

BRITISH GEOLOGICAL SURVEY

Lerwick Observatory

Monthly Magnetic Bulletin

April 2006

06/04/LE



SHETLAND
ISLANDS



British
Geological Survey

NATURAL ENVIRONMENT RESEARCH COUNCIL

1. LERWICK OBSERVATORY MAGNETIC DATA

1.1 Introduction

This bulletin is published to meet the needs of both 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.

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Scotland, UK

Tel: +44 (0) 131 667 1000
Fax: +44 (0) 131 668 4368
E-mail: orba@bgs.ac.uk
Internet: 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°0.3'N 88°3.1'E
Height above mean sea level: 85 m

The geomagnetic co-ordinates are calculated using the 10th generation International Geomagnetic Reference Field at epoch 2006.5.

1.3 The Observatory Operation

1.3.1 GDAS

The observatory operates under the control of the Geomagnetic Data Acquisition System (GDAS), which was developed by BGS staff, installed in 2002, and became fully operational in January 2003. The system operates under the control of data acquisition software running on QNX computers, which control the data logging and communications.

There are two sets of sensors used for making magnetic measurements. A tri-axial linear-core fluxgate magnetometer, manufactured by the Danish Meteorological Institute, 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.

In addition to the fluxgate sensors there is a proton precession magnetometer making measurements of the absolute total field intensity (*F*) at a rate of 0.1Hz.

The raw unfiltered data are retrieved automatically via Internet connections to the BGS office in Edinburgh in near real-time. The fluxgate data are filtered to produce one-minute values using a 61-point cosine filter whilst the total field intensity samples are filtered using a 7-point cosine filter. These one-minute values 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 Systems

There are two other fully independent identical systems, GDAS 2 and GDAS 3, operating at the observatory. The data from these are also processed in near real-time and used for quality control purposes. They can also be used to fill any gaps or replace any corrupt values in the primary system, GDAS 1.

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 16 days a page and show the variations in *D*, *H* and *Z*. The scales are shown on the right-hand side of the page. On disturbed days the scales are multiplied by a factor, 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 daily magnetograms are plotted using one-minute values of D , H and Z from the fluxgate sensors, with any gaps filled using 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 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 dayside 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.

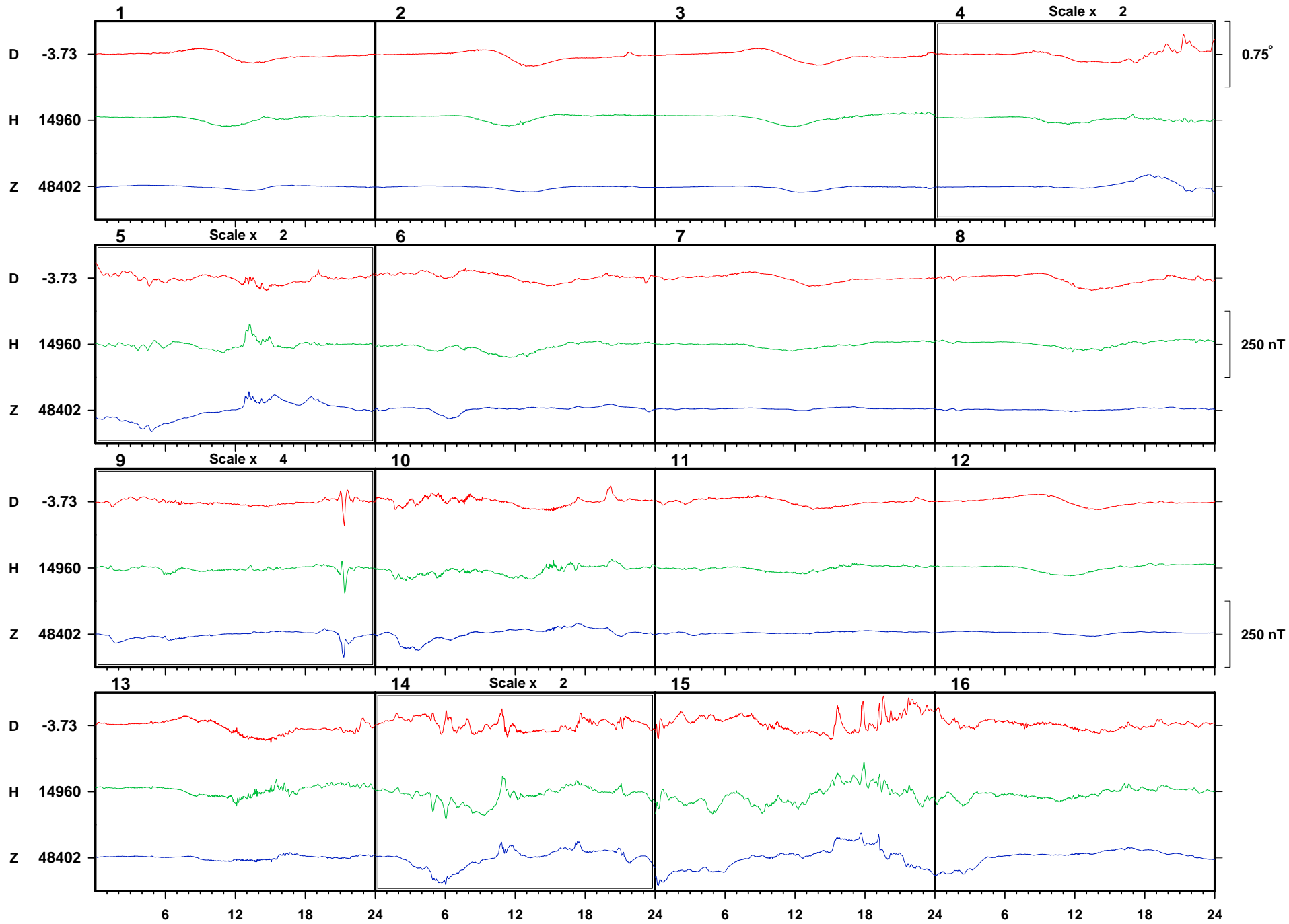
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Licence Number: 100017897/2006**

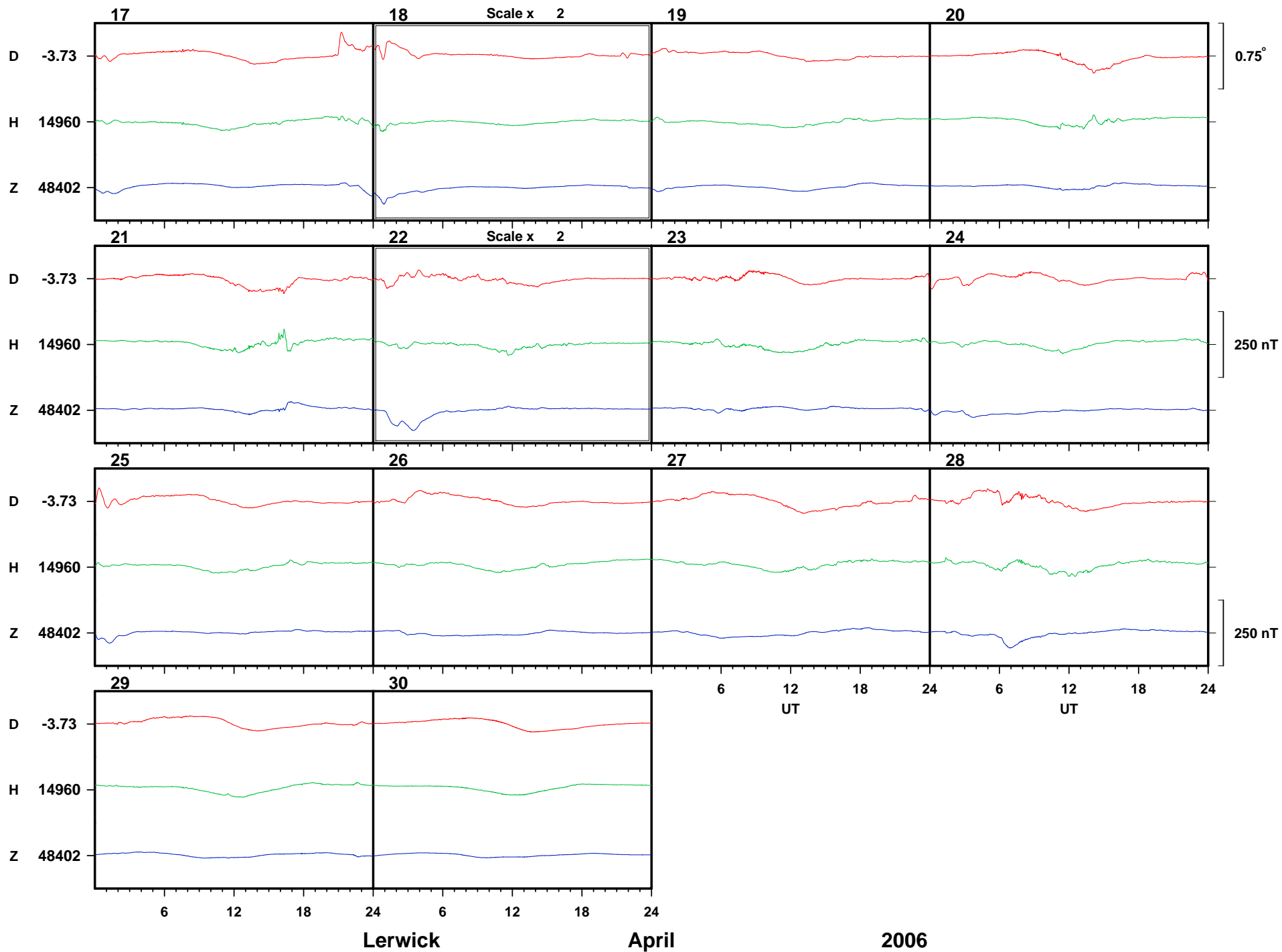
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Lerwick

April

2006





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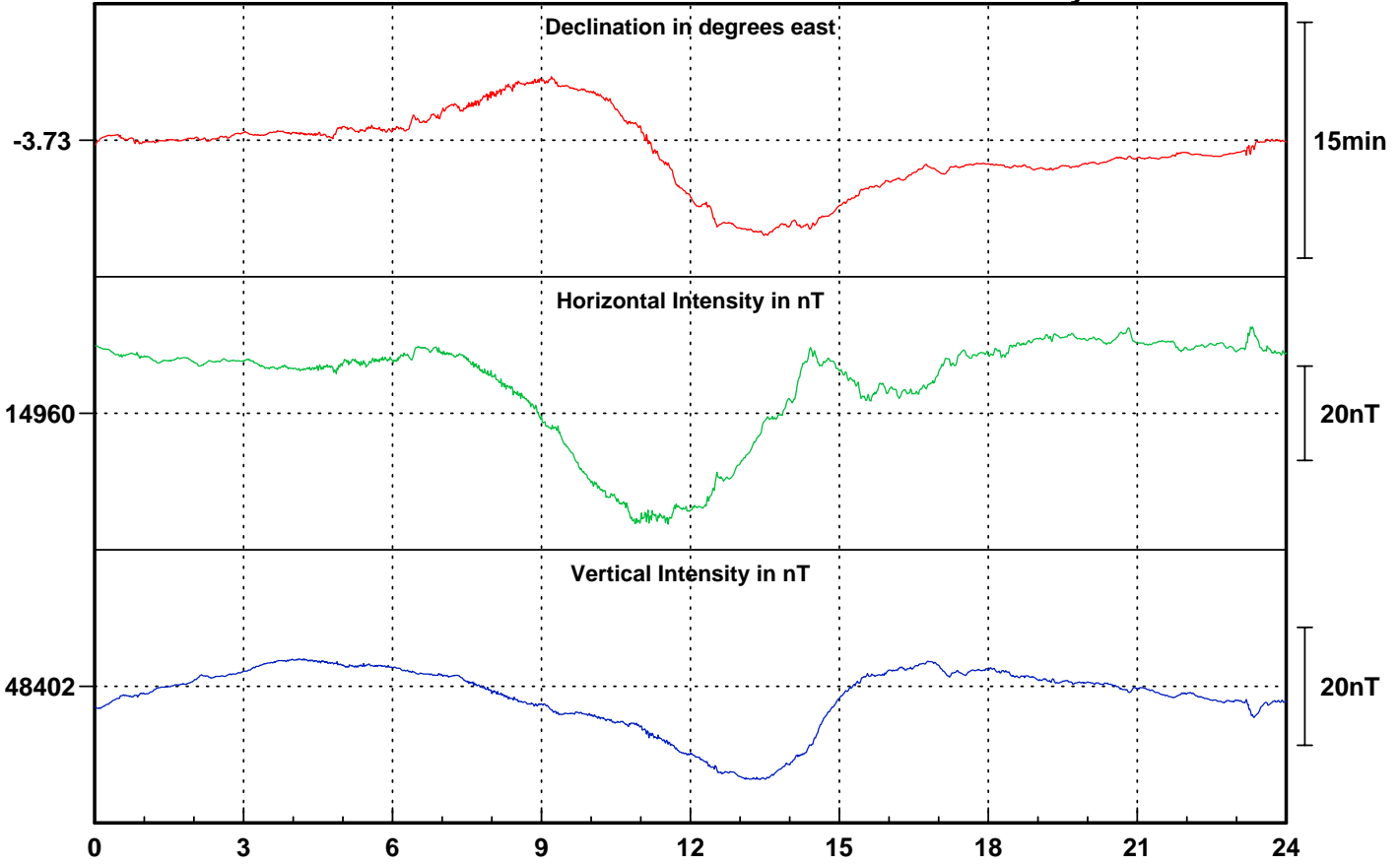
April

2006

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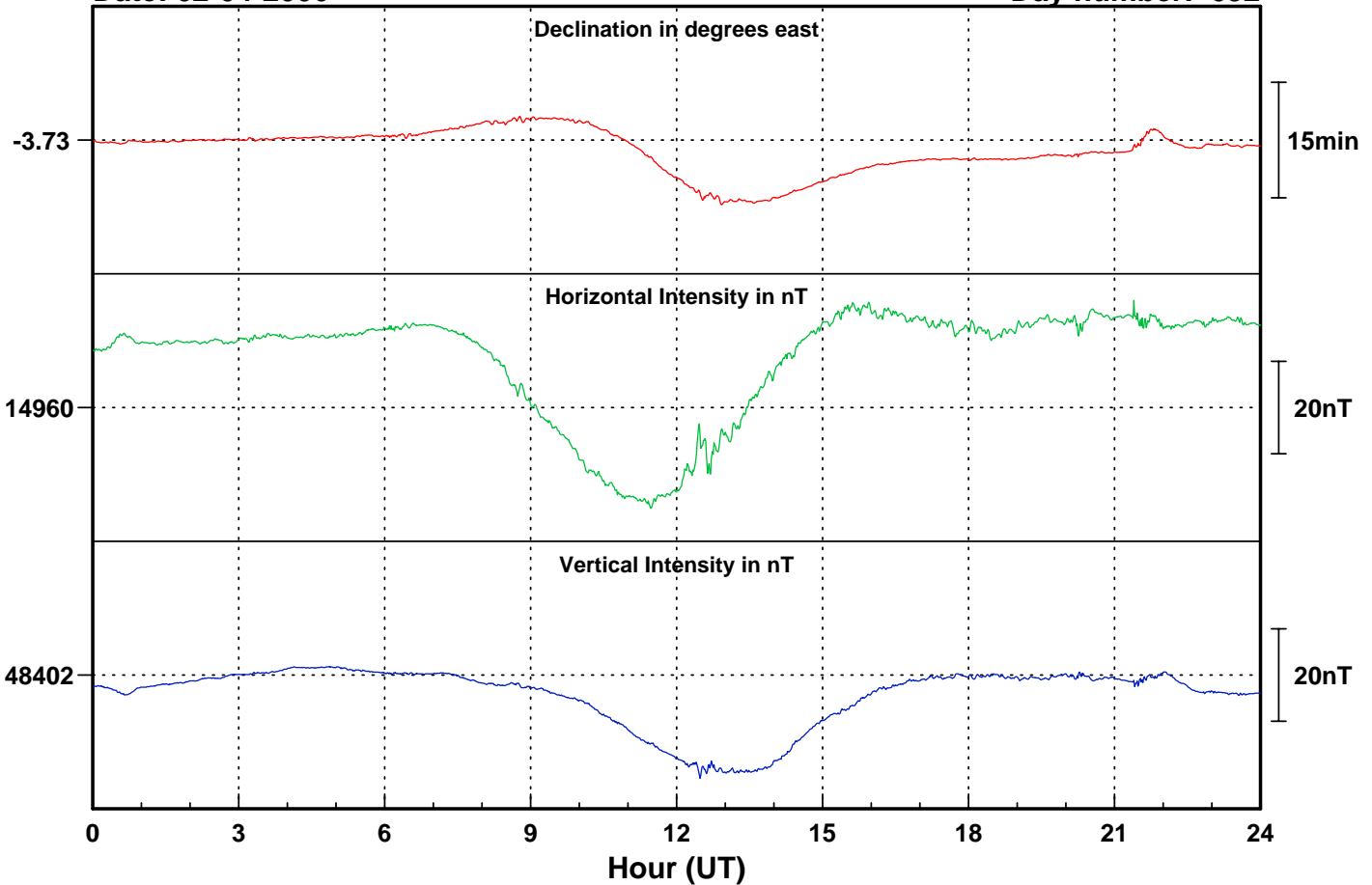
Lerwick

Day number: 091



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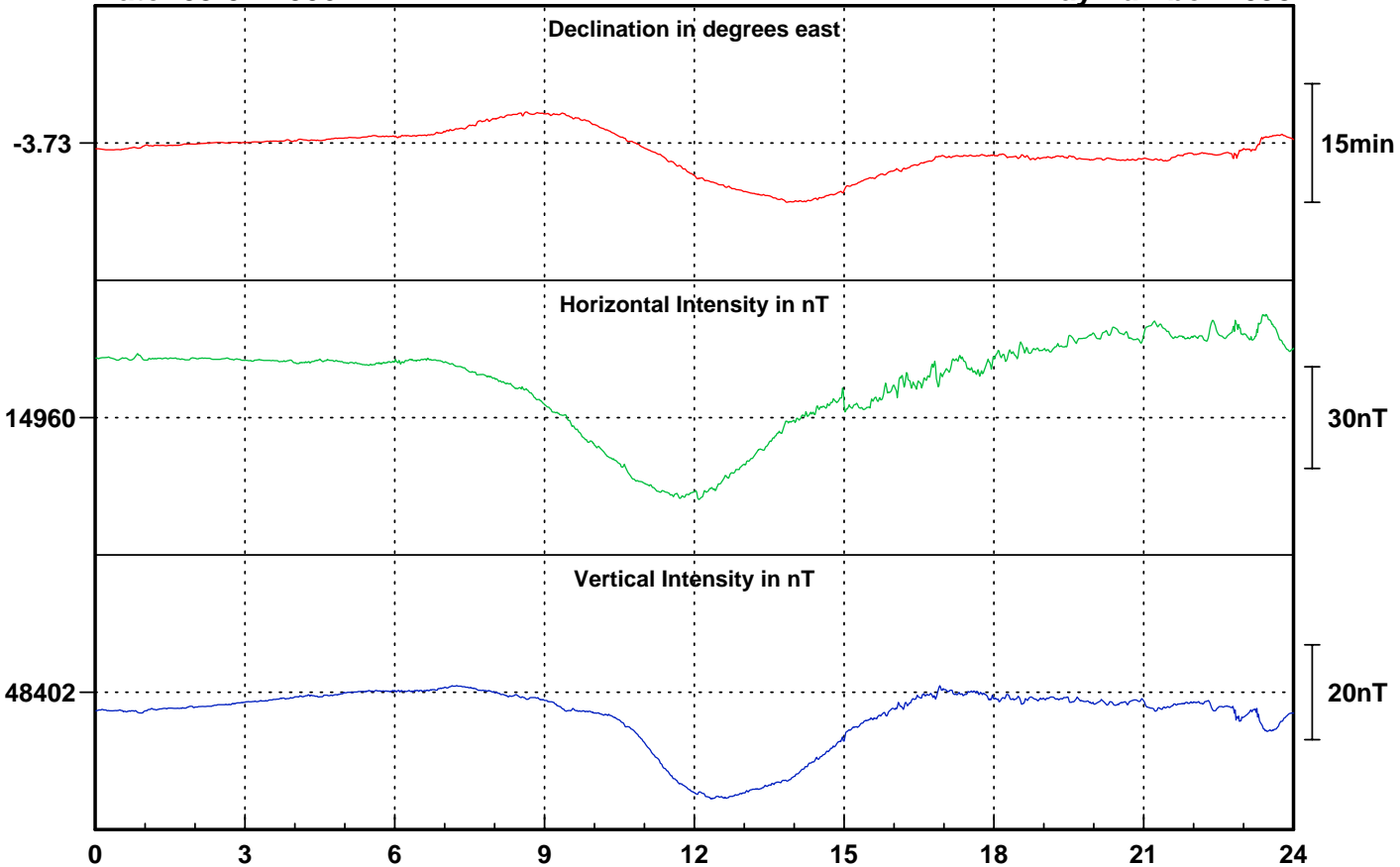
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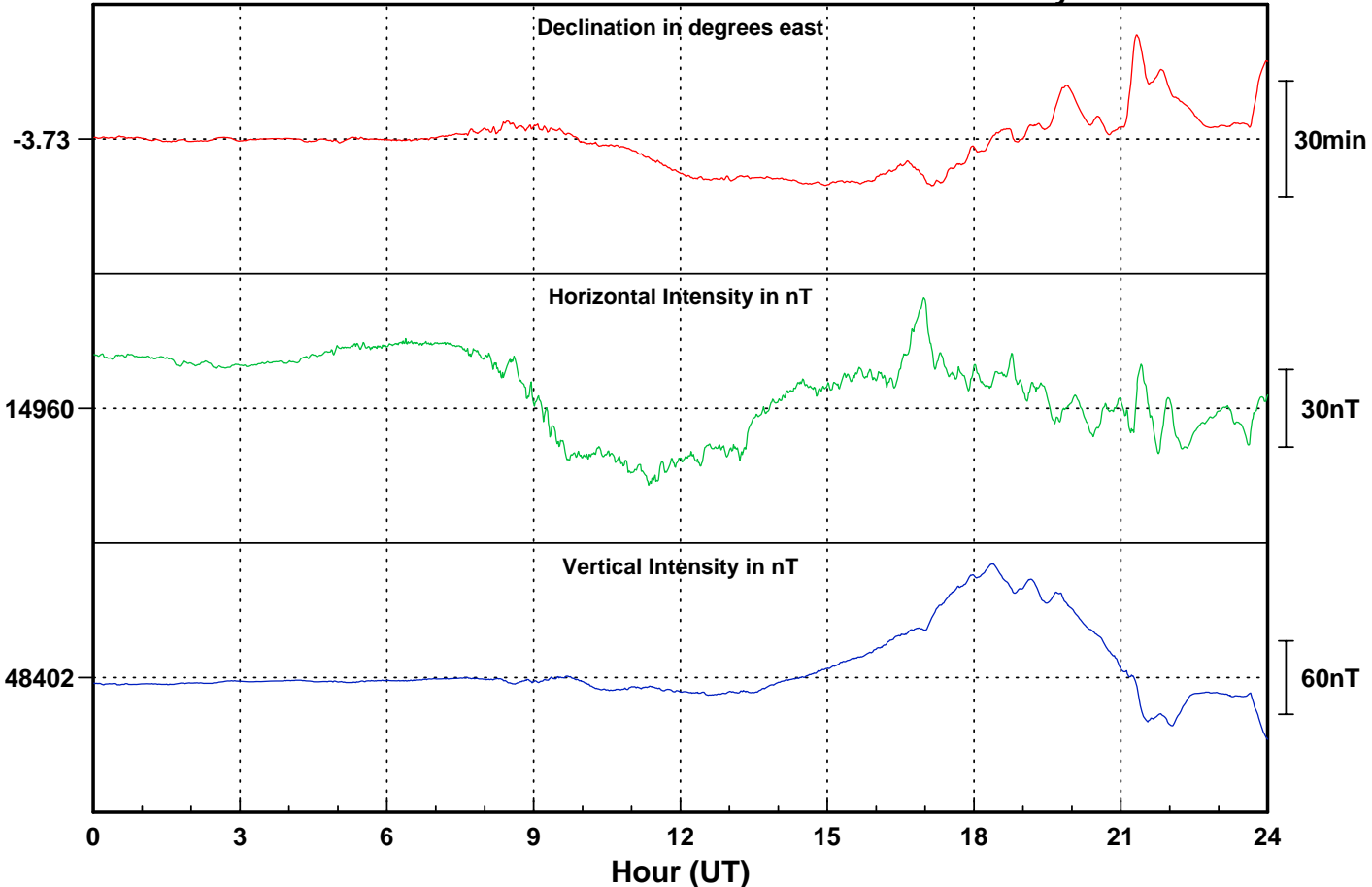
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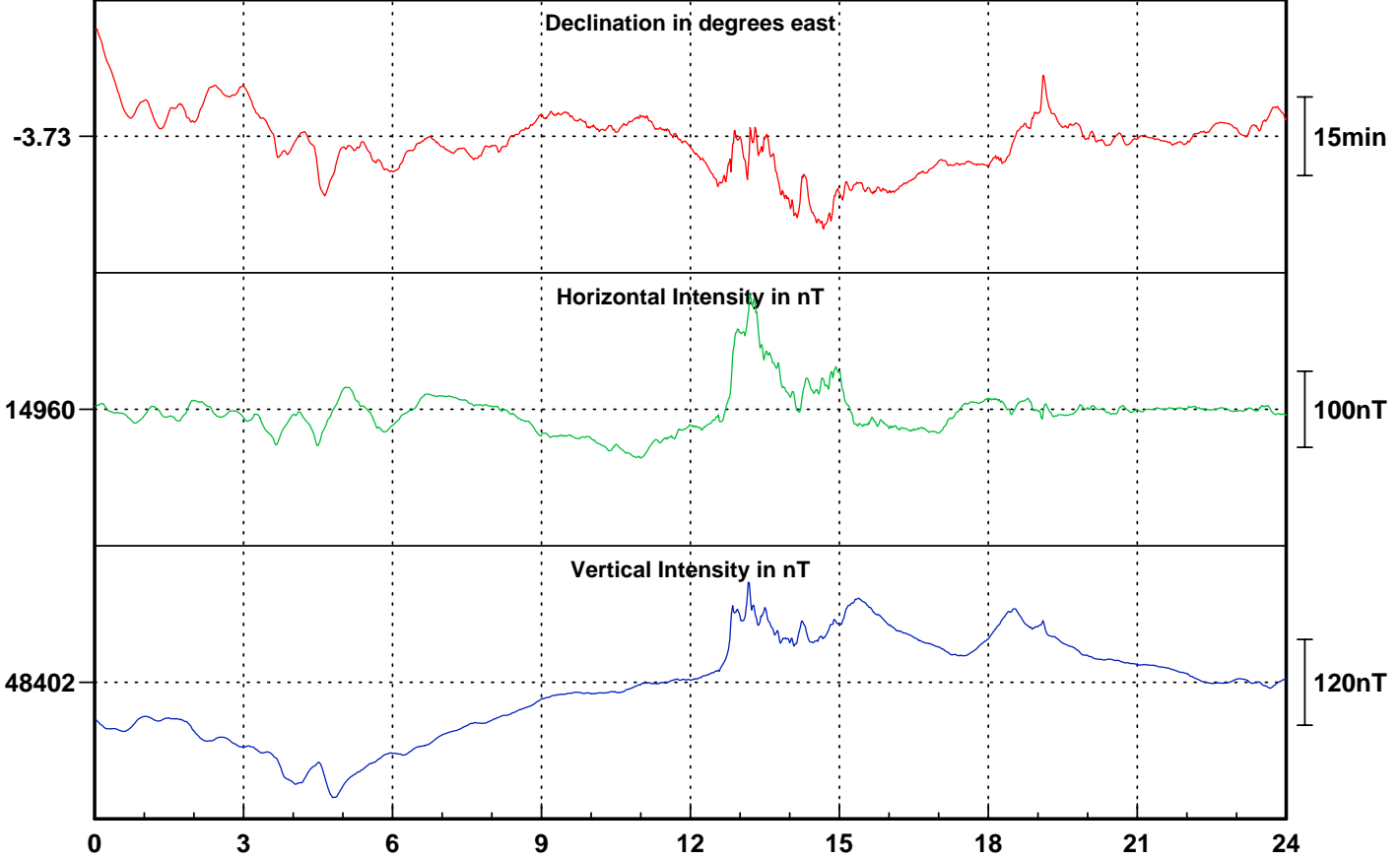
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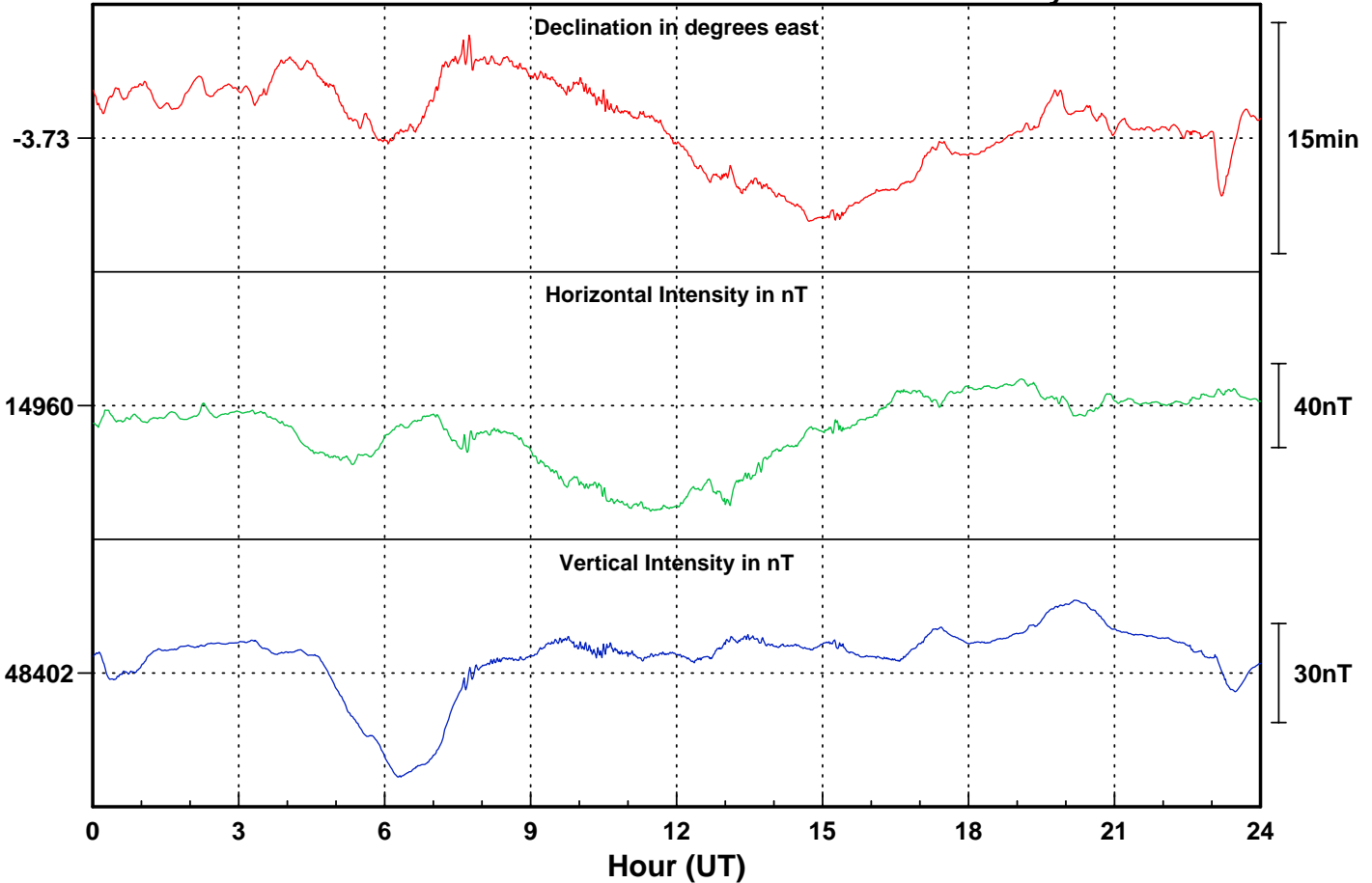
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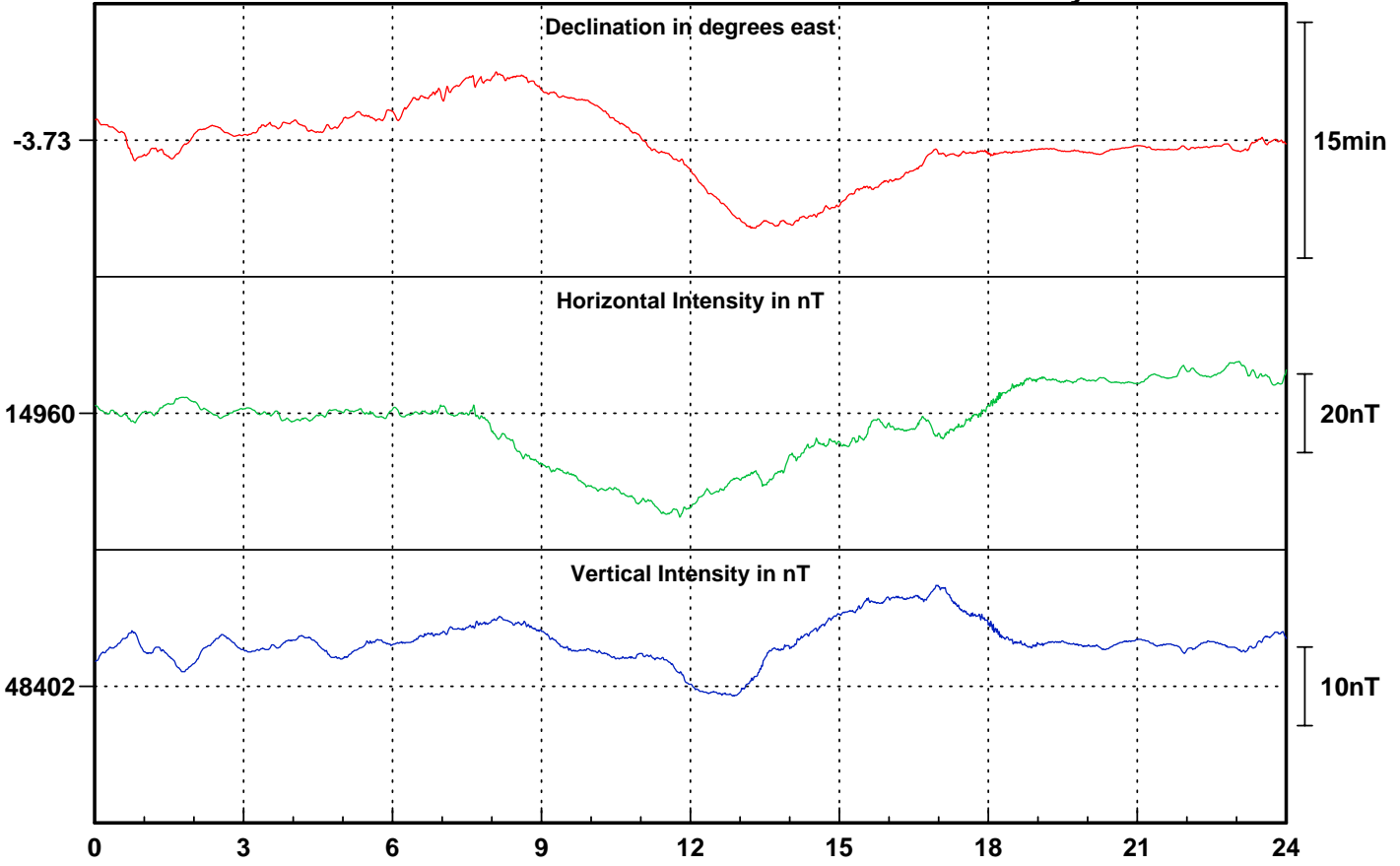
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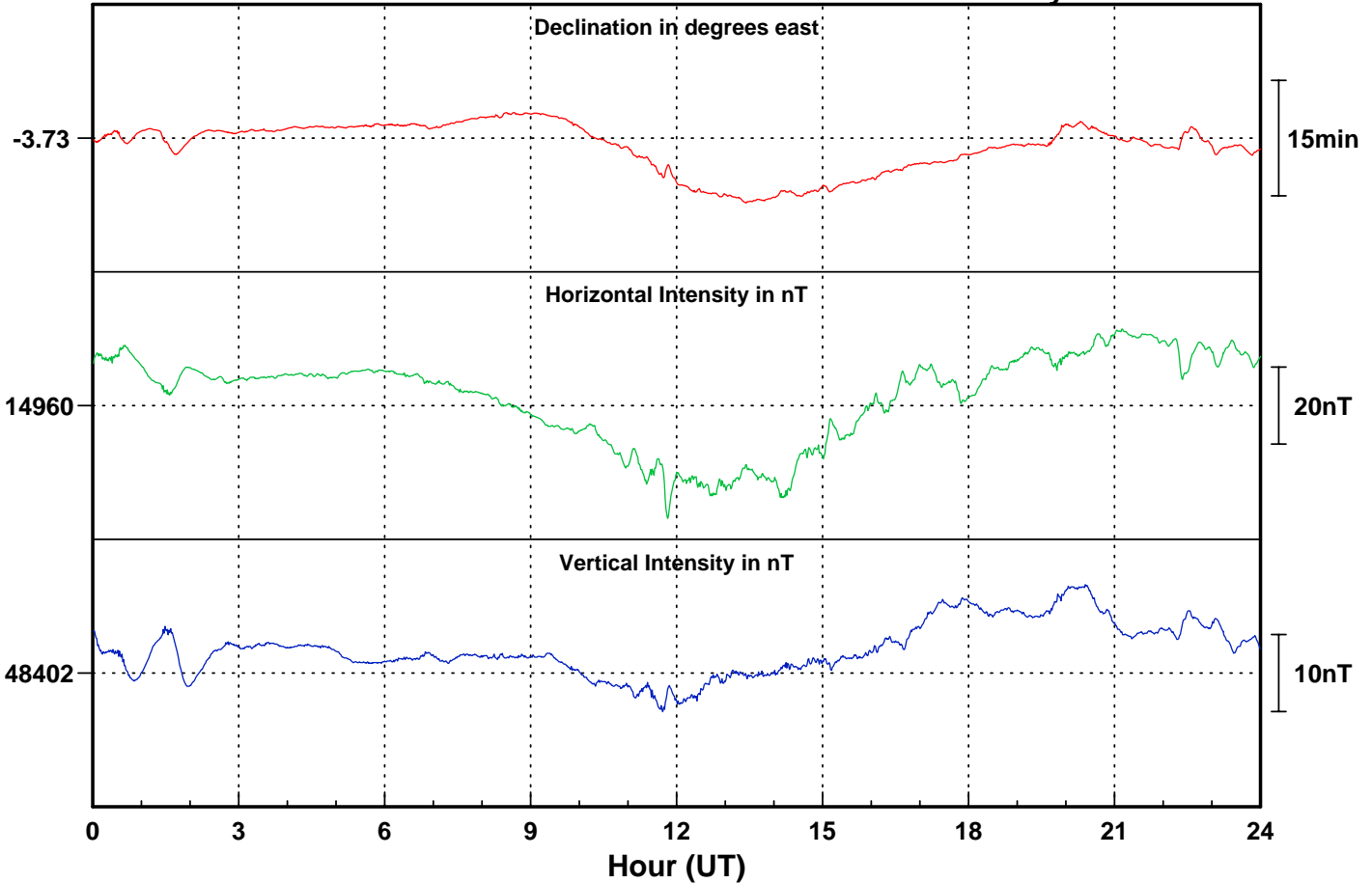
Lerwick

Day number: 097



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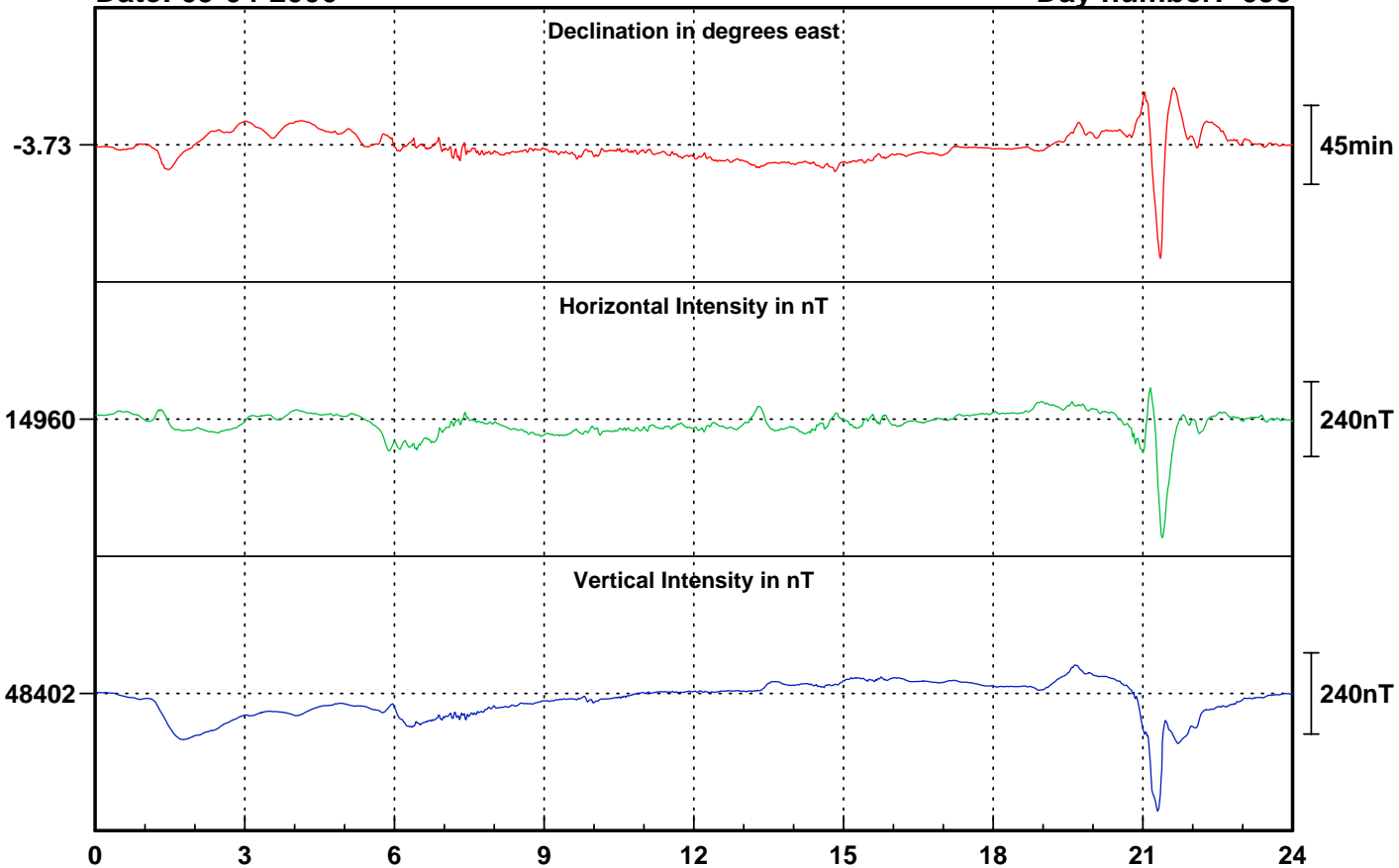
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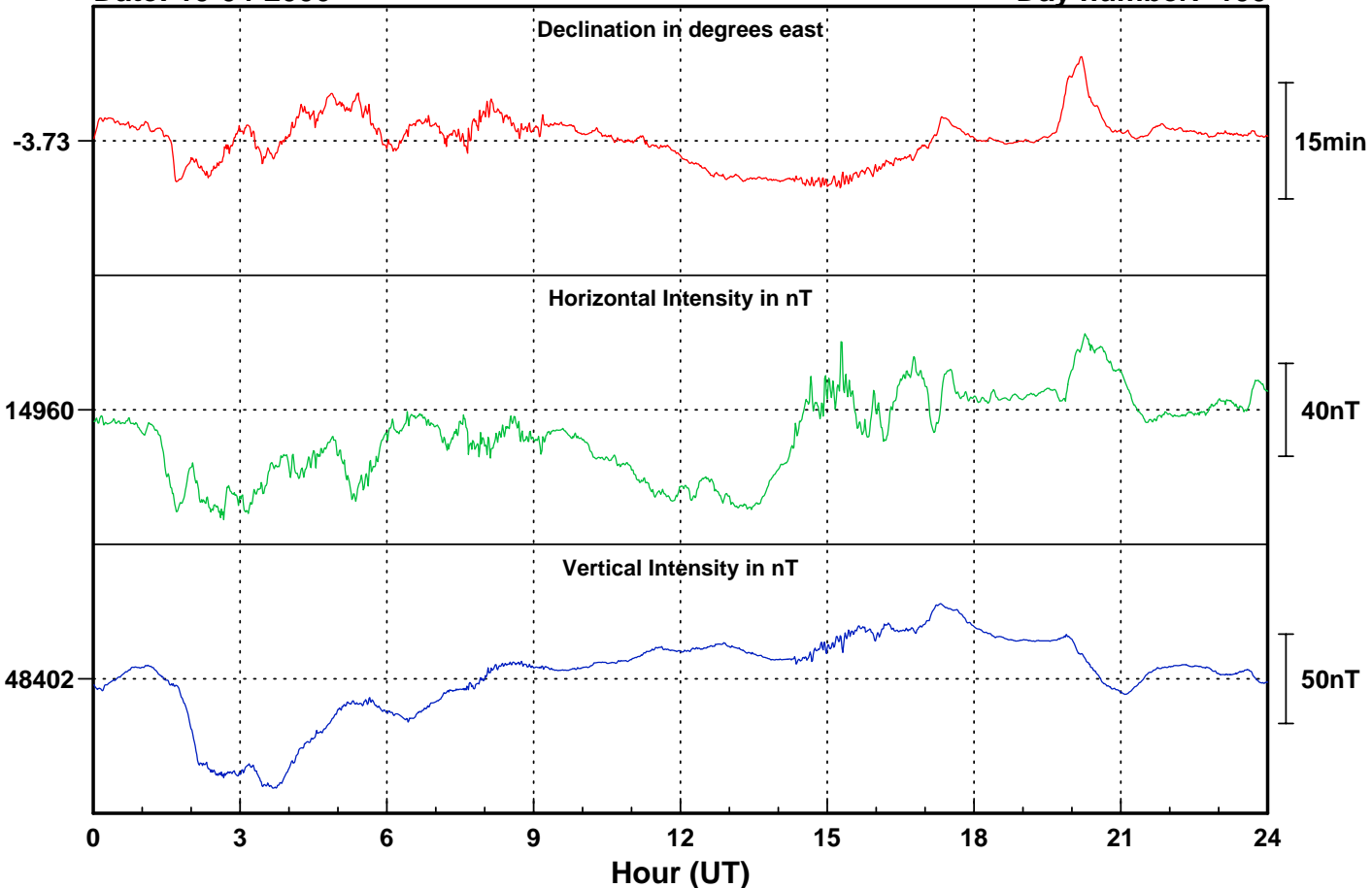
Lerwick

Day number: 099



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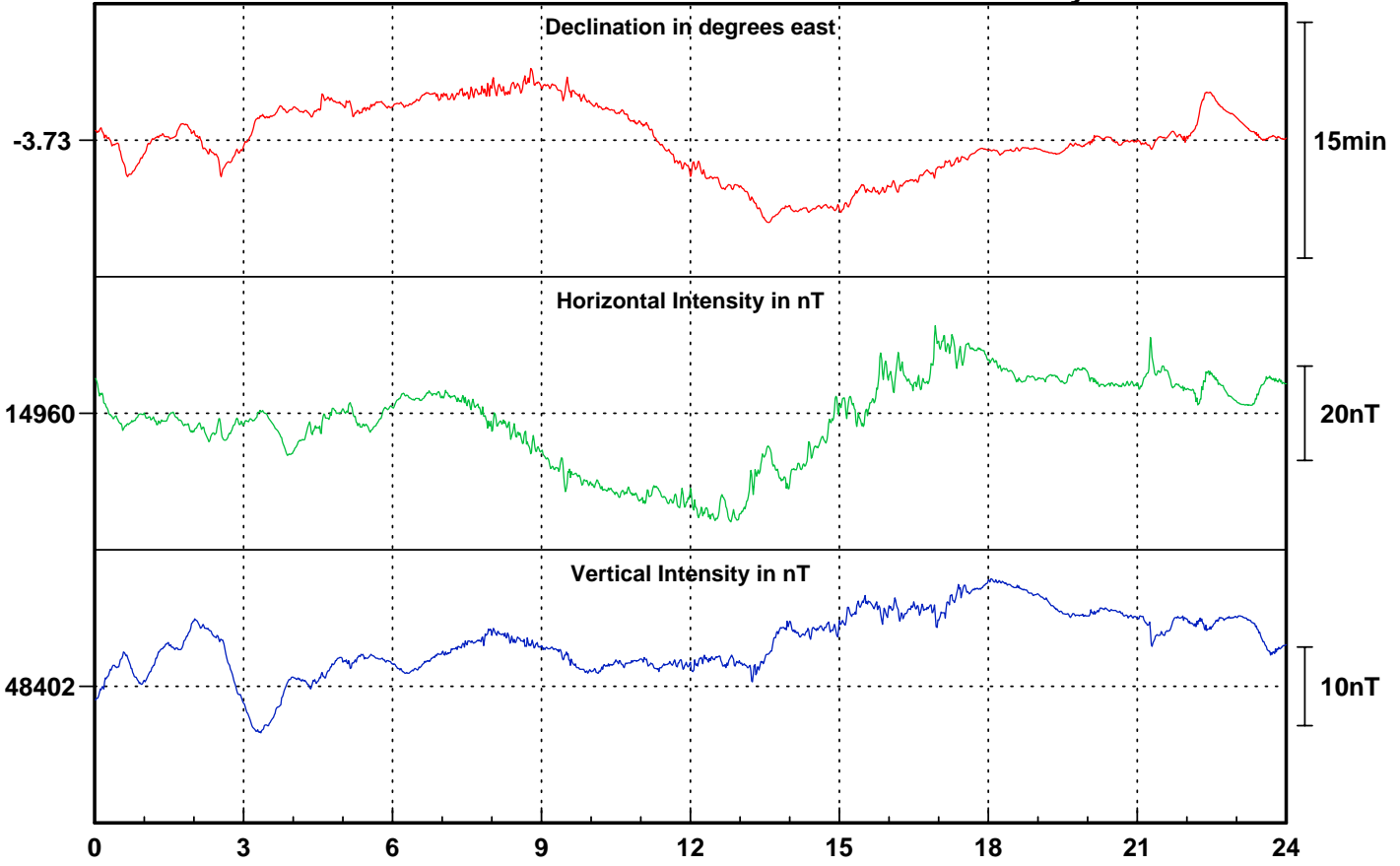
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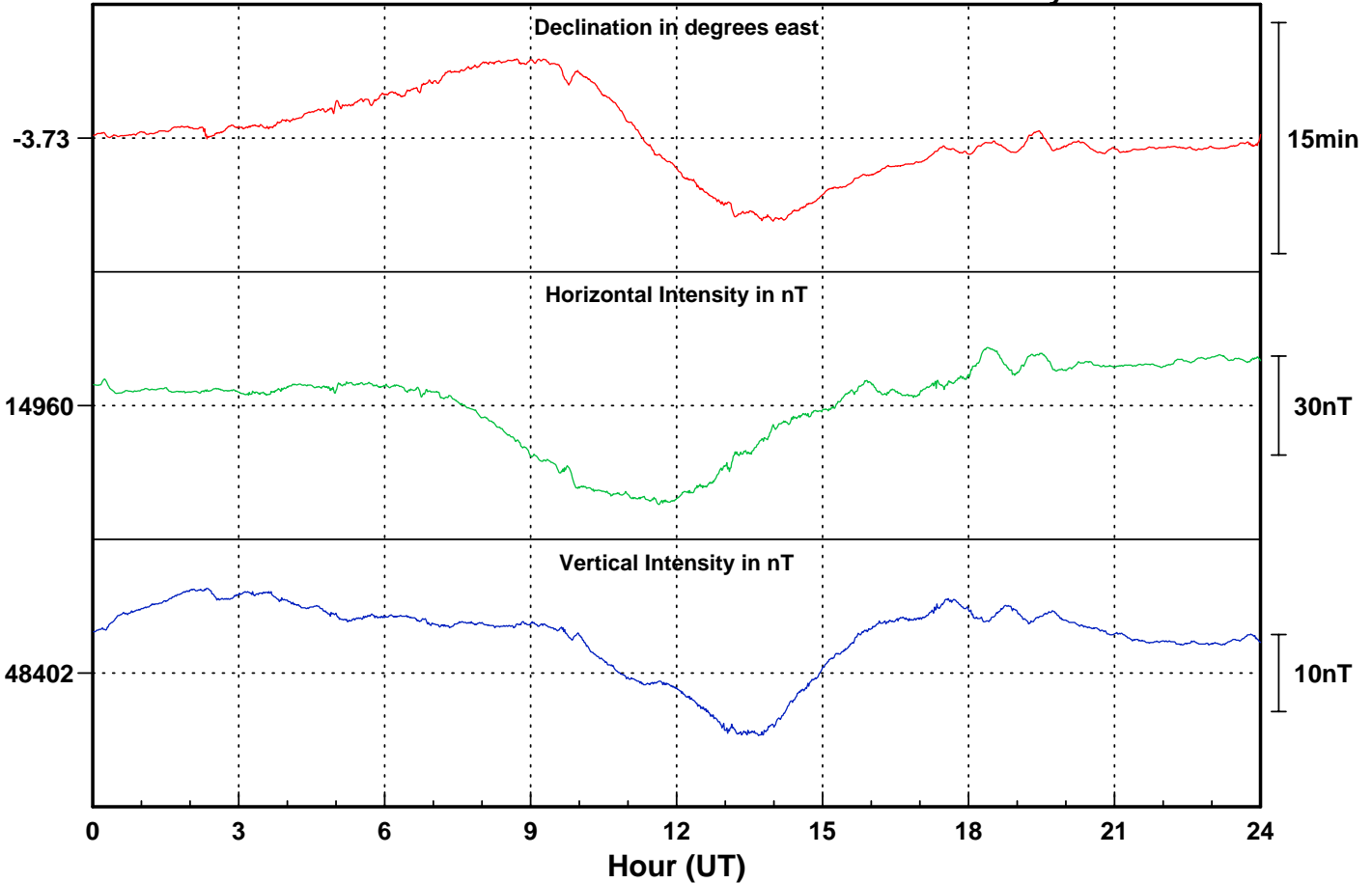
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Day number: 101



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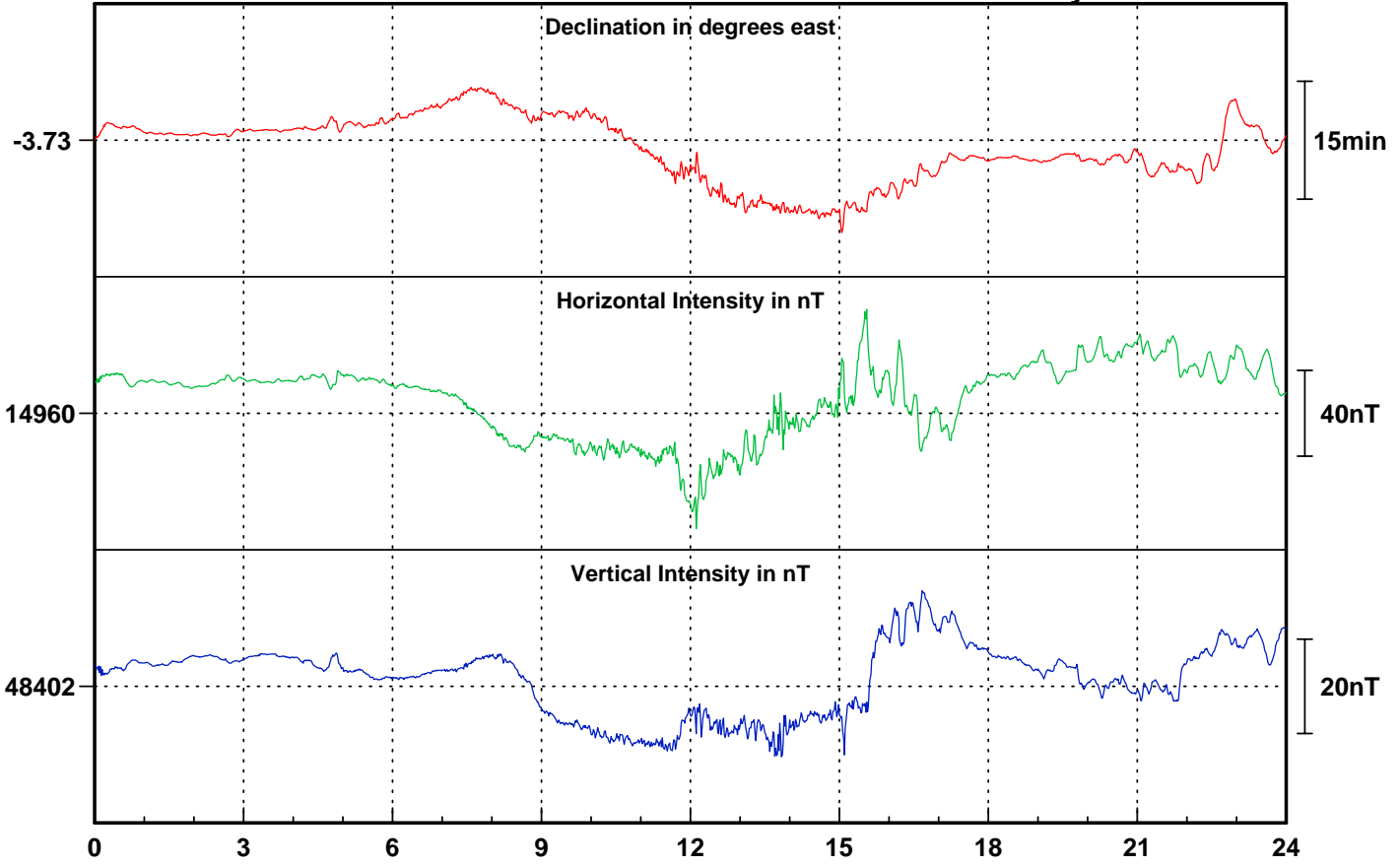
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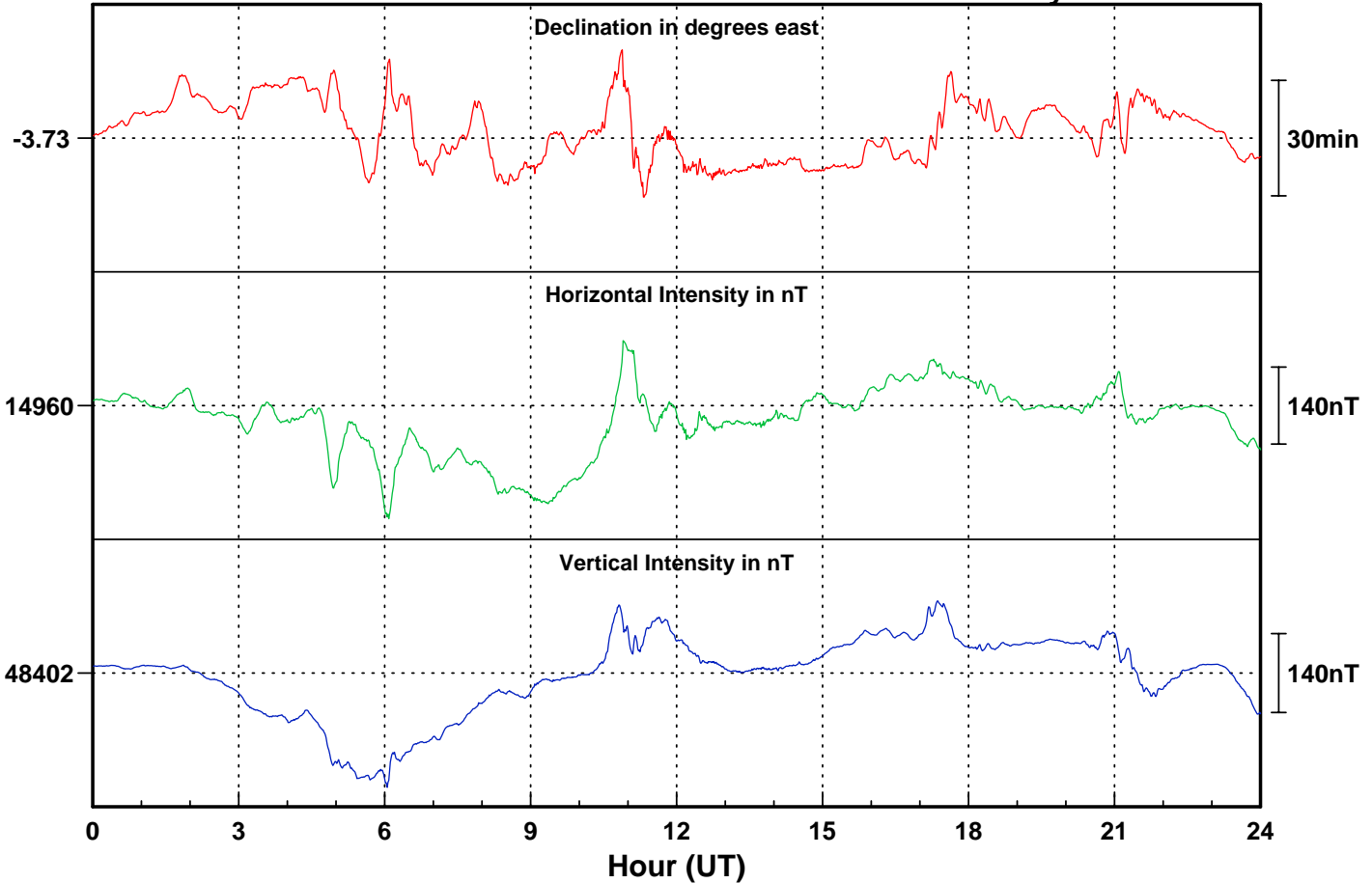
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Day number: 103



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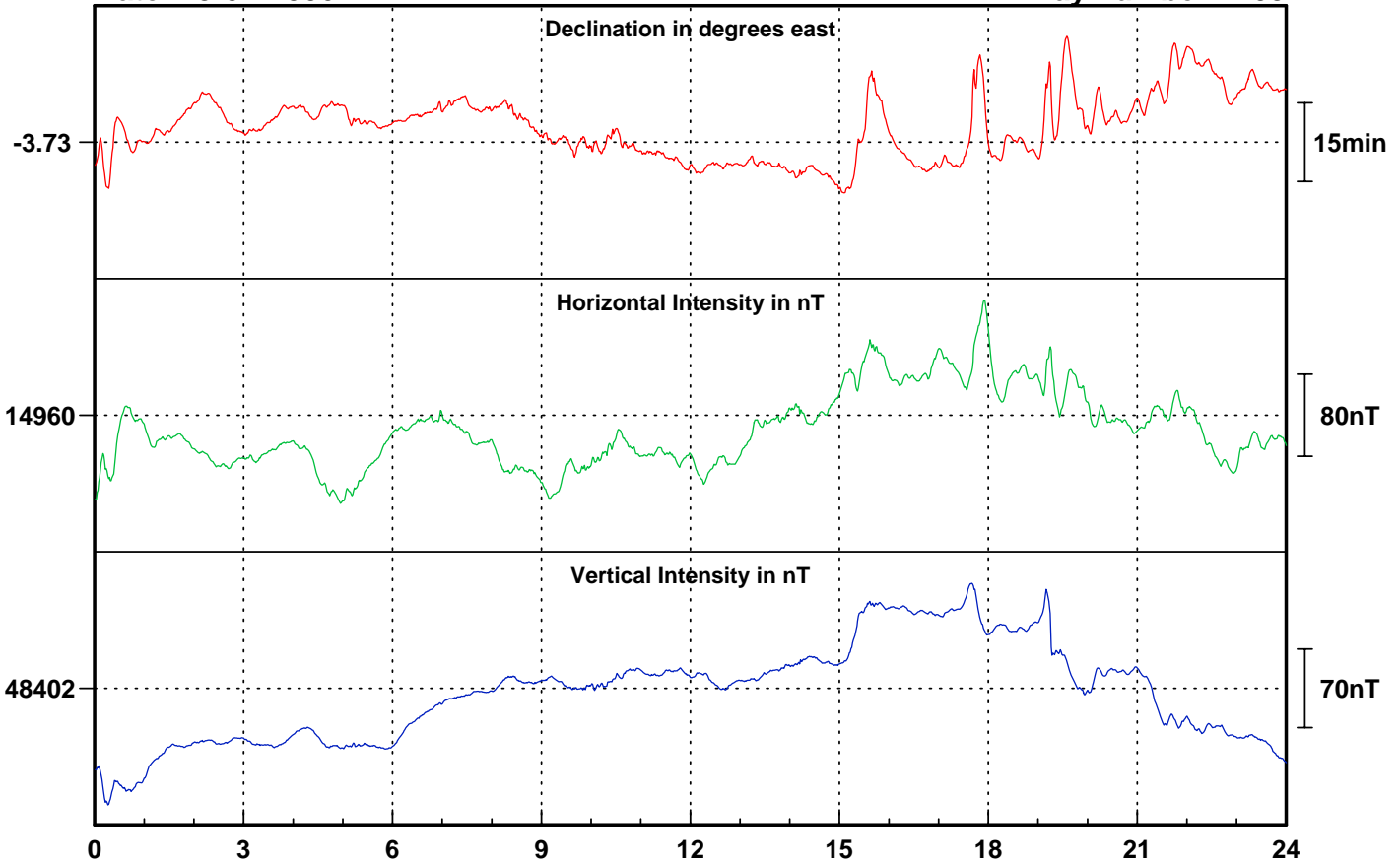
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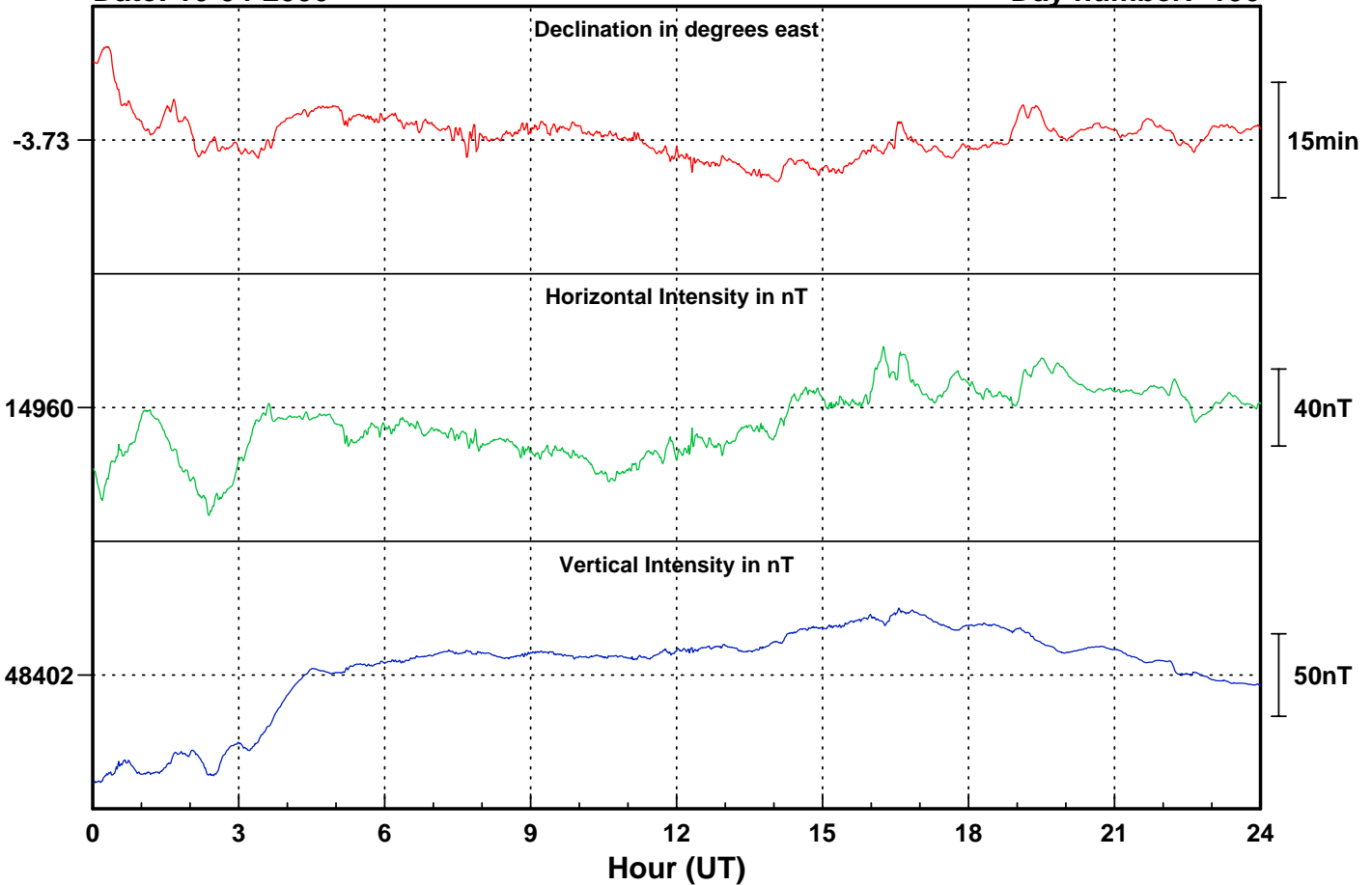
Lerwick

Day number: 105



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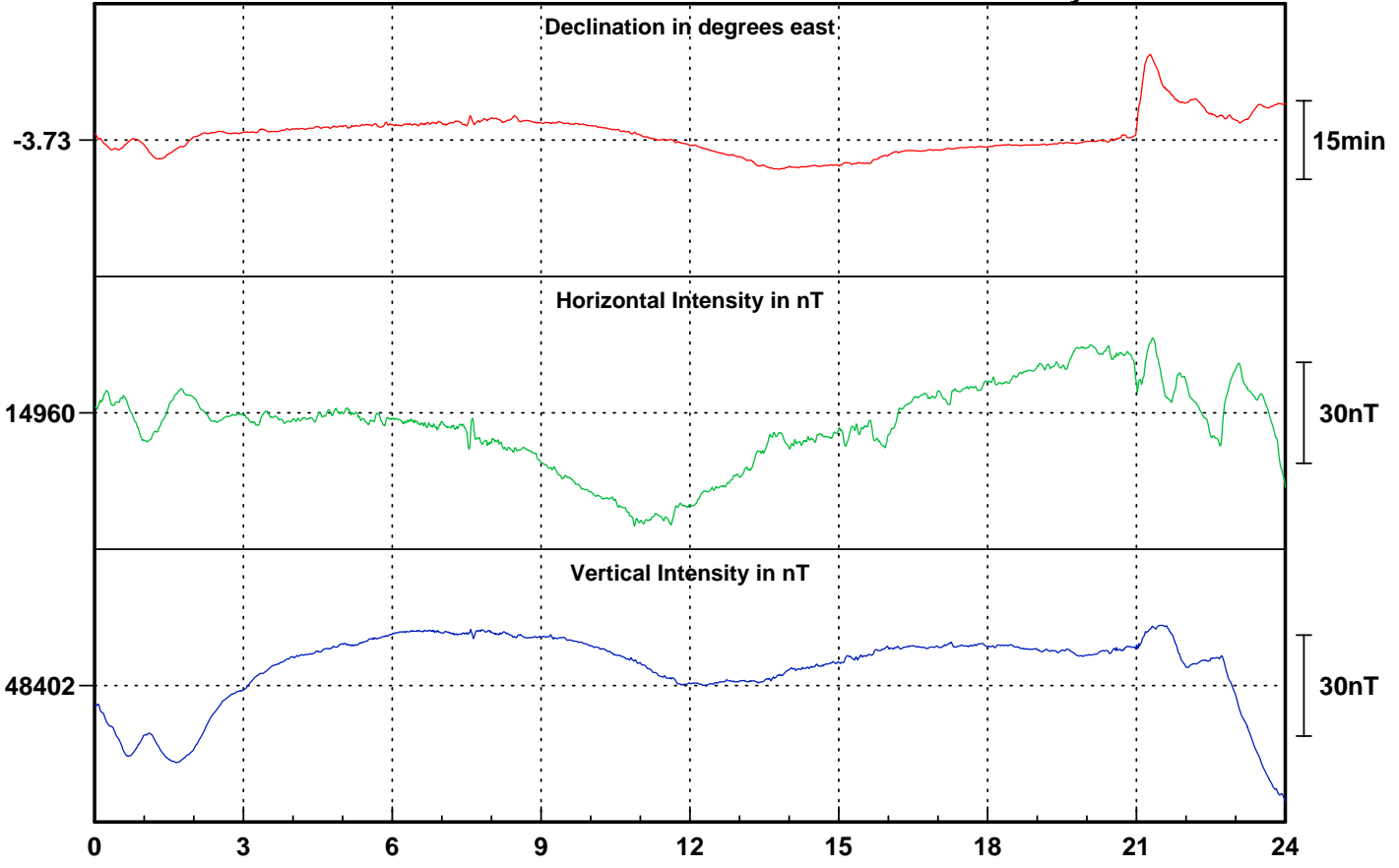
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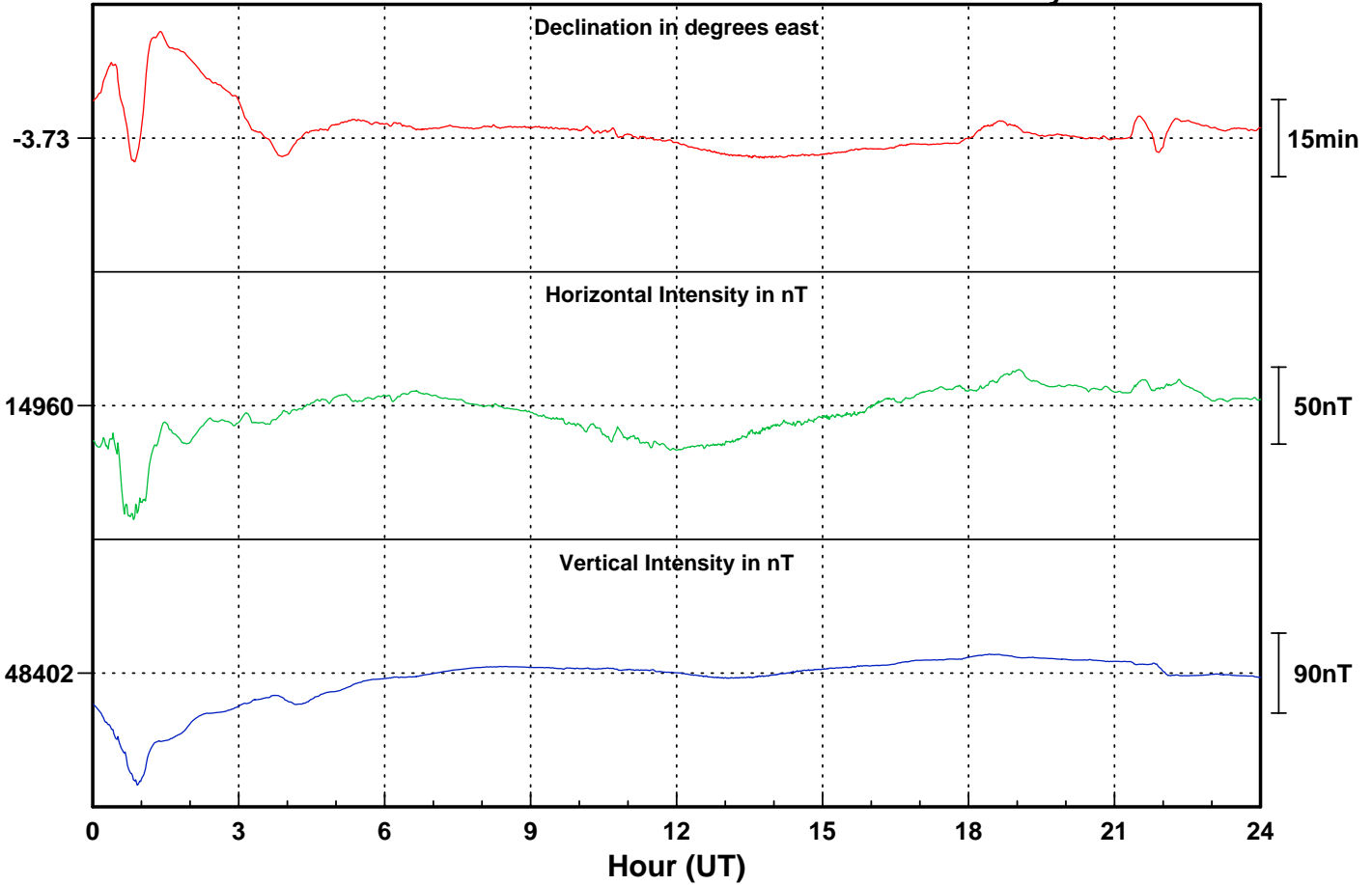
Lerwick

Day number: 107



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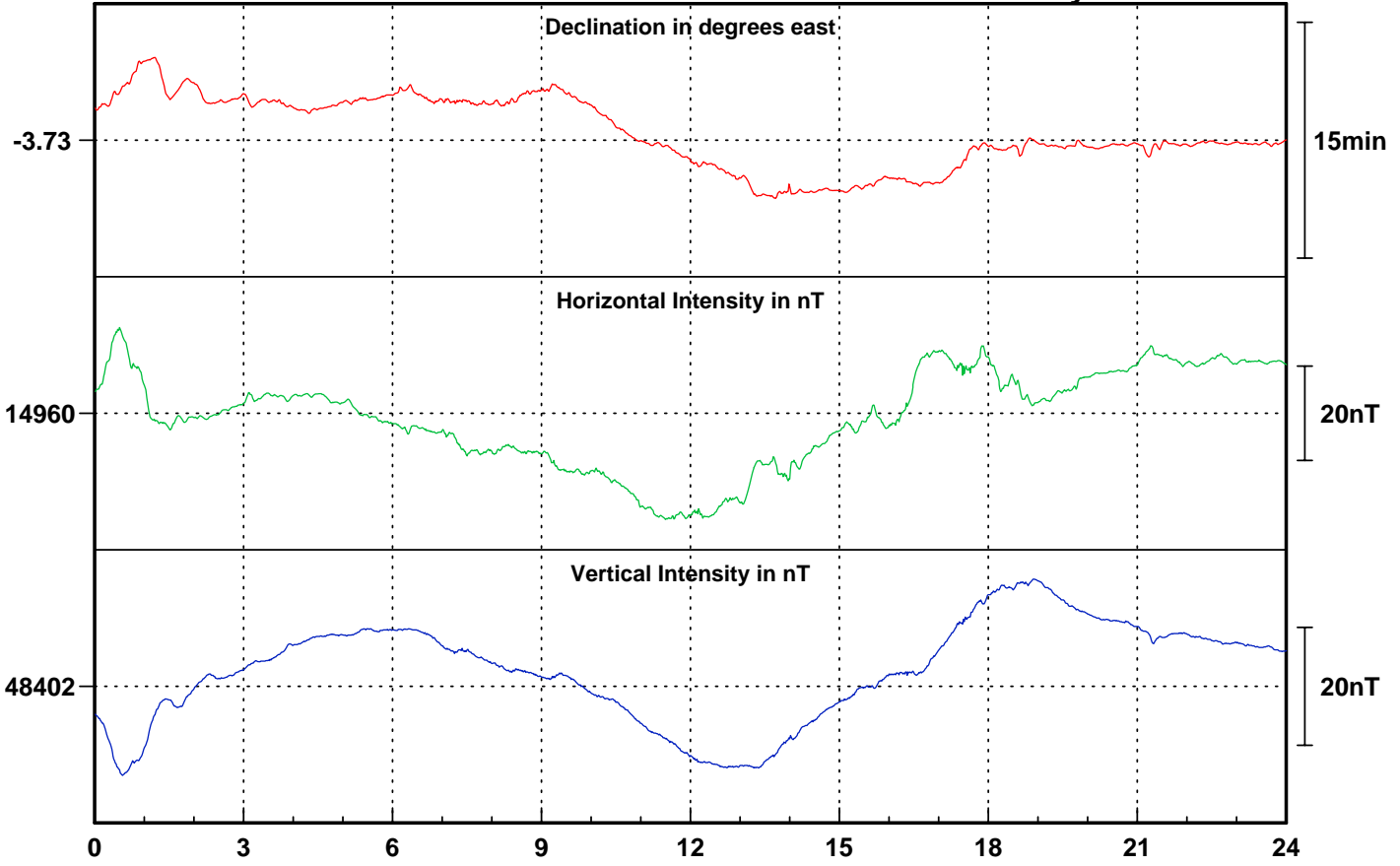
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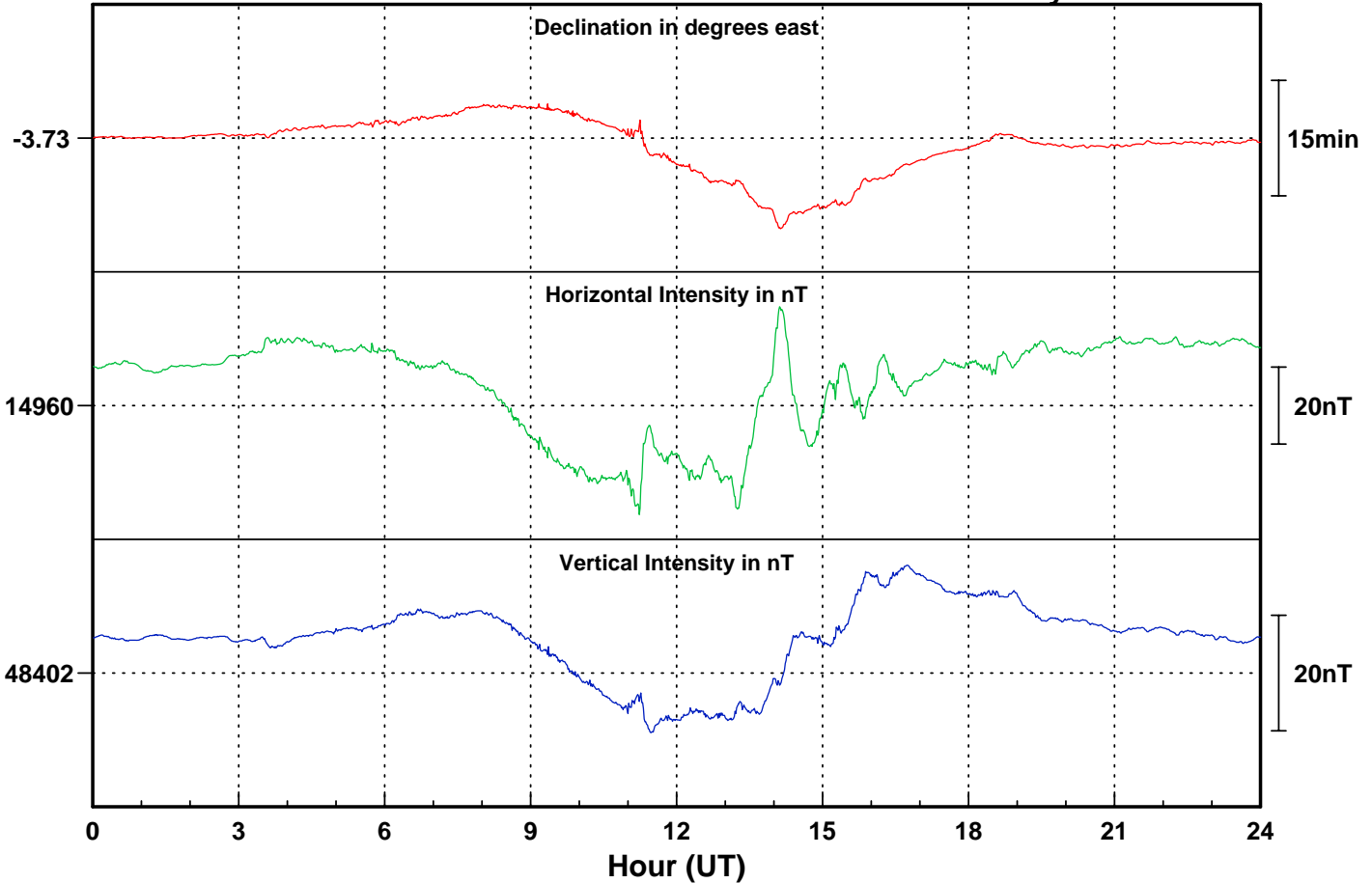
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Day number: 109



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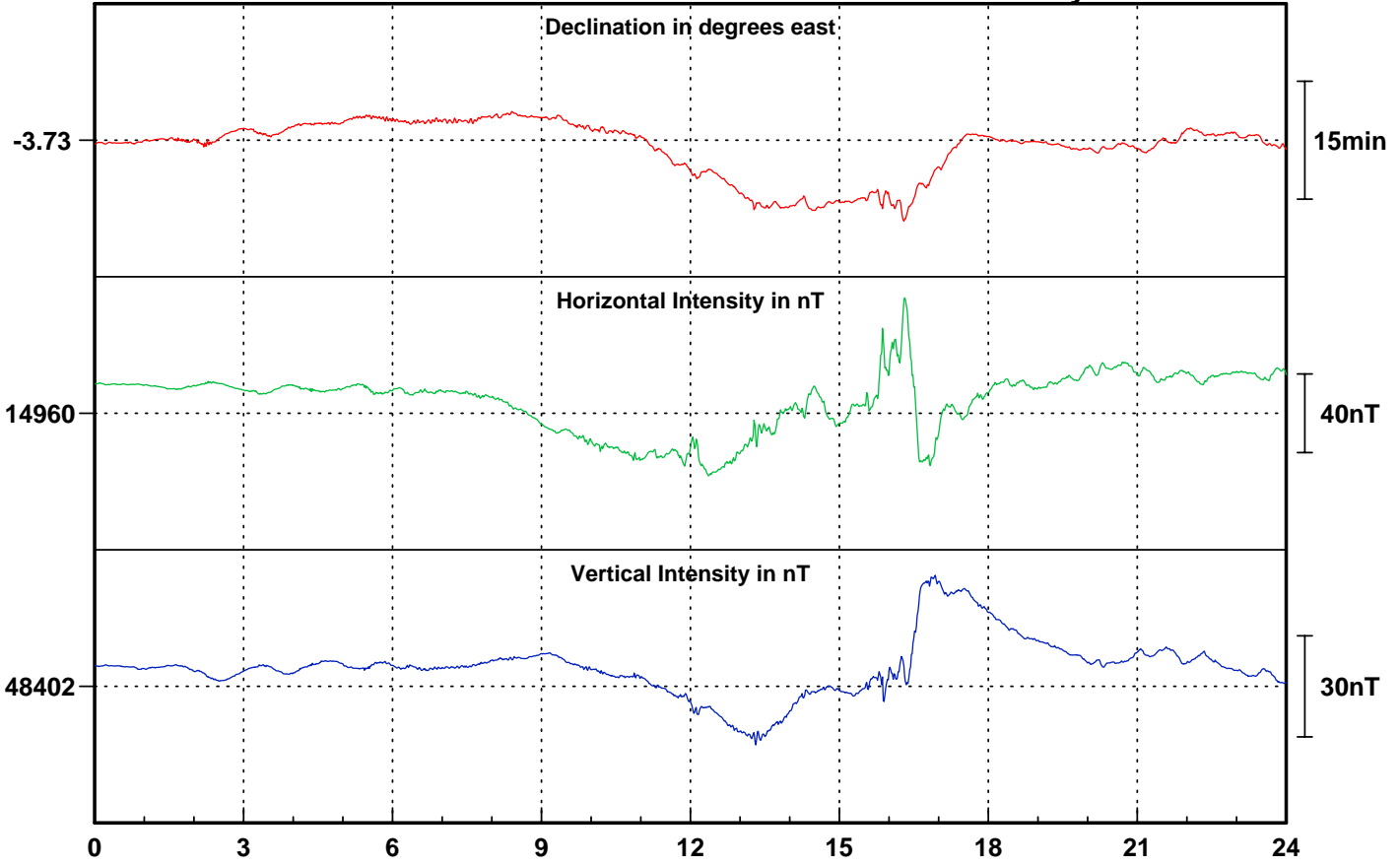
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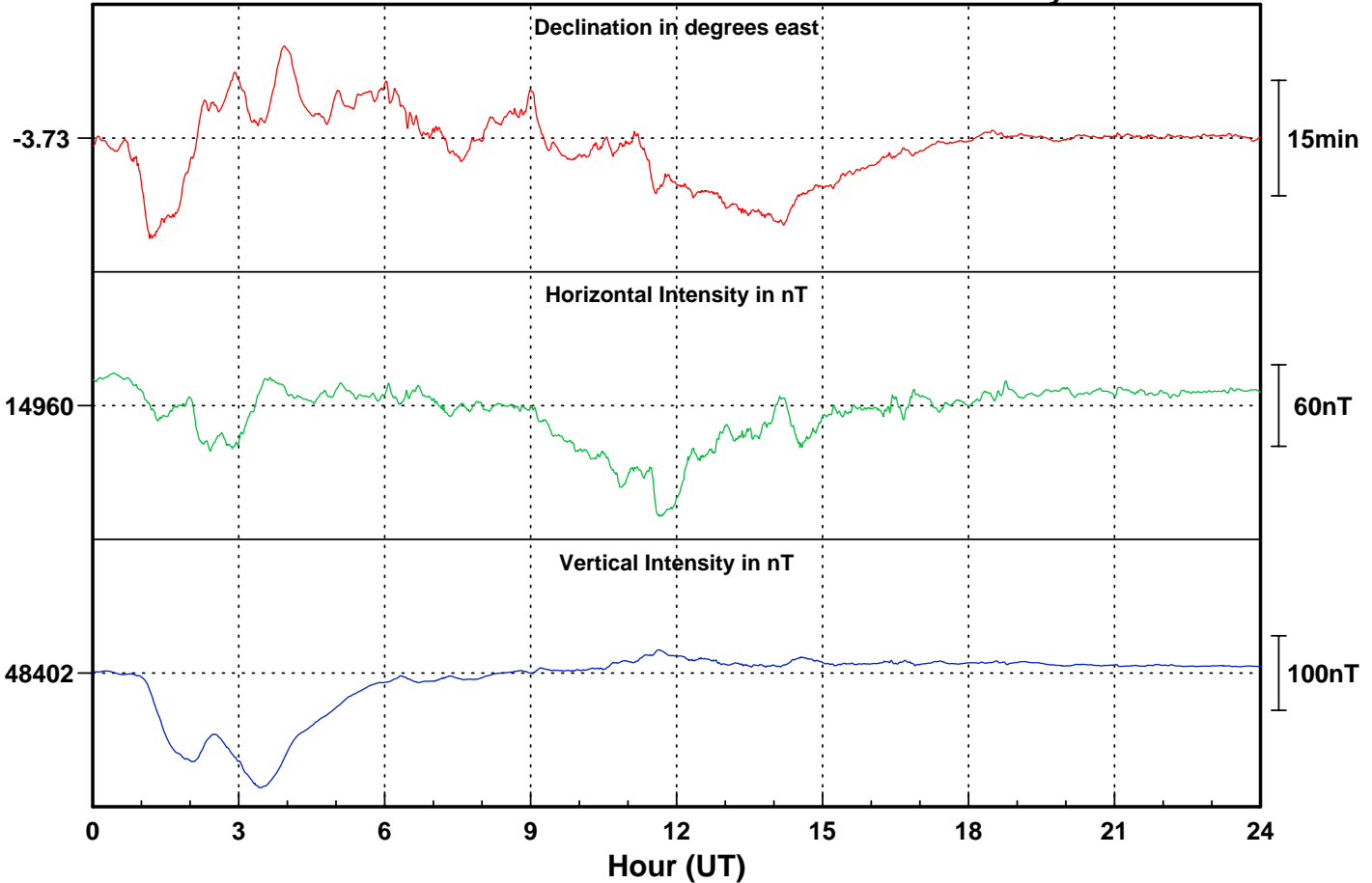
Lerwick

Day number: 111



Date: 22-04-2006

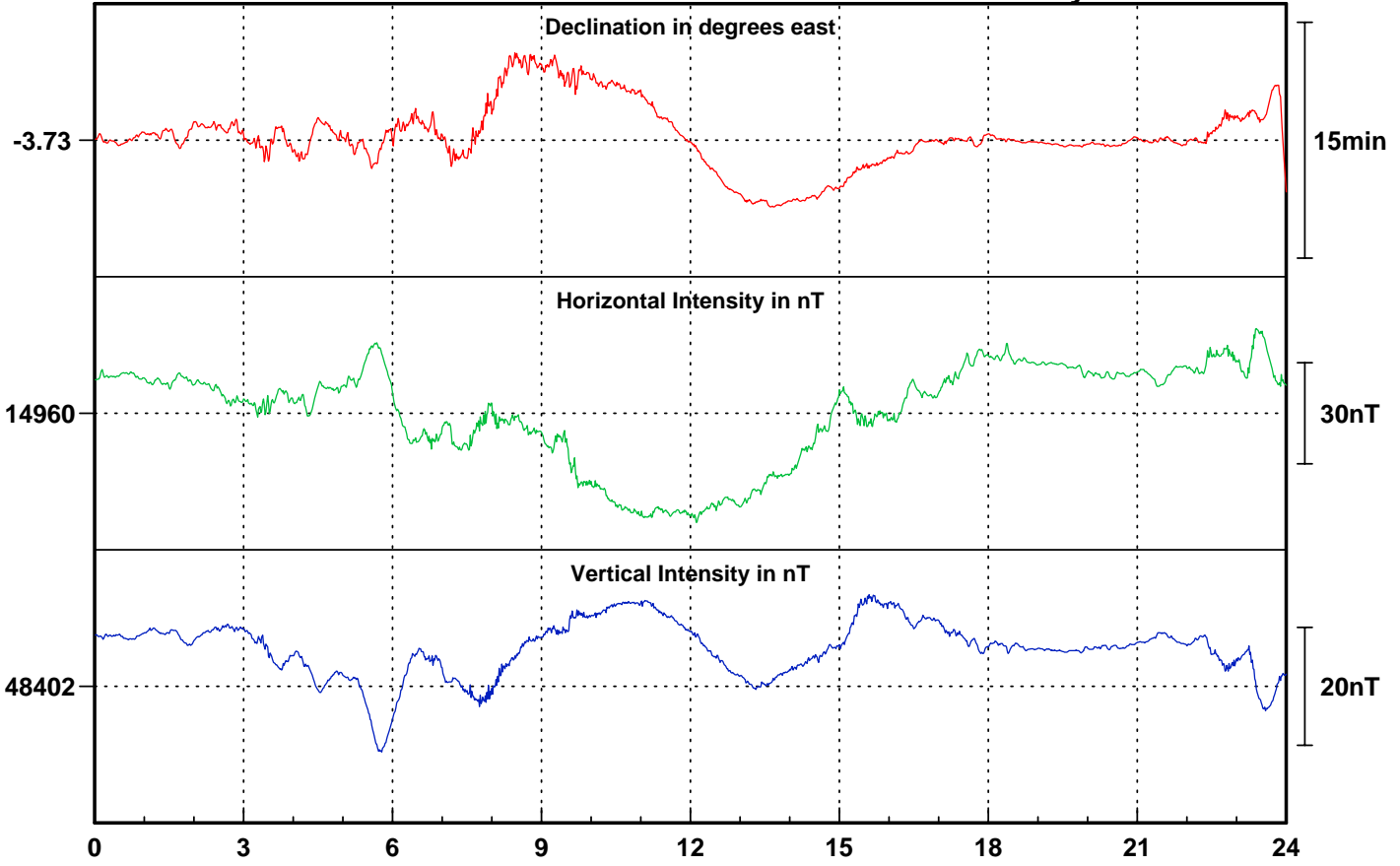
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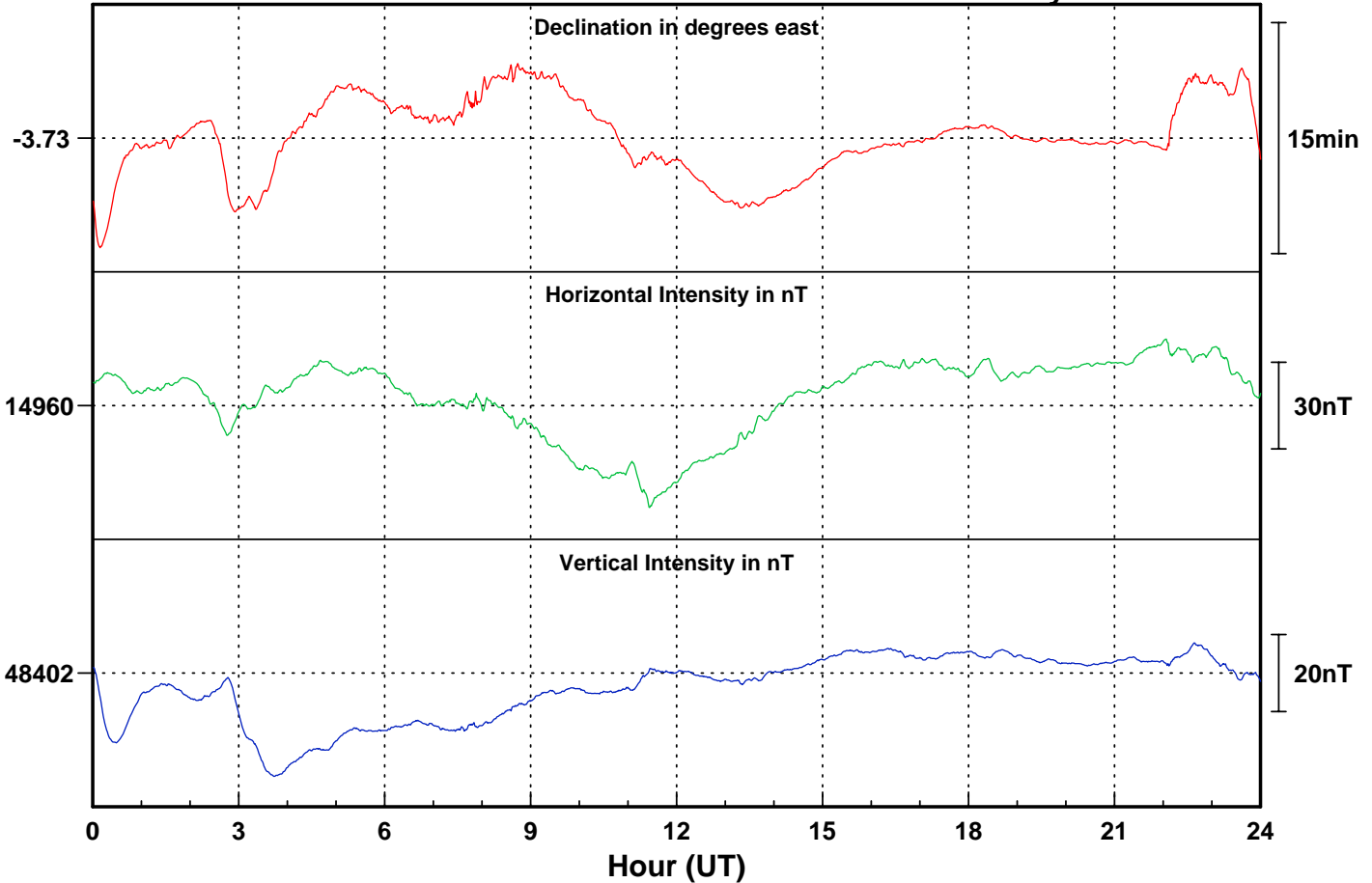
Lerwick

Day number: 113



Date: 24-04-2006

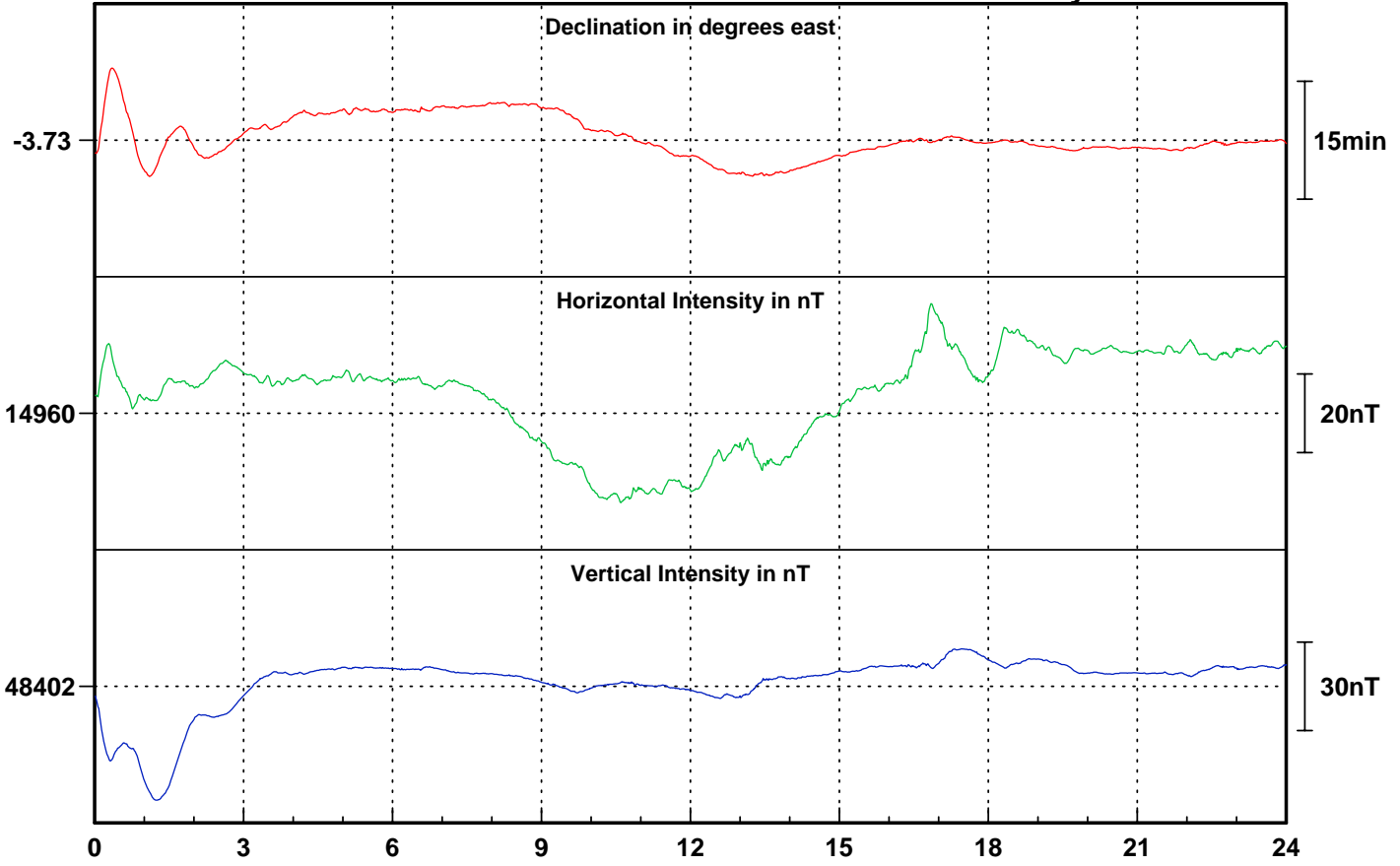
Day number: 114



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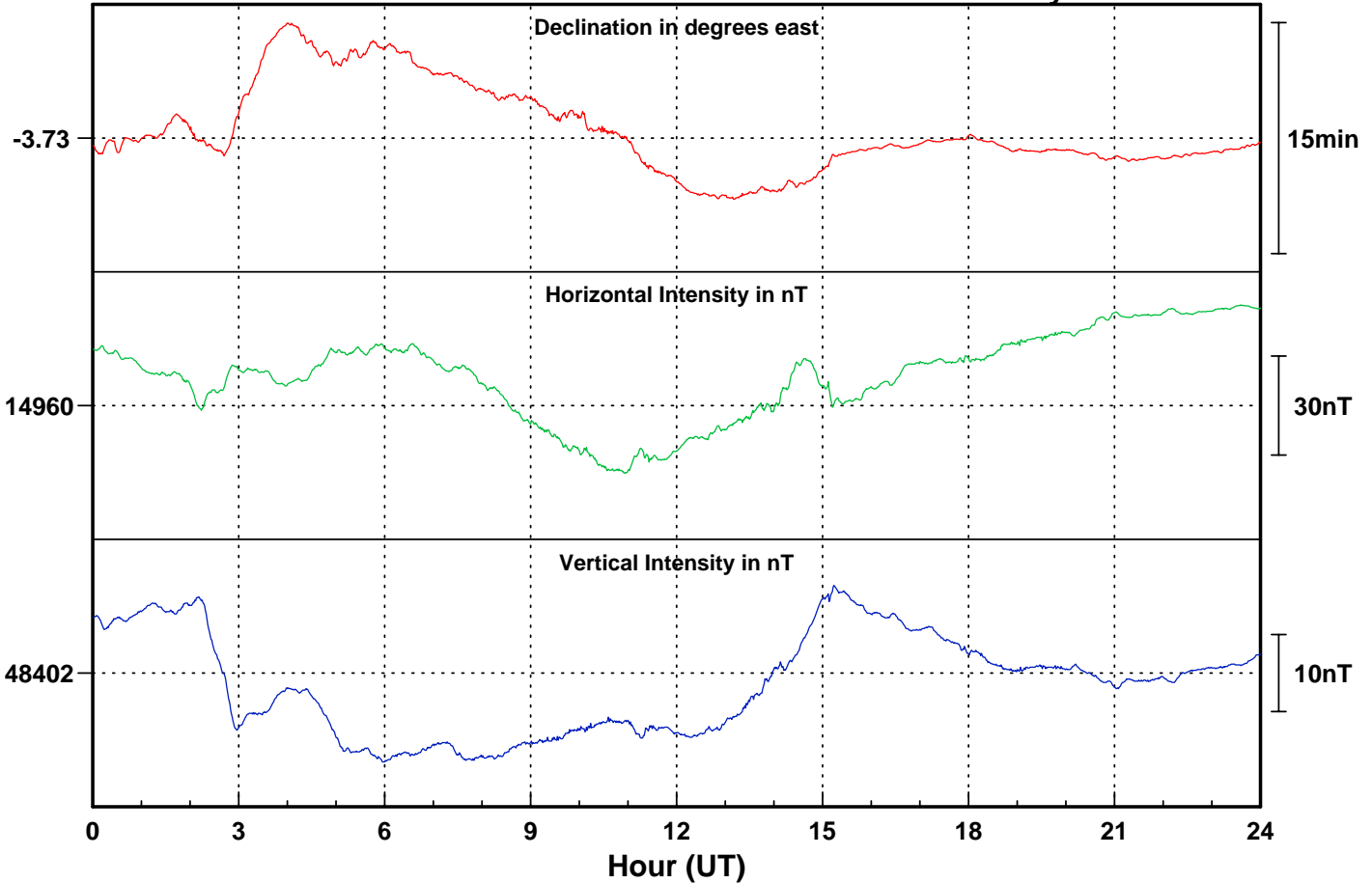
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Day number: 115



Date: 26-04-2006

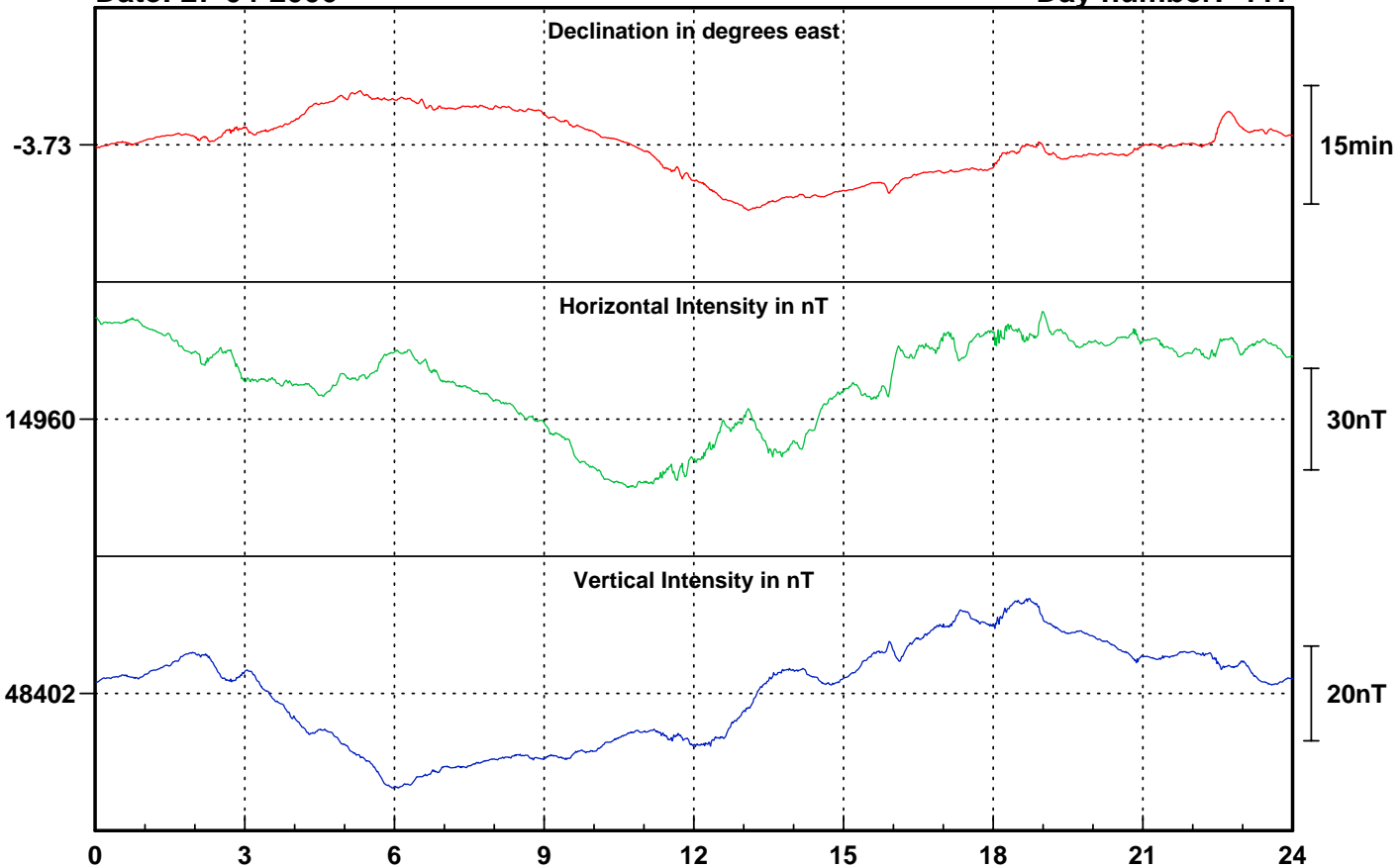
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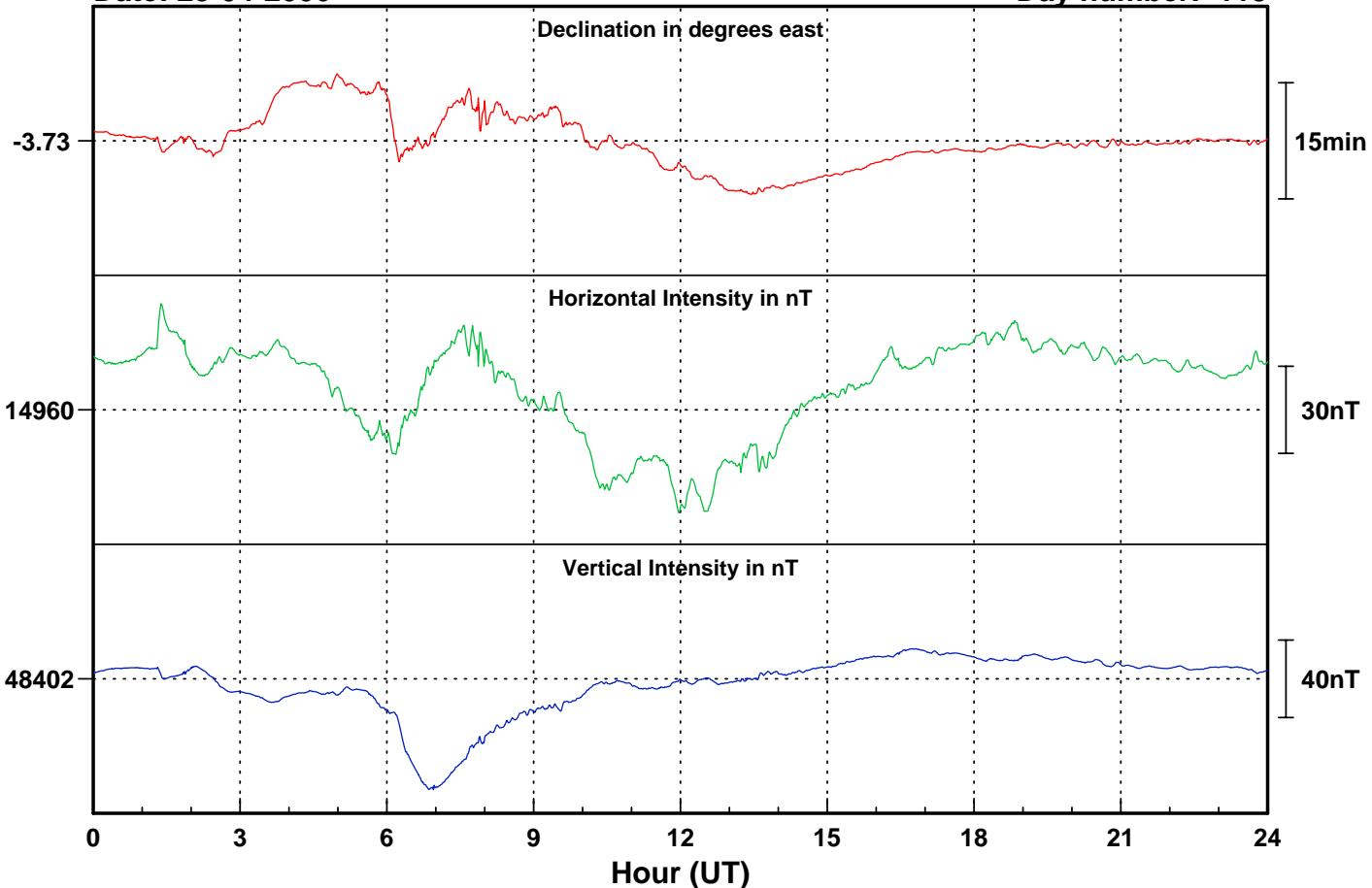
Lerwick

Day number: 117



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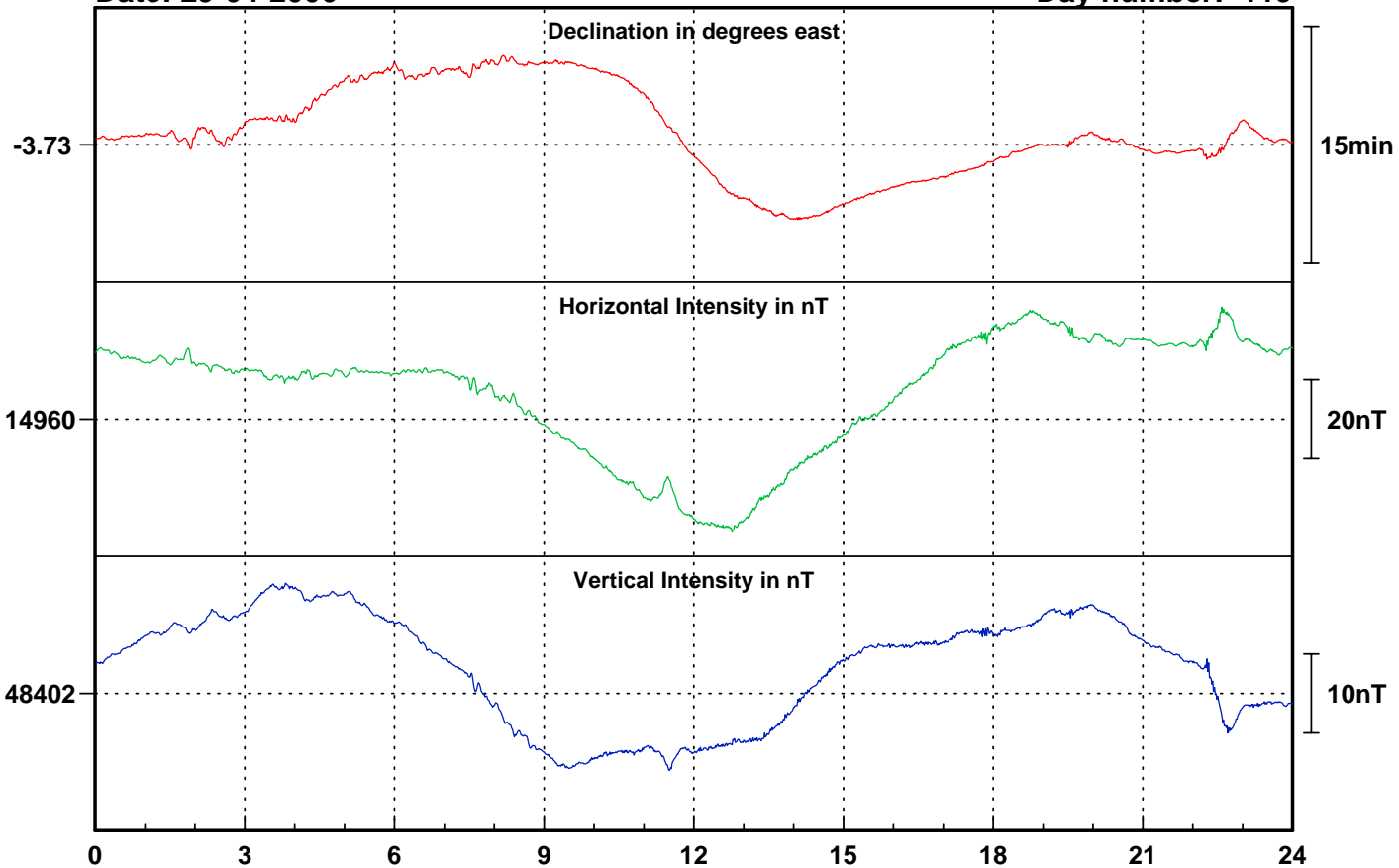
Day number: 118



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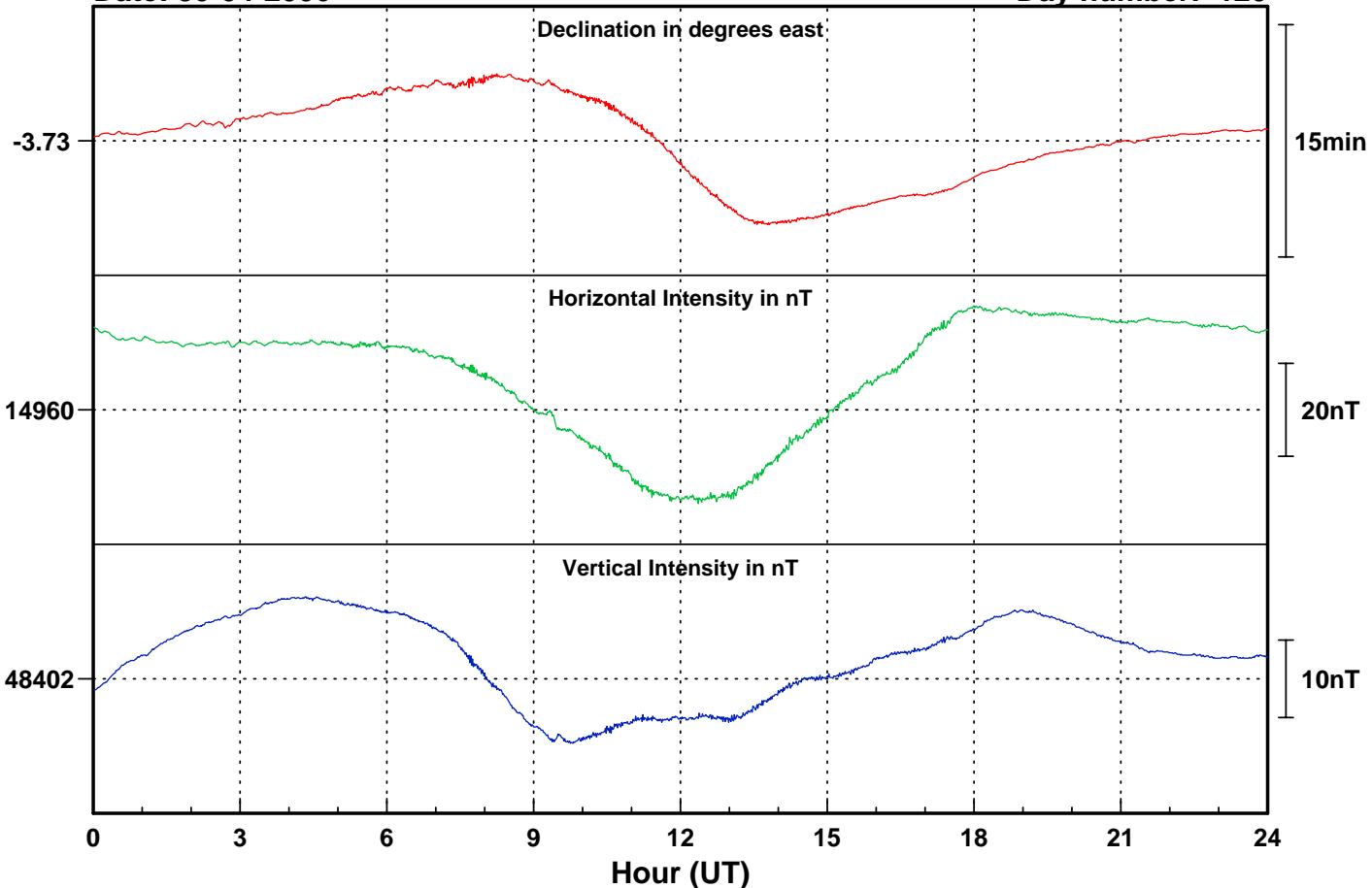
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Day number: 119

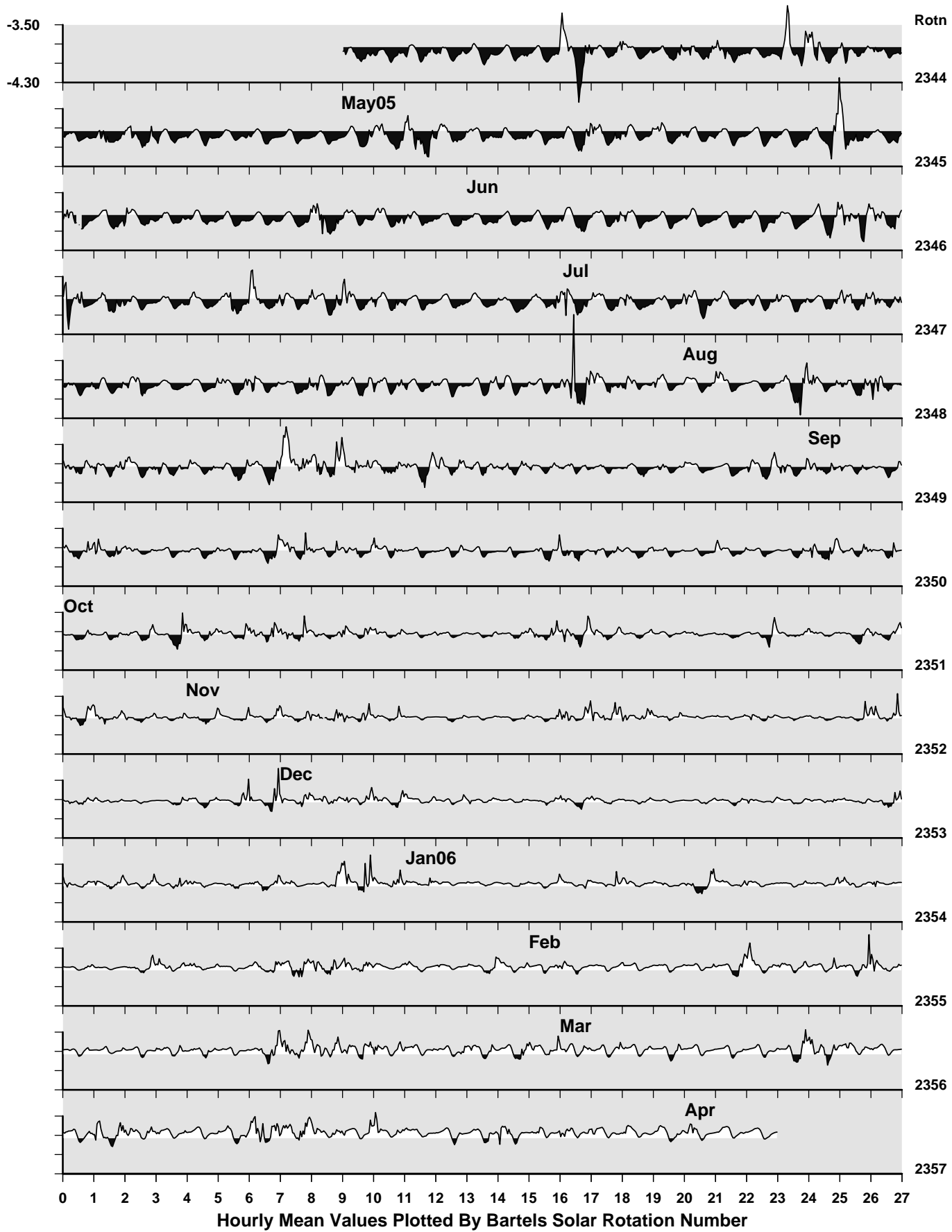


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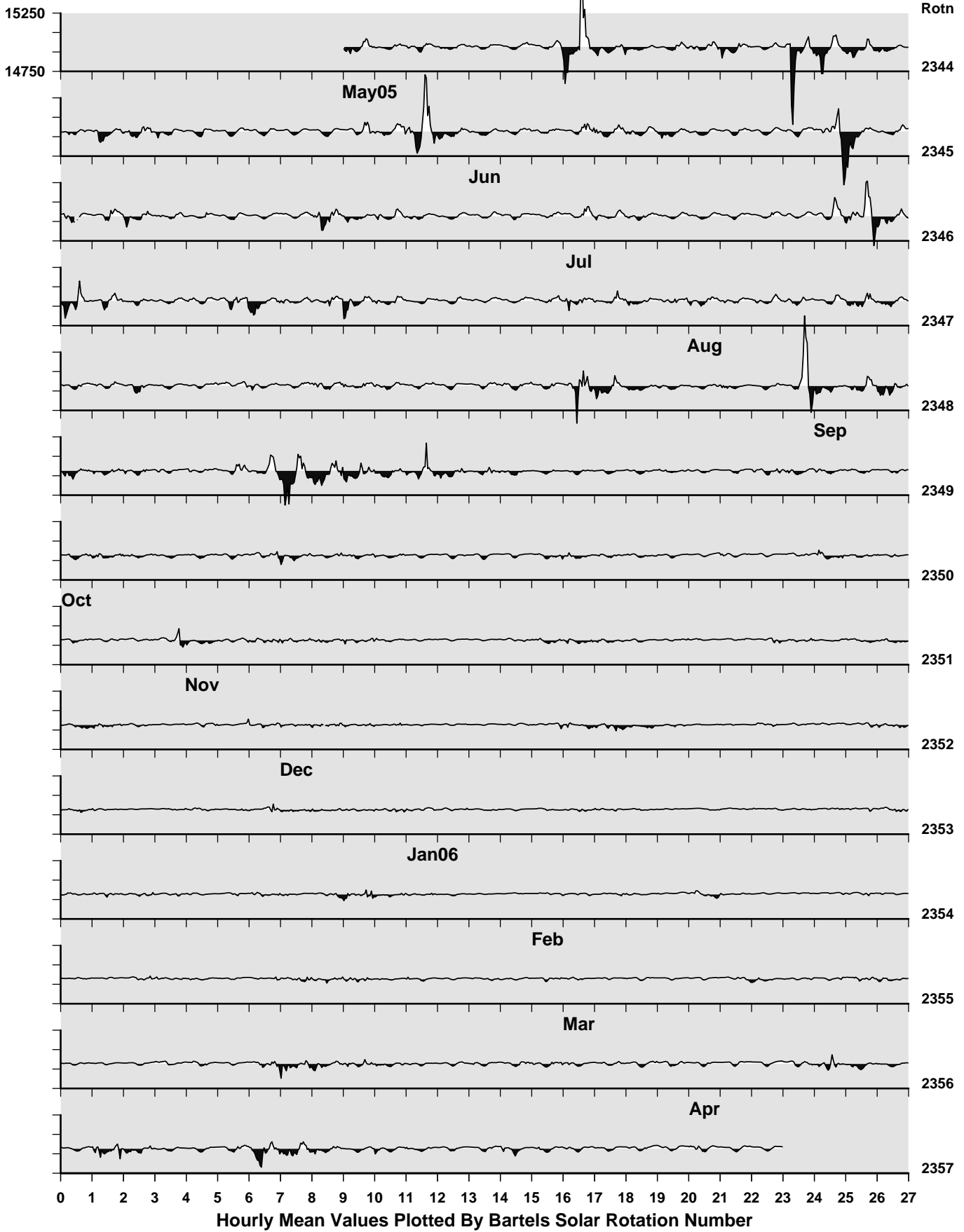
Day number: 120



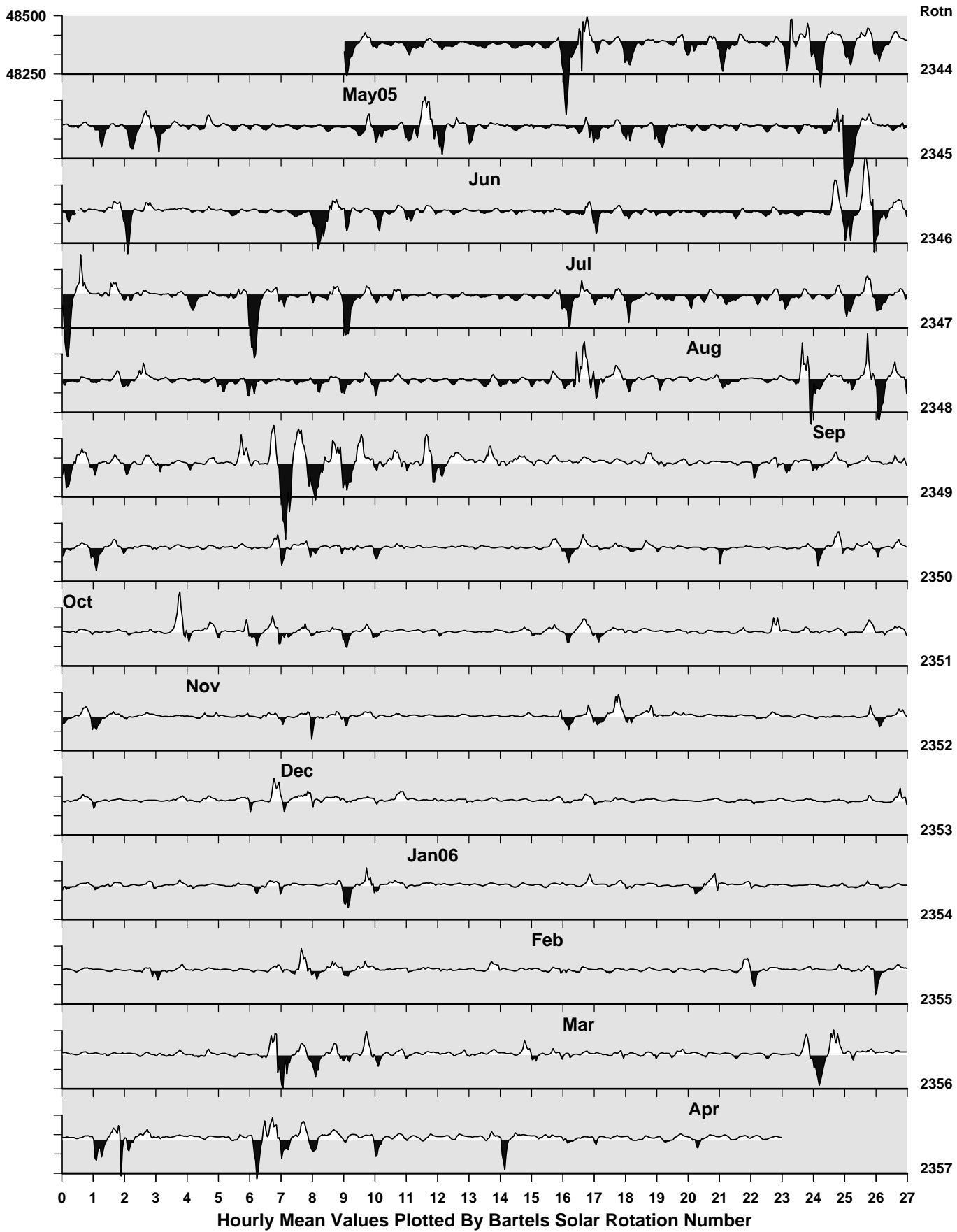
Lerwick Observatory: Declination (degrees)



Lerwick Observatory: Horizontal Intensity (nT)

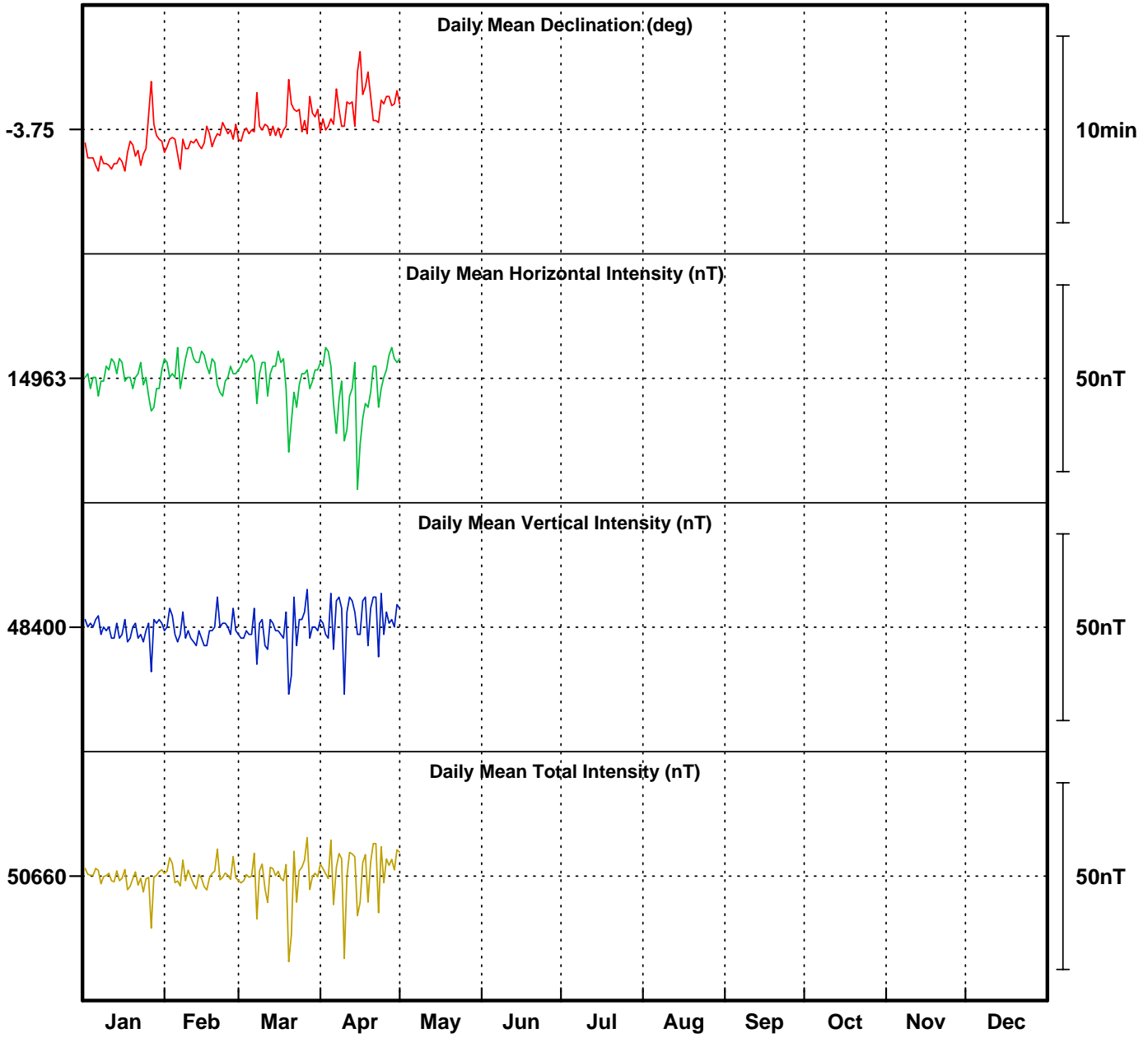


Lerwick Observatory: Vertical Intensity (nT)



Hourly Mean Values Plotted By Bartels Solar Rotation Number

Lerwick Observatory 2006



Monthly Mean Values for Lerwick Observatory 2006

Month	<i>D</i>	<i>H</i>	<i>I</i>	<i>X</i>	<i>Y</i>	<i>Z</i>	<i>F</i>
January	-3° 46.4′	14963 nT	72° 49.2′	14930 nT	-985 nT	48399 nT	50659 nT
February	-3° 45.8′	14965 nT	72° 49.1′	14933 nT	-982 nT	48399 nT	50660 nT
March	-3° 44.9′	14963 nT	72° 49.2′	14931 nT	-978 nT	48399 nT	50659 nT
April	-3° 43.9′	14960 nT	72° 49.5′	14928 nT	-974 nT	48402 nT	50661 nT

Note

i. The values shown here are provisional.

INDICES OF GEOMAGNETIC ACTIVITY

Lerwick Observatory

April 2006

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	0	0	0	0	1	1	0	0	2
2	0	0	0	1	1	1	0	1	4
3	0	0	0	0	1	1	0	1	3
4	0	0	1	1	2	2	3	4	13
5	4	4	3	2	5	4	3	2	27
6	1	2	2	0	1	1	1	2	10
7	1	0	0	0	0	1	0	0	2
8	1	0	0	1	1	1	1	1	6
9	4	4	4	2	4	3	5	7	33
10	3	2	2	1	3	3	3	2	19
11	1	1	0	0	1	1	0	1	5
12	0	0	0	0	0	1	0	0	1
13	0	0	1	2	3	3	1	3	13
14	3	5	5	6	4	4	3	5	35
15	4	3	3	3	4	4	4	4	29
16	3	2	2	1	2	2	2	2	16
17	2	0	0	0	1	1	1	3	8
18	4	2	0	1	1	0	2	2	12
19	1	0	0	0	0	1	1	0	3
20	0	0	0	2	3	2	1	0	8
21	0	0	0	0	2	4	1	1	8
22	4	3	3	3	3	2	1	0	19
23	0	2	2	1	1	1	1	2	10
24	2	2	1	1	1	1	0	2	10
25	3	0	0	0	1	2	1	0	7
26	1	1	0	0	1	0	0	0	3
27	1	1	0	0	1	1	1	1	6
28	2	2	3	2	2	1	1	1	14
29	0	0	0	0	1	0	1	1	3
30	0	0	0	0	0	0	0	0	0

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)
01-04-06	91	00000100	00001100	3	4	2	4	3
02-04-06	92	00001011	00000000	4	2	2	4	3
03-04-06	93	00000101	00000001	4	3	2	4	3
04-04-06	94	00121344	12222223	23	17	11	30	20
05-04-06	95	44334442	22355441	46	50	44	53	48
06-04-06	96	12312122	11433111	15	21	21	14	18
07-04-06	97	10000000	00012101	3	6	4	6	5
08-04-06	98	20021112	00122101	9	8	8	9	9
09-04-06	99	44434456	34544433	74	55	58	71	65
10-04-06	100	33323332	23432321	28	27	32	23	27
11-04-06	101	22111102	21111102	10	9	11	9	10
12-04-06	102	00000010	01000000	3	3	3	3	3
13-04-06	103	12134423	13234312	28	26	19	35	27
14-04-06	104	44544544	35675644	69	124	109	84	96
15-04-06	105	43433553	23454432	56	47	49	54	52
16-04-06	106	42222222	23233211	21	20	25	16	21
17-04-06	107	20101113	11110102	10	8	8	11	9
18-04-06	108	43110122	22100100	18	7	19	7	13
19-04-06	109	20100101	00010000	6	3	5	4	5
20-04-06	110	01124210	01123100	15	10	9	16	12
21-04-06	111	11112421	01012311	16	11	6	20	13
22-04-06	112	44344221	33343201	38	27	45	20	33
23-04-06	113	13311212	11310101	16	10	17	9	13
24-04-06	114	32121102	10121001	13	7	13	7	10
25-04-06	115	31001210	11002100	10	6	8	8	8
26-04-06	116	21111100	00010000	7	3	7	4	5
27-04-06	117	11101211	11101111	8	7	6	9	8
28-04-06	118	32332111	22432001	19	19	29	9	19
29-04-06	119	11010101	00000000	6	2	4	4	4
30-04-06	120	00000000	10000000	2	3	3	2	3
Monthly mean value =			18.8					

- (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)
03-04-06	14 56	SI*	B	-7.0	0.83	1.8
20-04-06	11 12	SSC*	C	18.5	1.49/-1.70	1.5
28-04-06	01 16	SSC*	C	15.5	-1.81	-5.4

Notes:

An asterisk (*) 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

Date	Universal Time			H (nT)	D (min)	Z (nT)
	Start	Maximum	End			
27-04-06	15 48	15 53	16 03	-3.0	-1.22	2.3

Note:

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