BRITISH GEOLOGICAL SURVEY

Lerwick Observatory

Monthly Magnetic Bulletin

August 2005

05/08/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.

Enquiries about the data should be addressed to:

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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: o.baillie@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: 61°58.9′N 88°58.2′E
Height above mean sea level: 85 m

The geomagnetic co-ordinates are calculated using the 10th generation International Geomagnetic Reference Field at epoch 2005.5.

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 triaxial 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.

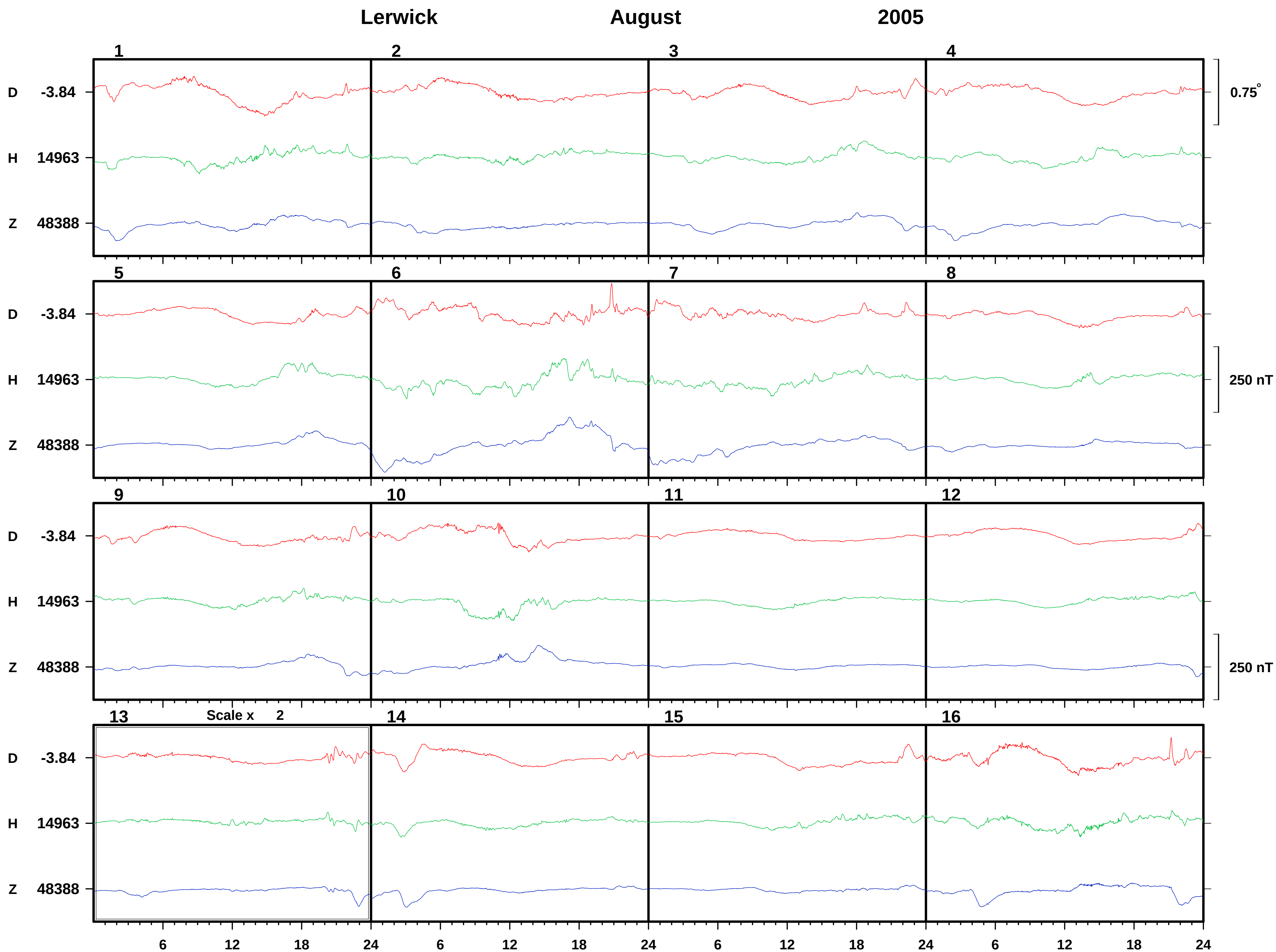
Although the *aa* index is based on data from only two observatories, provided averages over 12 hours or longer are used, the index is strongly correlated with the *ap* and *am* indices, which are derived using data from more extensive observatory networks.

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.

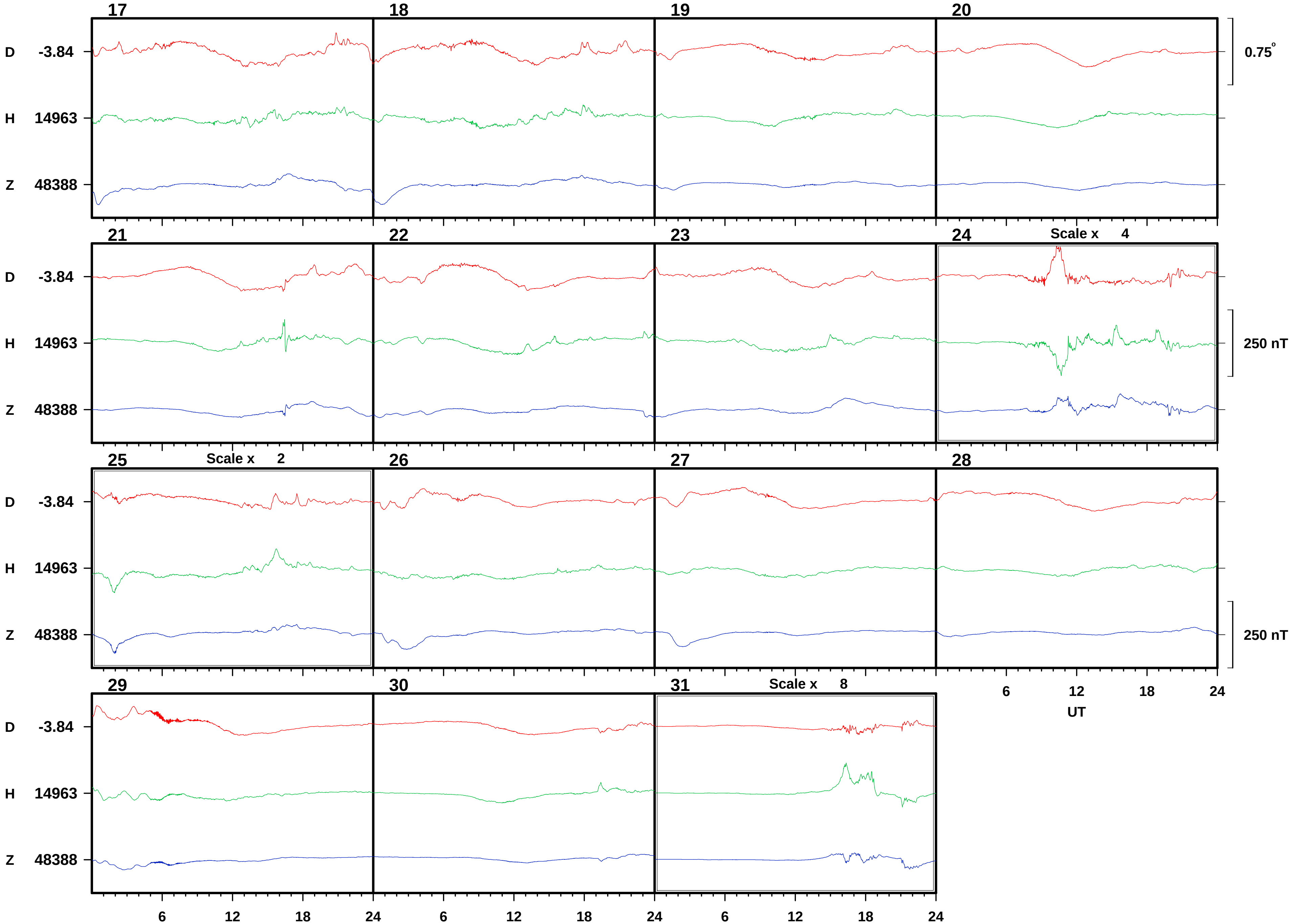
1.4.6 Rapid Variations

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.



Lerwick
August
2005
1
2
3
4
5
6
7
8
9
10
11
12
13
Scale x 2
14
15
16
D -3.84
H 14963
Z 48388
0.75°
250 nT
250 nT
6
12
18
24



Lerwick August 2005

Lerwick

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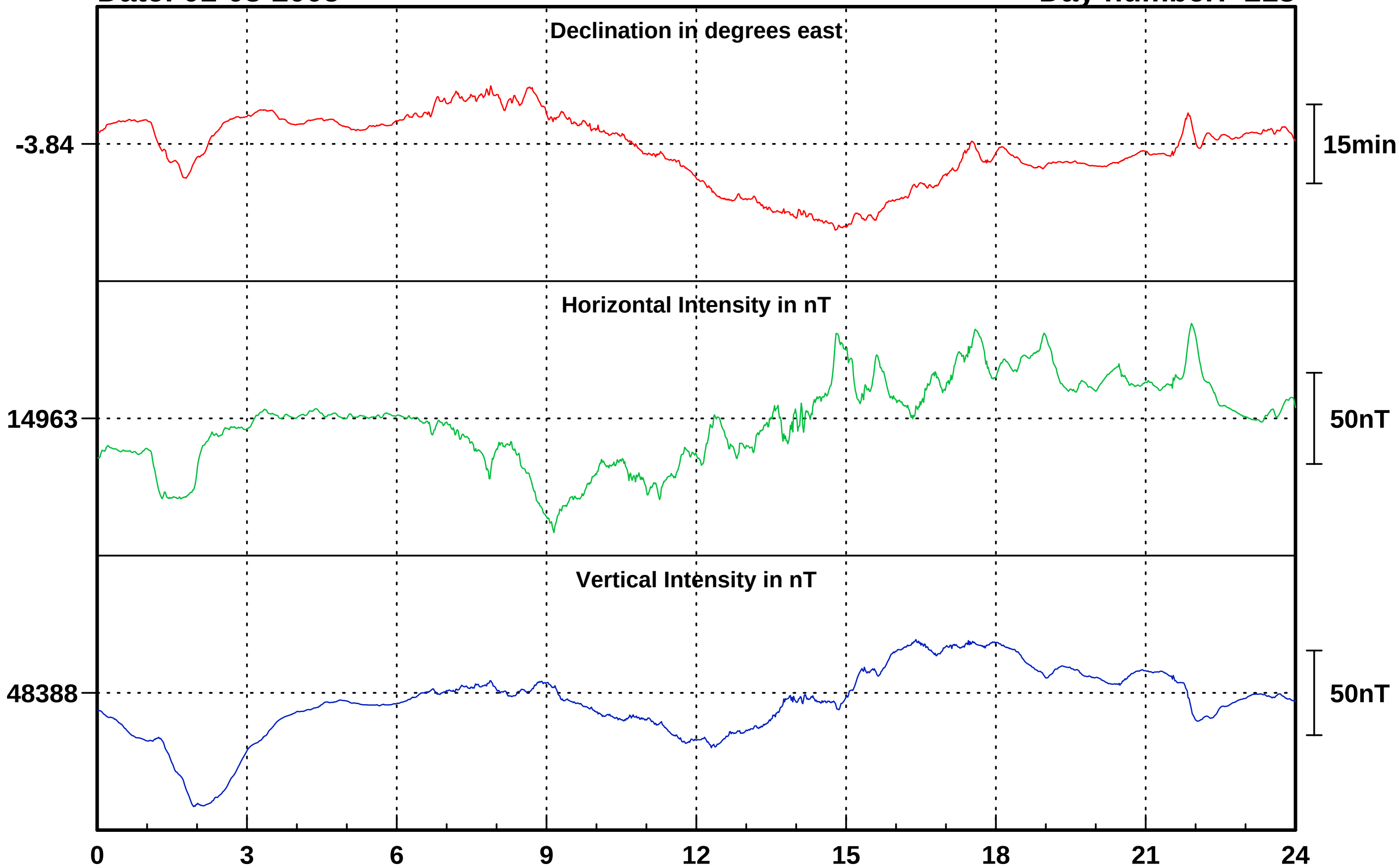

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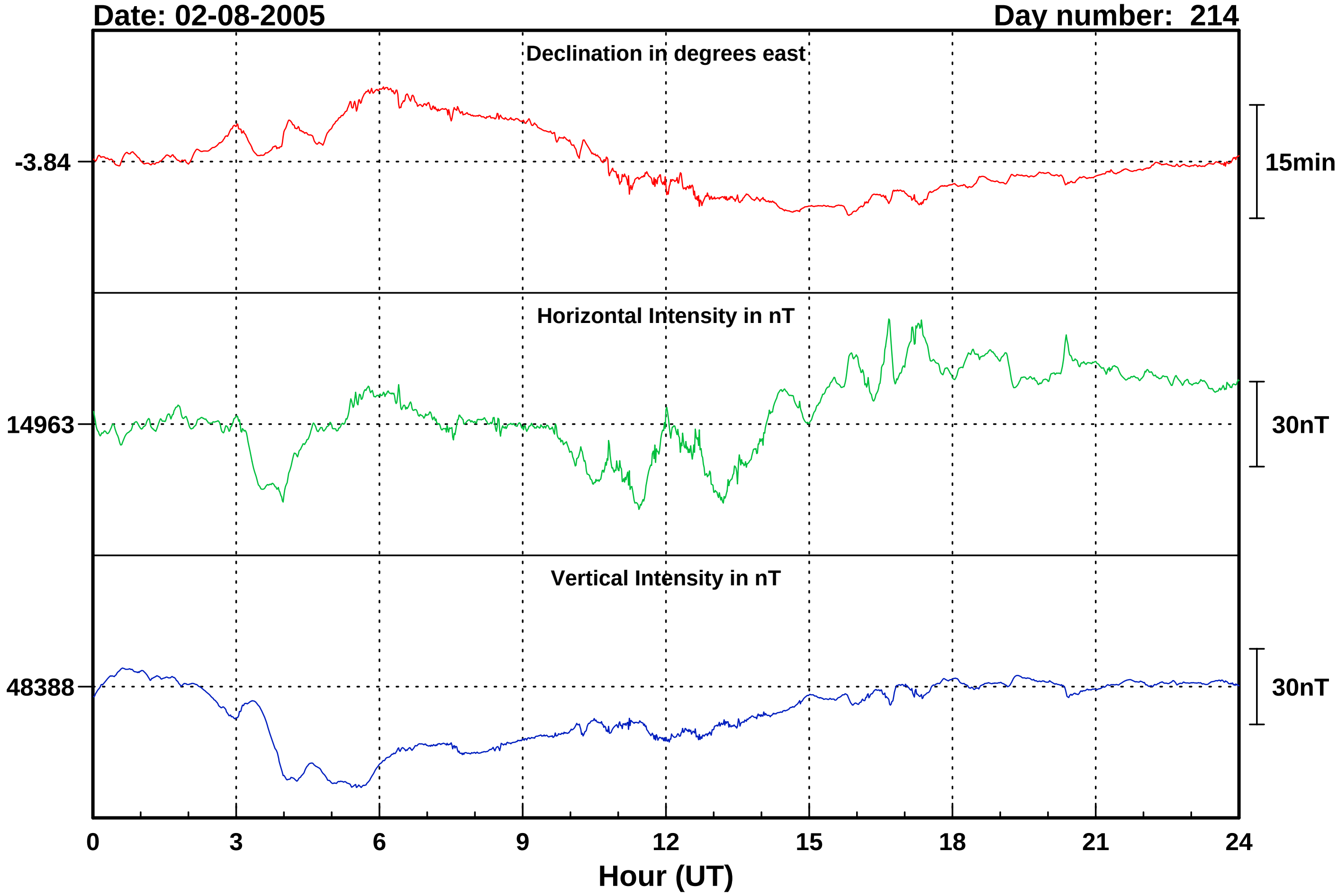
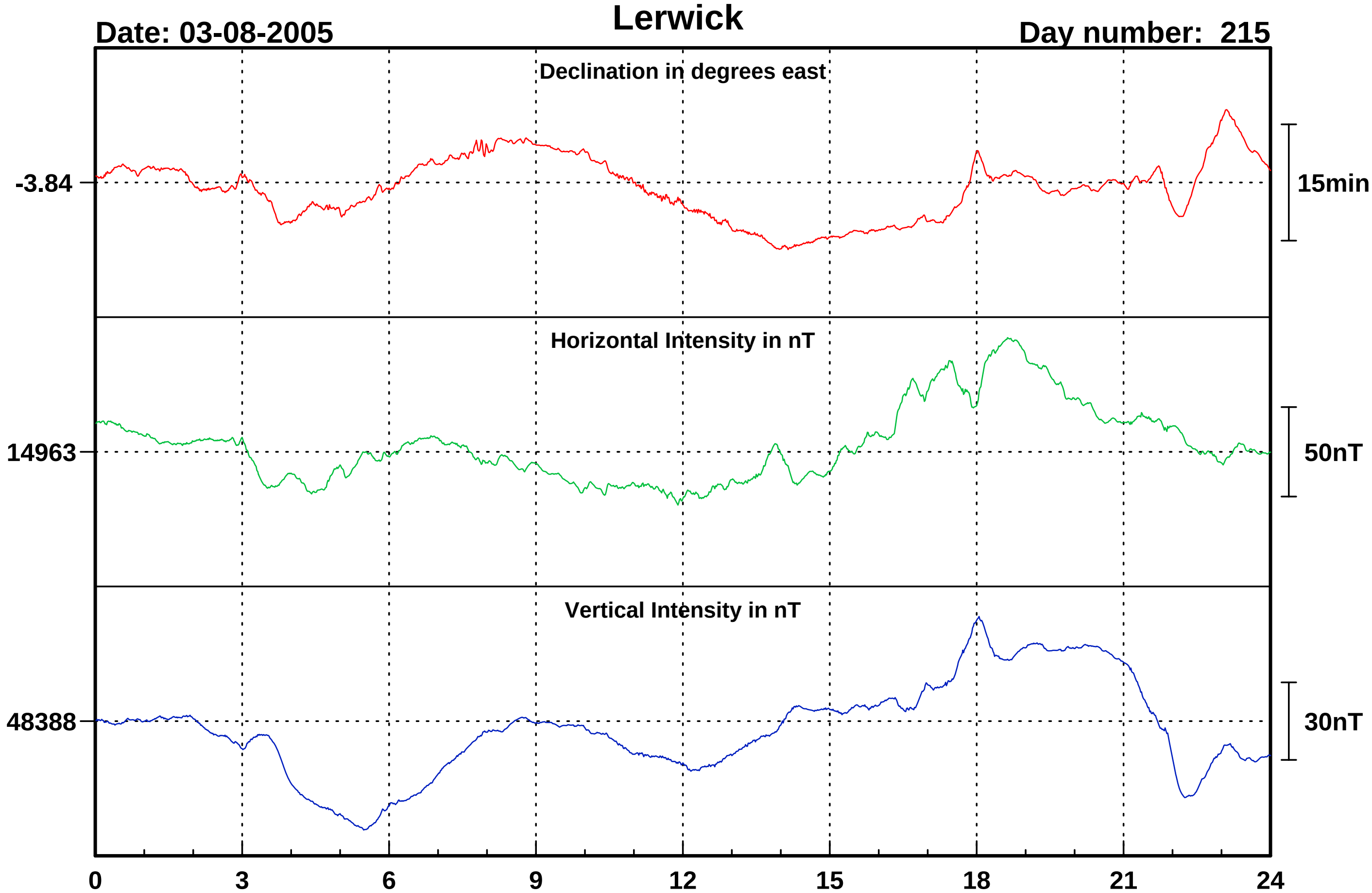
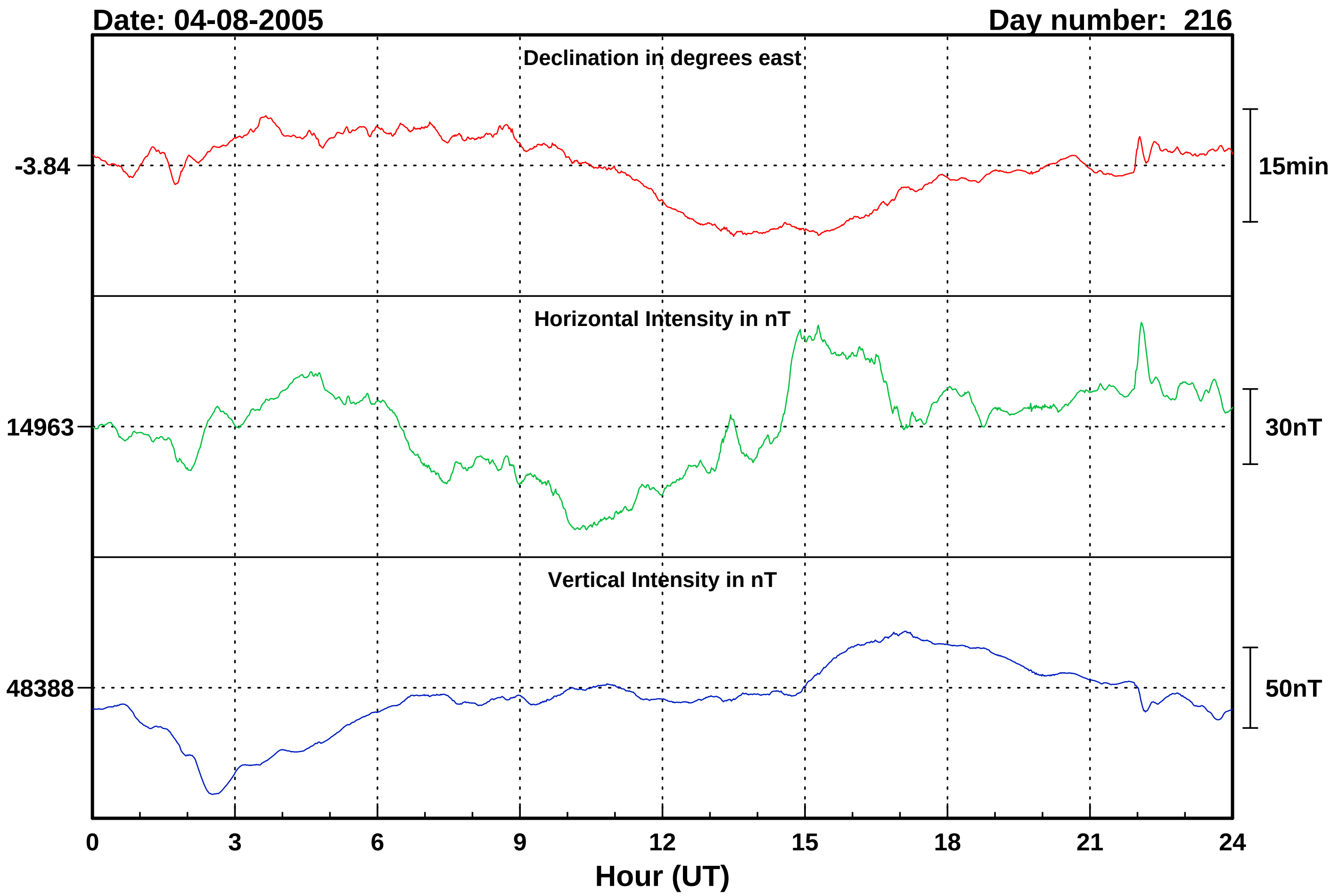


Lerwick



Date: 03-08-2005
Day number: 215
Declination in degrees east
-3.84
15min
Horizontal Intensity in nT
14963
50nT
Vertical Intensity in nT
48388
30nT
0
3
6
9
12
15
18
21
24



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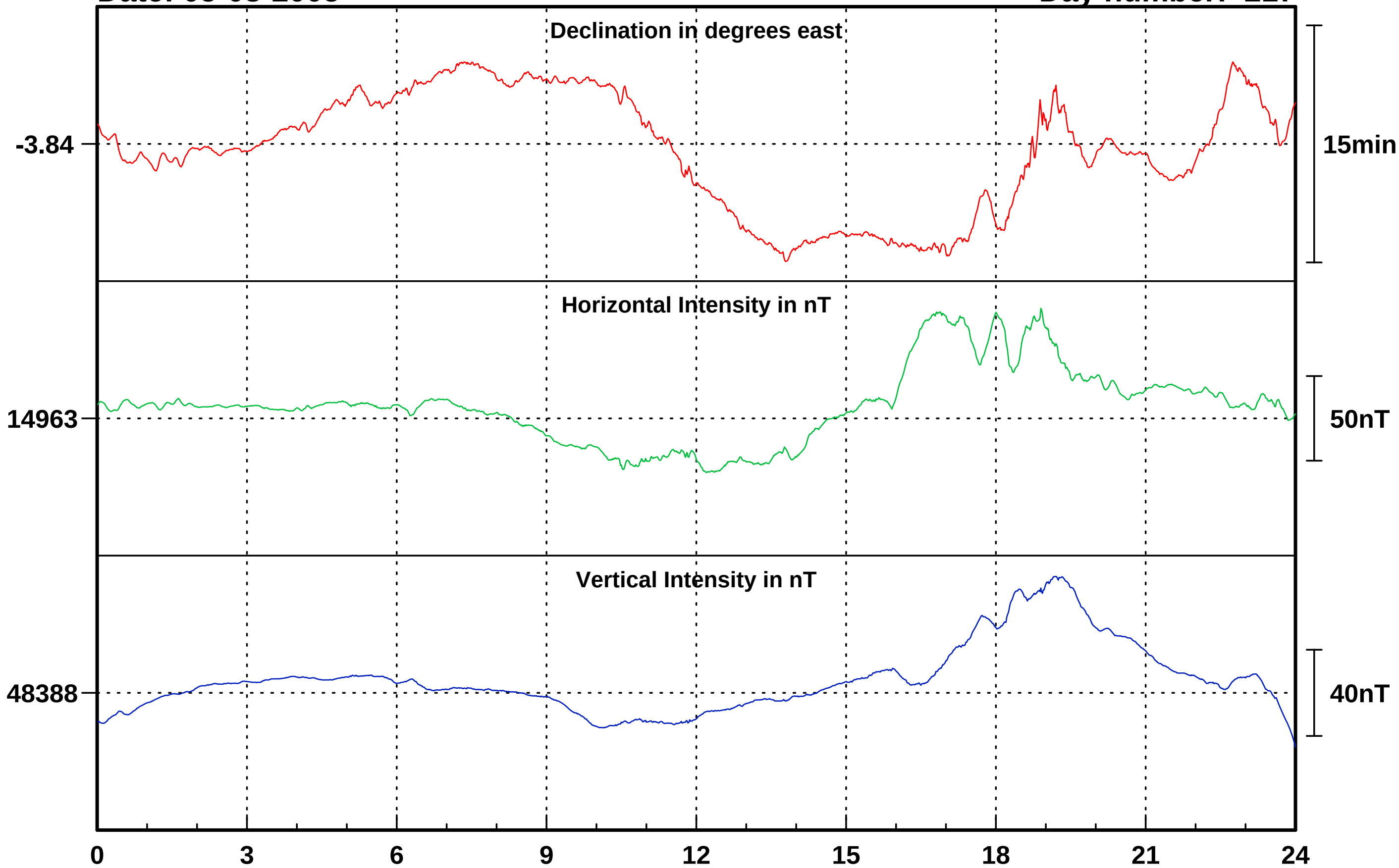
Day number: 216
Declination in degrees east
-3.84
15min
Horizontal Intensity in nT
14963
30nT
Vertical Intensity in nT
48388
50nT
0
3
6
9
12
15
18
21
24
Hour (UT)

Lerwick

Date: 05-08-2005 Day number: 217



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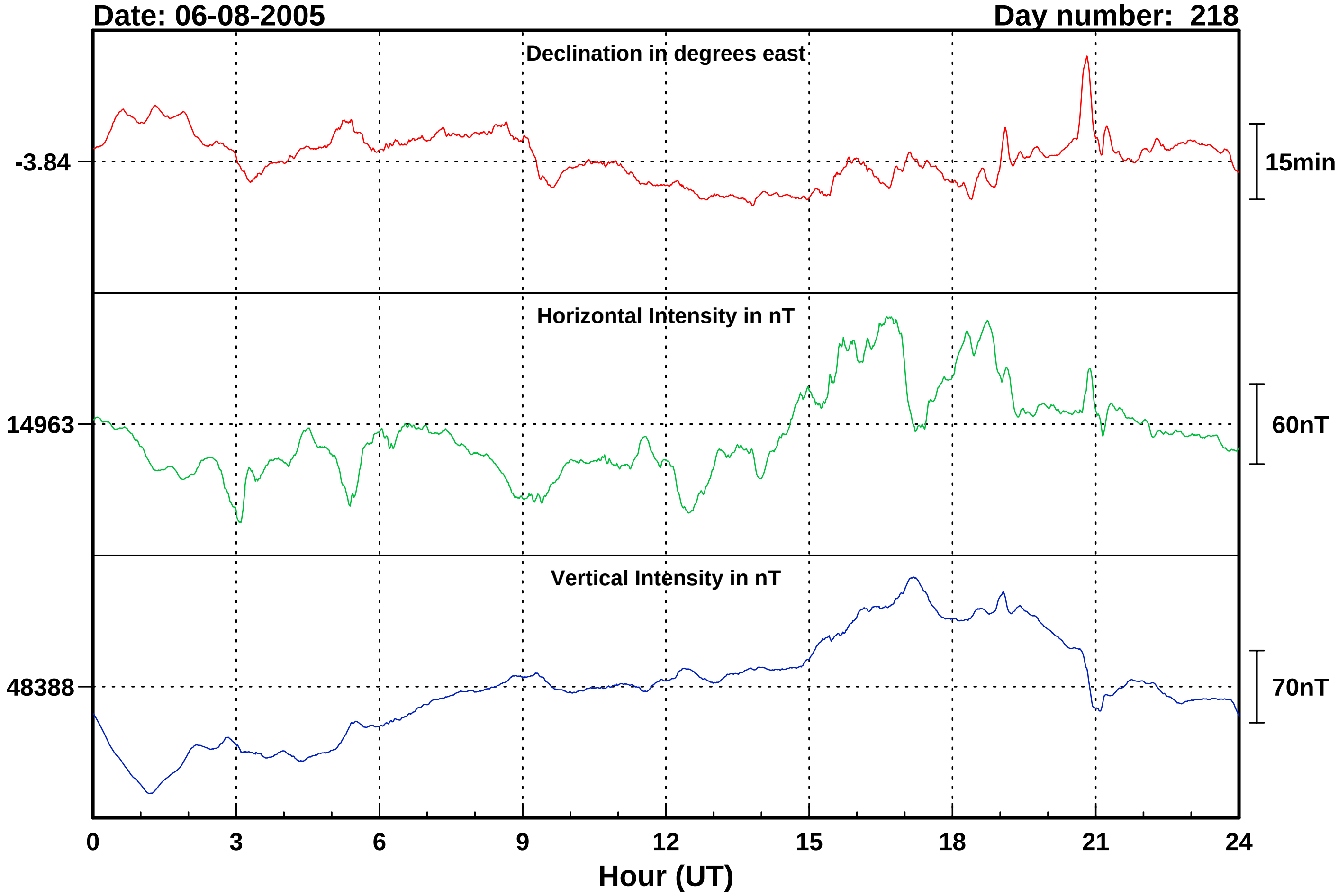
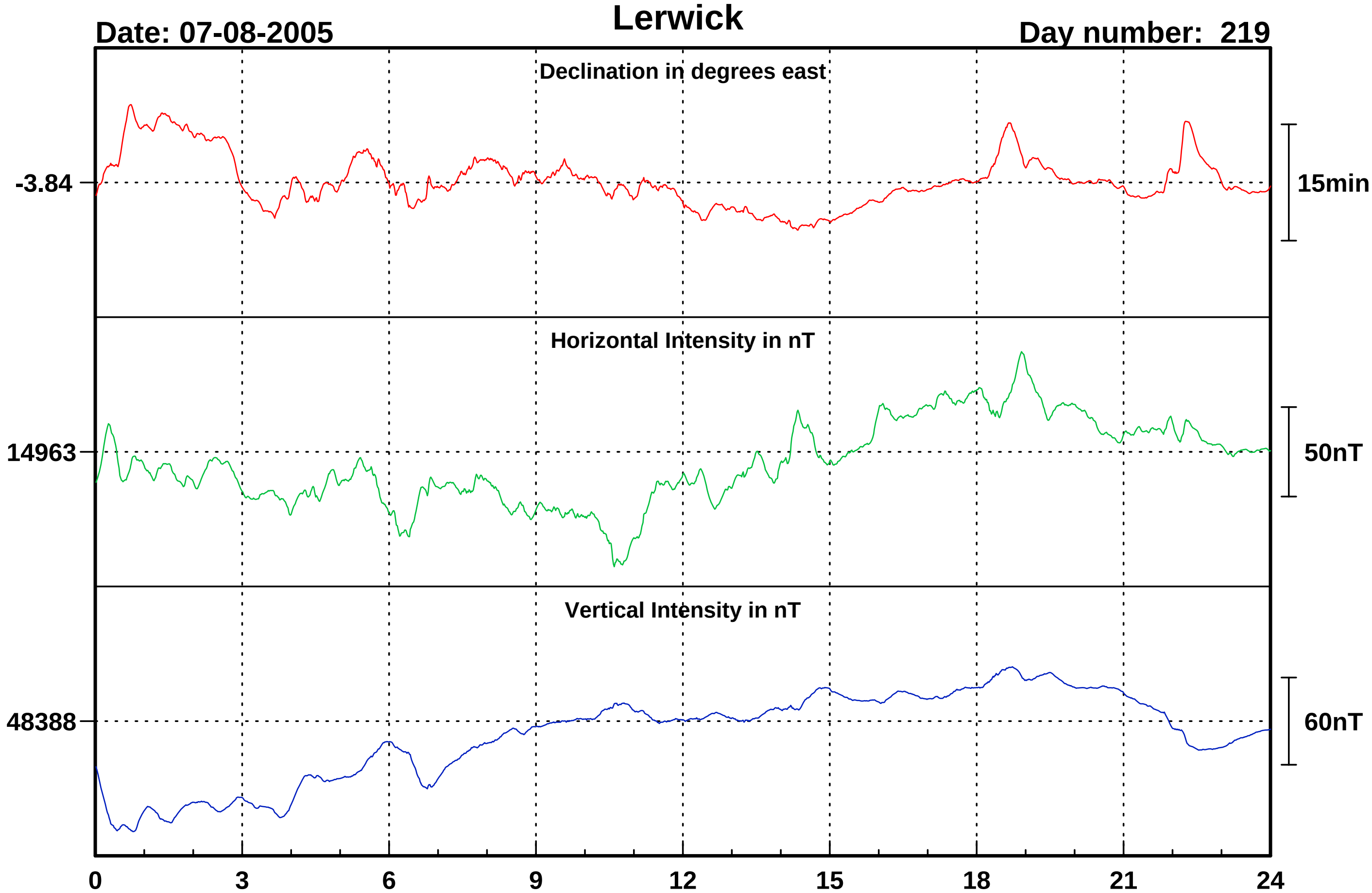


Lerwick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Day number: 219
Declination in degrees east
-3.84
15min
Horizontal Intensity in nT
14963
50nT
Vertical Intensity in nT
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60nT
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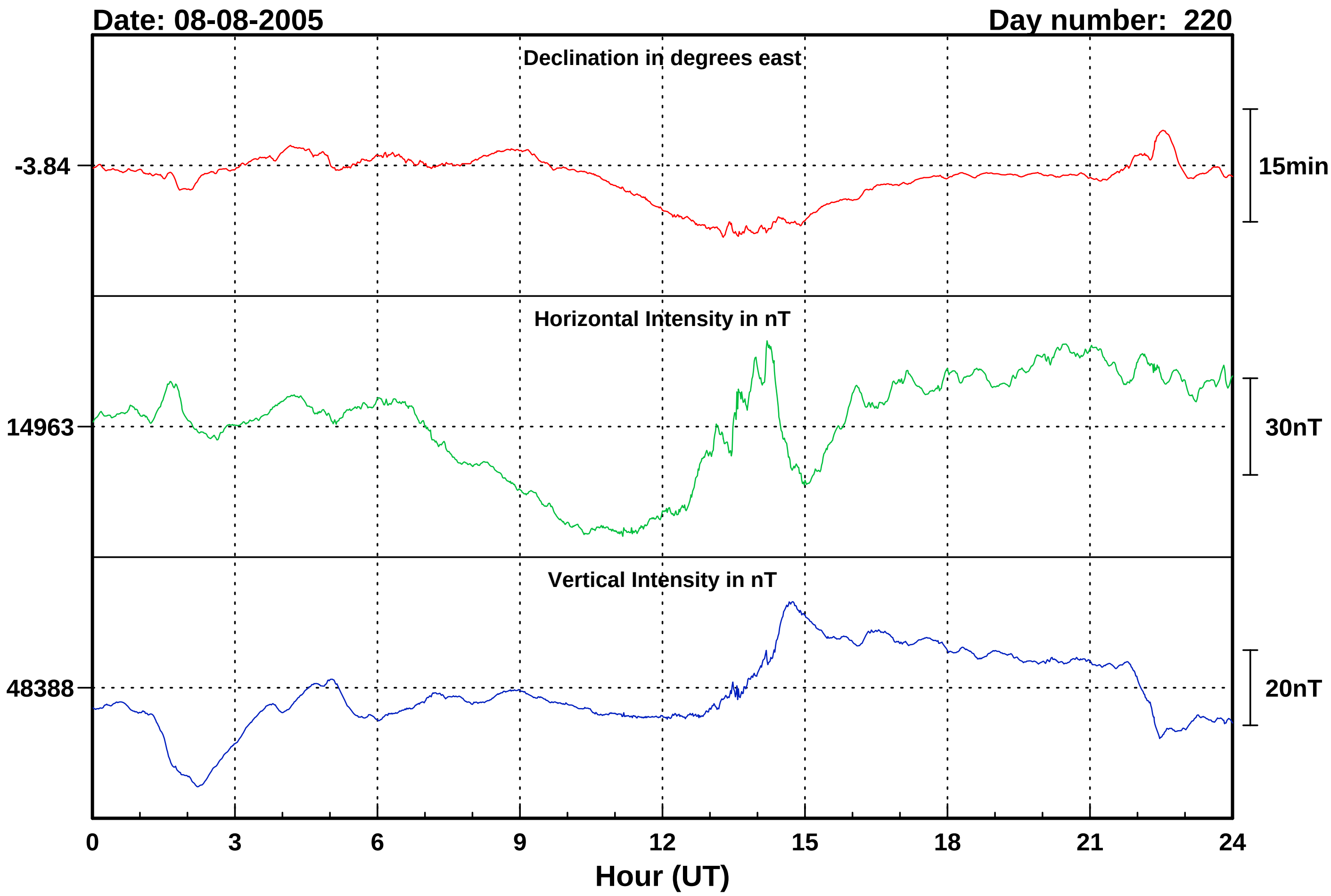
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Day number: 220
Declination in degrees east
-3.84
15min
Horizontal Intensity in nT
14963
30nT
Vertical Intensity in nT
48388
20nT
0
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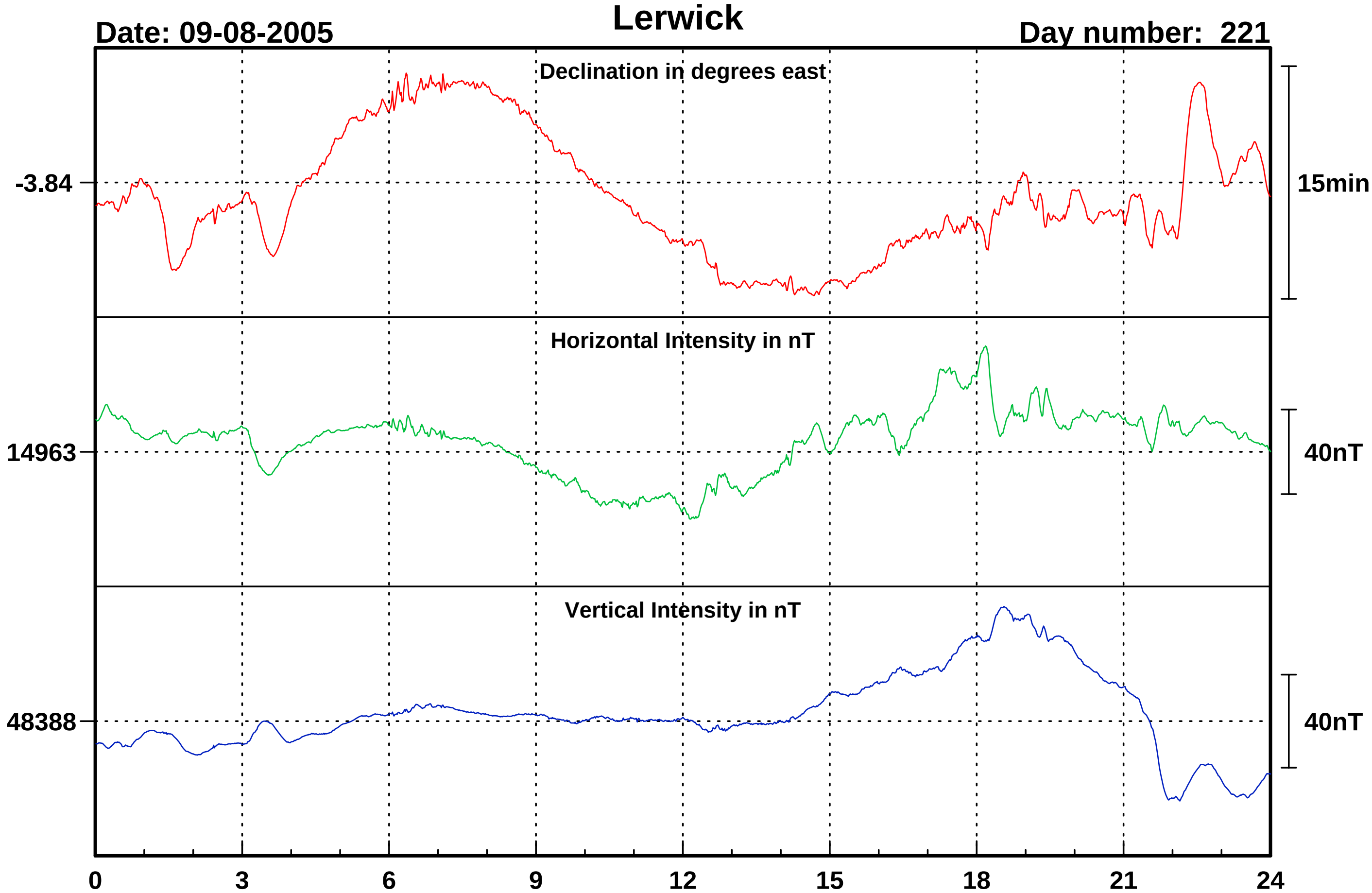
9
12
15
18
21
24
Hour (UT)

Lerwick



Date: 09-08-2005
Day number: 221
Declination in degrees east
-3.84
15min
Horizontal Intensity in nT
14963
40nT
Vertical Intensity in nT
48388
40nT
0
3
6
9
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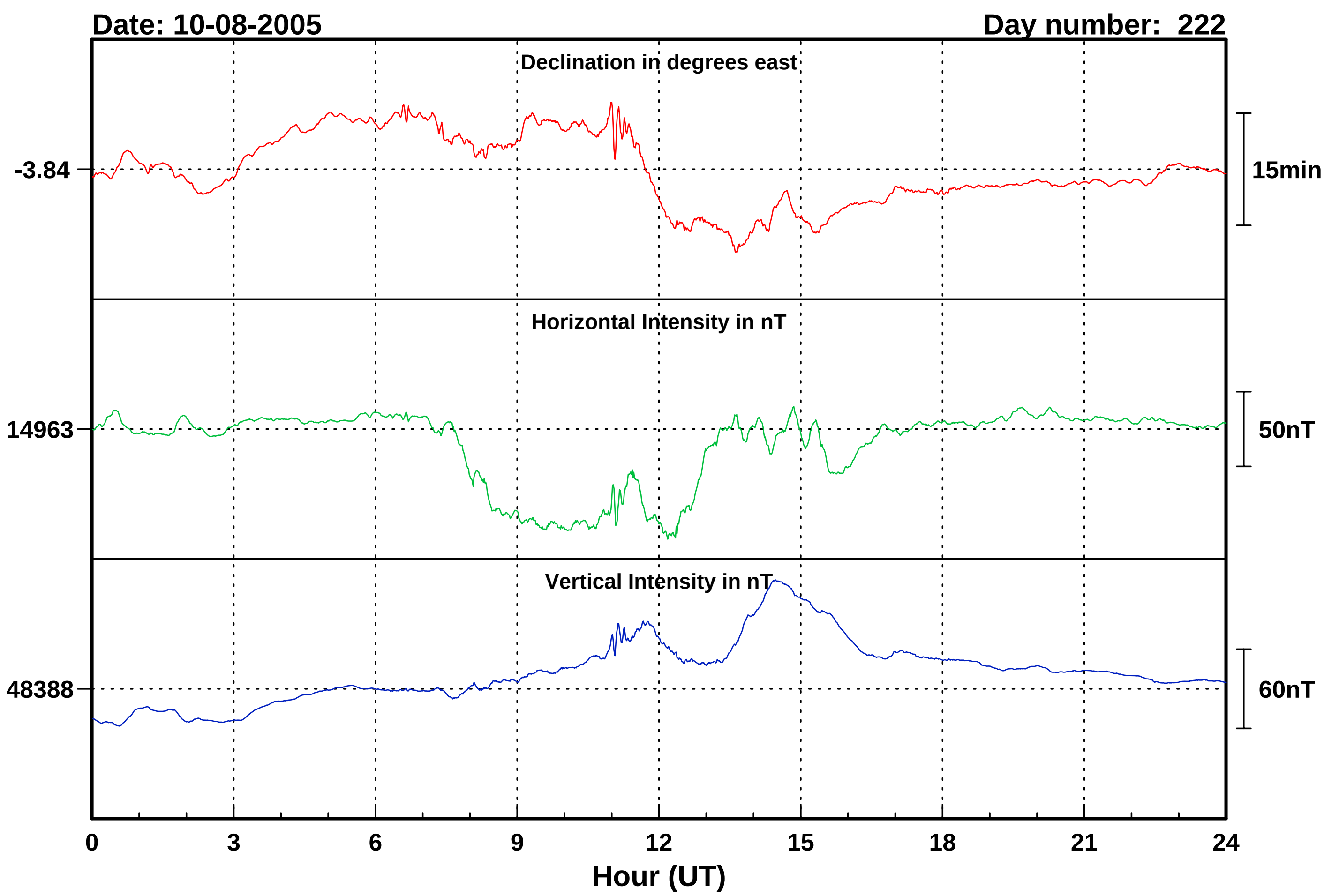
24



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Day number: 222
Declination in degrees east
-3.84
15min
Horizontal Intensity in nT
14963
50nT
Vertical Intensity in nT
48388
60nT
0
3
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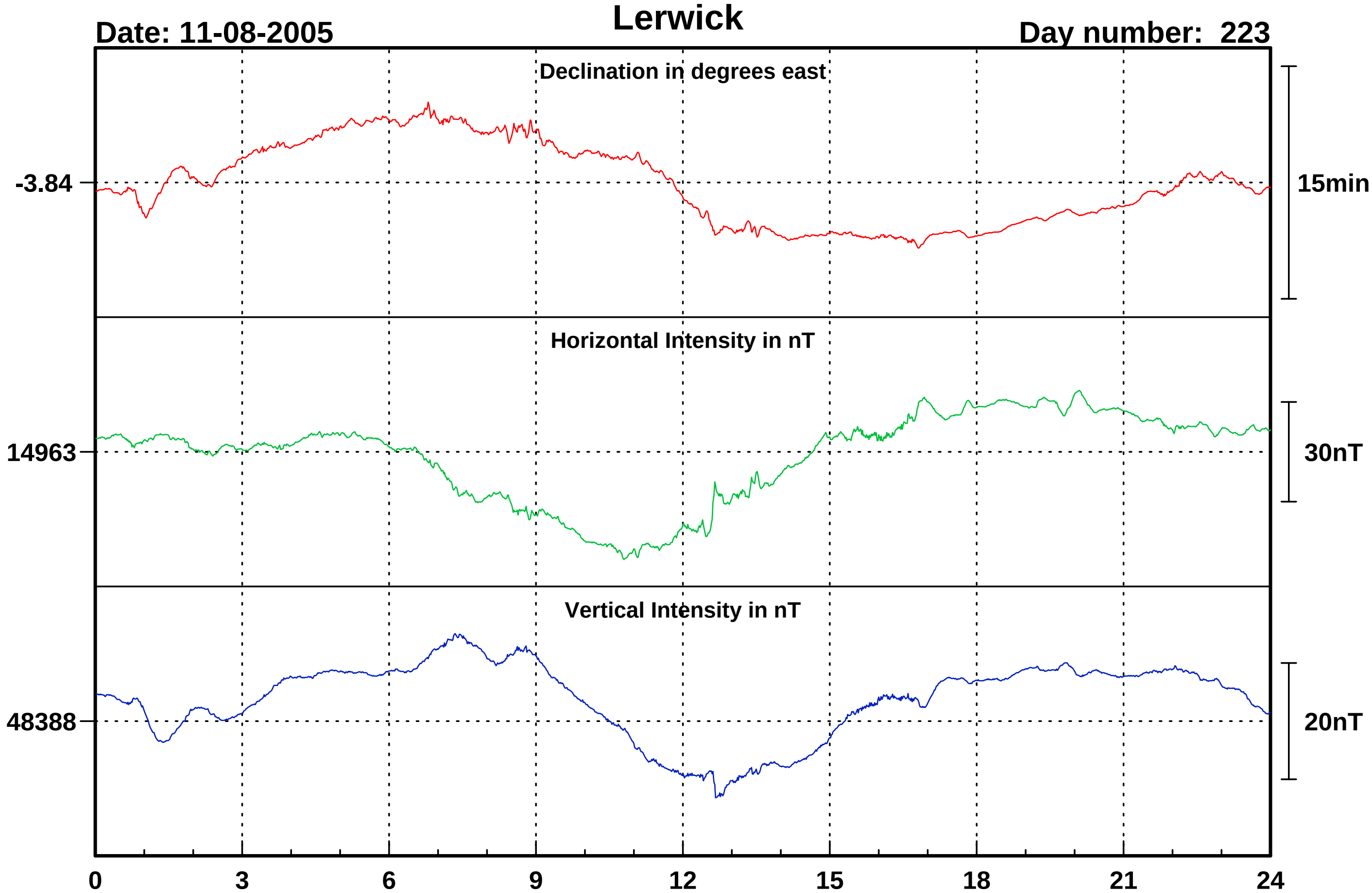
15
18
21
24
Hour (UT)

Lerwick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Day number: 223
Declination in degrees east
-3.84
15min
Horizontal Intensity in nT
14963
30nT
Vertical Intensity in nT
48388
20nT
0
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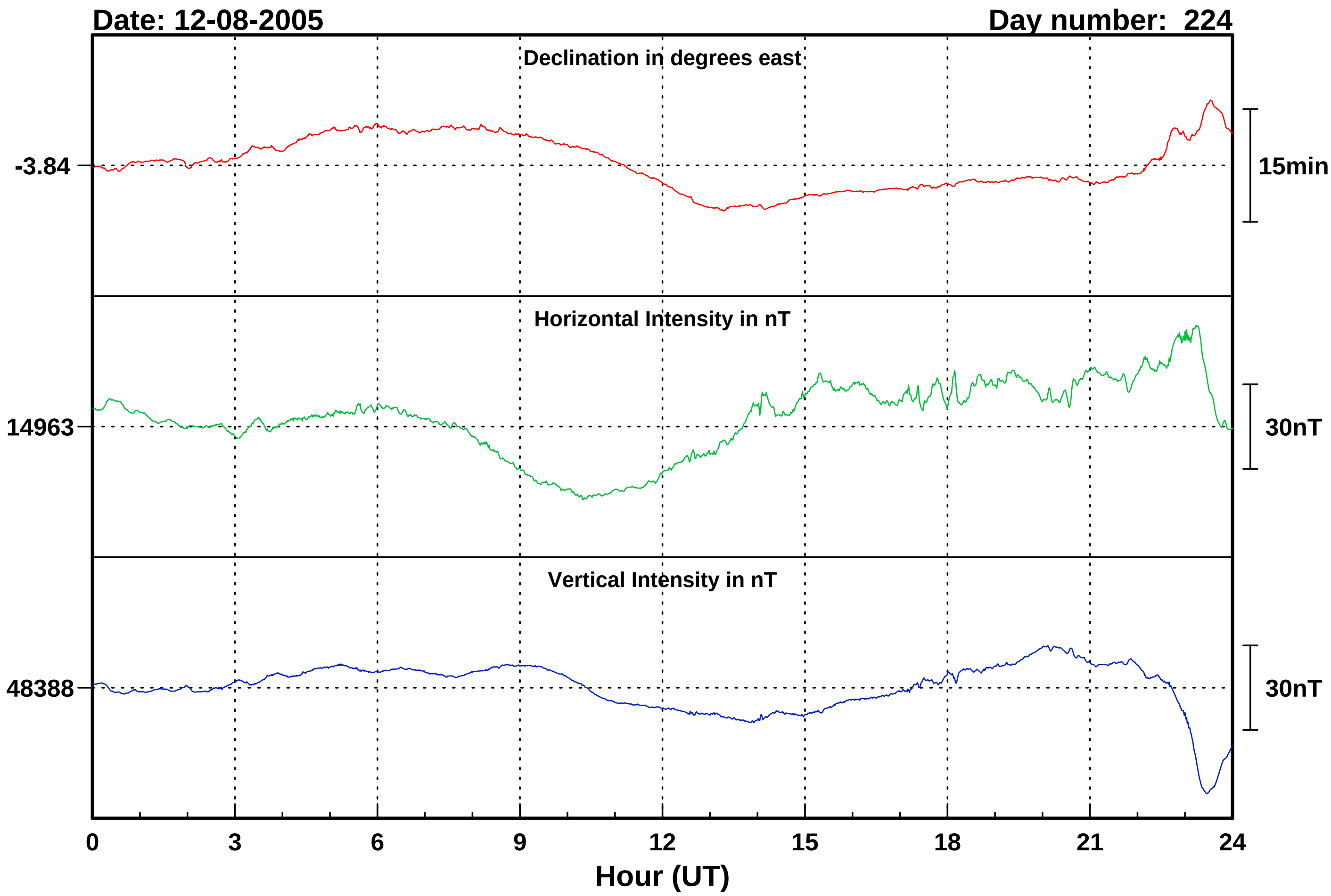
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Day number: 224
Declination in degrees east
-3.84
15min
Horizontal Intensity in nT
14963
30nT
Vertical Intensity in nT
48388
30nT
0
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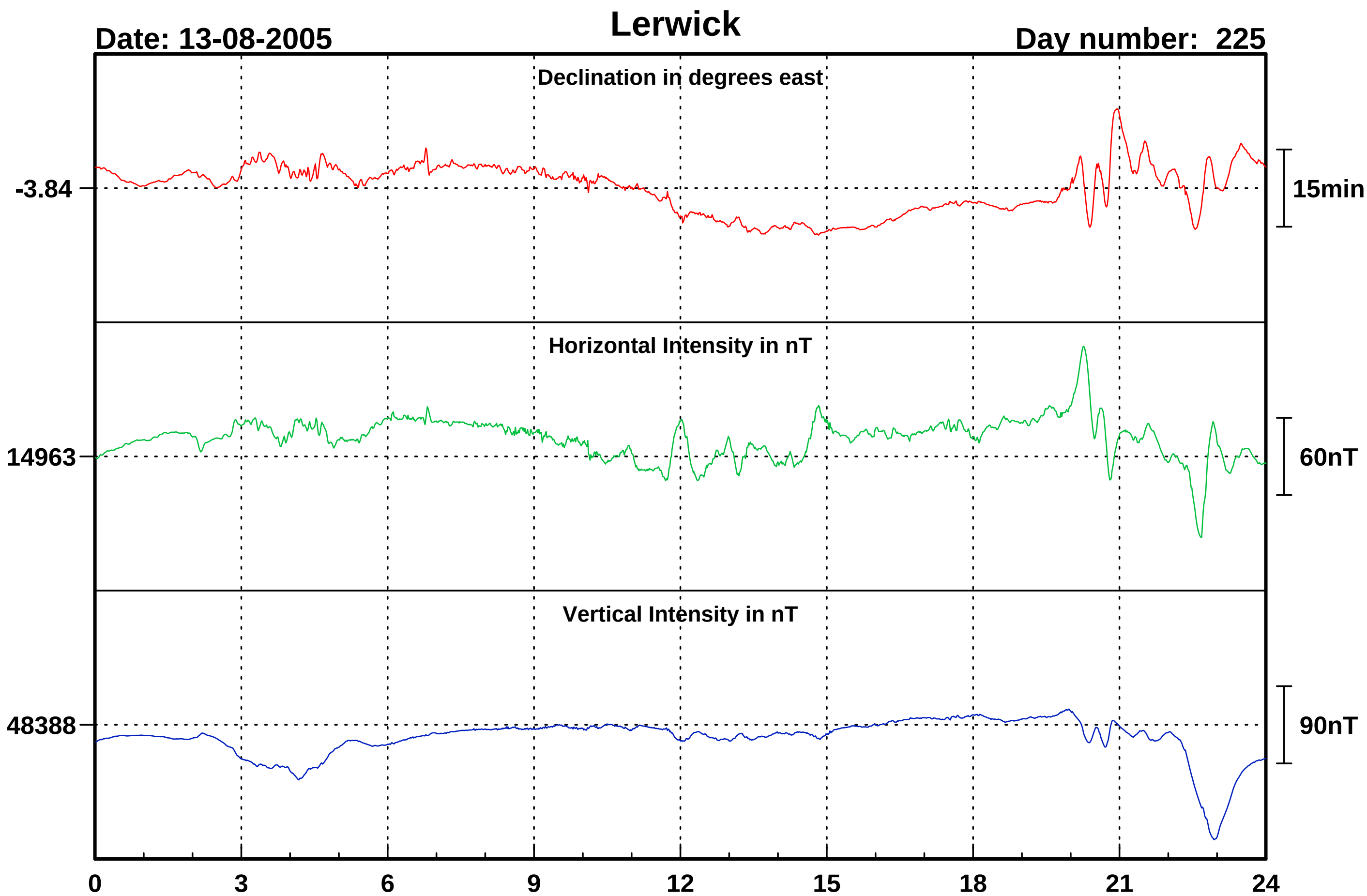
24
Hour (UT)


Lerwick
Date: 13-08-2005
Day number: 225
Declination in degrees east
-3.84
15min
Horizontal Intensity in nT
14963
60nT
Vertical Intensity in nT
48388
90nT
0
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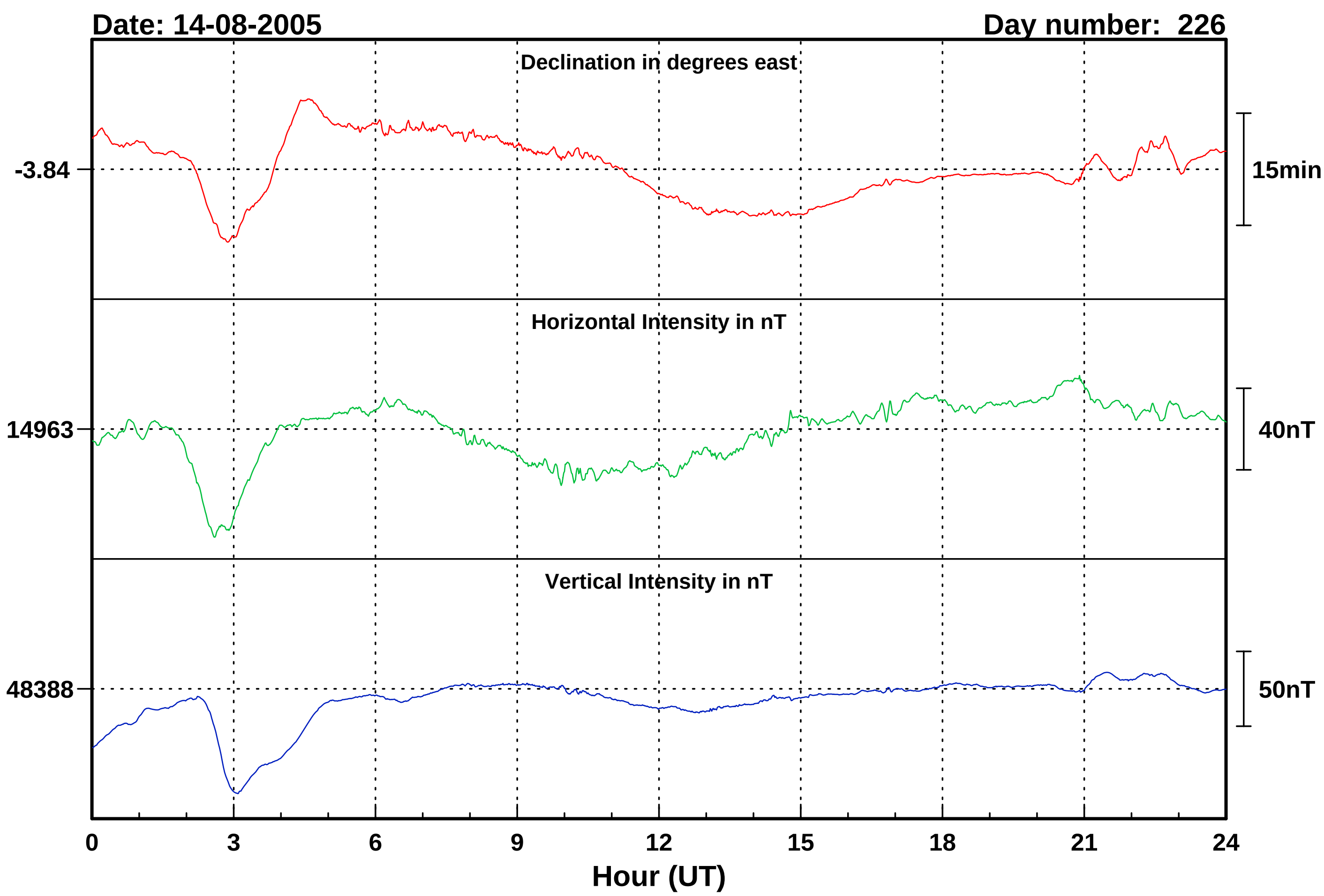
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Day number: 226
Declination in degrees east
-3.84
15min
Horizontal Intensity in nT
14963
40nT
Vertical Intensity in nT
48388
50nT
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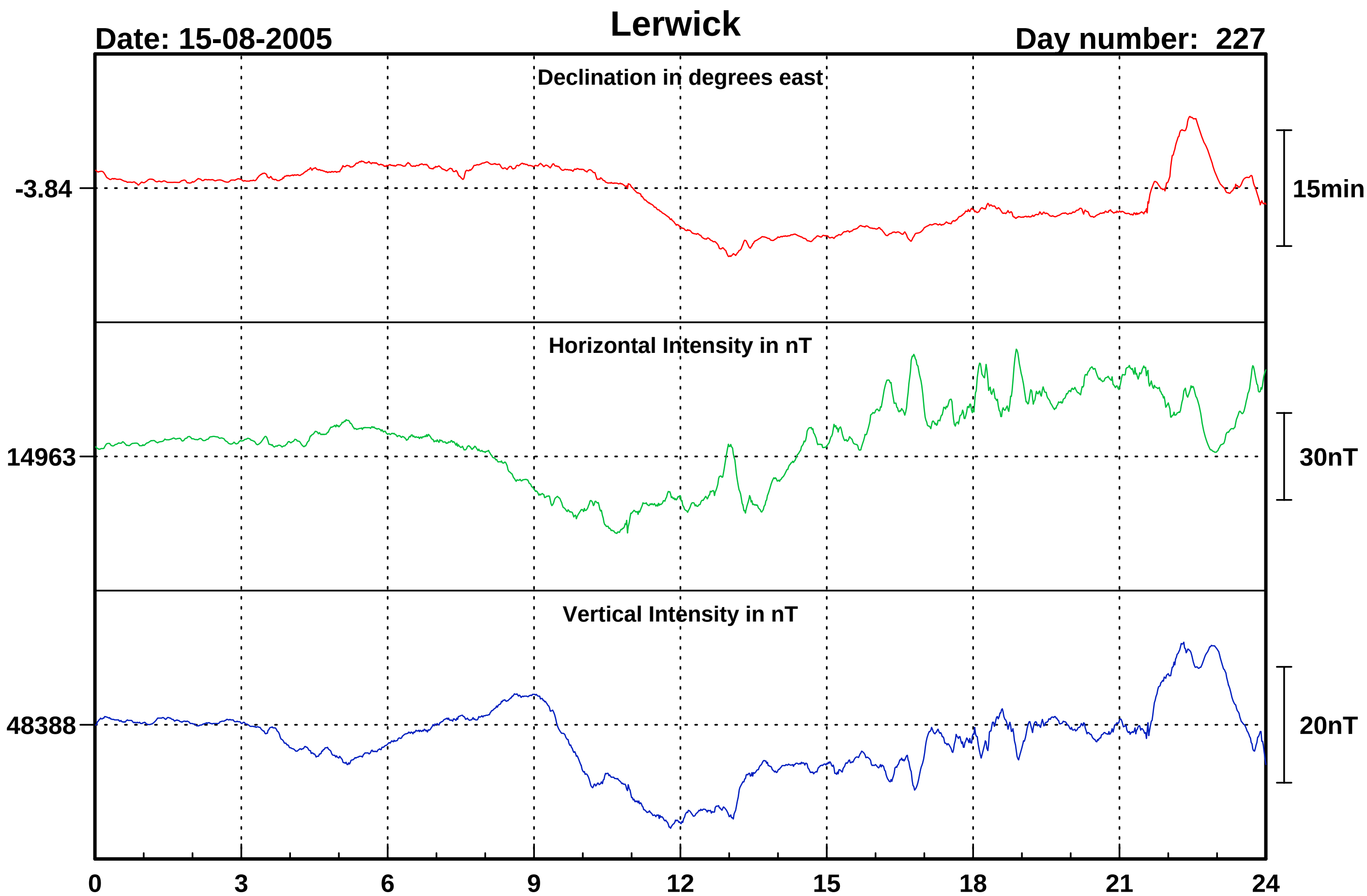
24
Hour (UT)



Lerwick
Date: 15-08-2005
Day number: 227
Declination in degrees east
Horizontal Intensity in nT
Vertical Intensity in nT
-3.84
14963
48388
15min
30nT
20nT
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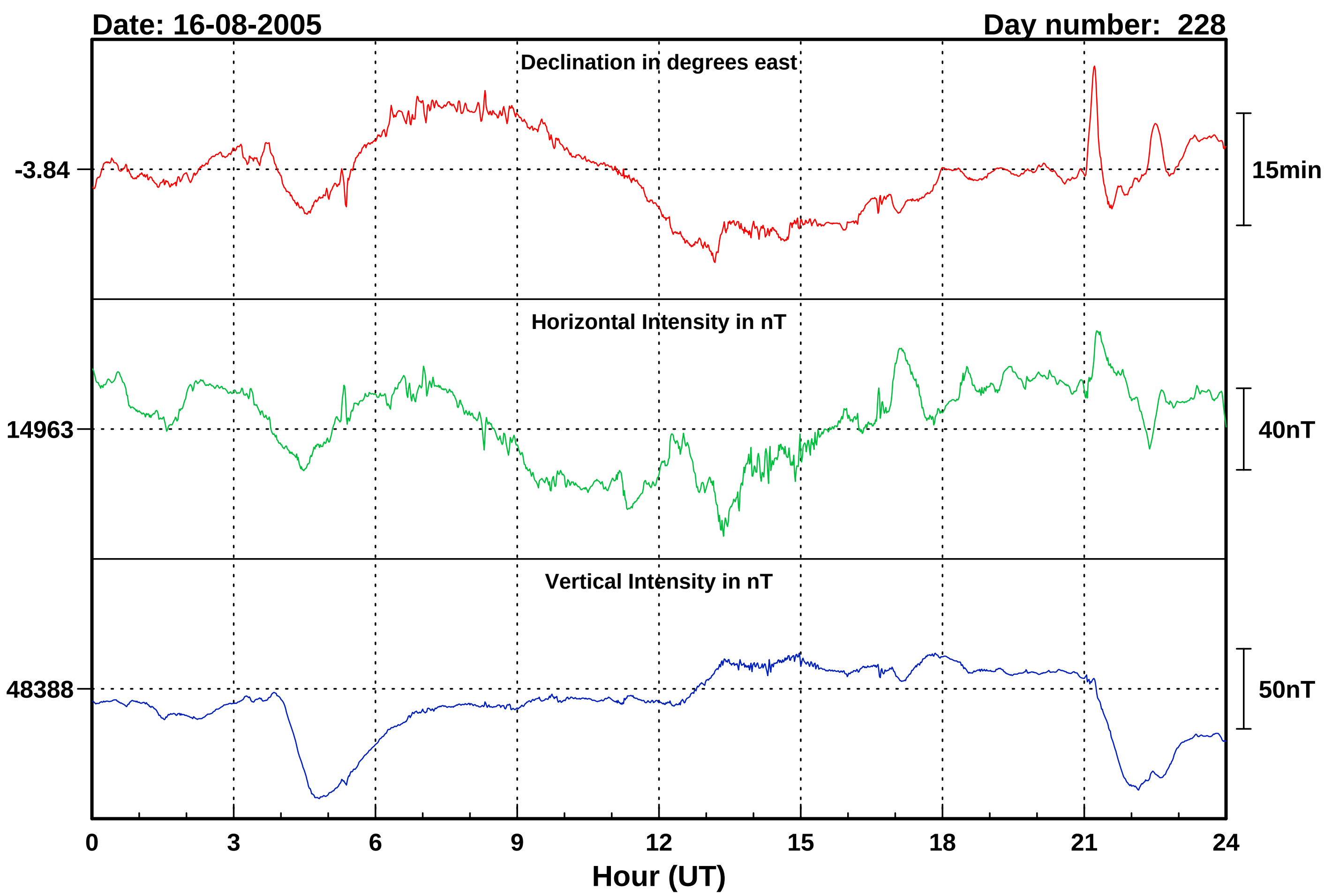

Date: 16-08-2005
Day number: 228
Declination in degrees east
Horizontal Intensity in nT
Vertical Intensity in nT
-3.84
14963
48388
15min
40nT
50nT
0
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12
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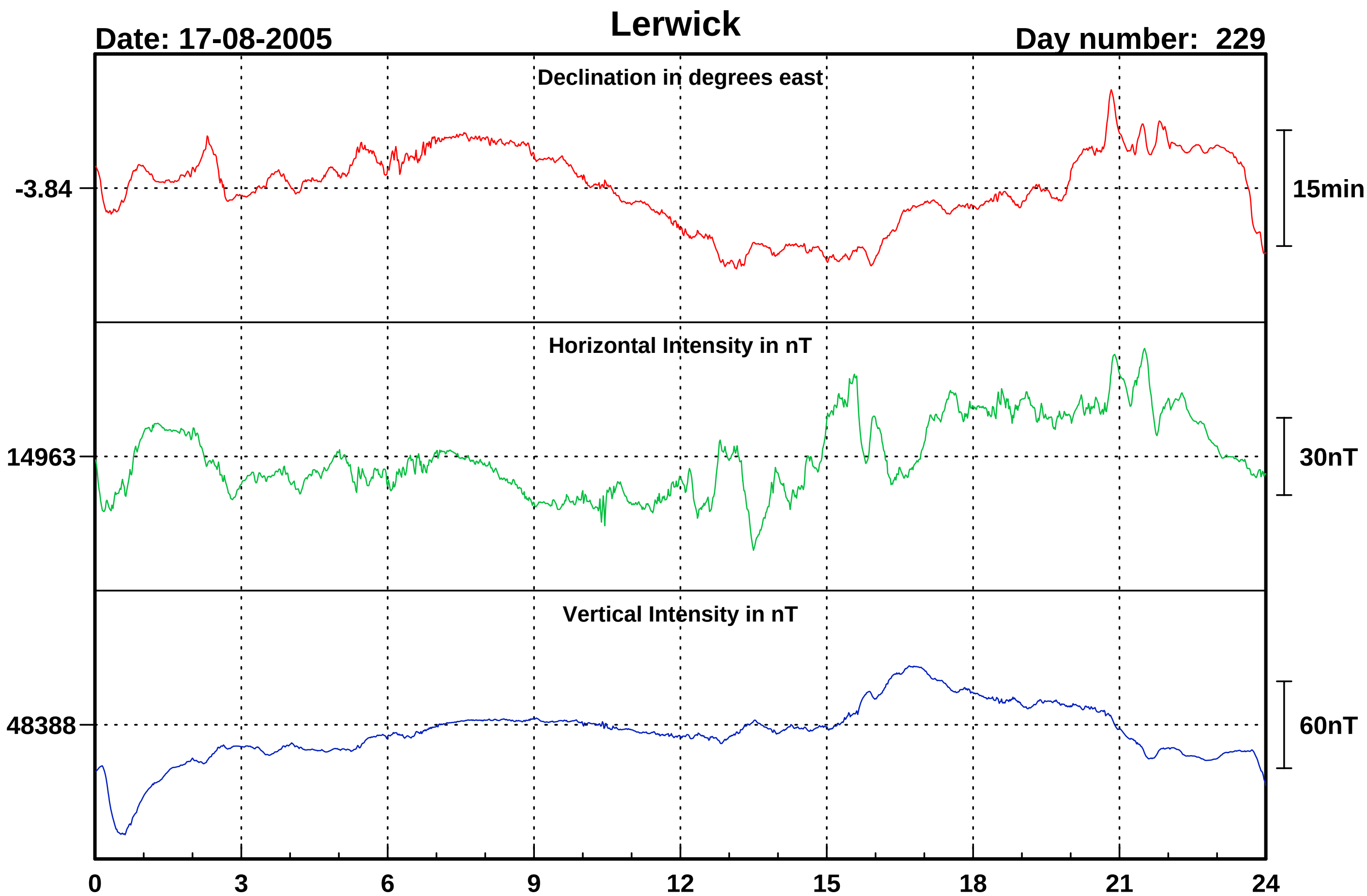
21
24
Hour (UT)


Lerwick
Date: 17-08-2005
Day number: 229
Declination in degrees east
-3.84
15min
Horizontal Intensity in nT
14963
30nT
Vertical Intensity in nT
48388
60nT
0
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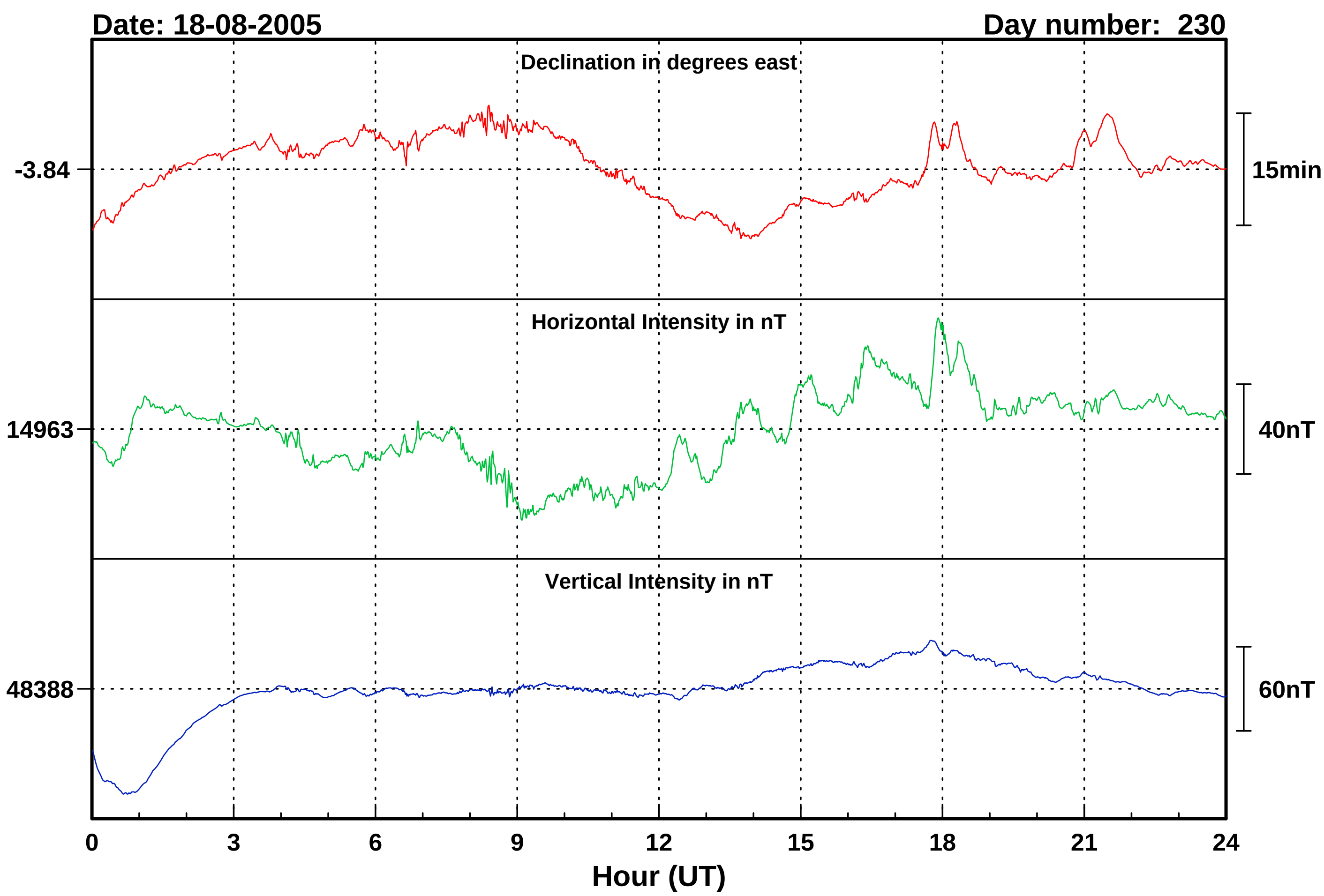
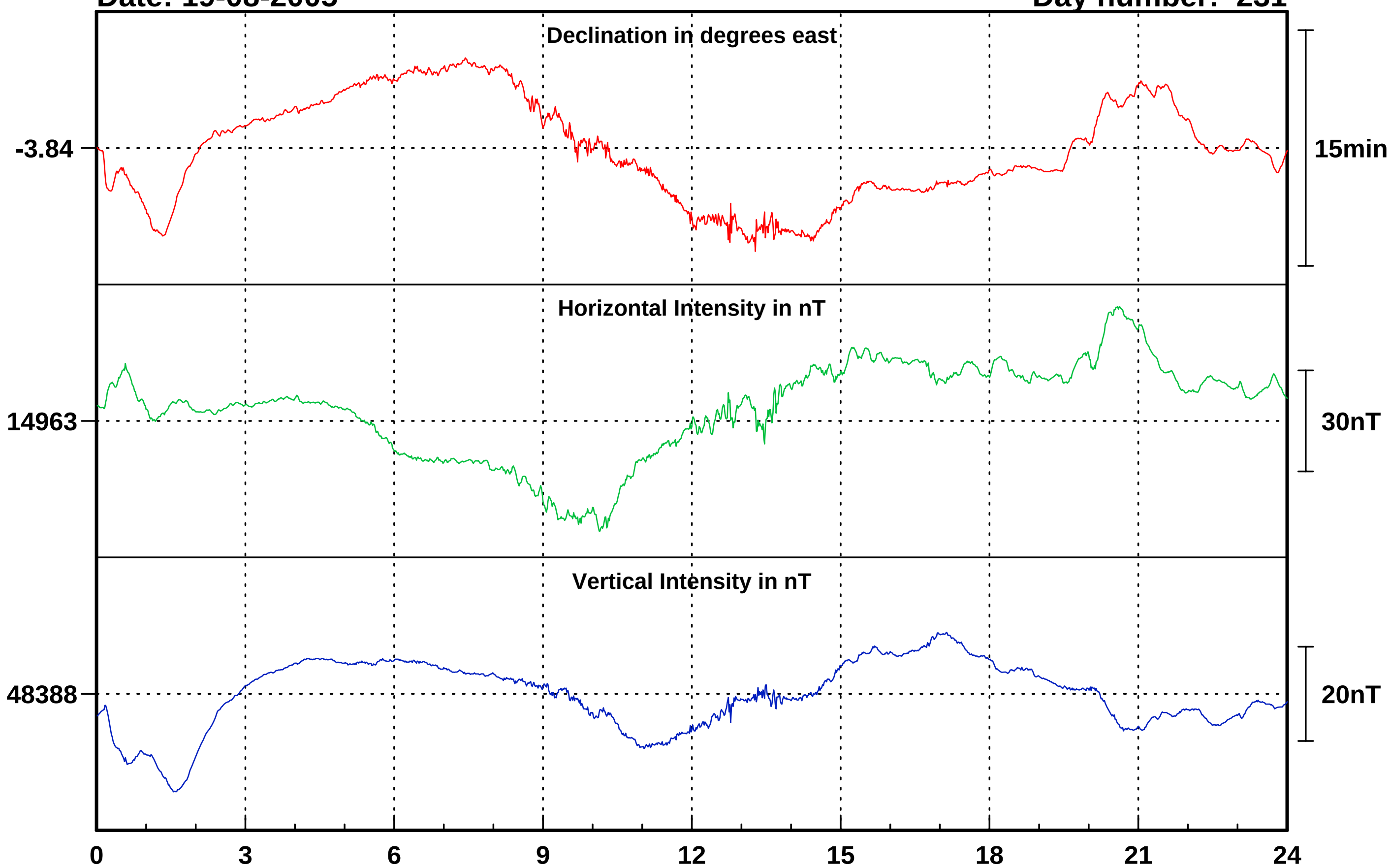

Date: 18-08-2005
Day number: 230
Declination in degrees east
-3.84
15min
Horizontal Intensity in nT
14963
40nT
Vertical Intensity in nT
48388
60nT
0
3
6
9
12
15
18
21
24
Hour (UT)

Lerwick



Date: 19-08-2005
Day number: 231
Declination in degrees east
-3.84
15min
Horizontal Intensity in nT
14963
30nT
Vertical Intensity in nT
48388
20nT
0
3
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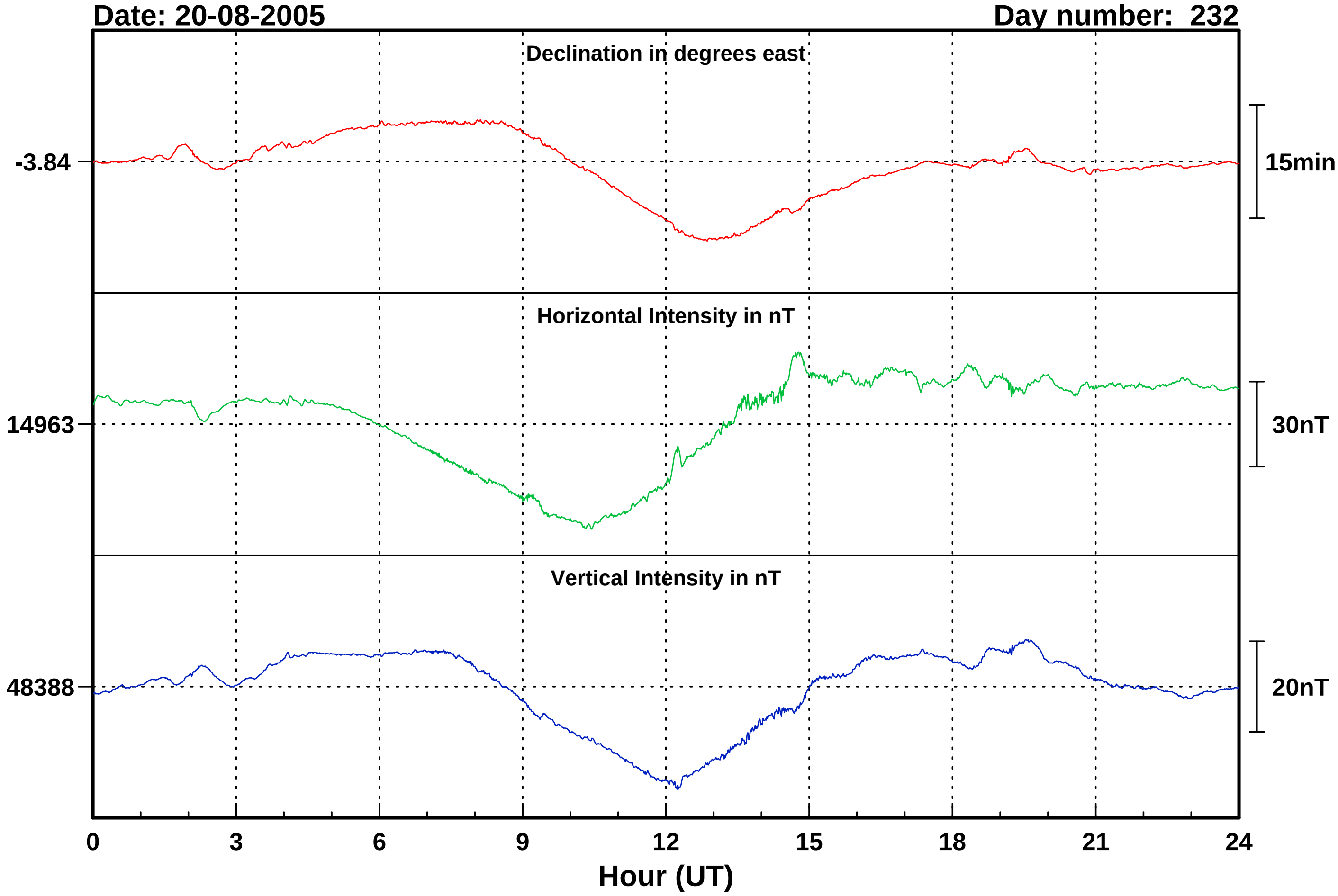

Date: 20-08-2005
Day number: 232
Declination in degrees east
-3.84
15min
Horizontal Intensity in nT
14963
30nT
Vertical Intensity in nT
48388
20nT
0
3
6
9
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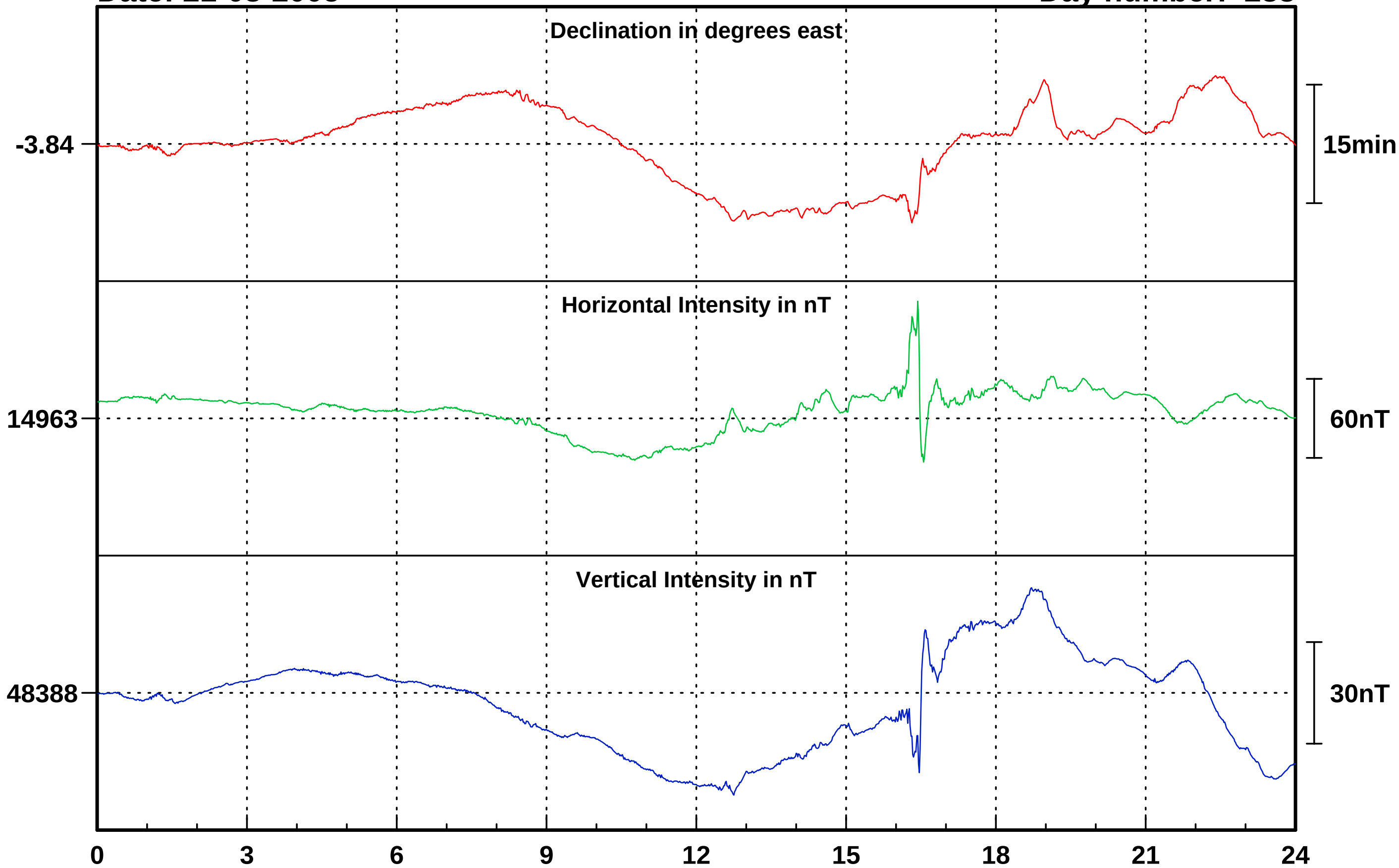
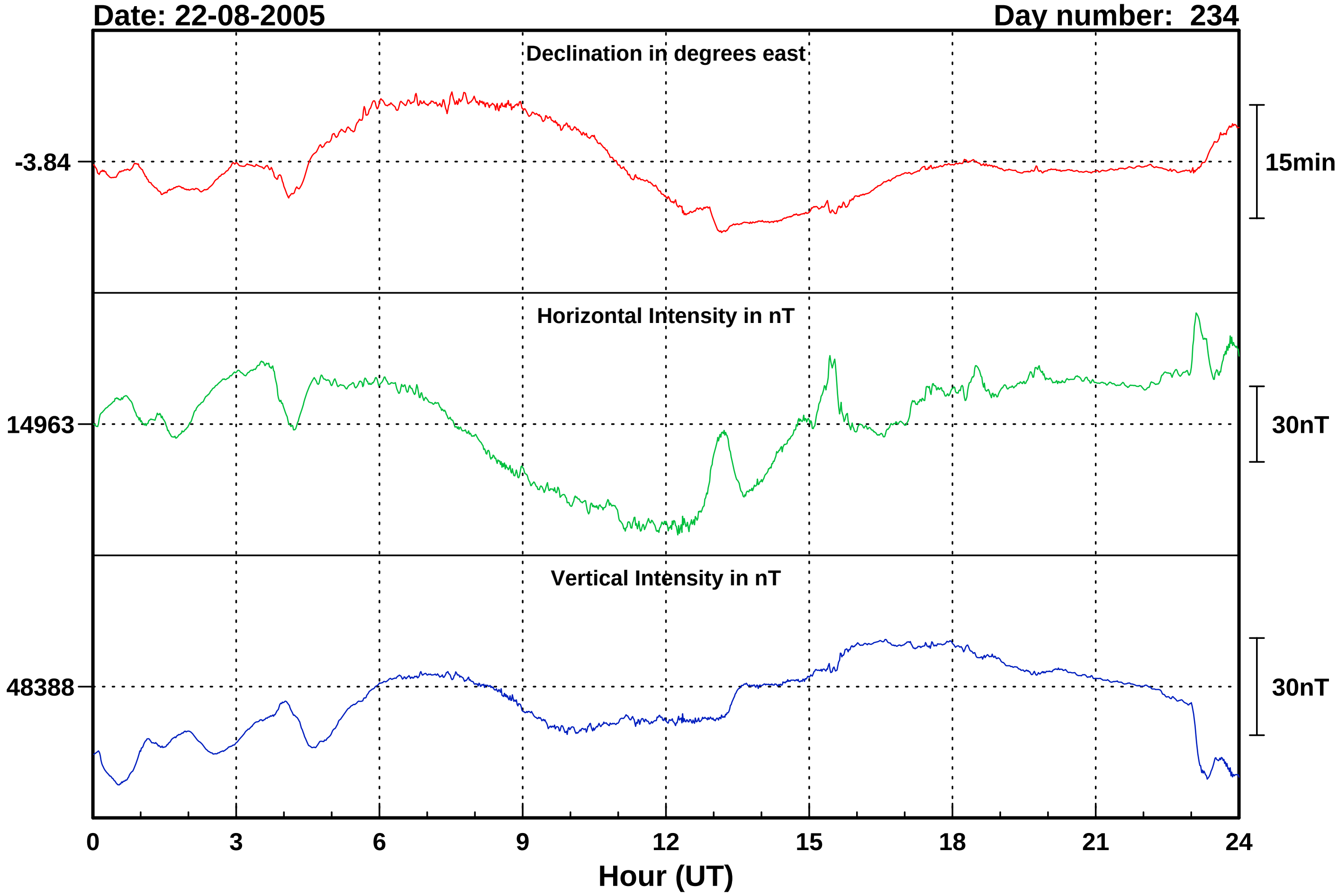
18
21
24
Hour (UT)

Lerwick

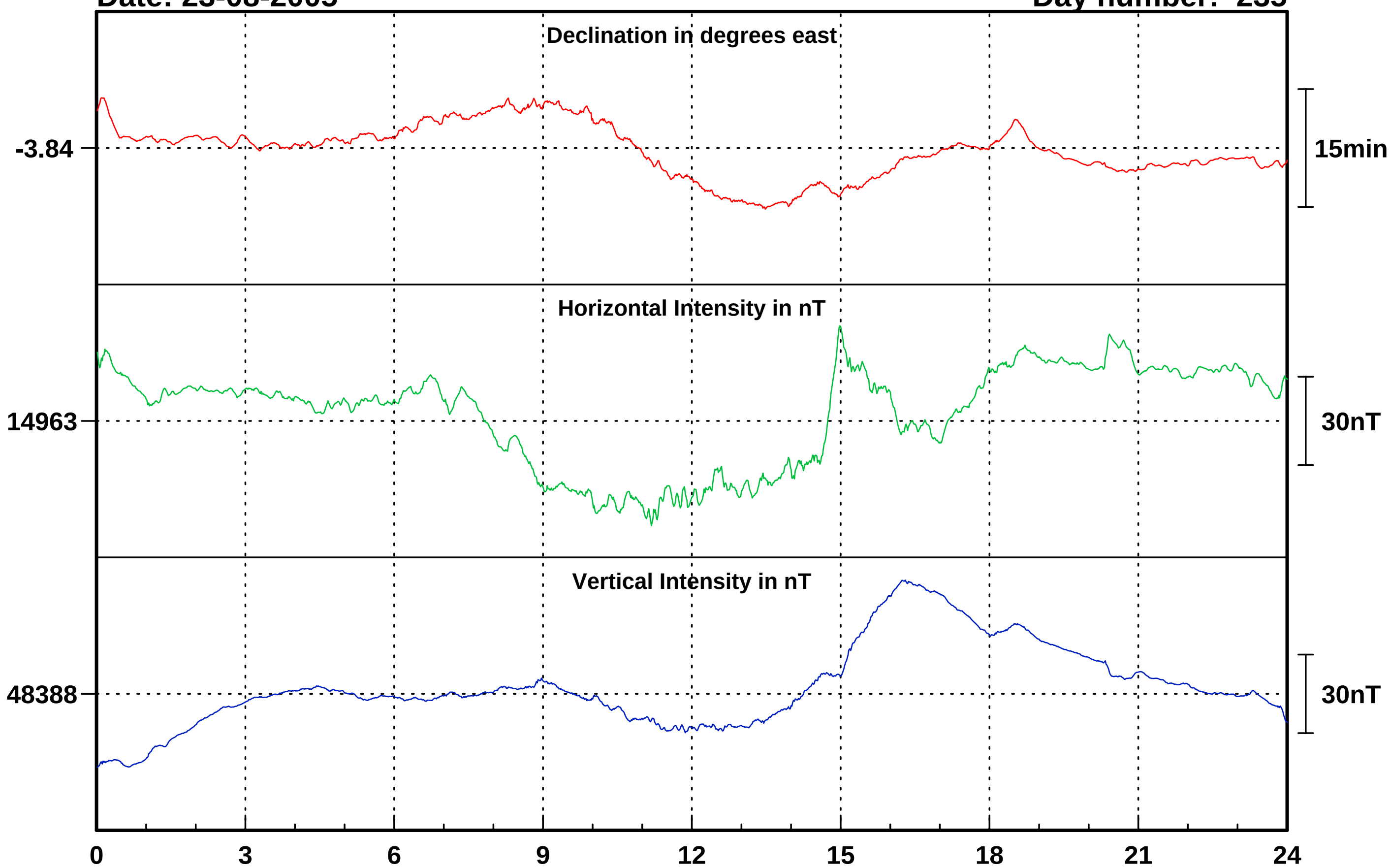
Date: 21-08-2005 **Day number: 233**



Date: 22-08-2005 **Day number: 234**



Lerwick


Date: 23-08-2005
Day number: 235
Declination in degrees east
-3.84
15min
Horizontal Intensity in nT
14963
30nT
Vertical Intensity in nT
48388
30nT
0
3
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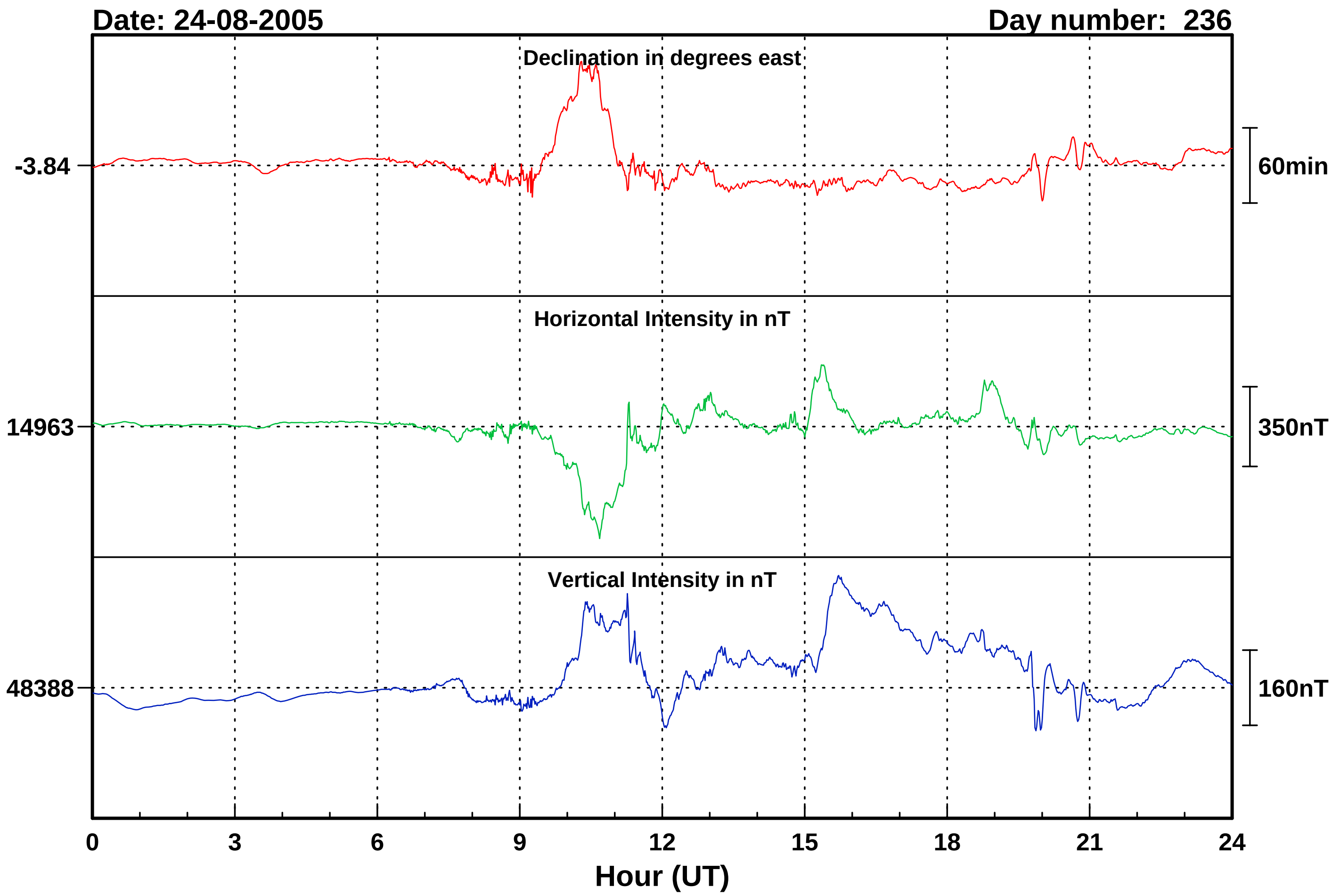
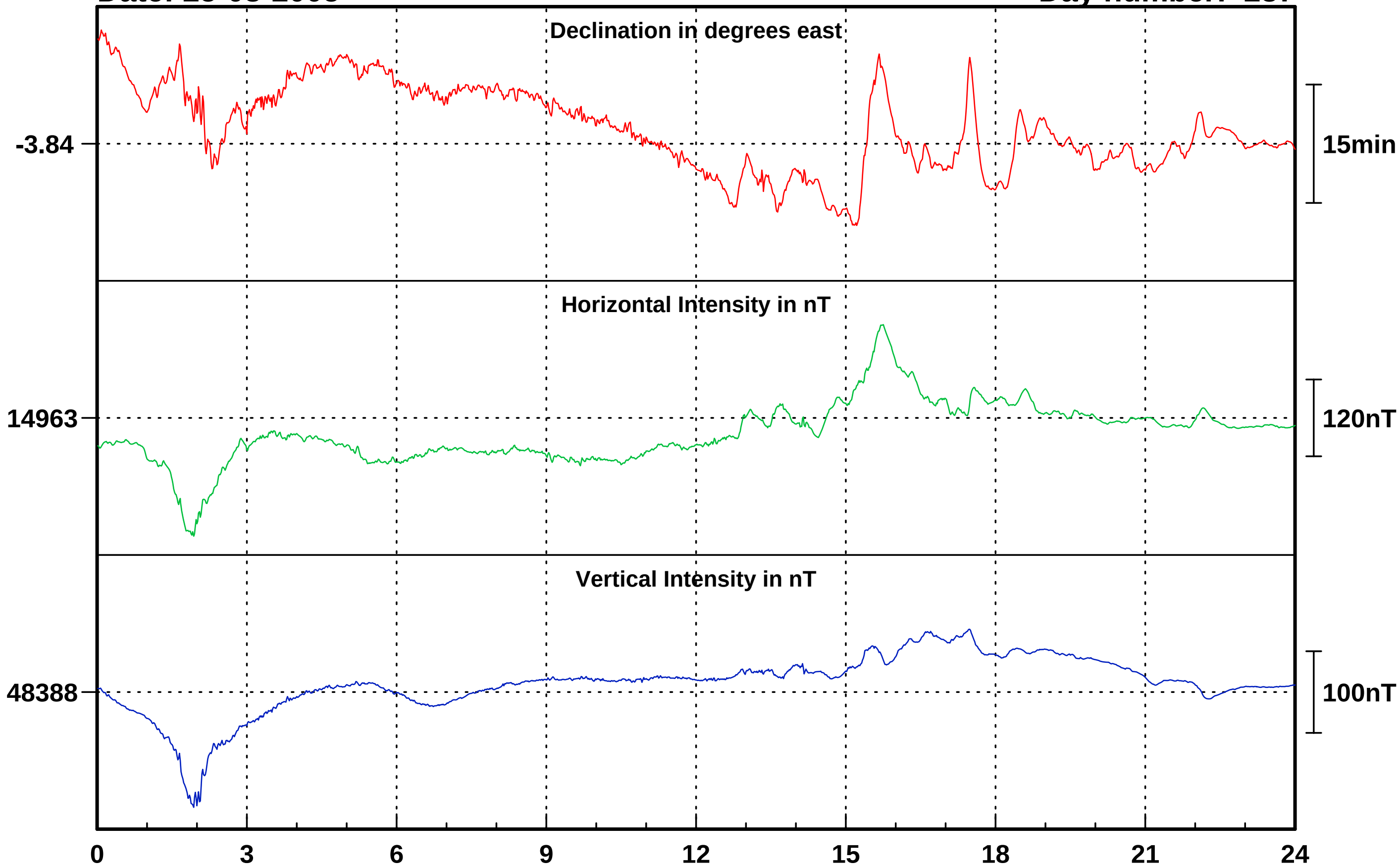
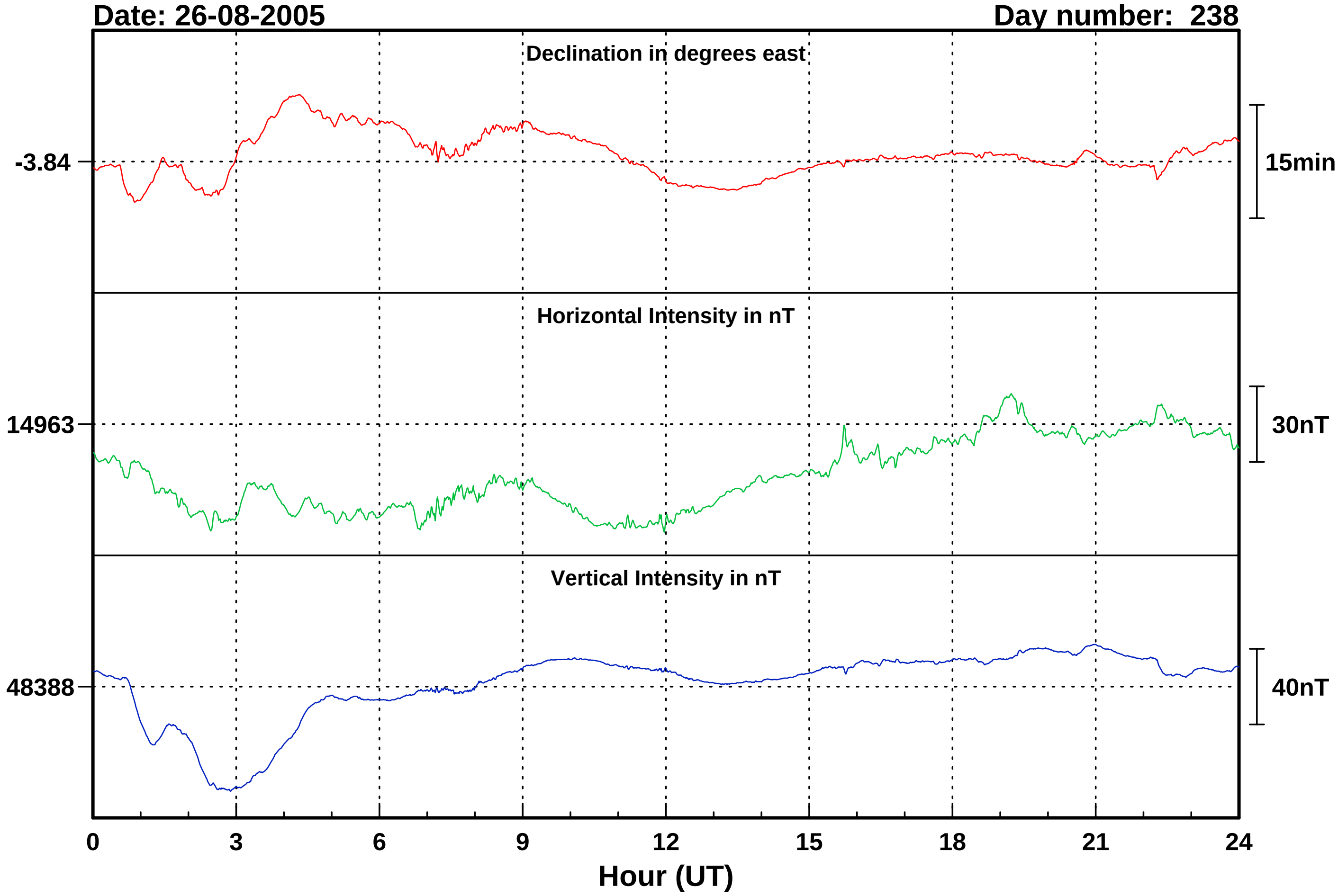

Date: 24-08-2005
Day number: 236
Declination in degrees east
-3.84
60min
Horizontal Intensity in nT
14963
350nT
Vertical Intensity in nT
48388
160nT
0
3
6
9
12
15
18
21
24
Hour (UT)

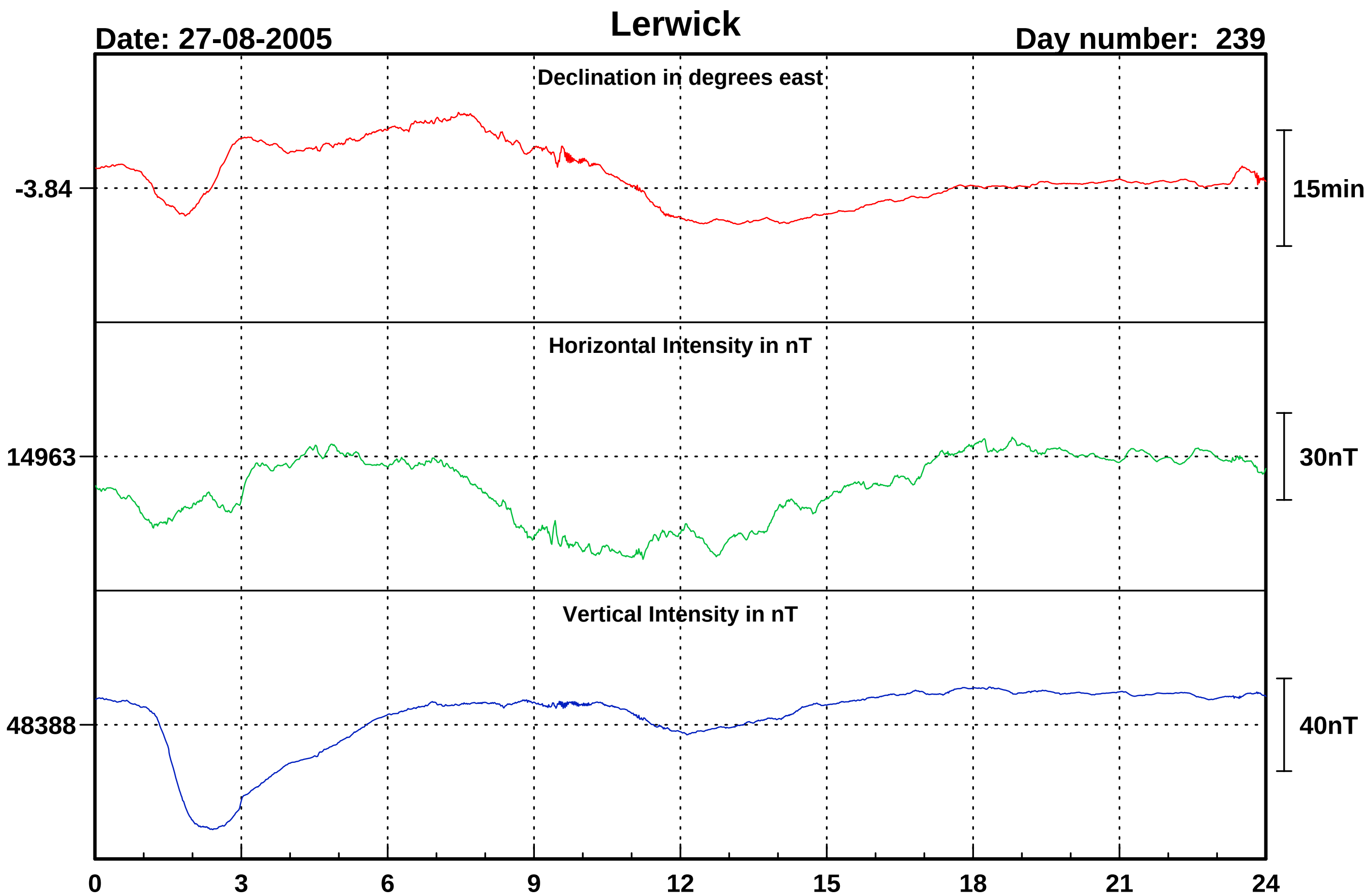
Lerwick

Date: 25-08-2005 **Day number: 237**



Date: 26-08-2005 **Day number: 238**




Lerwick
Date: 27-08-2005
Day number: 239
Declination in degrees east
-3.84
15min
Horizontal Intensity in nT
14963
30nT
Vertical Intensity in nT
48388
40nT
0
3
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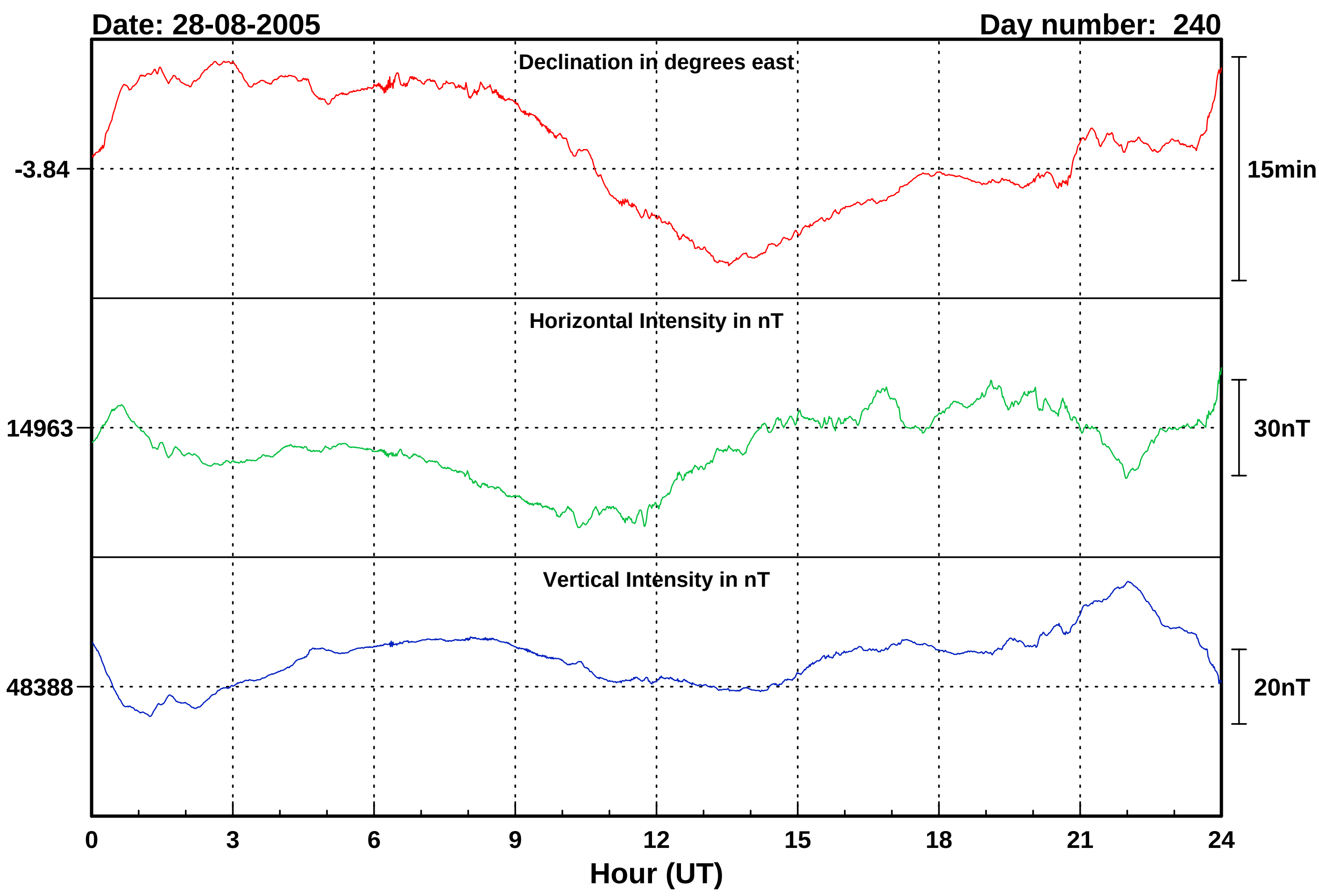
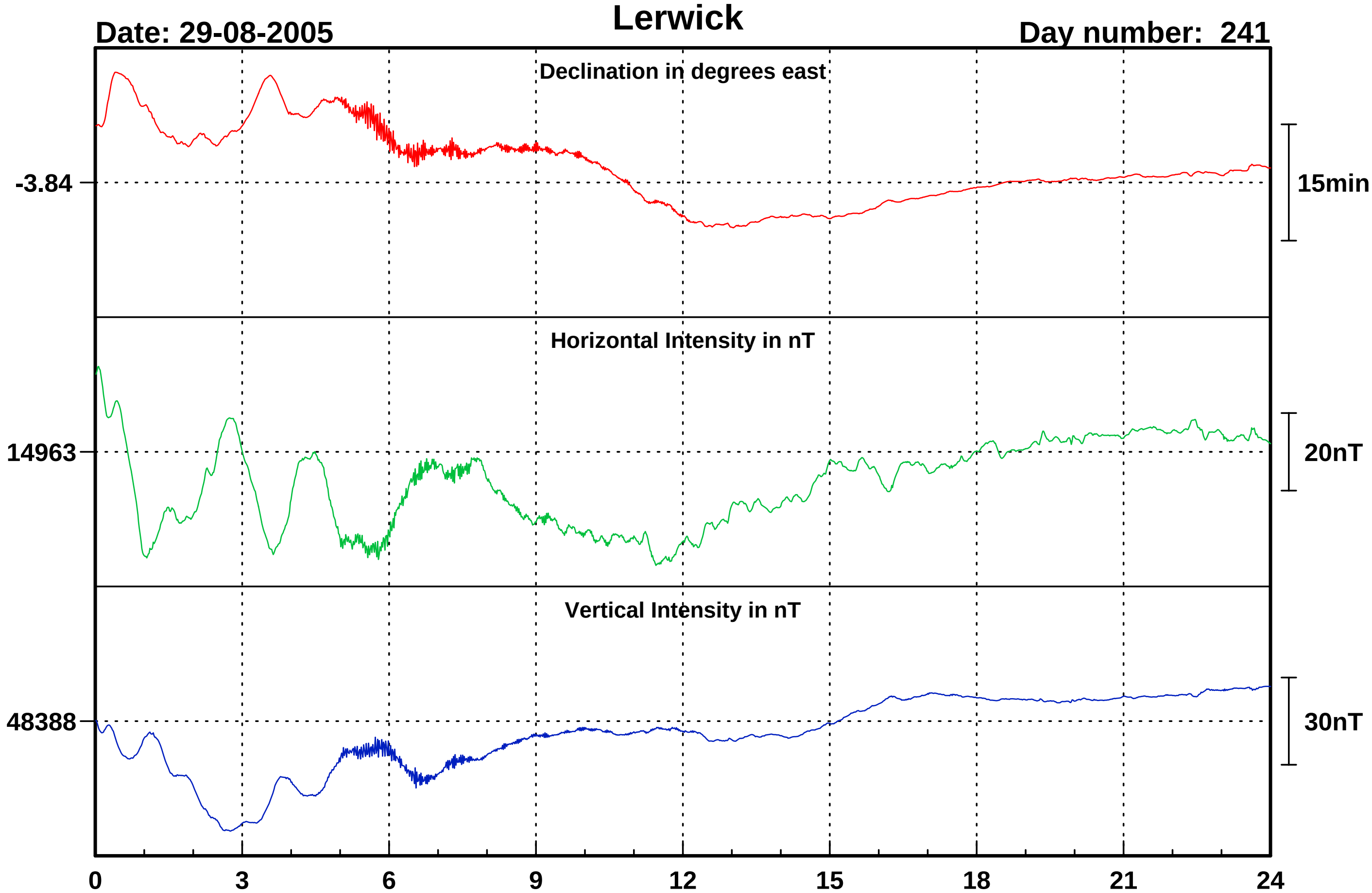
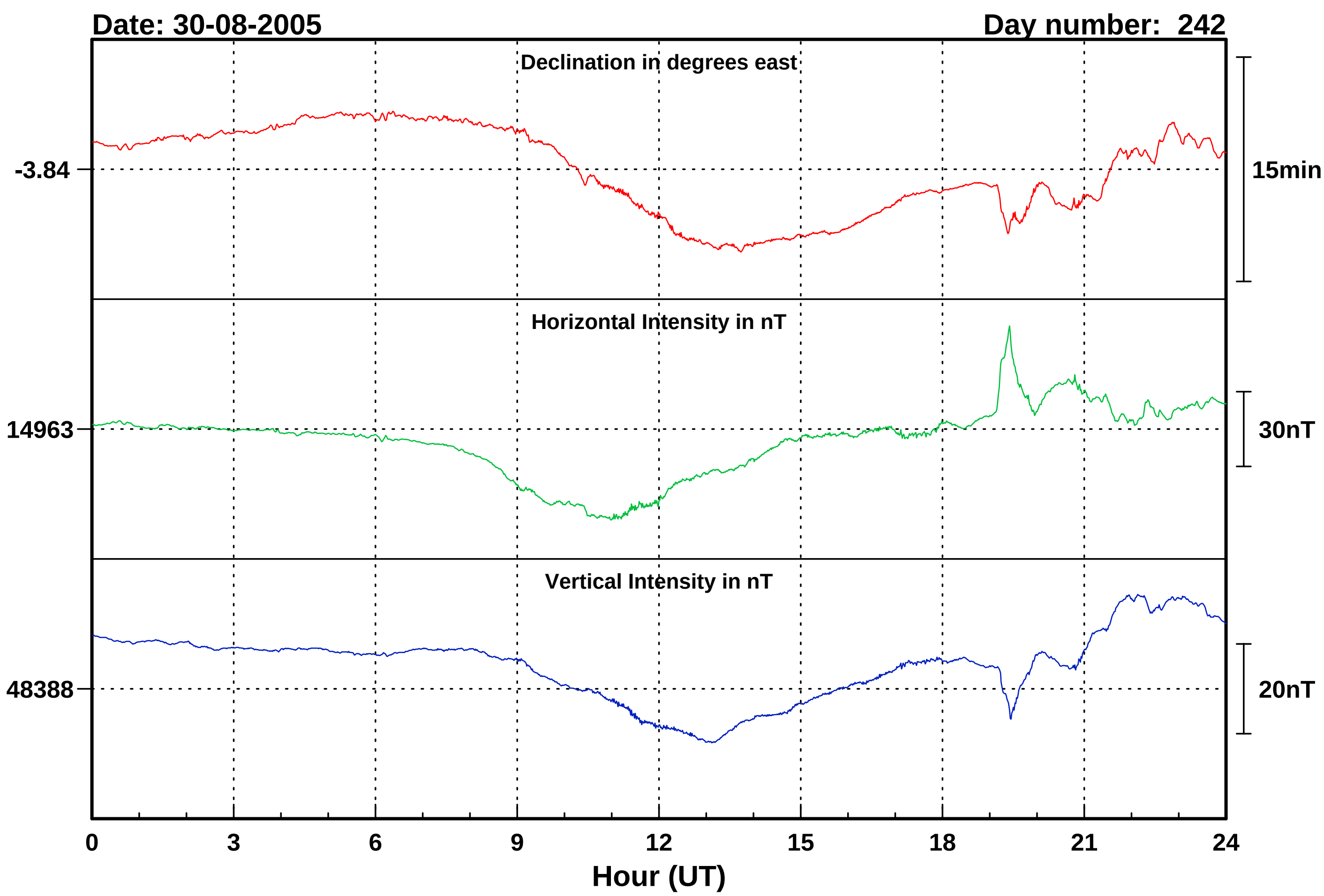

Date: 28-08-2005
Day number: 240
Declination in degrees east
-3.84
15min
Horizontal Intensity in nT
14963
30nT
Vertical Intensity in nT
48388
20nT
0
3
6
9
12
15
18
21
24
Hour (UT)

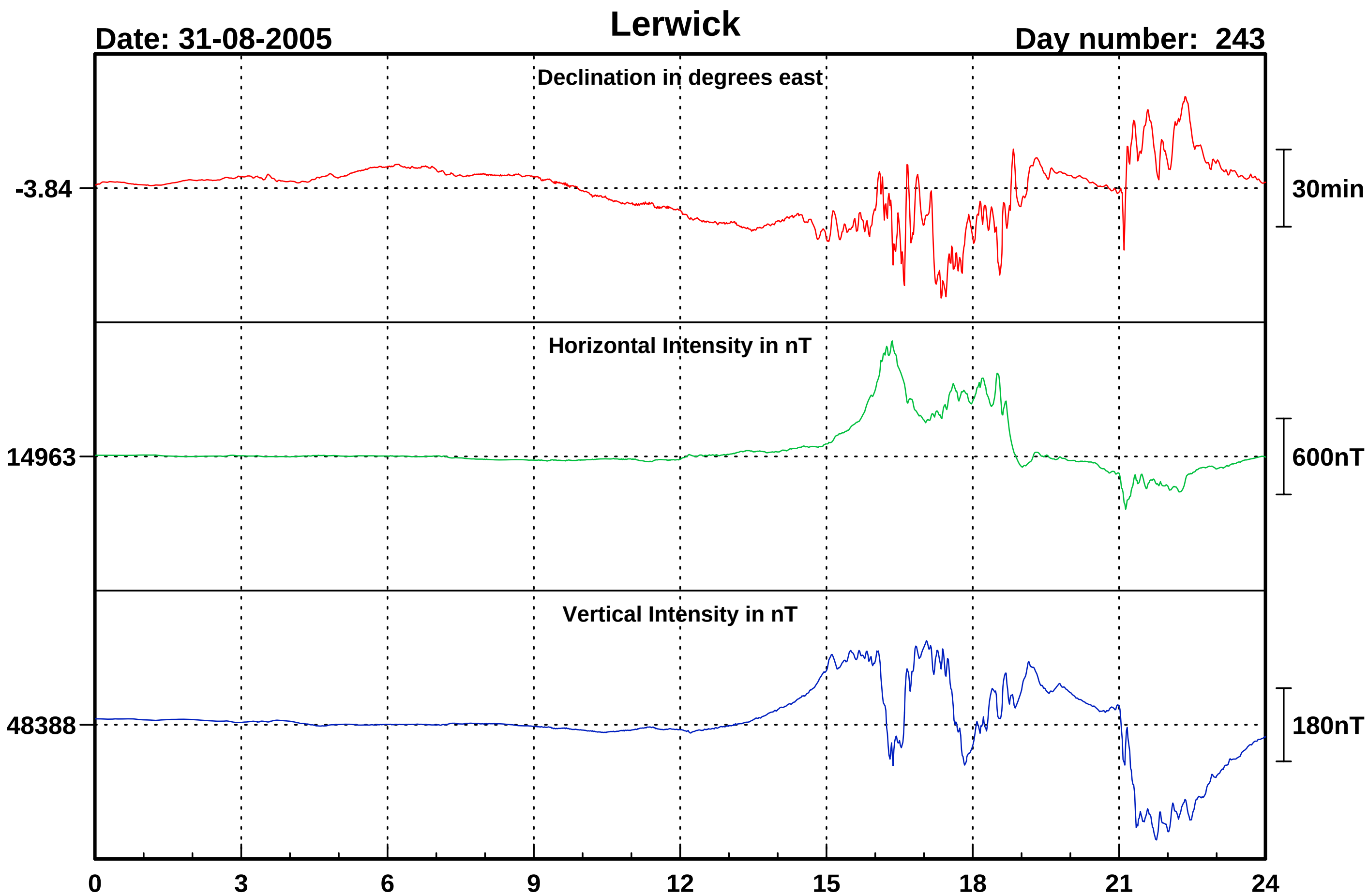
Lerwick



Date: 29-08-2005
Day number: 241
Declination in degrees east
-3.84
15min
Horizontal Intensity in nT
14963
20nT
Vertical Intensity in nT
48388
30nT
0
3
6
9
12
15
18
21
24

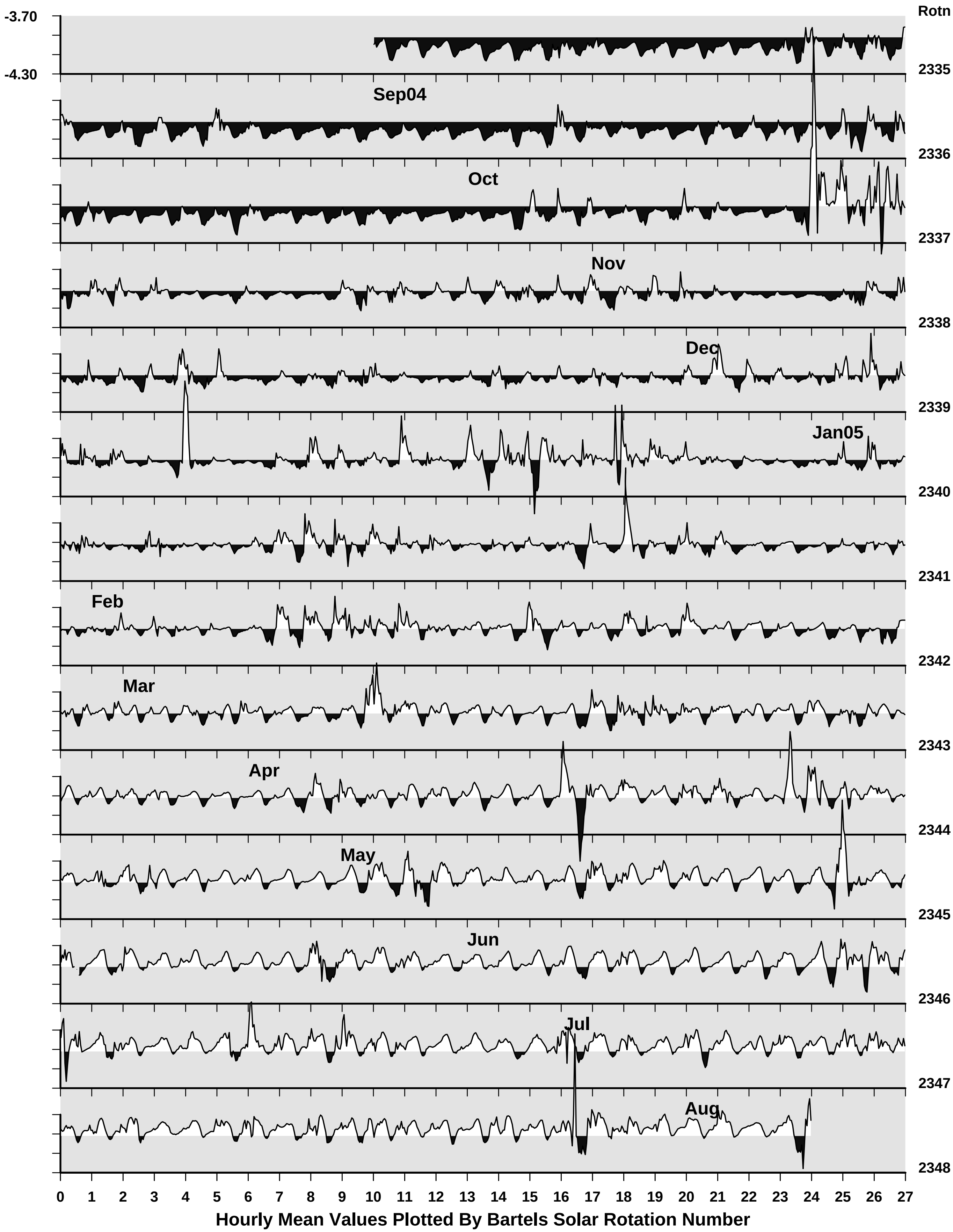


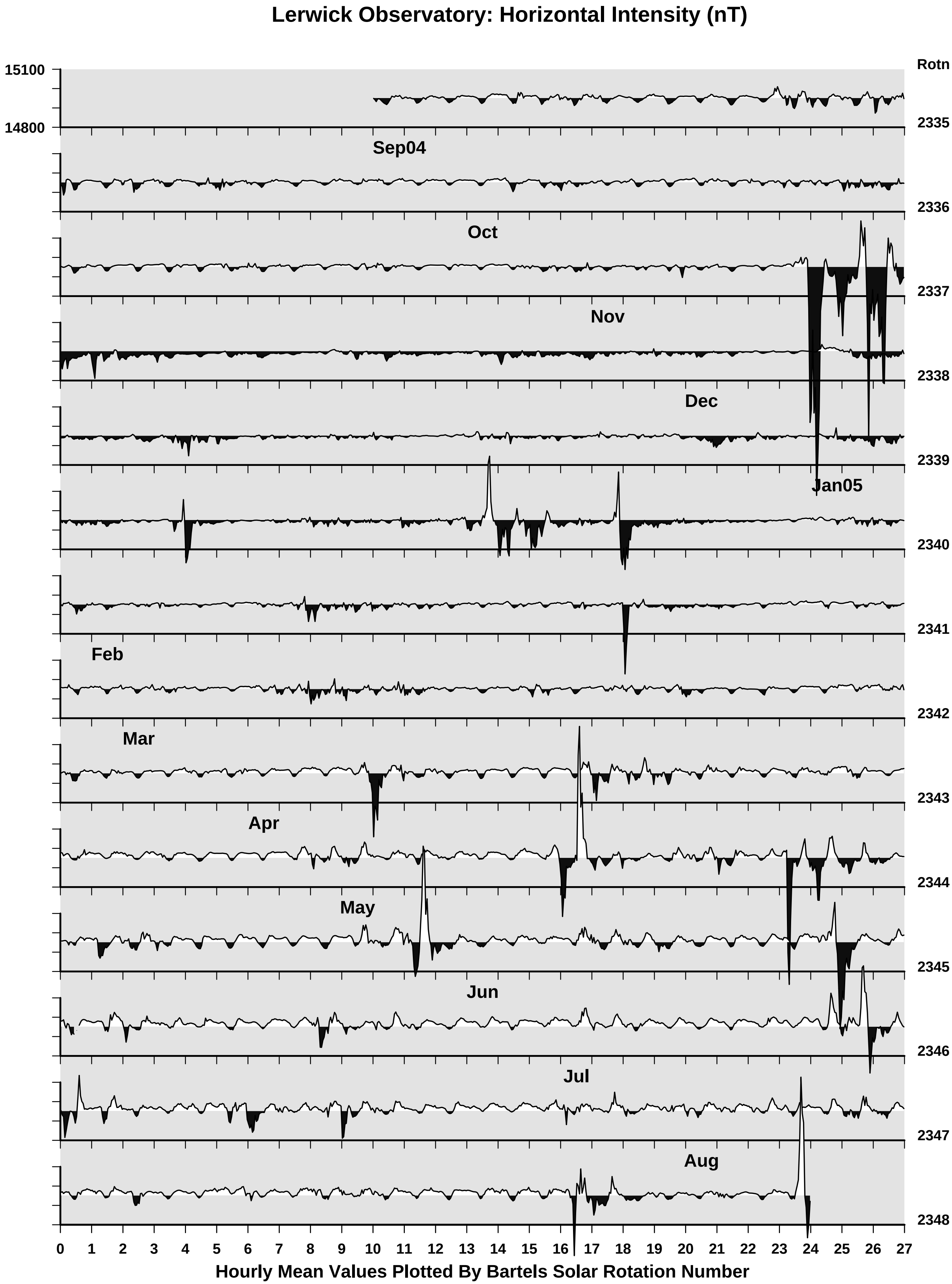
Date: 30-08-2005
Day number: 242
Declination in degrees east
-3.84
15min
Horizontal Intensity in nT
14963
30nT
Vertical Intensity in nT
48388
20nT
0
3
6
9
12
15
18
21
24
Hour (UT)



Lerwick
Date: 31-08-2005
Day number: 243
Declination in degrees east
-3.84
30min
Horizontal Intensity in nT
14963
600nT
Vertical Intensity in nT
48388
180nT
0
3
6
9
12
15
18
21
24

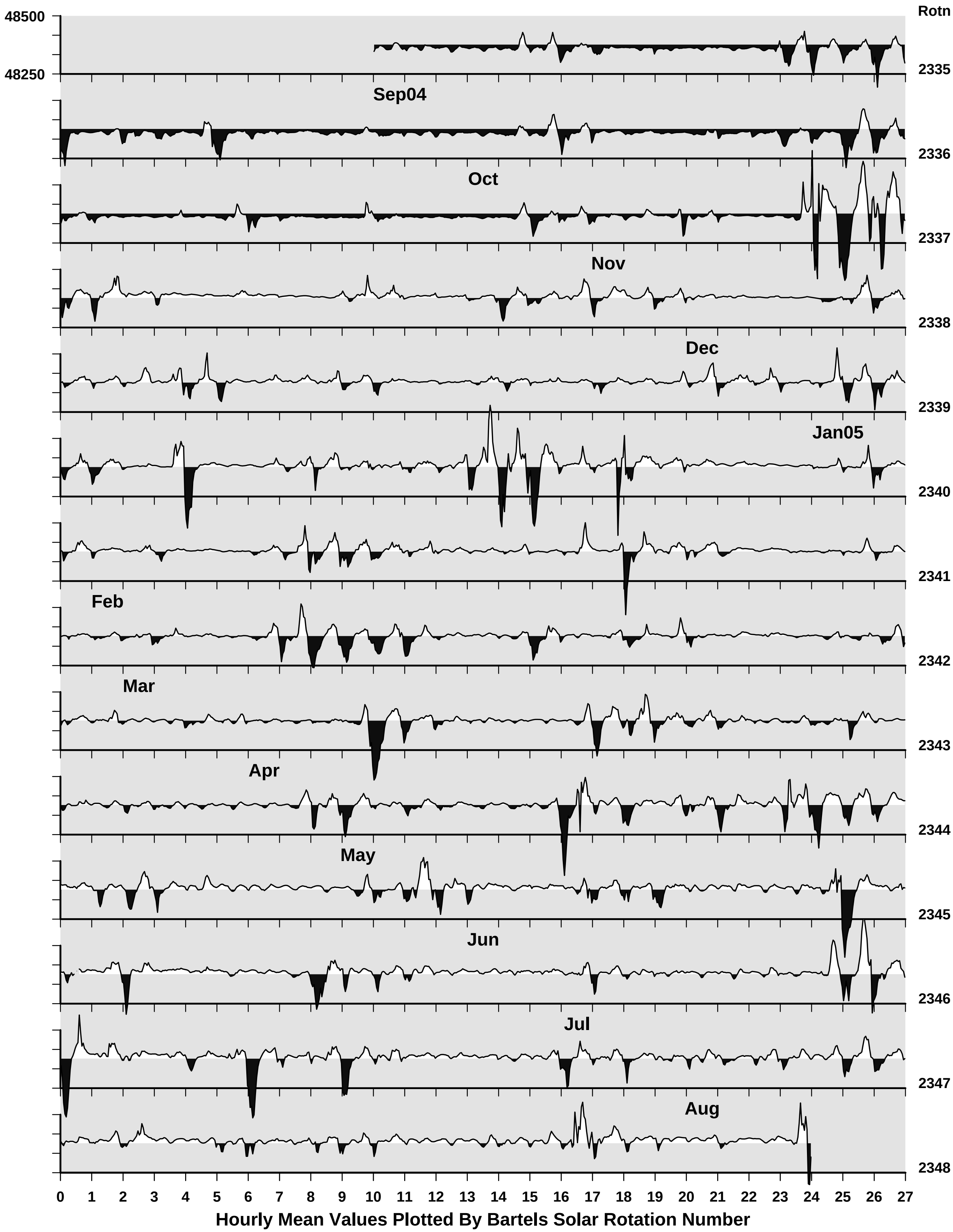
Lerwick Observatory: Declination (degrees)

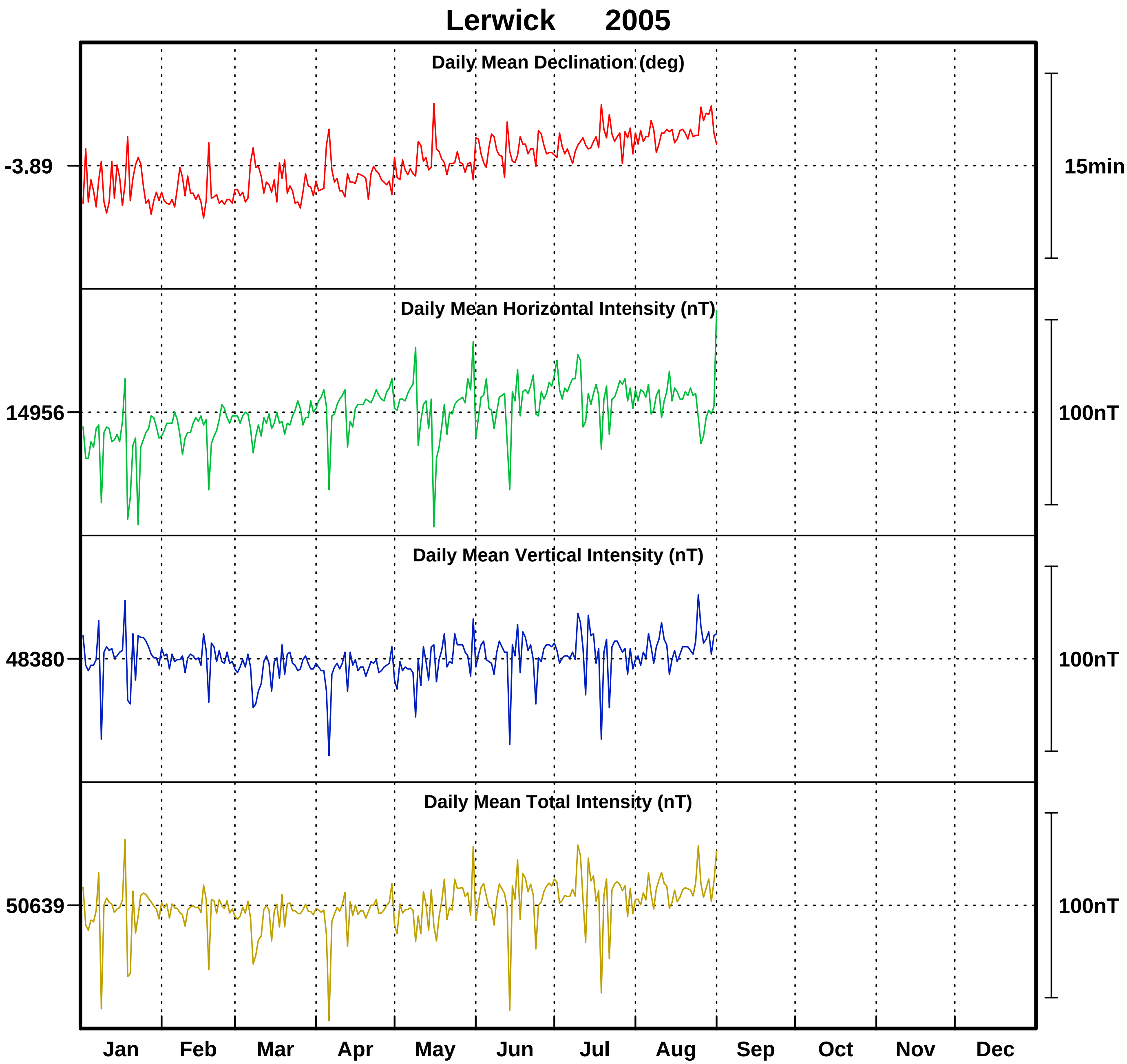




Lerwick Observatory: Horizontal Intensity (nT)
15100
14800
Rotn
2335
Sep04
2336
Oct
2337
Nov
2338
Dec
2339
Jan05
2340
2341
Feb
2342
Mar
2343
Apr
2344
May
2345
Jun
2346
Jul
2347
Aug
2348
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted By Bartels Solar Rotation Number

Lerwick Observatory: Vertical Intensity (nT)




Lerwick 2005
Daily Mean Declination (deg)
-3.89
15min
Daily Mean Horizontal Intensity (nT)
14956
100nT
Daily Mean Vertical Intensity (nT)
48380
100nT
Daily Mean Total Intensity (nT)
50639
100nT
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Monthly Mean Values for Lerwick Observatory 2005

Month	*D*	*H*	*I*	*X*	*Y*	*Z*	*F*
January	-3° 55.1´	14939 nT	72° 50.4´	14904 nT	-1021 nT	48382 nT	50636 nT
February	-3° 55.8´	14948 nT	72° 49.8´	14913 nT	-1025 nT	48380 nT	50637 nT
March	-3° 55.0´	14952 nT	72° 49.5´	14917 nT	-1021 nT	48375 nT	50633 nT
April	-3° 54.5´	14959 nT	72° 49.0´	14925 nT	-1019 nT	48374 nT	50634 nT
May	-3° 53.1´	14957 nT	72° 49.2´	14923 nT	-1014 nT	48379 nT	50639 nT
June	-3° 52.2´	14962 nT	72° 49.0´	14928 nT	-1010 nT	48382 nT	50643 nT
July	-3° 51.5´	14966 nT	72° 48.7´	14932 nT	-1007 nT	48383 nT	50645 nT
August	-3° 50.7´	14963 nT	72° 49.0´	14930 nT	-1003 nT	48388 nT	50648 nT

Note

i. The values shown here are provisional.

LERWICK RAPID VARIATIONS

SIs and SSCs

Date	Time (UT)	Type	Quality	H (nT)	D (min)	Z (nT)
24-08-05	06 13	SSC*	B	-15.3	-3.62	-2.8

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			
NONE						

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

INDICES OF GEOMAGNETIC ACTIVITY

Lerwick Observatory — August 2005

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	3	3	3	2	3	21
2	1	2	1	2	2	2	1	0	11
3	1	2	1	1	2	2	3	3	15
4	2	2	2	1	3	3	1	2	16
5	1	0	1	1	1	3	3	2	12
6	3	3	3	3	4	4	4	3	27
7	3	2	2	3	2	2	3	3	20
8	1	1	0	0	3	2	1	2	10
9	2	2	0	1	2	2	3	3	15
10	2	2	3	3	4	3	1	1	19
11	1	0	0	0	1	0	0	0	2
12	1	0	0	0	1	1	1	2	6
13	2	2	2	3	3	2	4	4	22
14	3	3	1	1	1	1	1	2	13
15	0	0	1	1	2	2	2	3	11
16	2	3	2	1	3	3	2	4	20
17	2	2	1	1	3	3	3	3	18
18	2	1	2	2	2	3	3	2	17
19	2	0	0	1	2	1	2	1	9
20	1	0	0	0	1	1	1	0	4
21	0	0	1	0	2	4	3	3	13
22	2	2	1	1	2	2	1	2	13
23	2	0	1	1	3	2	2	1	12
24	2	3	4	7	5	6	6	4	37
25	5	3	2	2	3	5	3	2	25
26	2	2	2	1	0	2	2	2	13
27	2	1	1	1	1	0	0	1	7
28	2	1	0	0	0	1	1	2	7
29	3	2	2	0	0	1	0	0	8
30	0	0	0	0	0	1	2	1	4
31	1	1	1	3	4	8	8	7	33

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)
01-08-05	213	3 3 2 3 3 3 3 3	2 1 3 4 3 3 2 1	30	26	28	27	28
02-08-05	214	2 3 2 3 3 3 3 1	1 2 1 4 3 1 1 0	25	18	23	19	21
03-08-05	215	2 2 2 1 2 3 3 3	1 2 1 0 1 2 2 1	21	10	11	20	16
04-08-05	216	2 1 2 1 2 2 2 3	2 1 2 3 2 2 1 1	16	15	15	16	15
05-08-05	217	1 1 1 1 1 3 3 2	0 1 0 1 1 3 3 2	15	14	6	22	14
06-08-05	218	4 3 3 4 4 4 5 3	2 3 5 4 4 3 3 3	54	46	49	51	50
07-08-05	219	3 3 3 3 3 2 3 3	3 2 3 3 2 1 3 2	30	23	30	23	27
08-08-05	220	2 2 1 1 3 2 1 3	1 0 1 1 2 1 0 2	17	9	9	16	13
09-08-05	221	2 2 1 1 2 2 3 3	1 2 2 2 2 2 2 1	18	14	13	19	16
10-08-05	222	2 2 4 2 3 2 1 1	2 1 3 6 5 3 1 0	21	47	42	26	34
11-08-05	223	1 1 1 1 1 1 1 1	0 0 0 1 2 1 0 0	8	6	6	8	7
12-08-05	224	1 1 1 0 1 1 2 3	0 1 0 1 1 1 0 1	11	6	6	11	8
13-08-05	225	3 3 2 3 3 2 4 4	2 3 2 3 2 1 2 2	34	19	26	28	27
14-08-05	226	4 4 1 1 2 1 2 2	2 2 2 1 1 0 1 1	23	10	24	10	17
15-08-05	227	0 1 1 1 2 3 2 3	0 1 0 1 2 2 1 2	15	10	6	19	12
16-08-05	228	3 3 2 2 3 3 3 4	2 3 1 3 3 2 2 2	31	21	23	29	26
17-08-05	229	3 2 2 2 3 3 3 4	2 2 2 2 3 4 2 2	29	24	18	35	26
18-08-05	230	2 2 3 3 3 3 3 3	2 2 3 3 3 3 2 1	28	23	24	27	26
19-08-05	231	3 1 1 1 1 1 2 2	1 1 1 3 2 2 0 1	13	12	14	11	13
20-08-05	232	2 1 0 0 1 1 1 0	1 0 0 1 1 0 1 0	7	5	6	6	6
21-08-05	233	1 1 1 0 2 5 3 3	0 1 1 1 2 4 1 0	26	14	6	33	20
22-08-05	234	3 4 2 1 2 3 1 3	1 3 1 2 3 2 1 2	25	17	22	20	21
23-08-05	235	2 1 1 1 2 3 2 1	1 1 1 3 3 1 1 1	14	14	12	16	14
24-08-05	236	3 4 5 8 6 5 6 4	2 3 6 7 7 5 5 4	141	133	142	131	137
25-08-05	237	4 3 2 2 3 4 3 3	4 3 3 4 4 4 3 1	34	43	38	39	39
26-08-05	238	3 3 2 1 1 2 2 2	2 2 2 2 0 0 0 0	18	9	19	8	14
27-08-05	239	3 2 1 1 1 0 1 1	1 1 3 1 1 0 0 0	11	9	15	5	10
28-08-05	240	2 1 0 1 1 1 2 3	1 0 0 1 1 1 0 1	12	6	7	11	9
29-08-05	241	3 3 2 1 1 1 0 1	1 1 1 1 1 0 0 0	14	6	15	5	10
30-08-05	242	0 0 0 0 0 0 3 2	1 0 0 0 0 0 2 1	8	6	3	10	7
31-08-05	243	1 2 2 2 4 6 5 5	1 2 3 2 5 6 5 4	61	64	16	108	62
Monthly mean value =			24.0					

(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