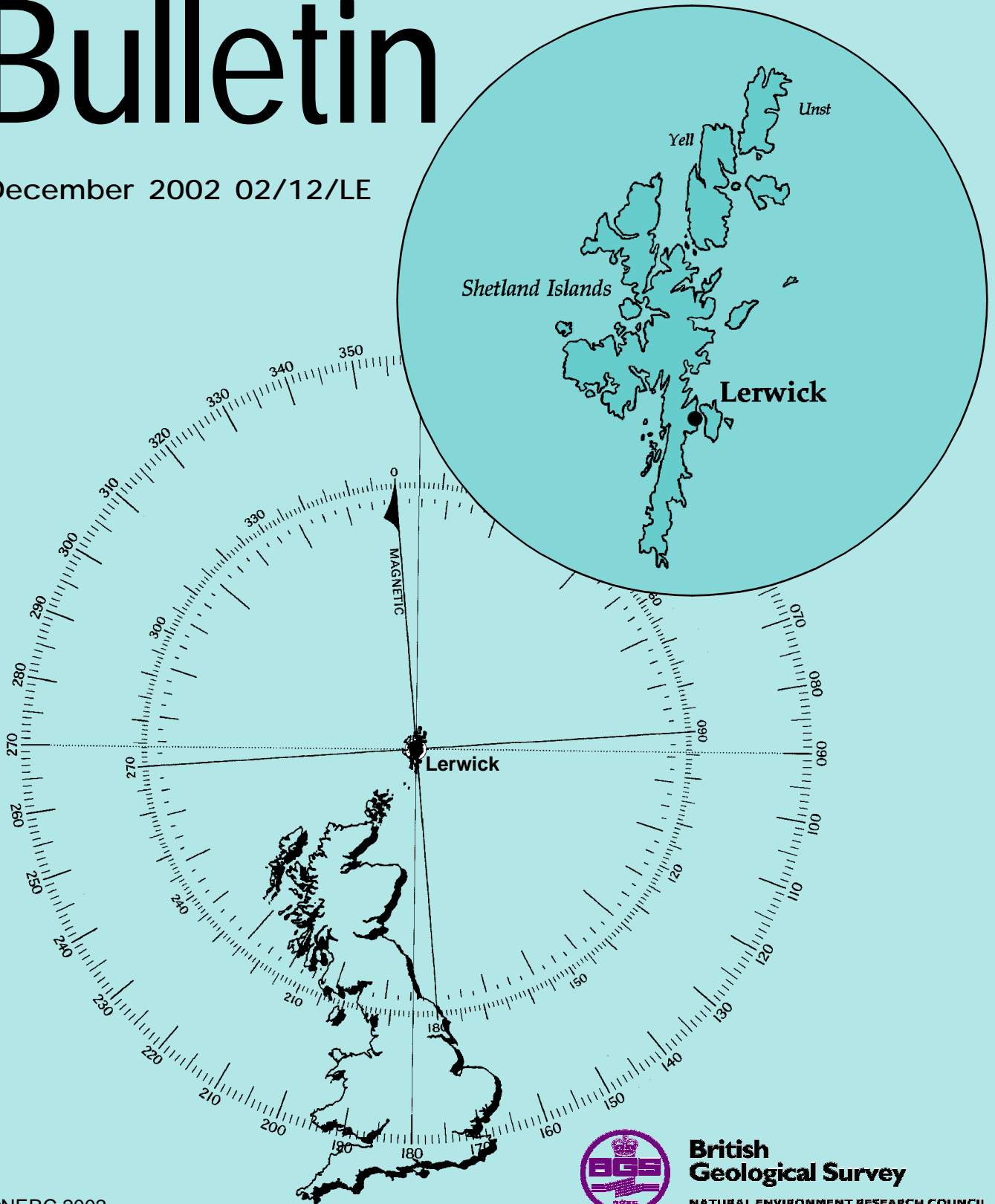


# Monthly Geomagnetic Bulletin

December 2002 02/12/LE



# 1. LERWICK OBSERVATORY MAGNETIC DATA

## 1.1 Introduction

This bulletin is published to meet the needs of some commercial and academic users of geomagnetic data. Magnetic observatory data is presented as a series of plots of one-minute, hourly and daily values, followed by tabulations of monthly values, geomagnetic activity indices and reports of rapid variations. The operation of the observatory and presentation of data are described in the rest of this section.

Enquiries about the data should be addressed to:

National Geomagnetic Service  
British Geological Survey  
Murchison House, West Mains Road  
Edinburgh EH9 3LA  
Scotland, UK

Tel: +44 (0) 131 667 1000  
Fax: +44 (0) 131 668 4368  
E-mail: [s.reay@bgs.ac.uk](mailto:s.reay@bgs.ac.uk)  
Internet: [www.geomag.bgs.ac.uk](http://www.geomag.bgs.ac.uk)

## 1.2 Position

Lerwick Observatory, one of the three geomagnetic observatories operated and maintained in the UK by BGS, is situated on a ridge of high ground about 2.5 km to the SW of the port of Lerwick in Shetland. The observatory co-ordinates are:-

*Geographic:* 60°08.0'N 358°49.0'E  
*Geomagnetic:* 62°00.3'N 89°02.3'E  
*Height above mean sea level:* 85 m

The geomagnetic co-ordinates are calculated using the 8th generation International Geomagnetic Reference Field at epoch 2002.5.

## 1.3 The Observatory Operation

### 1.3.1 Primary System: GAUSS

The observatory operates under the control of the Geomagnetic Automatic Unmanned Sampling System (GAUSS), which was developed by BGS staff, was installed in 1996, and became operational in January 1997. The system is based on two IBM-compatible personal computers (PCs), which control the data-logging and communications. There are two sets of sensors used for making magnetic measurements. A

triaxial linear-core fluxgate magnetometer, manufactured by the Danish Meteorological Institute (DMI) is used to measure the variations in the horizontal ( $H$ ) and vertical ( $Z$ ) components of the field. The third sensor is oriented perpendicular to these, and measures variations which are proportional to the changes in declination ( $D$ ). Measurements are made at a rate of 1 Hz, and are filtered to produce one-minute values using a 61-point cosine filter.

In addition to the fluxgate sensors there is a proton precession magnetometer (PPM) with its sensor mounted at the centre of two sets of orthogonal Helmholtz coils, which is used to make measurements each minute of the absolute total field intensity ( $F$ ) and the variations in declination and inclination ( $I$ ).

The data are retrieved via telephone to the BGS office in Edinburgh. In normal operation this is performed automatically every 8 minutes by an IBM-compatible PC located in Edinburgh, but data can be retrieved on demand if required.

The data sets are used to update the Geomagnetism Information and Forecast Service (GIFS), an on-line information system accessed via the World-Wide Web at the address given in Section 1.1. GIFS also provides information on geomagnetic and solar activity.

### 1.3.2 Back-up System: FLAREplus

The back-up system provides completely independent back-up data in the event of a total GAUSS failure. This system is the Fluxgate Logging Automatic Recording Equipment (FLAREplus), which was developed by BGS. The FLAREplus system is PC based, controlling the data logging and communications. The measurements are made using two types of magnetometers: a DMI triaxial linear-core fluxgate magnetometer, which is identical to that used in GAUSS; and an Overhauser PPM. Measurements of  $H$ ,  $D$  and  $Z$  are made every 5 seconds and are filtered to produce one-minute values using a 19-point Gaussian filter. One-minute values of  $F$  are obtained from the PPM.

FLAREplus data are retrieved via telephone to the BGS office in Edinburgh automatically by the data collection processor four times a day. Facilities have been included to allow immediate data retrieval in the event of the loss of GAUSS data.

## 1.4 Data Presentation

The data presented in the bulletin are in the form of plots and tabulations described in the following sections.

### 1.4.1 Summary magnetograms

Small-scale magnetograms are plotted which allow the month's data to be viewed at a glance. They are plotted with 16 days on a page, showing the variations in  $D$ ,  $H$  and  $Z$ . The scales are shown on the right-hand side of the page. Occasionally the amplitude of disturbance requires that the scales be multiplied by a factor throughout the course of one day, which is indicated above the panel for that day. The variations are centred on the monthly mean value, shown on the left side of the page.

### 1.4.2 Magnetograms

The magnetograms are plotted using one-minute values of  $D$ ,  $H$  and  $Z$  from the GAUSS fluxgate sensors, with any gaps filled using the back-up data. The magnetograms are plotted to a variable scale; scale bars are shown to the right of each plot. The absolute level (the monthly mean value) is indicated on the left side of the plots.

### 1.4.3 Hourly Mean Value Plots

Hourly mean values of  $D$ ,  $H$  and  $Z$  for the past 12 months are plotted in 27-day segments corresponding to the Bartels solar rotation number. Magnetic disturbances associated with active regions on the surface of the Sun may recur after 27 days: the same is true for geomagnetically quiet intervals. Plotting the data in this way highlights this recurrence, and also illustrates seasonal and diurnal variations throughout the year.

### 1.4.4 Daily and Monthly Mean Values

Daily mean values of  $D$ ,  $H$ ,  $Z$  and  $F$  are plotted throughout the year. In addition a table of monthly mean values of all the geomagnetic elements is provided. These values depend on accurate specification of the fluxgate sensor baselines. Provisional and definitive values are indicated in the table as **P** or **D** respectively. It is anticipated that provisional values will not be altered by more than a few nT or tenths of arcminutes, if at all, before being made definitive.

### 1.4.5 Geomagnetic activity indices

*The Observatory K index.* This summarises geomagnetic activity at an observatory by assigning a code, an integer in the range 0 to 9, to each 3-hour Universal Time (UT) interval. The index for each 3-hour UT interval is determined

from the ranges in  $H$  and in  $D$  (scaled in nT), with allowance made for the regular (undisturbed) diurnal variation. The conversion from range to an index value is made using a quasi-logarithmic scale, with the scale values dependent on the geomagnetic latitude of the observatory. The  $K$  index retains the local time (LT) and seasonal dependence of activity associated with the position of the observatory.

*The provisional aa index.* 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 LT and seasonal effects. The simplest of these is the  $aa$  index, computed using the  $K$  indices from two approximately antipodal observatories: Hartland in the UK and Canberra in Australia. The  $aa$  index is calculated from linearisations of the Hartland and Canberra  $K$  indices, and has units of nT. The daily mean value of  $aa$  (denoted  $Aa$ ), the mean values of  $aa$  for the intervals 00-12UT and 12-24UT and the daily mean values for Hartland alone ( $Aa_n$ ) and Canberra alone ( $Aa_s$ ) are tabulated.

Although the  $aa$  index is based on data from only two observatories, provided averages over 12 hours or longer are used, the index is strongly correlated with the  $ap$  and  $am$  indices, which are derived using data from more extensive observatory networks.

The  $aa$  indices listed in this publication are provisional only; the definitive values are published by the International Service for Geomagnetic Indices, CRPE/CNET - CNRS, 4 Avenue de Neptune, F-94107 Saint Maur Cedex, France.

### 1.4.6 Rapid Variations

Charged particles stream from the Sun in the solar wind. The solar wind interacts with the geomagnetic field to create a cavity, the magnetosphere, in which the field is confined. When a region of enhanced velocity and/or density in the solar wind arrives at the day-side boundary of the magnetosphere (at about 10 earth radii) the boundary is pushed towards the Earth. Currents set up on the boundary of the magnetosphere can cause an abrupt change in the geomagnetic field measured on the ground and this is recorded on observatory magnetograms as a Sudden Impulse (SI). If, following an SI, there is a change in the rhythm of activity, the SI is termed a Storm Sudden Commencement (SSC). A classical magnetic storm exhibiting initial, main and recovery phases (shown by, for instance, the  $Dst$

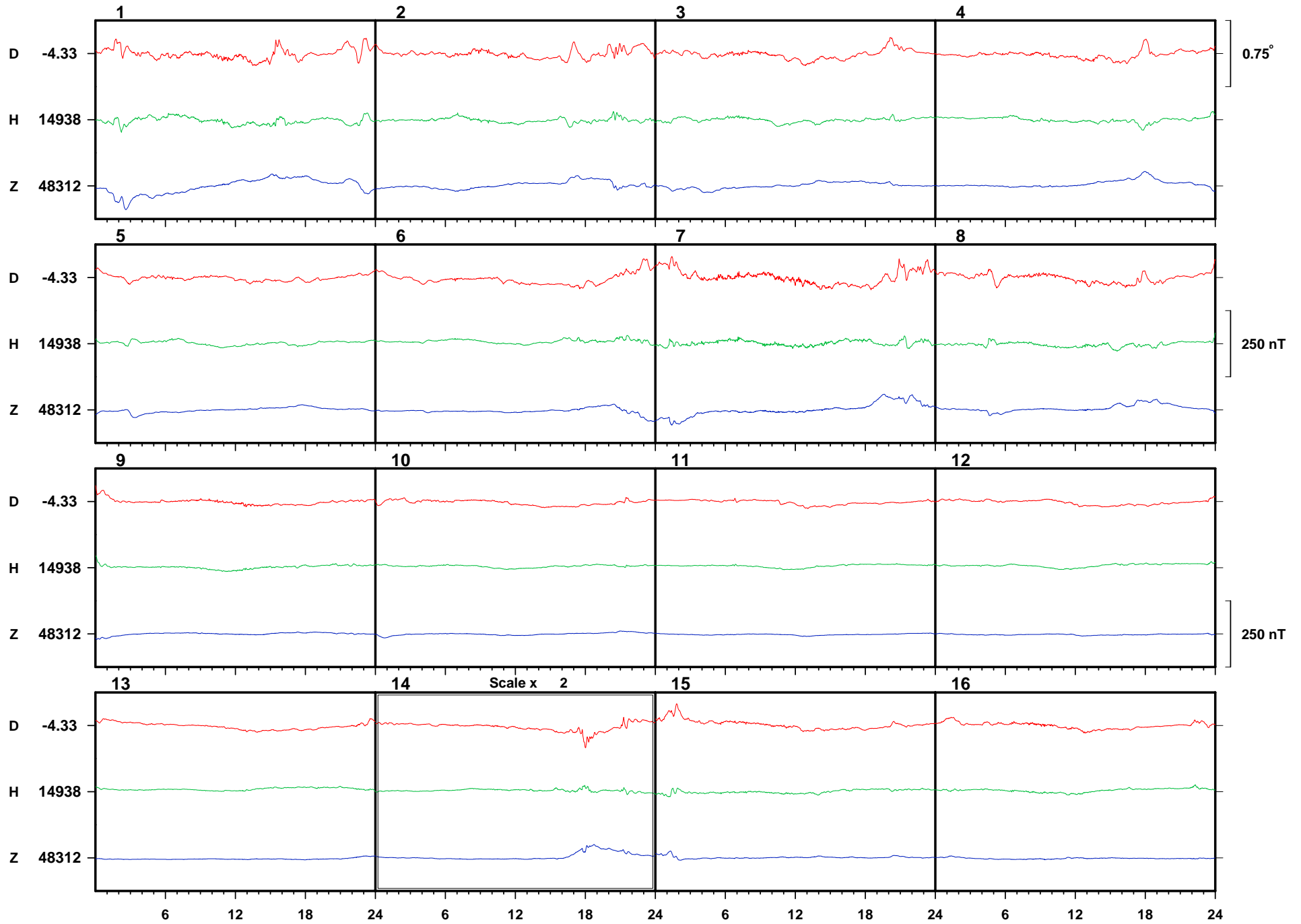
ring current index) can often occur after a SSC, in which case the start of the storm is taken as the time of the SSC.

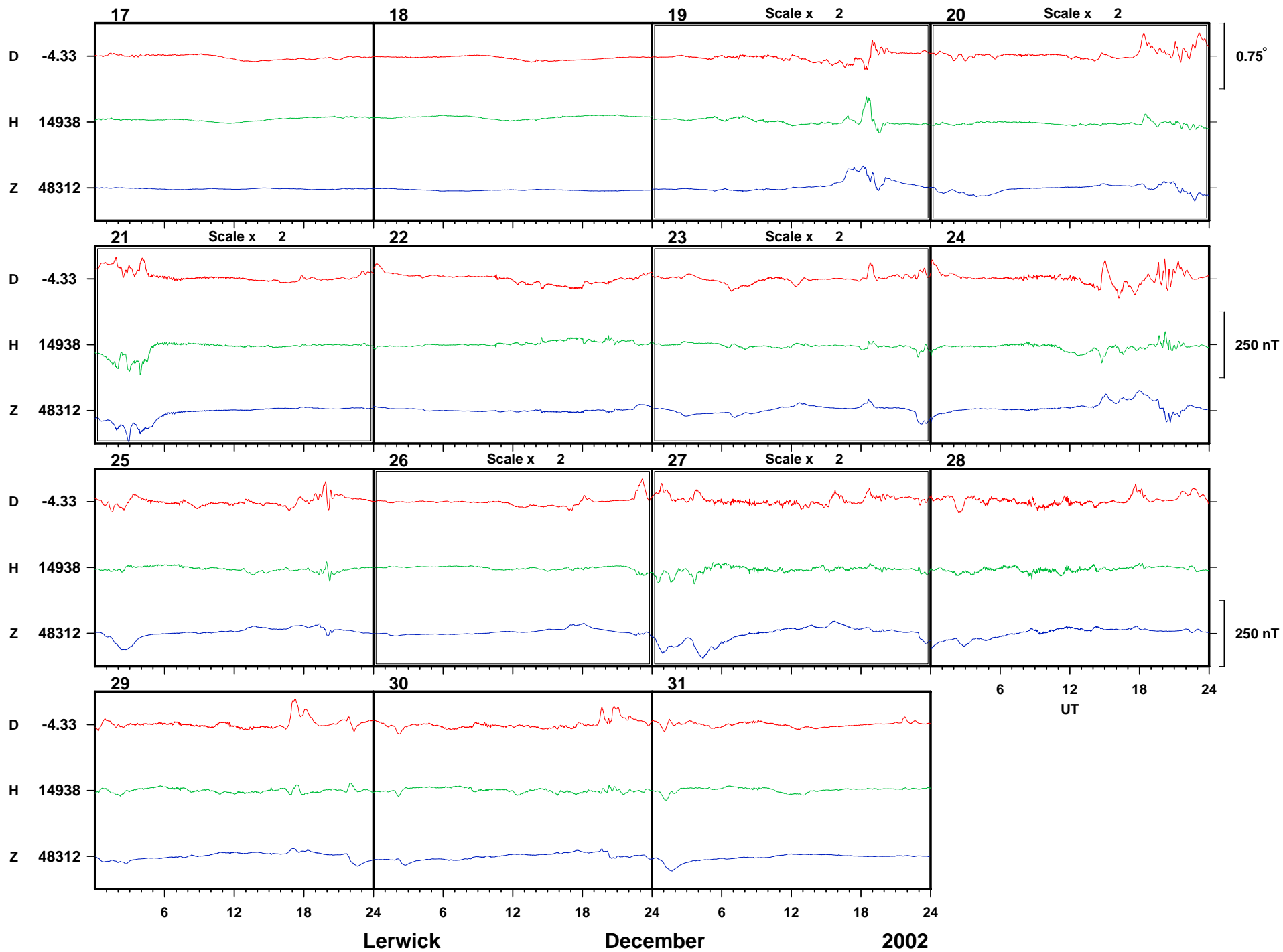
Solar flares, seen at optical wavelengths as a sudden brightening of a small region of the Sun's surface, are also responsible for increased X-ray emissions. The X-rays cause increased ionisation in the ionosphere which leads to absorption of short-wave radio signals. On an observatory magnetogram a Solar Flare Effect (SFE), or "crochet" may be observed. This is an enhancement to the diurnal variation of the order of 10 nT, lasting about an hour.

Lerwick

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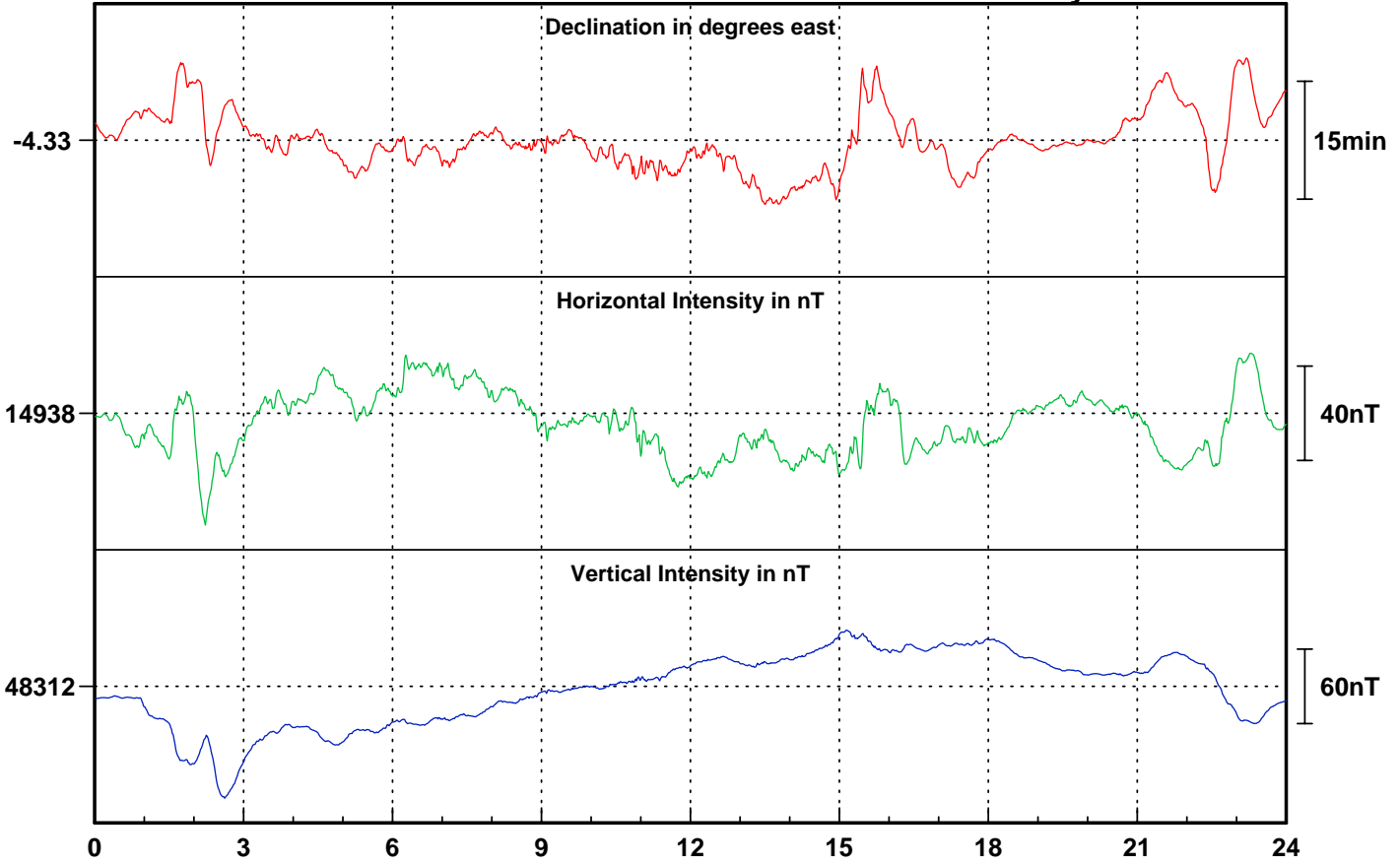




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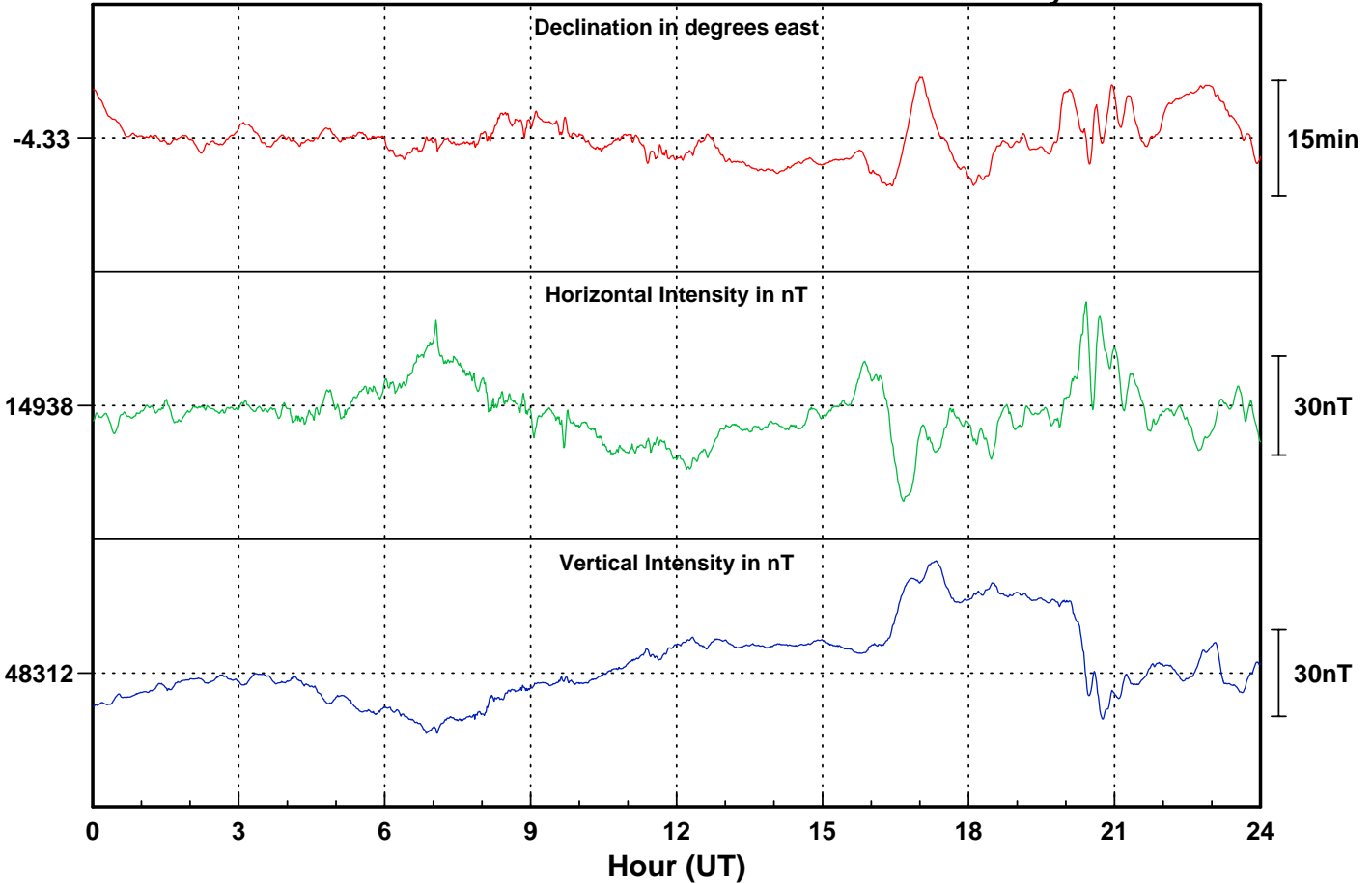
# Lerwick

Day number: 335



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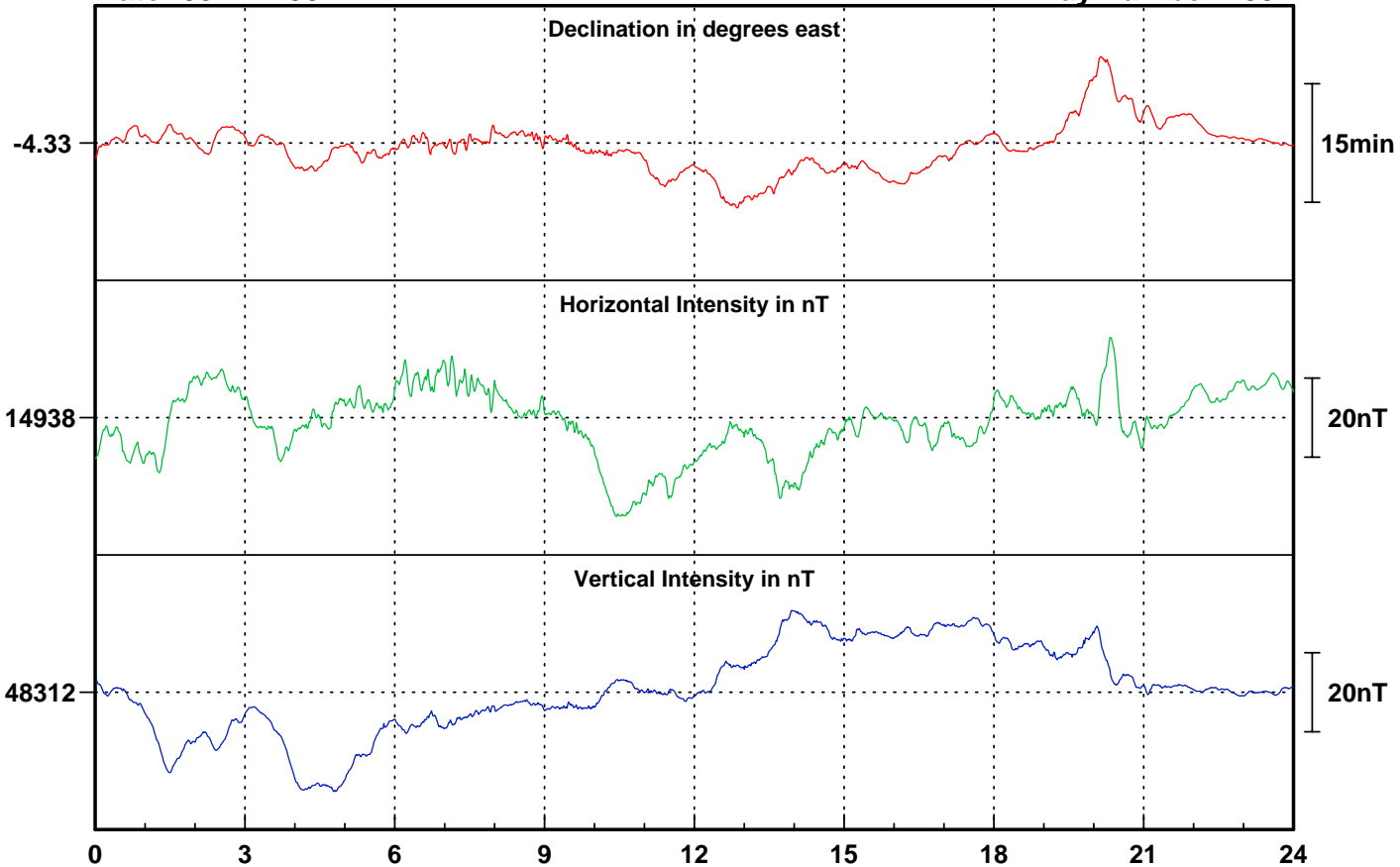
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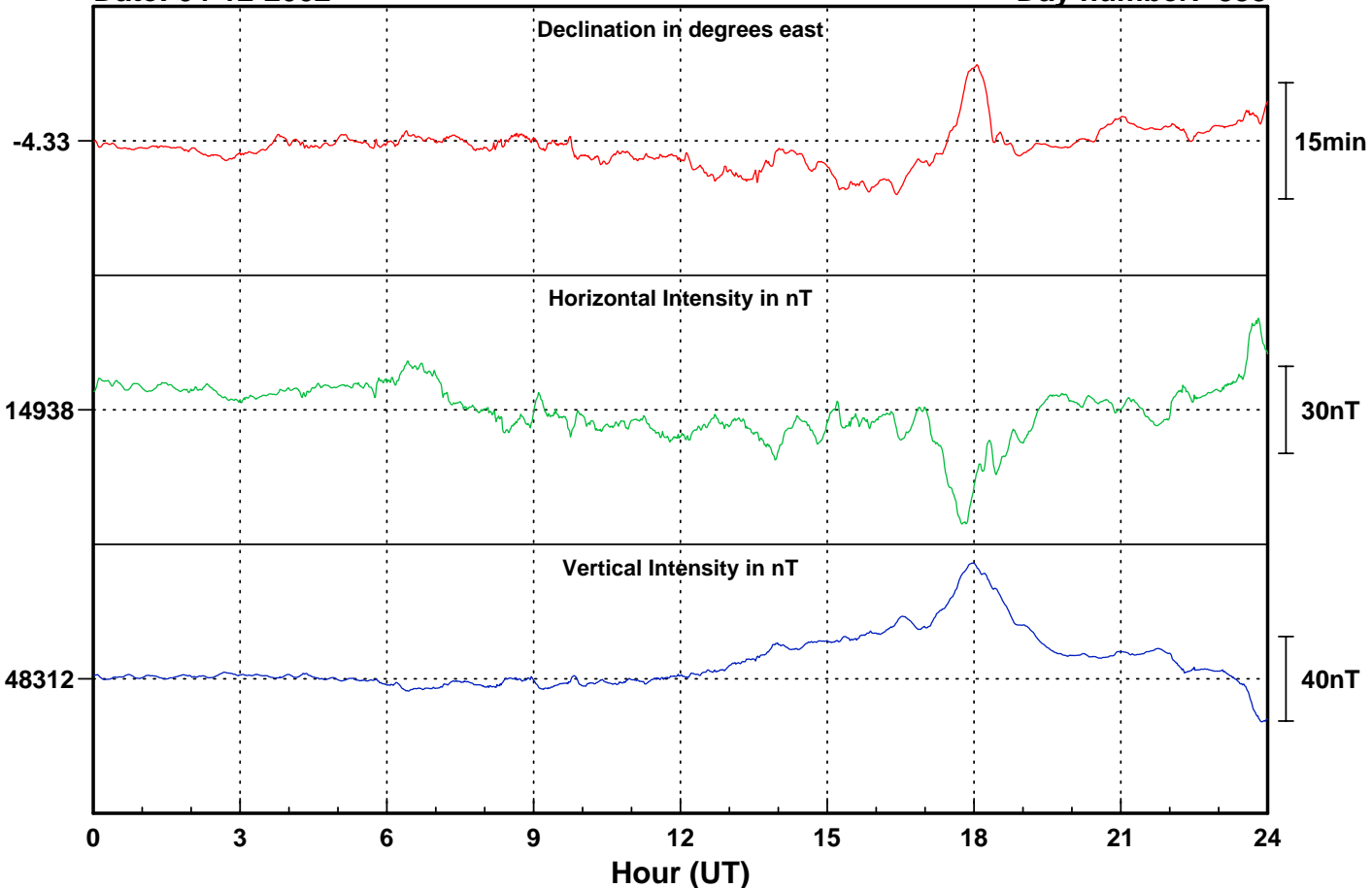
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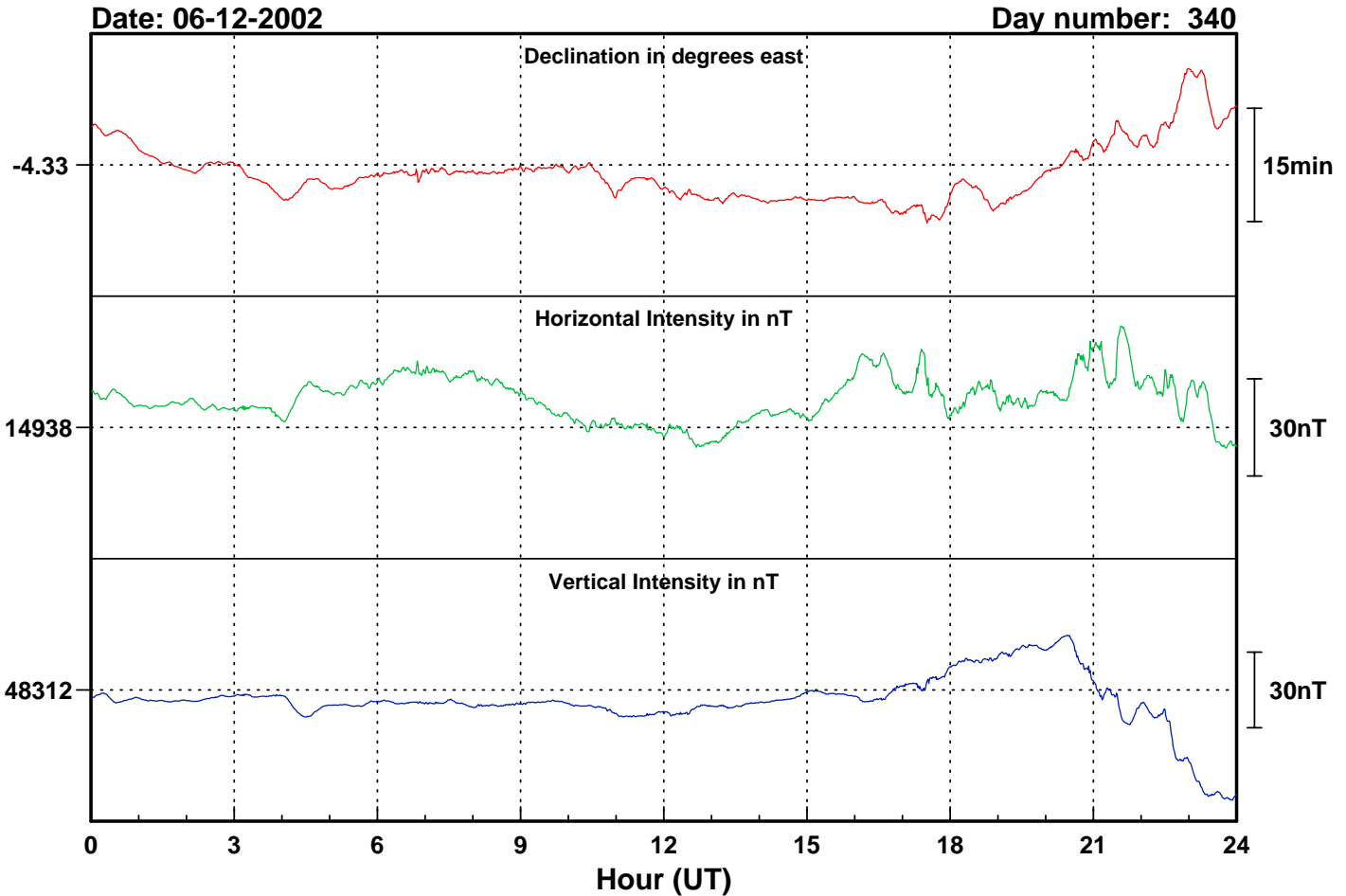
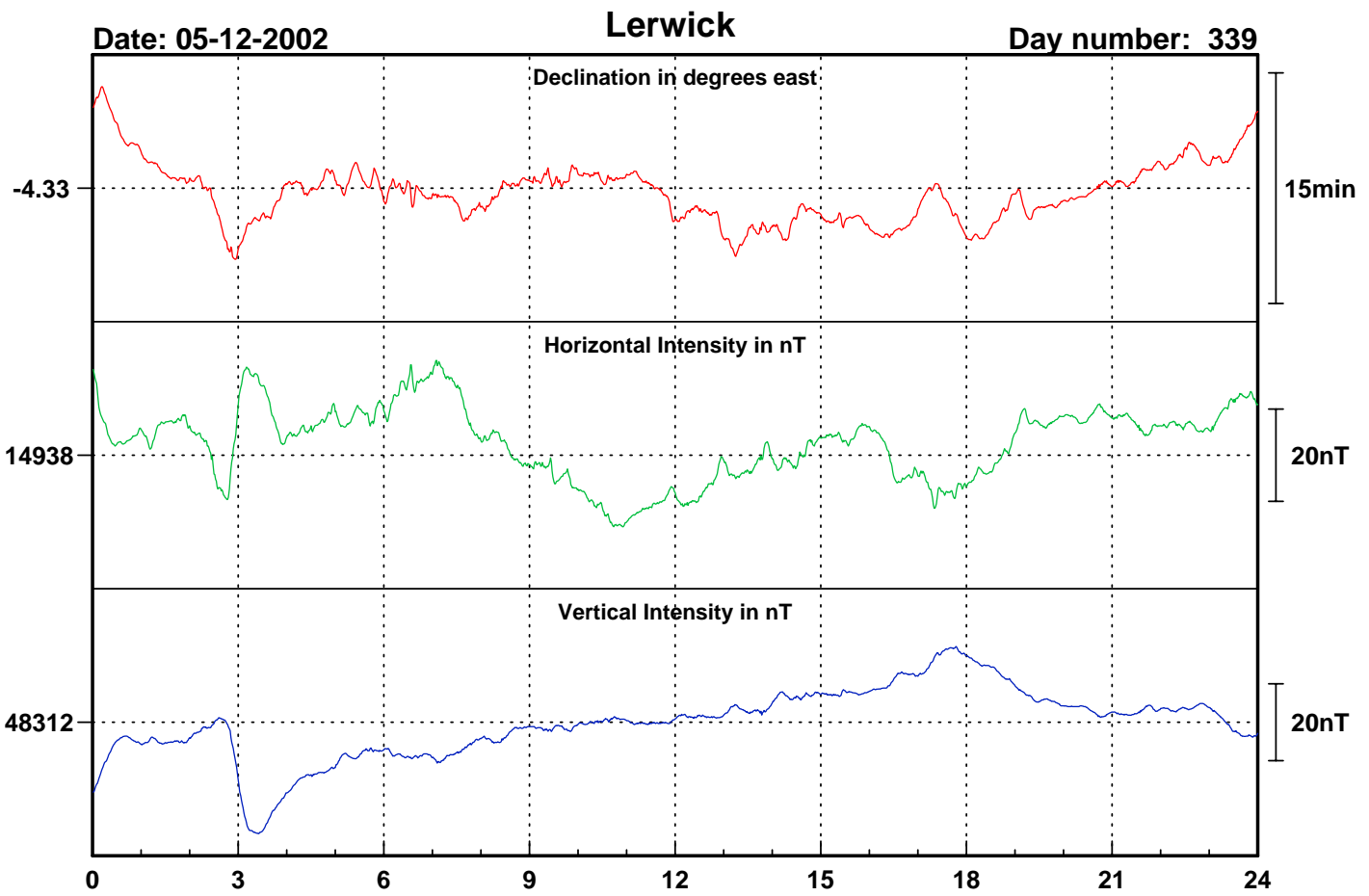


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Day number: 338



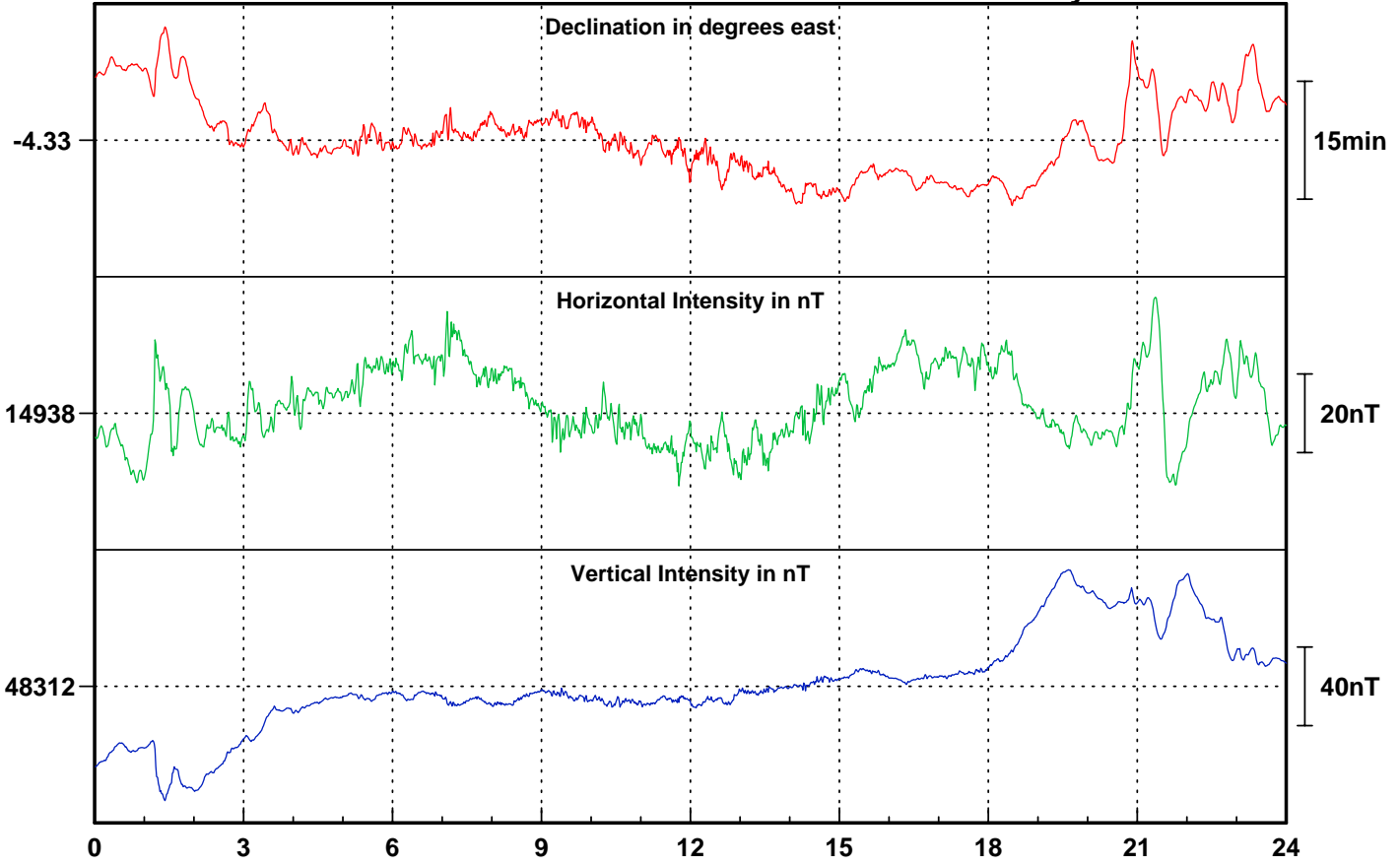




Date: 07-12-2002

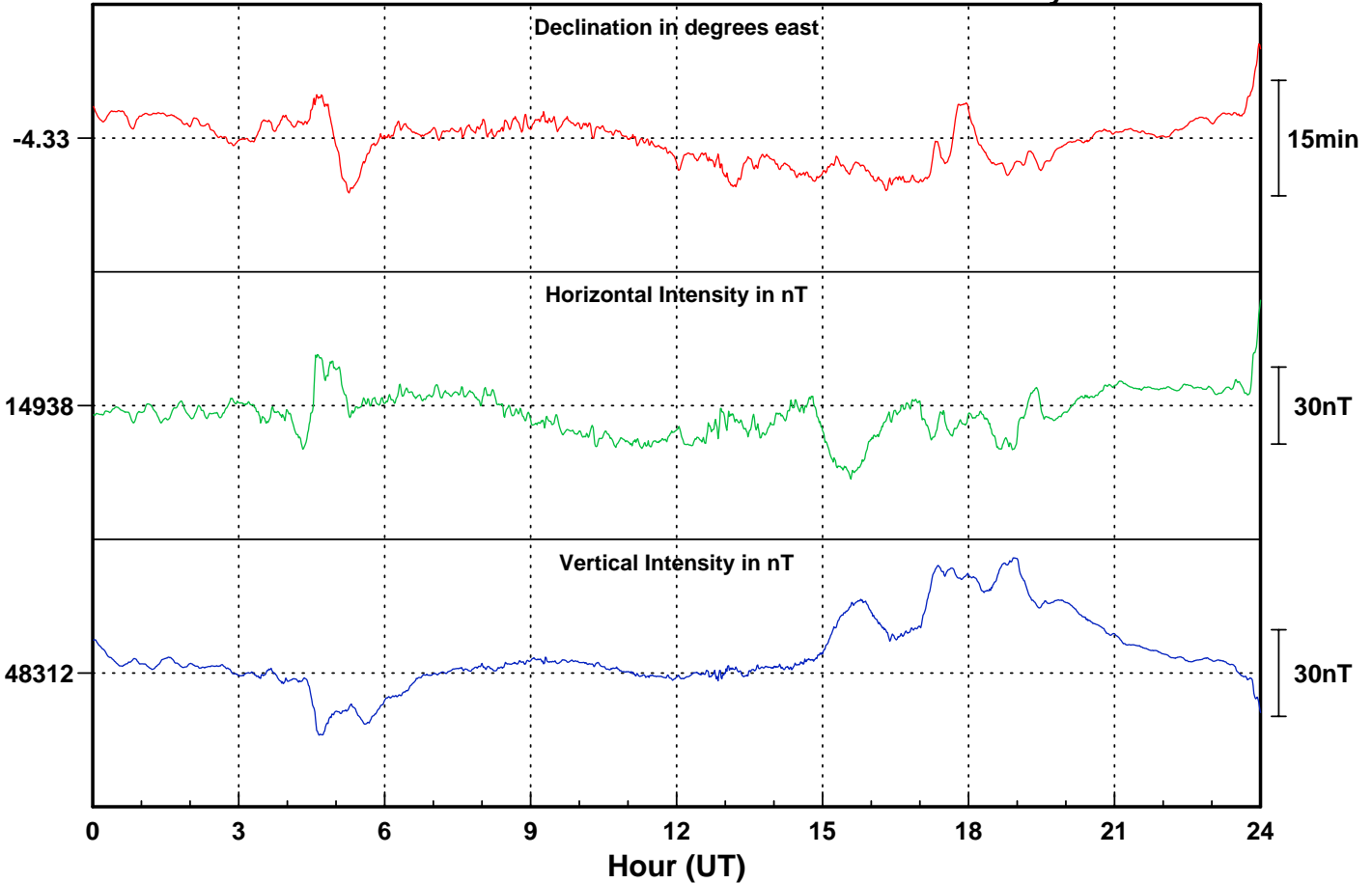
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Day number: 341



Date: 08-12-2002

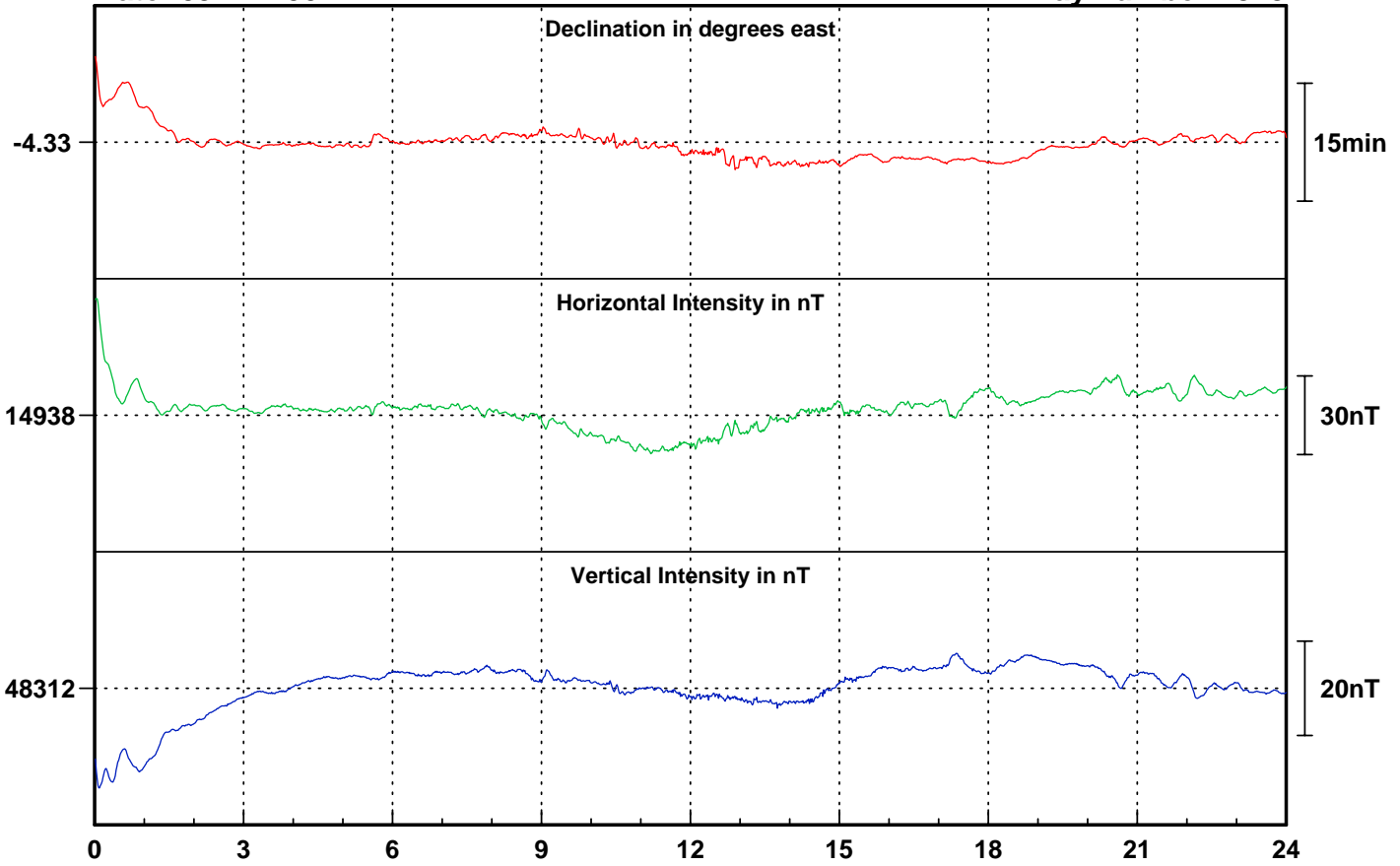
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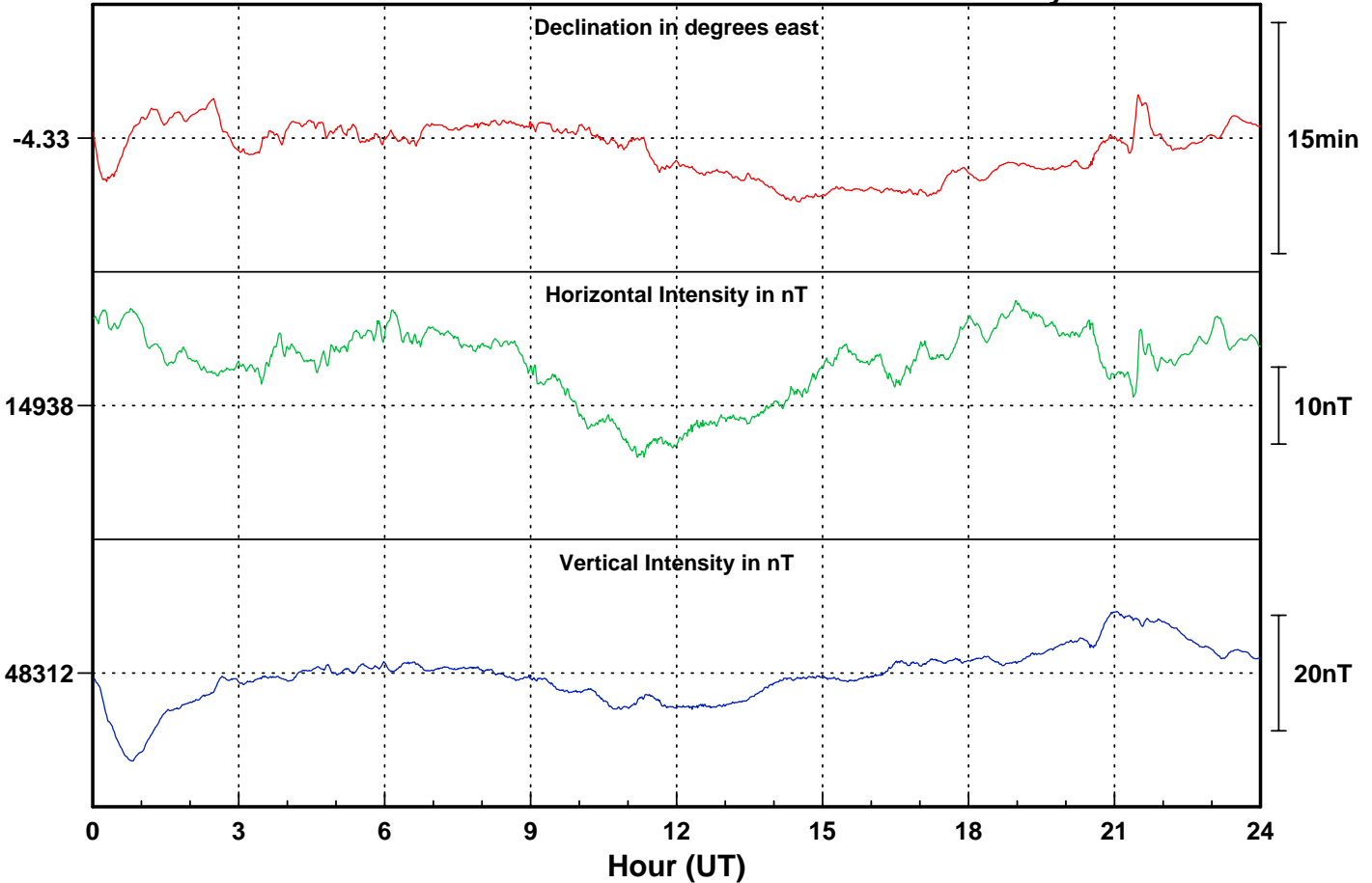
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Day number: 343



Date: 10-12-2002

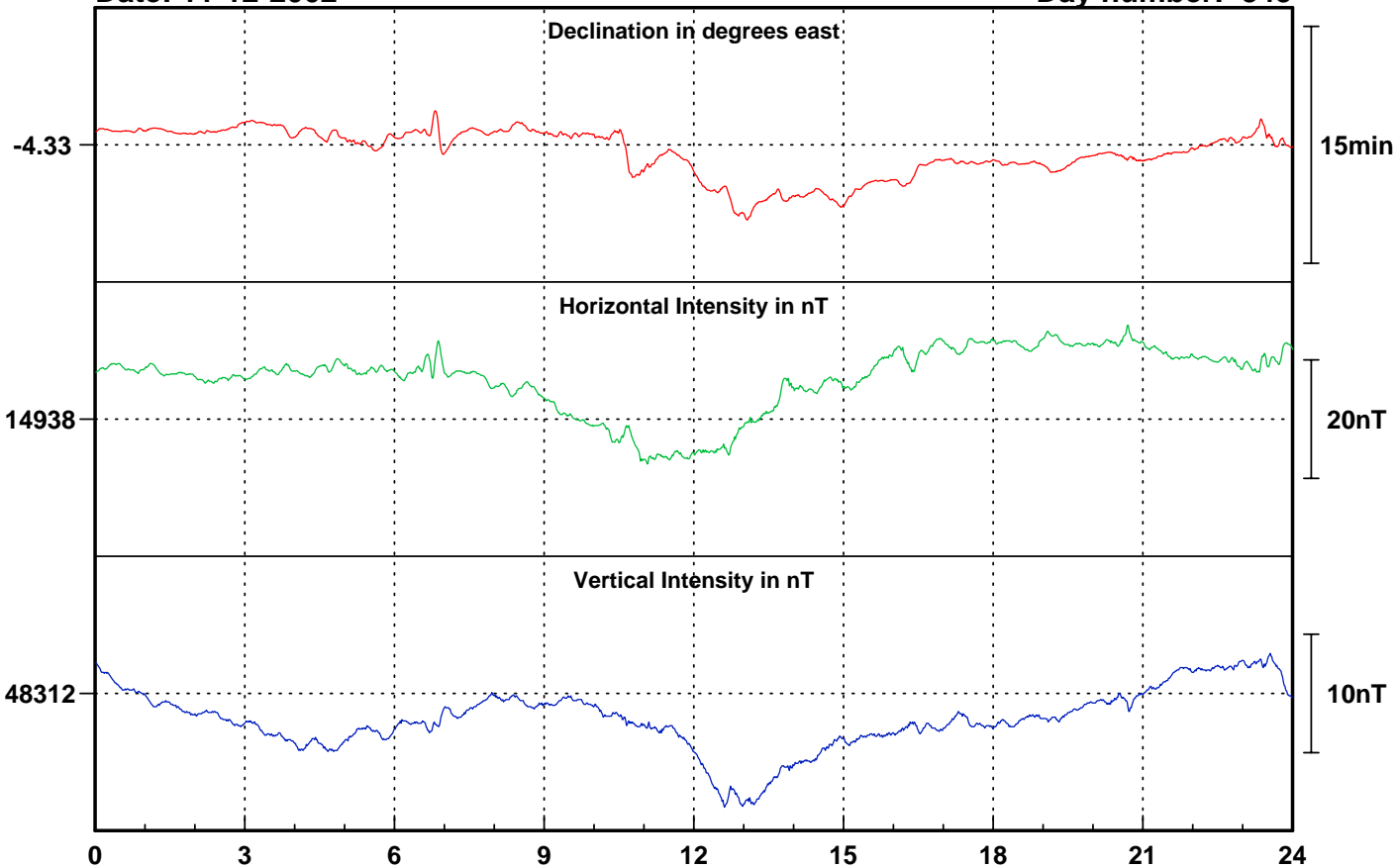
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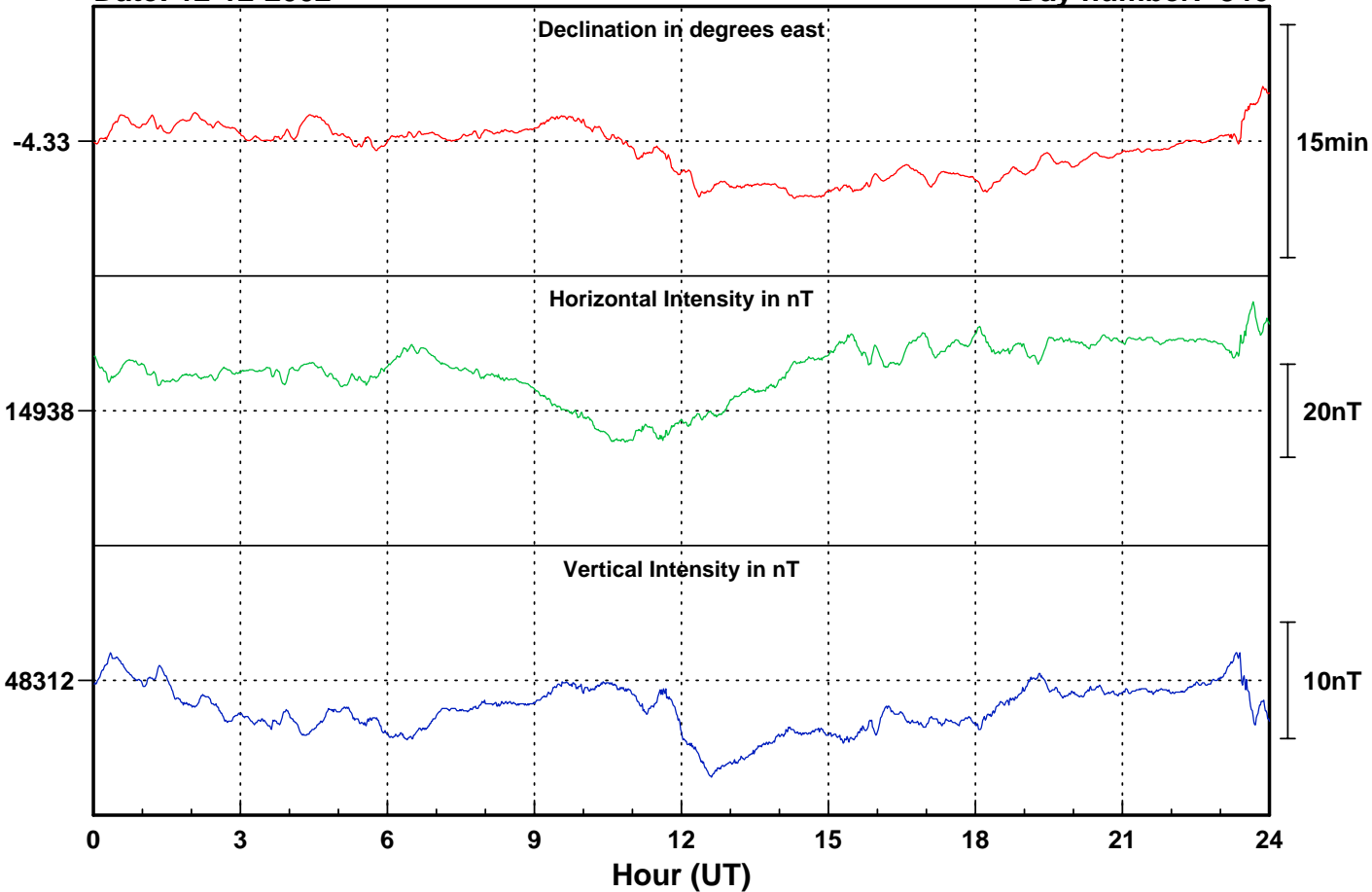
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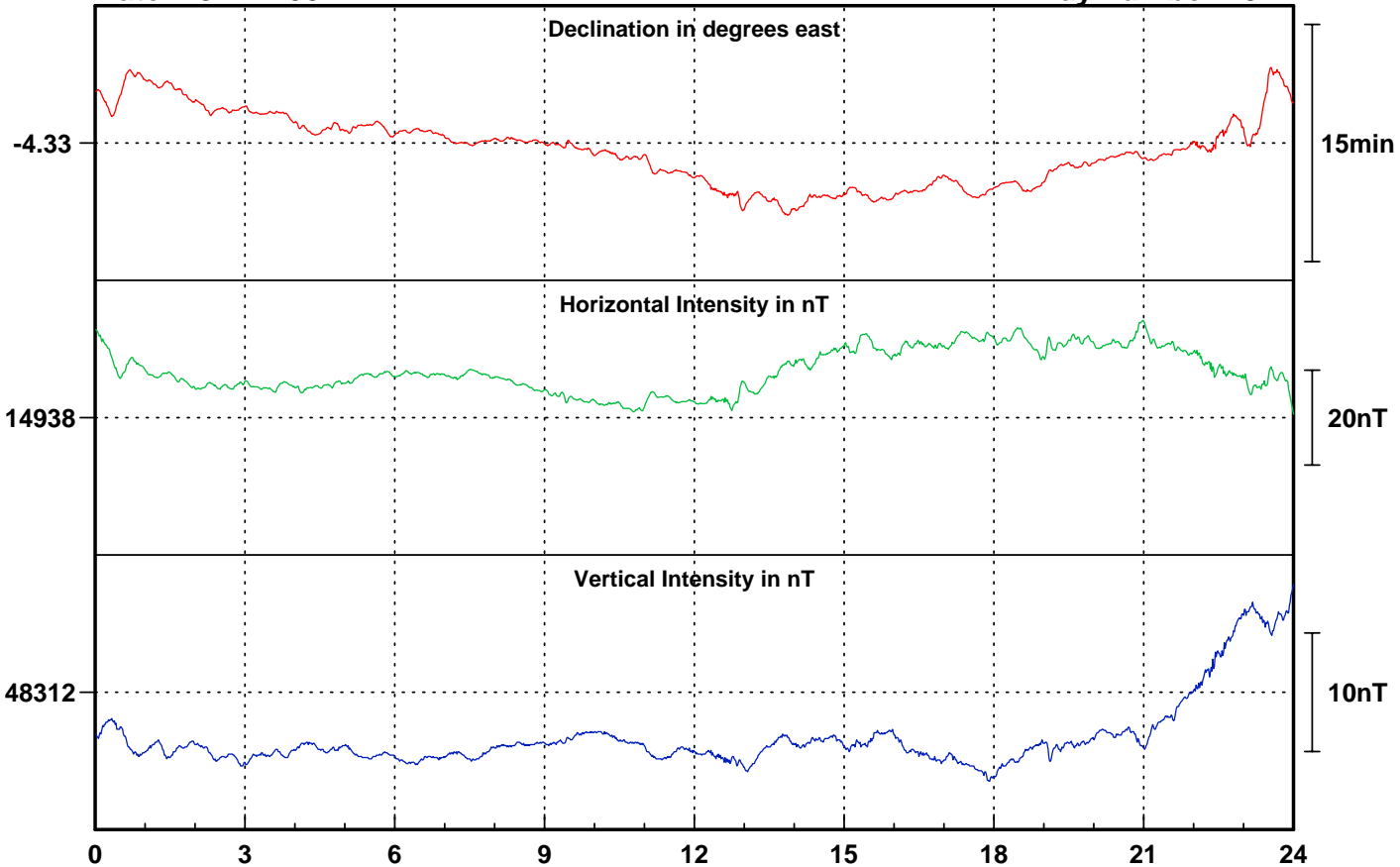
Day number: 346



Date: 13-12-2002

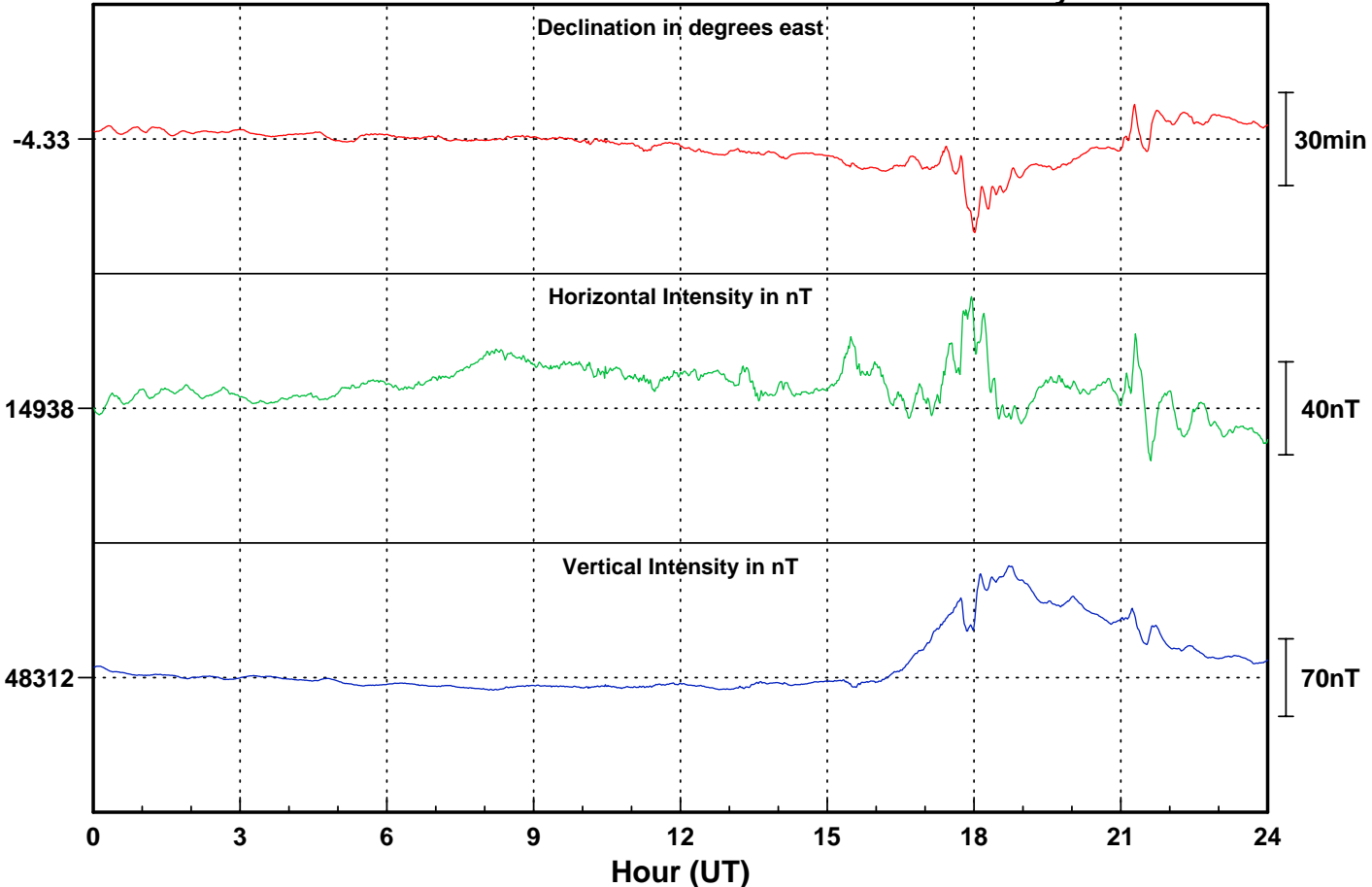
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Day number: 347



Date: 14-12-2002

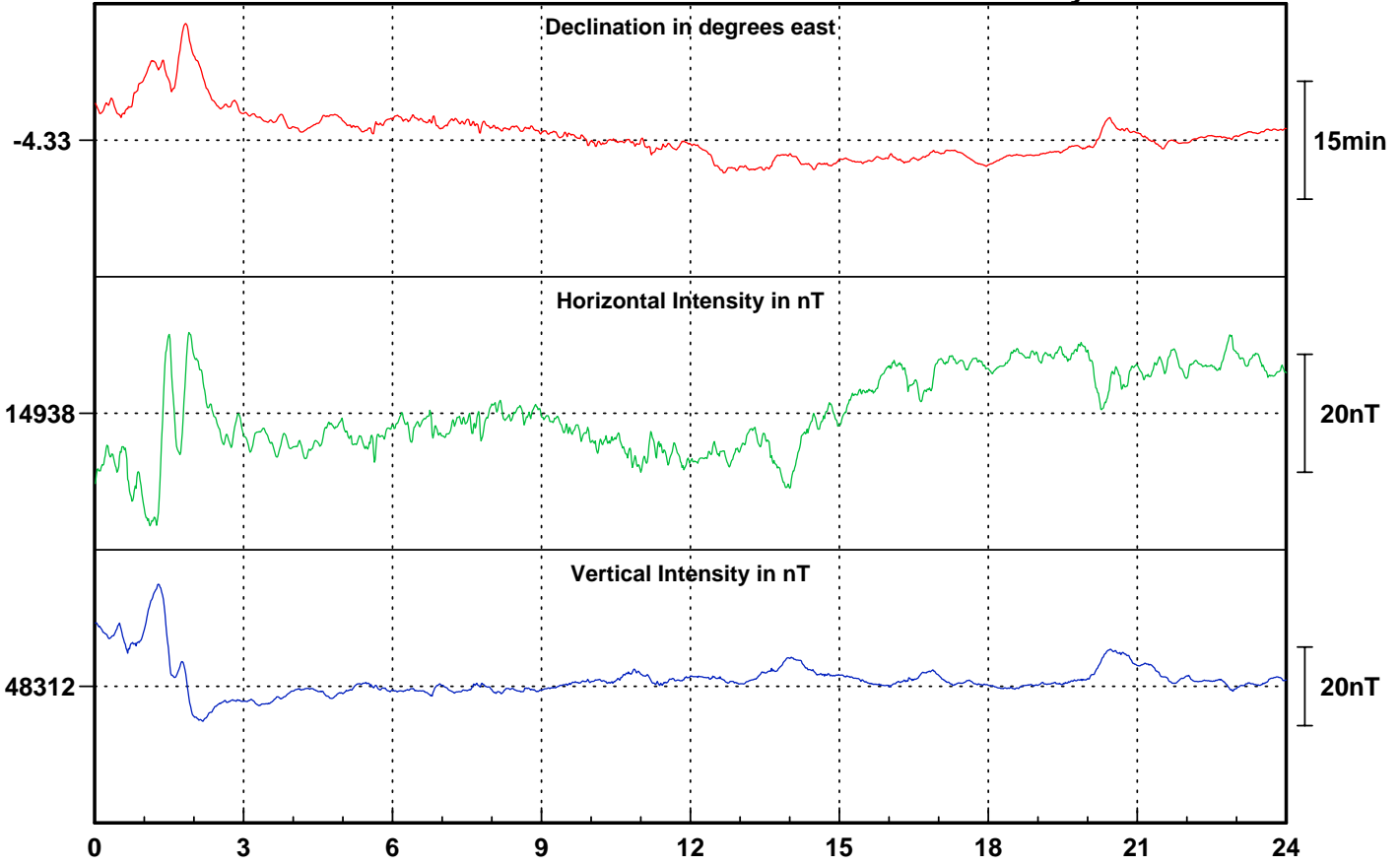
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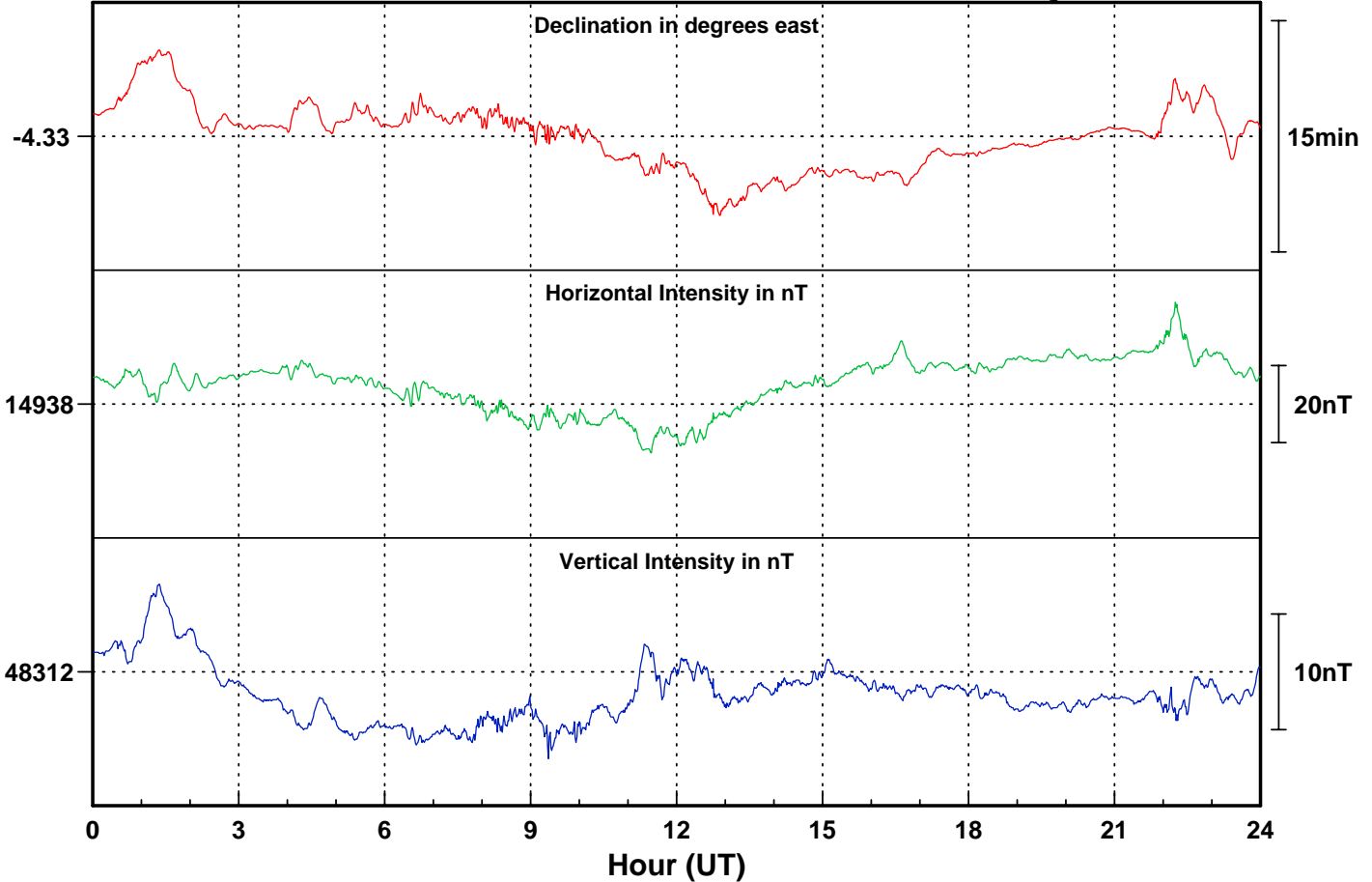
# Lerwick

Day number: 349



Date: 16-12-2002

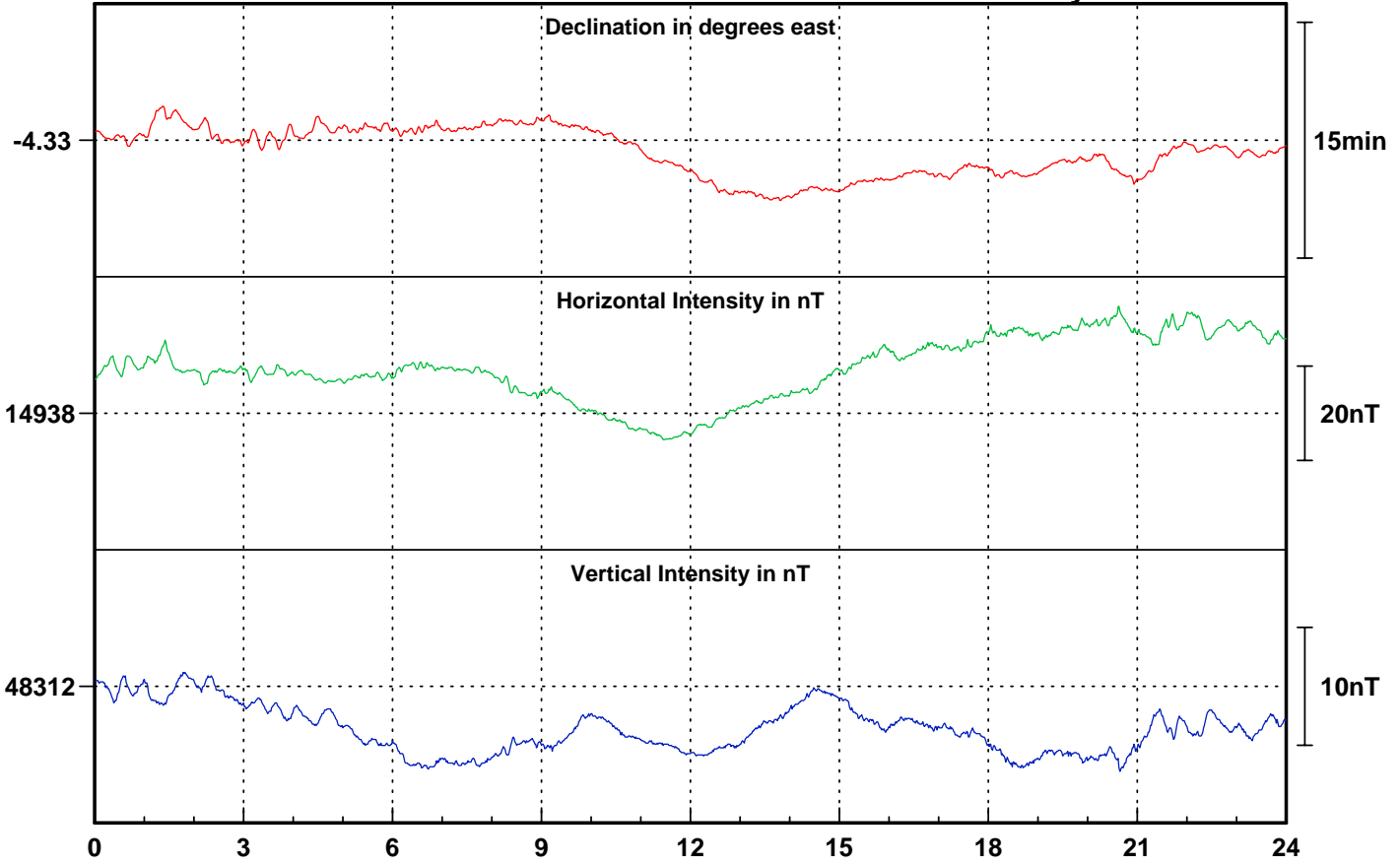
Day number: 350



Date: 17-12-2002

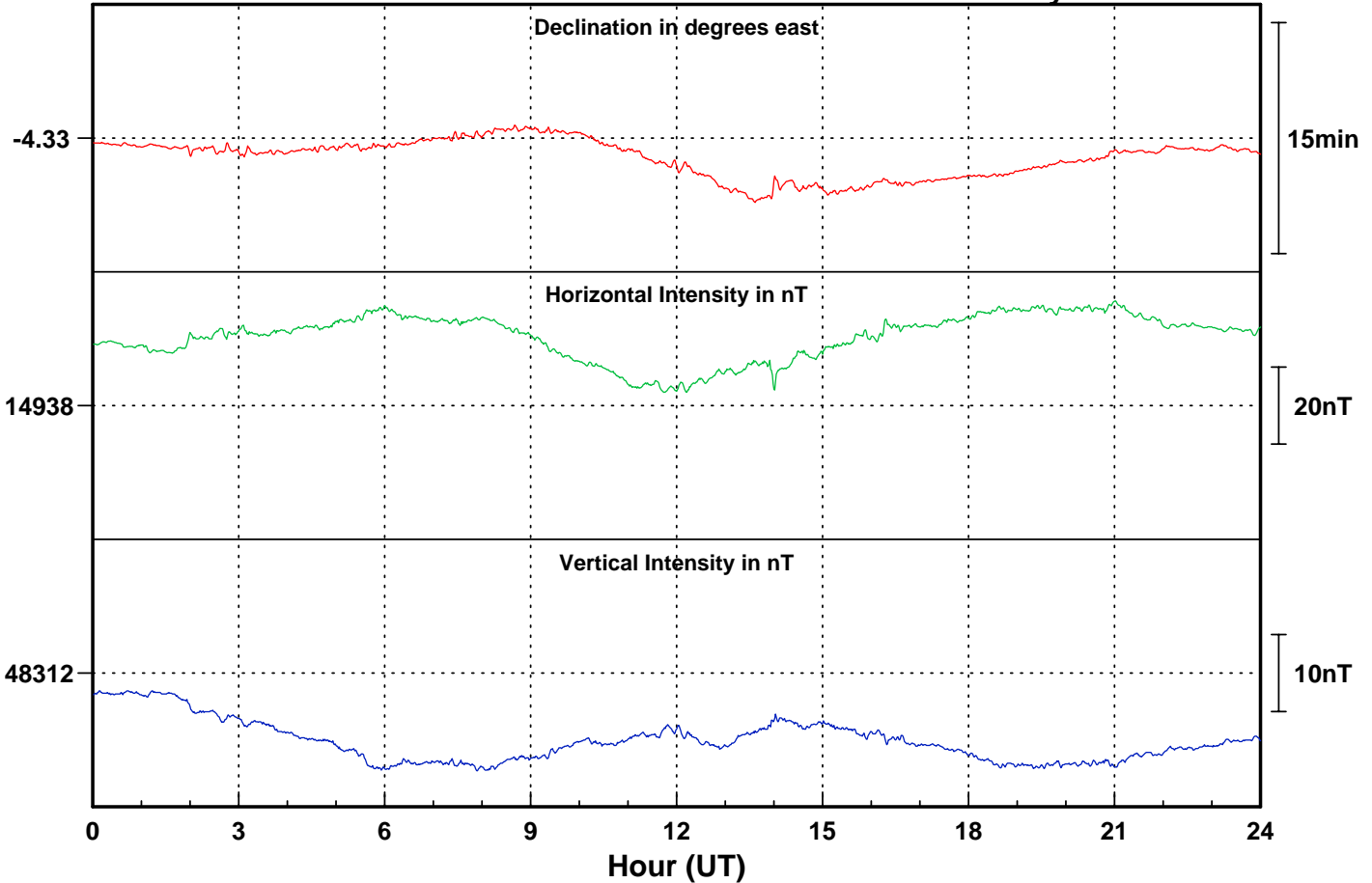
# Lerwick

Day number: 351



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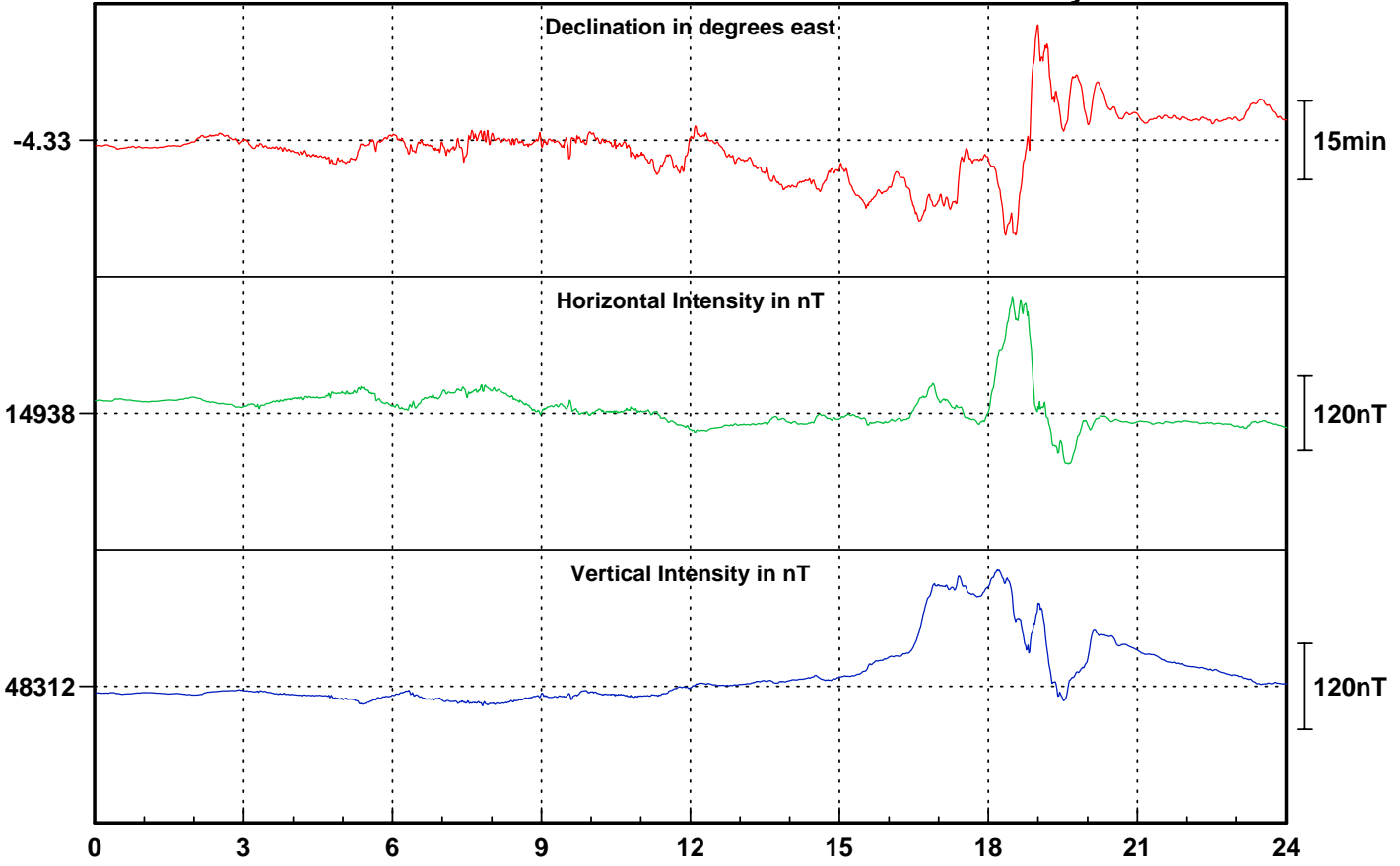
Day number: 352



Date: 19-12-2002

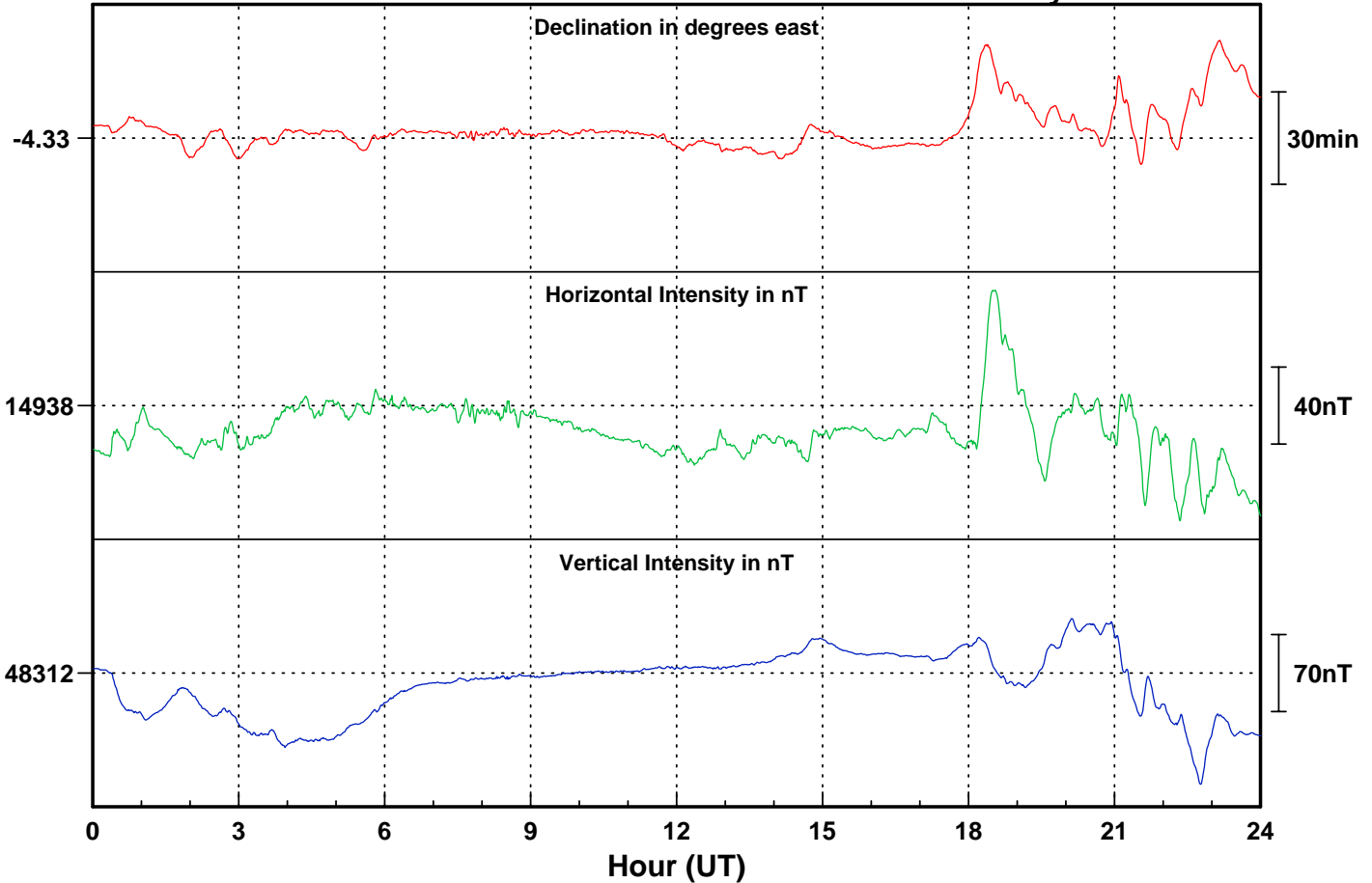
# Lerwick

Day number: 353



Date: 20-12-2002

Day number: 354

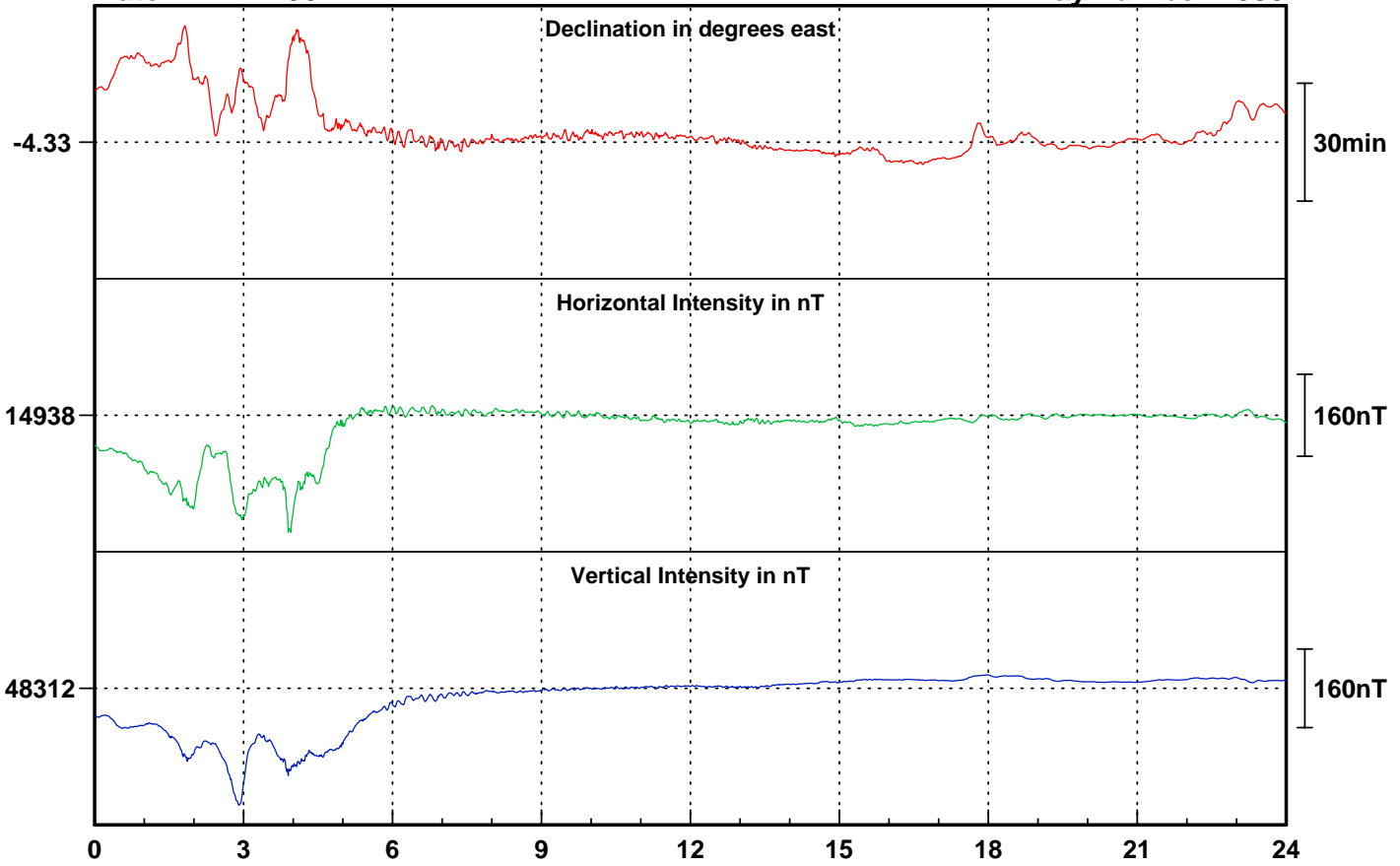




Date: 21-12-2002

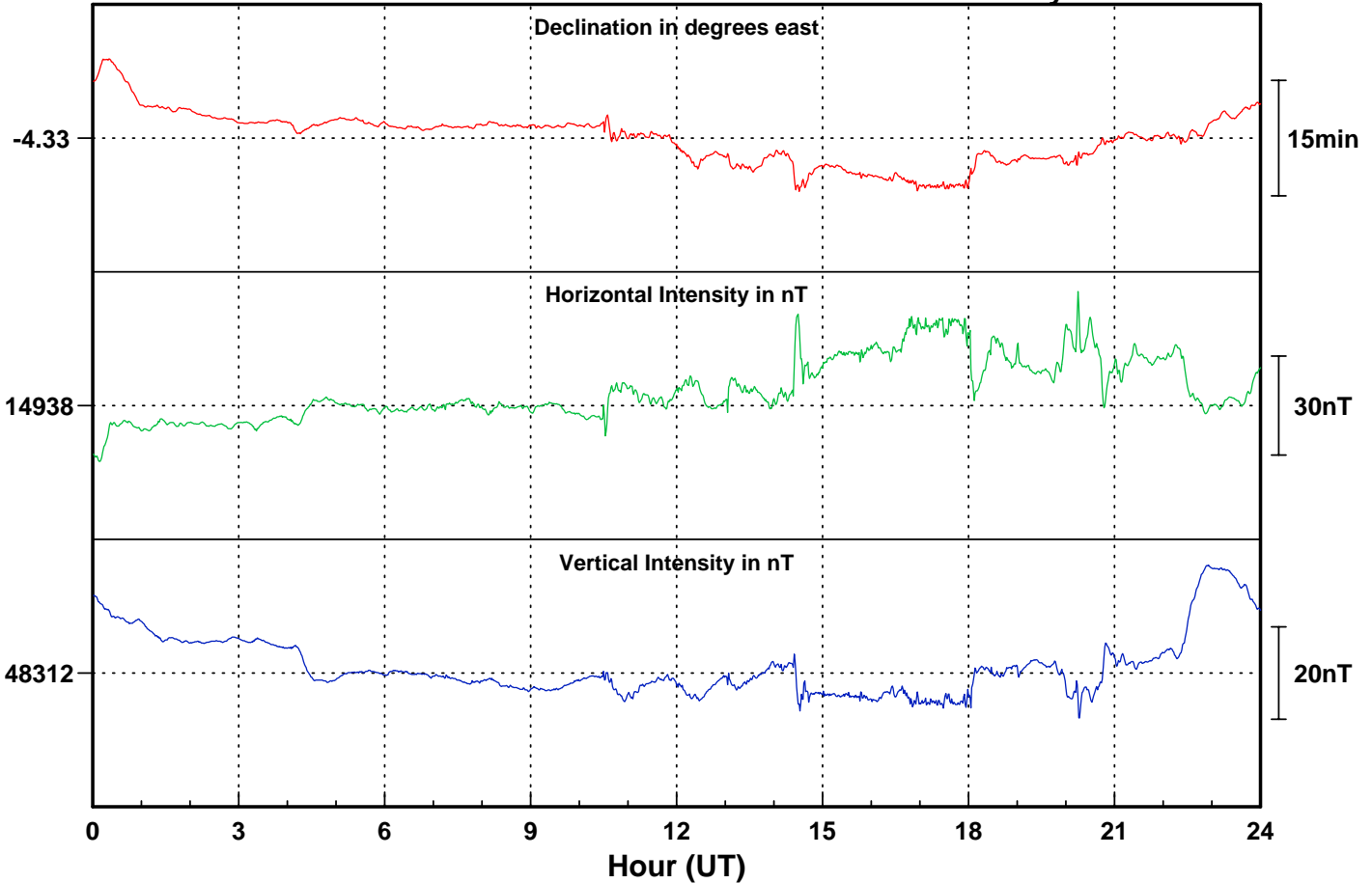
# Lerwick

Day number: 355



Date: 22-12-2002

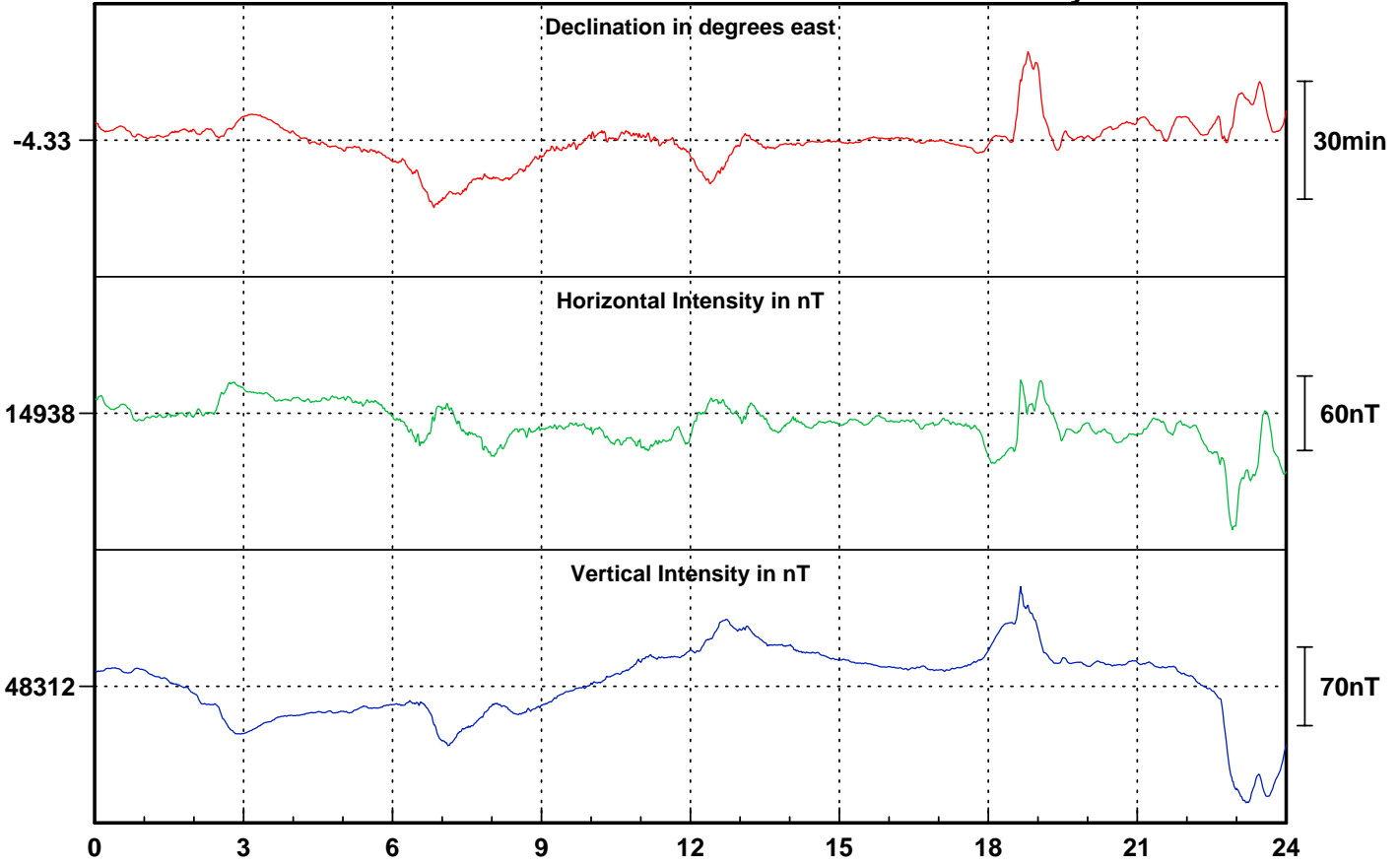
Day number: 356



Date: 23-12-2002

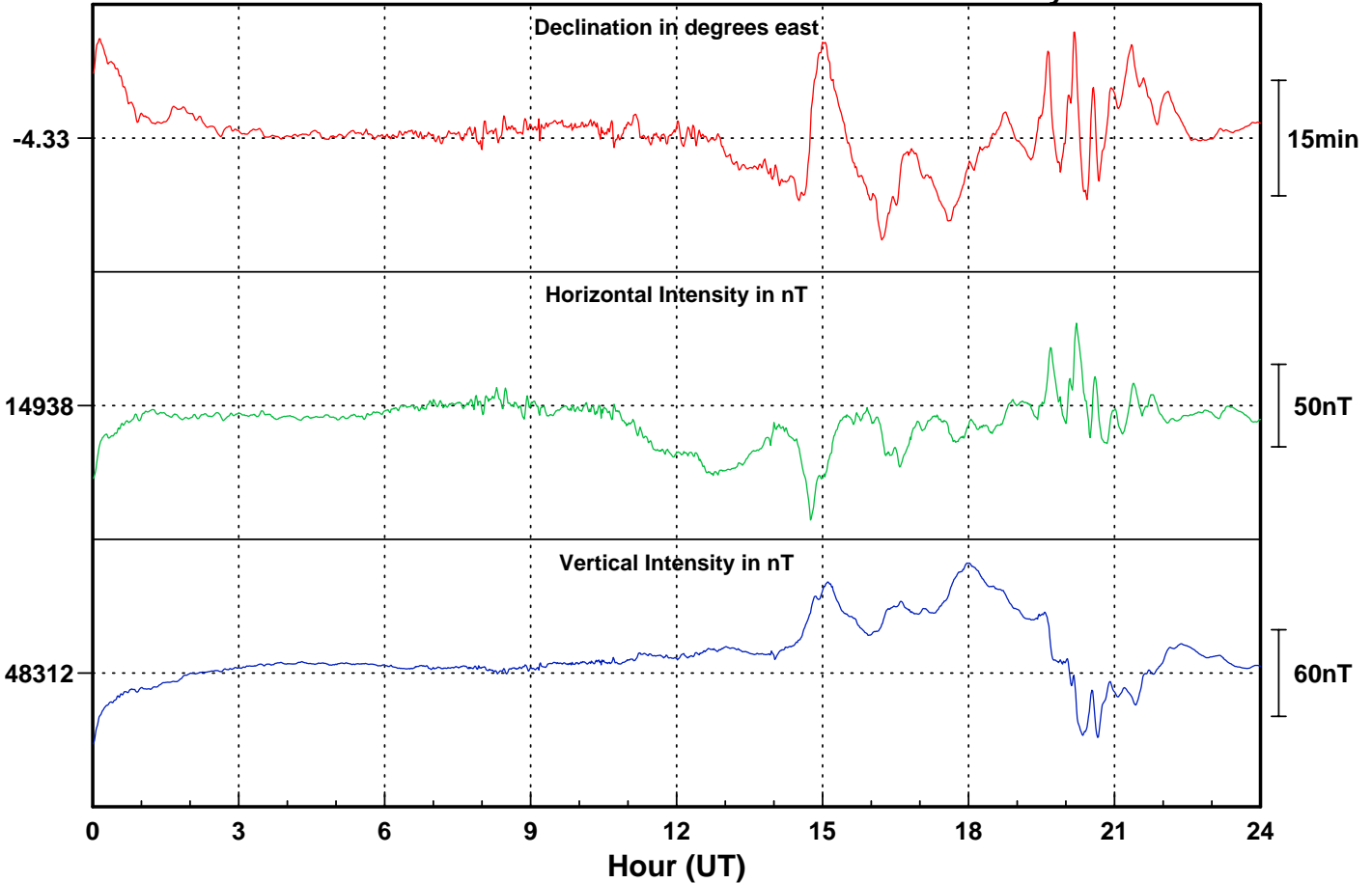
# Lerwick

Day number: 357



Date: 24-12-2002

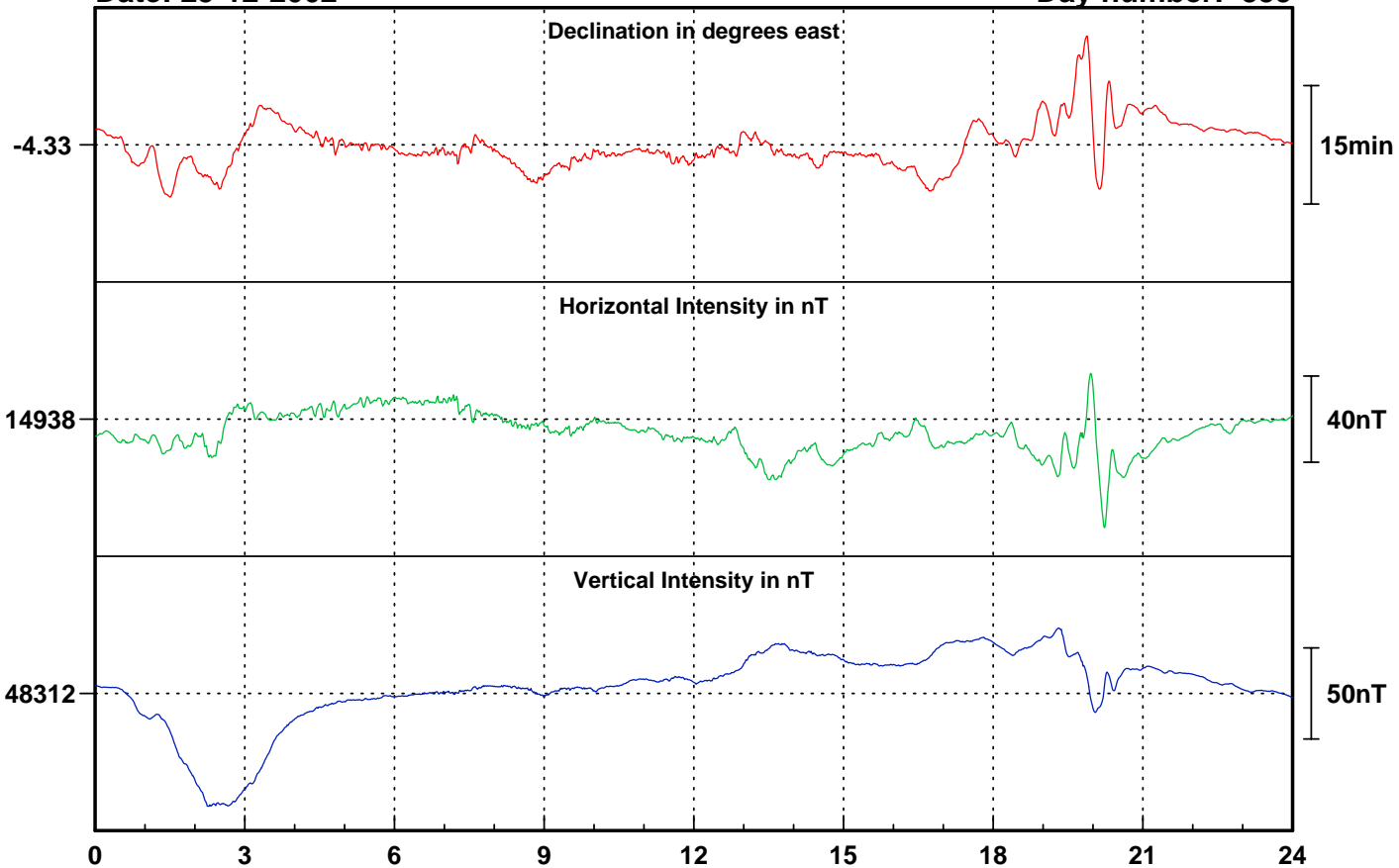
Day number: 358



Date: 25-12-2002

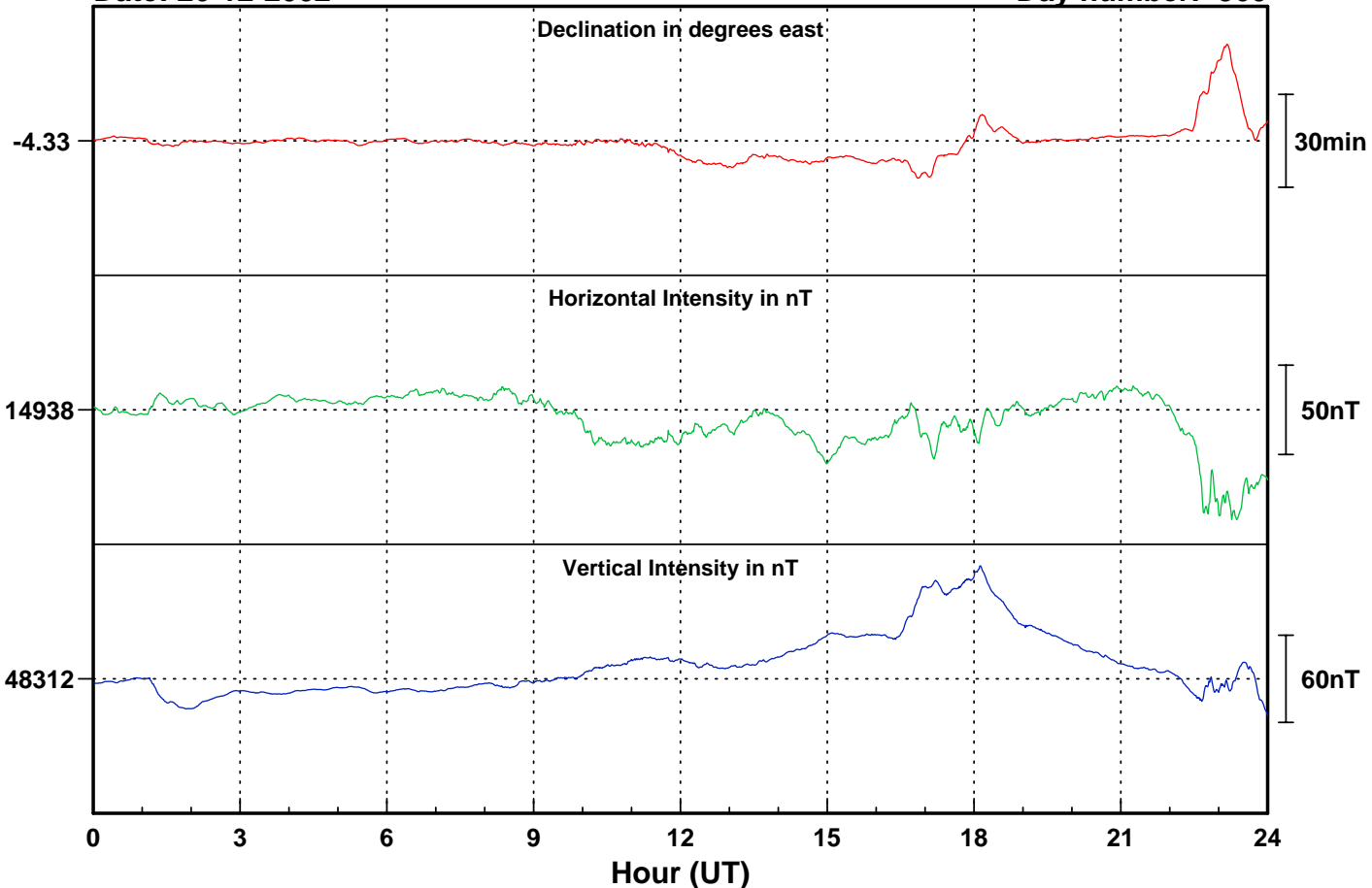
# Lerwick

Day number: 359



Date: 26-12-2002

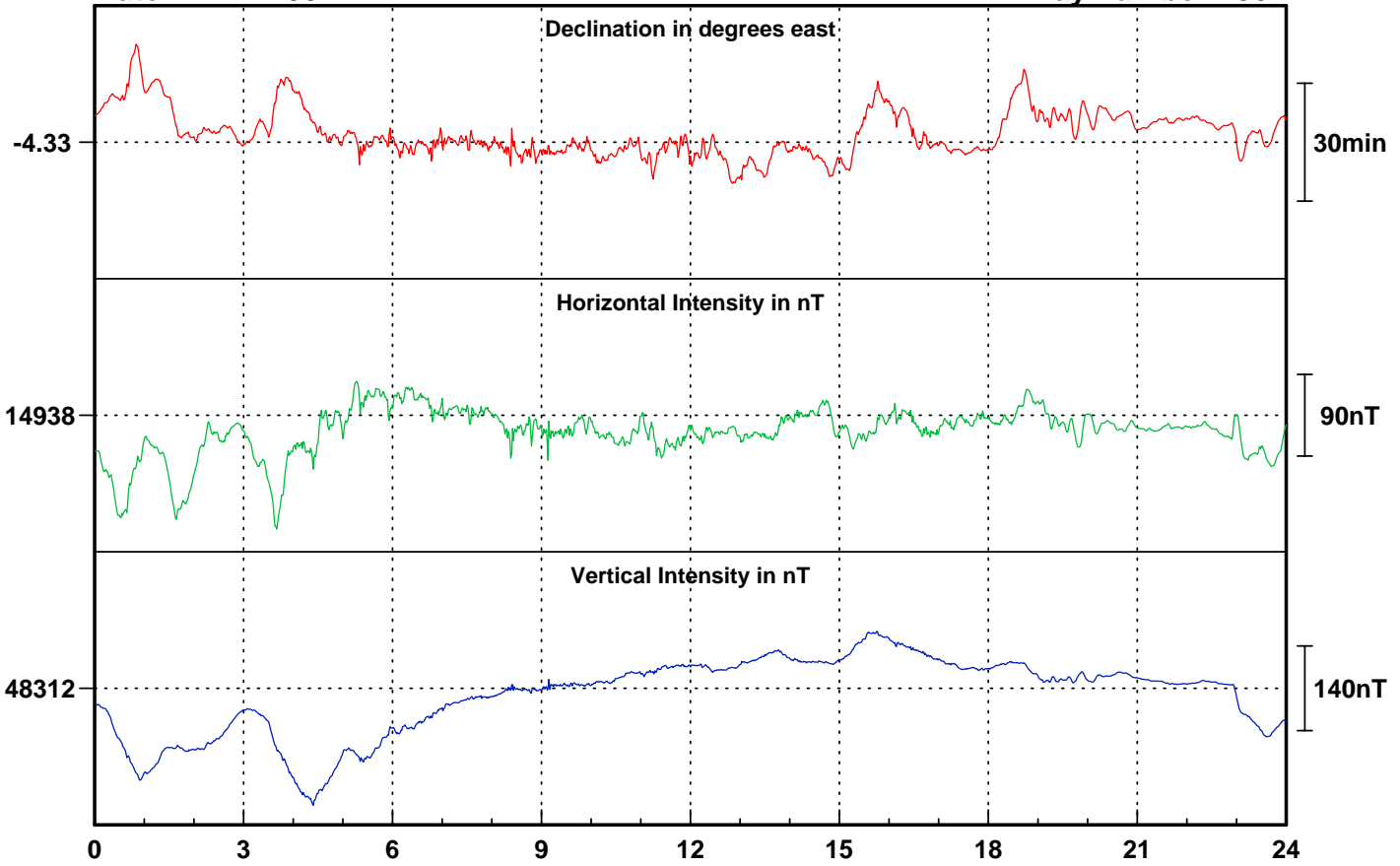
Day number: 360



Date: 27-12-2002

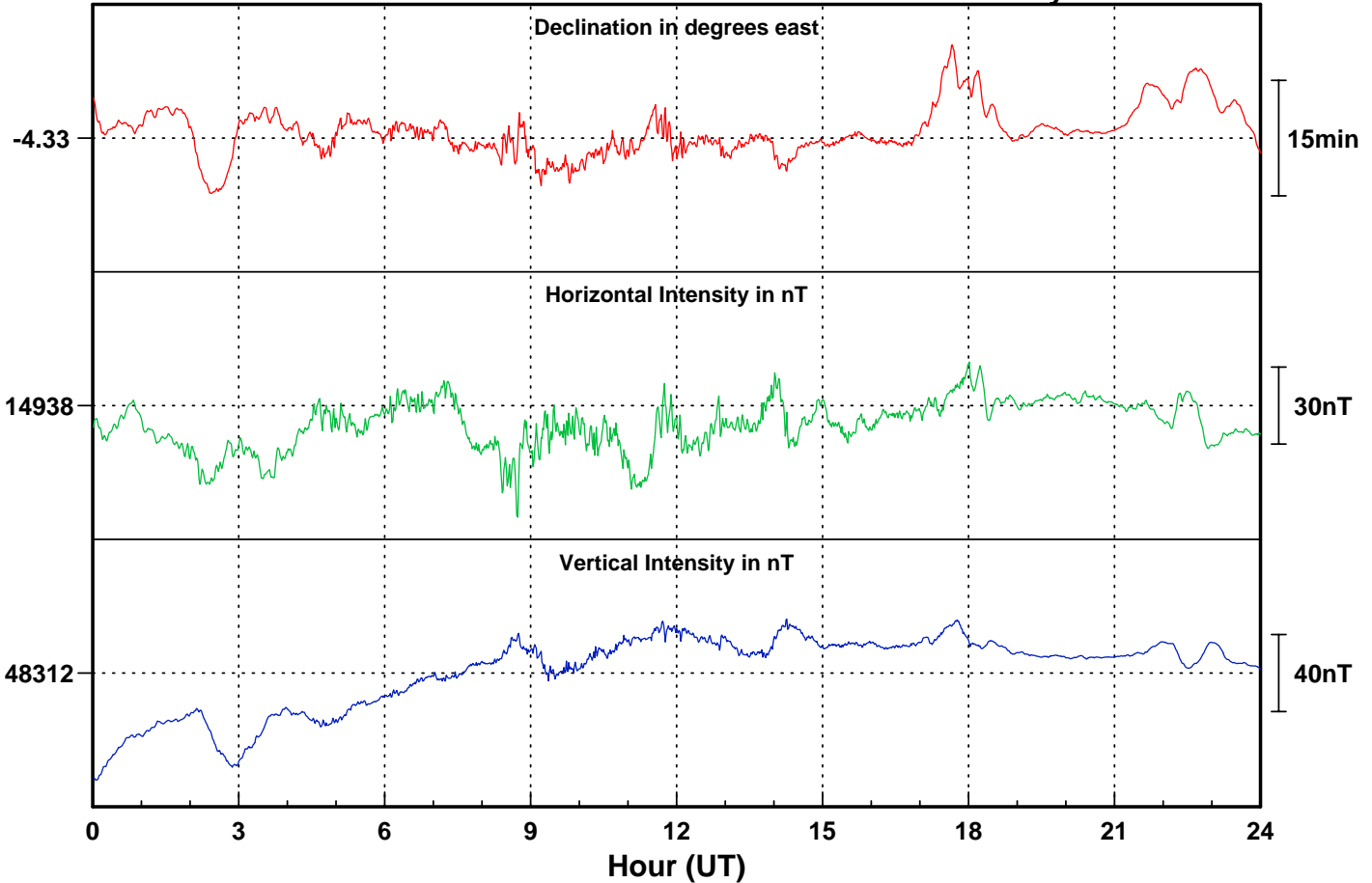
# Lerwick

Day number: 361



Date: 28-12-2002

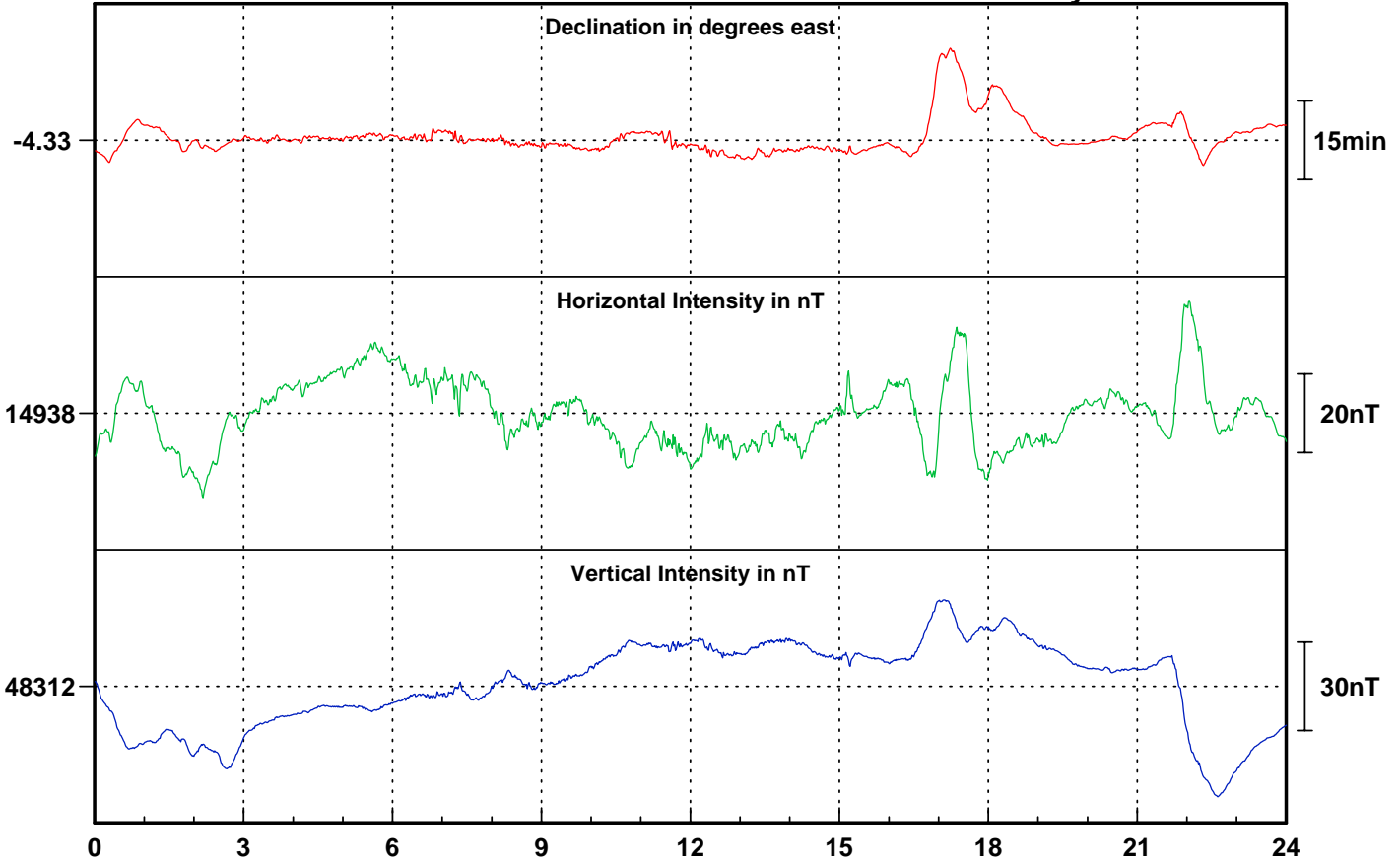
Day number: 362



Date: 29-12-2002

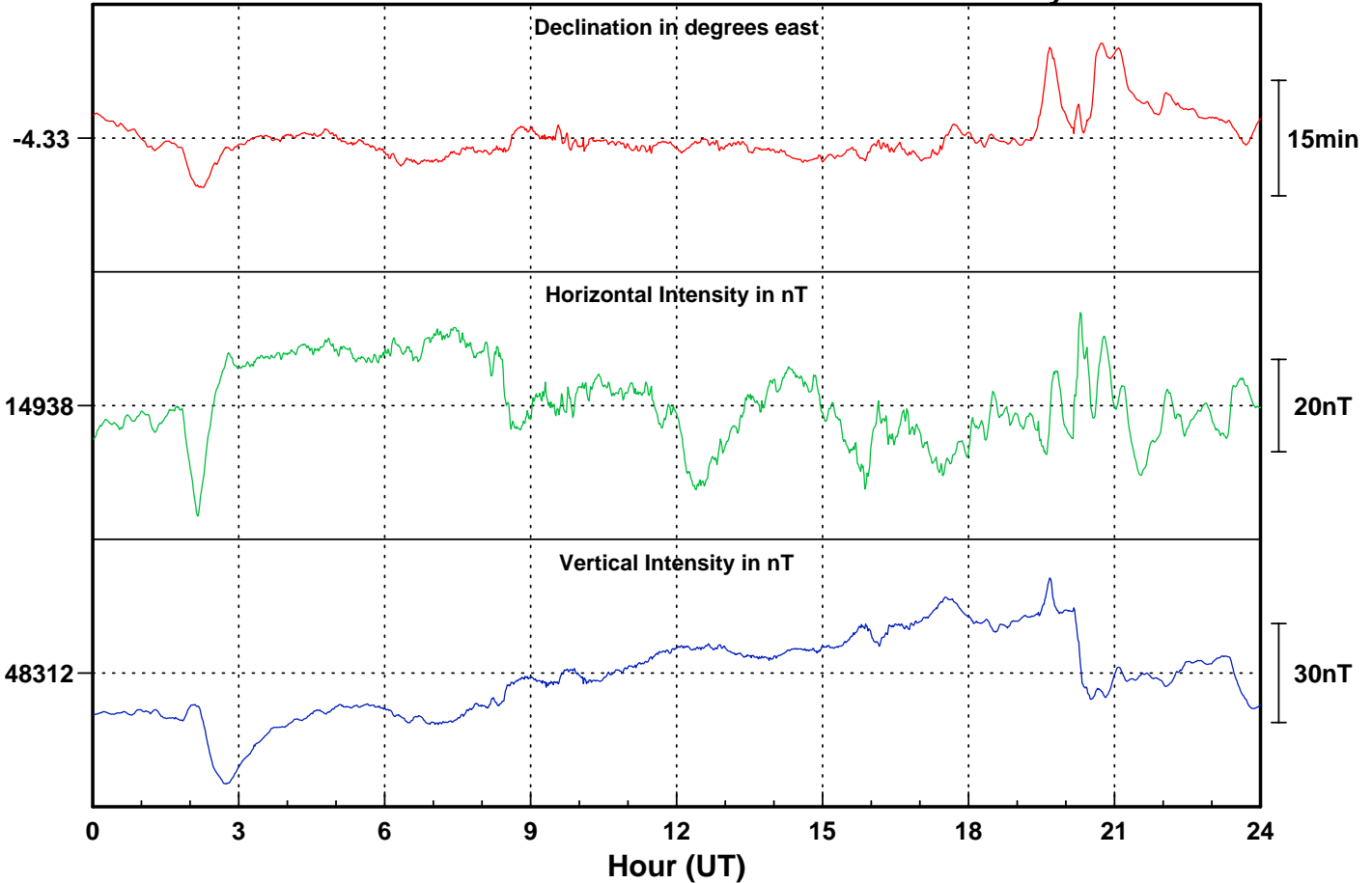
# Lerwick

Day number: 363



Date: 30-12-2002

Day number: 364

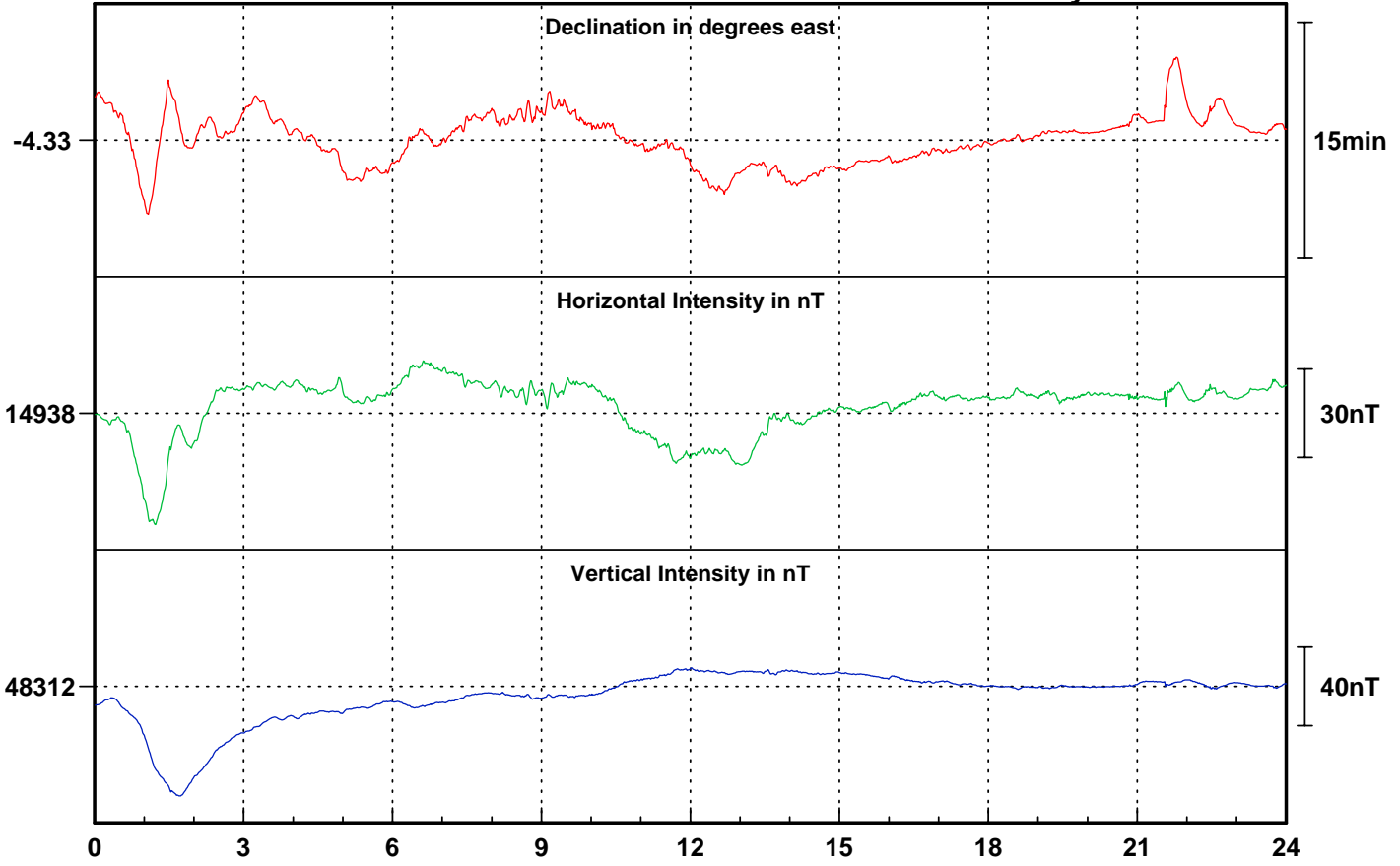


Hour (UT)

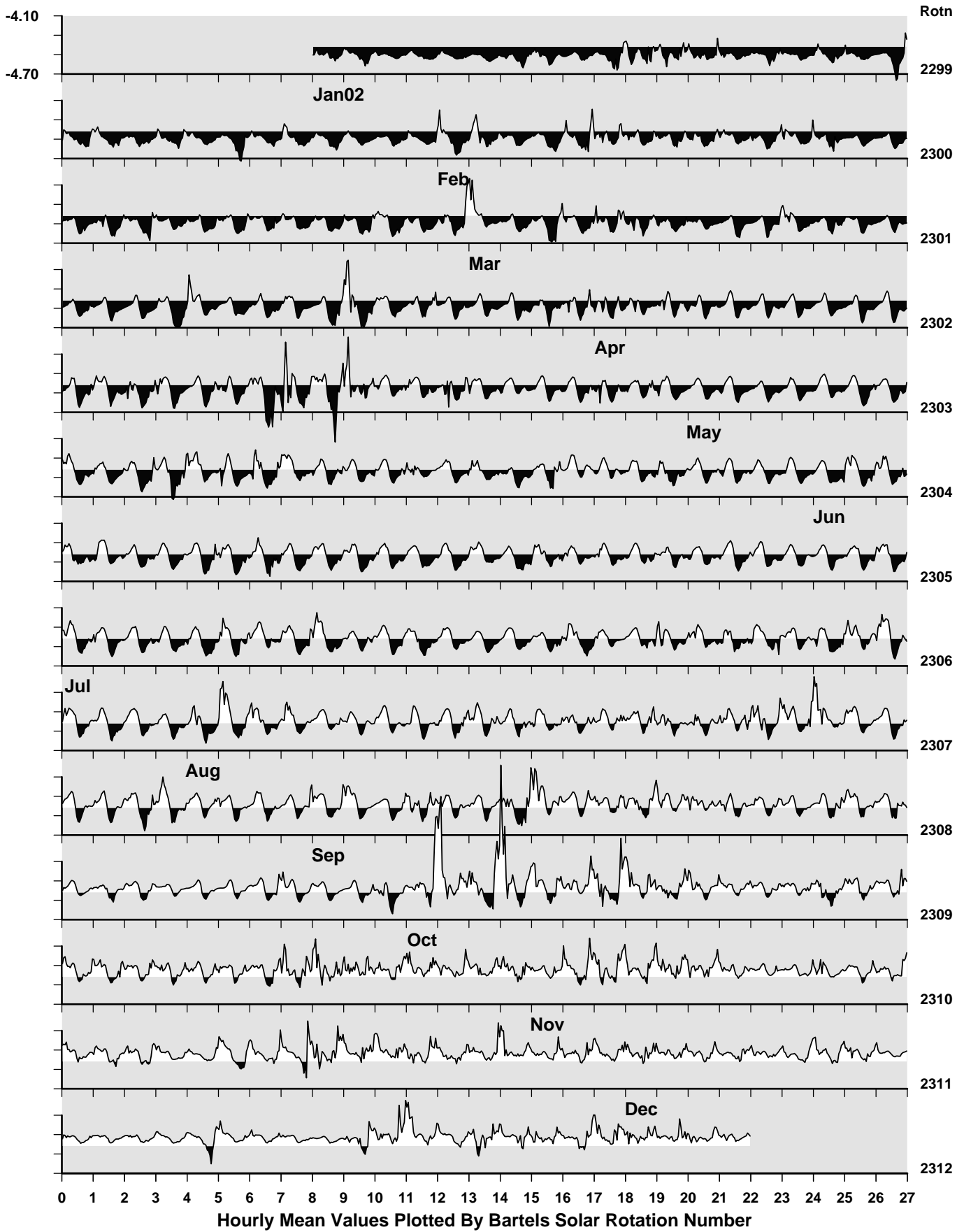
Date: 31-12-2002

# Lerwick

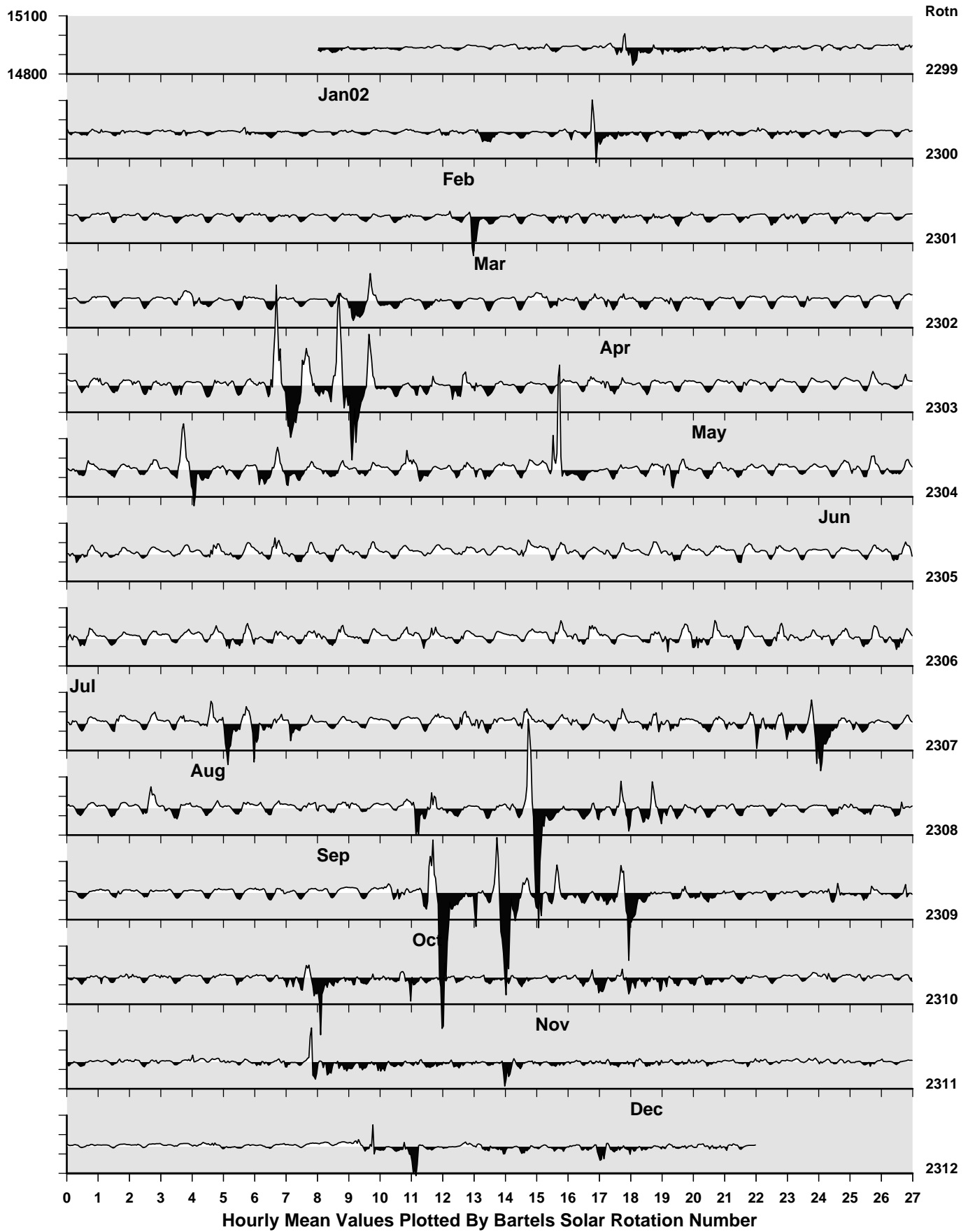
Day number: 365



# Lerwick Observatory: Declination (degrees)

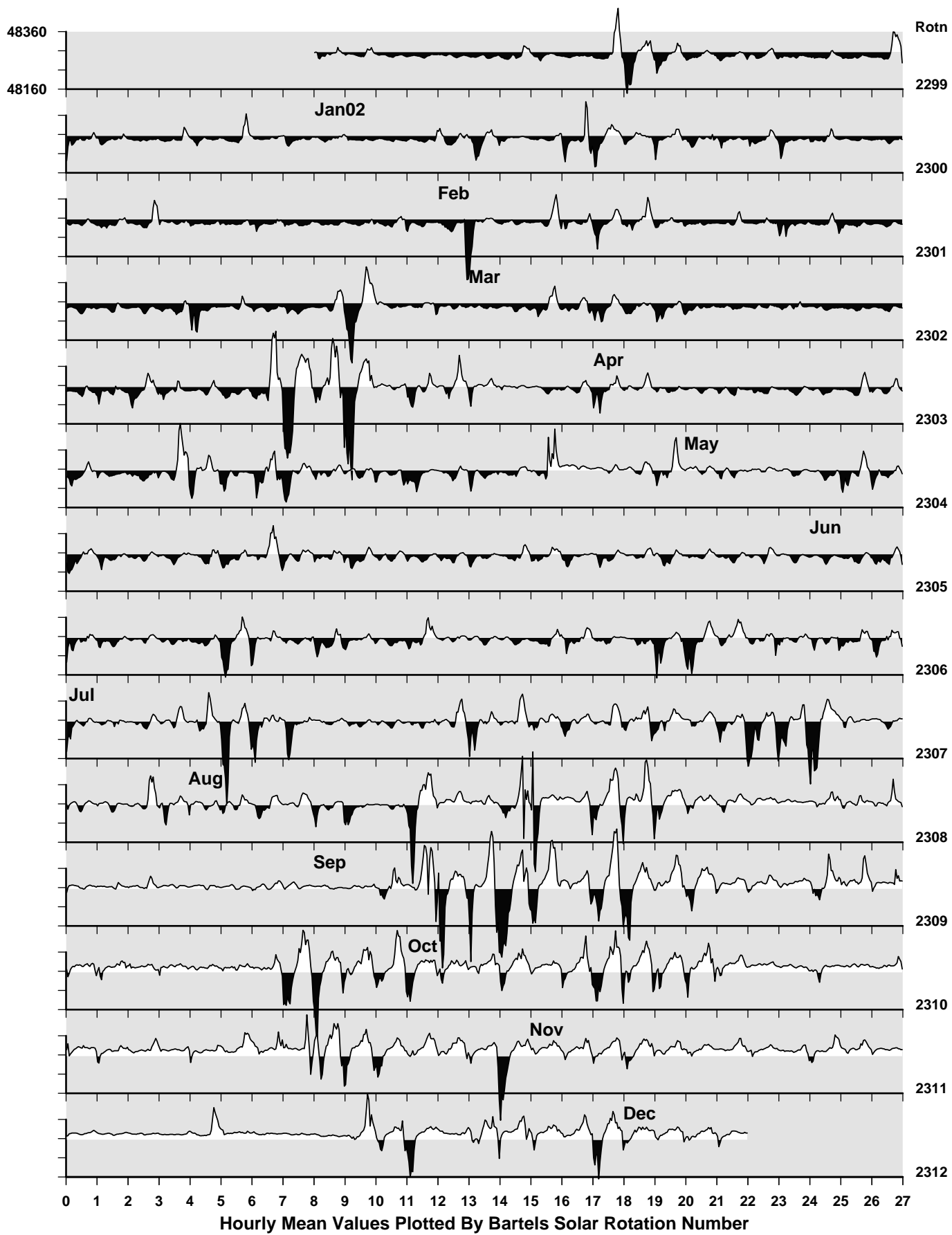


# Lerwick Observatory: Horizontal Intensity (nT)

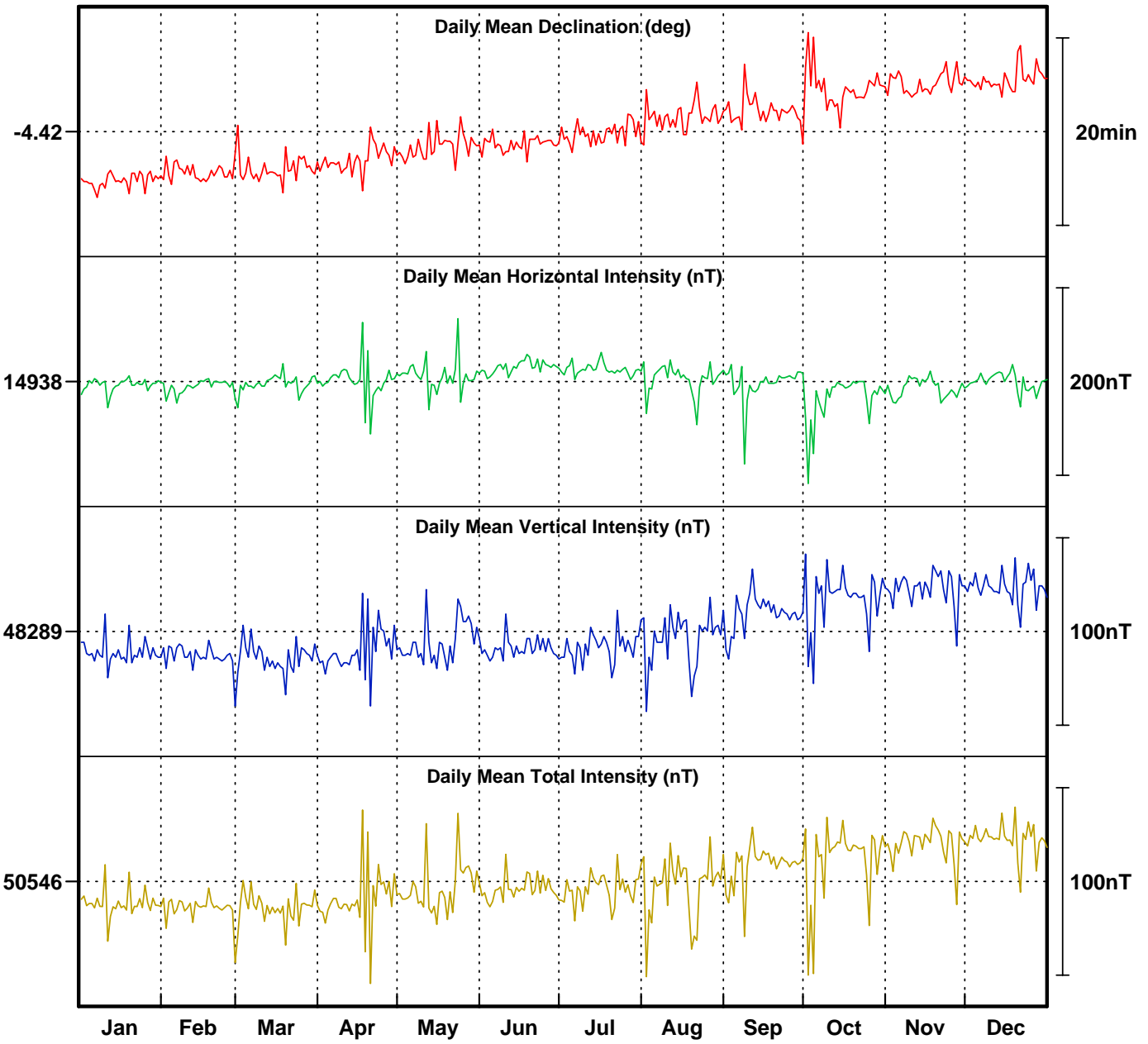




# Lerwick Observatory: Vertical Intensity (nT)



# Lerwick 2002



### Monthly Mean Values for Lerwick Observatory 2002

Month	<i>D</i>	<i>H</i>	<i>I</i>	<i>X</i>	<i>Y</i>	<i>Z</i>	<i>F</i>	Data
January	-4° 30.4′	14934 nT	72° 48.7′	14888 nT	-1173 nT	48278 nT	50535 nT	<b>P</b>
February	-4° 29.5′	14932 nT	72° 48.7′	14887 nT	-1169 nT	48275 nT	50532 nT	<b>P</b>
March	-4° 29.1′	14936 nT	72° 48.5′	14890 nT	-1168 nT	48275 nT	50533 nT	<b>P</b>
April	-4° 28.1′	14939 nT	72° 48.4′	14894 nT	-1164 nT	48278 nT	50537 nT	<b>P</b>
May	-4° 26.7′	14944 nT	72° 48.1′	14899 nT	-1158 nT	48283 nT	50543 nT	<b>P</b>
June	-4° 26.5′	14954 nT	72° 47.4′	14909 nT	-1158 nT	48280 nT	50542 nT	<b>P</b>
July	-4° 25.4′	14951 nT	72° 47.6′	14906 nT	-1153 nT	48281 nT	50543 nT	<b>P</b>
August	-4° 23.6′	14941 nT	72° 48.4′	14897 nT	-1144 nT	48285 nT	50544 nT	<b>P</b>
September	-4° 23.0′	14936 nT	72° 49.0′	14892 nT	-1142 nT	48298 nT	50555 nT	<b>P</b>
October	-4° 20.5′	14920 nT	72° 50.2′	14877 nT	-1130 nT	48306 nT	50558 nT	<b>P</b>
November	-4° 20.0′	14931 nT	72° 49.6′	14888 nT	-1128 nT	48312 nT	50566 nT	<b>P</b>
December	-4° 19.6′	14938 nT	72° 49.1′	14895 nT	-1127 nT	48312 nT	50569 nT	<b>P</b>

## INDICES OF GEOMAGNETIC ACTIVITY

Lerwick Observatory

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Day	K - INDICES FOR THREE-HOUR INTERVAL								SUM
	00-03	03-06	06-09	09-12	12-15	15-18	18-21	21-24	
1	3	2	2	2	2	3	1	3	18
2	2	1	2	1	1	3	3	3	16
3	2	2	1	1	2	1	3	2	14
4	1	1	1	1	1	3	3	2	13
5	3	2	1	1	1	1	1	1	11
6	1	1	0	1	0	2	2	3	10
7	3	2	2	2	2	2	4	3	20
8	1	3	1	1	2	3	2	3	16
9	3	0	0	0	1	1	0	0	5
10	2	0	0	0	0	0	0	1	3
11	0	0	1	1	1	0	0	0	3
12	1	0	0	0	0	0	0	1	2
13	1	0	0	0	0	0	1	1	3
14	1	1	1	1	1	4	4	3	16
15	3	1	0	1	1	1	2	1	10
16	2	0	0	1	1	0	0	2	6
17	1	0	0	0	0	0	0	0	1
18	0	0	0	0	0	0	0	0	0
19	1	2	3	2	3	3	6	2	22
20	3	2	1	1	3	2	5	5	22
21	5	6	2	1	1	3	2	3	23
22	2	1	0	1	2	1	2	1	10
23	2	2	3	2	3	2	4	4	22
24	3	0	1	2	4	4	4	3	21
25	2	2	2	1	2	2	4	1	16
26	1	1	1	1	2	3	3	4	16
27	4	5	3	3	3	4	4	3	29
28	3	2	3	3	2	3	3	3	22
29	2	1	1	1	1	4	3	3	16
30	2	1	1	1	2	1	3	3	14
31	3	2	1	1	1	0	0	2	10

Lower bound (nT) for the range for each index value at Lerwick Observatory									
K-Index									
0	1	2	3	4	5	6	7	8	9
0	10	20	40	80	140	240	400	660	1000

### The aa Index

Date	Day	K-North	K-South	(a)	(b)	(c)	(d)	(e)
01-12-03	335	4 3 2 3 3 3 3 4	3 3 2 4 3 3 2 2	36	30	35	31	33
02-12-03	336	3 2 2 2 2 4 4 3	2 2 3 4 3 3 2 2	30	28	26	33	29
03-12-03	337	2 2 2 2 3 2 3 1	2 3 2 3 3 2 2 1	19	21	20	20	20
04-12-03	338	1 1 2 1 2 4 3 3	1 2 3 2 2 3 3 2	22	21	14	29	22
05-12-03	339	3 2 2 2 2 2 2 1	2 2 3 2 2 2 2 2	17	18	20	15	18
06-12-03	340	1 2 1 2 1 3 2 3	1 2 2 3 3 3 2 3	17	23	15	25	20
07-12-03	341	4 2 3 3 3 3 4 3	3 3 4 4 4 2 3 3	36	41	40	37	39
08-12-03	342	2 4 2 1 3 3 3 3	2 4 2 1 2 3 2 2	28	23	25	26	25
09-12-03	343	3 1 1 1 2 1 1 1	2 0 1 2 2 1 0 2	12	11	12	10	11
10-12-03	344	2 1 1 1 1 1 1 2	1 2 2 1 1 1 2 2	10	12	11	11	11
11-12-03	345	0 1 1 2 1 1 0 0	1 2 3 2 1 1 1 1	7	13	13	6	10
12-12-03	346	1 1 0 1 1 1 1 1	1 1 1 1 1 2 1 1	7	9	7	9	8
13-12-03	347	1 0 0 1 1 1 1 1	1 1 0 1 1 2 2 2	6	10	6	11	8
14-12-03	348	1 1 1 2 2 4 4 3	2 2 2 3 2 3 3 3	25	24	15	35	25
15-12-03	349	3 1 1 1 2 1 2 1	2 2 2 1 3 2 2 2	13	17	14	16	15
16-12-03	350	2 1 1 2 2 1 1 2	2 1 2 1 2 1 1 2	12	12	12	12	12
17-12-03	351	1 1 0 0 0 1 0 1	2 1 1 0 1 1 1 1	5	8	7	6	7
18-12-03	352	1 0 1 0 2 1 0 1	1 2 2 1 2 1 2 2	7	13	9	11	10
19-12-03	353	3 4 4 4 4 4 5 2	3 4 4 5 4 4 3 3	55	55	58	52	55
20-12-03	354	3 3 2 2 3 3 5 5	2 3 2 2 3 3 4 3	45	30	22	53	37
21-12-03	355	4 4 2 2 2 3 2 2	4 5 3 2 2 3 2 2	28	37	45	20	33
22-12-03	356	2 1 0 2 3 2 4 3	2 1 1 3 4 3 4 3	22	31	13	40	27
23-12-03	357	3 2 3 3 4 3 4 3	2 3 4 4 4 3 4 4	36	47	35	49	42
24-12-03	358	3 1 2 2 4 4 5 3	2 1 2 3 4 3 3 3	40	29	18	51	34
25-12-03	359	3 2 2 2 3 3 4 2	3 2 2 2 4 2 2 2	27	24	20	31	25
26-12-03	360	2 1 1 2 3 3 4 5	1 2 3 4 3 4 2 5	34	41	20	54	37
27-12-03	361	5 5 4 3 4 4 4 4	4 5 4 4 4 3 2 2	66	51	72	45	58
28-12-03	362	3 3 3 3 3 3 3 3	2 3 3 4 3 2 1 1	32	26	34	24	29
29-12-03	363	3 2 2 2 3 4 3 3	2 2 3 3 2 2 1 2	29	19	22	26	24
30-12-03	364	3 1 2 1 3 2 4 3	1 1 3 2 2 2 1 2	25	15	16	24	20
31-12-03	365	3 2 1 1 1 0 0 2	1 2 2 1 1 0 0 2	11	10	14	7	11
Monthly mean value =				24.4				

- (a) The northern daily mean value,  $Aa_n$
- (b) The southern daily mean value,  $Aa_s$
- (c) The mean value of aa for the interval 00-12 UT
- (d) The mean value of aa for the interval 12-24 UT
- (e) The daily mean value of aa ( $Aa$ )

Notes

- i. The values are rounded to the nearest integer.
- ii. The units of the aa index are nT.
- iii. The values shown here are provisional. The definitive values are computed and published by the International Service for Geomagnetic Indices, Paris

## LERWICK RAPID VARIATIONS

### SI and SSCs

Date	Time (UT)	Type	Quality	H (nT)	D (min)	Z (nT)
06-12-02	06:47	SSC*	B	4	-1.75	-
22-12-02	10:28	SSC*	B	-9.3	-1.36	-1.9
31-12-02	21:31	SI*	B	-5.10	0.96	-2.20

### SFEs

Date	Start (UT)	Maximum (UT)	End (UT)	H (nT)	D (min)	Z (nT)
NONE						

### Notes

- i. For SIs and SSCs a \* indicates that the principal impulse was preceded by a smaller reversed impulse.
- ii. The quality of SIs and SSCs are classified as follows:  
A = very distinct  
B = fair, ordinary, but unmistakable  
C = doubtful
- iii. The amplitudes given are for the first chief movement of the event.