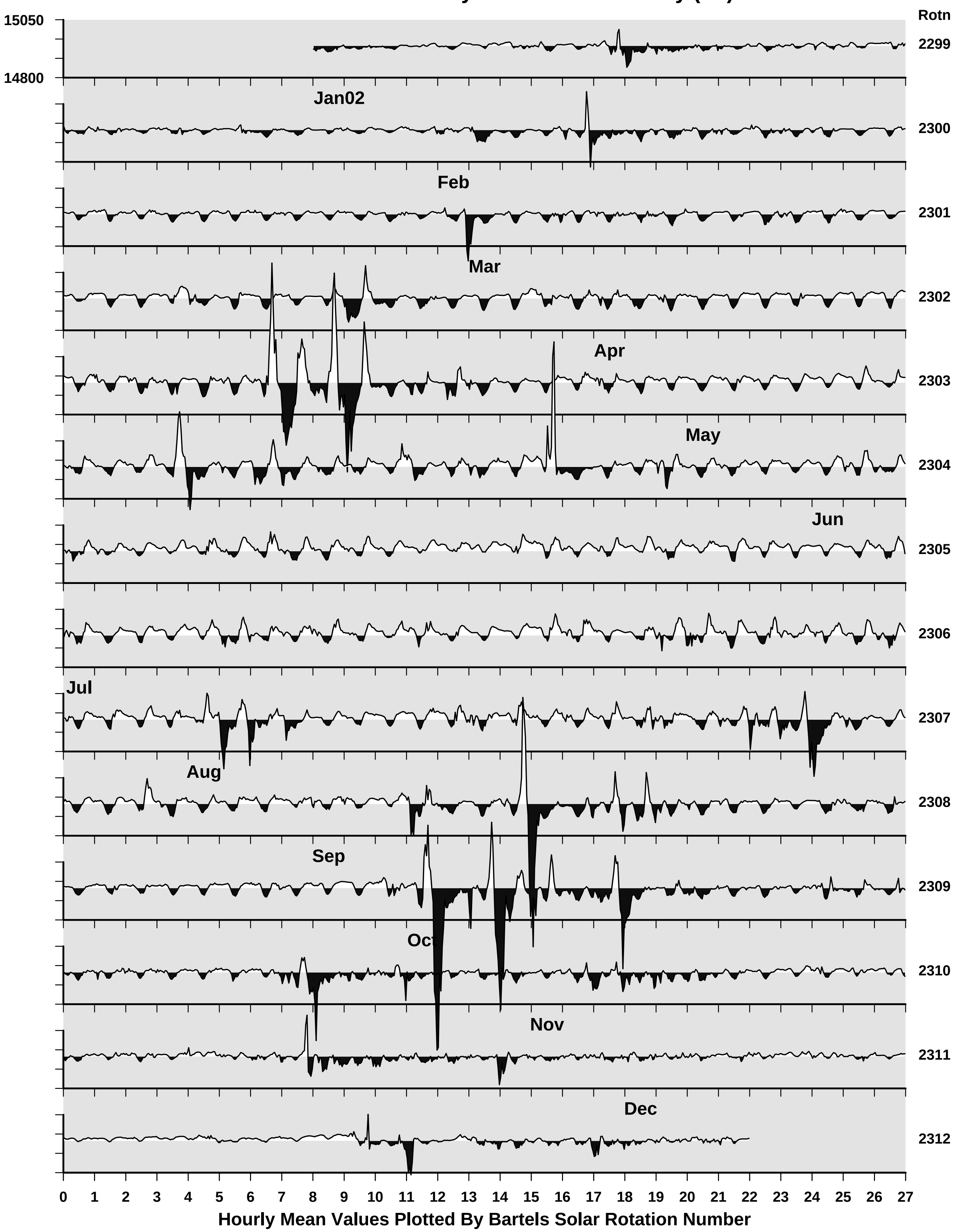
Scale x 2
21
Scale x 2
22
23
24
25
26
Scale x 2
27
Scale x 2
28
29
30
31
D -4.33
H 14940
Z 48310
0.75°
250 nT
250 nT
6
12
18
24
UT

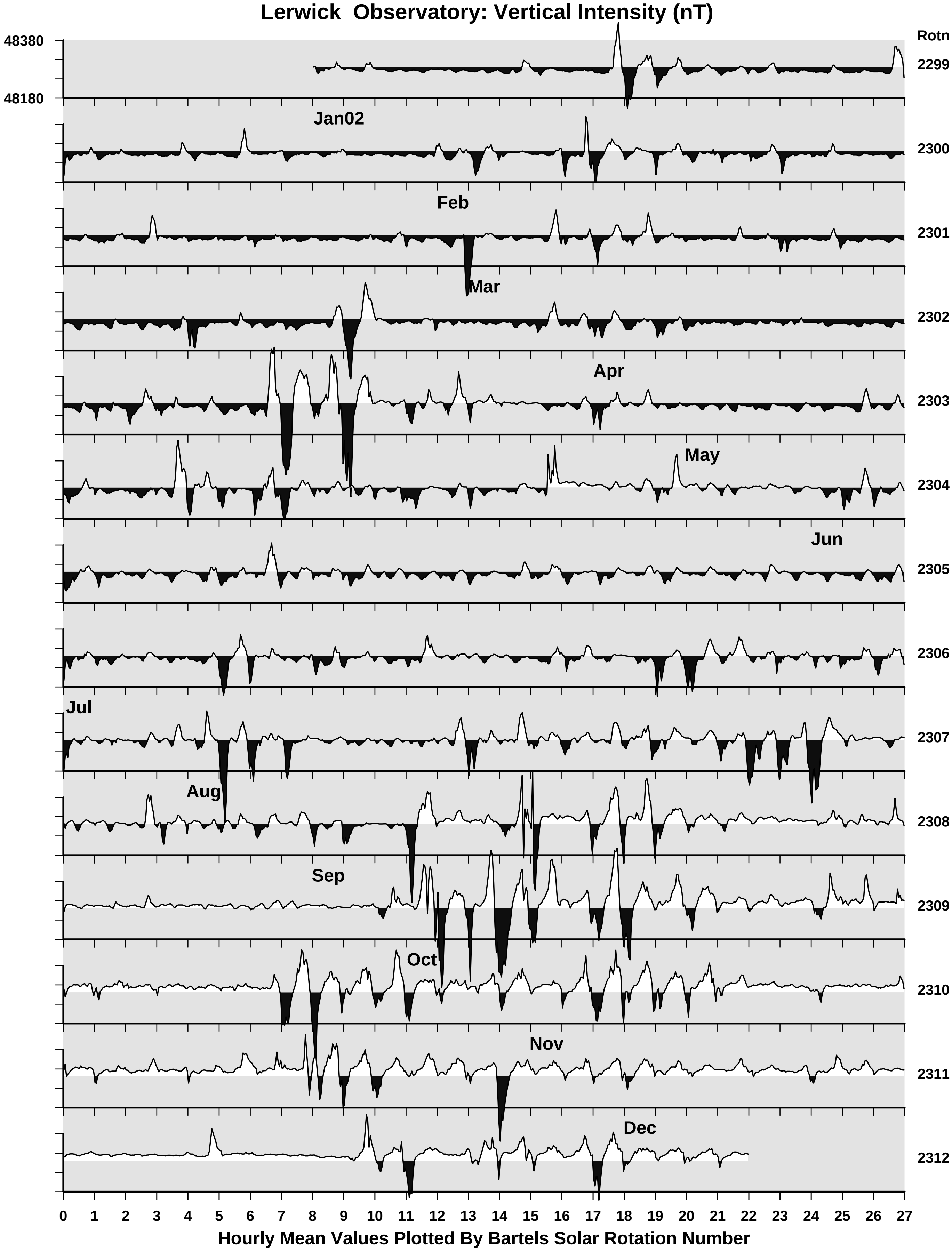
LE 12 2

Lerwick Observatory: Declination (degrees)



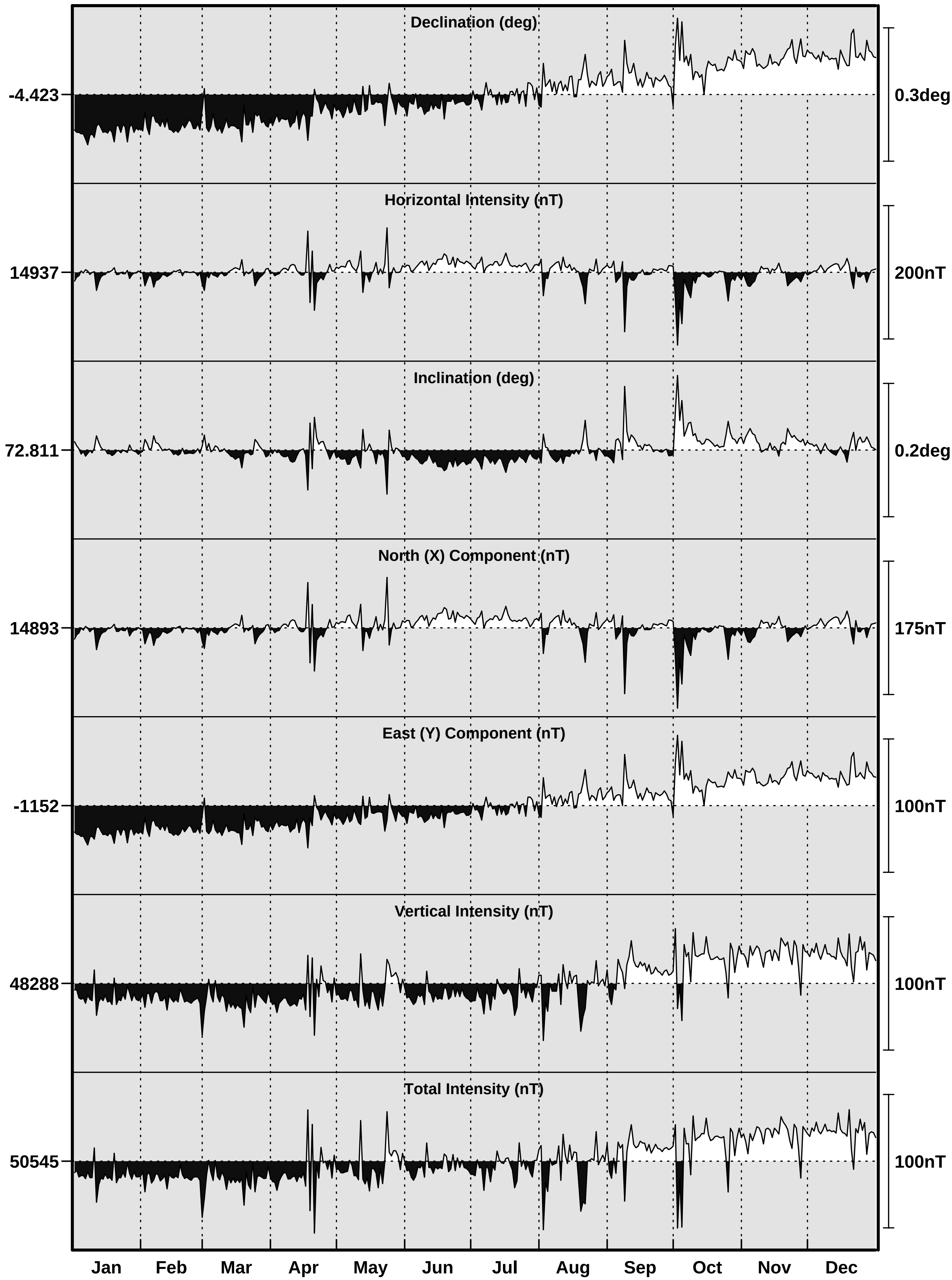
Lerwick Observatory: Horizontal Intensity (nT)



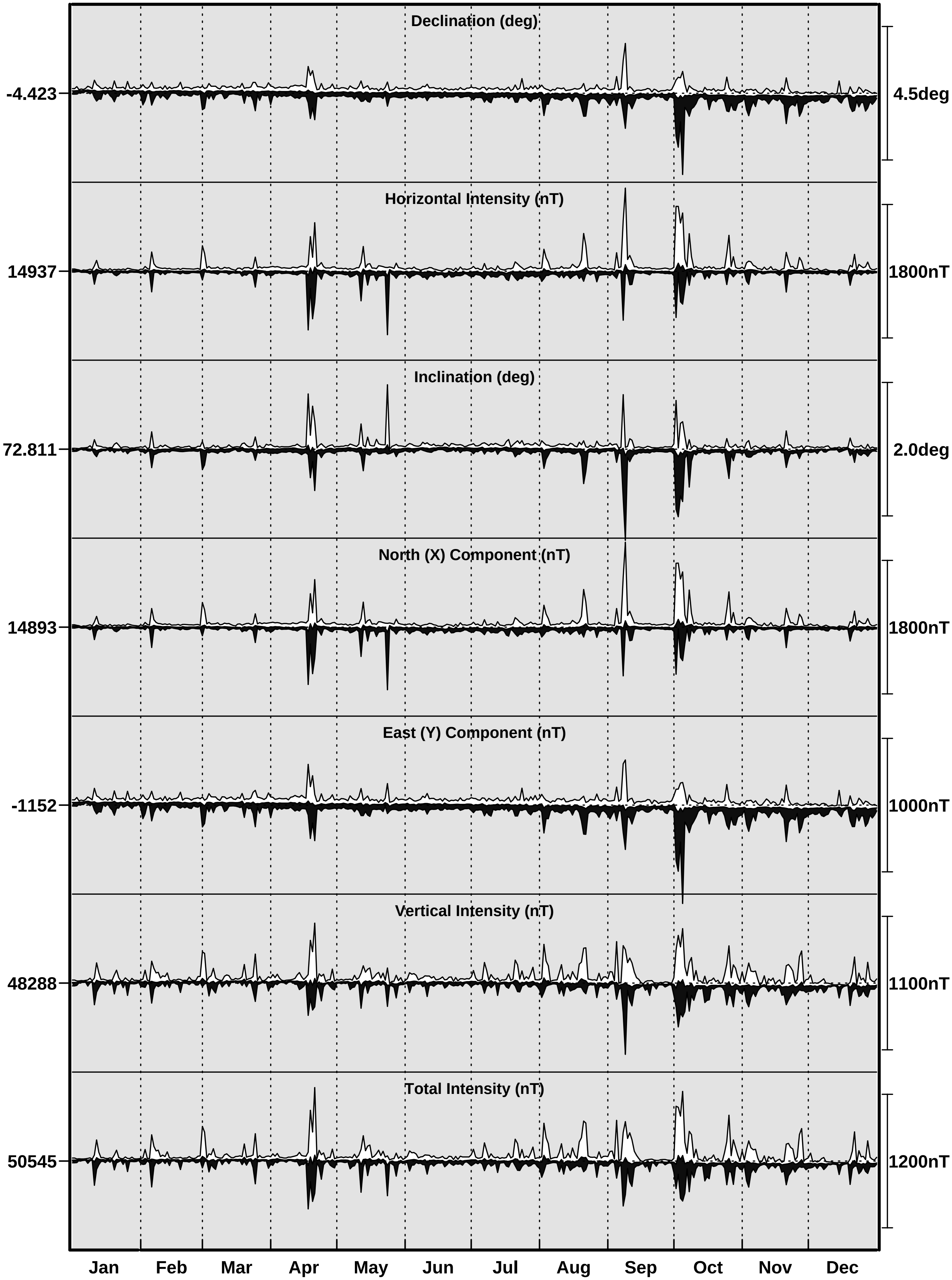


Lerwick Observatory: Vertical Intensity (nT)
48380
48180
Rotn
2299
2300
2301
2302
2303
2304
2305
2306
2307
2308
2309
2310
2311
2312
Jan02
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted By Bartels Solar Rotation Number

Lerwick Daily Mean Values 2002



Lerwick Daily Minimum/Maximum Values 2002



Monthly Mean Values for Lerwick 2002

Month	D	H	I	X	Y	Z	F

Based on All Days

Month	D	H	I	X	Y	Z	F
January	-4° 30.4′	14934 nT	72° 48.7′	14888 nT	-1173 nT	48278 nT	50535 nT
February	-4° 29.5′	14932 nT	72° 48.7′	14887 nT	-1169 nT	48275 nT	50532 nT
March	-4° 29.3′	14935 nT	72° 48.6′	14889 nT	-1169 nT	48275 nT	50532 nT
April	-4° 28.2′	14937 nT	72° 48.5′	14892 nT	-1164 nT	48279 nT	50537 nT
May	-4° 26.9′	14942 nT	72° 48.2′	14897 nT	-1159 nT	48283 nT	50542 nT
June	-4° 26.8′	14951 nT	72° 47.6′	14906 nT	-1159 nT	48279 nT	50541 nT
July	-4° 25.5′	14948 nT	72° 47.8′	14904 nT	-1154 nT	48280 nT	50541 nT
August	-4° 23.8′	14939 nT	72° 48.5′	14895 nT	-1145 nT	48284 nT	50542 nT
September	-4° 23.3′	14934 nT	72° 49.0′	14890 nT	-1143 nT	48297 nT	50553 nT
October	-4° 21.1′	14920 nT	72° 50.2′	14877 nT	-1132 nT	48305 nT	50557 nT
November	-4° 20.4′	14933 nT	72° 49.4′	14890 nT	-1130 nT	48310 nT	50565 nT
December	-4° 20.1′	14940 nT	72° 49.0′	14897 nT	-1129 nT	48310 nT	50567 nT
Annual	**-4° 25.4′**	**14937 nT**	**72° 48.7′**	**14893 nT**	**-1152 nT**	**48288 nT**	**50545 nT**

International quiet day means

Month	D	H	I	X	Y	Z	F
January	-4° 30.7′	14937 nT	72° 48.4′	14891 nT	-1175 nT	48276 nT	50534 nT
February	-4° 30.0′	14935 nT	72° 48.6′	14889 nT	-1172 nT	48276 nT	50533 nT
March	-4° 29.6′	14938 nT	72° 48.3′	14892 nT	-1170 nT	48273 nT	50532 nT
April	-4° 28.1′	14940 nT	72° 48.3′	14895 nT	-1164 nT	48278 nT	50536 nT
May	-4° 26.1′	14938 nT	72° 48.6′	14893 nT	-1155 nT	48287 nT	50545 nT
June	-4° 27.0′	14951 nT	72° 47.5′	14906 nT	-1160 nT	48278 nT	50540 nT
July	-4° 26.1′	14950 nT	72° 47.7′	14905 nT	-1156 nT	48280 nT	50542 nT
August	-4° 23.9′	14943 nT	72° 48.2′	14899 nT	-1146 nT	48286 nT	50545 nT
September	-4° 23.6′	14941 nT	72° 48.6′	14897 nT	-1145 nT	48296 nT	50554 nT
October	-4° 22.5′	14935 nT	72° 49.2′	14892 nT	-1139 nT	48308 nT	50564 nT
November	-4° 21.5′	14942 nT	72° 48.8′	14899 nT	-1135 nT	48309 nT	50567 nT
December	-4° 20.8′	14950 nT	72° 48.2′	14907 nT	-1133 nT	48306 nT	50566 nT
Annual	**-4° 25.8′**	**14942 nT**	**72° 48.4′**	**14897 nT**	**-1154 nT**	**48288 nT**	**50547 nT**

International disturbed day means

Month	D	H	I	X	Y	Z	F
January	-4° 30.4′	14929 nT	72° 49.1′	14882 nT	-1173 nT	48281 nT	50536 nT
February	-4° 28.2′	14921 nT	72° 49.4′	14876 nT	-1163 nT	48271 nT	50524 nT
March	-4° 28.3′	14932 nT	72° 48.7′	14886 nT	-1164 nT	48271 nT	50528 nT
April	-4° 28.2′	14934 nT	72° 48.8′	14889 nT	-1164 nT	48286 nT	50543 nT
May	-4° 27.7′	14958 nT	72° 47.4′	14913 nT	-1164 nT	48292 nT	50555 nT
June	-4° 26.9′	14949 nT	72° 47.8′	14904 nT	-1159 nT	48280 nT	50542 nT
July	-4° 25.4′	14946 nT	72° 47.9′	14901 nT	-1153 nT	48278 nT	50538 nT
August	-4° 22.7′	14918 nT	72° 49.5′	14874 nT	-1139 nT	48265 nT	50518 nT
September	-4° 23.3′	14919 nT	72° 50.0′	14875 nT	-1142 nT	48296 nT	50548 nT
October	-4° 18.5′	14882 nT	72° 52.3′	14840 nT	-1118 nT	48293 nT	50534 nT
November	-4° 19.4′	14920 nT	72° 50.2′	14878 nT	-1125 nT	48309 nT	50560 nT
December	-4° 19.4′	14932 nT	72° 49.5′	14889 nT	-1126 nT	48311 nT	50566 nT
Annual	**-4° 24.9′**	**14928 nT**	**72° 49.2′**	**14884 nT**	**-1149 nT**	**48286 nT**	**50541 nT**

Lerwick Observatory K Indices 2002

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1210 1122	4212 3202	5201 1100	3333 3231	0100 1110	0000 0212	3322 3321	0233 5423	3111 2124	1133 6768	1011 1223	3222 2313
2	1001 2221	3342 2202	1011 1210	1233 1120	2101 3310	3312 3333	2100 0120	5532 4436	3212 1000	8743 1333	5212 3354	2121 1333
3	1000 0000	1000 1100	1111 2243	3332 2121	1110 1210	2320 2122	0011 2120	5232 3221	0002 2132	6232 2777	3433 3545	2211 2132
4	0000 0001	0101 1212	3111 1212	1111 2101	1110 1110	3232 2321	1000 1012	3422 1220	4643 4442	8644 4384	4322 2434	1111 1332
5	1100 0000	3211 2366	4322 2333	0110 1110	1001 1001	3210 2111	1121 2333	1100 1112	1311 1210	4512 5543	3423 3333	3211 1111
6	0000 1100	4233 3232	1232 2332	0001 1111	0001 2423	1110 0112	4433 3433	2100 2100	1111 2111	1222 1144	3222 2354	1101 0223
7	0111 1221	2222 2113	1112 2112	1112 3300	2110 2333	2101 1112	3111 3221	1000 1220	2321 3788	2443 4567	3212 2221	3222 2243
8	2231 2100	3112 2323	0121 0000	0011 1010	2221 2211	0101 4433	2110 2214	2201 2222	8631 1223	4432 3443	0011 1020	1311 2323
9	0000 0101	2211 1134	0001 1220	0111 1100	2012 2011	2211 1222	4322 2332	1021 4423	1001 1235	1132 3454	1000 1123	3000 1100
10	1011 3453	3211 1101	0012 2113	0011 3211	1123 2323	1231 3433	2111 2222	4413 3223	3112 3545	3323 2214	3341 1111	2000 0001
11	4432 2433	3112 2222	2312 2111	1133 3323	1014 6655	2122 2221	1000 2122	0112 4332	3223 3544	1111 1122	1122 3123	0011 1000
12	3233 2341	3211 1004	1122 2213	3112 3221	6322 2212	2111 2212	2224 3321	3212 3222	3322 2222	2011 1202	1213 2143	1000 0001
13	2122 2113	2122 2400	1011 2100	3322 3323	3210 2210	0211 2331	1211 2221	3211 1222	3222 2221	1110 0122	3212 2012	1000 0011
14	2110 1111	0010 0000	0001 0110	2201 3310	4433 4454	1010 1111	0000 1110	1211 3432	2221 2110	3332 5423	2111 1211	1111 1443
15	0111 1222	0000 1210	0011 0022	1000 1222	4321 2221	0000 1101	1010 1211	1123 3444	1101 1222	2223 2322	2211 2223	3101 1121
16	1000 1100	1101 0200	0001 1100	2221 2121	1211 2222	2121 2112	0111 3332	2232 3210	1111 2100	3111 2353	3110 0012	2001 1002
17	3201 1212	1232 2112	0001 1110	2224 6763	1010 2221	2110 1110	2321 2442	0320 2222	0212 2223	3221 2223	3100 1111	1000 0000
18	3100 1000	1111 1243	2011 3322	6655 5545	1111 2144	0002 3432	2101 1000	3211 2244	3222 3212	3321 2233	2111 1233	0000 0000
19	0002 2324	2010 1110	4321 1111	3335 5765	3420 1000	3222 2222	0003 2323	5443 3434	2112 3322	2221 1143	2221 2033	1232 3362
20	3211 1112	2011 2213	0000 2320	7753 6643	0213 2231	2211 1100	4521 2234	3311 1467	1000 0001	3212 2213	2201 1376	3211 3255
21	3221 1222	1111 1112	2121 1121	2101 1012	3131 2112	1211 2331	4420 3431	6532 3222	1011 2200	1111 1222	3444 3354	5621 1323
22	0111 2111	1201 1131	2211 1000	2411 3321	1112 2221	1001 1222	2233 3322	3321 1121	2111 2222	3112 2121	3222 3434	2101 2121
23	2111 1232	2001 1001	0012 3344	1343 3423	1215 6853	1122 3221	3211 3335	0111 1222	0010 0110	1111 2333	3322 2332	2232 3244
24	1200 0000	1101 1111	5542 3533	3111 1212	1100 1000	1111 1210	3111 2121	1101 1111	0001 1010	5434 5666	3222 1443	3012 4443
25	1001 2342	2001 1122	2101 2310	2000 1110	1000 1310	1101 4212	3212 3223	2011 1112	0000 1101	7543 4234	2122 2313	2221 2241
26	3112 1121	1011 1122	1122 2123	1000 1111	1111 2312	2100 2310	3322 2322	1112 4443	1010 1123	3323 3443	3101 1125	1111 2334
27	3211 1101	2001 1002	0010 1110	1112 3332	3242 4422	1000 1010	3322 4423	2322 2313	3000 1101	3322 2445	4431 2232	4533 3443
28	2101 2121	1322 2346	0000 1100	3422 3321	2221 2222	0000 1100	3321 2322	1121 1222	1010 0110	5232 2232	2111 2232	3233 2333
29	2101 0000		0001 1112	2012 2223	3111 3111	1001 1122	1211 4321	3011 3310	0010 1102	3222 2233	2211 2333	2111 1433
30	0000 0011		1232 3322	2111 2220	1111 2211	2222 3323	1110 1232	1222 2120	1233 4323	1131 2233	3222 2223	2111 2133
31	2100 0003		1333 2342		1100 0111		1002 2321	0011 1223		3312 3332		3211 1002

SIs and SSCs

Day	Month	UT		Type	Quality	H (nT)	D (min)	Z (nT)
19	01	05	12	SSC	C	2.7	-0.92	-2.3
31	01	21	28	SSC	B	10.6	-0.40/+0.40	-5.1
17	02	02	56	SSC	C	13.6	-2.42	-5.6
28	02	04	52	SSC	B	11.7	-4.39	-2.3
15	03	17	51	SSC	B	-2.8	0.53	-1.4/1.3
18	03	13	23	SSC	A	54.8	-8.84	-23.3
20	03	13	29	SSC*	A	29.9	-2.44	5.7
22	03	04	07	SI	C	5.1	-2.09	-
23	03	11	36	SSC*	B	22.9	2.91	-7.7
29	03	22	37	SSC	B	33.6	-2.20	-13.6
14ext	04	12	34	SI	C	14.0	-1.94	2.5
17	04	11	07	SSC*	A	-42.7	16.99	-20.9
19	04	08	35	SSC*	A	-50.0	11.01	12.1
23	04	04	48	SSC*	A	27.4	-11.15	-11.7
10	05	11	22	SSC*	B	20.2	4.21	2.6
11	05	10	13	SSC*	A	14.1	6.59	6.8
18	05	20	09	SSC*	B	65.1	-1.88	-37.8
20	05	03	40	SSC*	B	16.9	-4.82	-4.7
21	05	22	02	SSC*	B	32.4	-0.87	-10.3
23	05	10	50	SSC*	A	-16.4	5.51	-9.2
23	05	11	50	SI*	C	-53.5	-11.79	-35.6
23	05	15	42	SI	A	166.1	-6.87	-62.5
01	06	16	44	SI*	C	14.3	-0.45	2.1
08	06	11	40	SSC*	C	-12	2.22	-4.8/+4.0
19	07	10	09	SSC*	A	-44.9/+44.1	5.45	13.5
22	07	10	57	SI*	B	14.8	-14.10	4.5
25	07	13	36	SI*	B	17.1	-6.40	5.3
29	07	13	21	SSC*	A	61.3	-21.00	6.5
18	08	18	46	SSC*	A	70.2	-4.87	9.8
20	08	13	58	SSC*	C	17.1	-0.19	2.7
26	08	11	30	SSC*	B	-9.9	3.09	-3.4

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)
07	09	16	38	SSC	C	65.2	-10.57	9.0
30	09	08	15	SSC*	B	-21.7	-1.87	-10.1
04	10	18	11	SI	B	+270.2/-298.9	-35.20	-358.1
29	10	20	27	SI	B	4.2	3.49	-2.5
09	11	17	51	SI*	A	11.4	-0.65	2.1
09	11	18	49	SSC*	A	19.9	-1.49	5.4
20	11	11	08	SSC*	B	8.8	2.17	-5.4
26	11	21	51	SSC	B	20.9	-0.63	3.3
06	12	06	47	SSC*	B	4.0	-1.75	-
22	12	10	28	SSC*	B	-9.3	-1.36	-1.9
31	12	21	31	SI*	B	-5.1	0.96	-2.2

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				
04	04	15	30	15	34	15	46	-2.6	-0.96	2.1
09	04	12	56	13	02	13	14	-5.7	-1.04	-
10	04	12	26	12	32	12	46	-16.4	-	6.3
20	05	15	25	15	28	15	39	-8.3	-2.22	4.9

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

Annual Values of Geomagnetic Elements

Lerwick

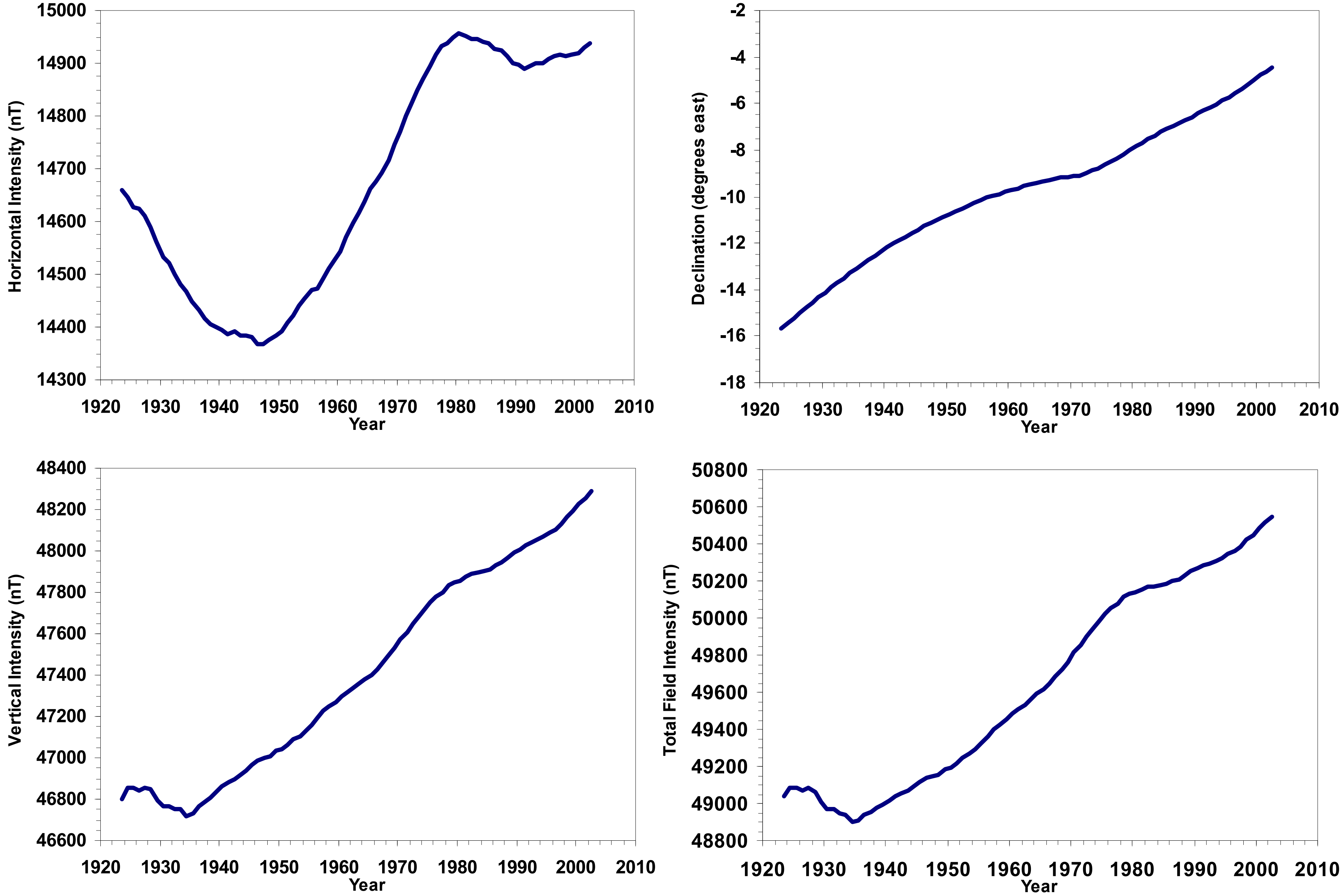
Year	D		H	I		X	Y	Z	F
1923.5	-15	40.3	14655	72	33.7	14111	-3959	46655	48902
1924.5	-15	26.5	14642	72	35.7	14113	-3899	46708	48950
1925.5	-15	13.5	14621	72	37.2	14108	-3840	46713	48948
1926.5	-14	58.6	14618	72	37.1	14121	-3778	46699	48933
1927.5	-14	45.7	14607	72	38.1	14125	-3722	46713	48944
1928.5	-14	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
2002.5	-4	25.4	14937	72	48.7	14893	-1152	48288	50545

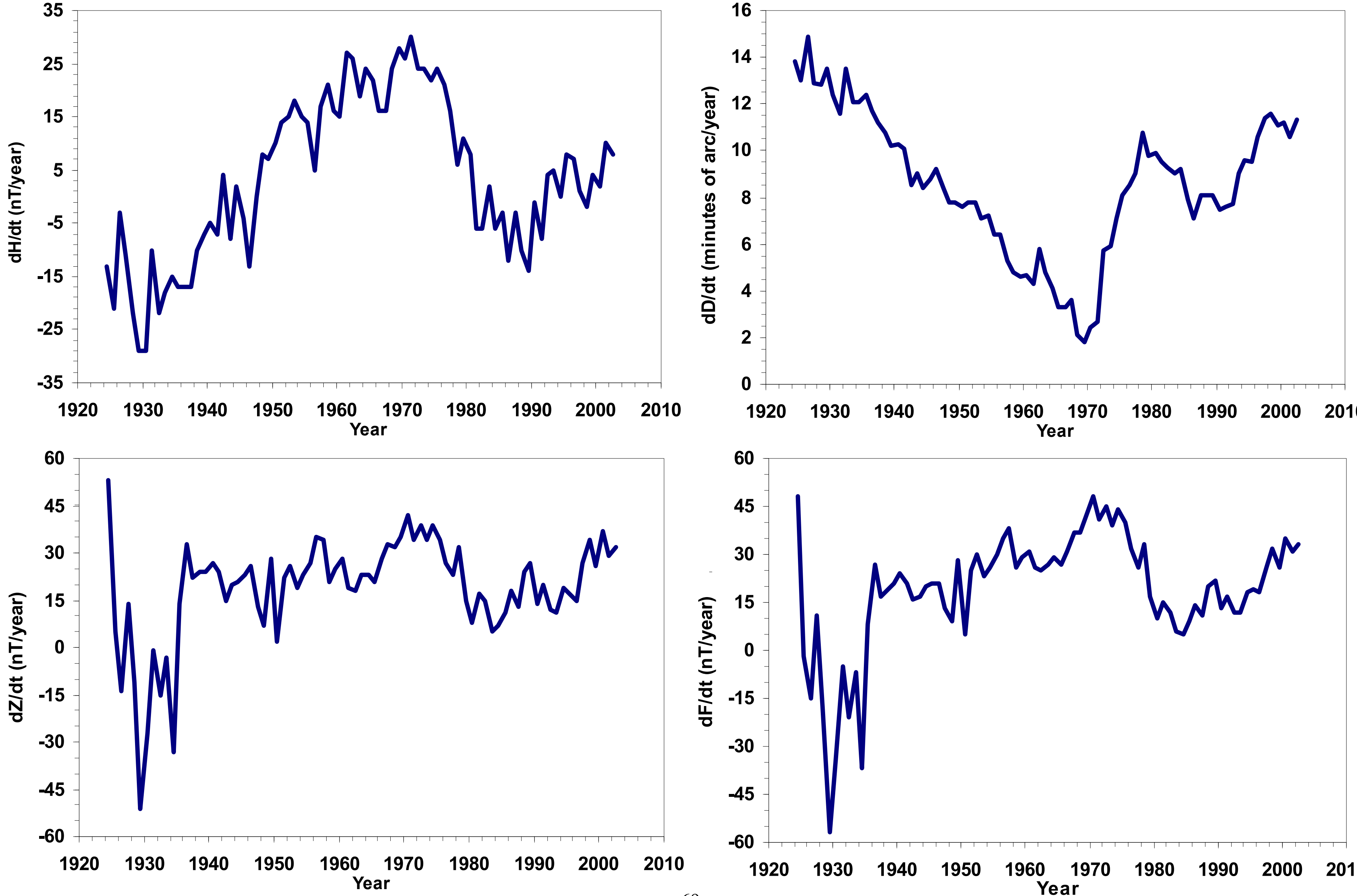
1 Site differences 1 Jan 1934 (new value - old value)
2 Site differences 1 Jan 1990 (new value - old value)
3 Site differences 1 Jan 1996 (new value - old value)

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

Annual Mean Values at Lerwick

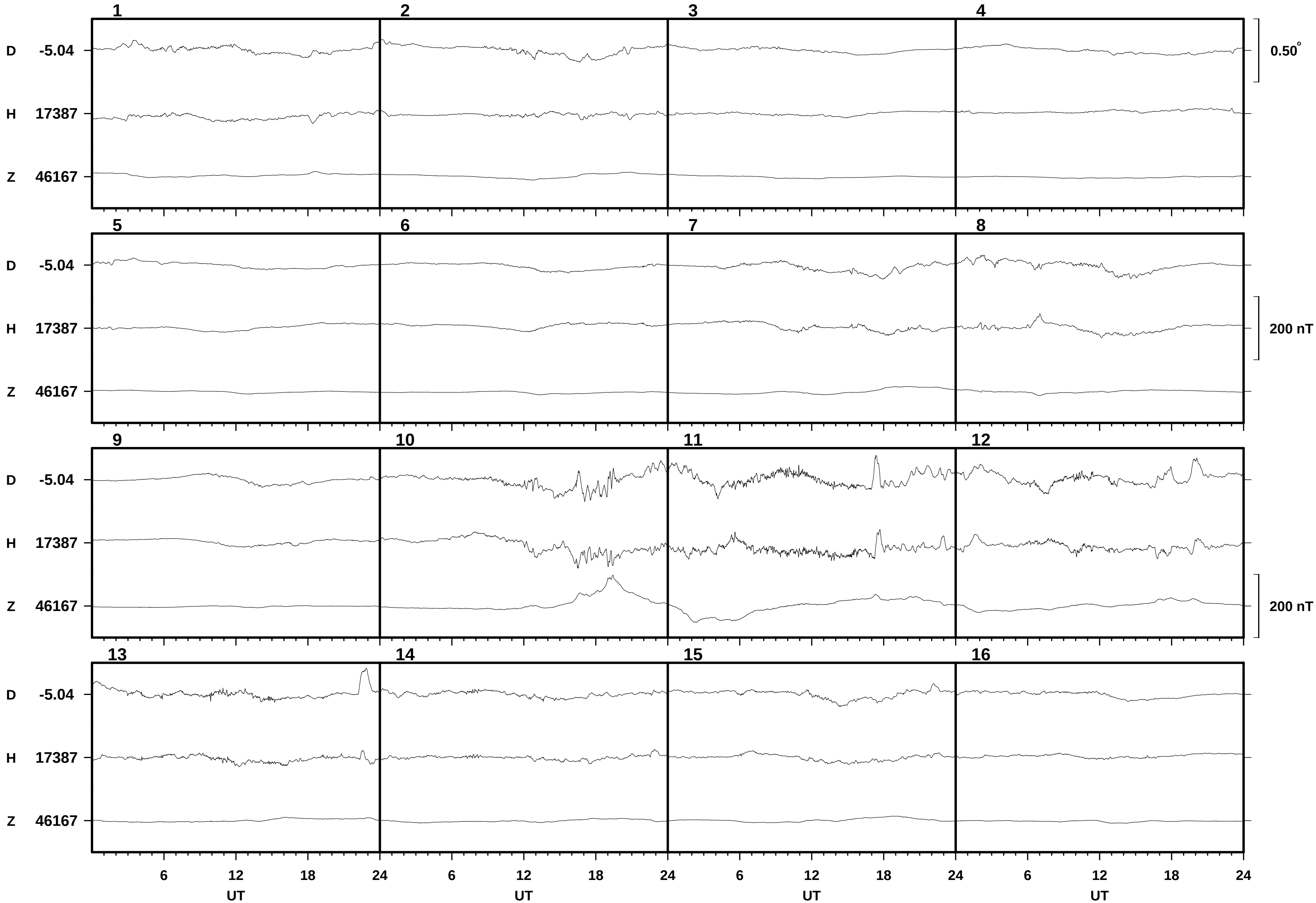


Rate of Change of Annual Mean Values at Lerwick

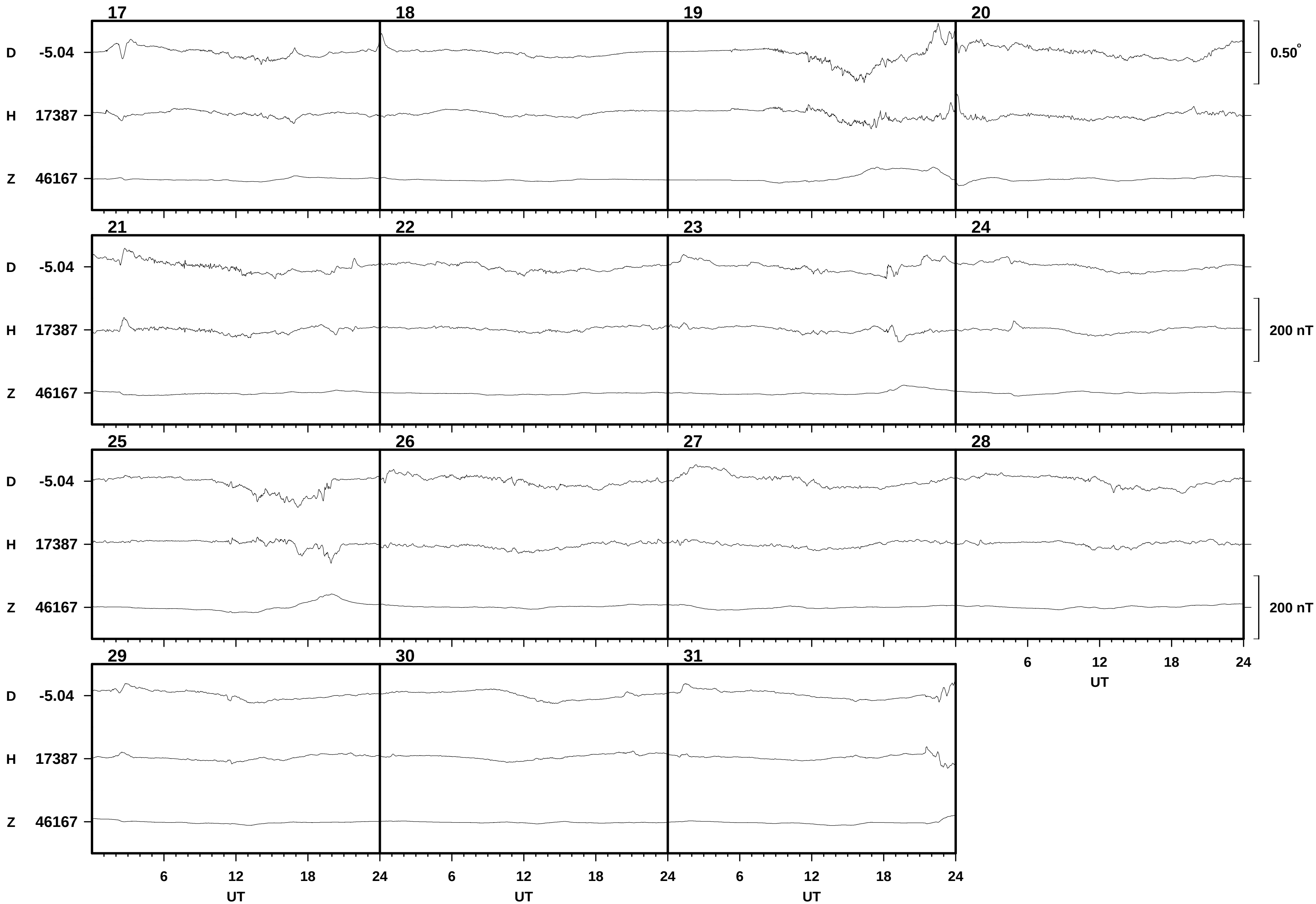


Eskdalemuir Observatory Results 2002

Eskdalemuir January 2002



ES 1 2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26
27
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29
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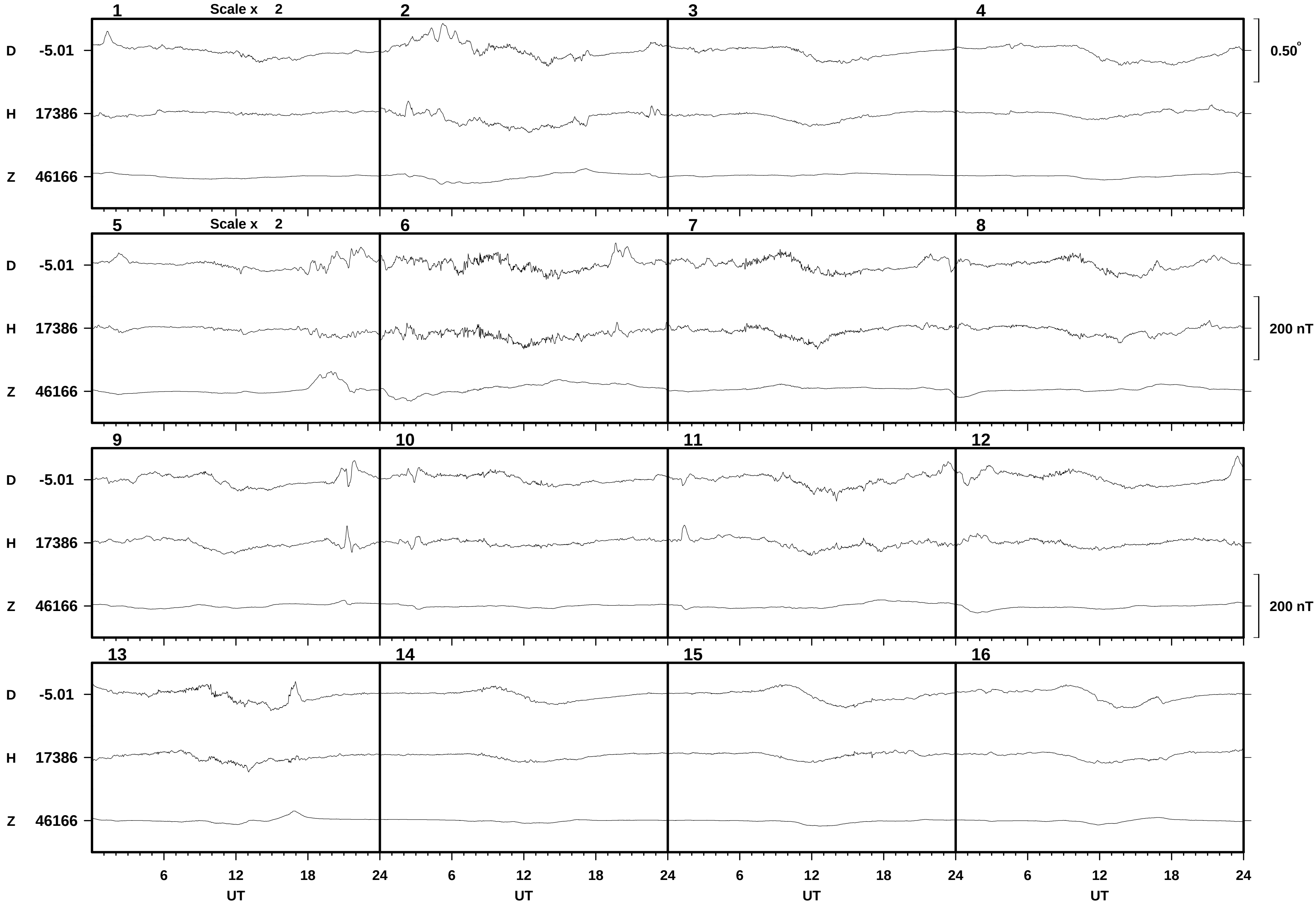
31
D -5.04
H 17387
Z 46167
0.50°
200 nT
200 nT
6
12
18
24
UT

ES 1 2

Eskdalemuir February 2002



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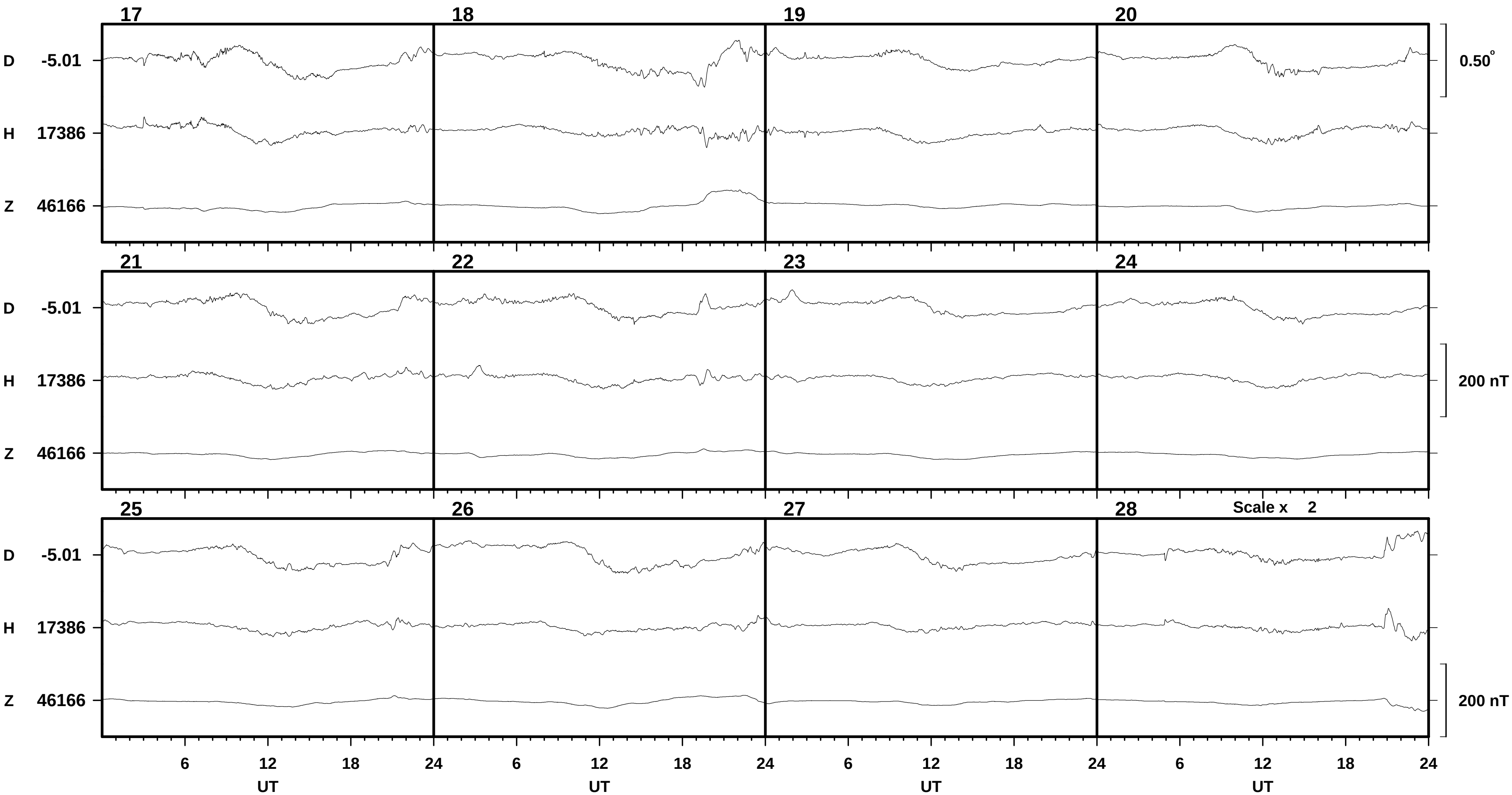
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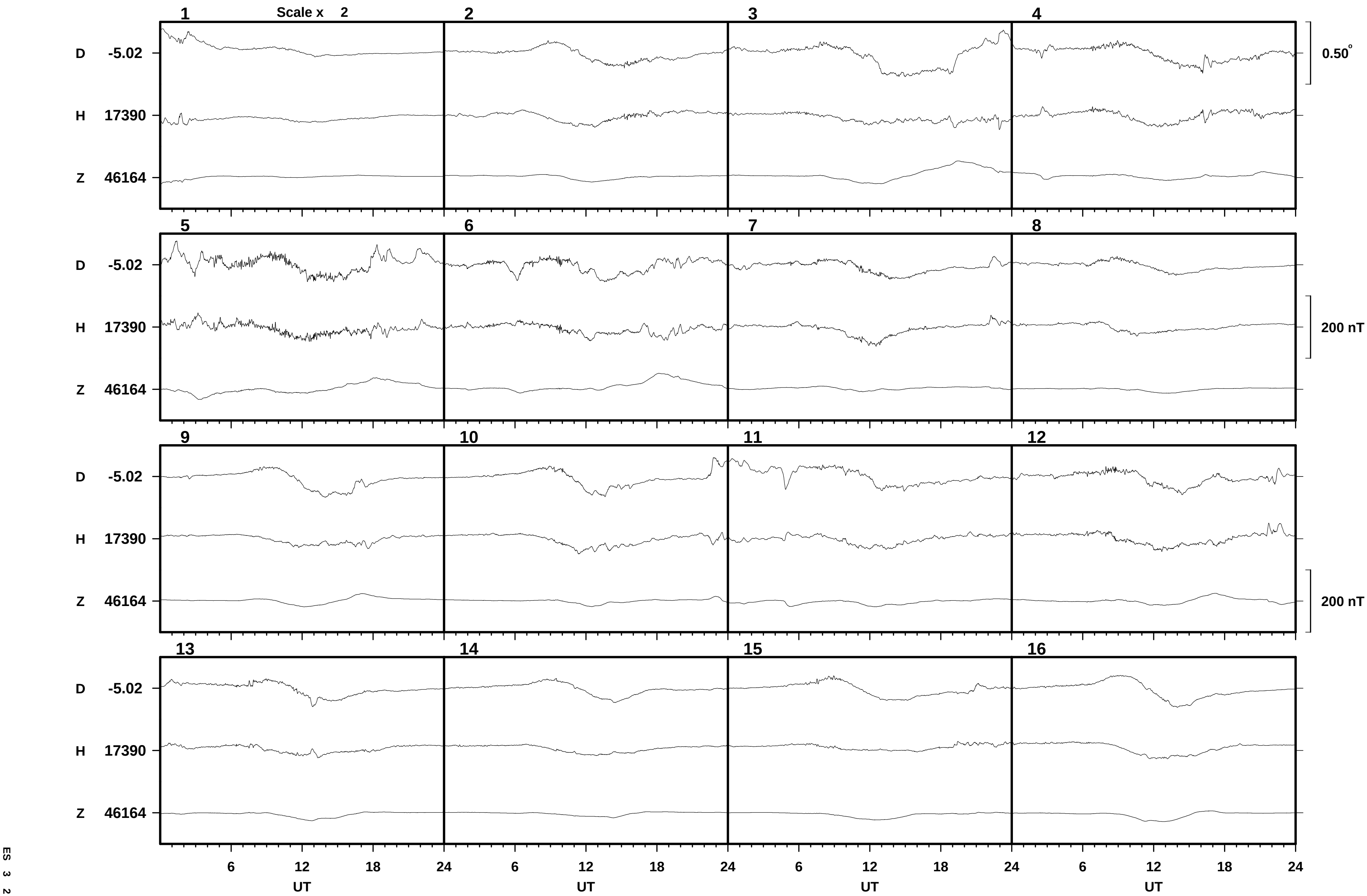
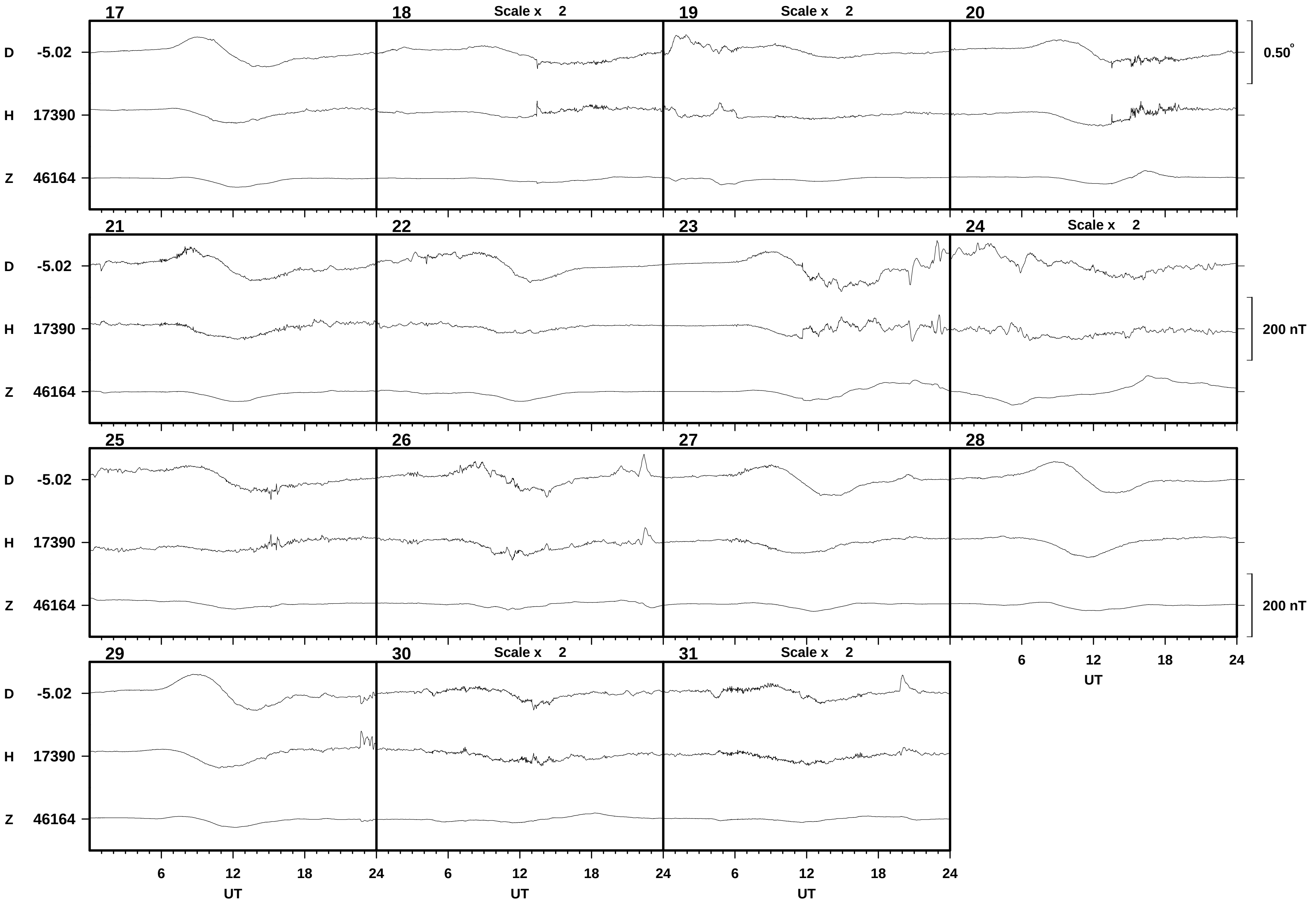
25
26
27
28
D -5.01
H 17386
Z 46166
0.50°
200 nT
Scale x 2
200 nT
6
12
18
24
UT

ES 2 2

Eskdalemuir March 2002

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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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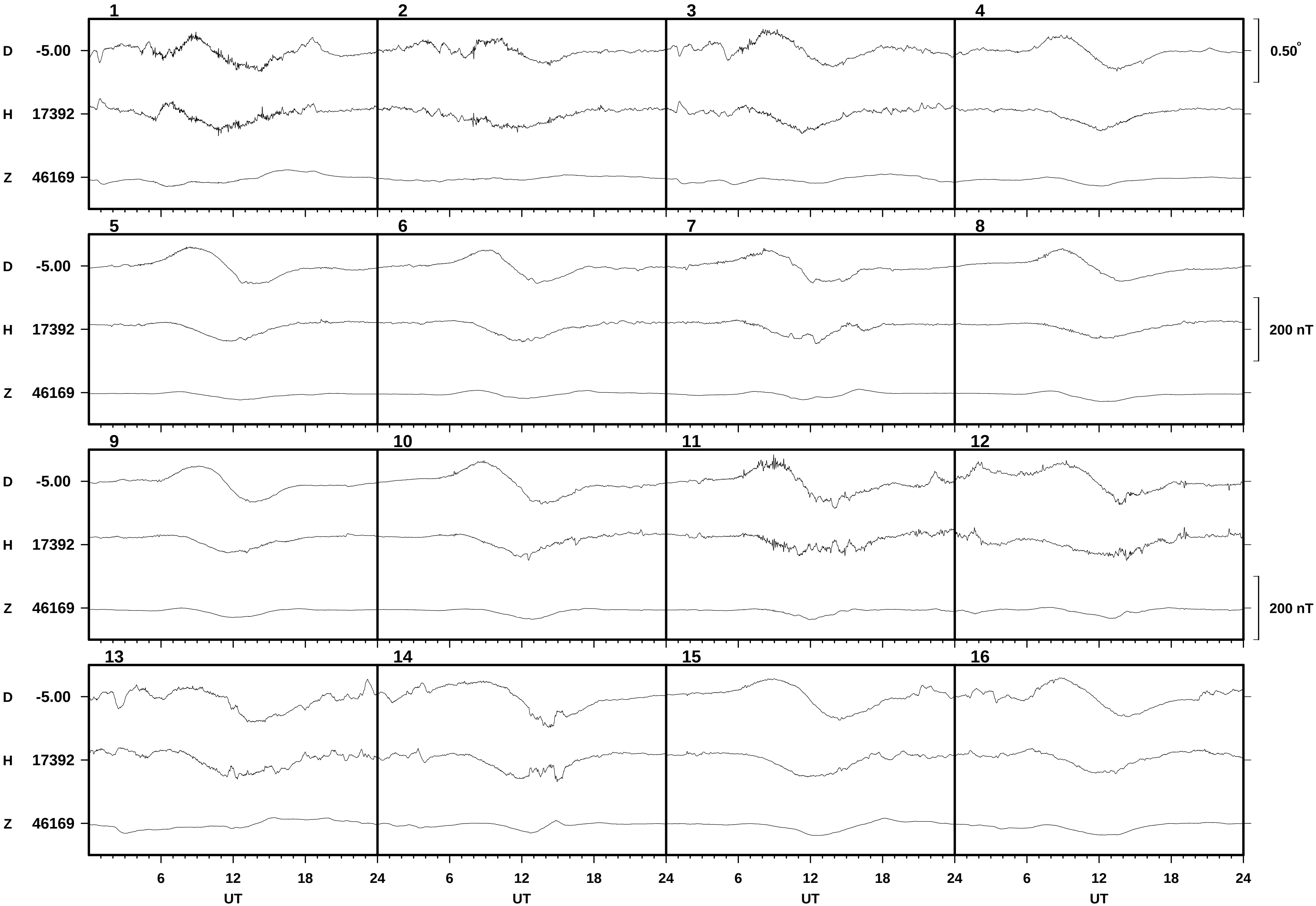
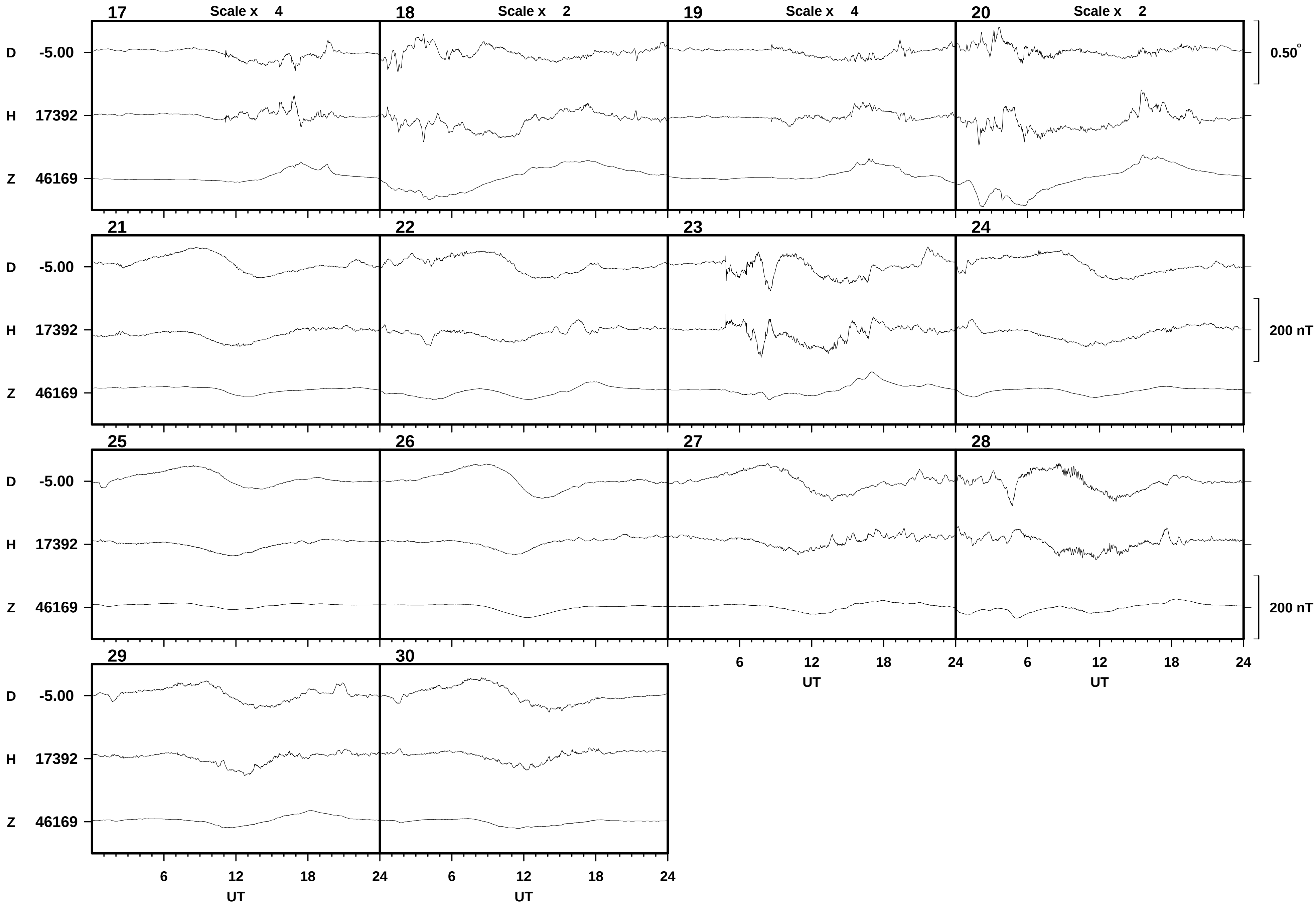
30
Scale x 2
31
Scale x 2
D -5.02
H 17390
Z 46164
0.50°
200 nT
200 nT
6 12 18 24
UT

ES 3 2

Eskdalemuir April 2002



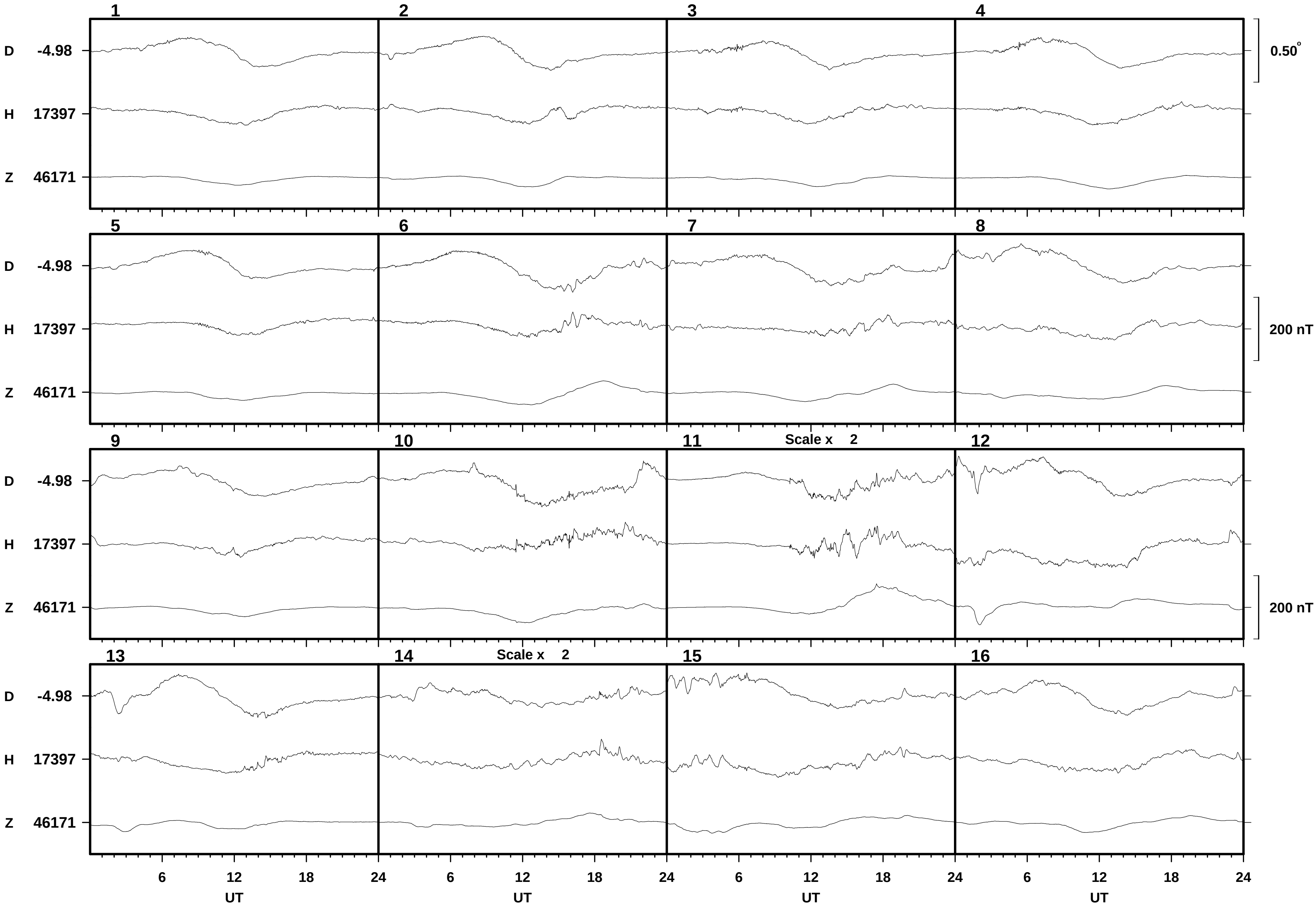
ES 4 2



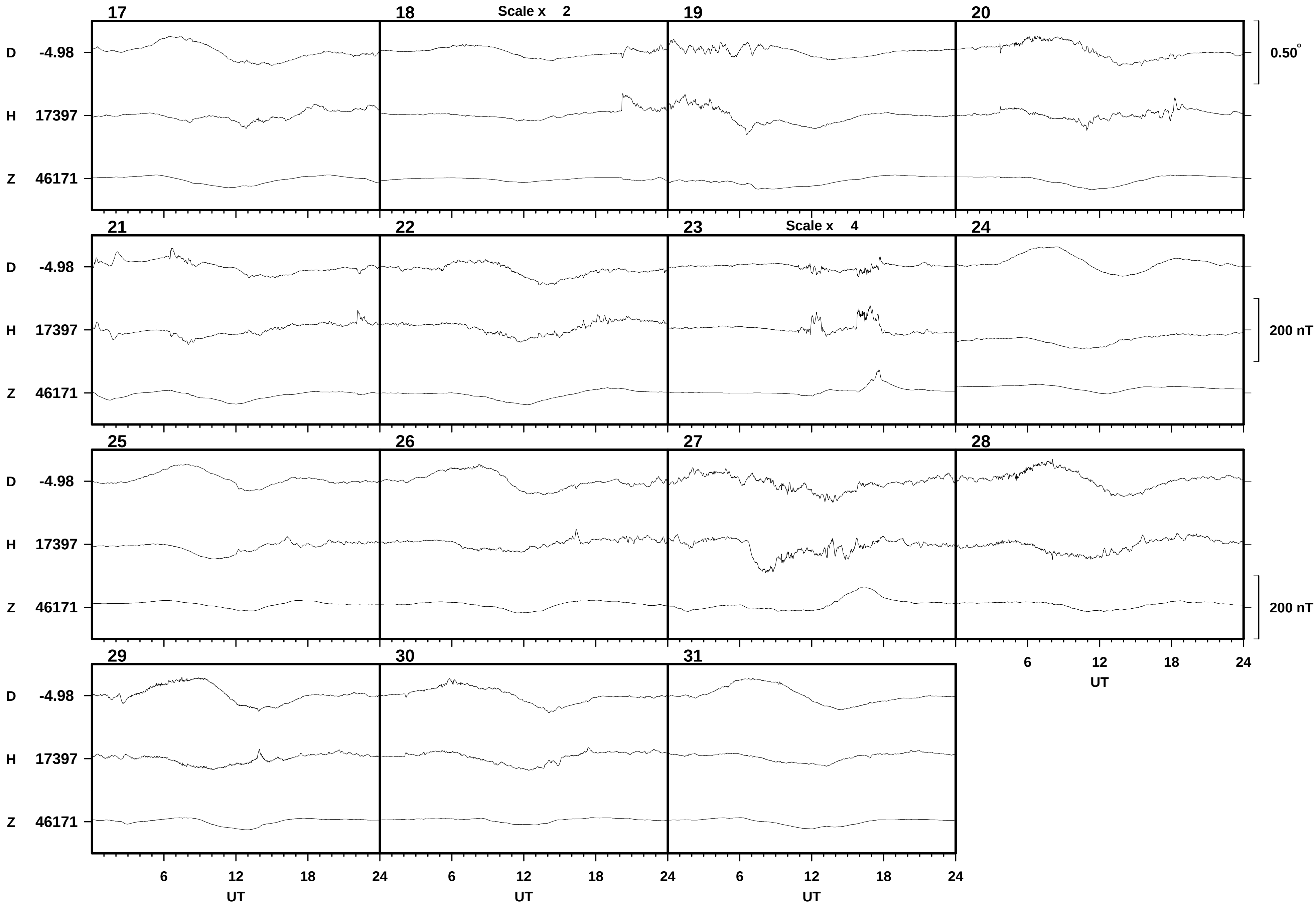
17 Scale x 4
18 Scale x 2
19 Scale x 4
20 Scale x 2
21
22
23
24
25
26
27
28
29
30
D -5.00
H 17392
Z 46169
0.50°
200 nT
200 nT
6 12 18 24
UT

ES 4 2

Eskdalemuir May 2002



ES 5 2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Scale x 2
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22
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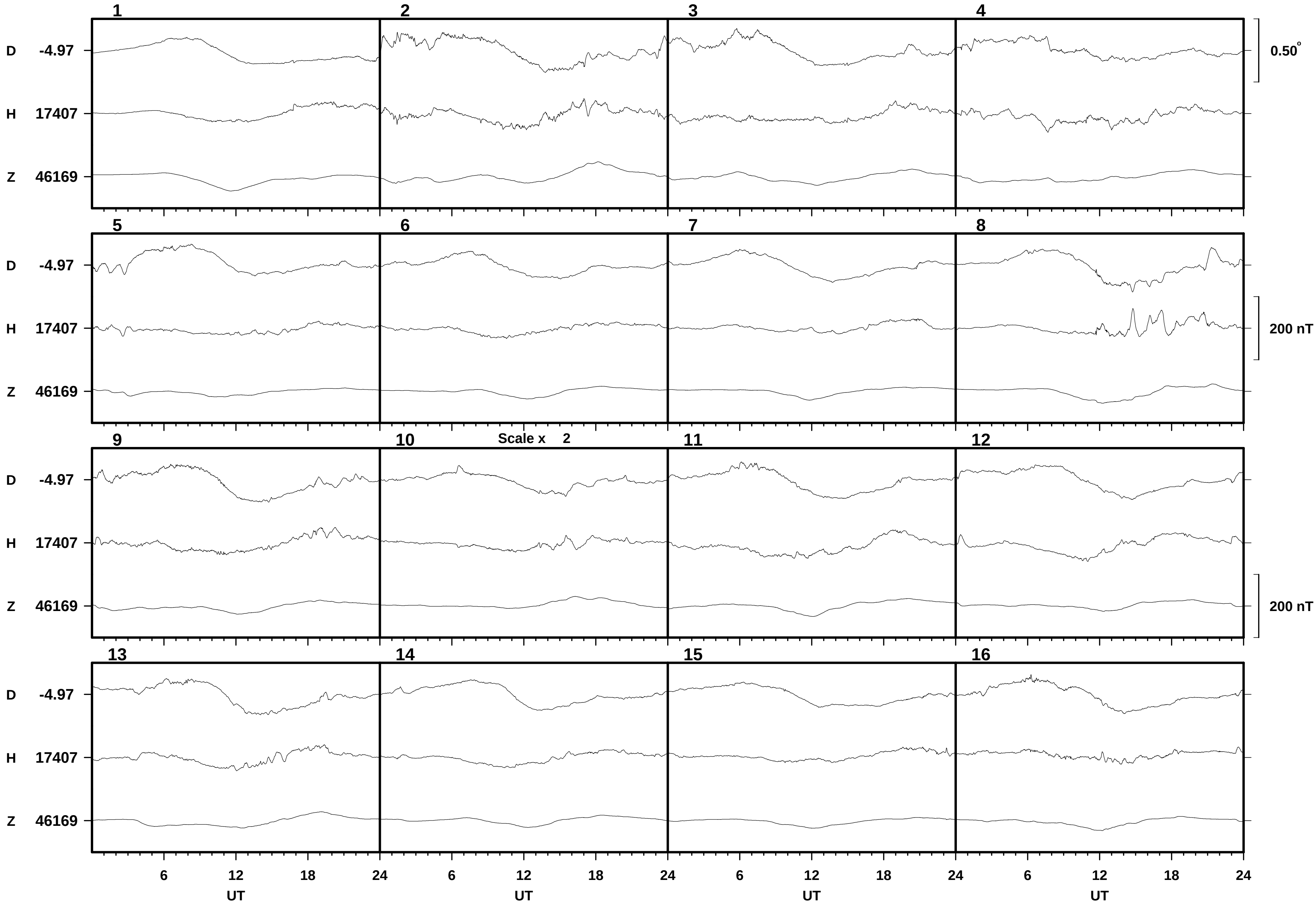
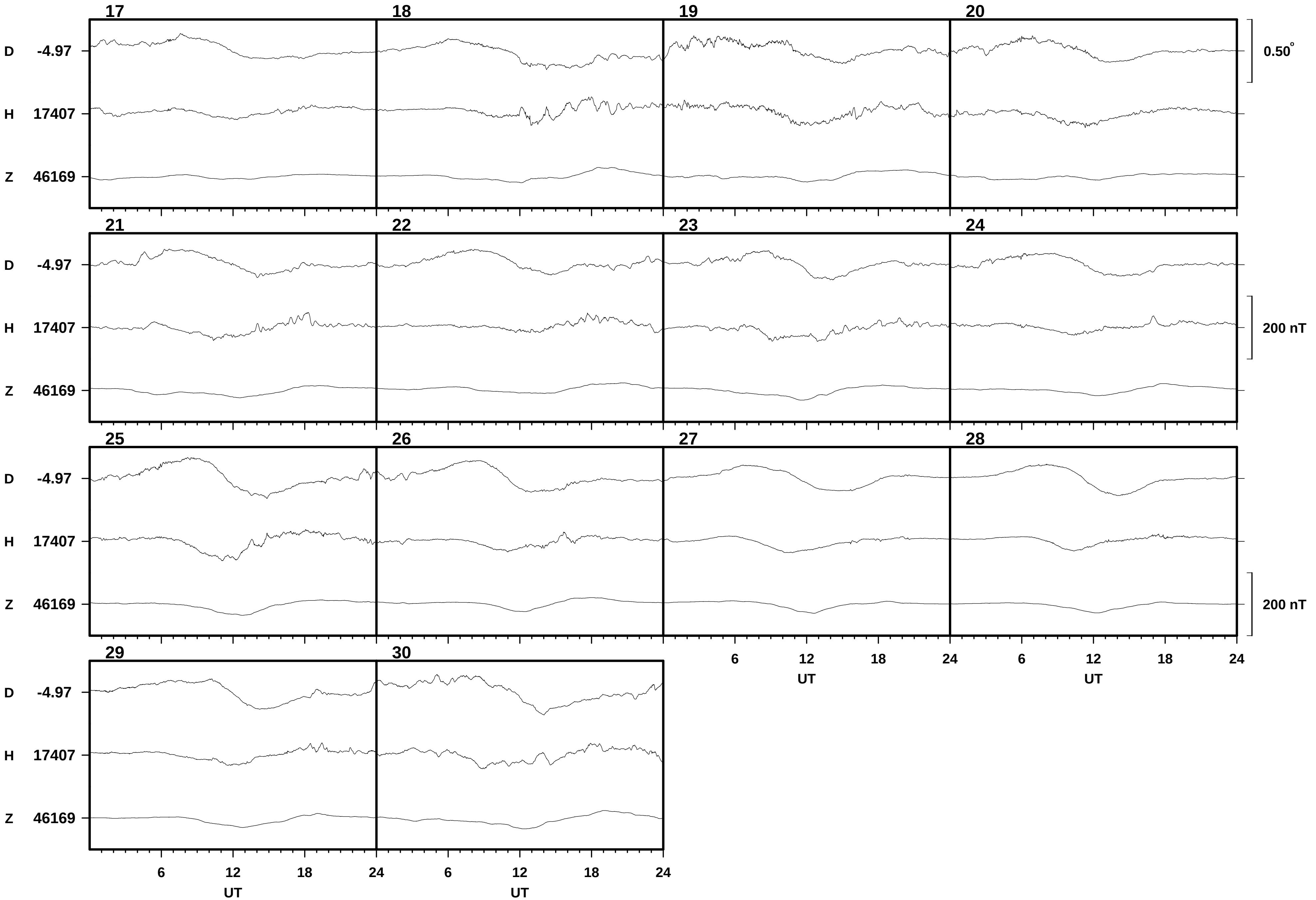
Scale x 4
24
25
26
27
28
29
30
31
D -4.98
H 17397
Z 46171
0.50°
200 nT
200 nT
6
12
18
24
UT

ES 5 2

Eskdalemuir June 2002



ES 6 2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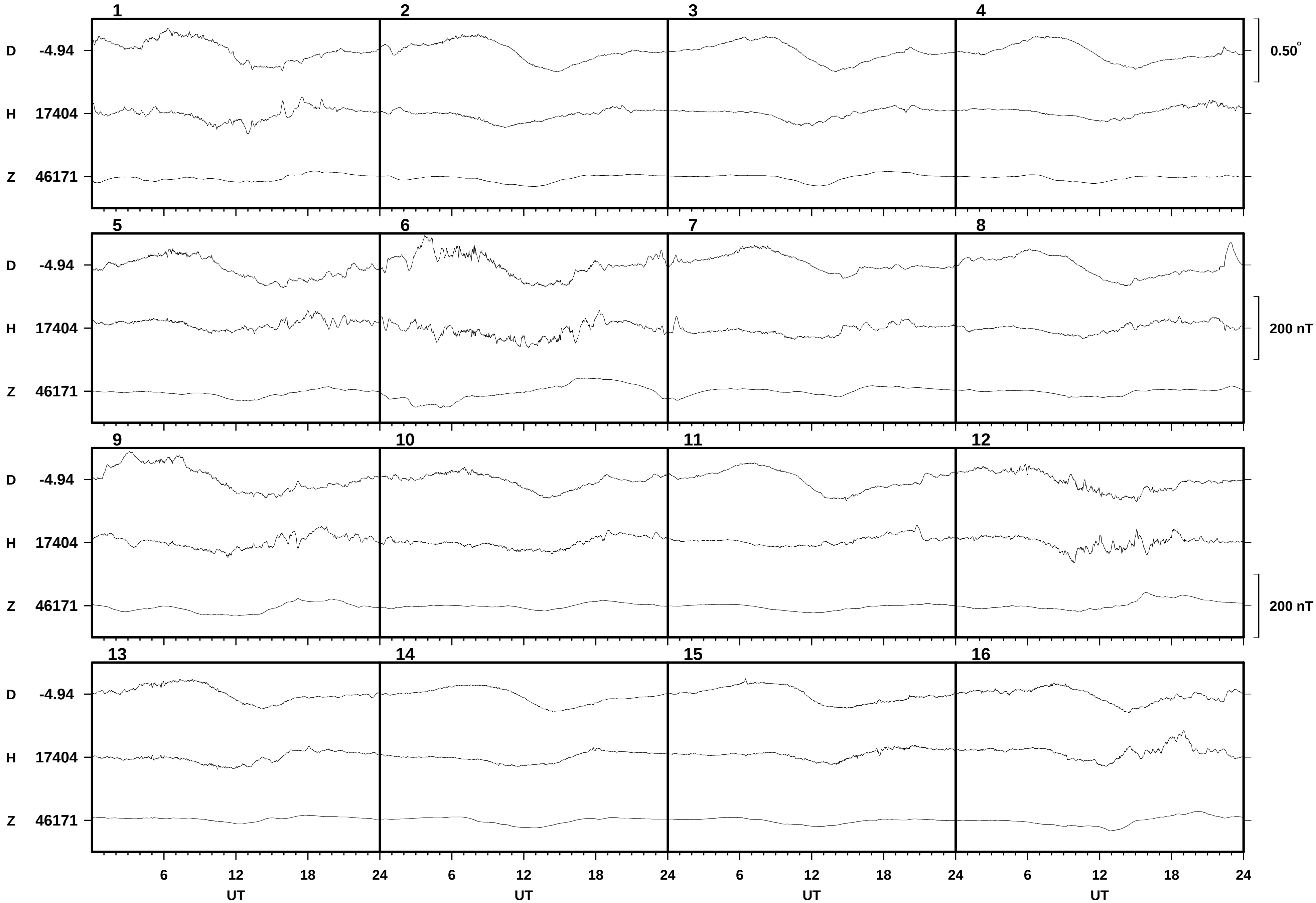
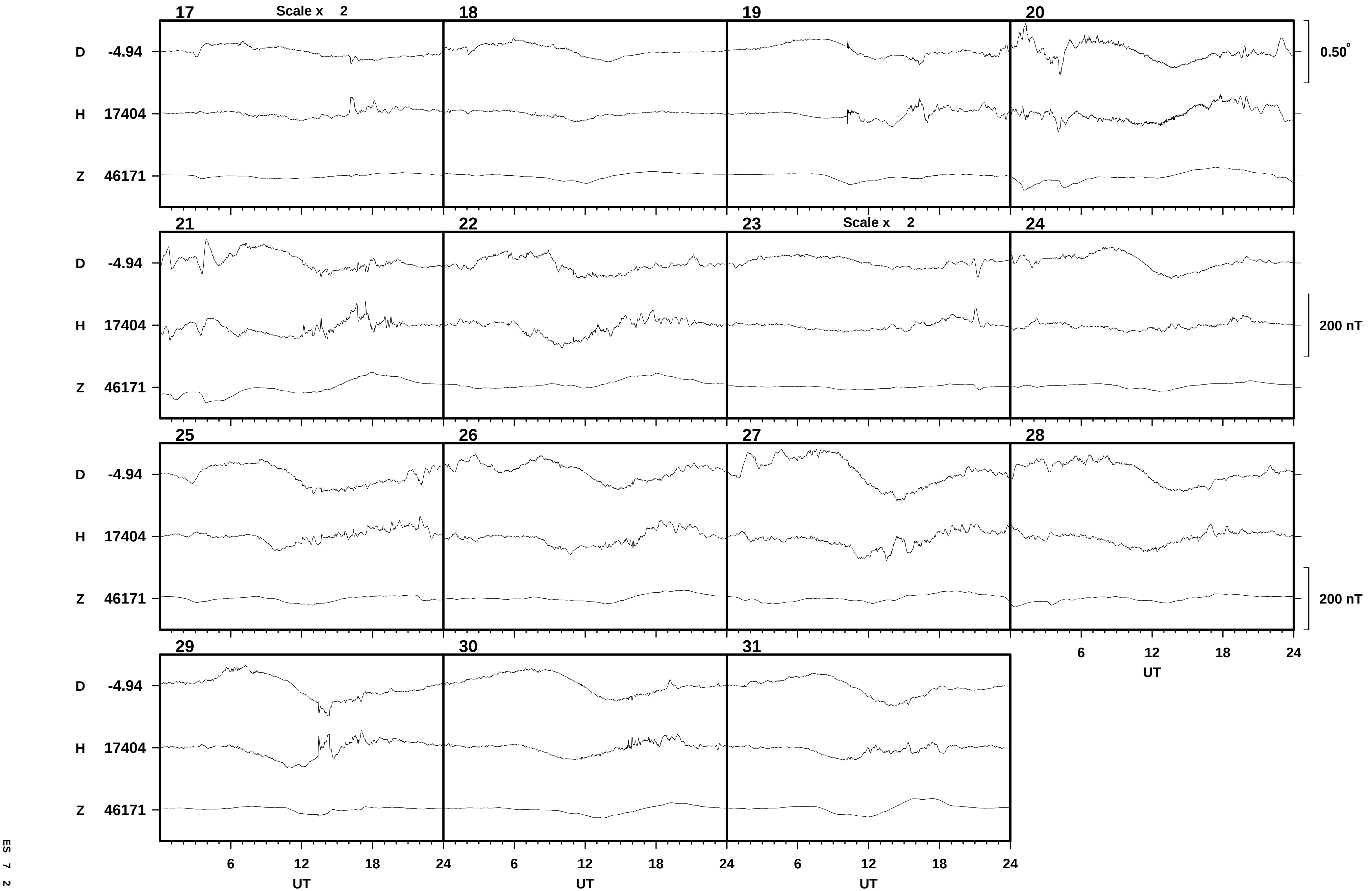
25
26
27
28
29
30
D -4.97
H 17407
Z 46169
0.50°
200 nT
200 nT
6
12
18
24
UT

ES 6 2

Eskdalemuir July 2002



ES 7 2



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Scale x 2
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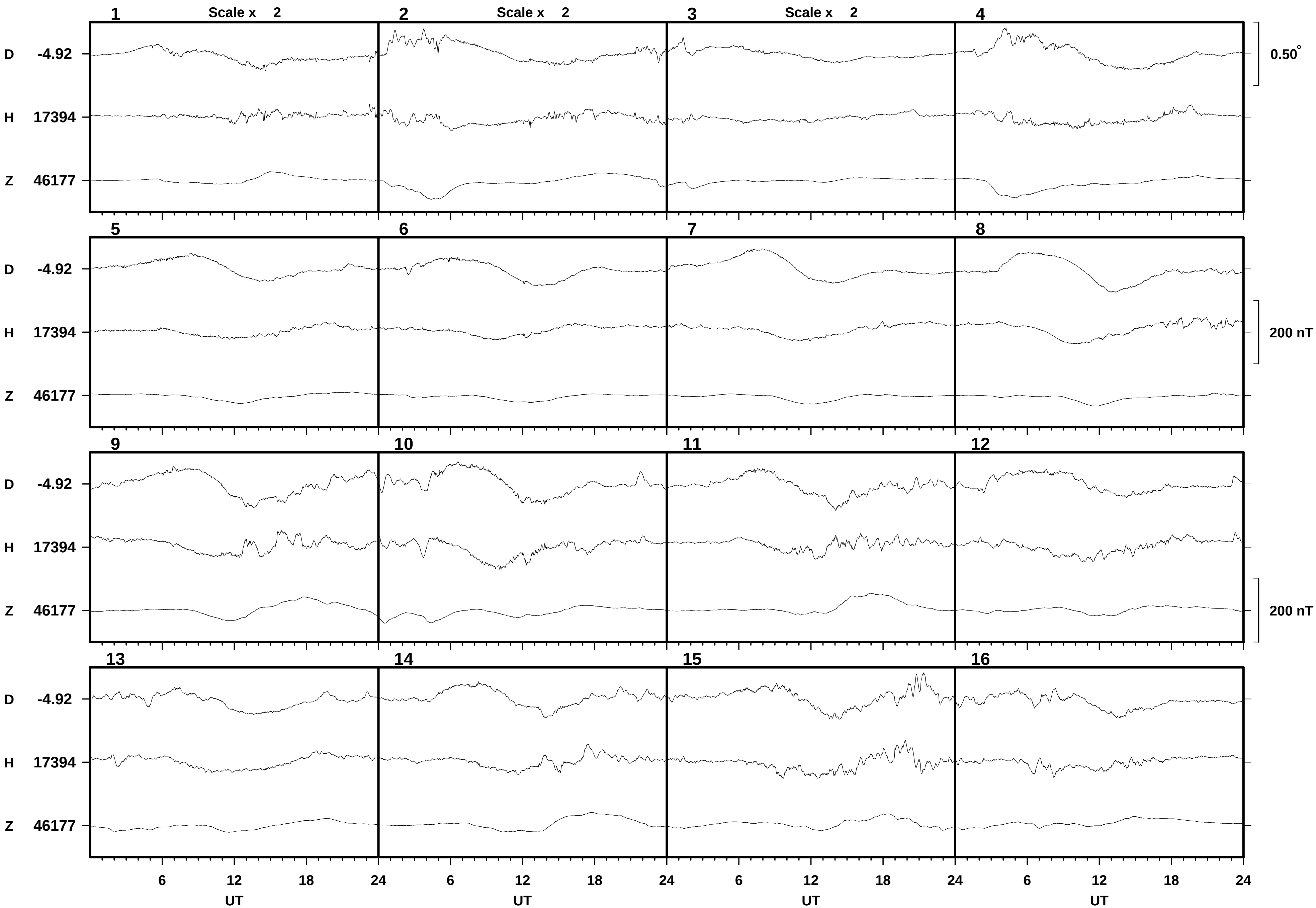
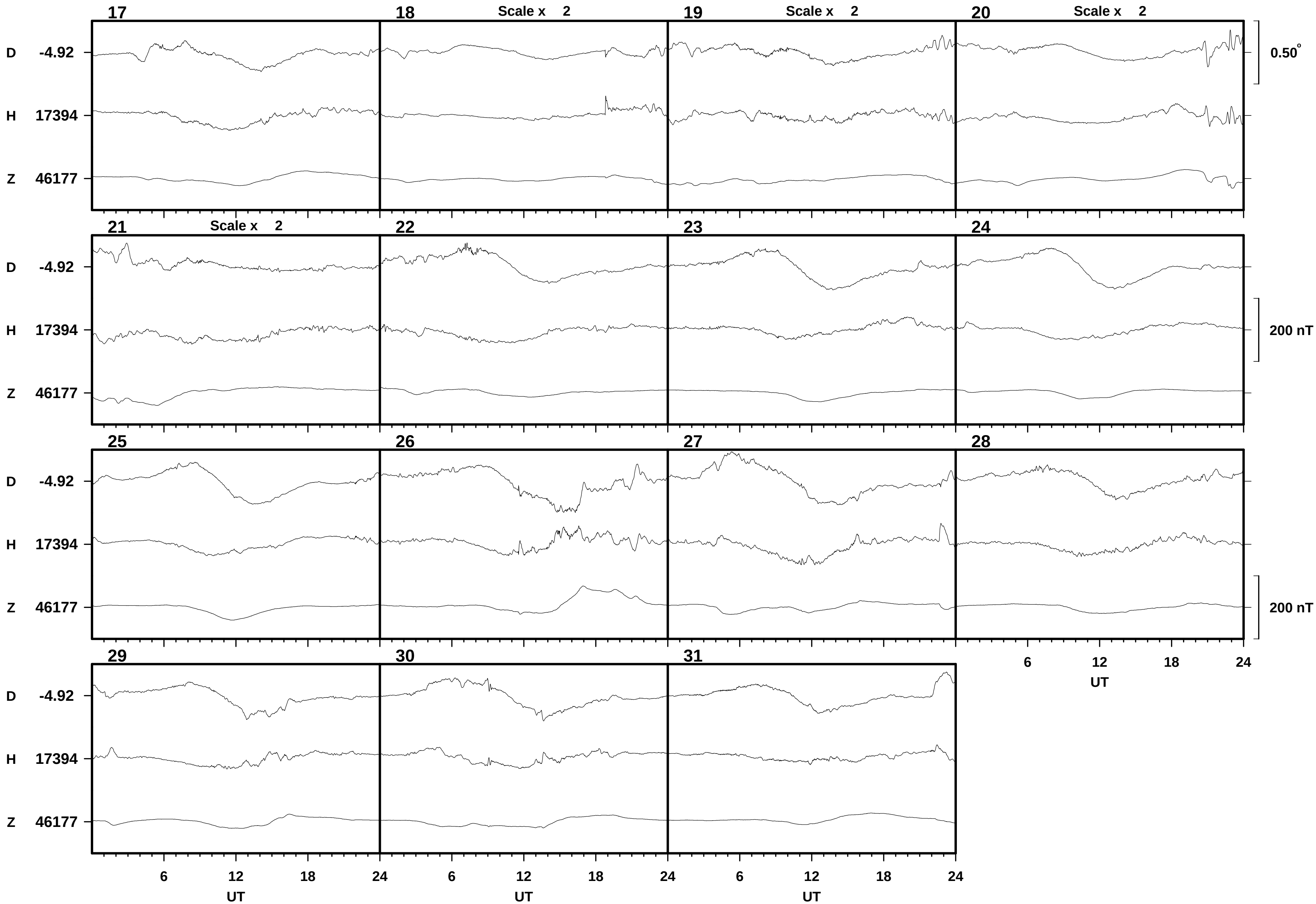
19
20
D -4.94
H 17404
Z 46171
0.50°
21
22
23
Scale x 2
24
200 nT
25
26
27
28
200 nT
29
30
31
6
12
18
24
UT
ES 7 2

Eskdalemuir August 2002



ES 8 2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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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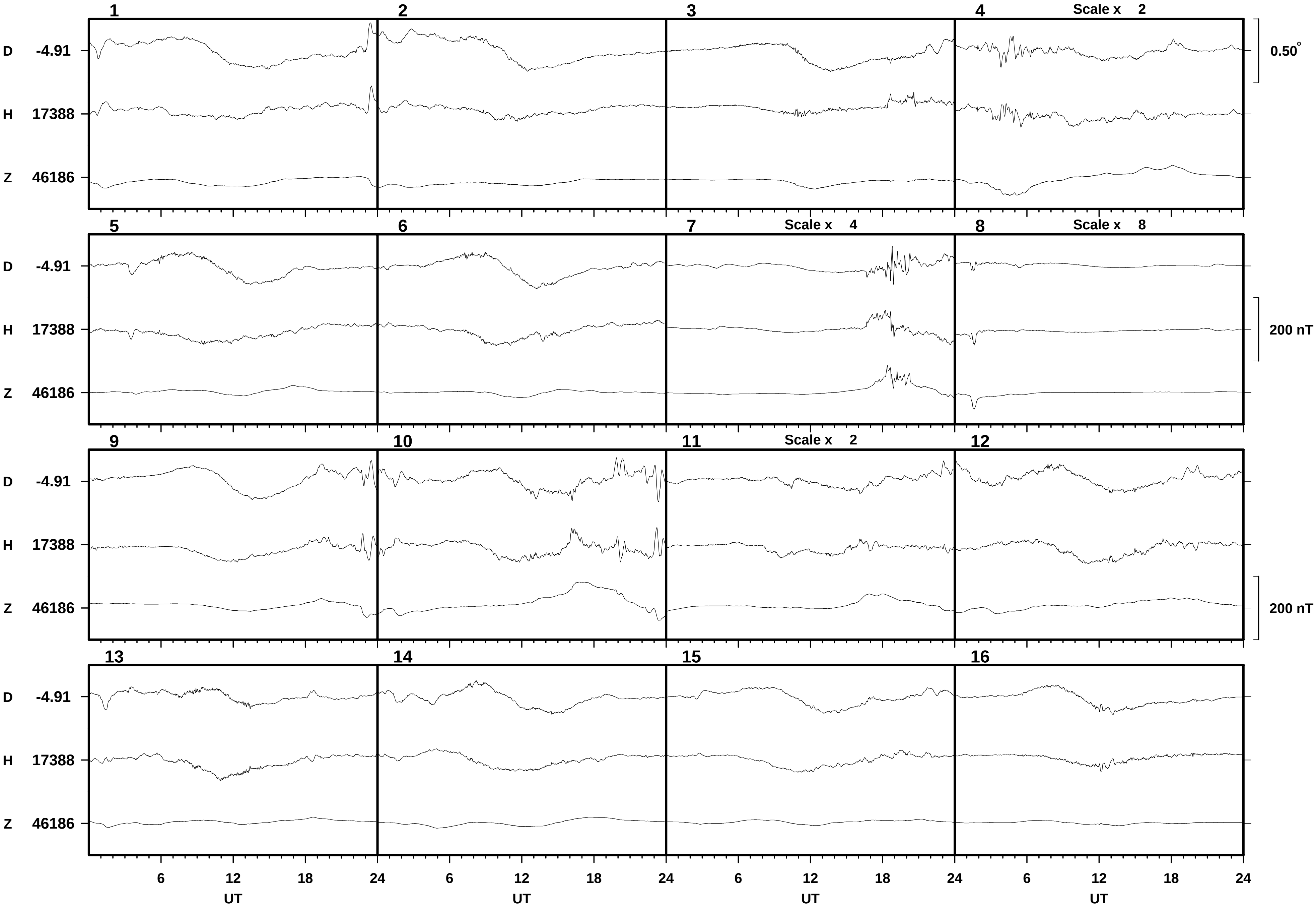
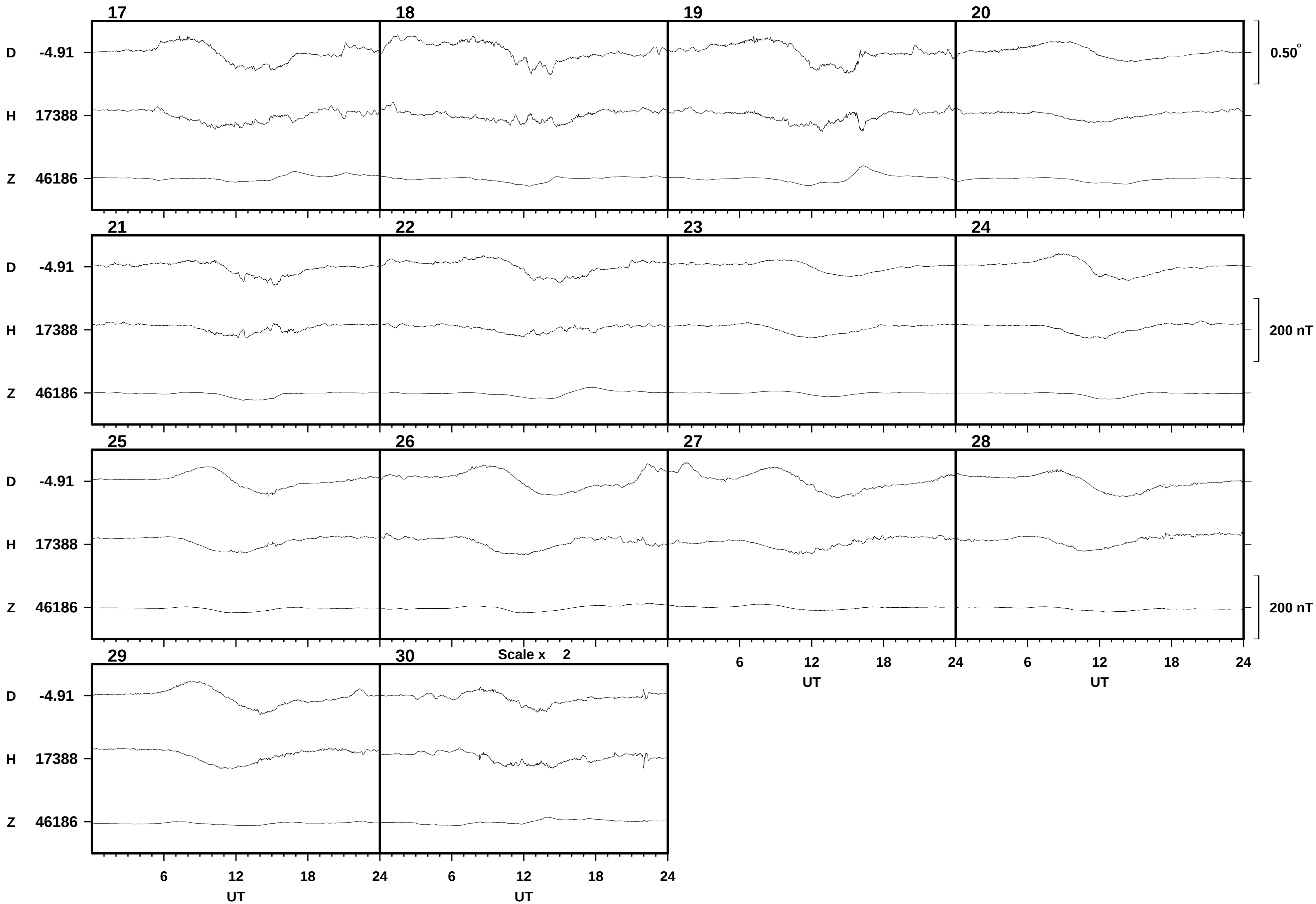
Scale x 2
22
23
24
25
26
27
28
29
30
31
D -4.92
H 17394
Z 46177
0.50°
200 nT
200 nT
6
12
18
24
UT

ES 8 2

Eskdalemuir September 2002



ES 9 2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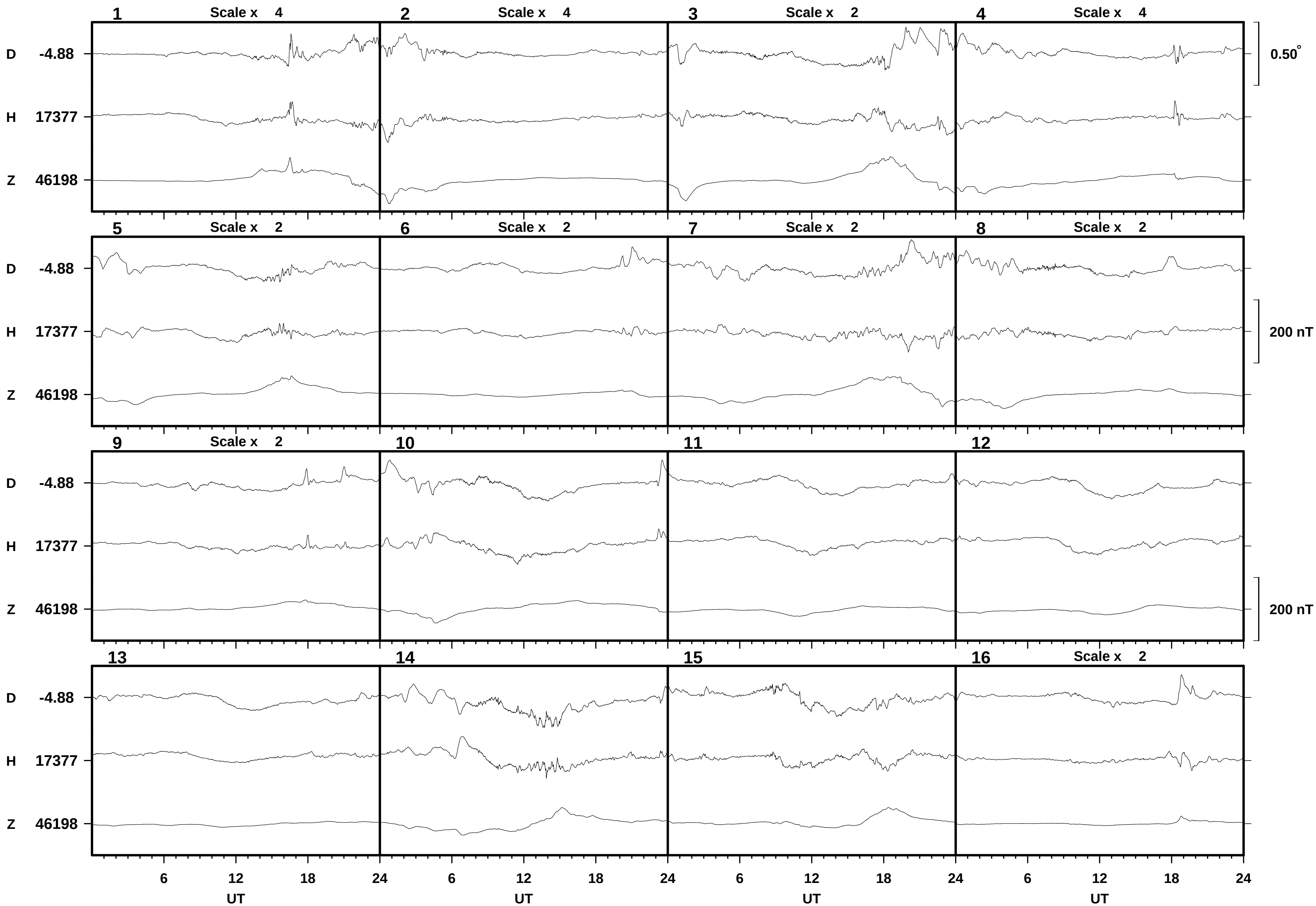
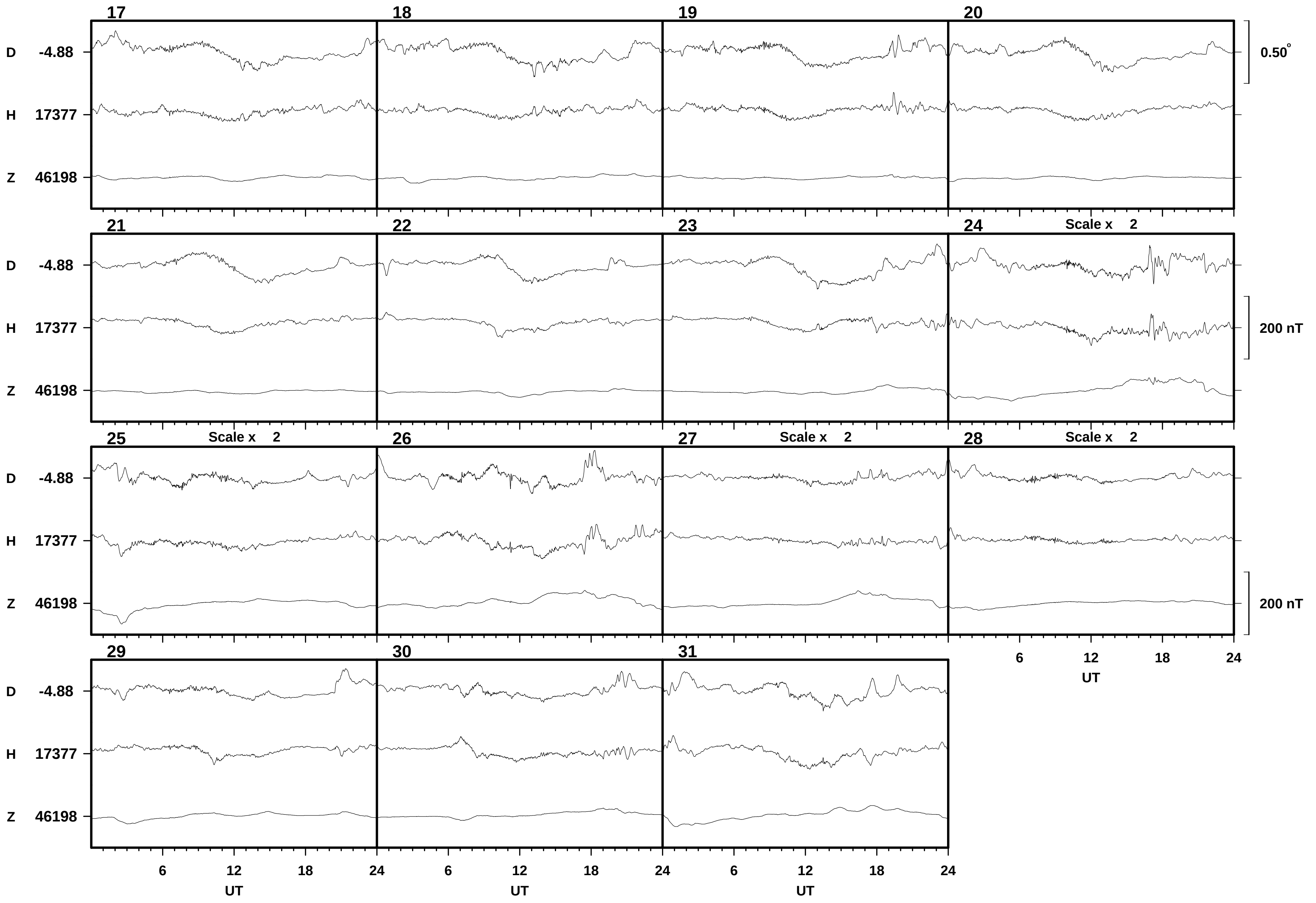
22
23
24
25
26
27
28
29
30
D -4.91
H 17388
Z 46186
0.50°
200 nT
200 nT
Scale x 2
6
12
18
24
UT

ES 9 2

Eskdalemuir October 2002

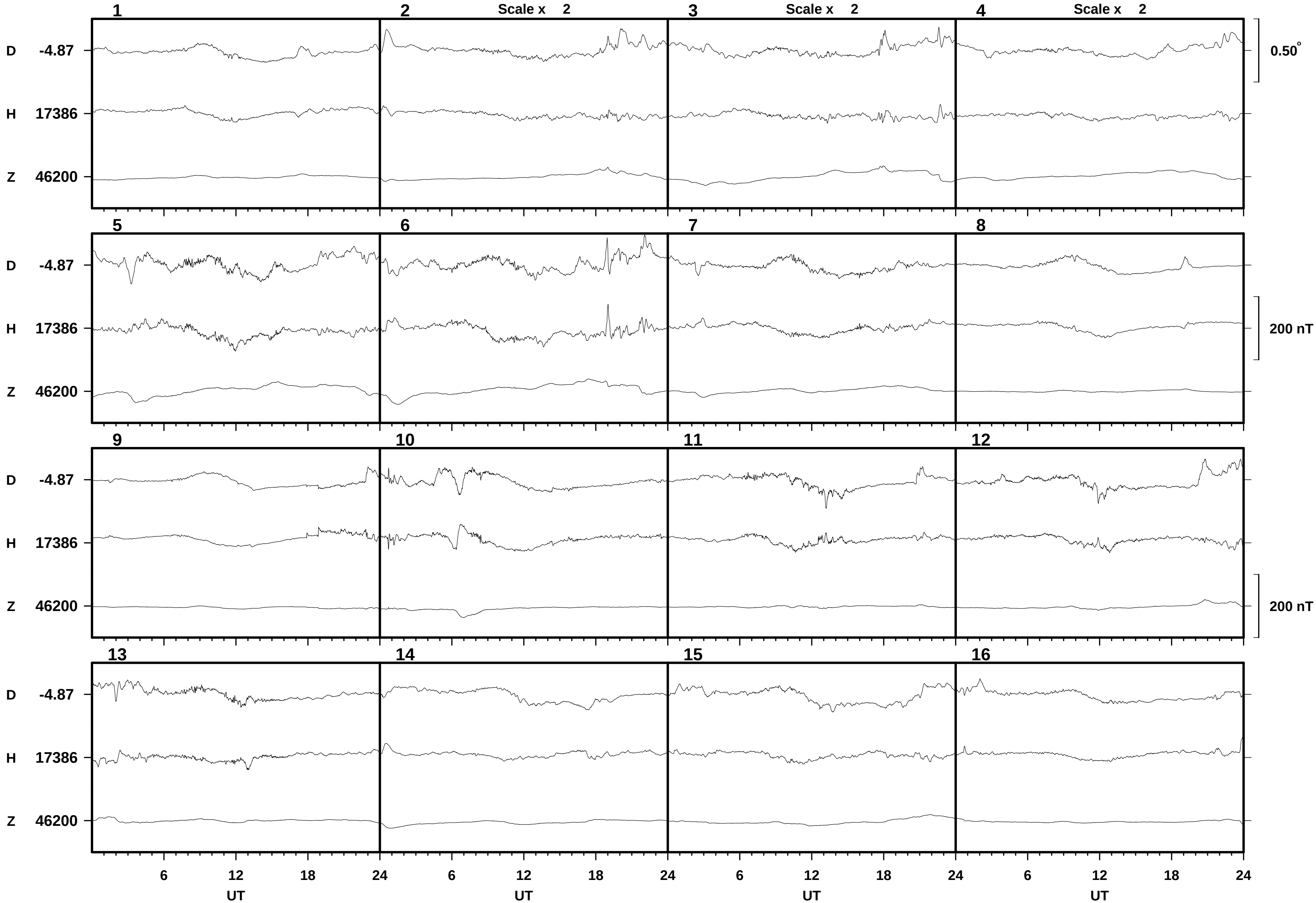


ES 10 2

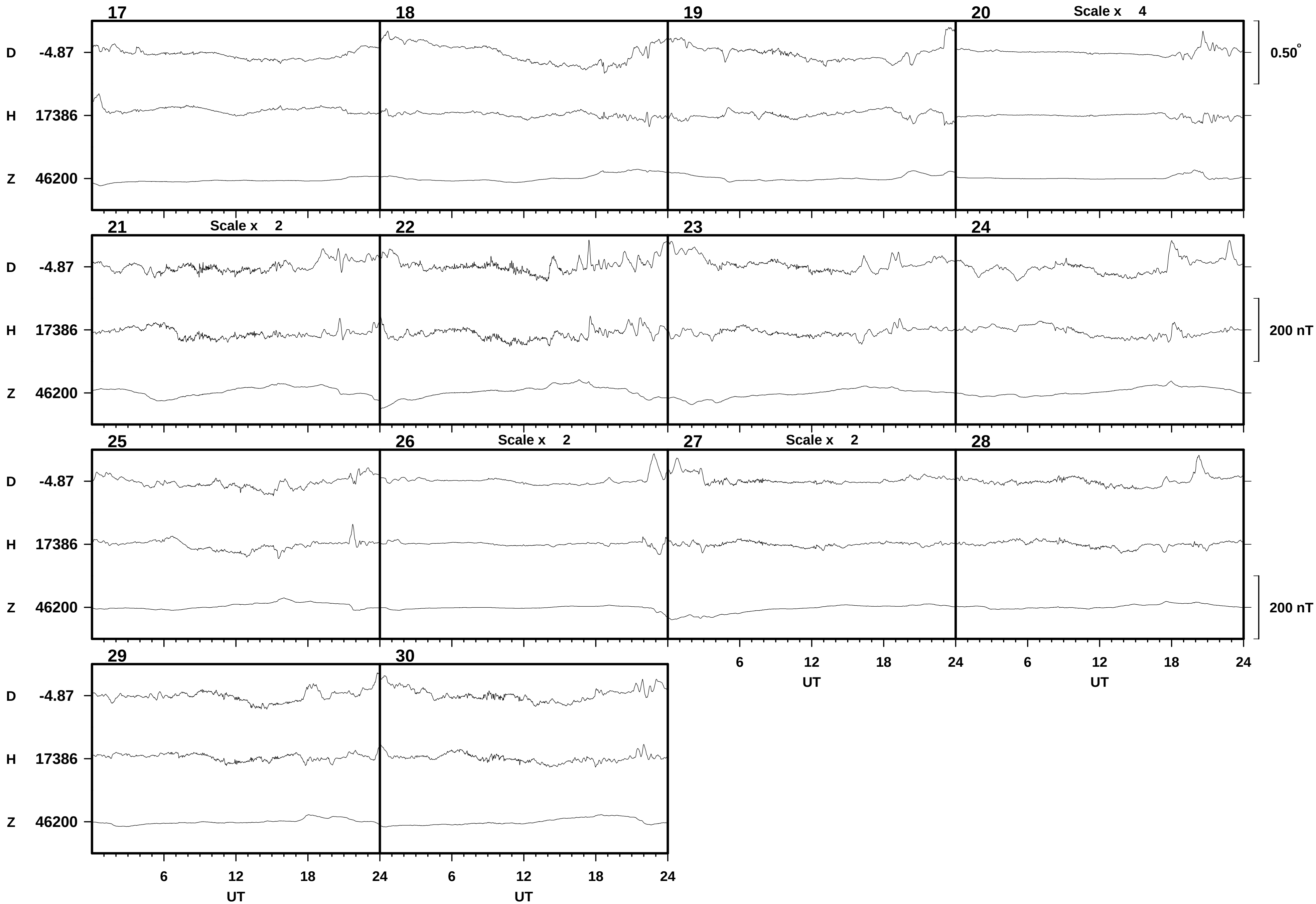

17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
Scale x 2
Scale x 2
Scale x 2
Scale x 2
D -4.88
H 17377
Z 46198
0.50°
200 nT
200 nT
6
12
18
24
UT

ES 10 2

Eskdalemuir November 2002

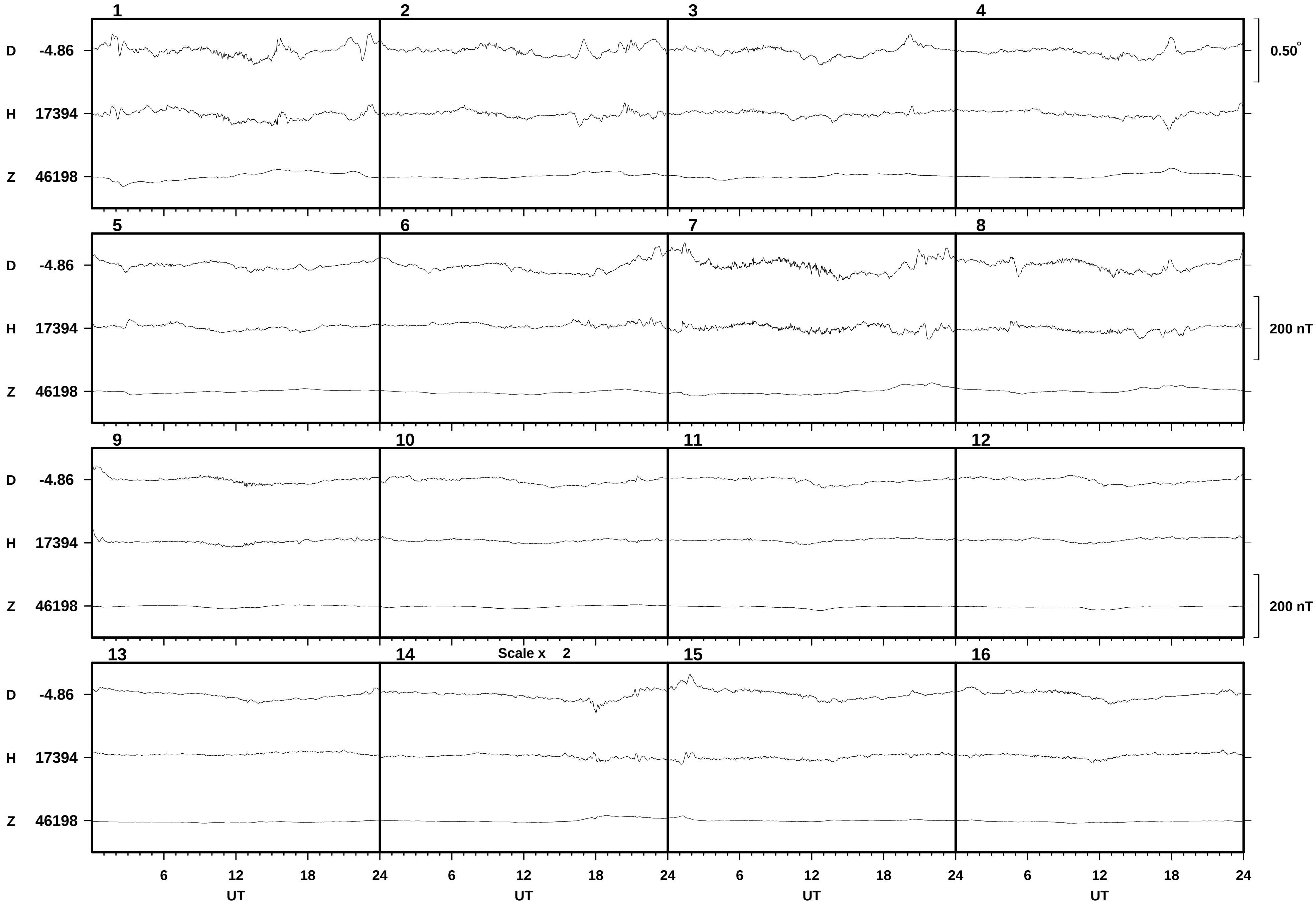


ES 11 2

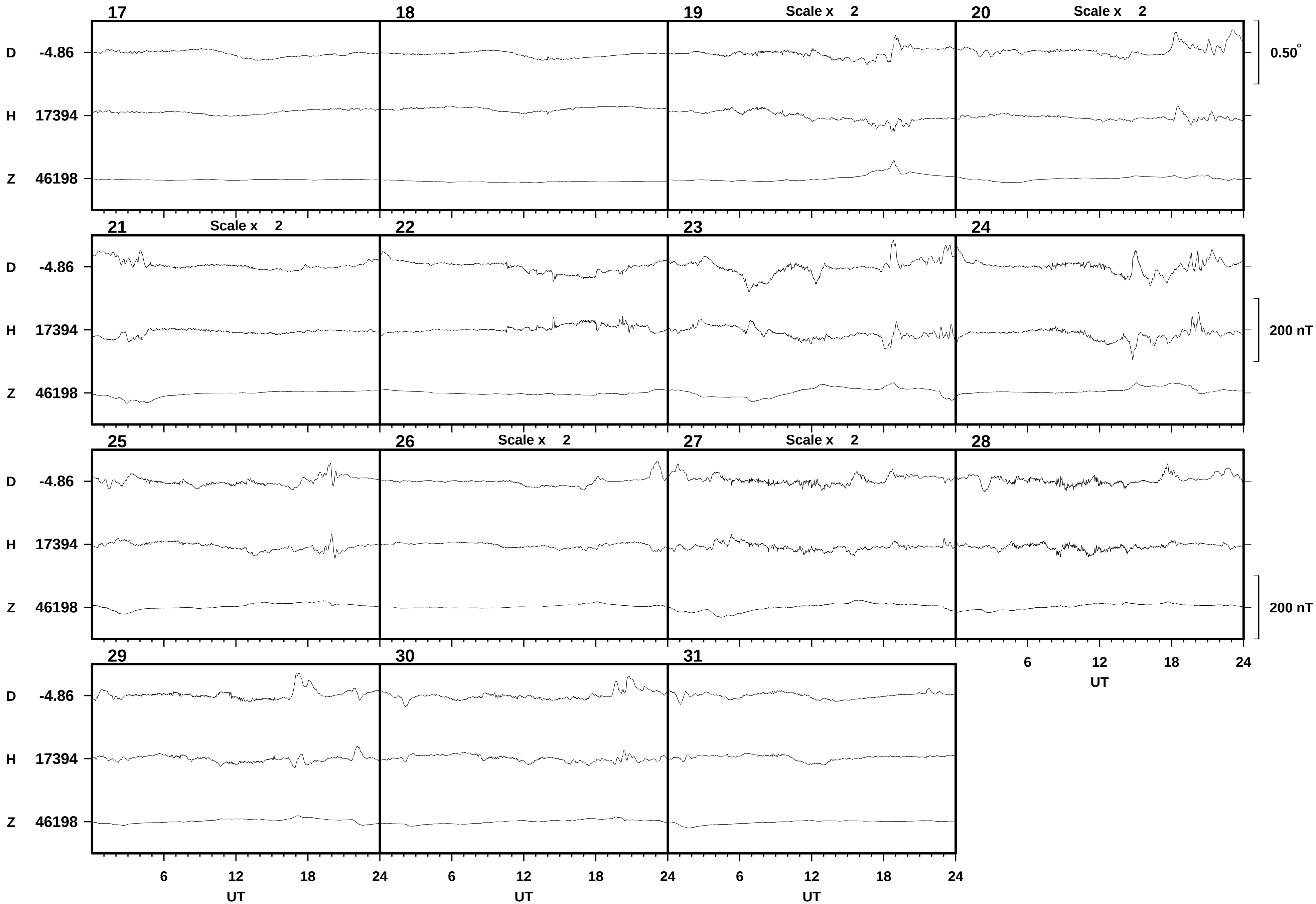

17
18
19
20
Scale x 4
21
Scale x 2
22
23
24
25
26
Scale x 2
27
Scale x 2
28
29
30
D -4.87
H 17386
Z 46200
0.50°
200 nT
200 nT
6
12
18
24
UT

ES 11 2

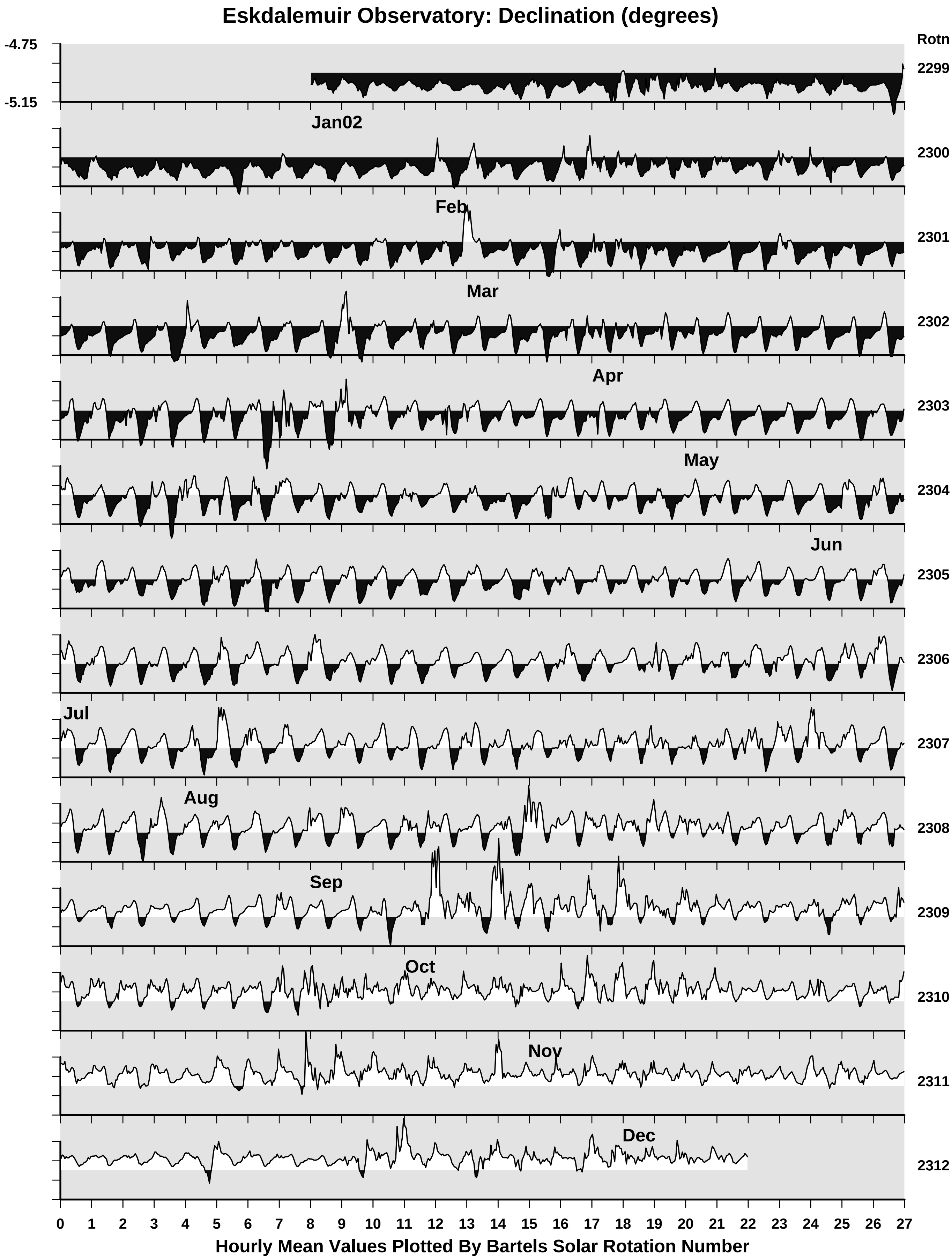
Eskdalemuir December 2002



ES 12 2

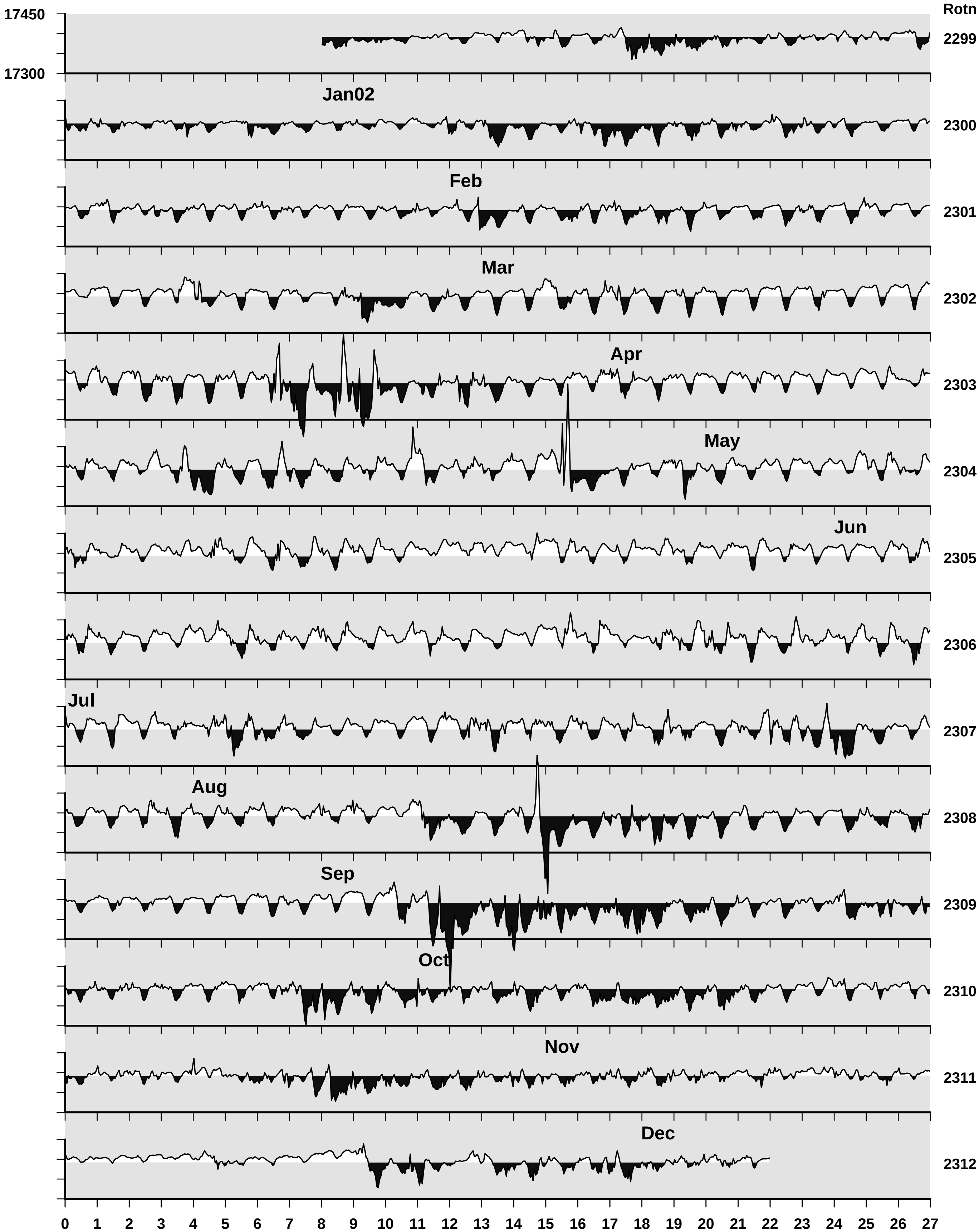

17
18
19
Scale x 2
20
Scale x 2
21
Scale x 2
22
23
24
25
26
Scale x 2
27
Scale x 2
28
29
30
31
D -4.86
H 17394
Z 46198
0.50°
200 nT
200 nT
6
12
18
24
UT

ES 12 2

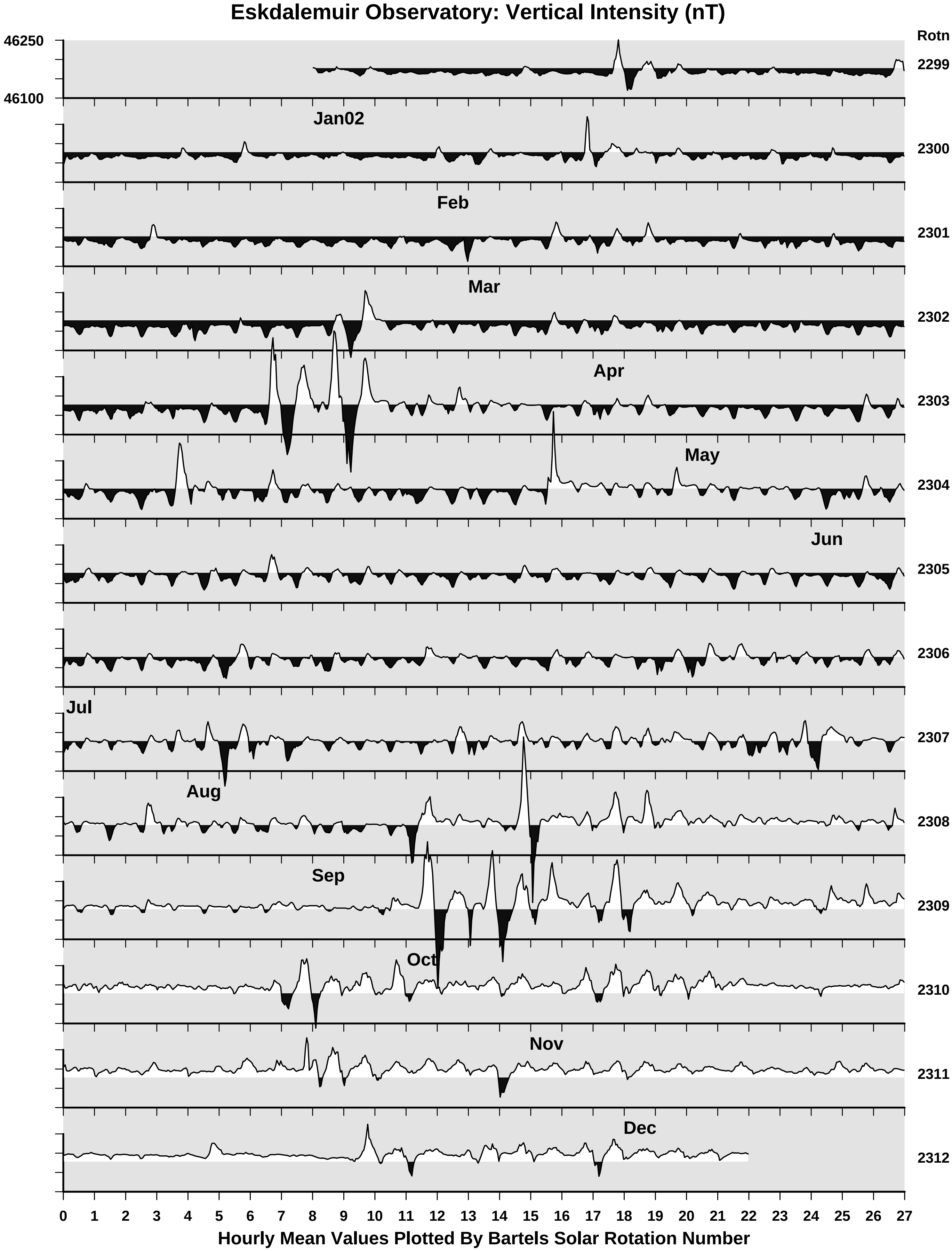


Eskdalemuir Observatory: Declination (degrees)
-4.75
-5.15
Rotn
2299
Jan02
2300
Feb
2301
Mar
2302
Apr
2303
May
2304
Jun
2305
2306
Jul
2307
Aug
2308
Sep
2309
Oct
2310
Nov
2311
Dec
2312
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted By Bartels Solar Rotation Number

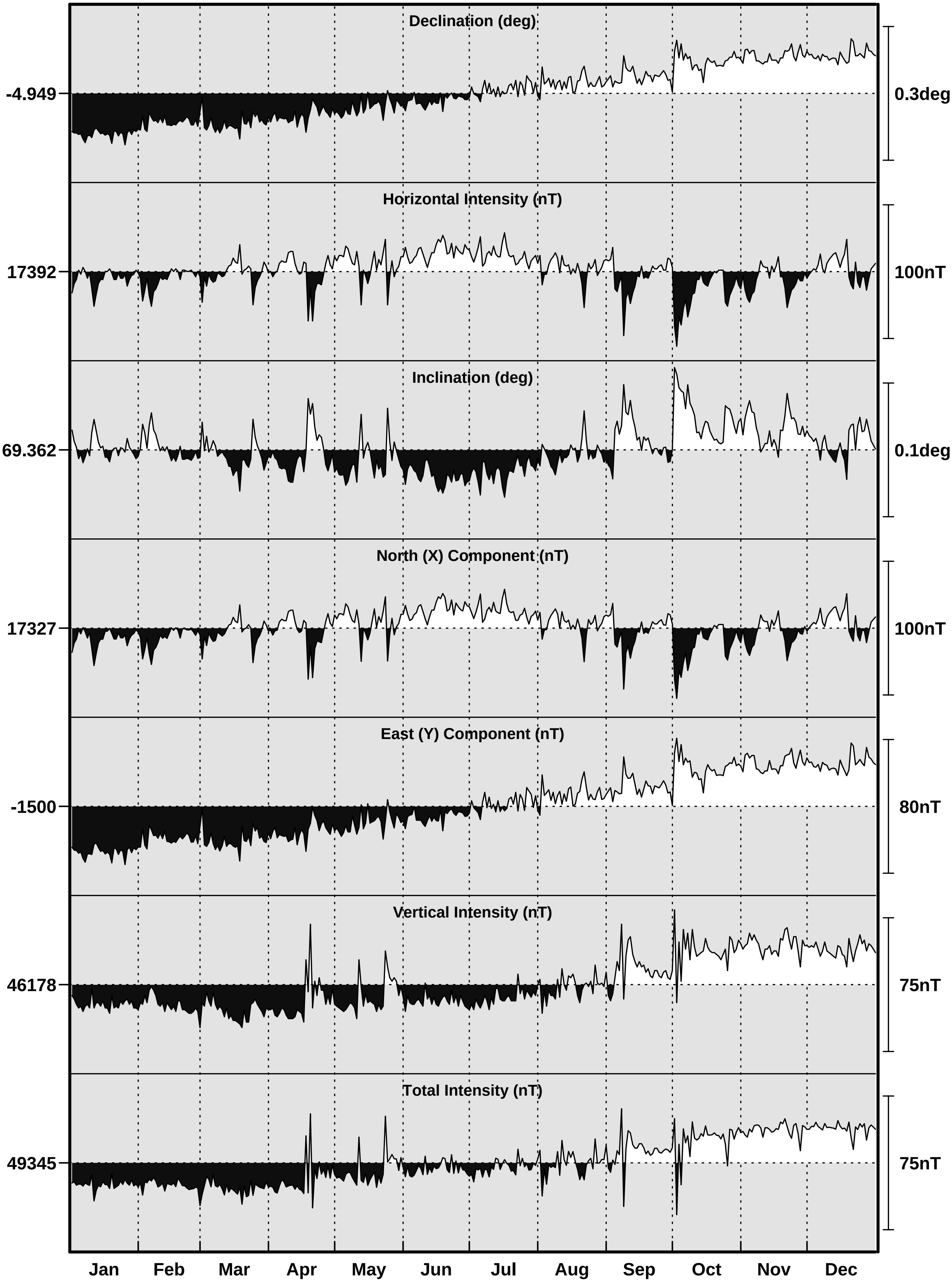
Eskdalemuir Observatory: Horizontal Intensity (nT)



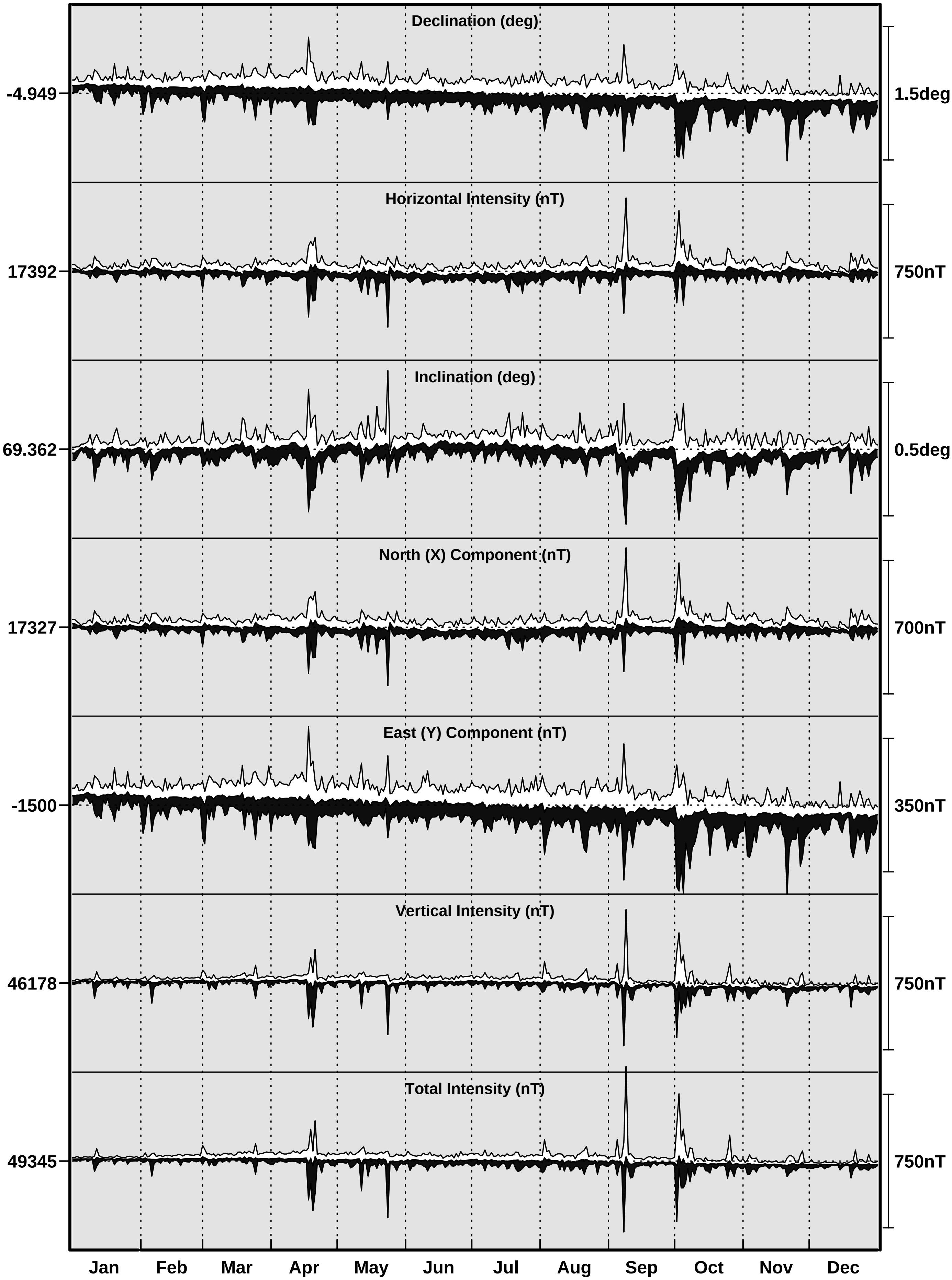
Hourly Mean Values Plotted By Bartels Solar Rotation Number


Eskdalemuir Observatory: Vertical Intensity (nT)
46250
46100
Rotn
2299
2300
2301
2302
2303
2304
2305
2306
2307
2308
2309
2310
2311
2312
Jan02
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 Daily Mean Values 2002



Eskdalemuir Daily Minimum/Maximum Values 2002



Monthly Mean Values for Eskdalemuir 2002

Month	D	H	I	X	Y	Z	F

Based on All Days

Month	D	H	I	X	Y	Z	F
January	-5° 2.4′	17387 nT	69° 21.8′	17320 nT	-1528 nT	46167 nT	49333 nT
February	-5° 0.8′	17386 nT	69° 21.8′	17320 nT	-1519 nT	46166 nT	49332 nT
March	-5° 1.0′	17390 nT	69° 21.5′	17324 nT	-1521 nT	46164 nT	49331 nT
April	-4° 59.9′	17392 nT	69° 21.5′	17326 nT	-1515 nT	46169 nT	49336 nT
May	-4° 58.8′	17397 nT	69° 21.2′	17331 nT	-1510 nT	46171 nT	49340 nT
June	-4° 57.9′	17407 nT	69° 20.5′	17342 nT	-1507 nT	46169 nT	49341 nT
July	-4° 56.4′	17404 nT	69° 20.8′	17339 nT	-1499 nT	46171 nT	49342 nT
August	-4° 55.5′	17394 nT	69° 21.5′	17330 nT	-1493 nT	46177 nT	49344 nT
September	-4° 54.7′	17388 nT	69° 22.2′	17324 nT	-1489 nT	46186 nT	49351 nT
October	-4° 52.5′	17377 nT	69° 23.2′	17314 nT	-1477 nT	46198 nT	49357 nT
November	-4° 51.9′	17386 nT	69° 22.7′	17323 nT	-1475 nT	46200 nT	49363 nT
December	-4° 51.9′	17394 nT	69° 22.1′	17332 nT	-1475 nT	46198 nT	49364 nT
Annual	**-4° 57.0′**	**17392 nT**	**69° 21.7′**	**17327 nT**	**-1500 nT**	**46178 nT**	**49345 nT**

International quiet day means

Month	D	H	I	X	Y	Z	F
January	-5° 2.5′	17392 nT	69° 21.4′	17324 nT	-1528 nT	46165 nT	49333 nT
February	-5° 1.1′	17389 nT	69° 21.6′	17323 nT	-1521 nT	46166 nT	49332 nT
March	-5° 1.2′	17395 nT	69° 21.1′	17328 nT	-1522 nT	46161 nT	49330 nT
April	-4° 59.9′	17398 nT	69° 21.0′	17332 nT	-1516 nT	46165 nT	49334 nT
May	-4° 58.2′	17394 nT	69° 21.5′	17328 nT	-1507 nT	46174 nT	49342 nT
June	-4° 58.2′	17409 nT	69° 20.4′	17343 nT	-1508 nT	46167 nT	49340 nT
July	-4° 57.1′	17406 nT	69° 20.6′	17341 nT	-1503 nT	46168 nT	49340 nT
August	-4° 55.5′	17398 nT	69° 21.2′	17334 nT	-1494 nT	46174 nT	49343 nT
September	-4° 54.7′	17396 nT	69° 21.6′	17332 nT	-1489 nT	46183 nT	49351 nT
October	-4° 53.4′	17390 nT	69° 22.3′	17327 nT	-1483 nT	46194 nT	49359 nT
November	-4° 52.8′	17396 nT	69° 21.9′	17333 nT	-1480 nT	46197 nT	49364 nT
December	-4° 52.4′	17407 nT	69° 21.1′	17344 nT	-1479 nT	46193 nT	49364 nT
Annual	**-4° 57.3′**	**17397 nT**	**69° 21.3′**	**17332 nT**	**-1502 nT**	**46176 nT**	**49344 nT**

International disturbed day means

Month	D	H	I	X	Y	Z	F
January	-5° 2.4′	17379 nT	69° 22.4′	17312 nT	-1527 nT	46170 nT	49332 nT
February	-4° 60.0′	17375 nT	69° 22.6′	17309 nT	-1514 nT	46169 nT	49331 nT
March	-5° 0.0′	17386 nT	69° 21.8′	17320 nT	-1515 nT	46163 nT	49329 nT
April	-4° 59.9′	17374 nT	69° 23.0′	17308 nT	-1514 nT	46185 nT	49345 nT
May	-4° 59.3′	17399 nT	69° 21.3′	17333 nT	-1513 nT	46181 nT	49350 nT
June	-4° 58.1′	17404 nT	69° 20.8′	17338 nT	-1507 nT	46170 nT	49341 nT
July	-4° 56.2′	17400 nT	69° 21.0′	17336 nT	-1497 nT	46171 nT	49341 nT
August	-4° 54.7′	17385 nT	69° 22.1′	17321 nT	-1489 nT	46173 nT	49337 nT
September	-4° 54.7′	17375 nT	69° 23.2′	17311 nT	-1488 nT	46191 nT	49351 nT
October	-4° 51.3′	17353 nT	69° 24.7′	17291 nT	-1468 nT	46195 nT	49347 nT
November	-4° 51.1′	17372 nT	69° 23.6′	17310 nT	-1469 nT	46204 nT	49362 nT
December	-4° 51.2′	17382 nT	69° 22.9′	17320 nT	-1471 nT	46201 nT	49363 nT
Annual	**-4° 56.6′**	**17382 nT**	**69° 22.4′**	**17317 nT**	**-1498 nT**	**46181 nT**	**49344 nT**

Eskdalemuir Observatory K Indices 2002

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2221 1132	4312 3212	4211 2110	3343 4331	0110 1110	0000 1222	3323 3431	0334 4434	3221 3224	2234 4745	1022 1322	3322 3324
2	2001 2222	3342 3313	1111 2221	2333 2221	2101 3311	3322 3333	3110 1121	5532 4444	3212 2110	7643 2333	5223 3354	2122 2343
3	1000 1100	1101 1100	1112 3243	3332 3222	1211 2221	3320 2232	0011 2121	4232 2331	0002 2133	4233 3465	3433 4545	2222 2231
4	1000 1001	0101 1113	3222 2333	1111 2101	1210 1221	3332 3321	1000 1123	2333 2330	3534 4443	6543 3374	4333 2434	1122 2333
5	1100 0000	3212 3354	4333 3433	1010 1110	1001 1101	3210 2211	2122 3433	1111 1222	2311 2221	4422 4443	3434 3233	3221 2221
6	0000 1101	3333 3232	2343 3332	0000 1111	0111 2423	1111 1212	3433 3433	2100 2111	2121 3211	1233 2144	3333 3353	1212 1323
7	0112 1232	2233 4213	2223 3213	1122 3210	2111 2333	1110 1212	3111 3321	2101 1221	2331 2675	3443 4455	3223 2222	3223 3243
8	2231 3210	2113 3323	1121 1000	0011 1010	3321 2212	0112 4443	2111 2224	1200 2233	7532 1234	4443 3443	0012 2130	1311 2333
9	0000 1101	2222 1134	1001 2320	0110 1101	3022 2111	3221 2232	4322 3332	2121 3433	1001 2134	1232 3544	1000 1223	3001 1111
10	1121 3443	3221 2101	0113 3113	0011 3312	2123 2434	1232 3432	2121 2232	3413 4323	3212 3444	3323 1224	3341 2222	2001 0012
11	3433 3433	3113 3323	3312 2221	2144 3323	0014 6644	2122 2332	1001 2133	1122 4332	2333 3424	1111 2212	1123 3123	0011 1100
12	3233 2341	3221 1114	2122 2323	3223 3333	4332 2333	3102 2212	2224 3432	3323 3233	4222 3332	2111 1212	1224 3143	1101 1111
13	2223 3214	2223 3410	2021 2110	3323 3433	3211 3221	1222 2331	2212 2221	3321 1122	3223 2121	1100 0122	3323 3112	1000 1011
14	2111 2222	0010 1100	0001 1100	3311 4410	3433 3453	2001 2211	0001 1220	1211 3432	3321 2221	3342 4323	3112 2322	1111 2443
15	0122 2222	0000 1221	0011 0122	2000 2223	3322 2331	1000 1112	0010 2221	2123 3444	2101 2222	2223 3443	3222 2223	3111 1121
16	1110 1100	1101 1211	1001 1110	2330 2121	1212 2322	2121 3222	1212 4443	2242 3211	0101 3110	3112 3353	3111 1014	2111 1102
17	3211 2313	2333 3212	0000 0111	2234 5763	1011 3332	2110 1211	3432 3543	0321 2222	0212 2233	3332 3223	4210 1212	1100 0001
18	3100 1100	1111 2243	3011 5333	5644 4434	1111 2154	0102 3432	2111 1000	3211 2254	3223 3322	3322 3333	3111 2233	0000 1000
19	0112 3334	3111 0121	4432 1122	3345 4654	3430 1000	3222 2333	0103 3423	4343 3434	2123 3423	2322 2243	2322 2134	2334 4452
20	4211 1222	2011 2223	1000 3431	6643 5543	1323 2331	3322 1110	4422 2333	2311 2455	2110 1001	3213 2213	3212 1465	3322 3355
21	3221 2232	1121 2223	2121 2232	1100 1112	3230 2123	1212 3331	4421 4431	4543 4333	1001 3310	2222 2222	4454 3354	4422 2322
22	0111 2111	2311 2132	2221 1100	3311 2321	1212 3331	1001 2323	2234 3323	2321 2221	2110 2321	3113 2131	4233 4434	2102 3232
23	2111 1233	2001 1101	0013 4344	1453 3433	2216 7733	1232 3232	4222 3445	1121 1222	1010 0100	1122 3333	3322 2332	3233 3344
24	1300 0101	1111 2111	4543 3433	3111 2212	0000 1001	1211 2321	3211 2221	2111 1111	0001 1010	5535 5654	3322 1433	3022 4443
25	1002 3341	2011 2123	2101 2321	2000 0110	1000 2321	2112 4222	3213 3334	2111 1212	0000 2201	5444 4334	2232 3324	3221 2241
26	3212 1221	1111 2223	2233 3223	0000 1121	1111 2322	3101 2311	3322 2433	2113 4433	2010 1223	4334 3443	3201 2135	2112 3334
27	3212 2111	3111 2112	0111 1110	1112 3333	3343 4422	1000 0110	4323 4433	2322 3324	3101 2211	3323 3444	4432 3233	4443 3444
28	2101 2122	1323 3345	0000 0100	4433 3422	2331 3322	0000 1110	3322 3322	2121 2232	2011 0221	4333 3233	1221 2242	3333 2323
29	2101 1101		0000 1113	2013 3323	3111 3221	1001 1132	1221 5421	3111 3321	0001 1112	3223 2133	2222 2333	2222 2433
30	1000 1012		2343 4322	2112 3220	1211 2221	2232 3323	1111 1332	1222 3230	2344 3334	2142 2233	3332 2323	3121 2233
31	2100 0104		2334 3343		1100 1110		1103 2321	0111 2224		4323 3432		3211 2101

SIs and SSCs

Day	Month	UT		Type	Quality	H (nT)	D (min)	Z (nT)
19	01	05	12	SSC	C	6.0	-0.91	-1.0
31	01	21	27	SSC	B	14.8	-0.70	-1.8
17	02	02	56	SSC	C	27.5	-3.01	-3.6
28	02	04	51	SSC	B	29.4	-6.25	-3.8
15	03	17	51	SSC	B	-5.3	0.59	-
18	03	13	23	SSC	A	98.6	-7.43	-12.8
20	03	13	29	SSC*	A	30.6	-3.16	-1.8
22	03	04	07	SI	C	5.5	-3.17	-1.1
23	03	11	36	SSC*	B	31.9	2.05	-6.0
29	03	22	37	SSC	B	52.2	-3.23	-6.5
17	04	11	07	SSC*	A	-72.0	12.47	1.4
19	04	08	35	SSC*	A	-56.9	9.95	4.3
23	04	04	48	SSC*	A	42.2	-12.2	-3.9
10	05	11	23	SSC*	B	38.5	-5.74	-5.8
11	05	10	13	SSC*	A	18.1	5.62	-6.1
18	05	20	08	SSC*	B	92.6	-3.55	-9.0
20	05	03	39	SSC*	B	19.4	-4.62	-2.5
21	05	22	02	SSC*	B	40.2	-0.79	-4.66
23	05	10	50	SSC*	A	-27.9	4.05	-2.8
23	05	11	50	SI*	C	97.5	-12.36	8.2
23	05	15	42	SI	A	198.4	-9.07	-10.4
01	06	16	44	SI*	C	19.4	-1.26	-1.0
08	06	11	40	SSC*	C	-13.1	1.75	-
19	07	10	09	SSC*	A	-45.9/+43.1	3.73	-2.1/+2.1
22	07	10	57	SI*	B	18.7	-15.80	-2.1
25	07	13	36	SI*	B	18.9	-10.60	-2.0
29	07	13	21	SSC*	A	74.1	-31.40	-6.0
18	08	18	46	SSC*	A	107.0	-6.64	-7.0
20	08	13	58	SSC*	C	20.7	-1.65	-1.0
26	08	11	30	SSC*	B	-9.6	2.53	-

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)
07	09	16	37	SSC	C	68.4	-10.41	-
30	09	08	15	SSC*	B	-33.0	2.07	3.0
29	10	20	27	SSC	B	4.7	3.81	-
09	11	17	51	SI*	A	15.9	-0.93	-1.5
09	11	18	49	SSC*	A	29.8	-1.88	-2.9
20	11	11	08	SSC	B	13.	-1.46	-2.4
26	11	21	51	SSC	B	35.6	0.93	-4.8
06	12	06	47	SSC*	B	4.6	-1.58	-
22	12	10	28	SSC*	B	-8.5	-1.26	-
31	12	21	31	SI*	B	2.4	0.73	-

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				
04	04	15	29	15	33	15	46	-2.5	-1.7	-
09	04	12	56	13	02	13	15	-7.2	-0.83	-
10	04	12	26	12	32	12	45	-26.6	-	1.2
20	05	15	25	15	27	15	38	-7.6	-1.58	-

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

Annual Values of Geomagnetic Elements

Eskdalemuir

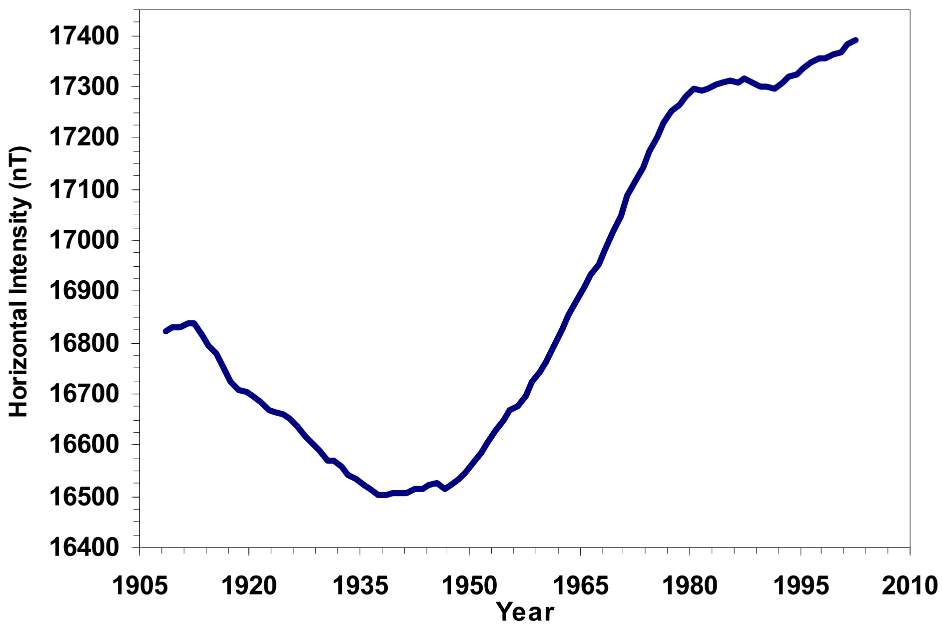
Year	D		H	I		X	Y	Z	F
1908.5	-18	33.3	16821	69	37.3	15947	-5353	45283	48306
1909.5	-18	30.1	16826	69	38.9	15956	-5339	45360	48380
1910.5	-18	23.3	16826	69	37.8	15967	-5308	45317	48340
1911.5	-18	12.4	16836	69	37.1	15993	-5260	45317	48343
1912.5	-18	3.9	16836	69	37.2	16006	-5221	45318	48344
1913.5	-17	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

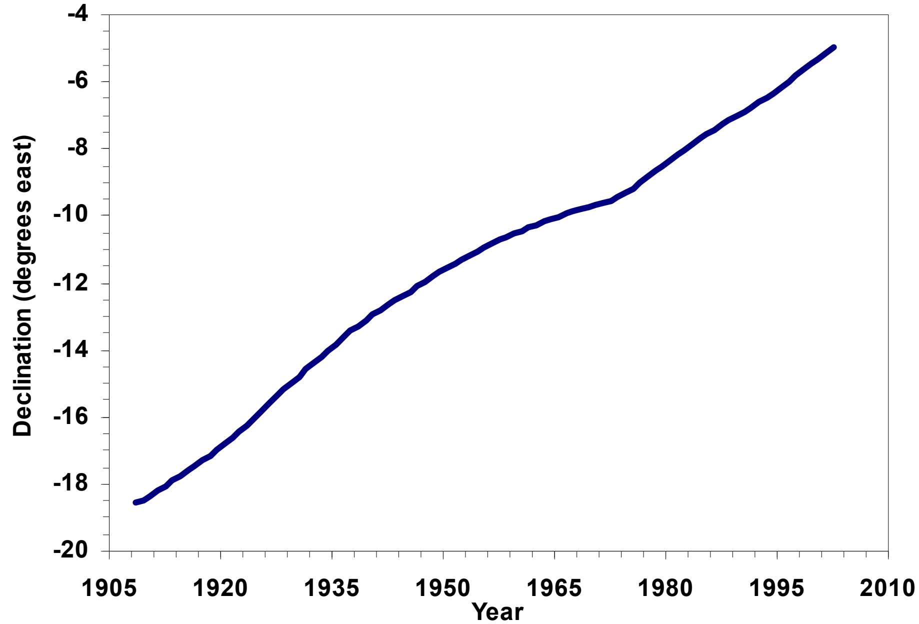
Year	D		H	I		X	Y	Z	F
1973.5	-9	25.2	17141	69	25.5	16910	-2805	45664	48775
1974.5	-9	17.4	17169	69	24.5	16944	-2772	45696	48815
1975.5	-9	9.8	17200	69	23.0	16981	-2739	45719	48847
1976.5	-9	1.1	17227	69	21.8	17014	-2700	45741	48877
1977.5	-8	51.2	17249	69	20.6	17044	-2655	45755	48899
1978.5	-8	40.5	17260	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
2002.5	-4	57.0	17392	69	21.7	17327	-1500	46178	49345

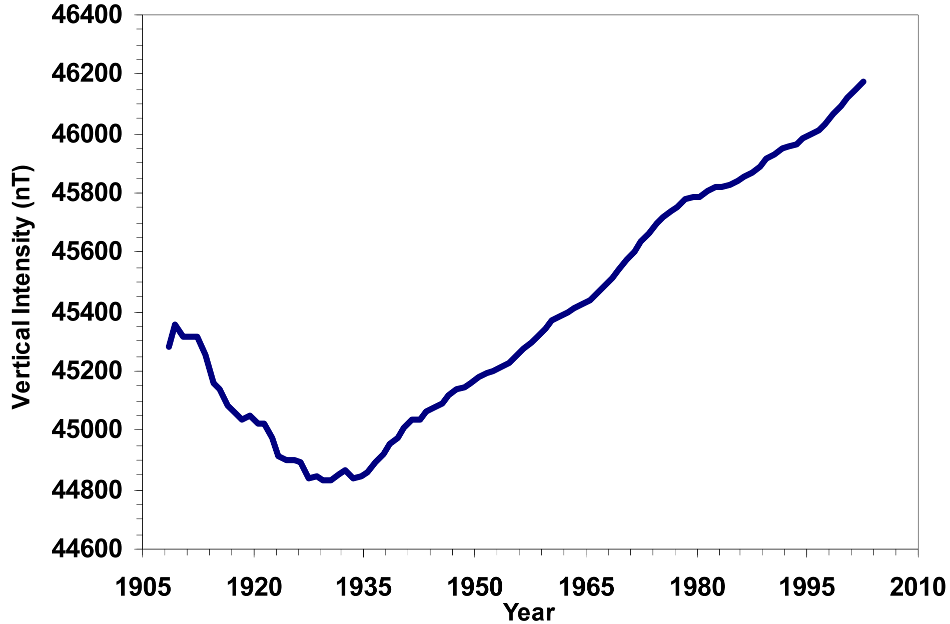
1 Site differences 1 Jan 1990 (new value - old value)
2 Site differences 1 Jan 1994 (new value - old value)

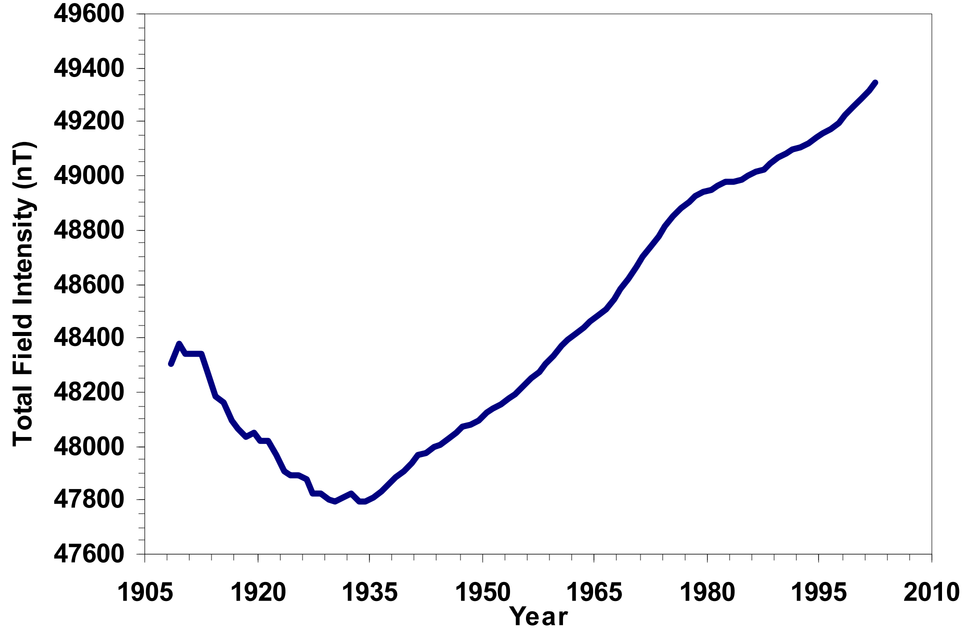
D and I are given in degrees and decimal minutes
All other elements are in nanoteslas

Annual Mean Values at Eskdalemuir

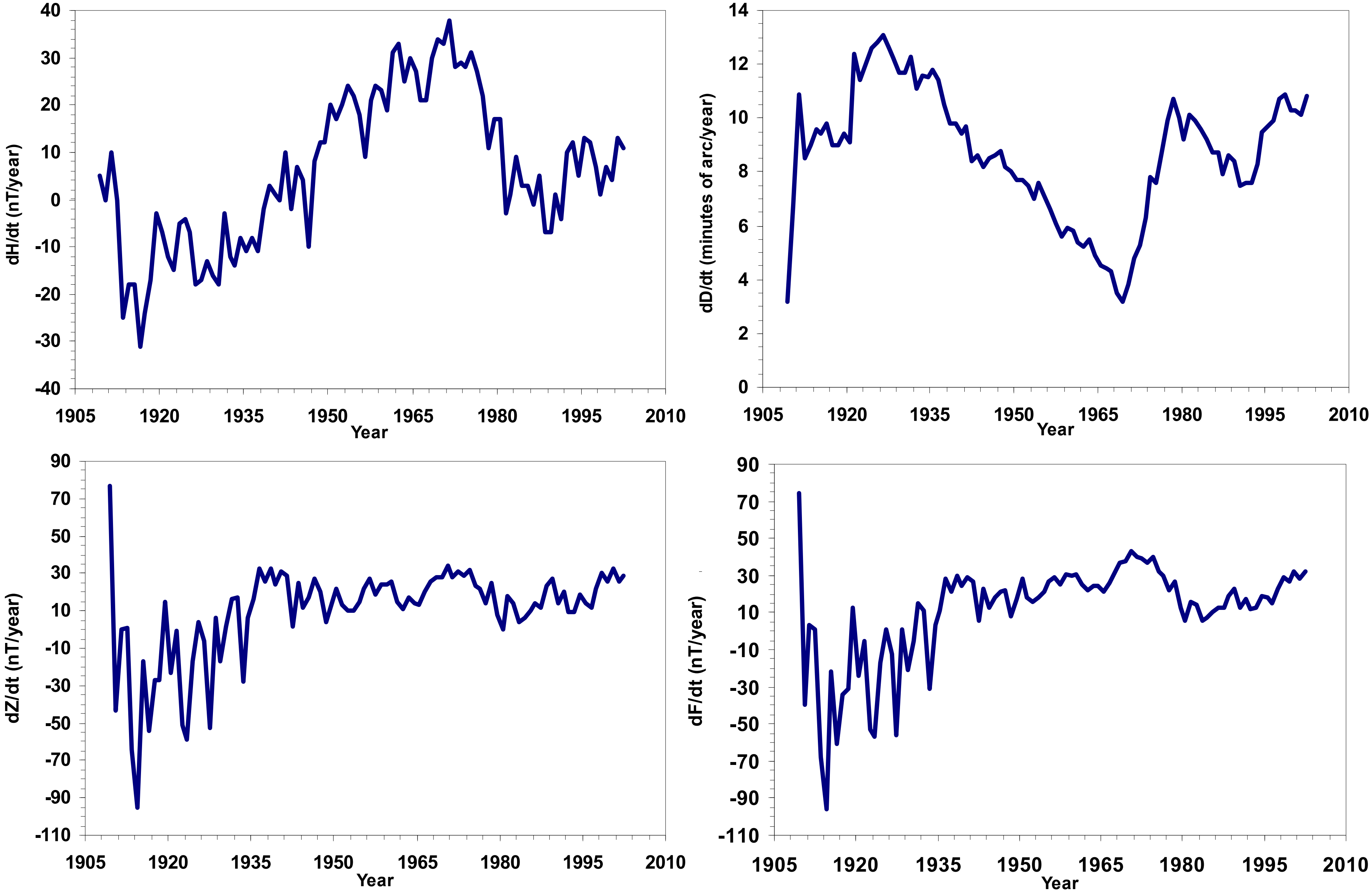






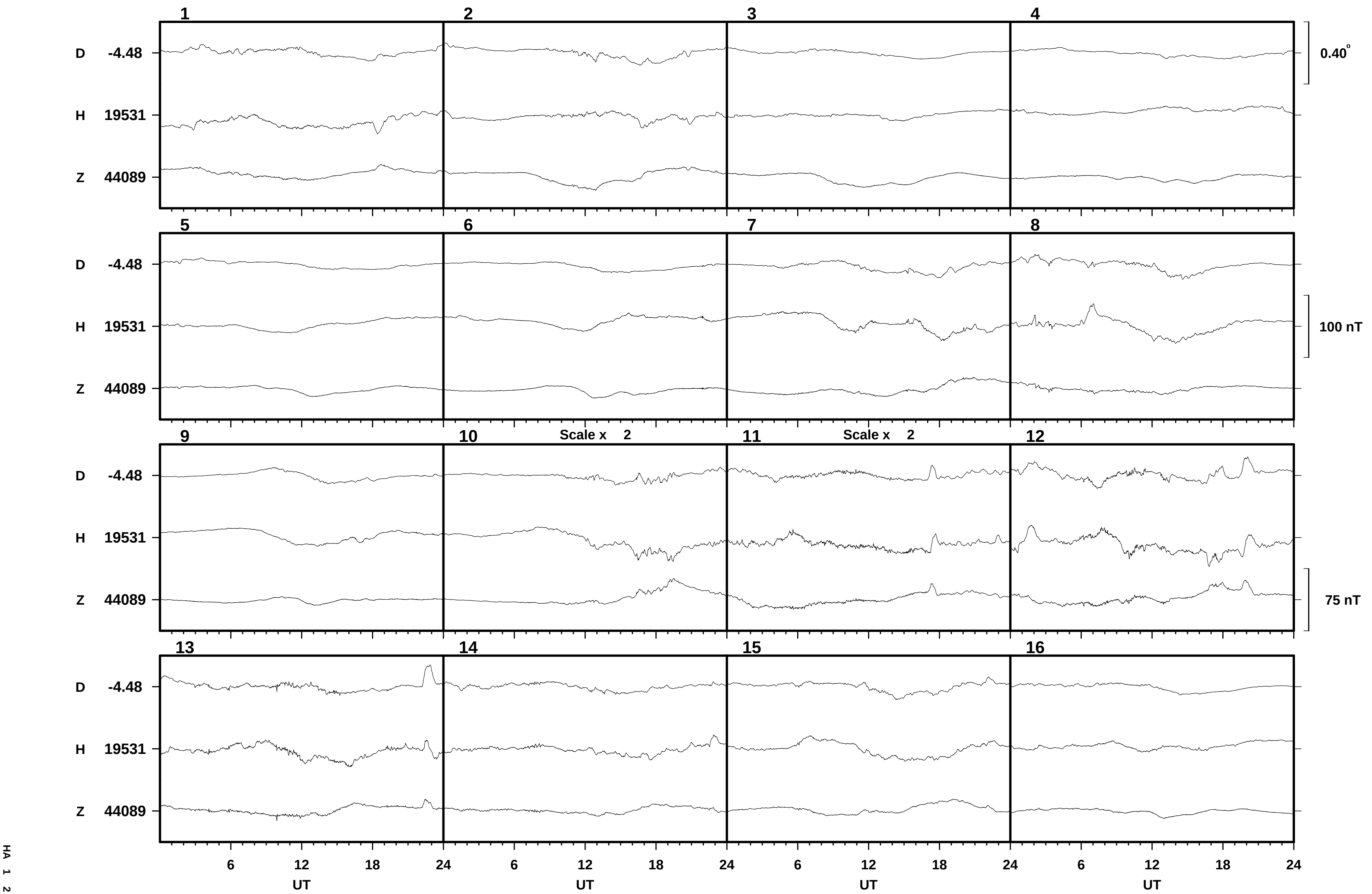


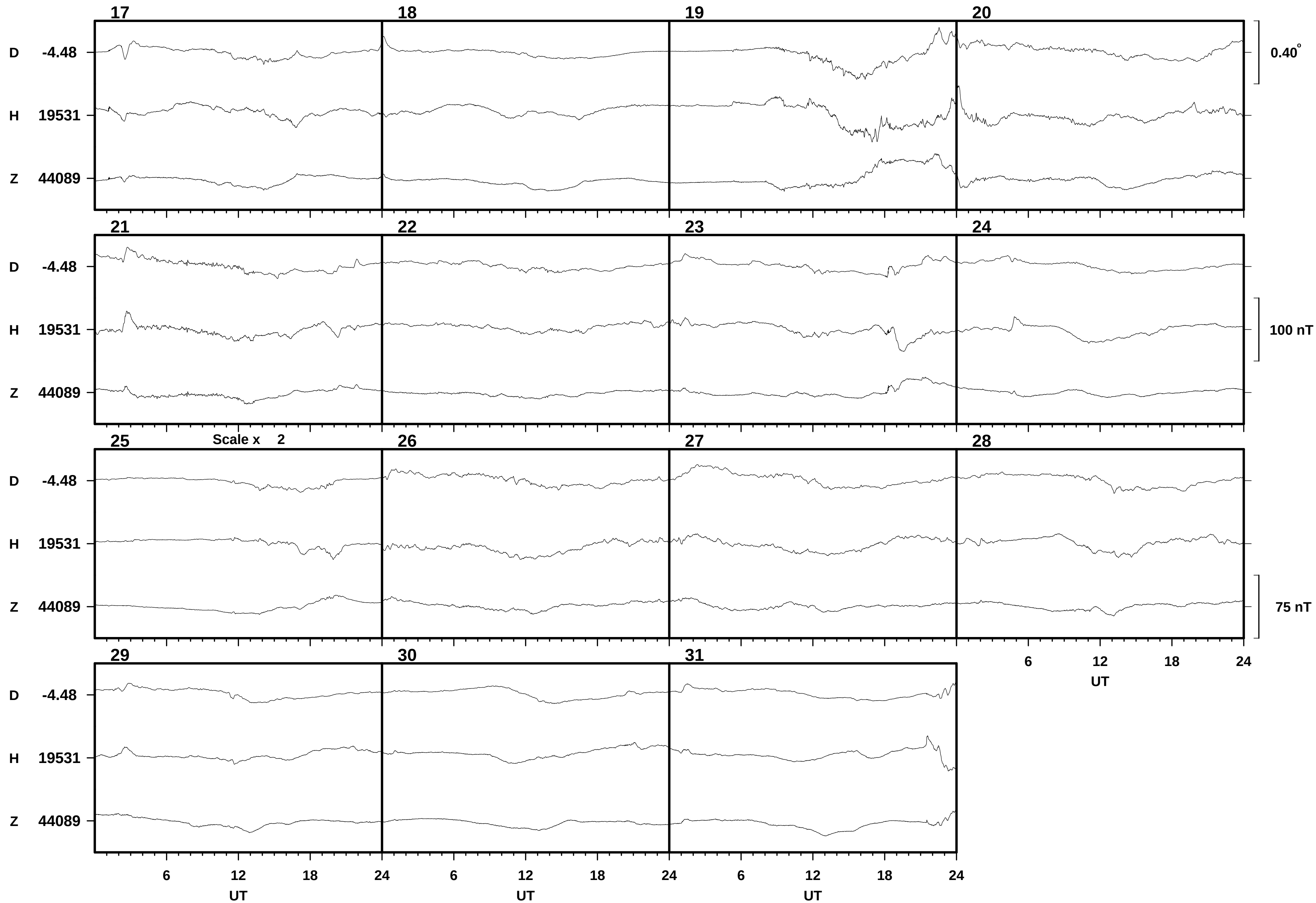
Rate of Change of Annual Mean Values at Eskdalemuir



Hartland Observatory Results 2002

Hartland January 2002

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29
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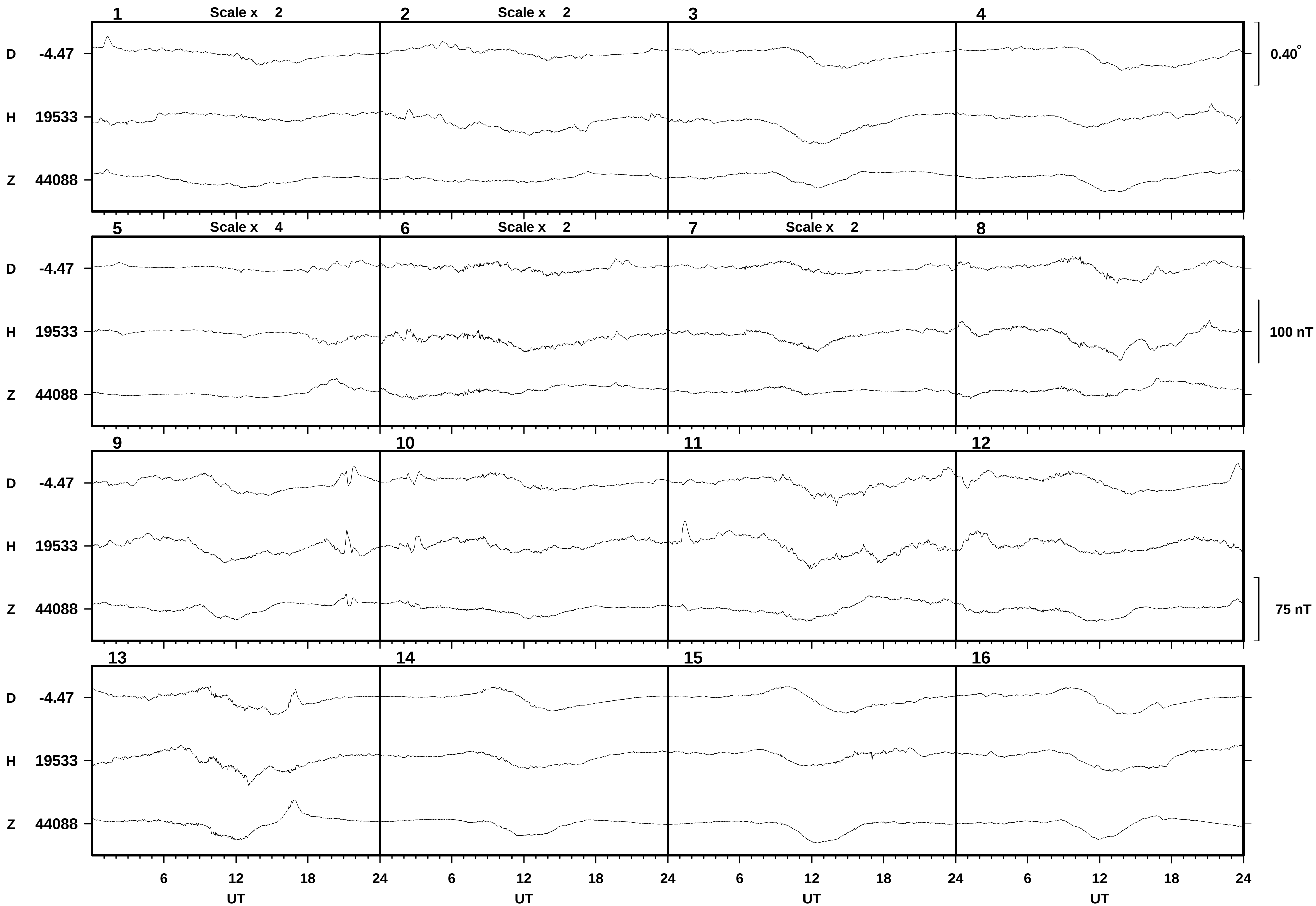
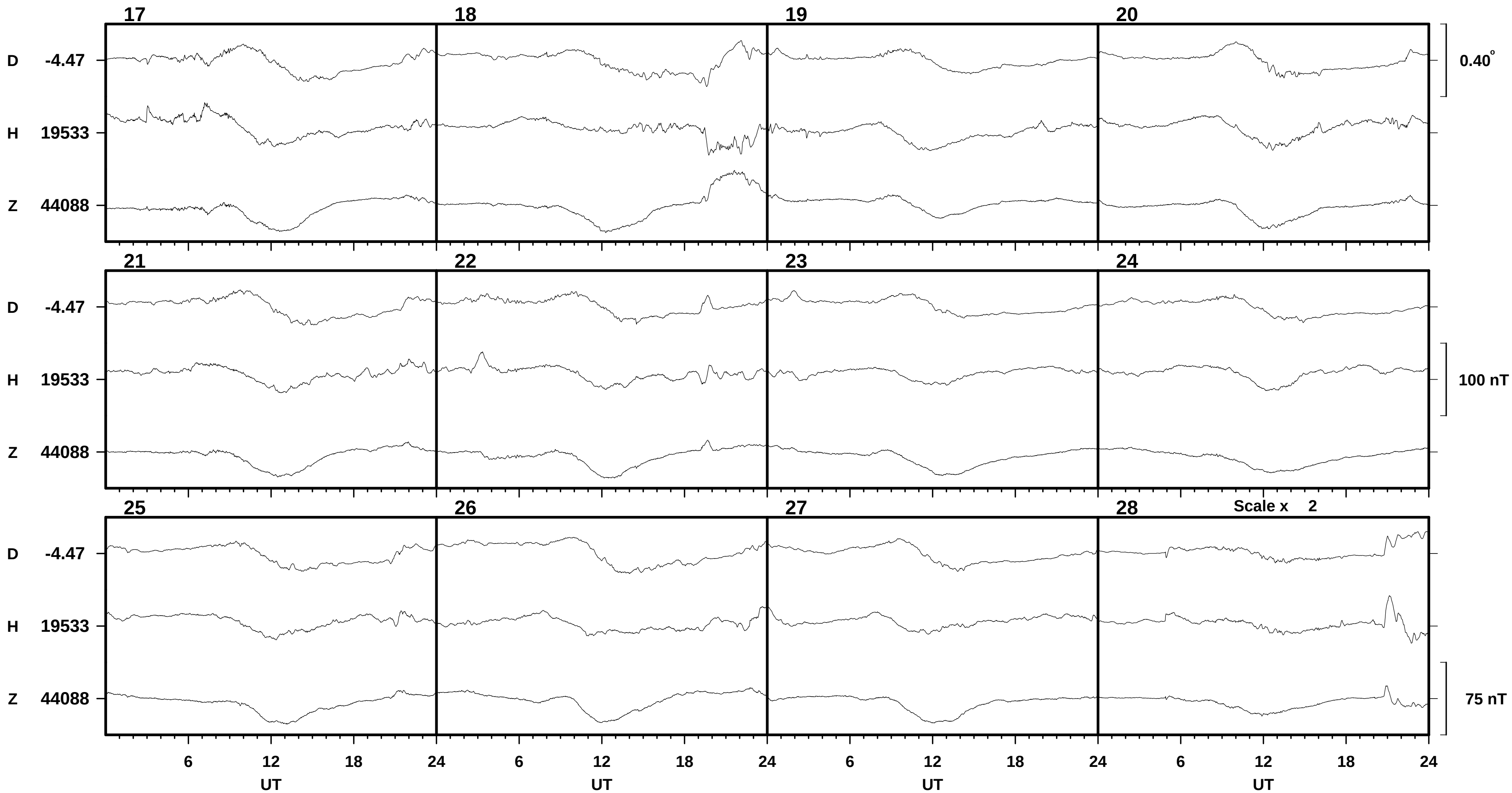
31
D -4.48
H 19531
Z 44089
0.40°
100 nT
75 nT
Scale x 2
6
12
18
24
UT

HA 1 2

Hartland February 2002



HA 2 2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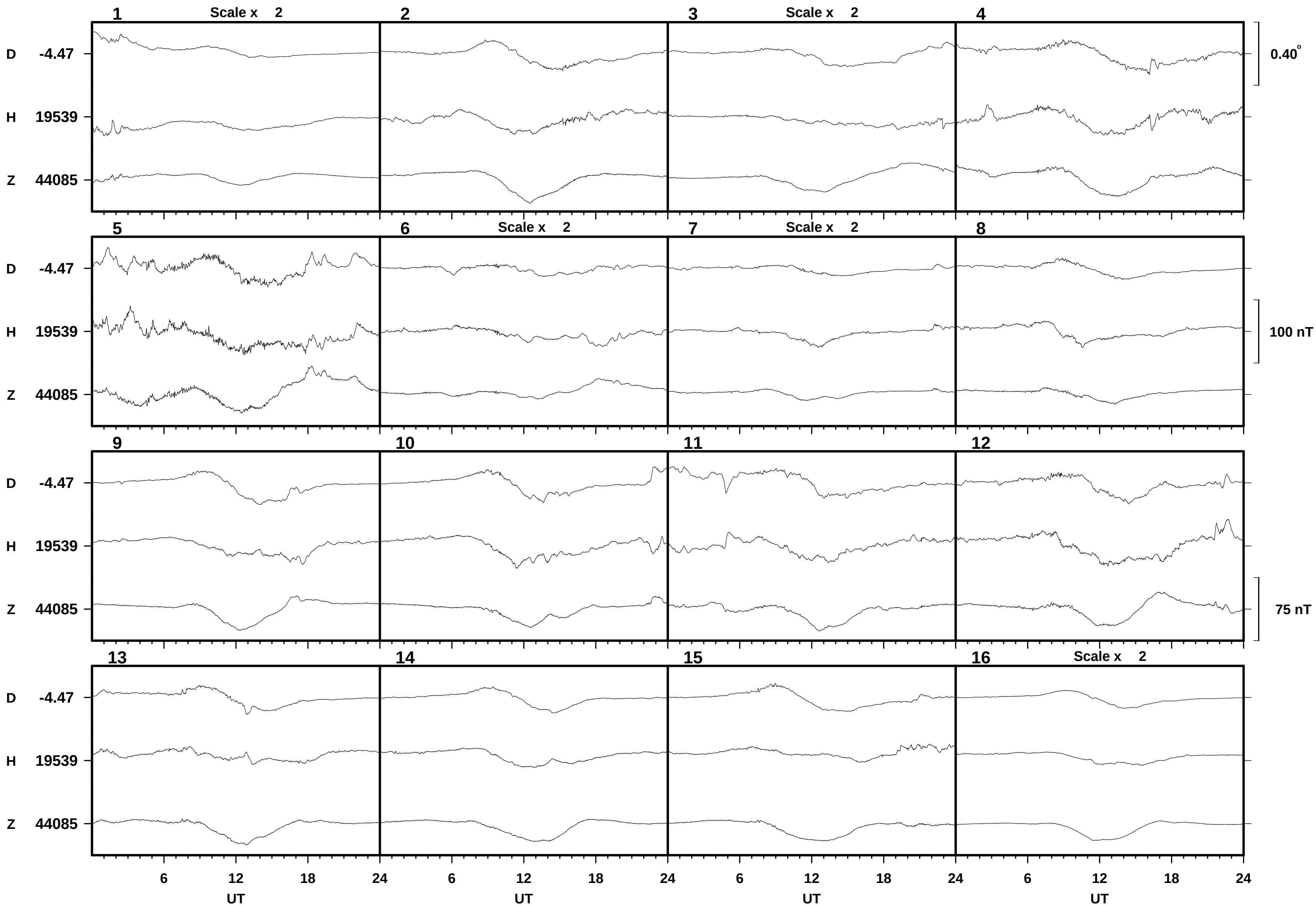
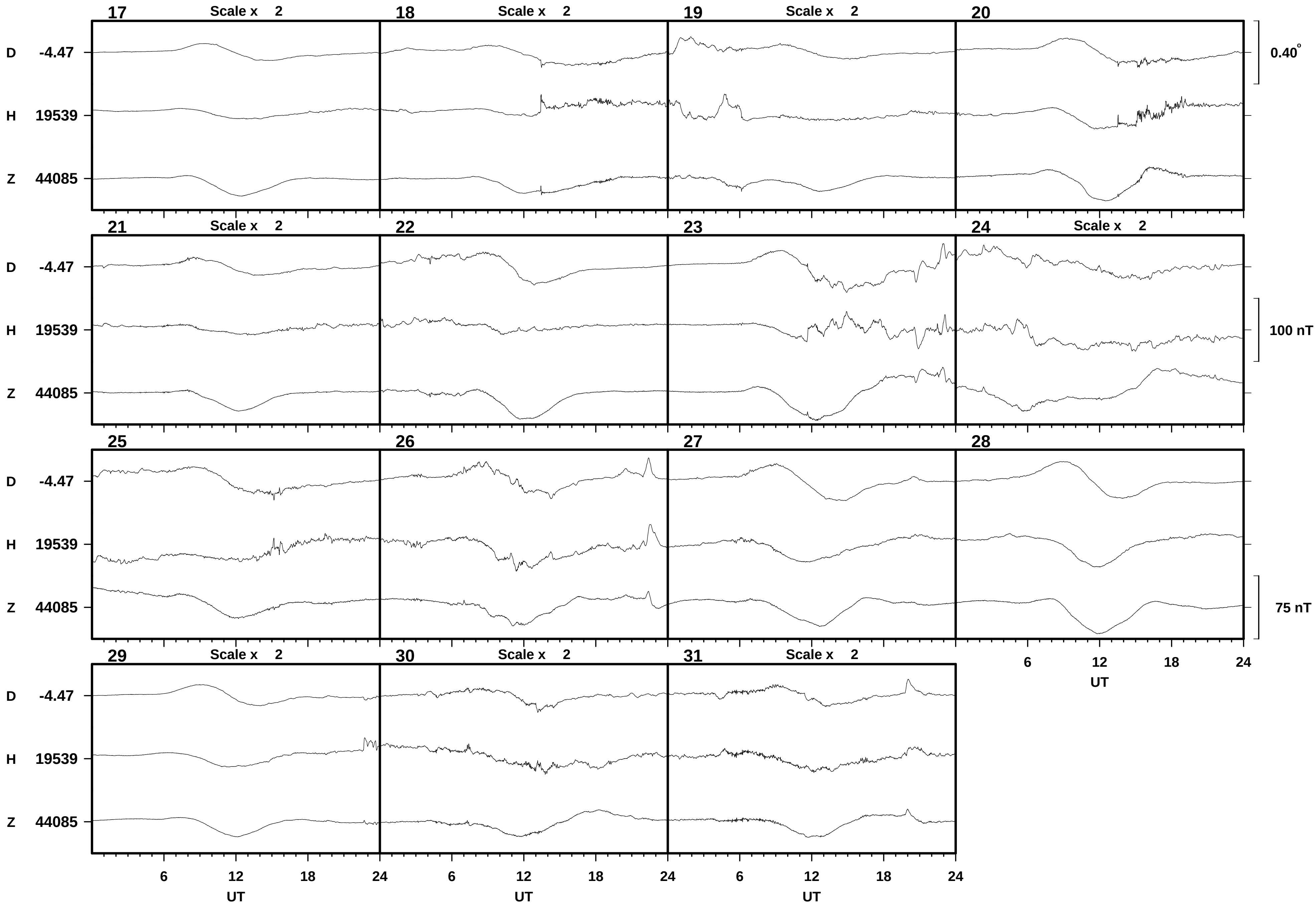
24
25
26
27
28
D -4.47
H 19533
Z 44088
0.40°
100 nT
75 nT
Scale x 2
6
12
18
24
UT

HA 2 2

Hartland March 2002



HA 3 2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21 Scale x 2
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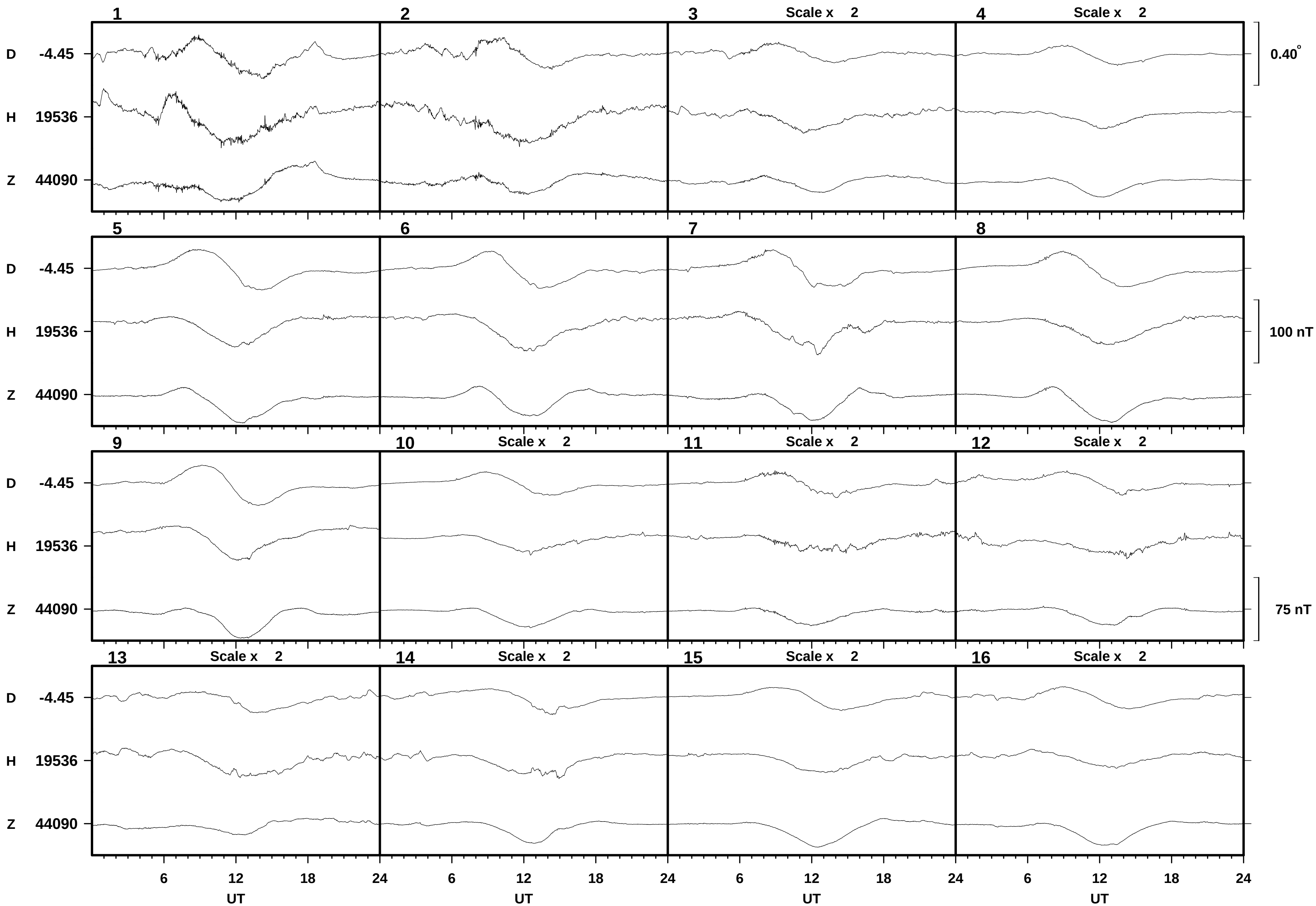
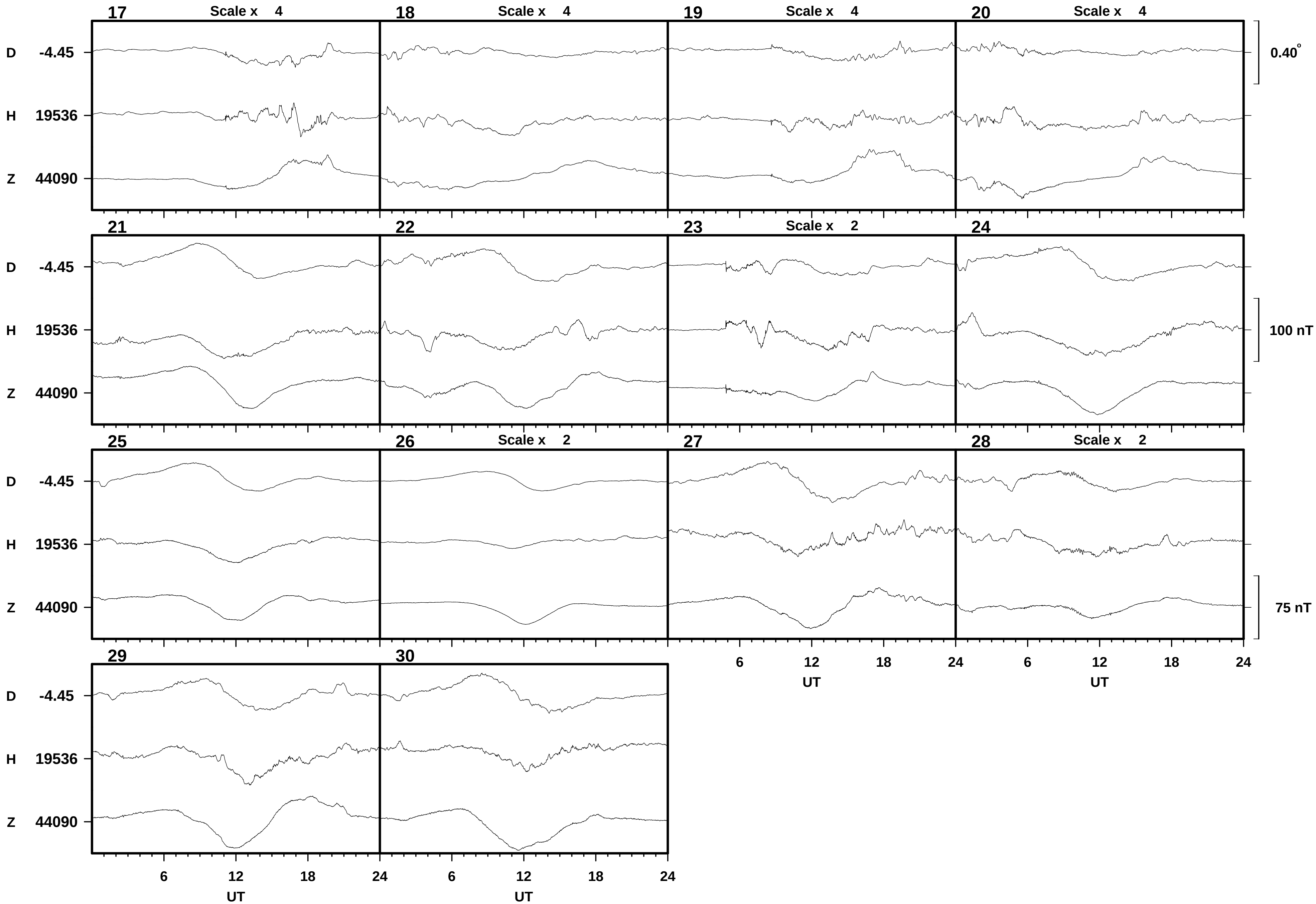
27
28
29 Scale x 2
30 Scale x 2
31 Scale x 2
D -4.47
H 19539
Z 44085
0.40°
100 nT
75 nT
6 12 18 24
UT

HA 3 2

Hartland April 2002



HA 4 2



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Scale x 4
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Scale x 4
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Scale x 4
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Scale x 4
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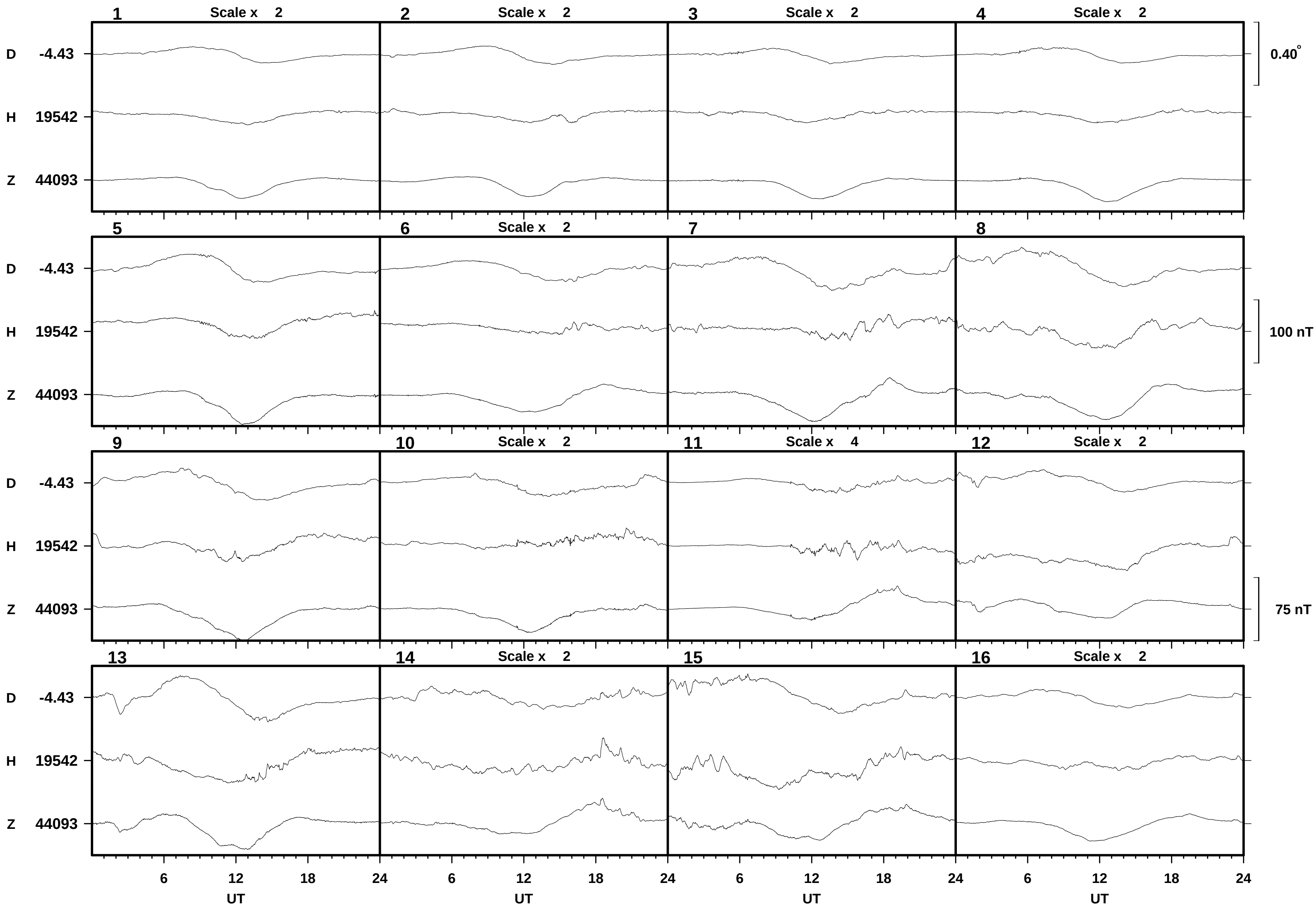
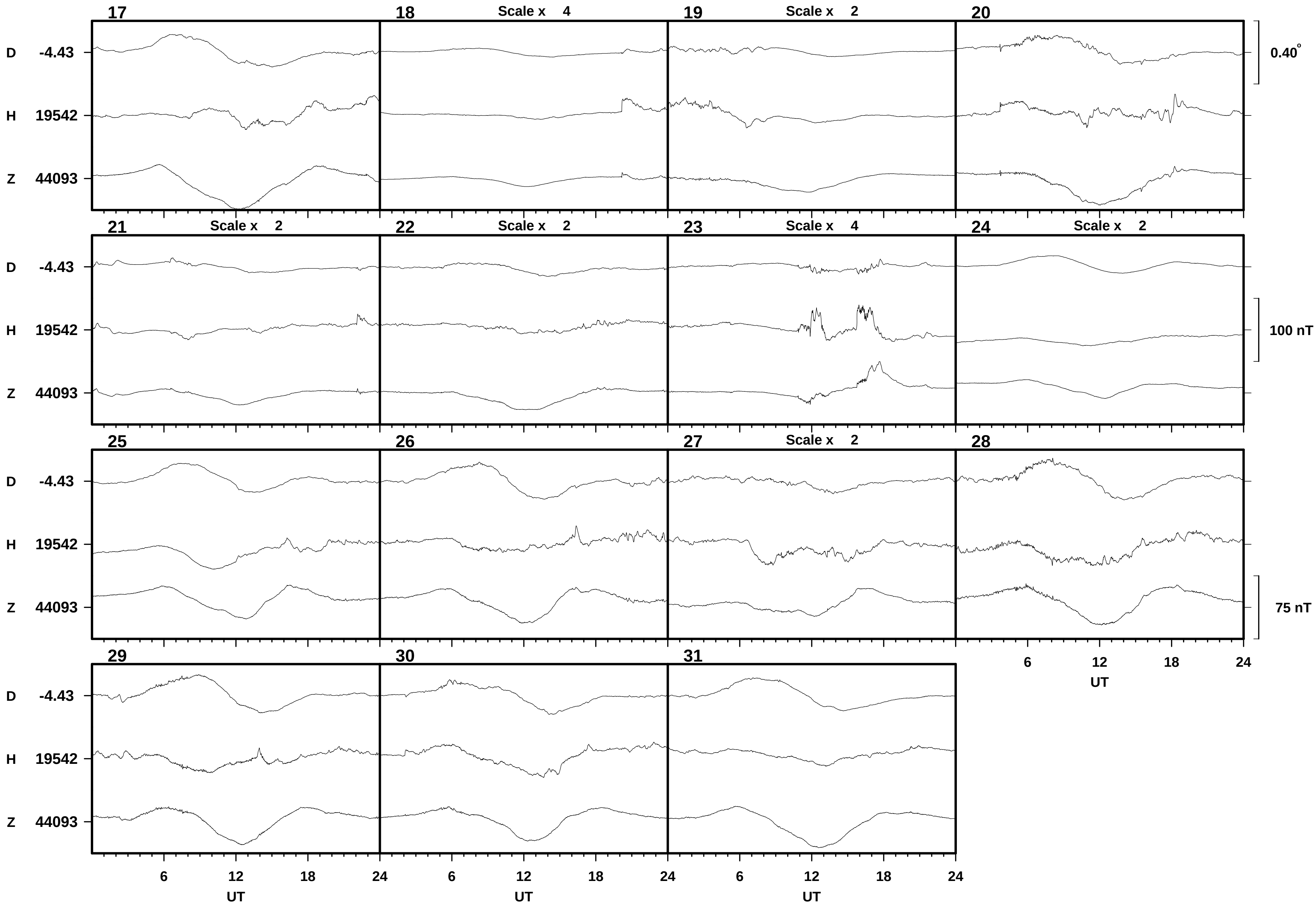
Scale x 2
24
25
26
Scale x 2
27
28
Scale x 2
29
30
D -4.45
H 19536
Z 44090
0.40°
100 nT
75 nT
6
12
18
24
UT

HA 4 2

Hartland May 2002



HA 5 2



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Scale x 4
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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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Scale x 4
24
Scale x 2
25
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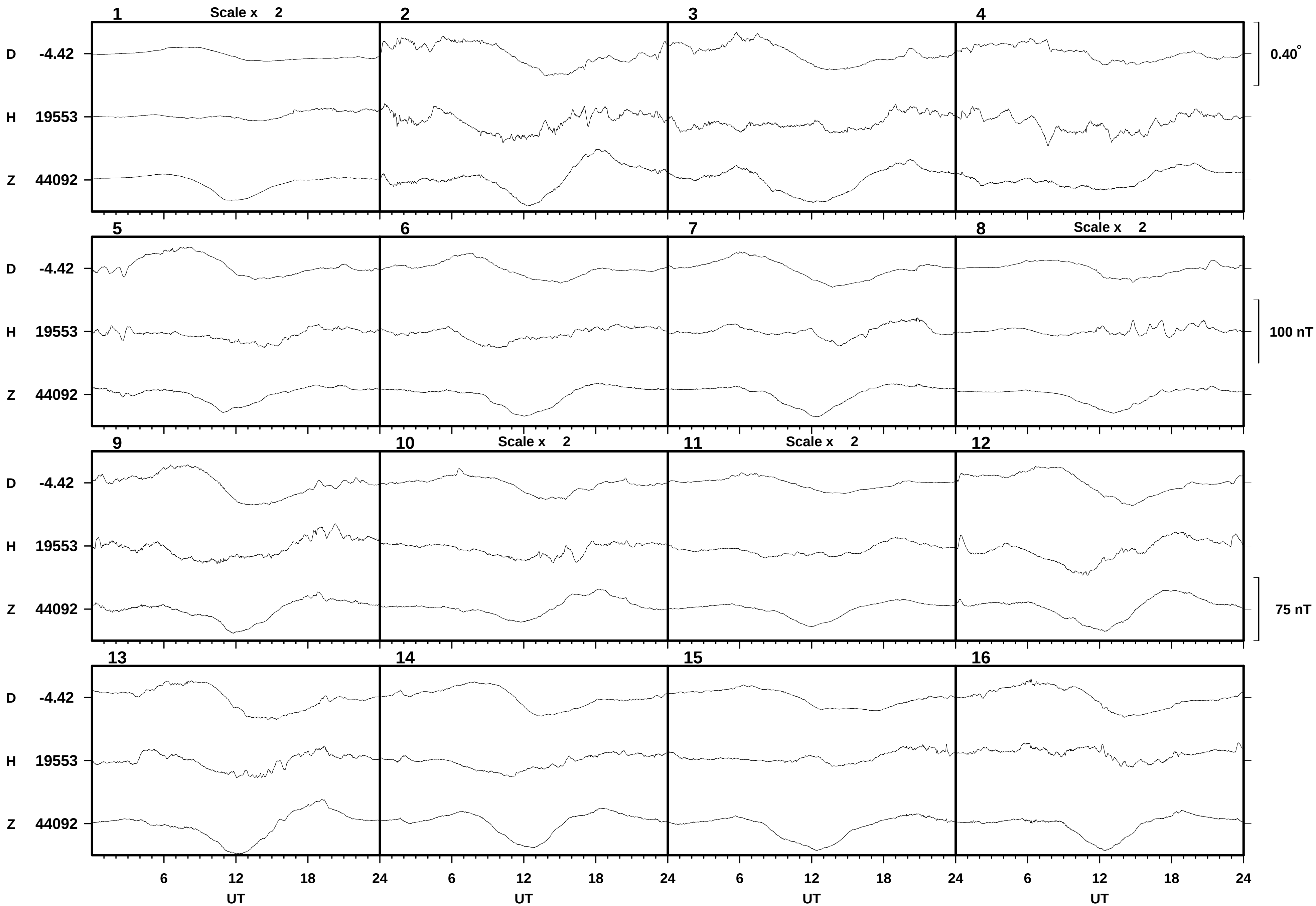
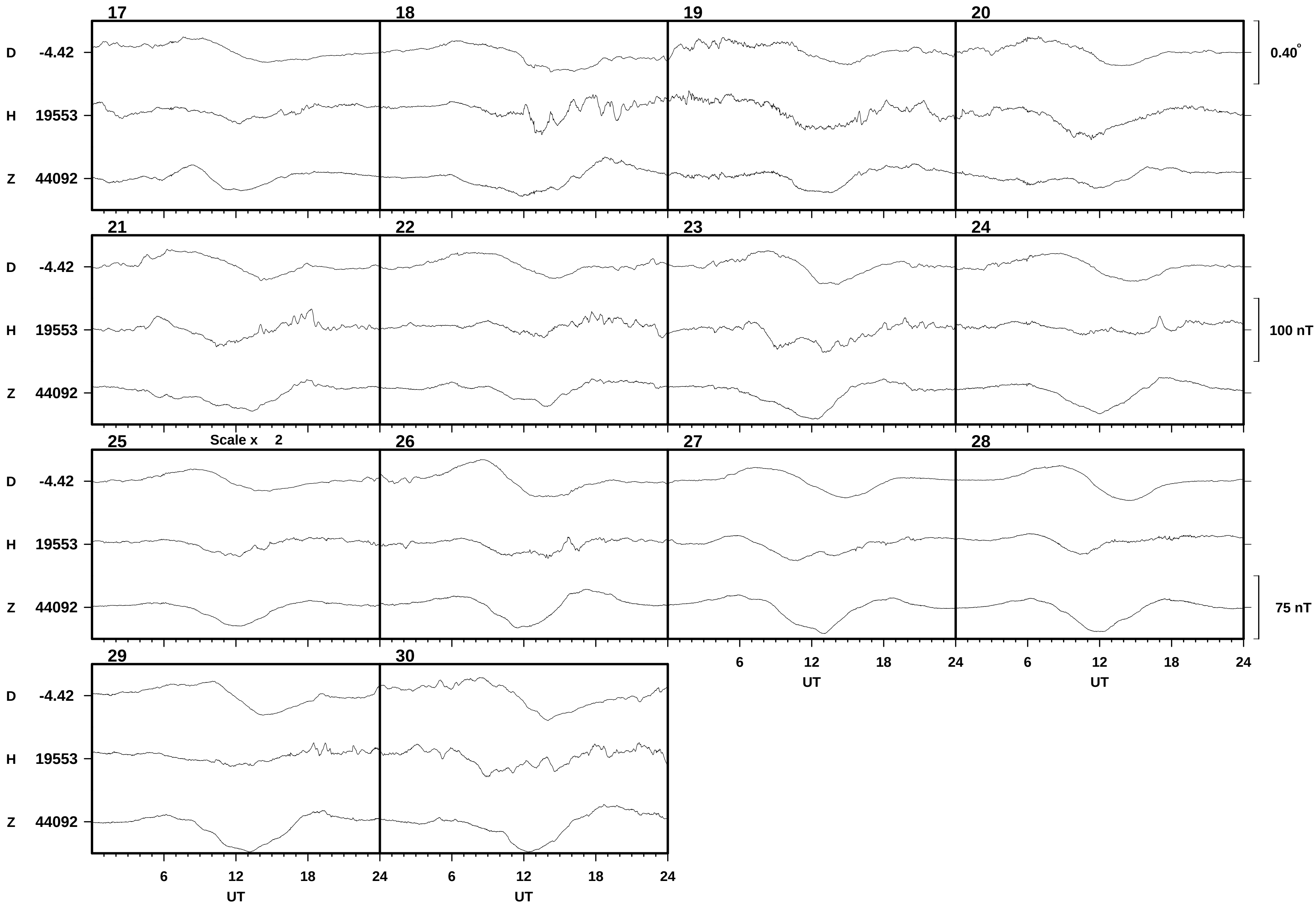
27
Scale x 2
28
29
30
31
D -4.43
H 19542
Z 44093
0.40°
100 nT
75 nT
6
12
18
24
UT

HA 5 2

Hartland June 2002



HA 6 2



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25
Scale x 2
26
27
28
29
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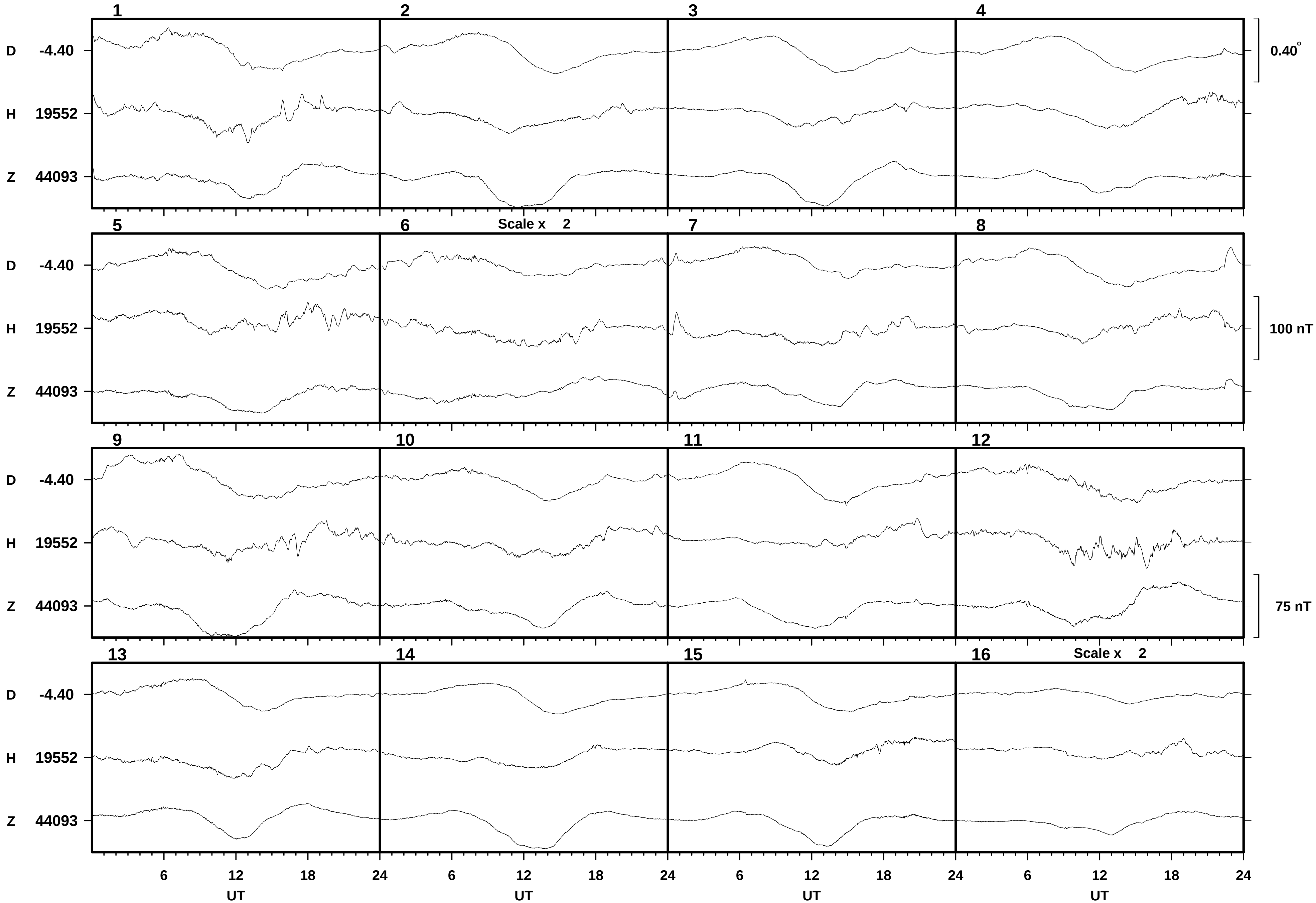
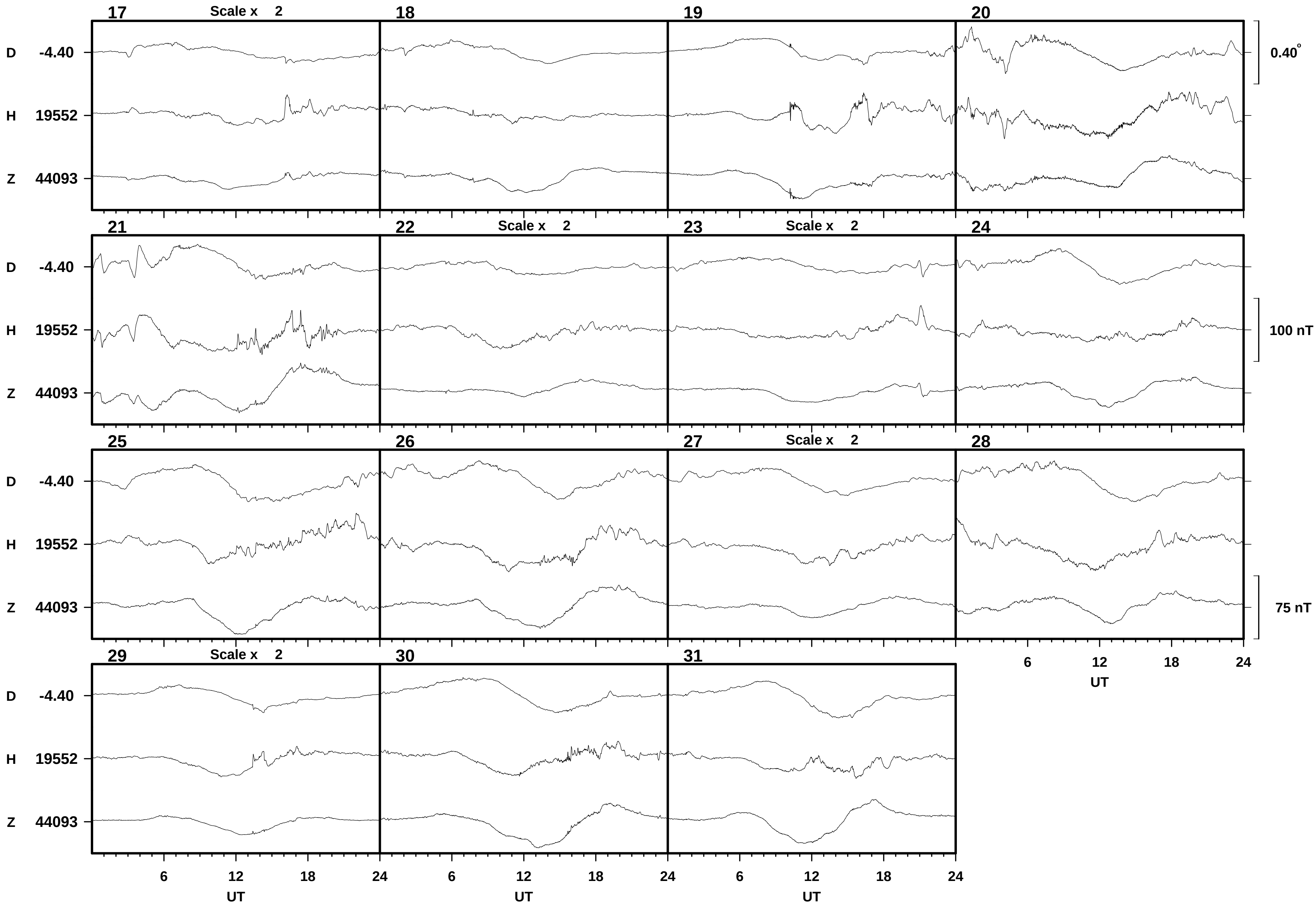
D -4.42
H 19553
Z 44092
0.40°
100 nT
75 nT
6
12
18
24
UT

HA 6 2

Hartland July 2002



HA 7 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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Scale x 2
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Scale x 2
30
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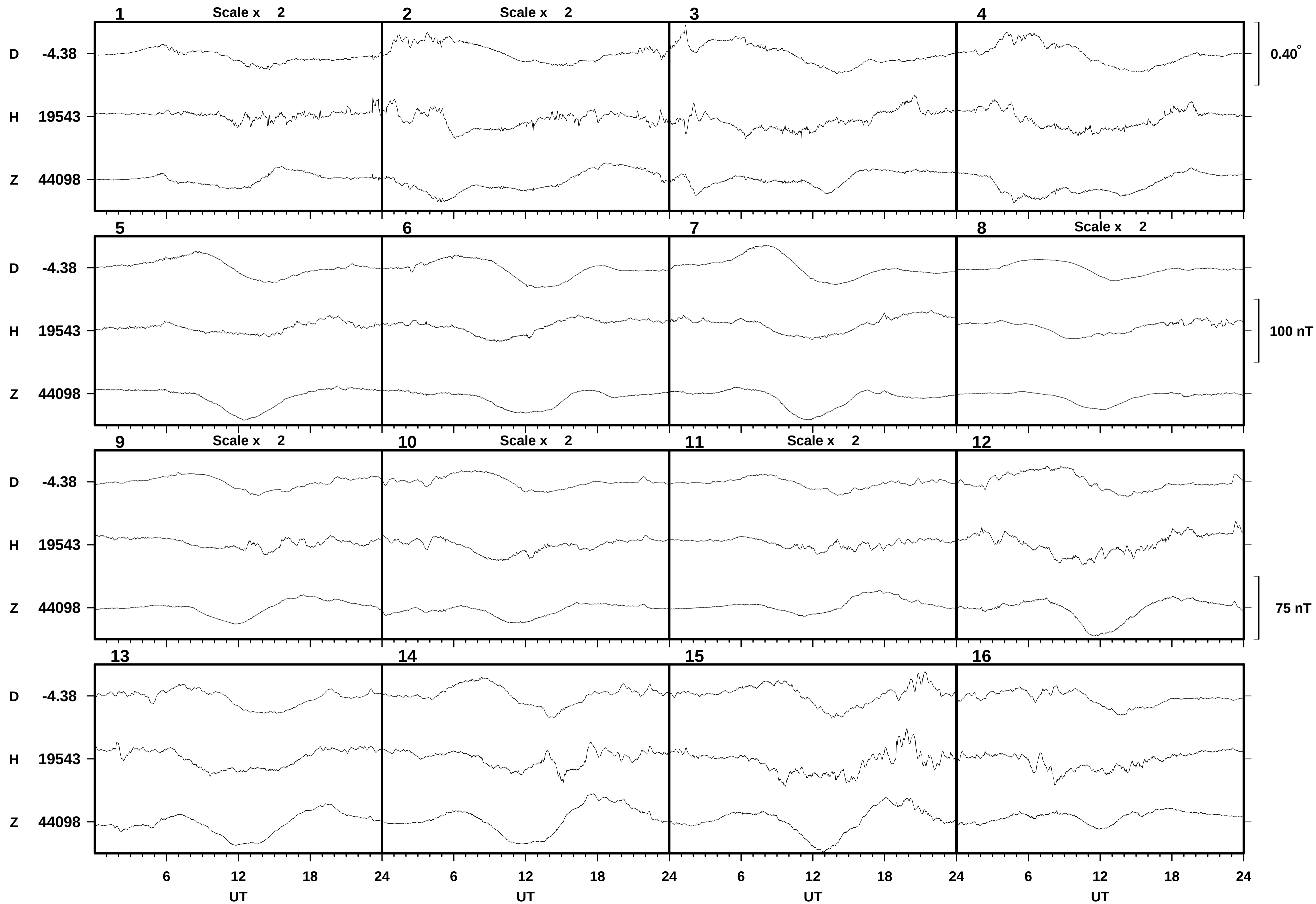
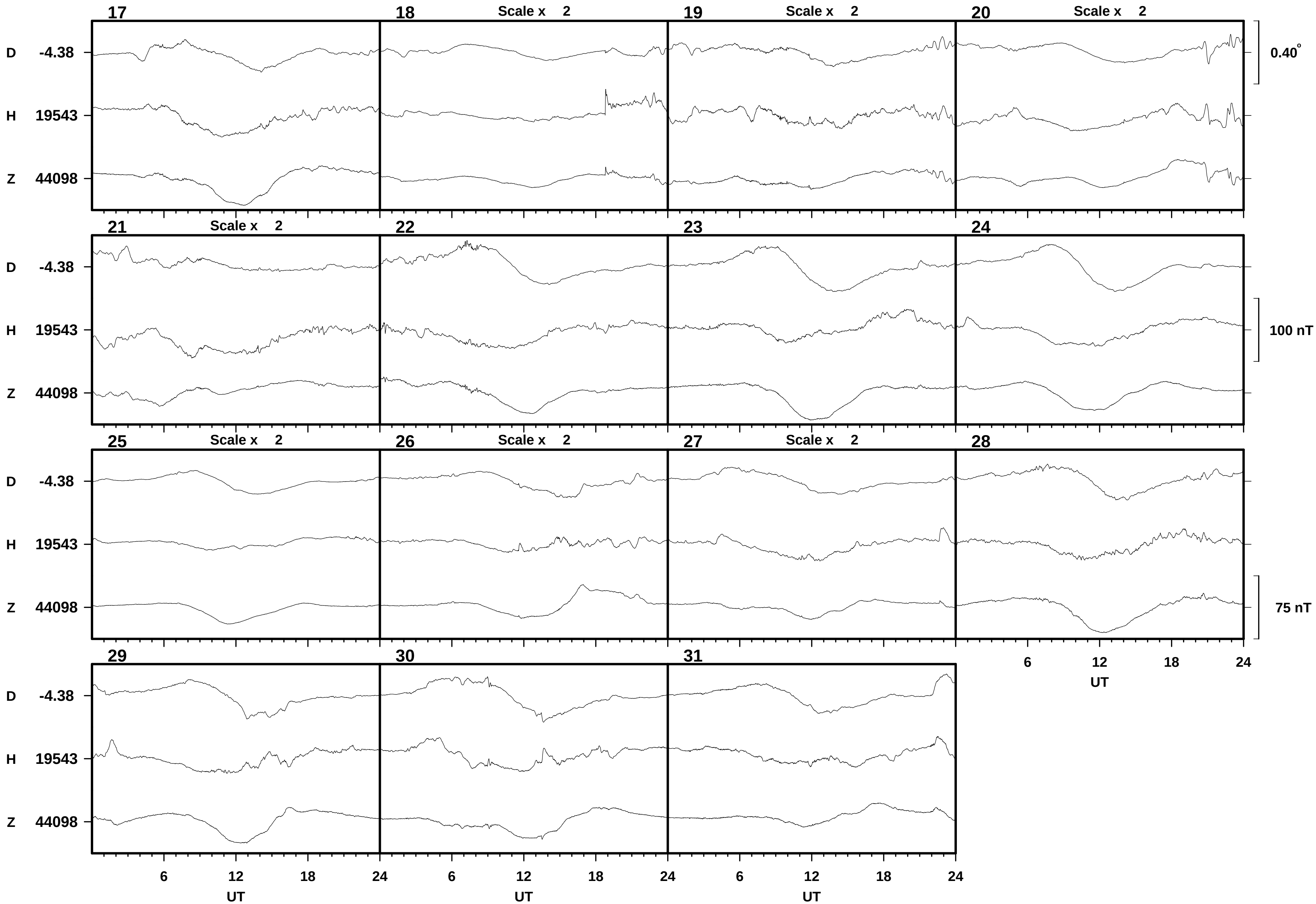
D -4.40
H 19552
Z 44093
0.40°
100 nT
75 nT
6
12
18
24
UT

HA 7 2

Hartland August 2002



HA 8 2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23
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25 Scale x 2
26 Scale x 2
27 Scale x 2
28
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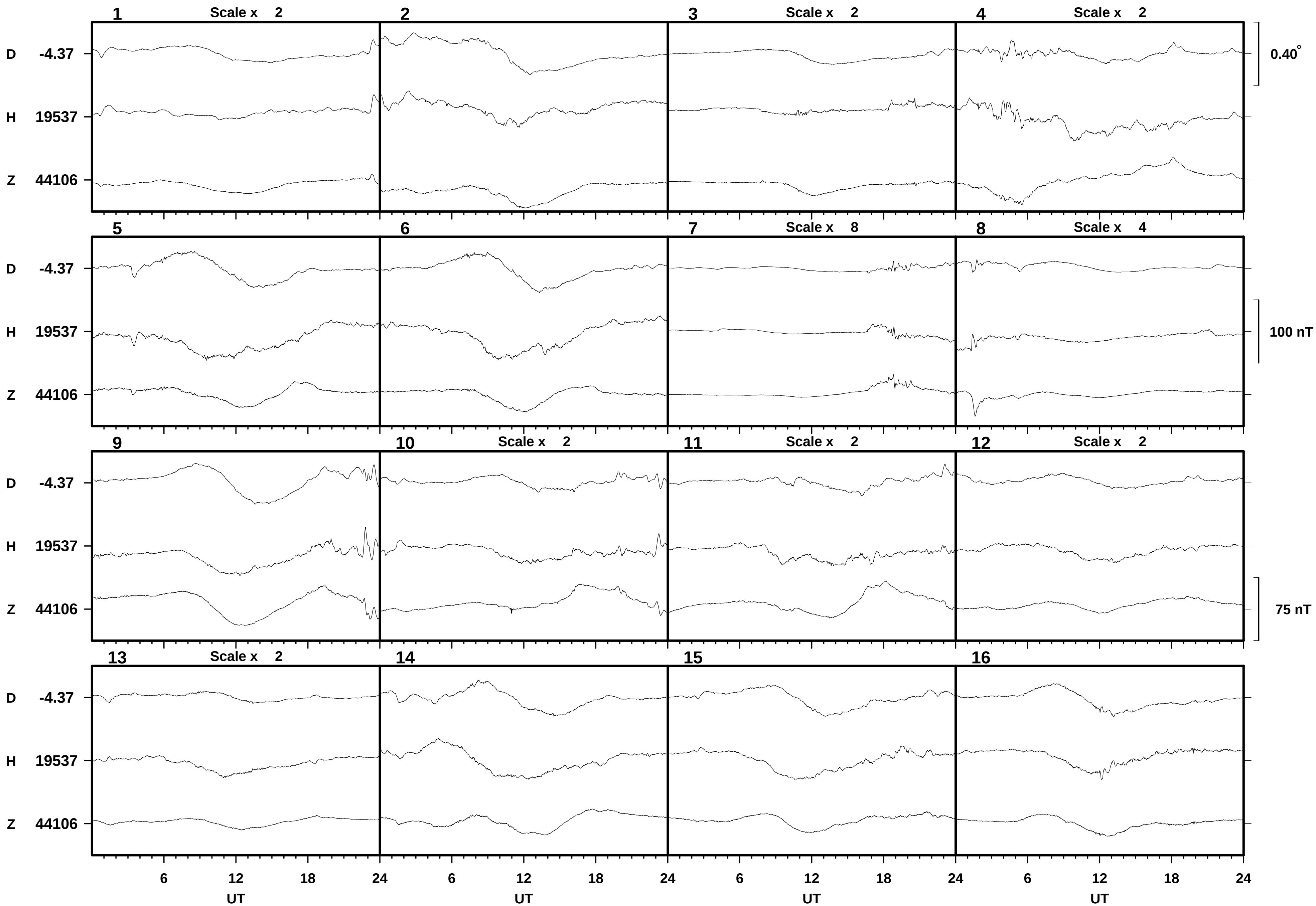
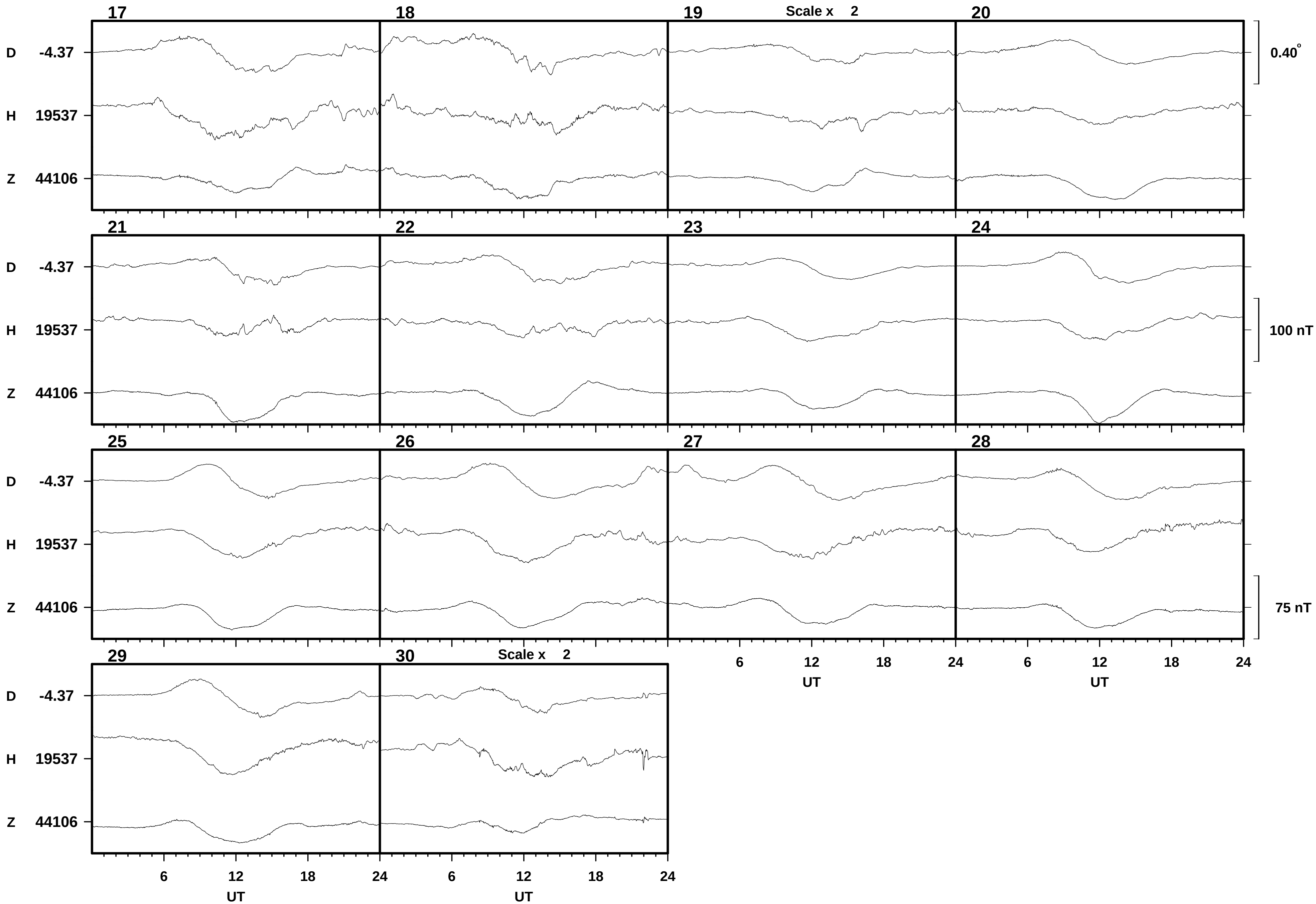
31
D -4.38
H 19543
Z 44098
0.40°
100 nT
75 nT
6 12 18 24
UT

HA 8 2

Hartland September 2002



HA 9 2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Scale x 2
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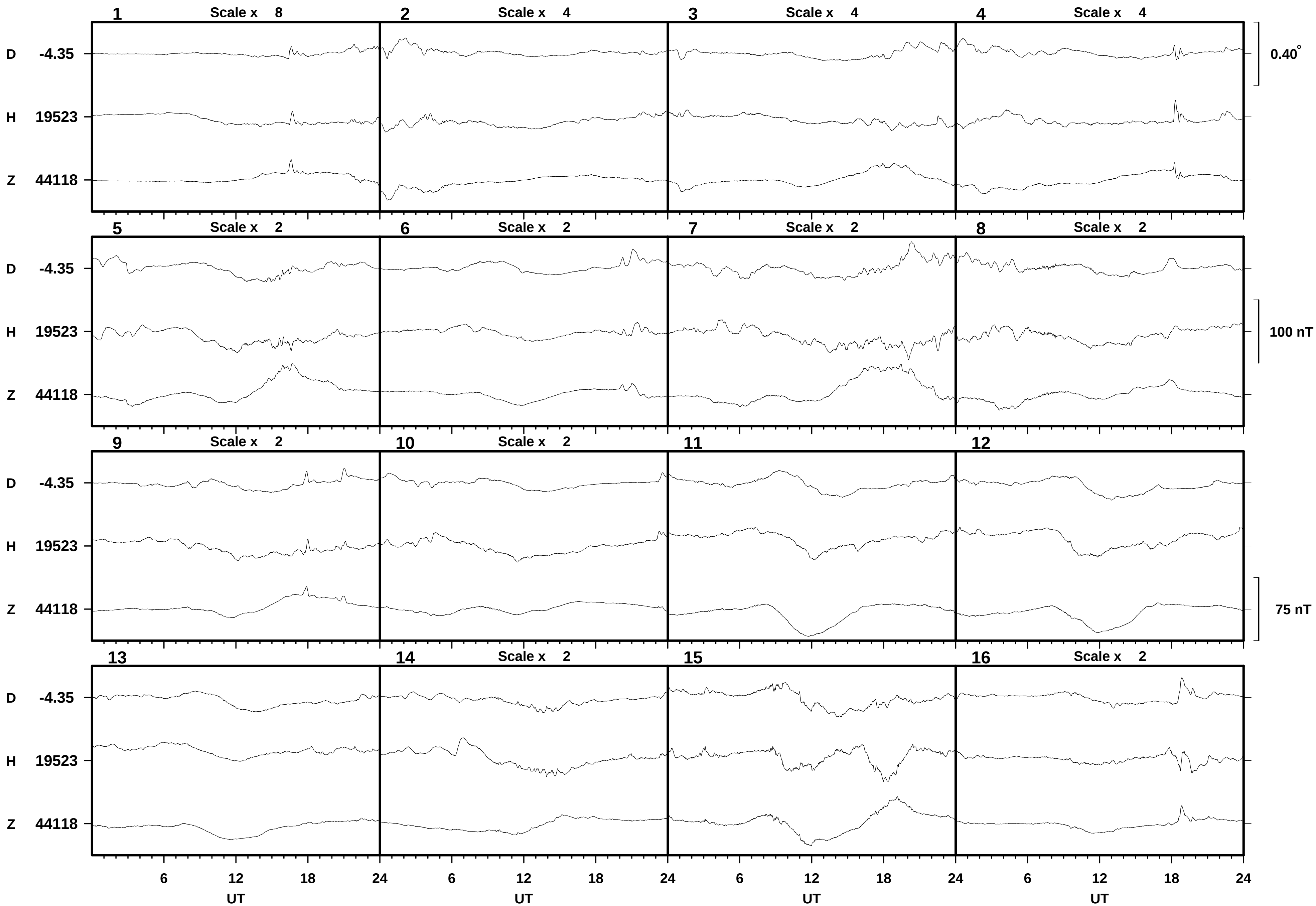
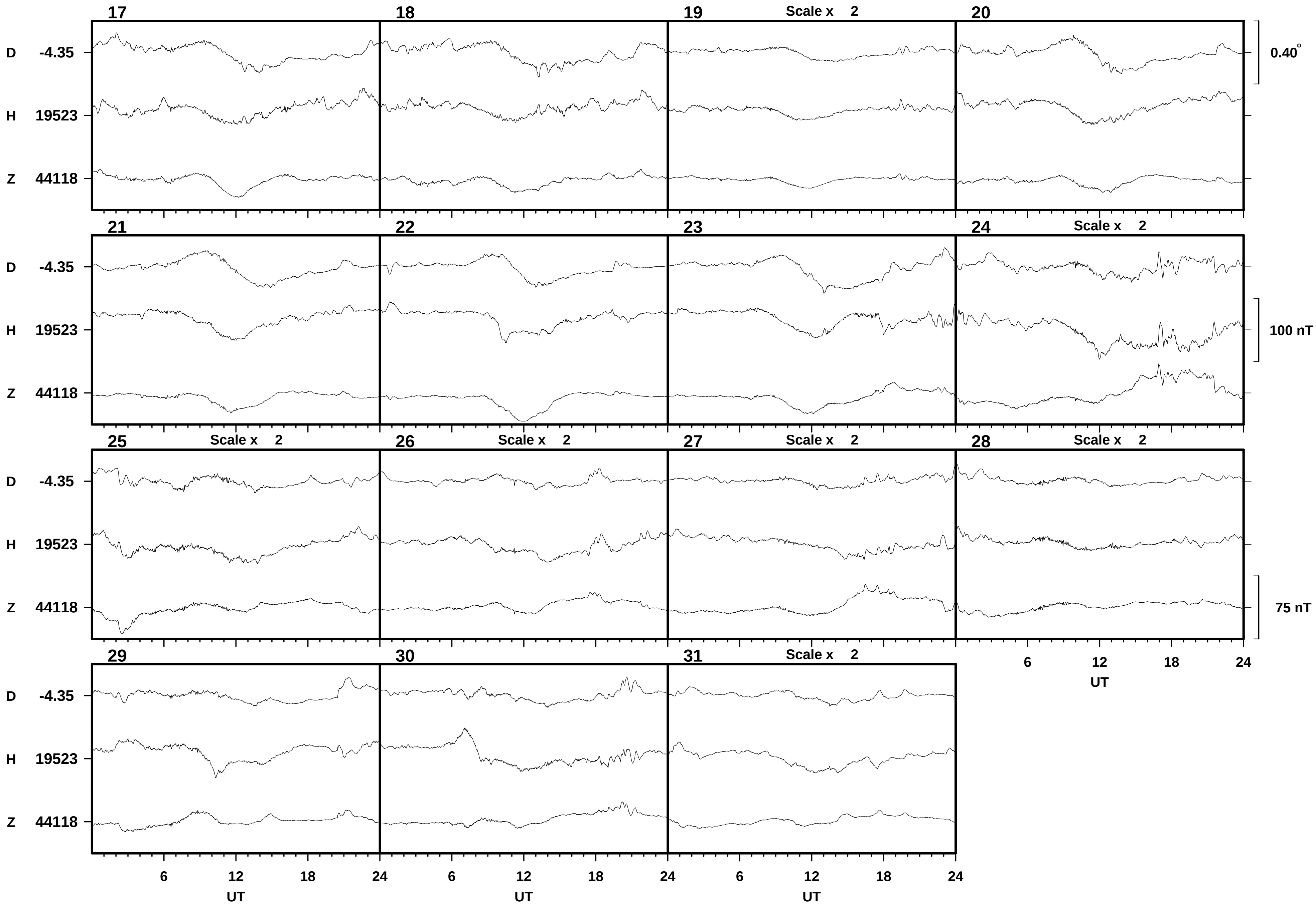
27
28
29
30
Scale x 2
D -4.37
H 19537
Z 44106
0.40°
100 nT
75 nT
6
12
18
24
UT

HA 9 2

Hartland October 2002



HA 10 2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18
19
Scale x 2
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D -4.35
H 19523
Z 44118
0.40°
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Scale x 2
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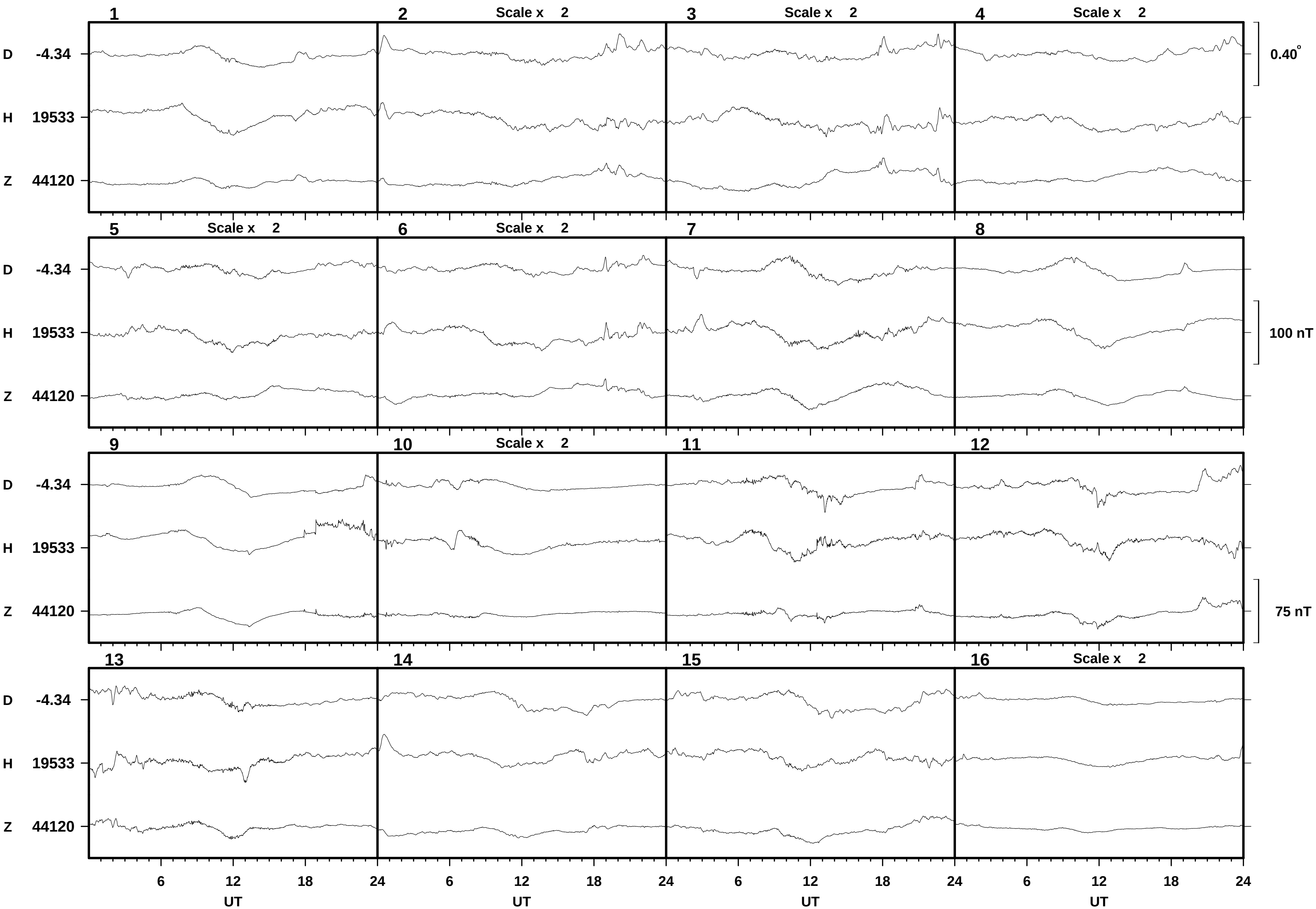
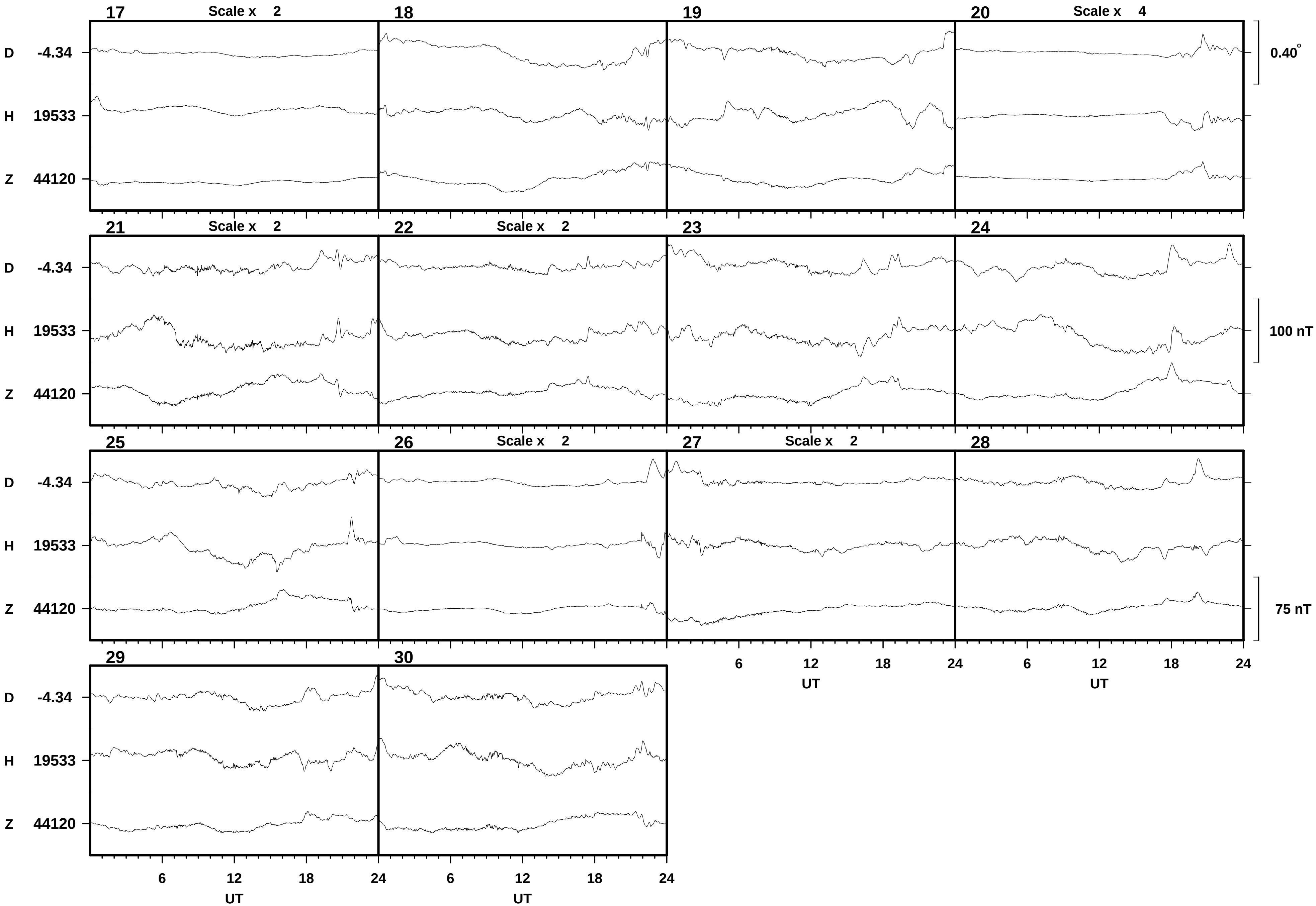
H 19523
Z 44118
100 nT
25
Scale x 2
26
Scale x 2
27
Scale x 2
28
Scale x 2
D -4.35
H 19523
Z 44118
75 nT
6 12 18 24
UT
29
30
31
Scale x 2
D -4.35
H 19523
Z 44118
6 12 18 24 6 12 18 24 6 12 18 24
UT
UT
UT

HA 10 2

Hartland November 2002



HA 11 2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Scale x 2
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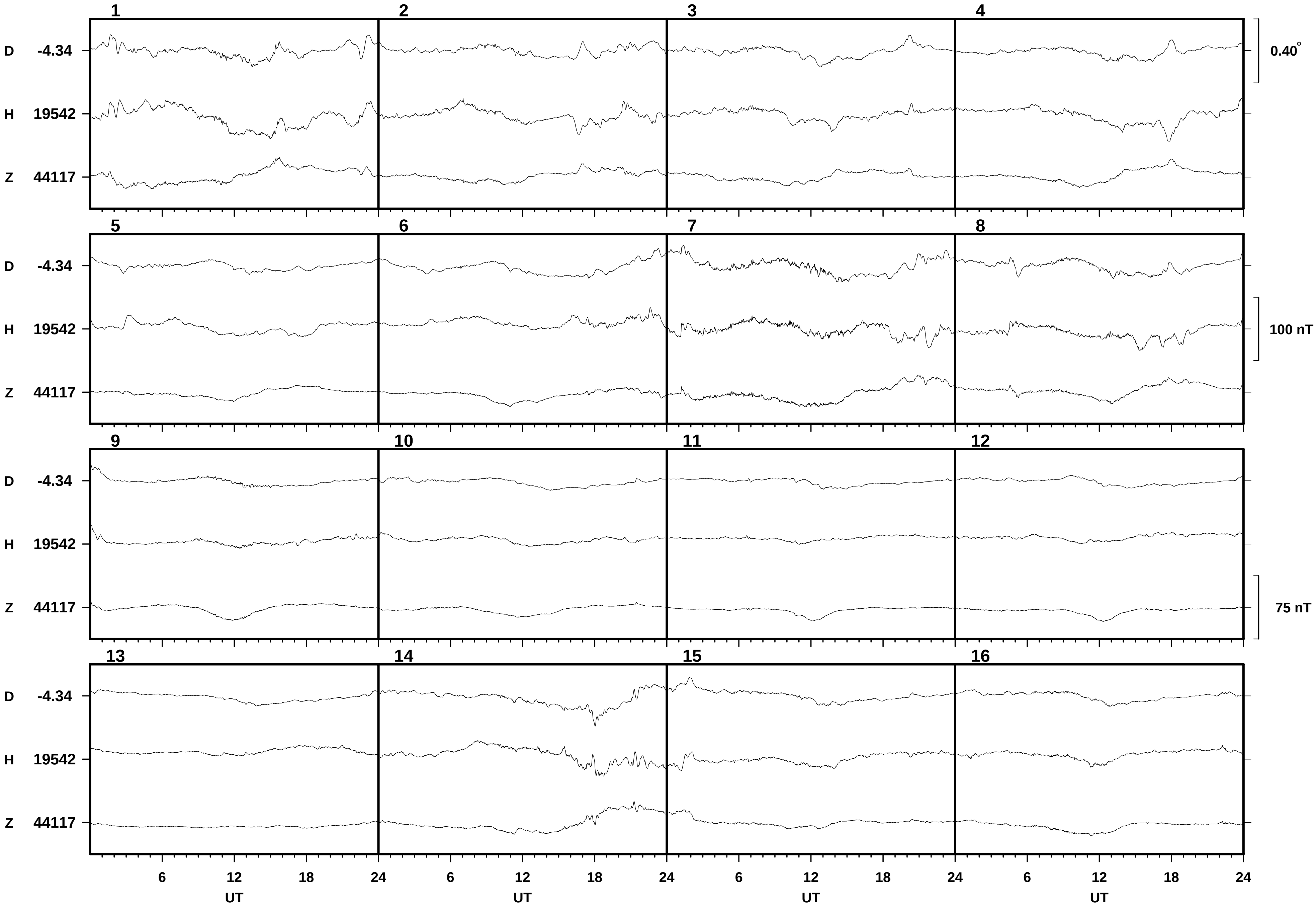
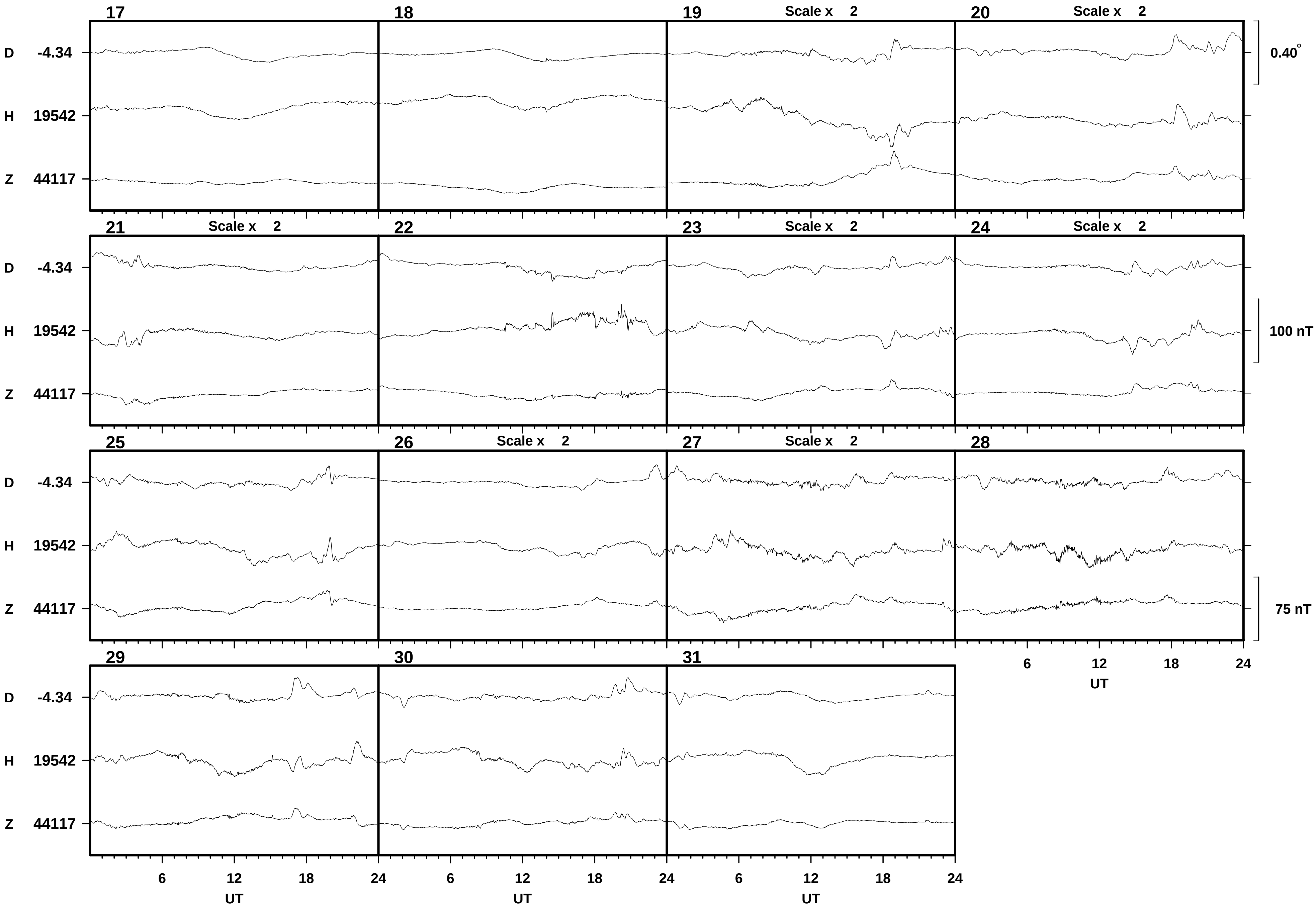
Scale x 4
D -4.34
H 19533
Z 44120
0.40°
21
Scale x 2
22
Scale x 2
23
24
100 nT
25
26
Scale x 2
27
Scale x 2
28
75 nT
29
30
6
12
18
24
UT

HA 11 2

Hartland December 2002



HA 12 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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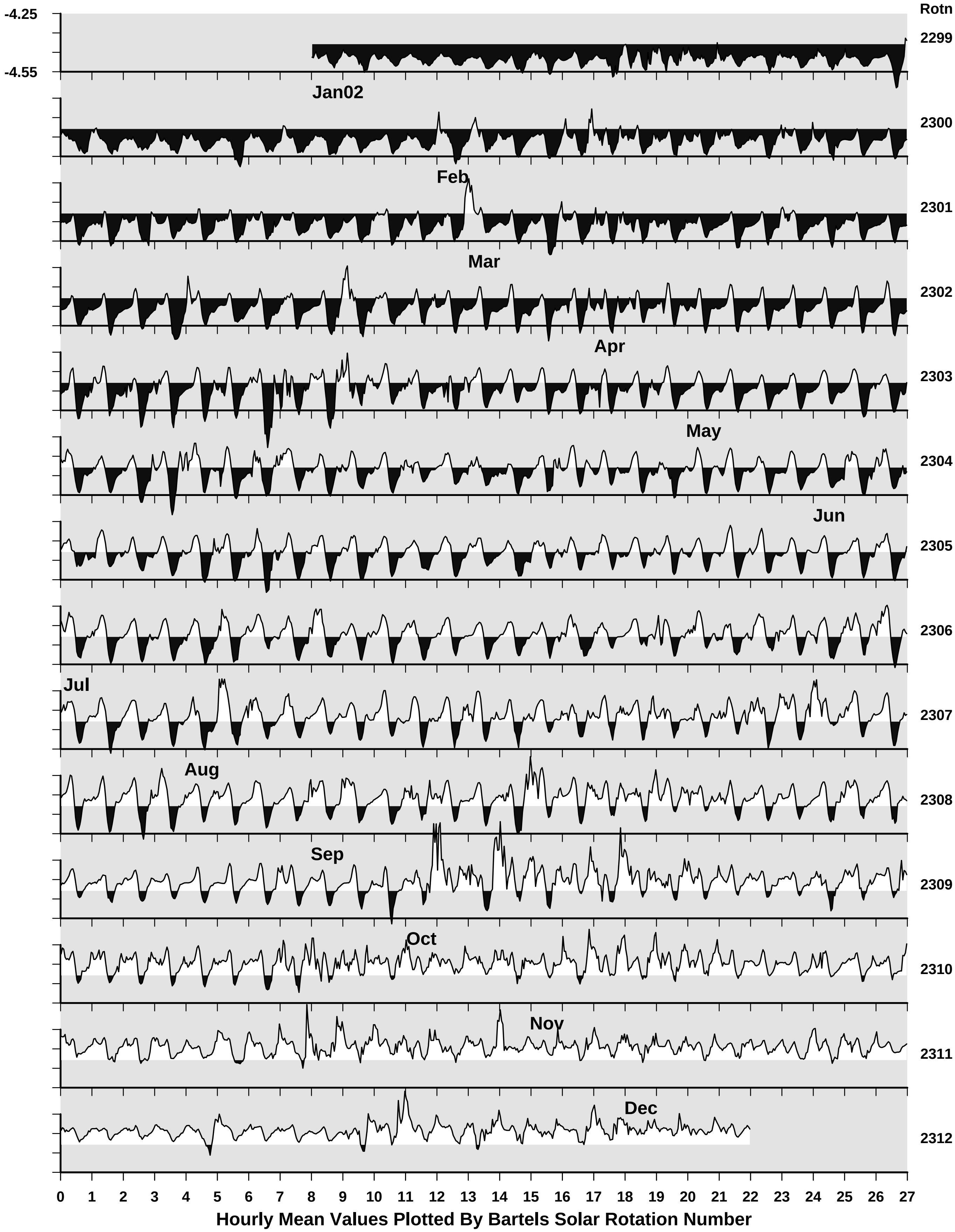
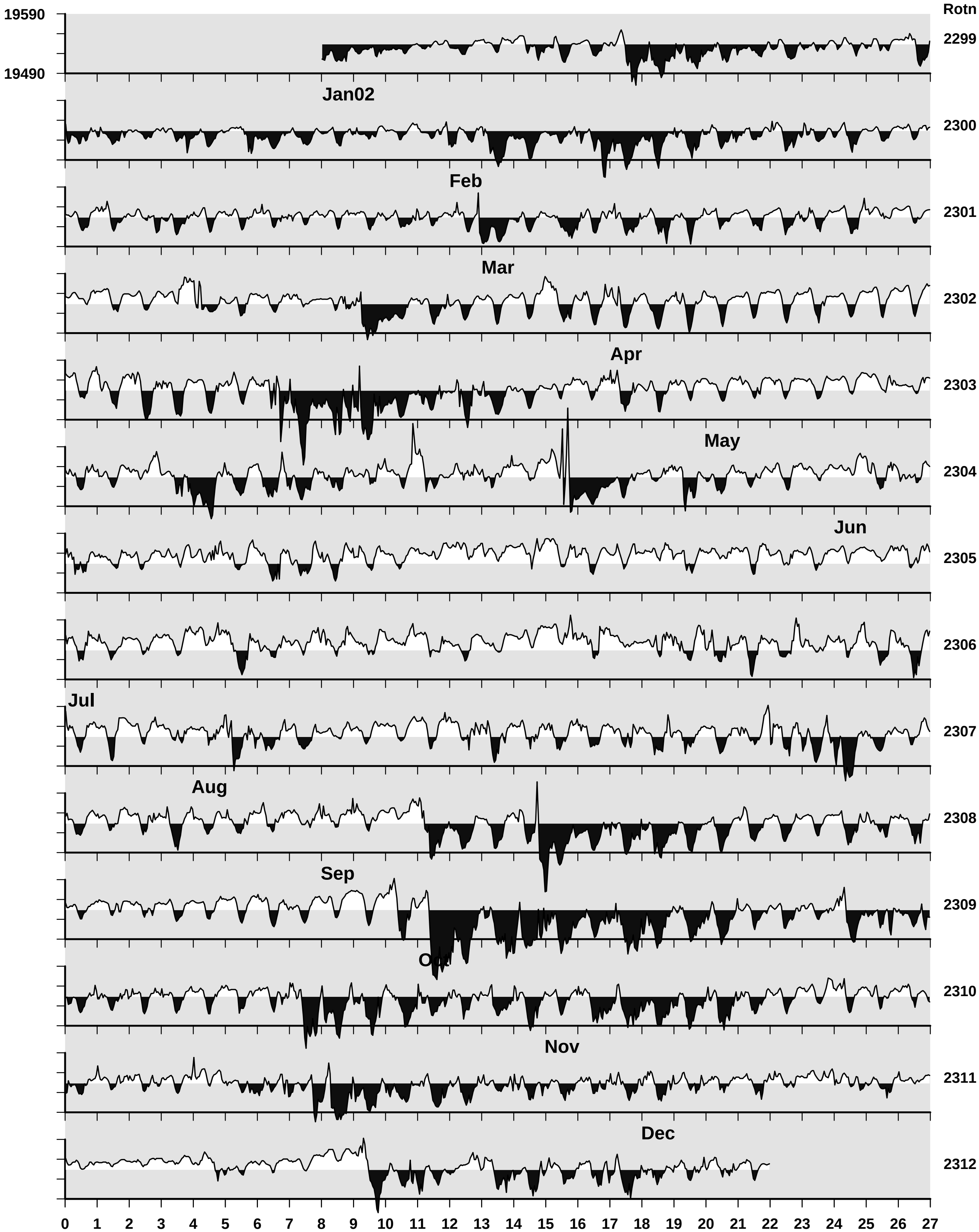
23
Scale x 2
24
Scale x 2
25
26
Scale x 2
27
Scale x 2
28
29
30
31
D -4.34
H 19542
Z 44117
0.40°
100 nT
75 nT
6
12
18
24
UT

HA 12 2

Hartland Observatory: Declination (degrees)

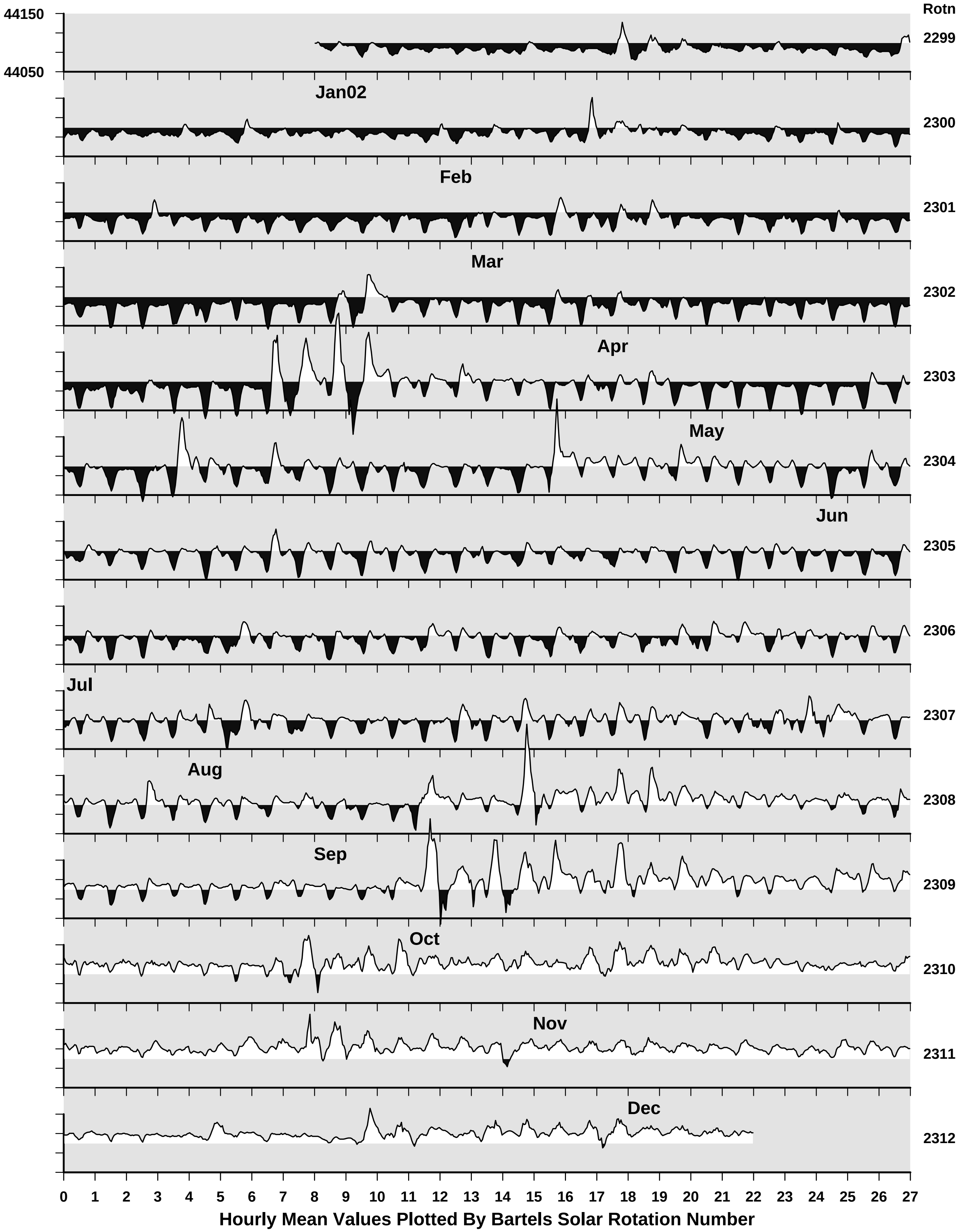


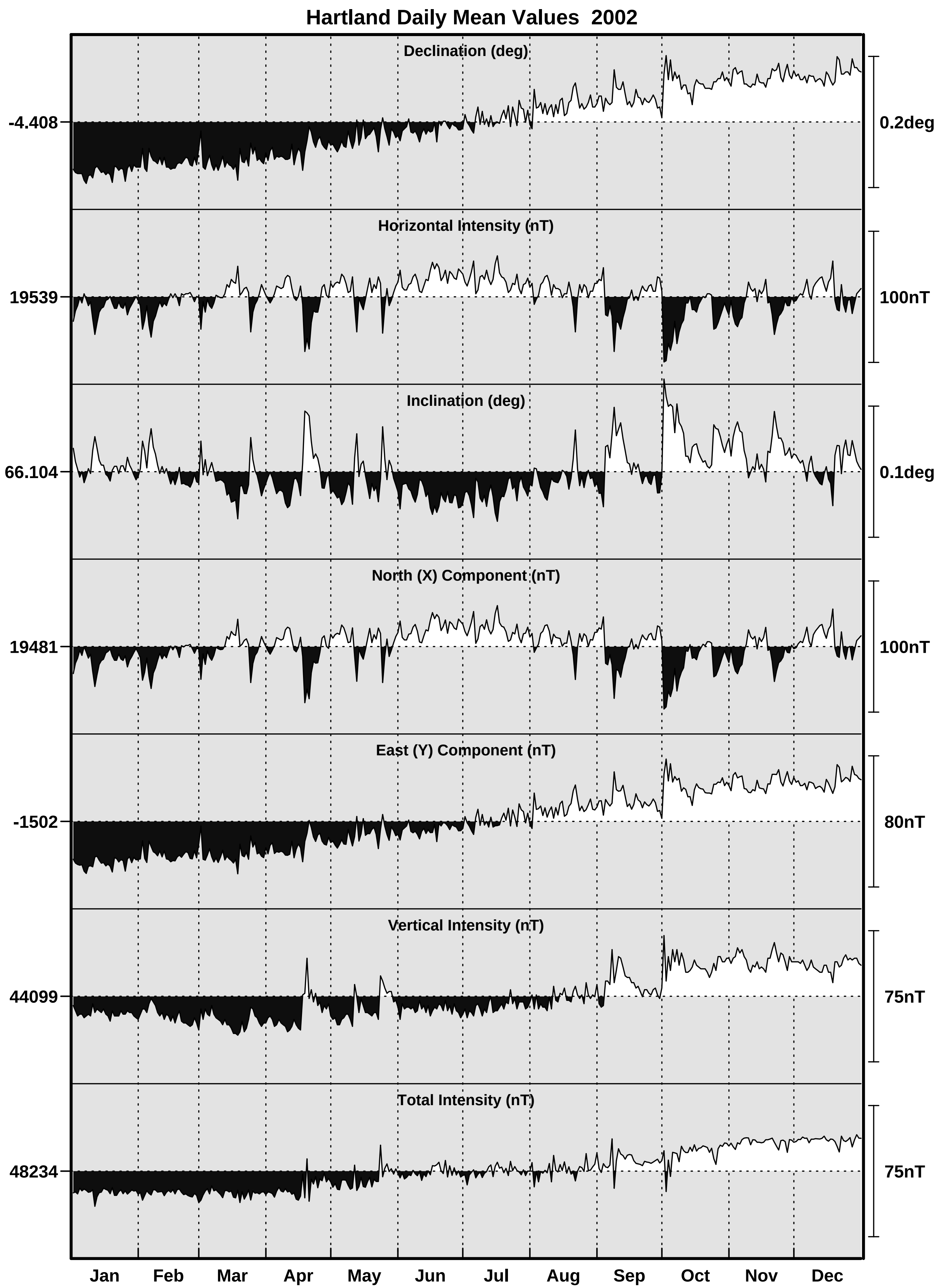
Hartland Observatory: Horizontal Intensity (nT)

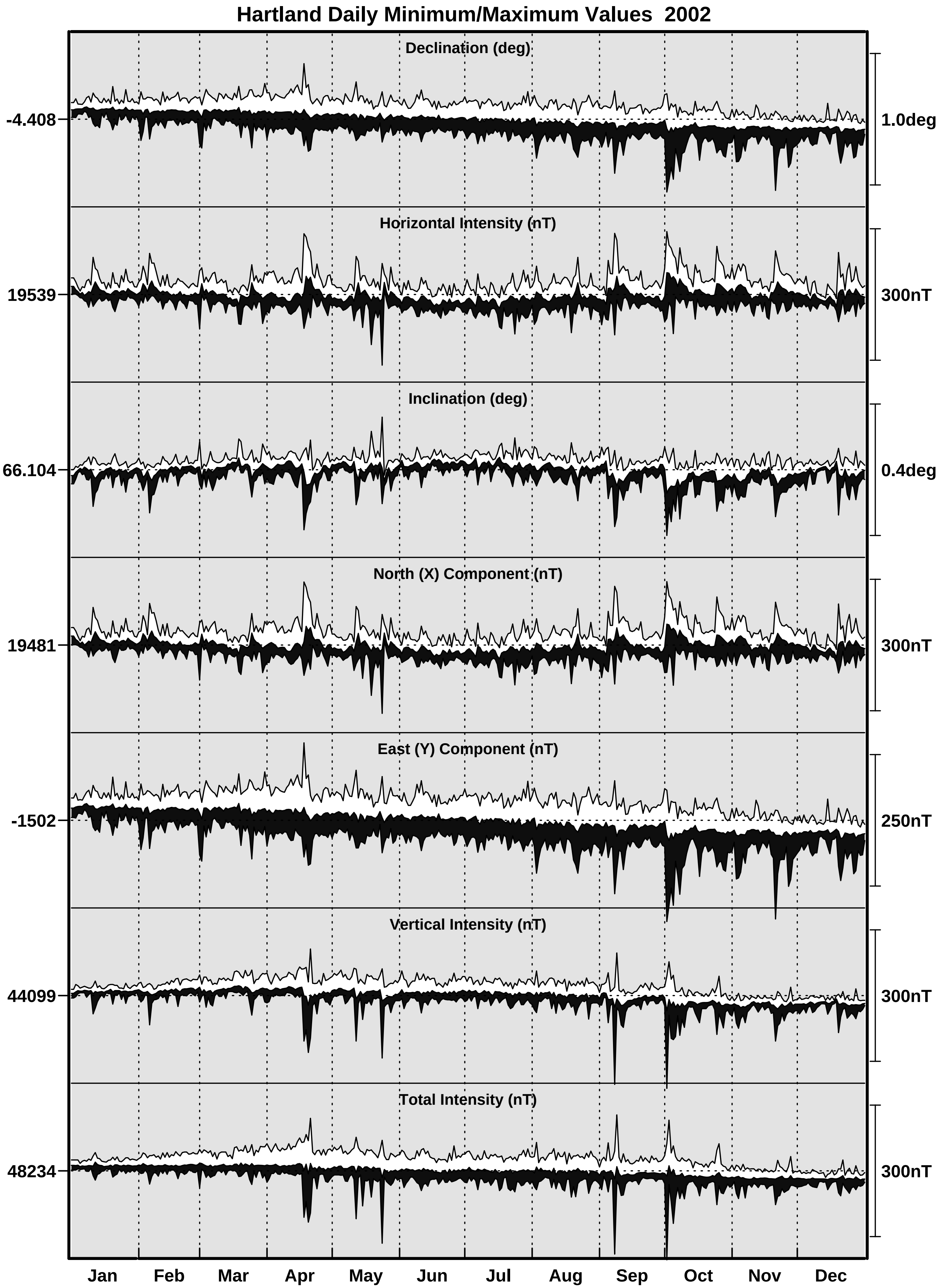


Hourly Mean Values Plotted By Bartels Solar Rotation Number

Hartland Observatory: Vertical Intensity (nT)




Hartland Daily Mean Values 2002
Declination (deg)
-4.408
0.2deg
Horizontal Intensity (nT)
19539
100nT
Inclination (deg)
66.104
0.1deg
North (X) Component (nT)
19481
100nT
East (Y) Component (nT)
-1502
80nT
Vertical Intensity (nT)
44099
75nT
Total Intensity (nT)
48234
75nT
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Hartland Daily Minimum/Maximum Values 2002
Declination (deg)
-4.408
1.0deg
Horizontal Intensity (nT)
19539
300nT
Inclination (deg)
66.104
0.4deg
North (X) Component (nT)
19481
300nT
East (Y) Component (nT)
-1502
250nT
Vertical Intensity (nT)
44099
300nT
Total Intensity (nT)
48234
300nT
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Monthly Mean Values for Hartland 2002

Month	D	H	I	X	Y	Z	F
Based on all days							
January	-4° 29.0′	19531 nT	66° 6.4′	19472 nT	-1527 nT	44089 nT	48222 nT
February	-4° 28.1′	19533 nT	66° 6.3′	19473 nT	-1522 nT	44088 nT	48221 nT
March	-4° 28.0′	19539 nT	66° 5.8′	19480 nT	-1522 nT	44085 nT	48221 nT
April	-4° 27.1′	19536 nT	66° 6.1′	19477 nT	-1516 nT	44090 nT	48225 nT
May	-4° 25.9′	19542 nT	66° 5.8′	19484 nT	-1510 nT	44093 nT	48229 nT
June	-4° 25.1′	19553 nT	66° 5.1′	19495 nT	-1507 nT	44092 nT	48233 nT
July	-4° 24.1′	19552 nT	66° 5.2′	19494 nT	-1501 nT	44093 nT	48234 nT
August	-4° 22.9′	19543 nT	66° 5.9′	19486 nT	-1493 nT	44098 nT	48235 nT
September	-4° 22.3′	19537 nT	66° 6.5′	19480 nT	-1489 nT	44106 nT	48239 nT
October	-4° 20.8′	19523 nT	66° 7.8′	19467 nT	-1480 nT	44118 nT	48245 nT
November	-4° 20.4′	19533 nT	66° 7.2′	19477 nT	-1478 nT	44120 nT	48250 nT
December	-4° 20.2′	19542 nT	66° 6.5′	19486 nT	-1478 nT	44117 nT	48252 nT
Annual	**-4° 24.5′**	**19539 nT**	**66° 6.2′**	**19481 nT**	**-1502 nT**	**44099 nT**	**48234 nT**
International quiet day means							
January	-4° 29.2′	19537 nT	66° 6.0′	19477 nT	-1528 nT	44088 nT	48223 nT
February	-4° 28.5′	19535 nT	66° 6.1′	19476 nT	-1524 nT	44087 nT	48222 nT
March	-4° 28.3′	19545 nT	66° 5.3′	19485 nT	-1524 nT	44082 nT	48220 nT
April	-4° 27.1′	19545 nT	66° 5.4′	19486 nT	-1517 nT	44087 nT	48225 nT
May	-4° 25.5′	19539 nT	66° 6.1′	19481 nT	-1508 nT	44095 nT	48230 nT
June	-4° 25.4′	19556 nT	66° 4.8′	19498 nT	-1508 nT	44090 nT	48232 nT
July	-4° 24.8′	19555 nT	66° 4.9′	19497 nT	-1505 nT	44090 nT	48232 nT
August	-4° 23.0′	19549 nT	66° 5.5′	19491 nT	-1494 nT	44095 nT	48234 nT
September	-4° 22.6′	19547 nT	66° 5.7′	19490 nT	-1492 nT	44101 nT	48239 nT
October	-4° 21.5′	19538 nT	66° 6.7′	19481 nT	-1485 nT	44113 nT	48246 nT
November	-4° 21.1′	19544 nT	66° 6.4′	19488 nT	-1483 nT	44116 nT	48252 nT
December	-4° 20.7′	19556 nT	66° 5.5′	19499 nT	-1482 nT	44112 nT	48252 nT
Annual	**-4° 24.8′**	**19545 nT**	**66° 5.7′**	**19487 nT**	**-1504 nT**	**44096 nT**	**48234 nT**
International disturbed day means							
January	-4° 29.1′	19523 nT	66° 7.1′	19463 nT	-1527 nT	44092 nT	48220 nT
February	-4° 27.3′	19519 nT	66° 7.3′	19460 nT	-1516 nT	44092 nT	48219 nT
March	-4° 27.3′	19534 nT	66° 6.2′	19475 nT	-1517 nT	44086 nT	48219 nT
April	-4° 26.8′	19512 nT	66° 8.1′	19454 nT	-1513 nT	44104 nT	48228 nT
May	-4° 26.1′	19540 nT	66° 6.1′	19482 nT	-1511 nT	44100 nT	48235 nT
June	-4° 25.4′	19549 nT	66° 5.4′	19491 nT	-1507 nT	44093 nT	48232 nT
July	-4° 23.9′	19546 nT	66° 5.6′	19489 nT	-1499 nT	44095 nT	48233 nT
August	-4° 22.3′	19533 nT	66° 6.6′	19476 nT	-1489 nT	44099 nT	48232 nT
September	-4° 22.1′	19520 nT	66° 7.8′	19464 nT	-1487 nT	44113 nT	48239 nT
October	-4° 19.7′	19499 nT	66° 9.4′	19443 nT	-1472 nT	44120 nT	48237 nT
November	-4° 19.7′	19518 nT	66° 8.3′	19463 nT	-1473 nT	44124 nT	48249 nT
December	-4° 19.6′	19530 nT	66° 7.4′	19474 nT	-1473 nT	44120 nT	48249 nT
Annual	**-4° 24.1′**	**19527 nT**	**66° 7.1′**	**19469 nT**	**-1499 nT**	**44103 nT**	**48233 nT**

Hartland Observatory K Indices 2002

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2221 1132	4322 4212	4311 2110	3343 4331	1111 1111	0010 1222	3333 3431	0334 4434	4222 2225	2255 4756	2122 1322	4323 3334
2	2012 3322	3332 3313	1122 1221	2344 2221	2101 2311	4322 3334	3111 0121	5532 4434	3222 2111	6543 3434	5324 3354	3222 2443
3	1110 1100	2111 2200	1122 4243	3443 2222	1211 2221	3421 2232	0011 2120	4333 2232	0012 1133	5233 3465	3444 3555	2222 3231
4	1100 1111	0101 2223	3222 2333	2221 2211	1210 1221	3342 3322	1110 1123	3332 2331	3544 4543	6543 3464	4333 2434	1121 2433
5	1200 0010	4223 3354	4434 3433	1110 1110	1101 1112	3221 2112	2122 3443	1111 1222	1321 2211	5323 4443	4434 4333	3222 2221
6	1000 1101	4344 3243	2343 3342	0101 1111	1111 2323	1111 1211	4433 3433	2111 1111	2121 2222	1333 2254	3333 3344	1212 1323
7	0112 1332	2334 4223	2223 3213	1123 4310	2111 2333	1111 1112	4111 2231	2111 1221	2331 2565	3443 4465	4324 2222	4233 3343
8	3231 3210	3123 3333	1122 1110	0011 0010	3321 1322	1212 4443	2221 3324	1201 2233	5532 1234	4433 3443	1122 2131	2421 3333
9	0001 1211	2323 2134	1011 2321	1111 2101	3022 2111	3321 1232	4333 3332	2121 4433	1011 2134	1233 3544	1011 2233	3111 2111
10	1122 4443	3322 2111	0113 3224	0011 3212	2133 3334	1242 3432	2121 2232	3423 4323	4212 3445	4433 1224	3341 2222	2111 1112
11	3433 3433	3223 3333	3422 2221	2245 3333	0115 5654	3222 2331	2010 2223	1122 4432	2244 3424	1111 2212	1234 4123	0112 1100
12	4333 3441	3321 1114	2233 2323	4332 4333	4332 2333	3211 2223	2334 3432	3322 3333	4222 3332	2112 1212	2224 3243	1101 1111
13	2223 3224	2234 3410	2121 3110	3334 3433	4211 3221	1321 2321	2211 2221	3321 1132	3323 2121	2110 0122	4323 3122	1001 1111
14	2211 2223	0011 1100	0011 1100	3311 4410	3433 3453	2101 1211	0010 0110	1211 4433	3332 1121	3343 3323	3213 2322	1112 2443
15	1122 2223	0011 1221	0021 1122	2111 1223	3322 2332	1011 1112	1021 1221	2123 3444	2111 1223	2334 3443	3223 3223	3111 2121
16	1111 1110	1111 1211	1012 1110	2331 1121	2222 2222	2221 3222	1212 2443	2242 2211	1111 3111	3122 3353	3111 1124	2112 2112
17	3212 2313	2332 3212	0011 1111	3335 5763	1111 3332	3210 1211	3432 3542	0321 2222	0323 2333	3331 3233	4211 1212	1100 0101
18	3101 1200	1222 2344	3011 4333	6544 3424	1111 2154	1112 4442	3221 1100	3311 2255	3234 4322	3333 3333	3111 1233	1010 2101
19	0123 4434	3121 1121	5532 1122	3345 5565	3430 1000	4322 1323	0114 2423	4343 3434	2123 3423	3323 2233	3322 2244	3444 4452
20	4321 2222	1123 2223	1011 3431	5644 4543	1323 2331	3322 1111	4432 2434	2321 2356	2111 1101	3313 3213	3212 1575	3322 3355
21	3321 2332	1122 2223	2131 1222	2111 1112	3131 2223	2311 2331	4431 4431	4542 4433	1113 2321	2221 2223	4454 3454	4422 2322
22	1122 2112	2312 2232	3321 1100	2321 2331	1212 2231	1111 2322	2344 3423	3231 1221	2110 2321	3124 3131	5333 4434	2102 3243
23	3112 2232	3111 1101	0013 4334	1453 3433	2226 7743	1233 2222	4222 3445	1121 1222	1010 0110	1122 4333	3333 2332	3233 4343
24	1301 1101	2112 2221	4544 4433	3122 1212	0000 1011	2211 1321	3211 2221	2111 1111	0012 2111	5535 5655	3323 1444	3122 4453
25	1112 3442	2011 2223	2211 2322	2100 0010	0000 1321	2211 4223	3212 3334	2121 2212	0001 1101	5444 4335	2233 3324	3222 3342
26	3212 2221	2113 2223	2234 3124	0001 1121	1111 2323	3110 2311	3322 2433	2223 4433	2011 1223	4334 4444	3211 2235	2112 3345
27	3212 2211	3113 2112	0110 1121	1112 3333	3353 4523	1100 1110	4323 4433	3322 3324	3111 2211	3323 4445	5432 3223	5543 4444
28	2112 3222	2423 3356	0100 0110	4444 3432	2331 2322	0000 1110	3332 2322	1121 2222	2111 0221	5333 3233	2222 2342	3333 3333
29	2212 2101		0011 1114	2113 3333	3211 3211	1111 1133	1221 5421	3111 3321	0111 2212	3224 3133	3223 2334	3222 3433
30	1001 1112		2343 4343	2212 3220	1221 2321	2332 3333	1111 1332	1222 3230	2345 4344	2242 2243	3332 3323	3121 3243
31	2100 1224		2444 3353		1110 1110		1102 3321	1112 2224		4333 4432		3211 1002

DAILY Aa INDICES 2002

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	18	26	15	30	7	6	25	38	26	85	13	33
2	17	27	12	25	9	28	8	54	17	56	43	29
3	6	9	26	24	10	18	8	26	15	71	51	20
4	7	12	22	14	9	26	8	20	56	81	37	22
5	4	39	44	6	6	12	23	9	15	44	42	18
6	6	38	30	8	14	9	38	6	15	29	34	20
7	18	26	20	16	15	7	16	10	57	62	23	39
8	21	24	9	4	16	23	18	12	33	41	12	25
9	7	21	10	6	11	18	25	25	16	37	15	11
10	36	15	20	9	27	30	14	25	44	30	26	11
11	39	27	20	28	60	20	11	24	39	11	26	10
12	30	19	23	29	30	14	31	26	24	12	31	8
13	25	22	11	30	16	13	11	17	19	10	25	8
14	16	5	6	25	41	6	3	24	17	34	19	25
15	14	8	11	12	22	7	8	35	11	39	24	15
16	8	8	9	12	13	15	20	20	11	28	16	12
17	20	25	5	80	13	9	34	15	23	24	15	7
18	9	26	25	72	20	21	9	31	31	28	21	10
19	37	13	36	82	17	20	19	38	28	27	25	55
20	22	19	17	74	21	11	36	33	8	22	52	37
21	24	18	13	9	18	13	36	43	14	14	72	33
22	12	18	14	19	16	10	31	14	13	25	39	27
23	19	10	25	43	90	15	31	11	4	22	26	42
24	9	12	66	14	4	10	12	9	6	85	28	34
25	24	18	13	5	7	15	21	10	5	57	27	25
26	16	18	24	7	14	11	23	33	12	43	27	37
27	15	12	7	18	45	4	31	24	11	42	33	58
28	14	45	4	42	17	3	18	13	10	34	23	29
29	9		11	20	12	9	24	16	11	24	28	24
30	6		40	14	13	20	13	17	50	30	27	20
31	16		40		5		13	18		35		11
Monthly Mean Values	**16.8**	**20.0**	**20.3**	**26.0**	**19.9**	**14.1**	**19.9**	**22.5**	**21.4**	**38.0**	**29.3**	**24.4**

Yearly Mean Value for 2002 = 22.7

SIs and SSCs

Day	Month	UT		Type	Quality	H (nT)	D (min)	Z (nT)
19	01	05	12	SSC	C	4.9	-0.51	-
31	01	21	27	SSC	B	11.4	-0.40	3.1
17	02	02	56	SSC	C	16.8	-1.63	2.2
28	02	04	51	SSC	B	19.6	-3.88	-6.8
15	03	17	51	SSC	B	-3.7	0.33	-
18	03	13	23	SSC	A	49.6	-4.58	-21.7
20	03	13	29	SSC*	A	17.8	-1.96	1.7
22	03	04	06	SI	C	4.5	-2.09	-4.2
23	03	11	36	SSC*	B	20.7	1.18	4.2
29	03	22	37	SSC	B	39.6	-1.64	4.6
17	04	11	07	SSC*	A	-33.2	-5.65	-
19	04	08	35	SSC*	A	-33.5	4.83	-7.9
23	04	04	48	SSC*	A	22.1	-8.14	-21.0
10	05	11	23	SSC*	B	11.2	1.35	3.3
11	05	10	13	SSC*	A	17.7	3.60	11.2
18	05	20	09	SSC*	B	68.7	-	23.2
20	05	03	40	SSC*	B	15.0	-2.63	3.9
21	05	22	02	SSC*	B	32.0	0.80	9.1
23	05	10	51	SSC*	A	-23.5	-4.08	-13.5
23	05	11	50	SI*	C	76.7	-6.39	23.0
23	05	15	42	SI	A	98.3	-5.40	21.1
01	06	16	44	SI*	C	13.0	-0.63	2.4
08	06	11	39	SSC	C	+5.2/-6.1	0.57	+1.6/-1.7
19	07	10	09	SSC*	A	-29.7/+27.1	-1.37/+1.42	-12.1
22	07	10	57	SI*	B	10.6	-8.20	-
25	07	13	36	SI*	B	11.2	-1.30	4.0
29	07	13	21	SSC	A	41.9	-3.89	5.7
18	08	18	46	SSC*	A	77.7	-2.16	19.2
20	08	13	58	SSC*	C	10.9	-4.39	3.3
26	08	11	30	SSC	B	-2.4	1.20	1.4

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)
07	09	16	37	SSC	C	23.0	-6.10	4.3
30	09	08	15	SSC*	B	-17.2	1.60	-4.9
29	10	20	27	SSC	B	4.7	3.81	-
09	11	17	51	SI*	A	12.2	-0.45	3.2
09	11	18	49	SSC*	A	23.4	-0.90	6.0
20	11	11	08	SSC	B	11.2	1.13	3.1
26	11	21	51	SSC	B	29.3	-0.67+/0.67	7.4
06	12	06	47	SSC*	B	3.3	-0.92	-2.3
22	12	10	28	SSC*	B	-6.4	-0.77	-3.4
31	12	21	31	SI*	B	2.8	-0.49	1.6

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				
04	04	15	29	15	33	15	47	-3.7	-1.12	-3.0
09	04	12	57	13	01	13	09	-2.8	-0.69	-1.2
10	04	12	26	12	32	12	45	-13.7	-	-3.7
20	05	15	25	15	27	15	38	-4.5	-1.16	-3.9
11	07	14	45	14	52	15	02	-5.0	-1.51	-3.2
30	08	13	27	13	30	13	40	-	-3.55	-4.1

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

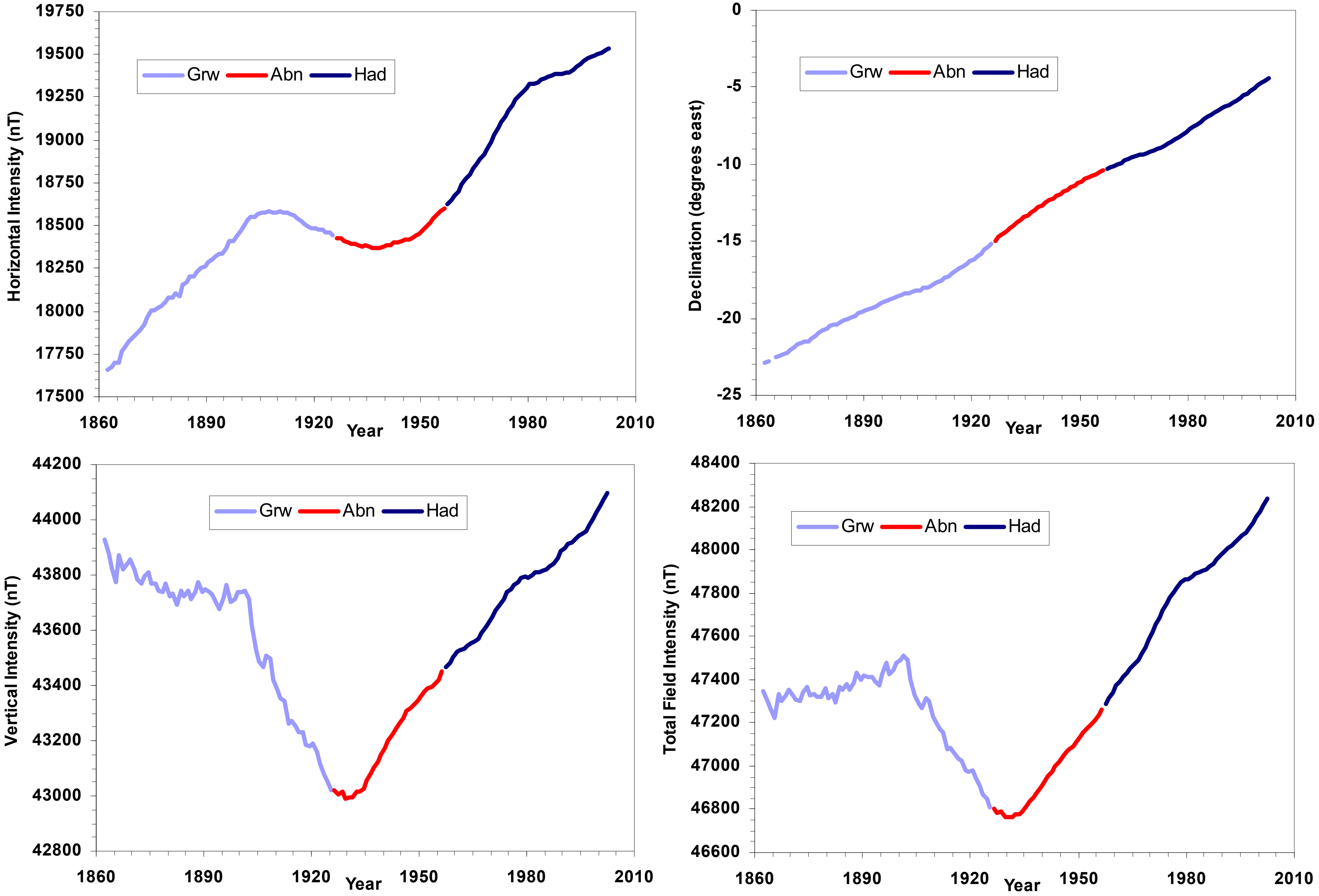
Note 1	-1	-46.6	-146	0	11.4	-247	-542	56	-6
1957.5	-10	17.2	18627	66	47.7	18328	-3326	43451	47275
1958.5	-10	11.0	18655	66	46.3	18361	-3298	43465	47299
1959.5	-10	5.0	18681	66	45.1	18392	-3271	43484	47327
1960.5	-9	58.8	18707	66	43.9	18424	-3242	43504	47356
1961.5	-9	53.0	18744	66	41.7	18466	-3217	43512	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
2002.5	-4	24.5	19539	66	6.2	19481	-1502	44099	48234

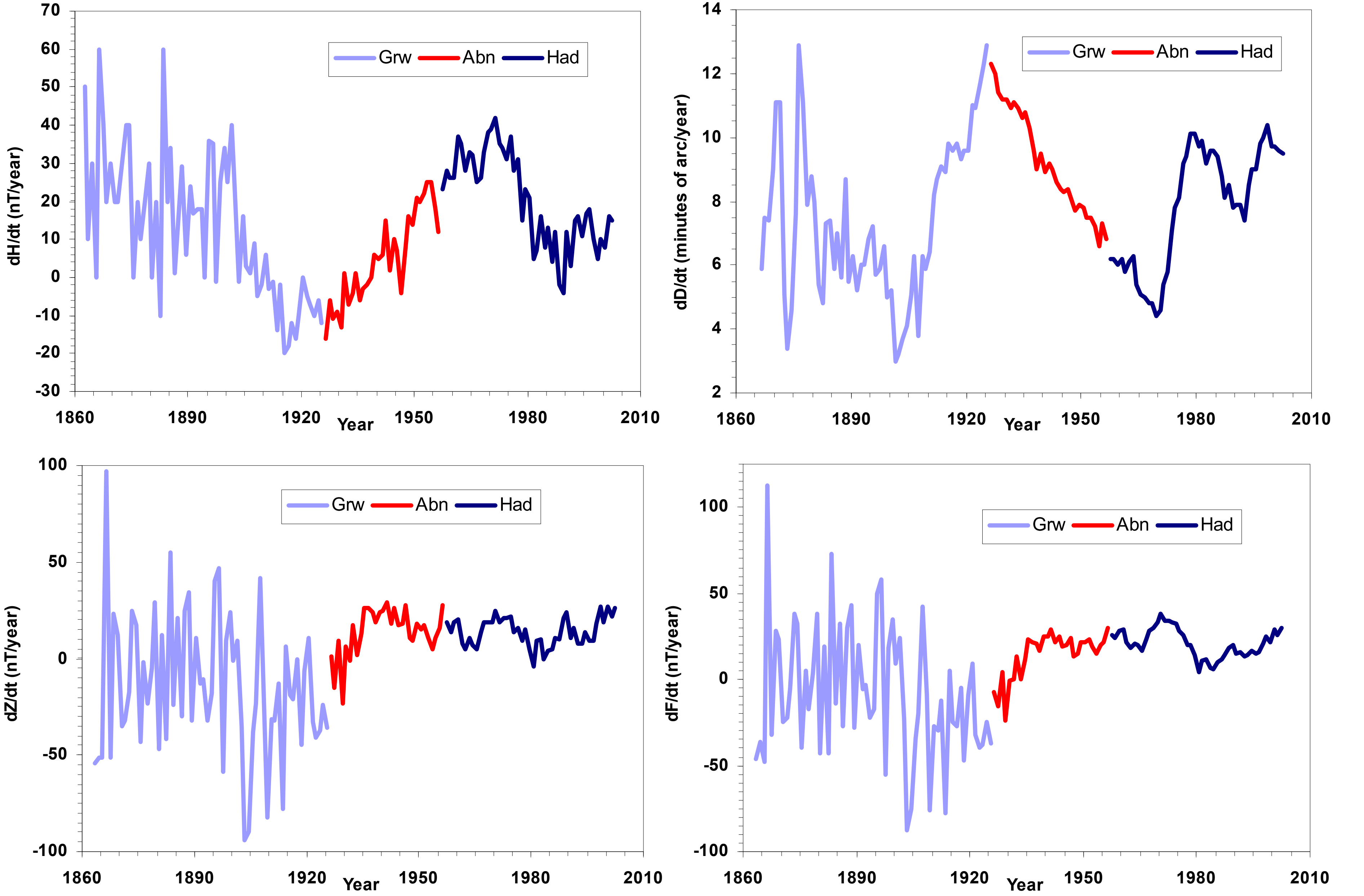
1 Site differences 1 Jan 1957 (Hartland value - Abinger value)
2 Site differences 1 Jan 1980 (new value - old value)
3 Site differences 1 Jan 1990 (new value - old value)

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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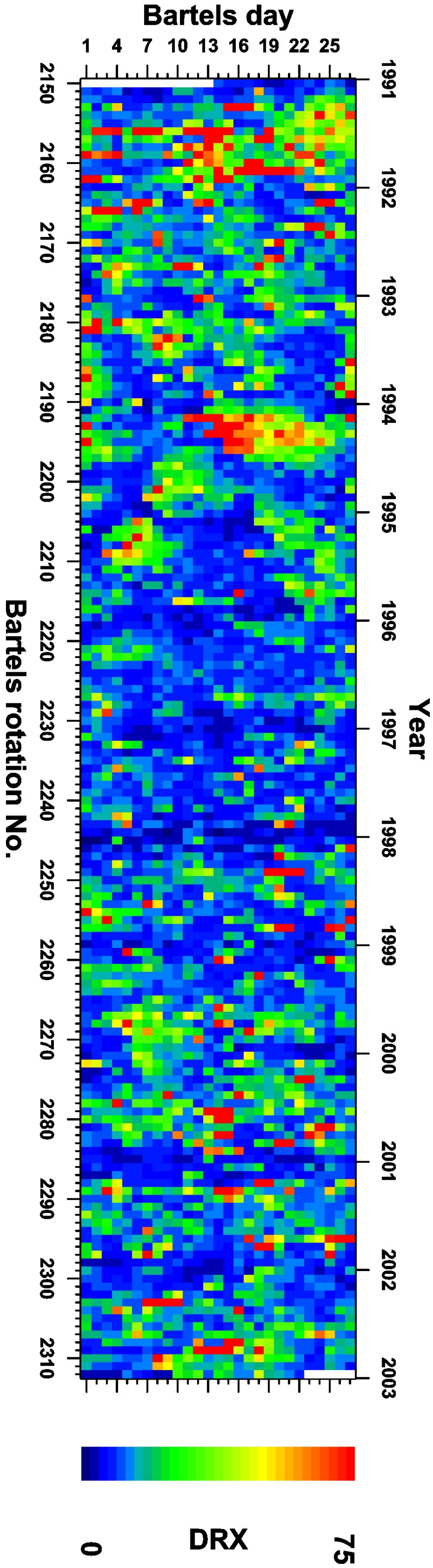
Front cover photograph
Repeat station site on the Island of Mull
(Photograph by J.Carrigan 2002)

Back cover plot
The daily geomagnetic index DRX from Lerwick Observatory plotted by Bartels rotation for the years 1991-2002 (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
31. Magnetic results 2001: Lerwick, Eskdalemuir and Hartland observatories and UK repeat stations