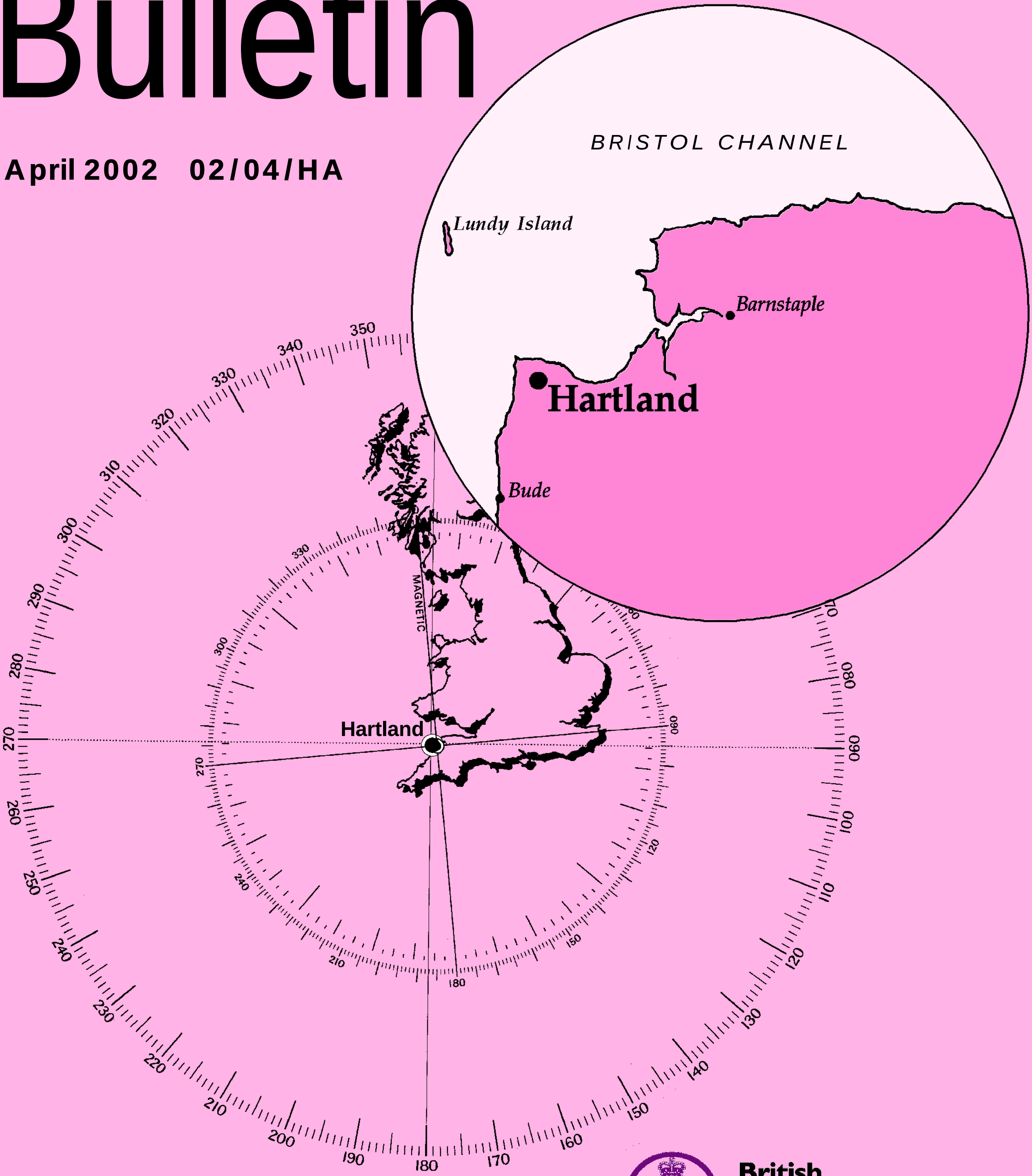
HARTLAND OBSERVATORY

Monthly Geomagnetic Bulletin

April 2002 02/04/HA



British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

1. HARTLAND 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
Internet: *www.geomag.bgs.ac.uk*

1.2 Position

Hartland Observatory, one of the three geomagnetic observatories operated and maintained in the UK by BGS, is situated on the NW boundary of the village of Hartland in North Devon. The observatory co-ordinates are:

Geographic:	*50° 59.7′N*	*355° 31.0′E*
Geomagnetic:	*53° 56.0′N*	*80° 10.1′E*
Height above mean sea level:		*95 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: FLARE*plus*

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 (FLARE*plus*), which was developed by BGS. The FLARE*plus* 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.

FLARE*plus* 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.

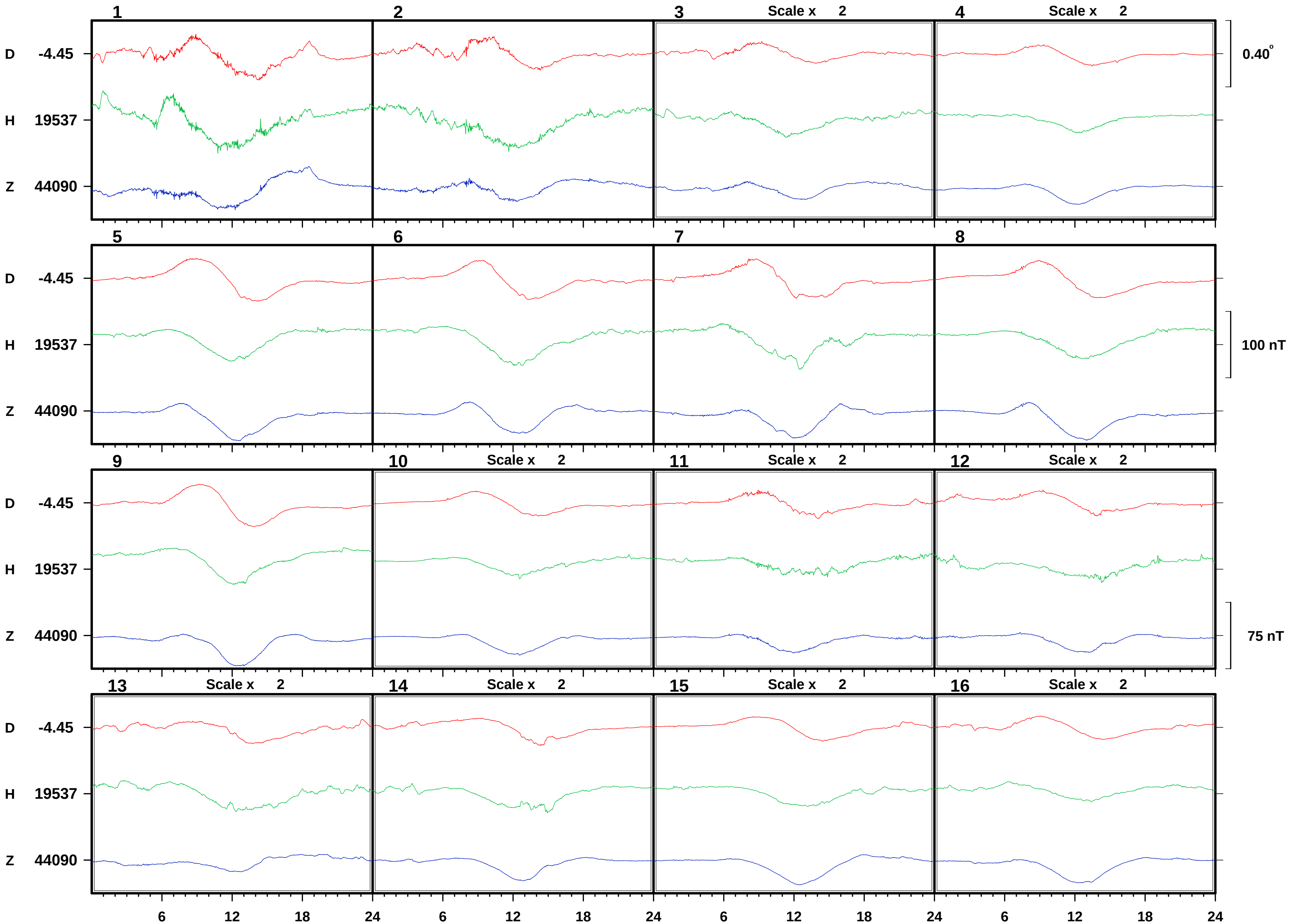
The *aa* indices listed in this publication are provisional only; the definitive values are published by the International Service for Geomagnetic Indices, CRPE/CNET - CNRS, 4 Avenue de Neptune, F-94107 Saint Maur Cedex, France.

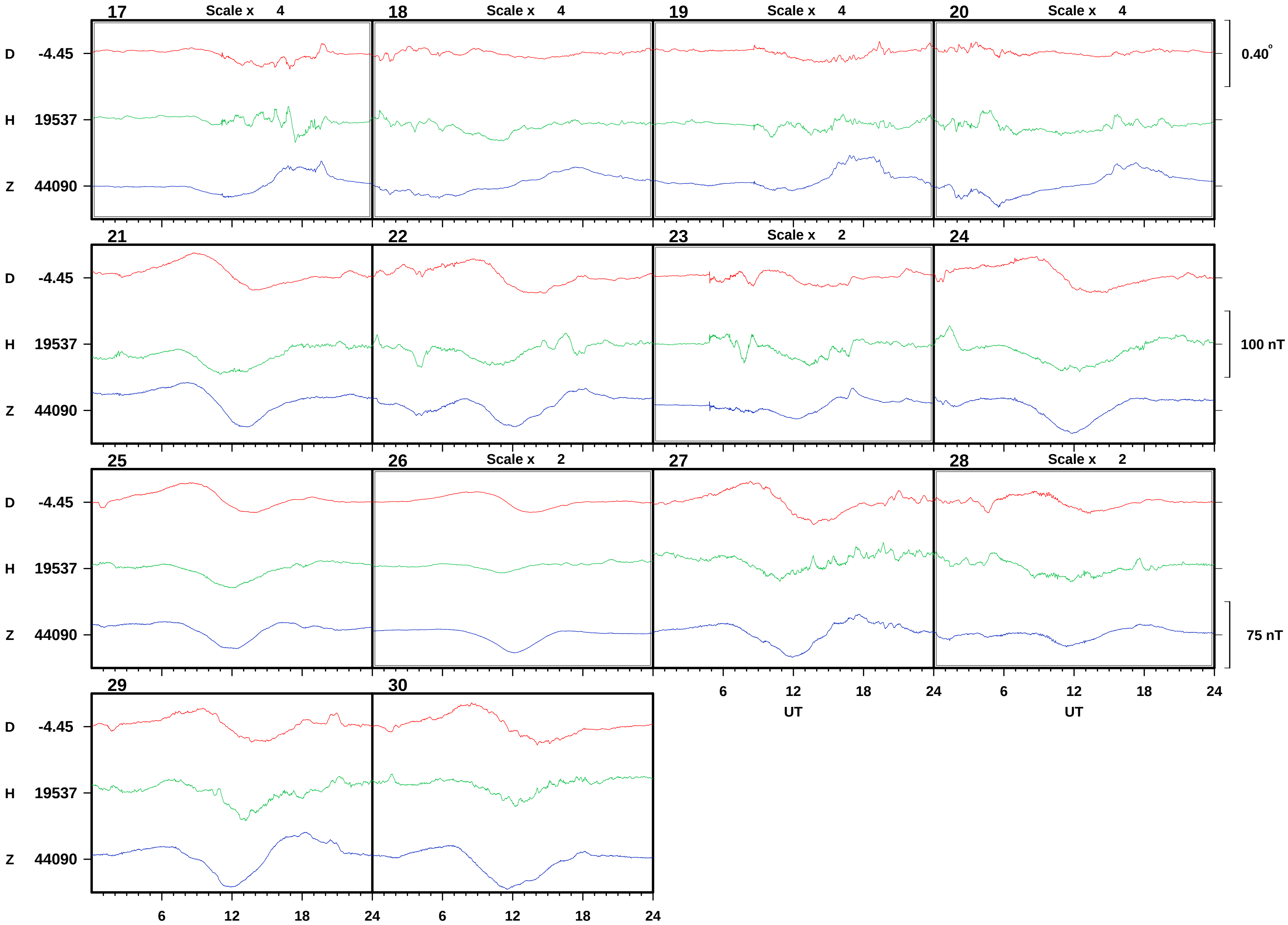
1.4.6 Rapid Variations

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.

Hartland April 2002





Hartland April 2002

Hartland

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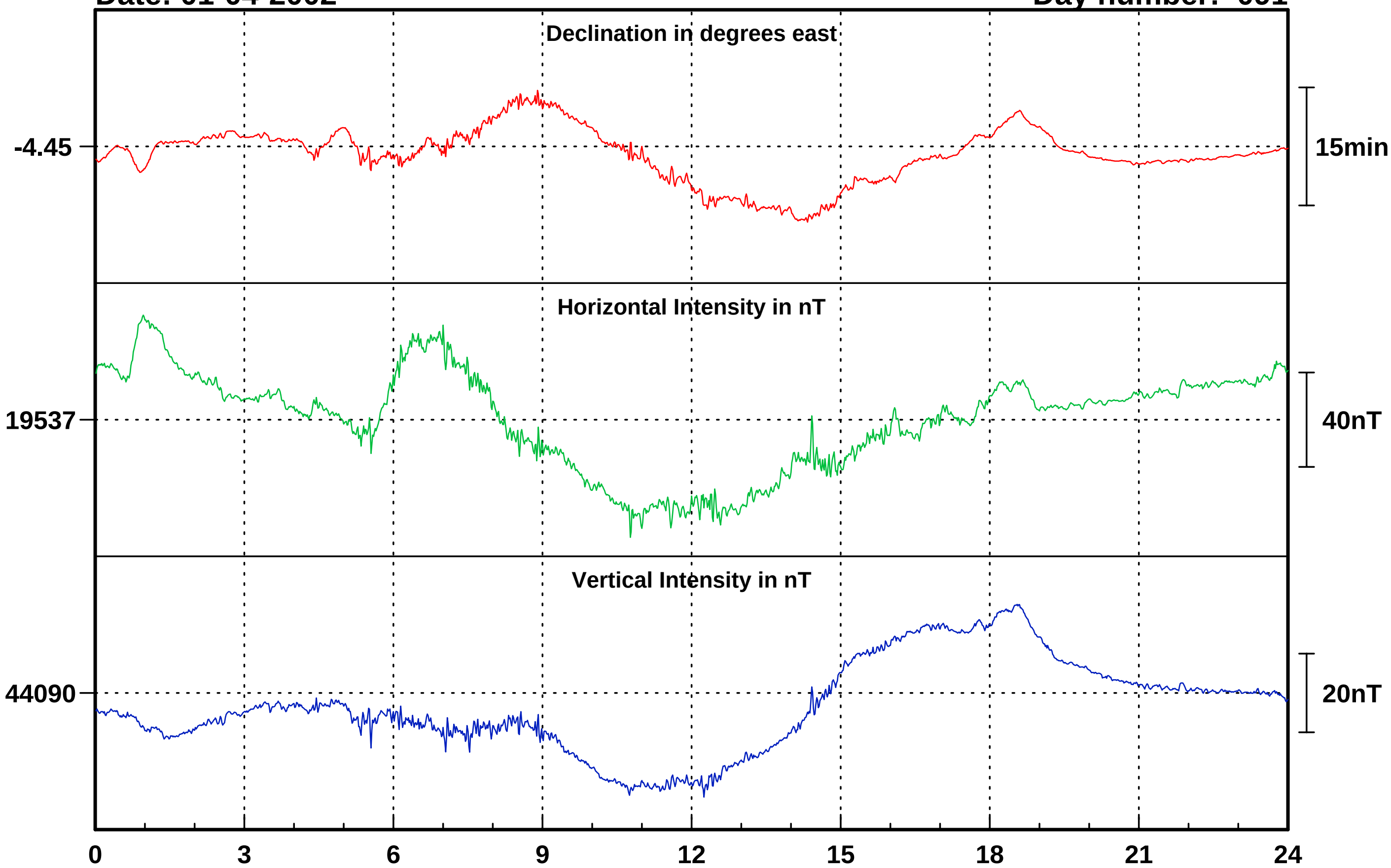

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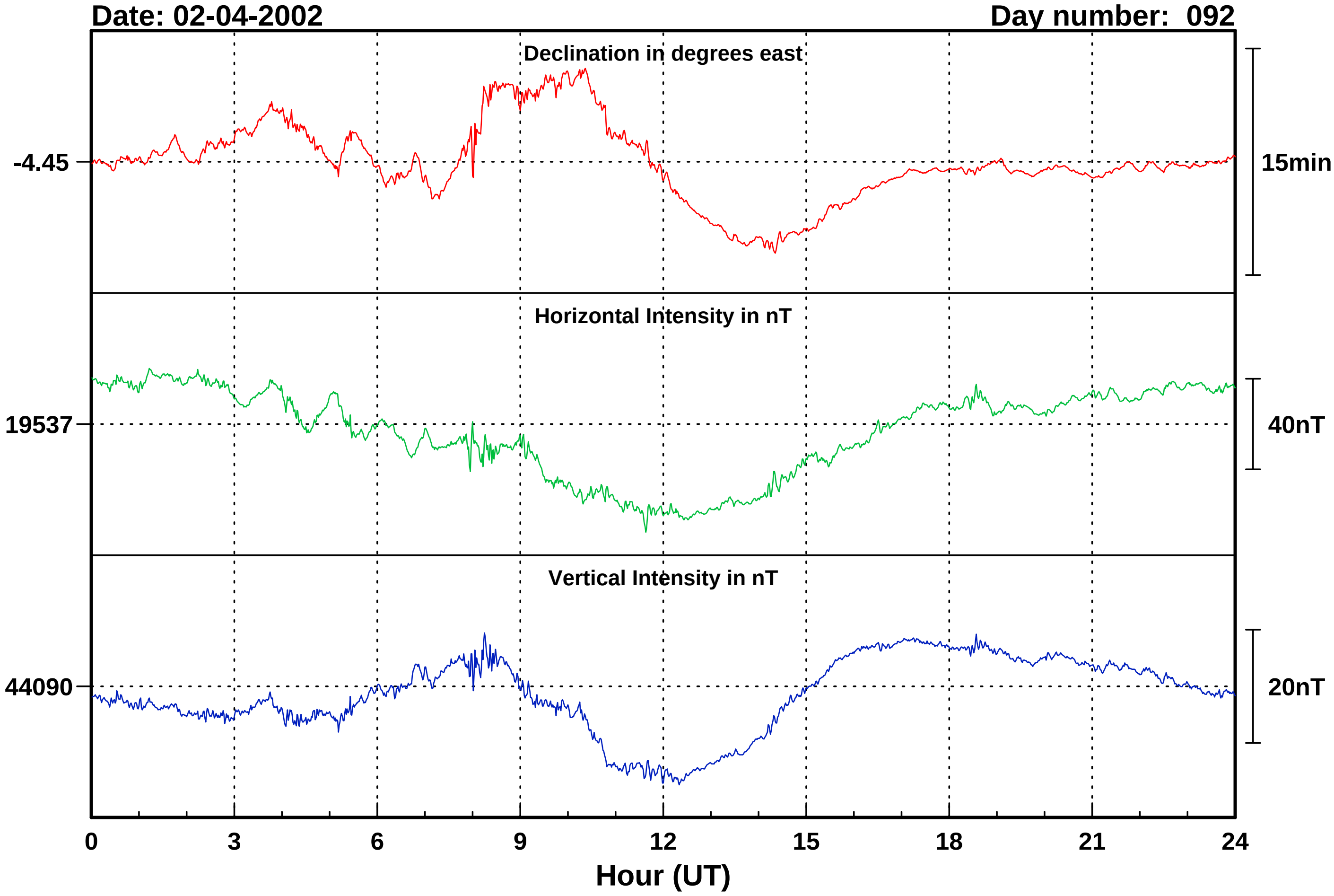

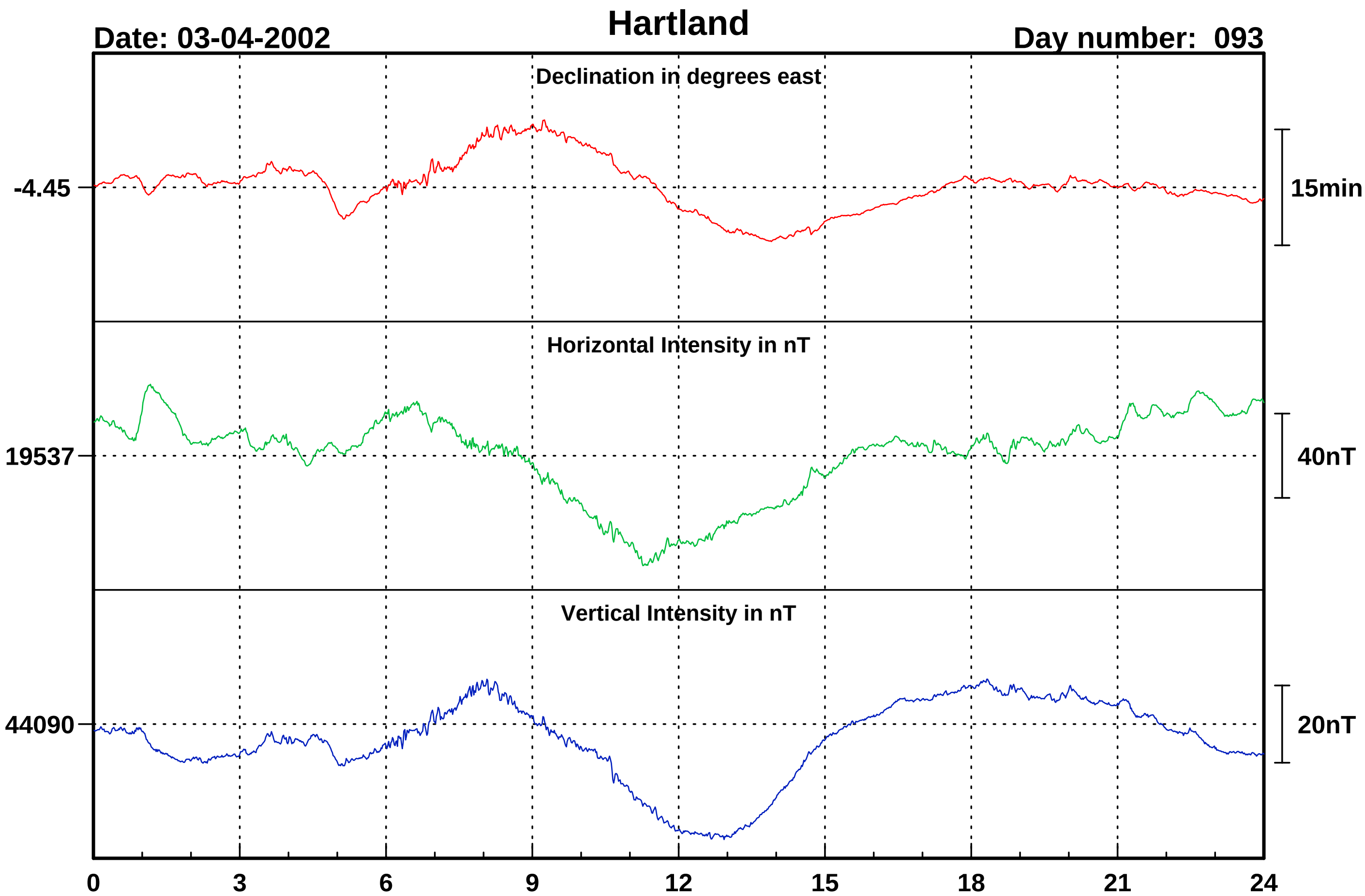
Hartland
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Day number: 093
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-4.45
15min
Horizontal Intensity in nT
19537
40nT
Vertical Intensity in nT
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20nT
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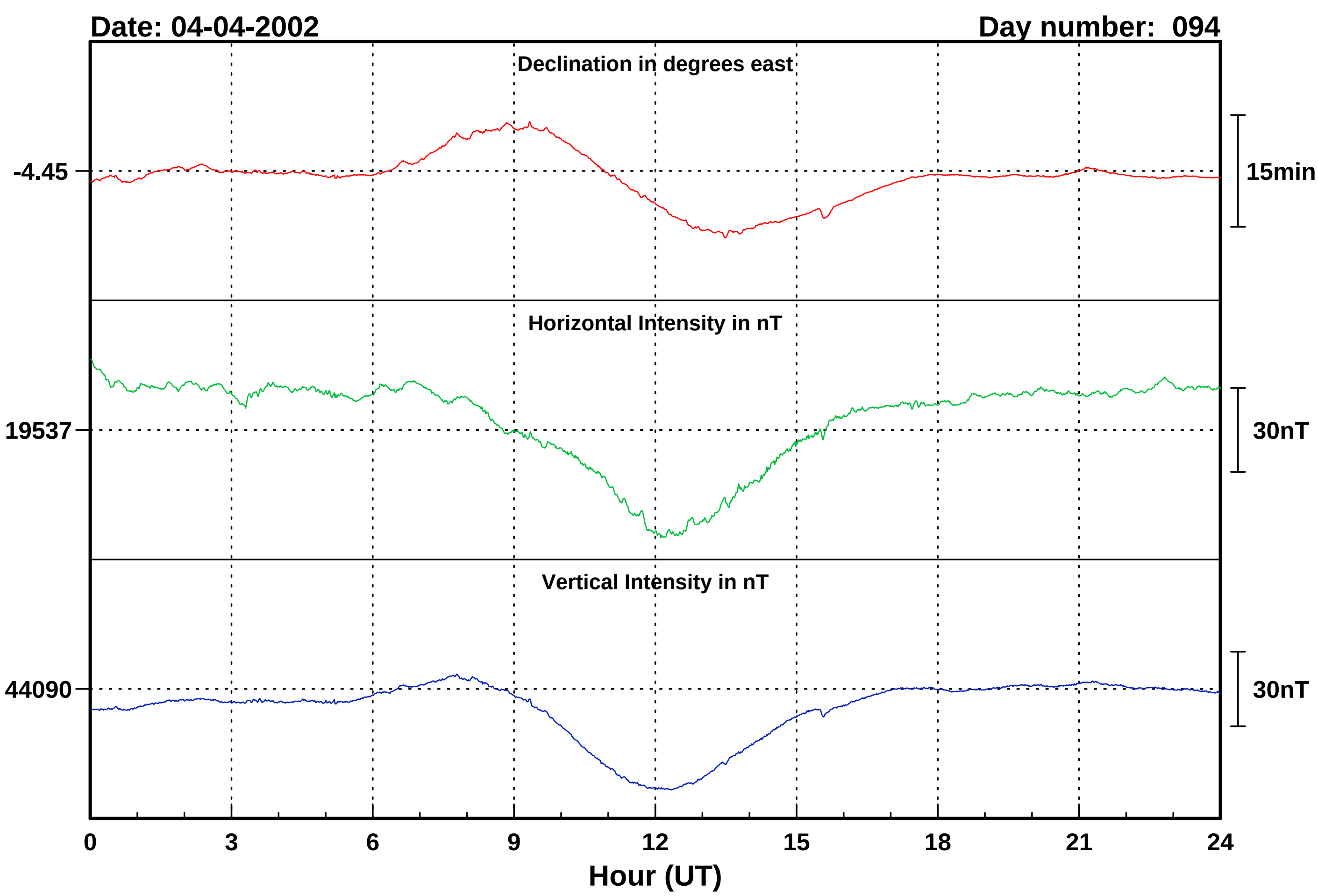
6
9
12
15
18
21
24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Day number: 094
Declination in degrees east
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15min
Horizontal Intensity in nT
19537
30nT
Vertical Intensity in nT
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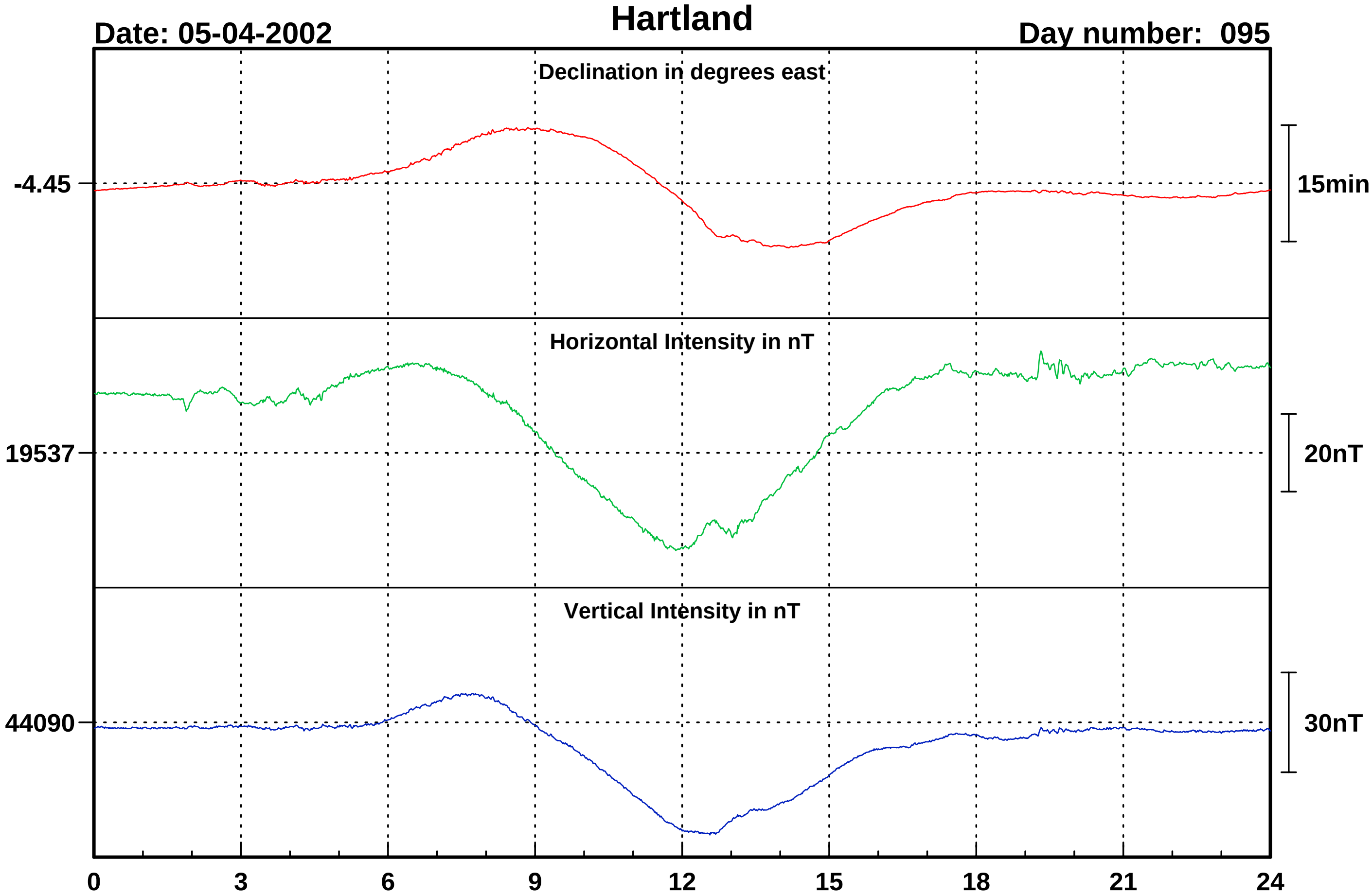
3
6
9
12
15
18
21
24
Hour (UT)

Hartland



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Day number: 095
Declination in degrees east
-4.45
15min
Horizontal Intensity in nT
19537
20nT
Vertical Intensity in nT
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30nT
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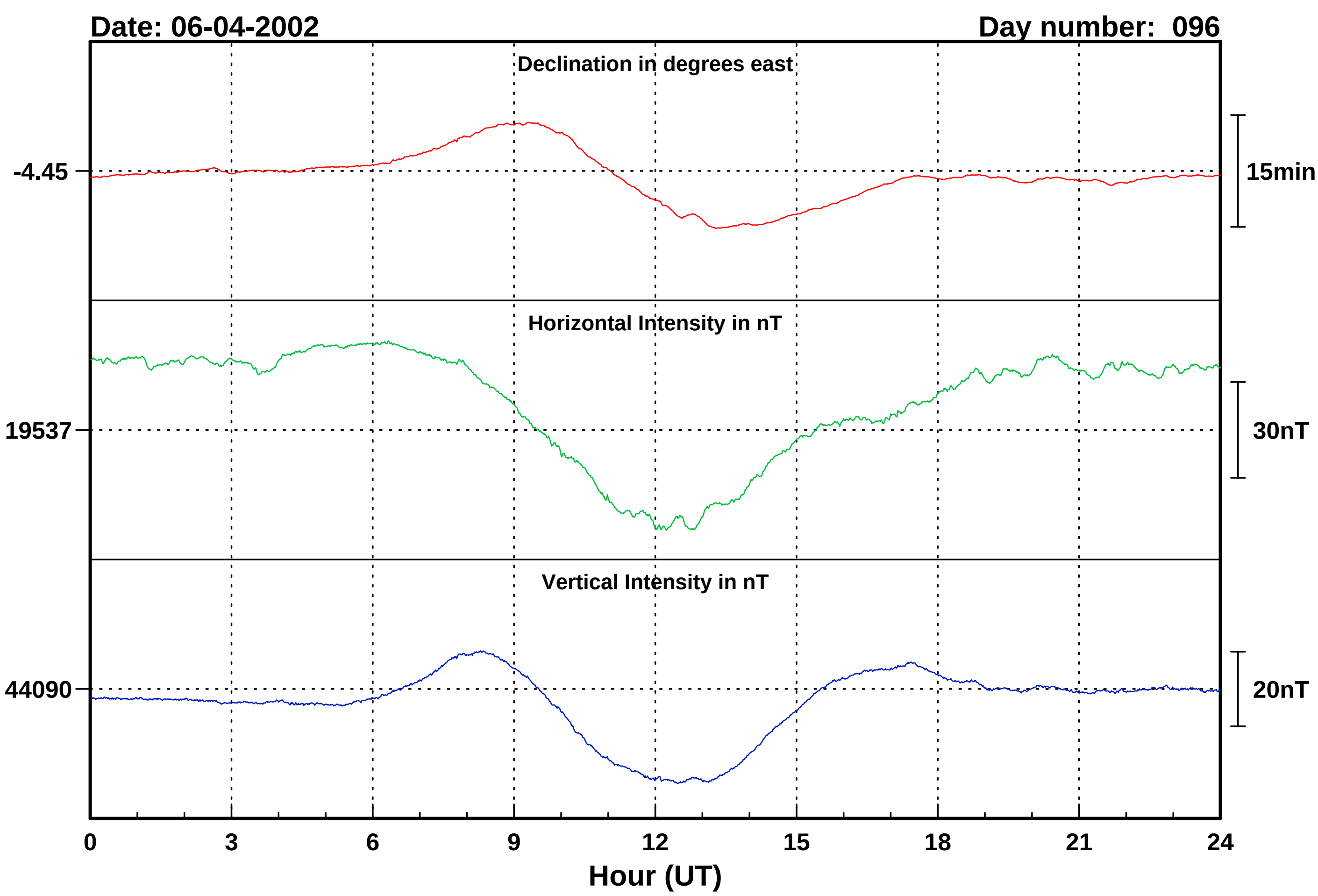
3
6
9
12
15
18
21
24



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Declination in degrees east
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15min
Horizontal Intensity in nT
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Vertical Intensity in nT
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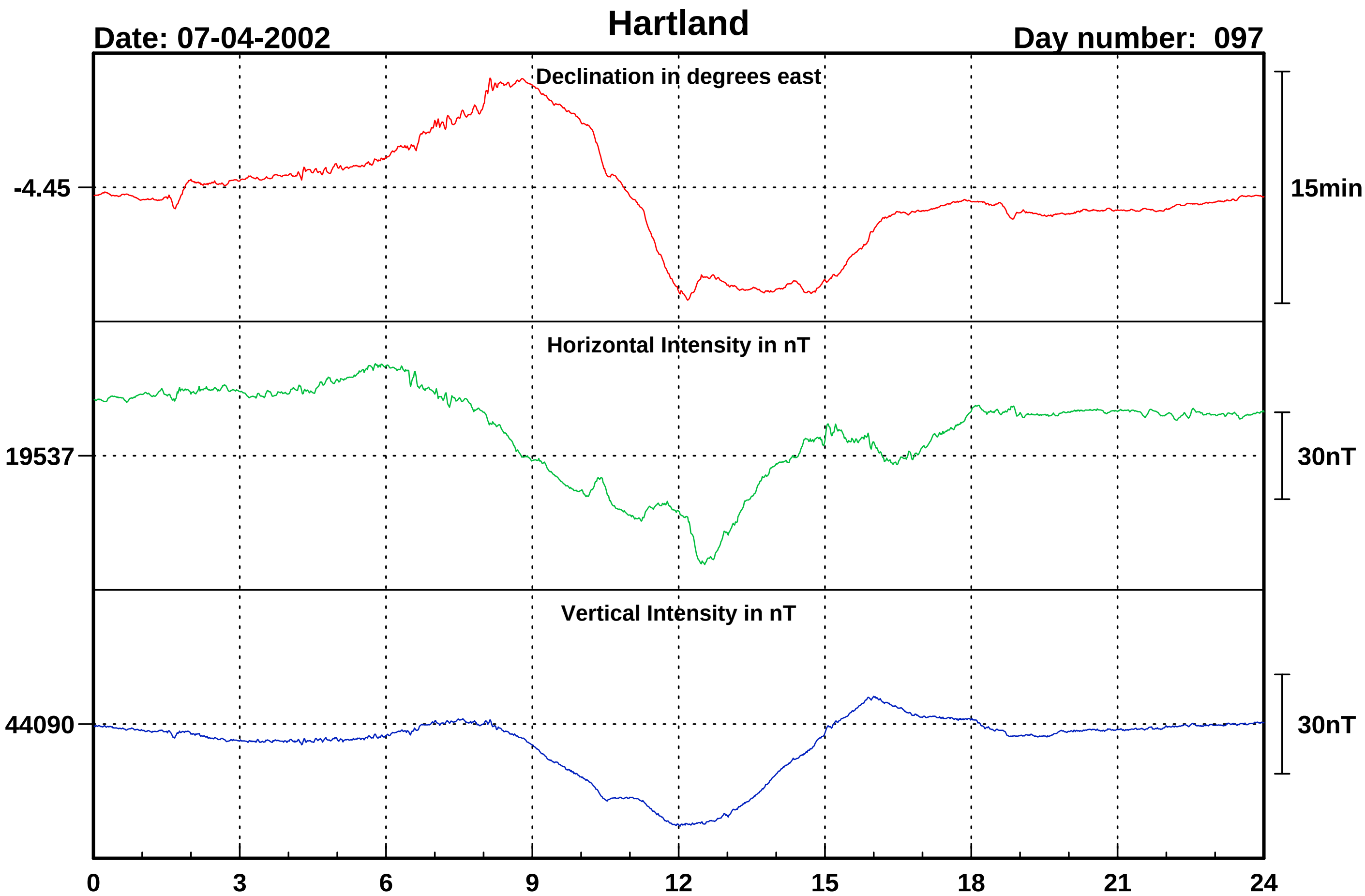
9
12
15
18
21
24
Hour (UT)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Day number: 097
Declination in degrees east
-4.45
15min
Horizontal Intensity in nT
19537
30nT
Vertical Intensity in nT
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30nT
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18
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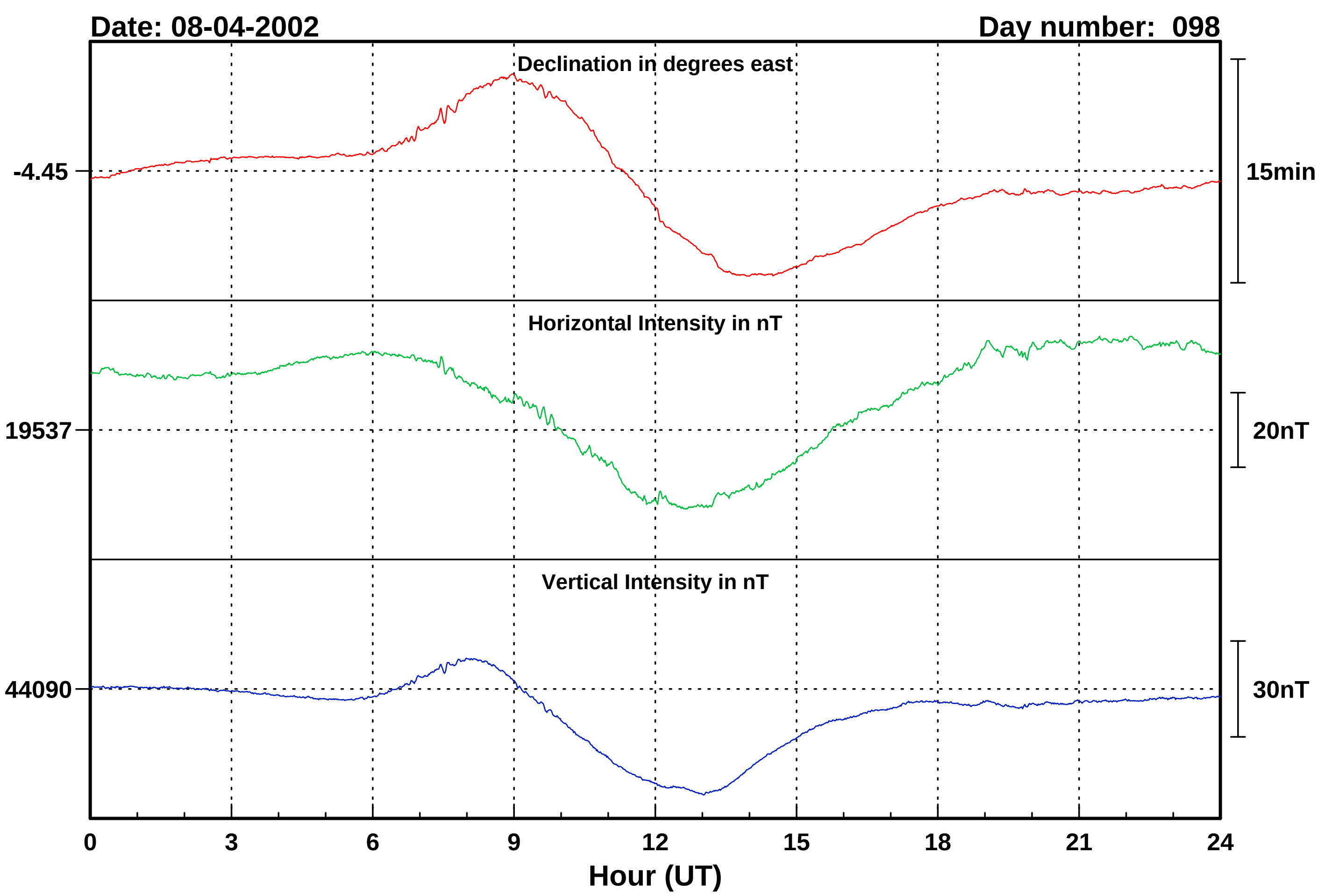
24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Day number: 098
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15min
Horizontal Intensity in nT
19537
20nT
Vertical Intensity in nT
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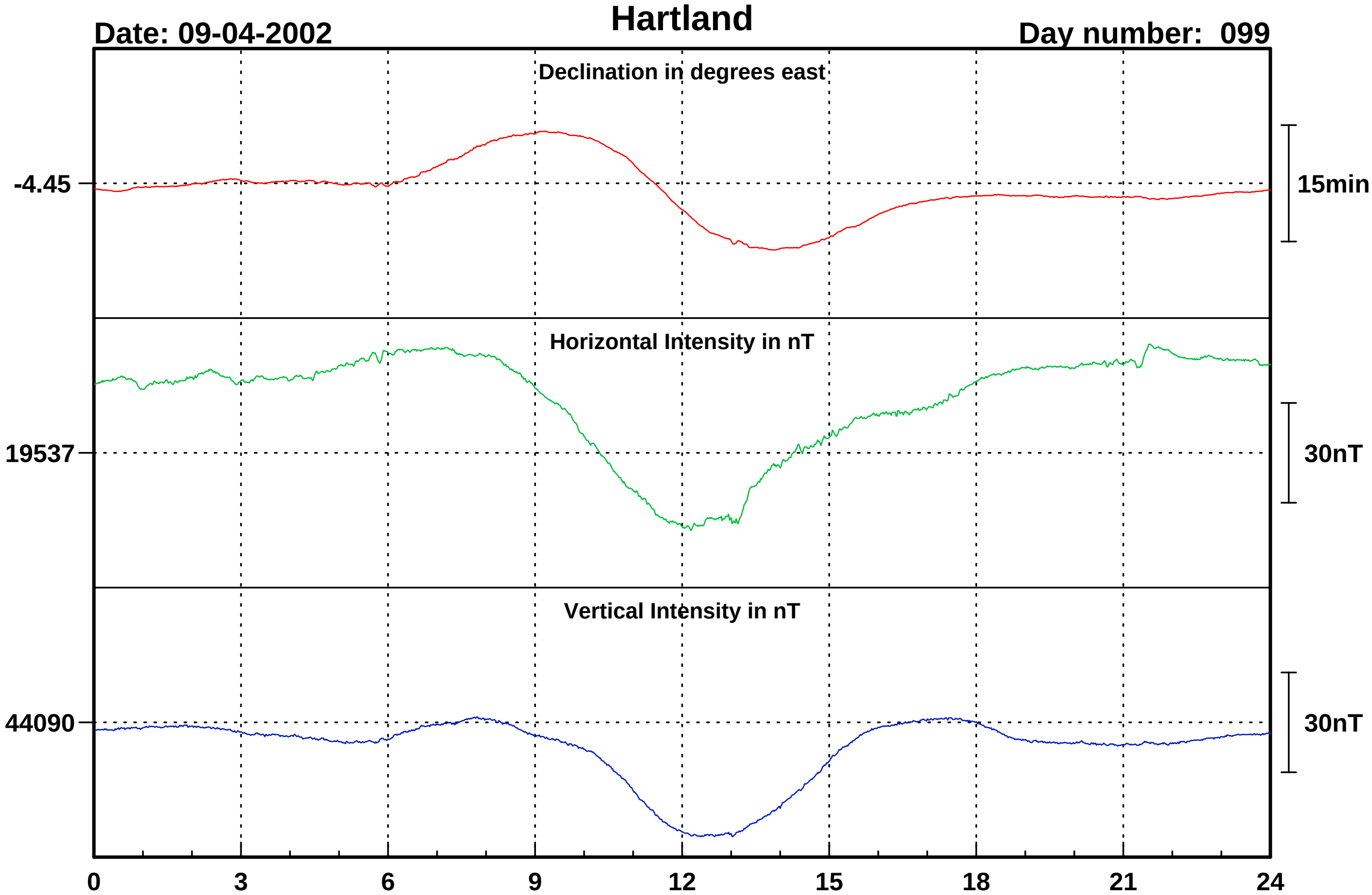
3
6
9
12
15
18
21
24
Hour (UT)

Hartland



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Day number: 099
Declination in degrees east
-4.45
15min
Horizontal Intensity in nT
19537
30nT
Vertical Intensity in nT
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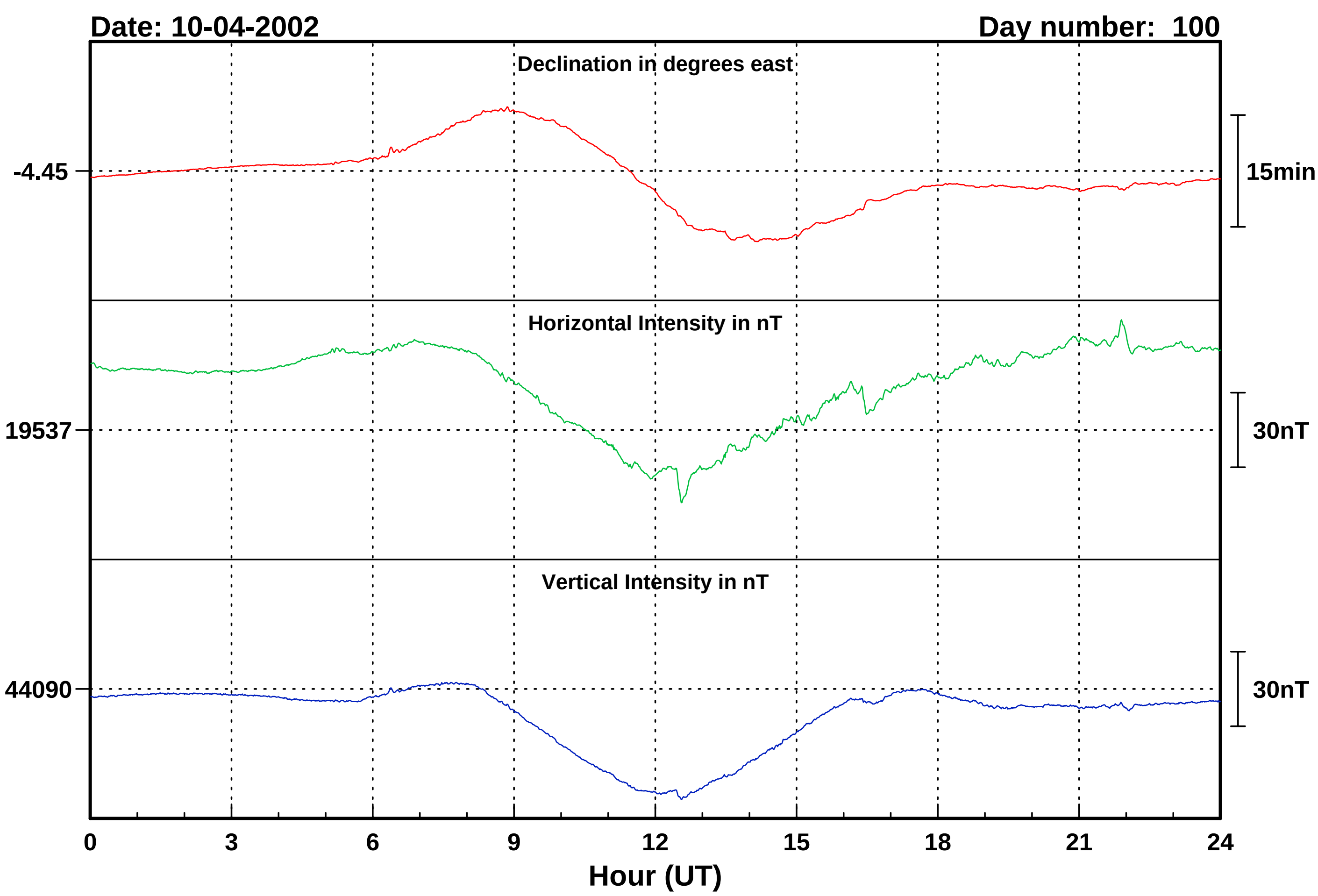

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Day number: 100
Declination in degrees east
-4.45
15min
Horizontal Intensity in nT
19537
30nT
Vertical Intensity in nT
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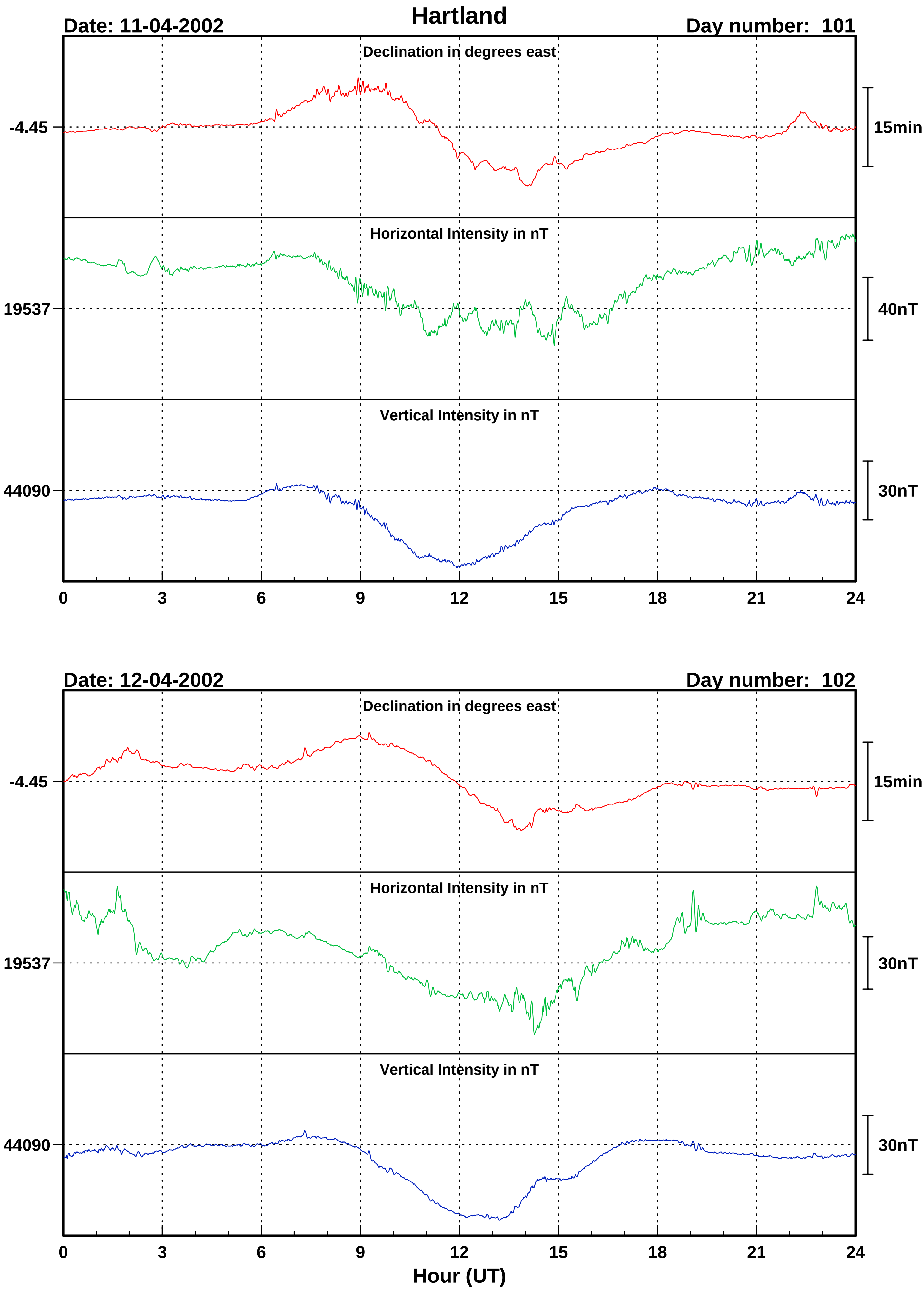
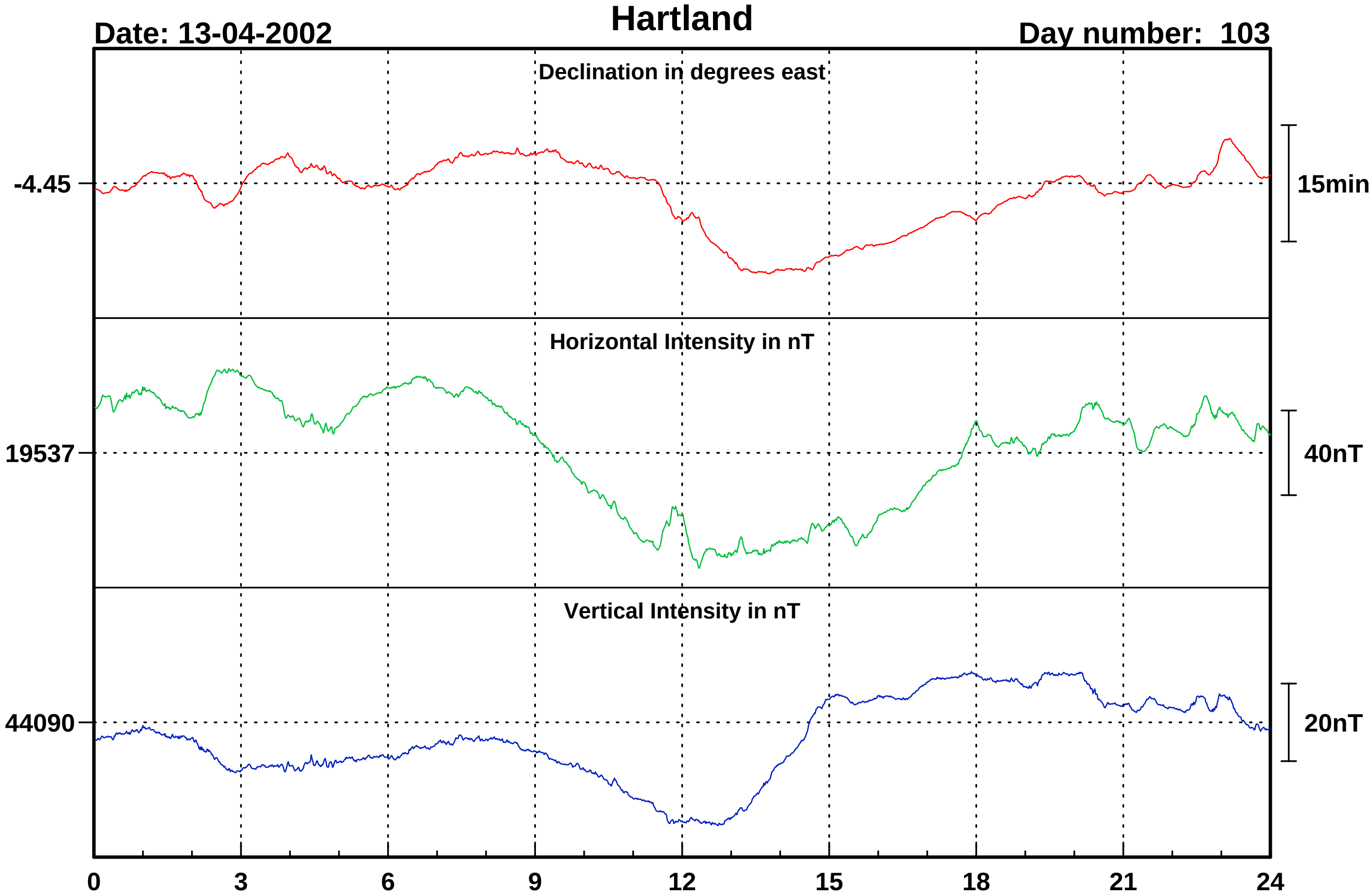
18
21
24
Hour (UT)



Hartland
Date: 11-04-2002
Day number: 101
Declination in degrees east
-4.45
15min
Horizontal Intensity in nT
19537
40nT
Vertical Intensity in nT
44090
30nT
0
3
6
9
12
15
18
21
24
Date: 12-04-2002
Day number: 102
Declination in degrees east
-4.45
15min
Horizontal Intensity in nT
19537
30nT
Vertical Intensity in nT
44090
30nT
0
3
6
9
12
15
18
21
24
Hour (UT)

Hartland



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Day number: 103
Declination in degrees east
-4.45
15min
Horizontal Intensity in nT
19537
40nT
Vertical Intensity in nT
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20nT
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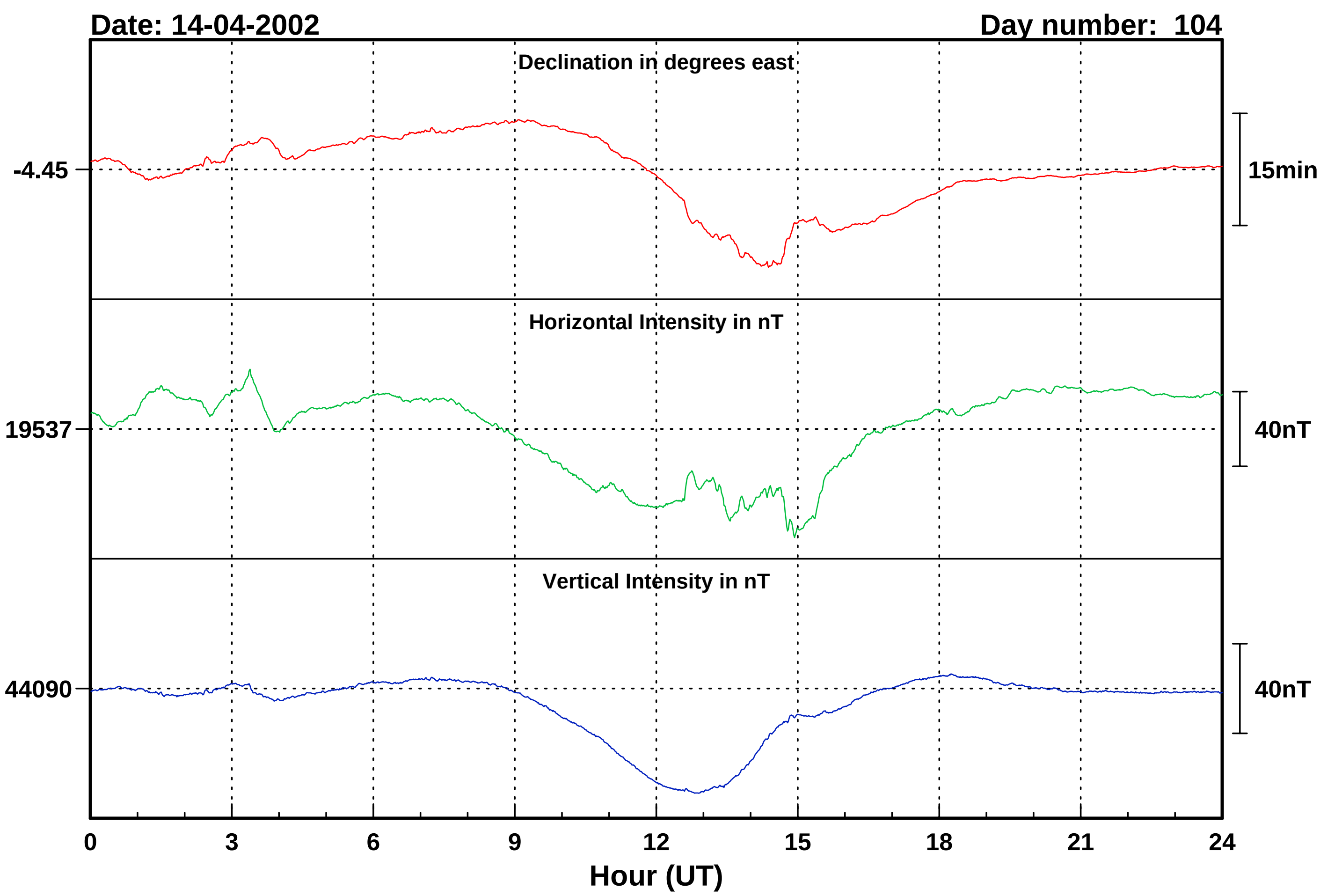
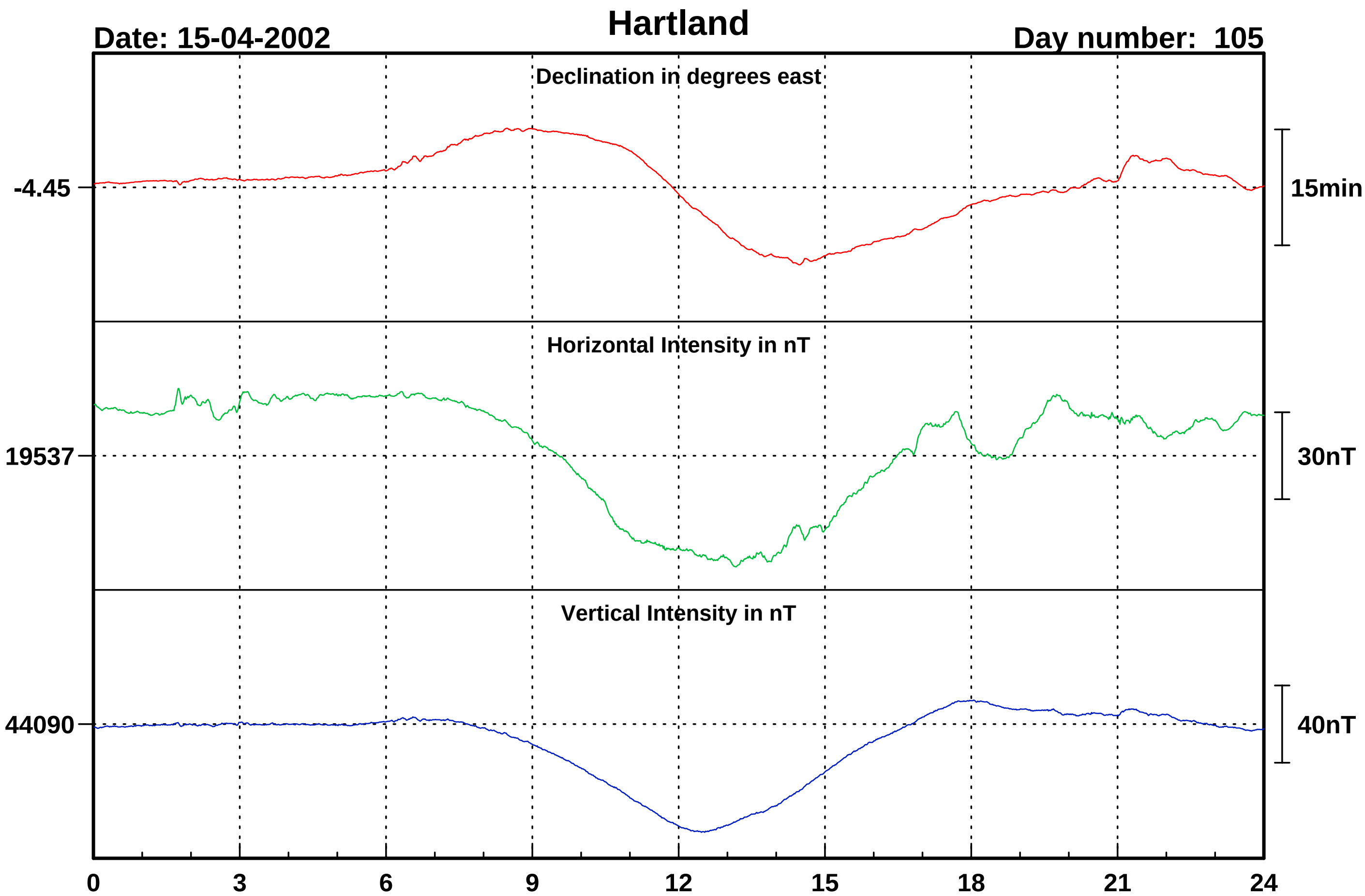
3
6
9
12
15
18
21
24



Date: 14-04-2002
Day number: 104
Declination in degrees east
-4.45
15min
Horizontal Intensity in nT
19537
40nT
Vertical Intensity in nT
44090
40nT
0
3
6
9
12
15
18
21
24
Hour (UT)



Hartland
Date: 15-04-2002
Day number: 105
Declination in degrees east
-4.45
15min
Horizontal Intensity in nT
19537
30nT
Vertical Intensity in nT
44090
40nT
0
3
6
9
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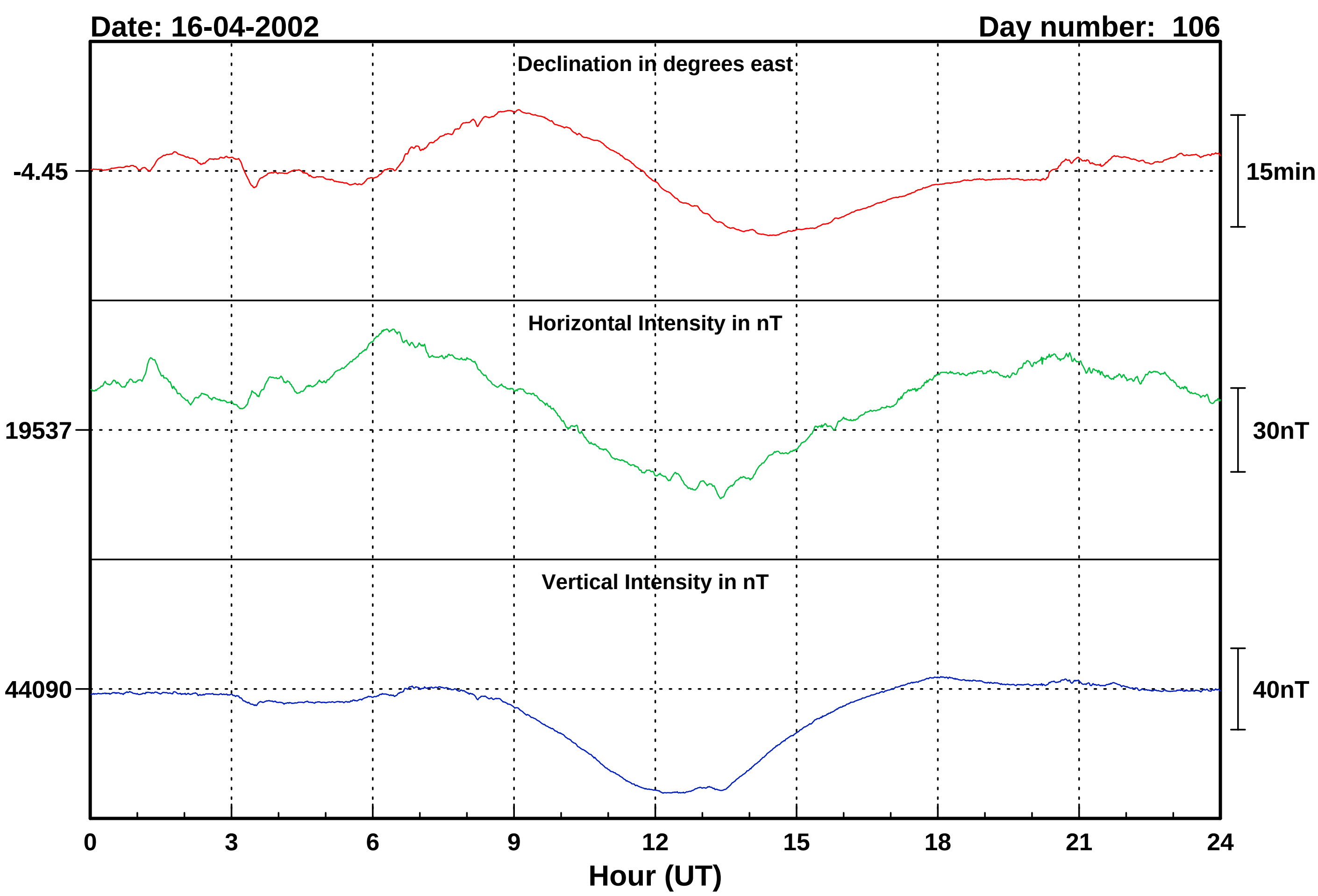

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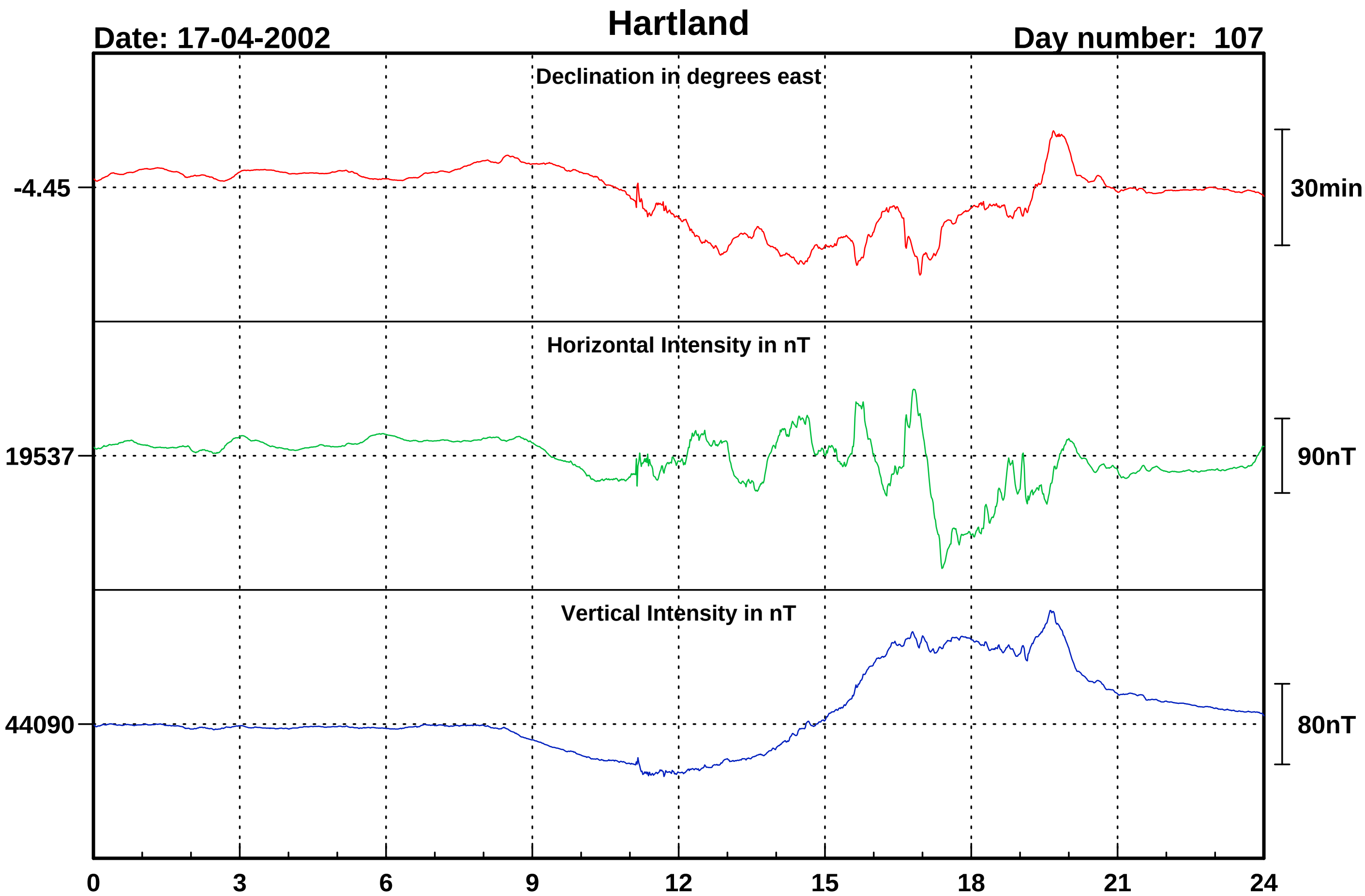
Day number: 106
Declination in degrees east
-4.45
15min
Horizontal Intensity in nT
19537
30nT
Vertical Intensity in nT
44090
40nT
0
3
6
9
12
15
18
21
24
Hour (UT)


Hartland
Date: 17-04-2002
Day number: 107
Declination in degrees east
-4.45
30min
Horizontal Intensity in nT
19537
90nT
Vertical Intensity in nT
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80nT
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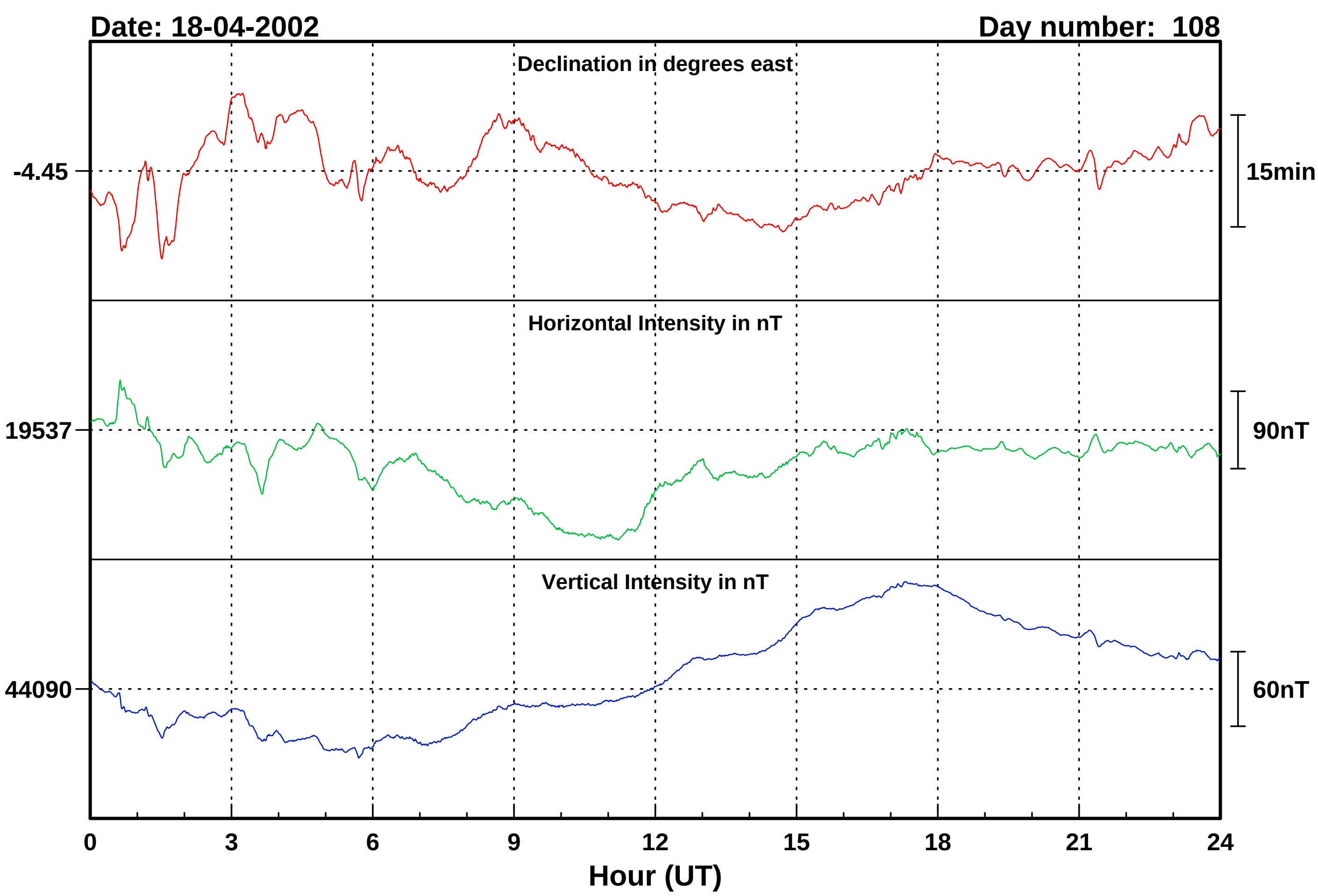
12
15
18
21
24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15min
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90nT
Vertical Intensity in nT
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60nT
0
3
6
9
12
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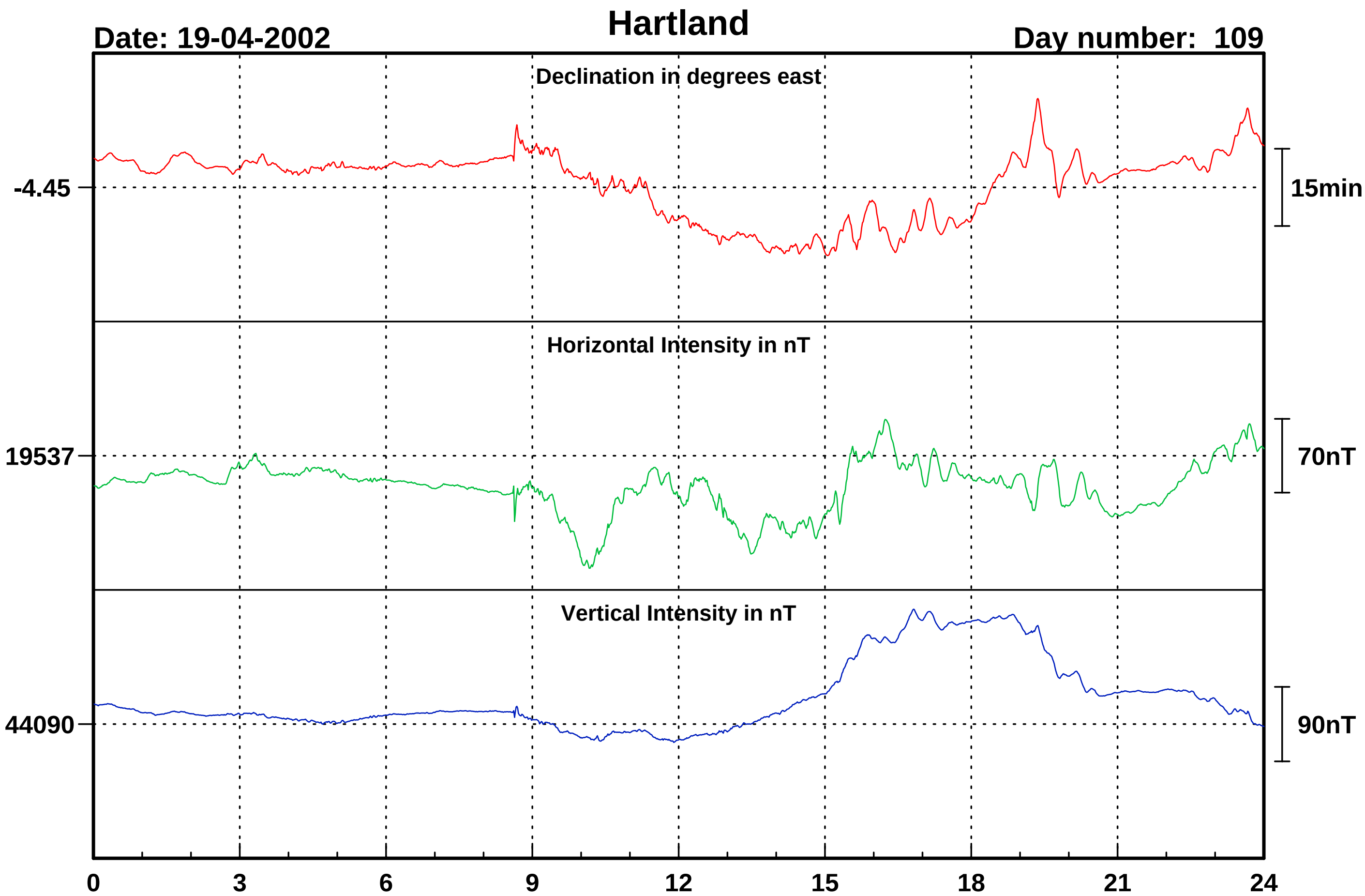
18
21
24
Hour (UT)


Hartland
Date: 19-04-2002
Day number: 109
Declination in degrees east
-4.45
15min
Horizontal Intensity in nT
19537
70nT
Vertical Intensity in nT
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12
15
18
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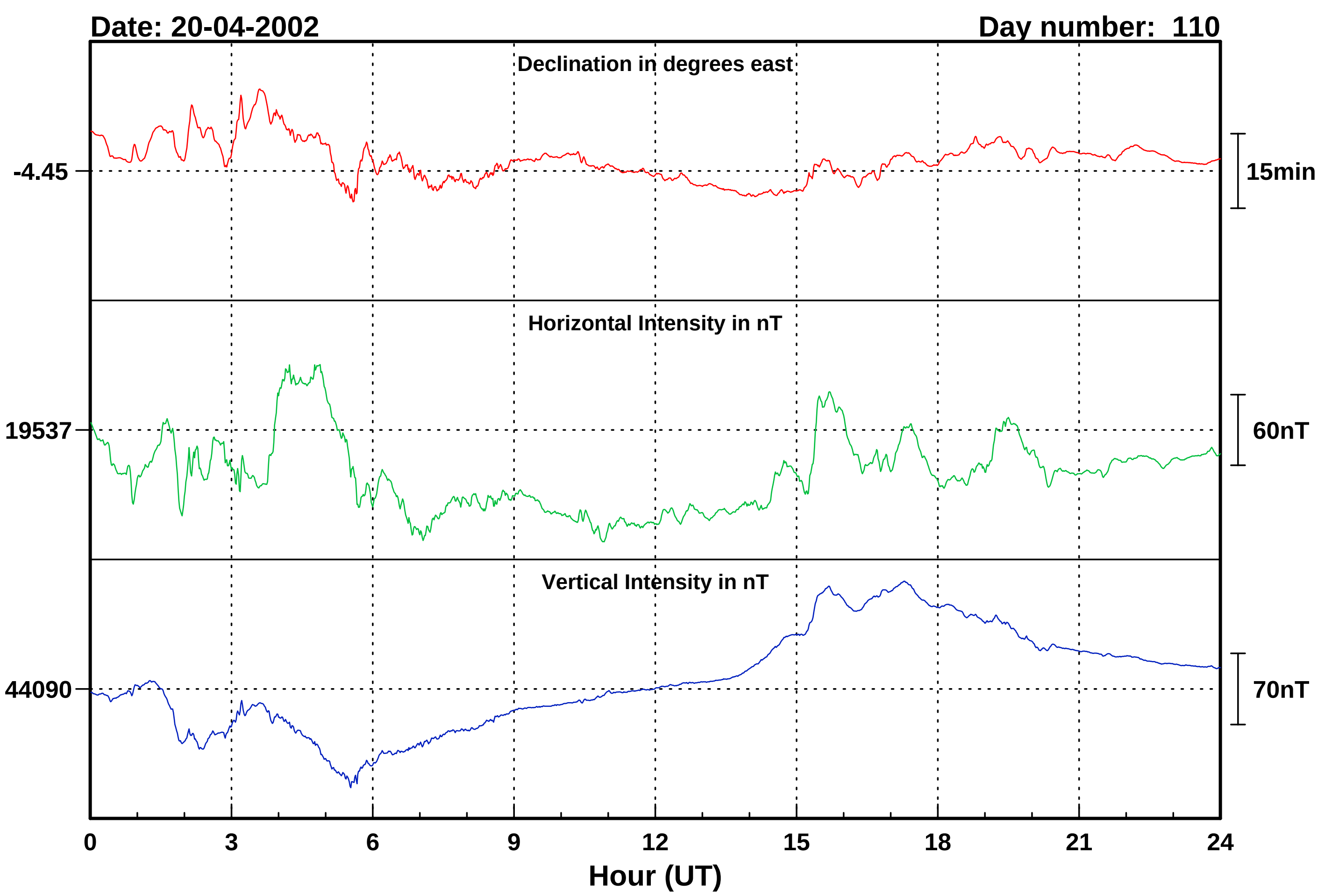
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Declination in degrees east
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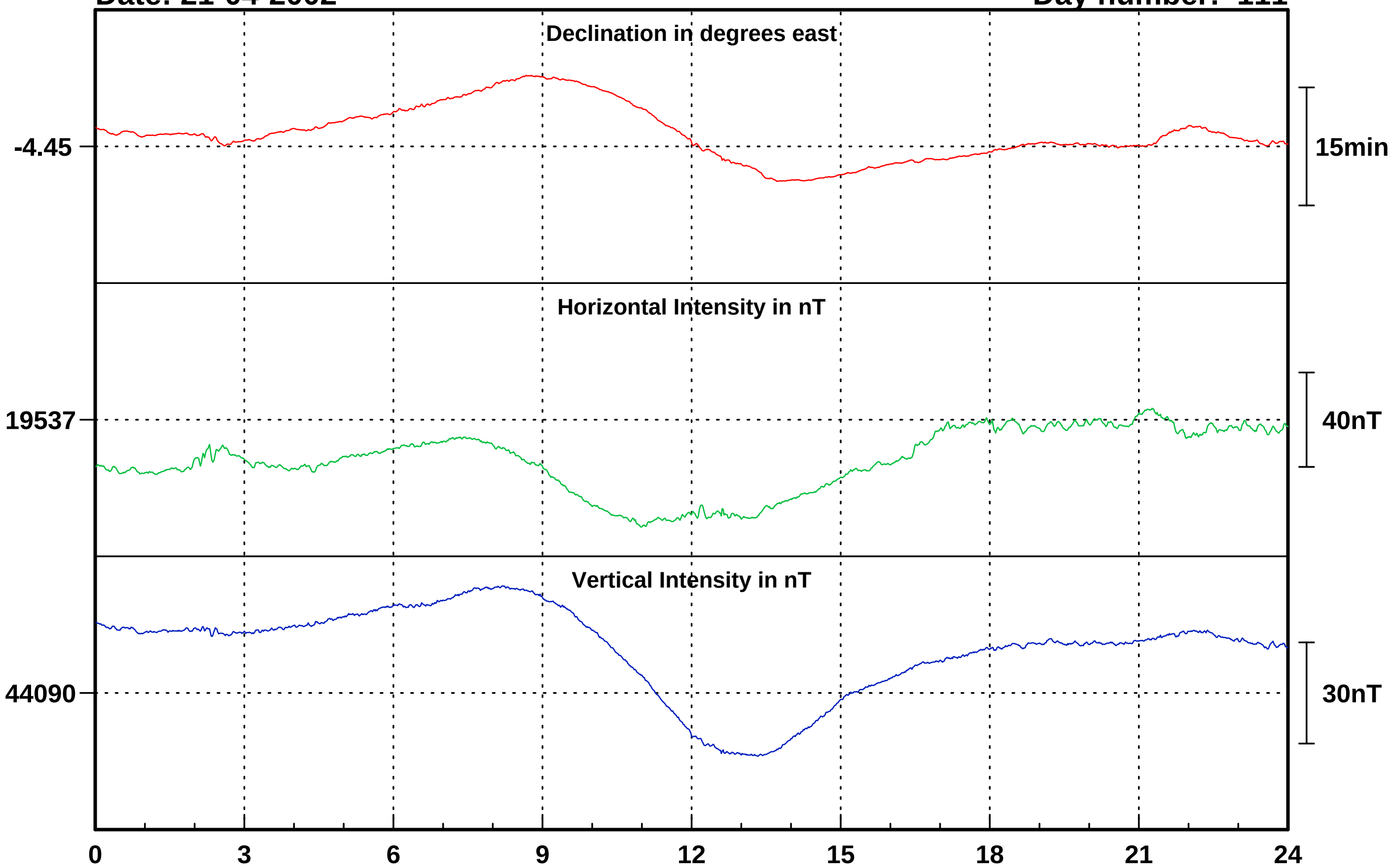
15min
Horizontal Intensity in nT
19537
60nT
Vertical Intensity in nT
44090
70nT
0
3
6
9
12
15
18
21
24
Hour (UT)

Hartland

Date: 21-04-2002 Day number: 111



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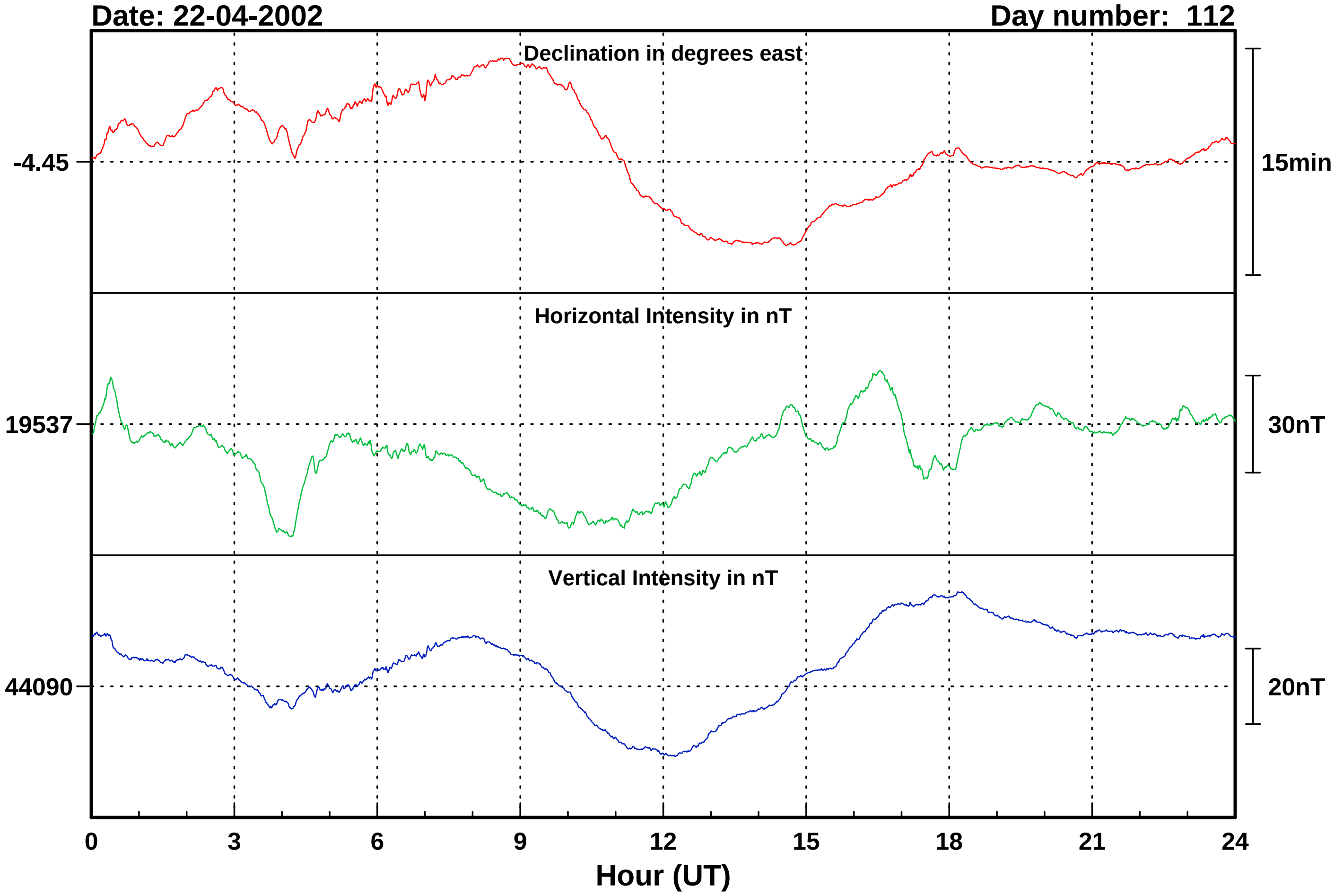
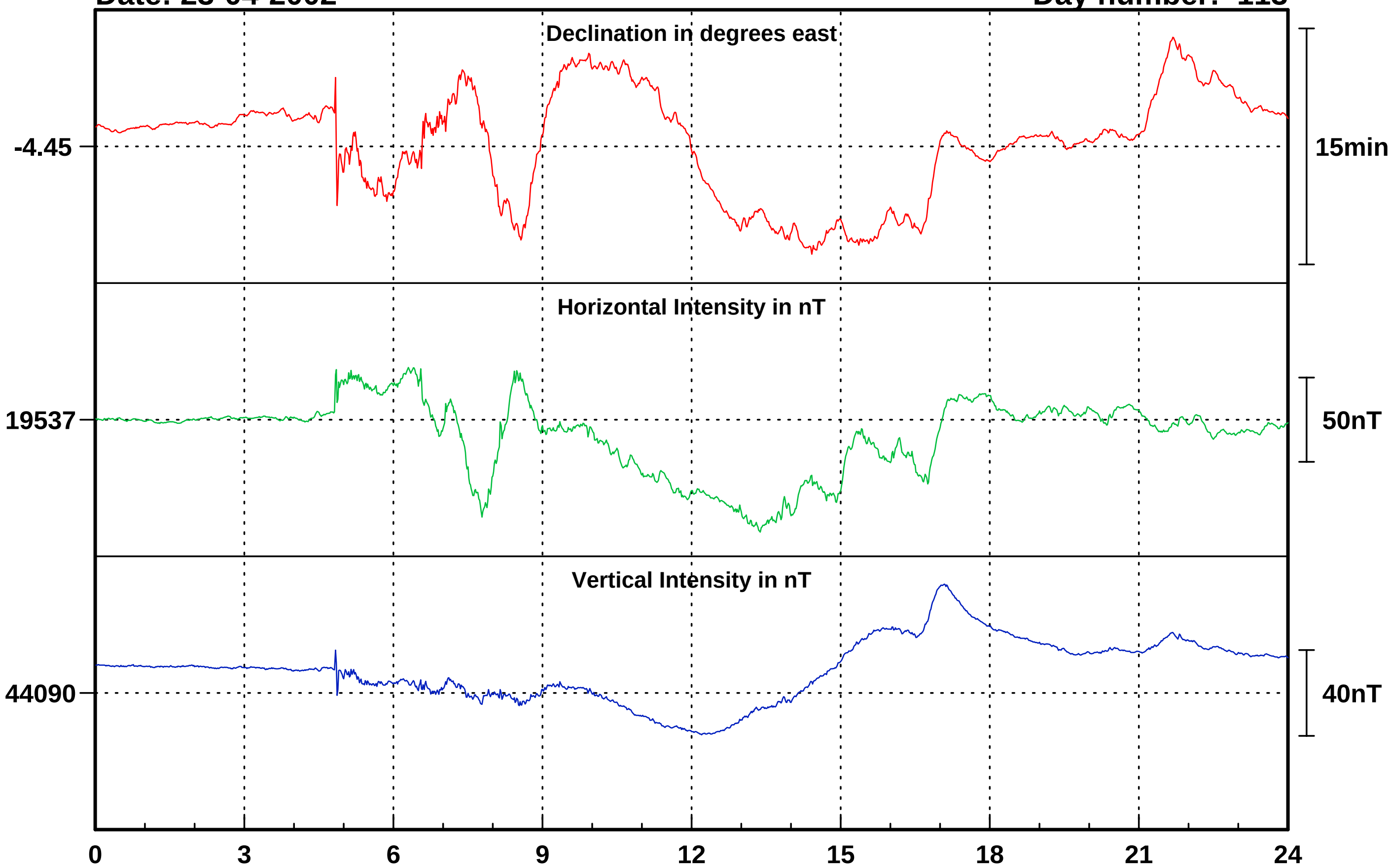


Hartland

Date: 23-04-2002 Day number: 113



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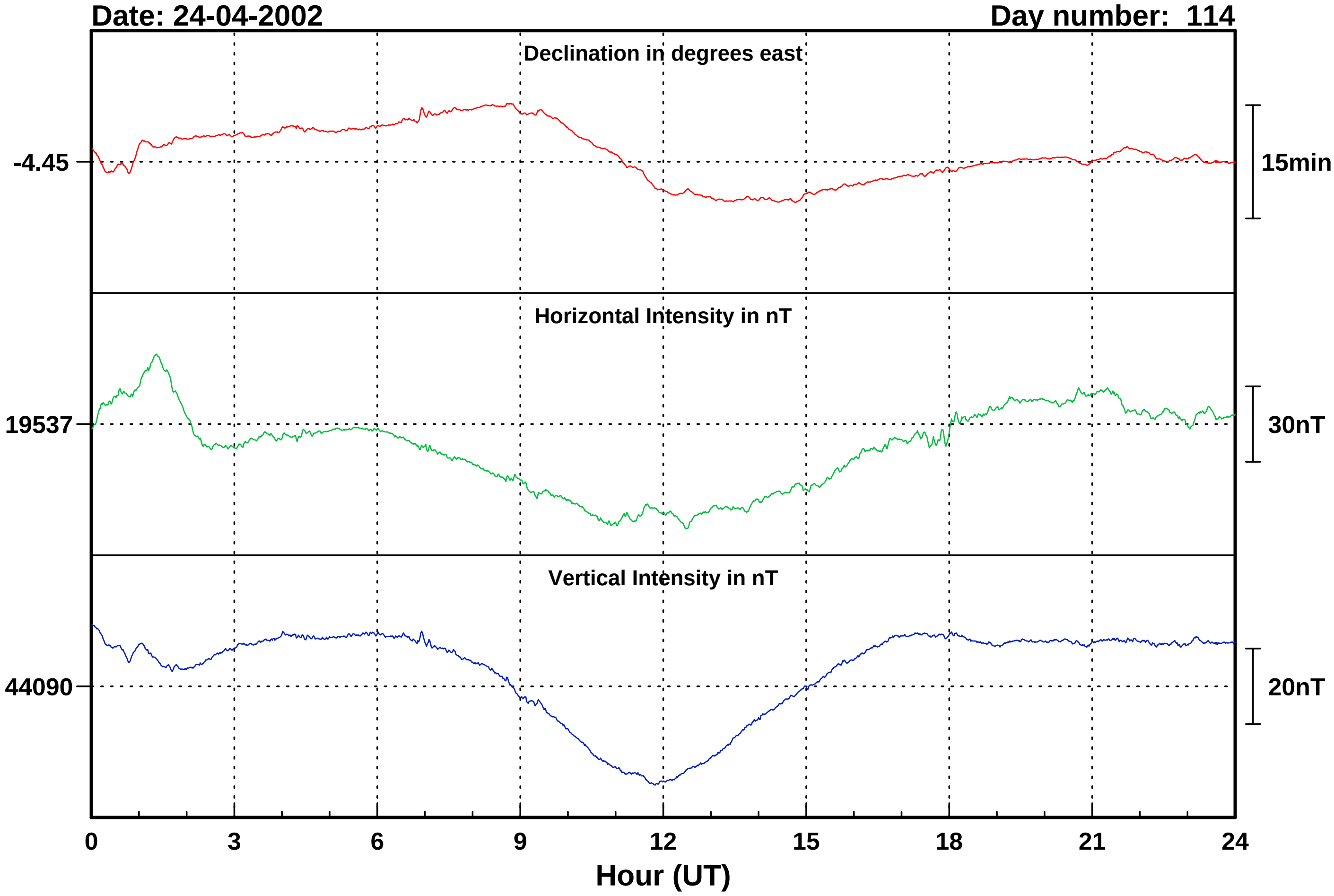
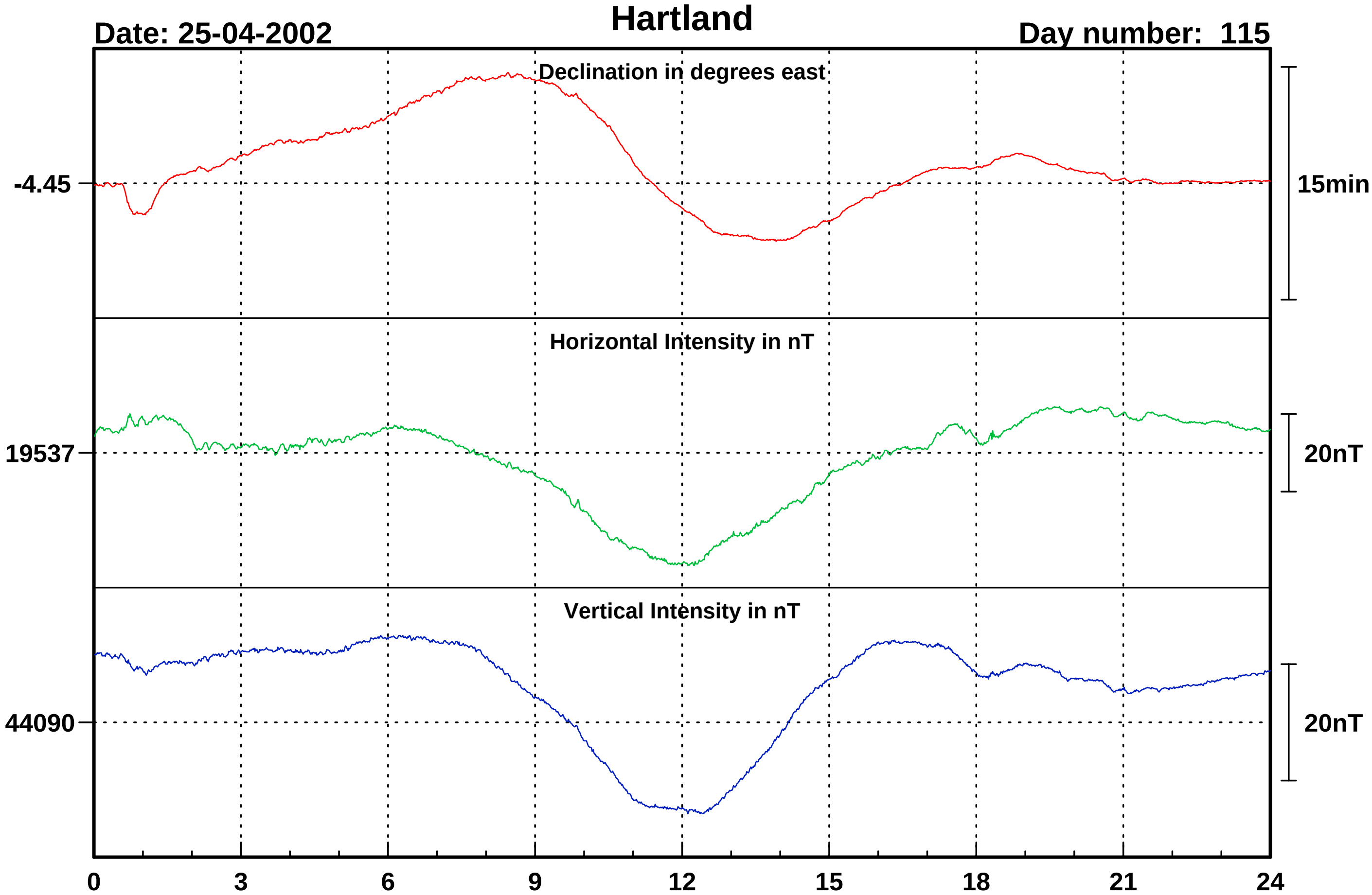


Hartland



Date: 25-04-2002
Day number: 115
Declination in degrees east
-4.45
15min
Horizontal Intensity in nT
19537
20nT
Vertical Intensity in nT
44090
20nT
0
3
6
9
12
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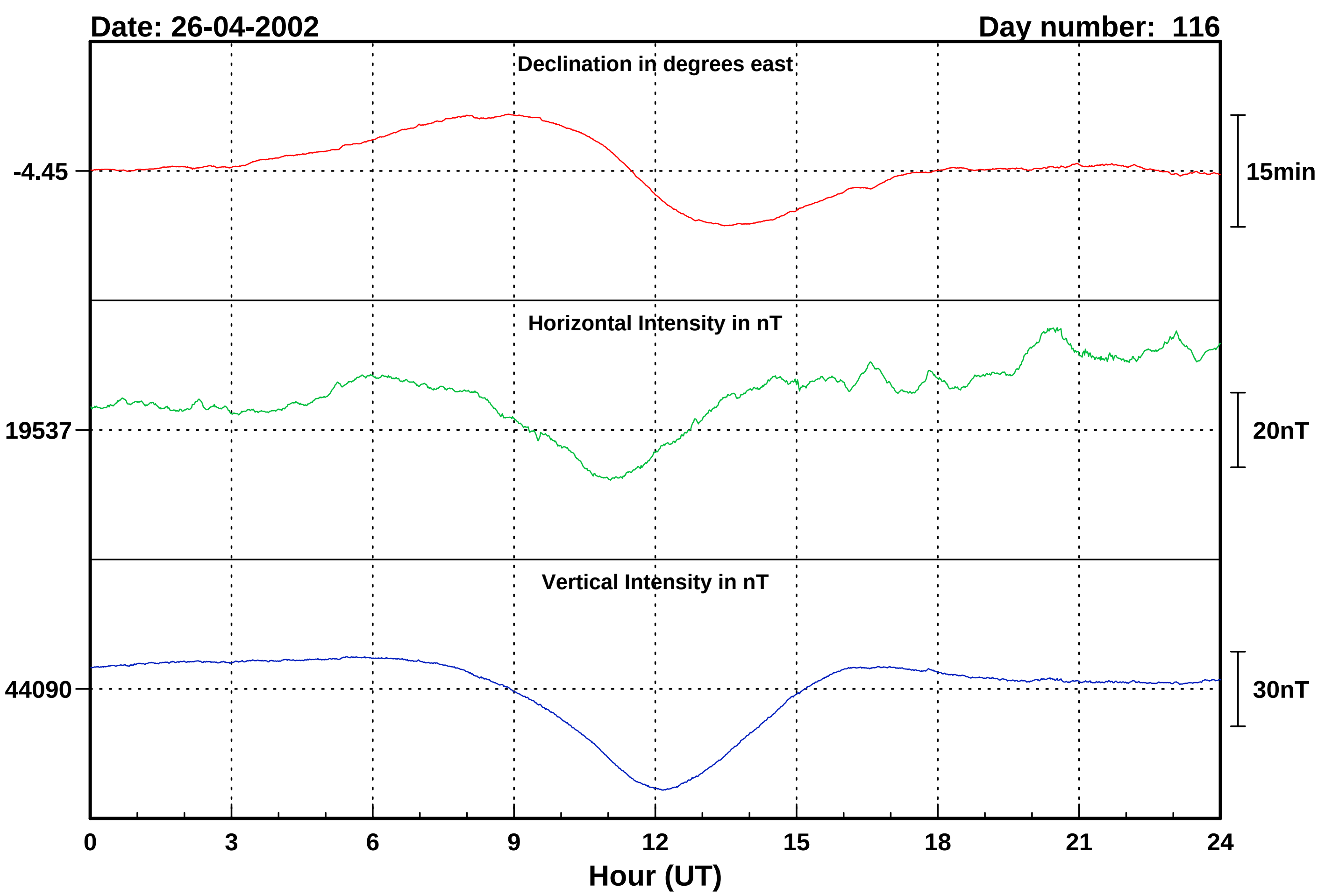

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15min
Horizontal Intensity in nT
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20nT
Vertical Intensity in nT
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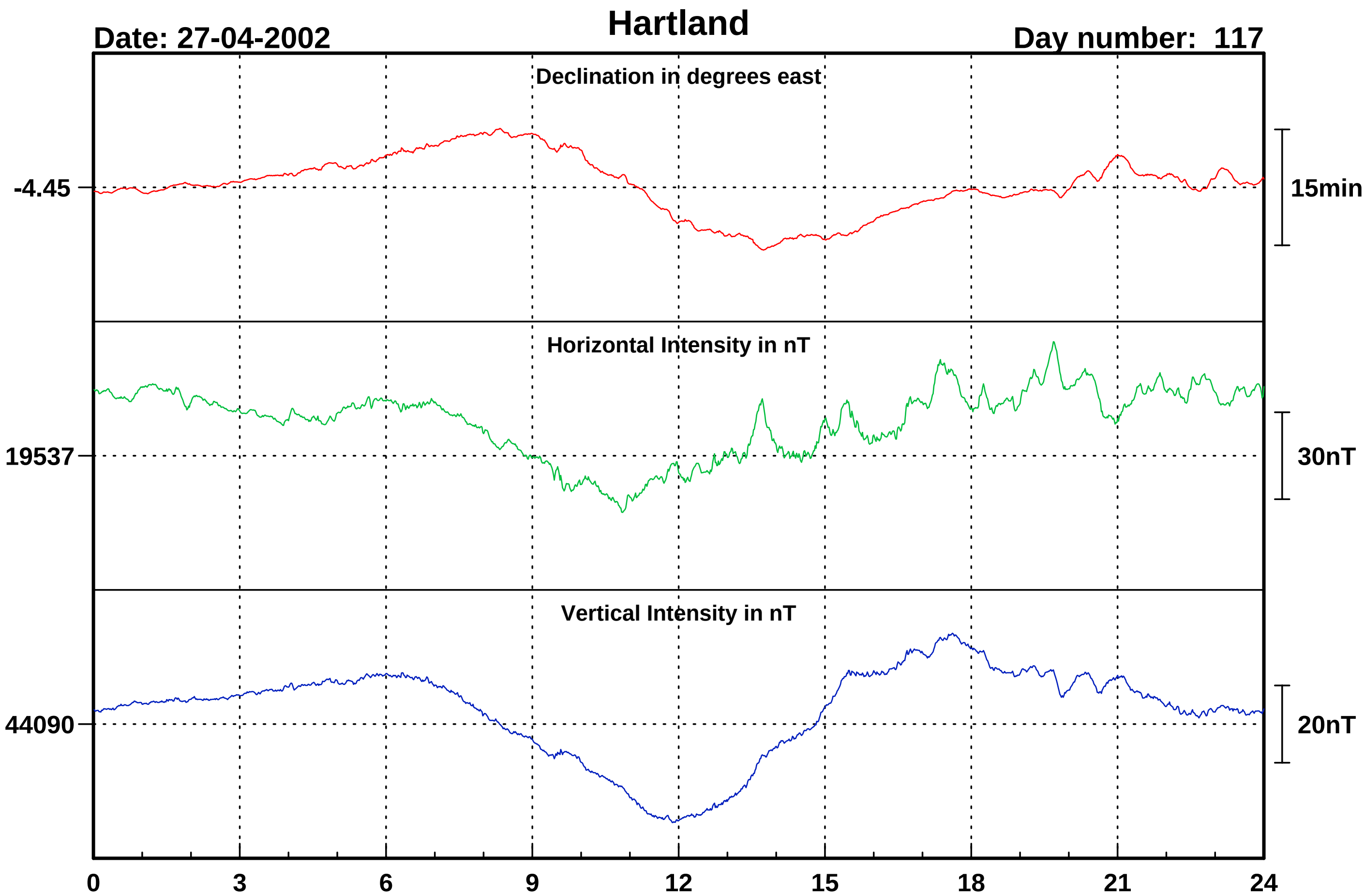
30nT
0
3
6
9
12
15
18
21
24
Hour (UT)



Hartland
Date: 27-04-2002
Day number: 117
Declination in degrees east
-4.45
15min
Horizontal Intensity in nT
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30nT
Vertical Intensity in nT
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20nT
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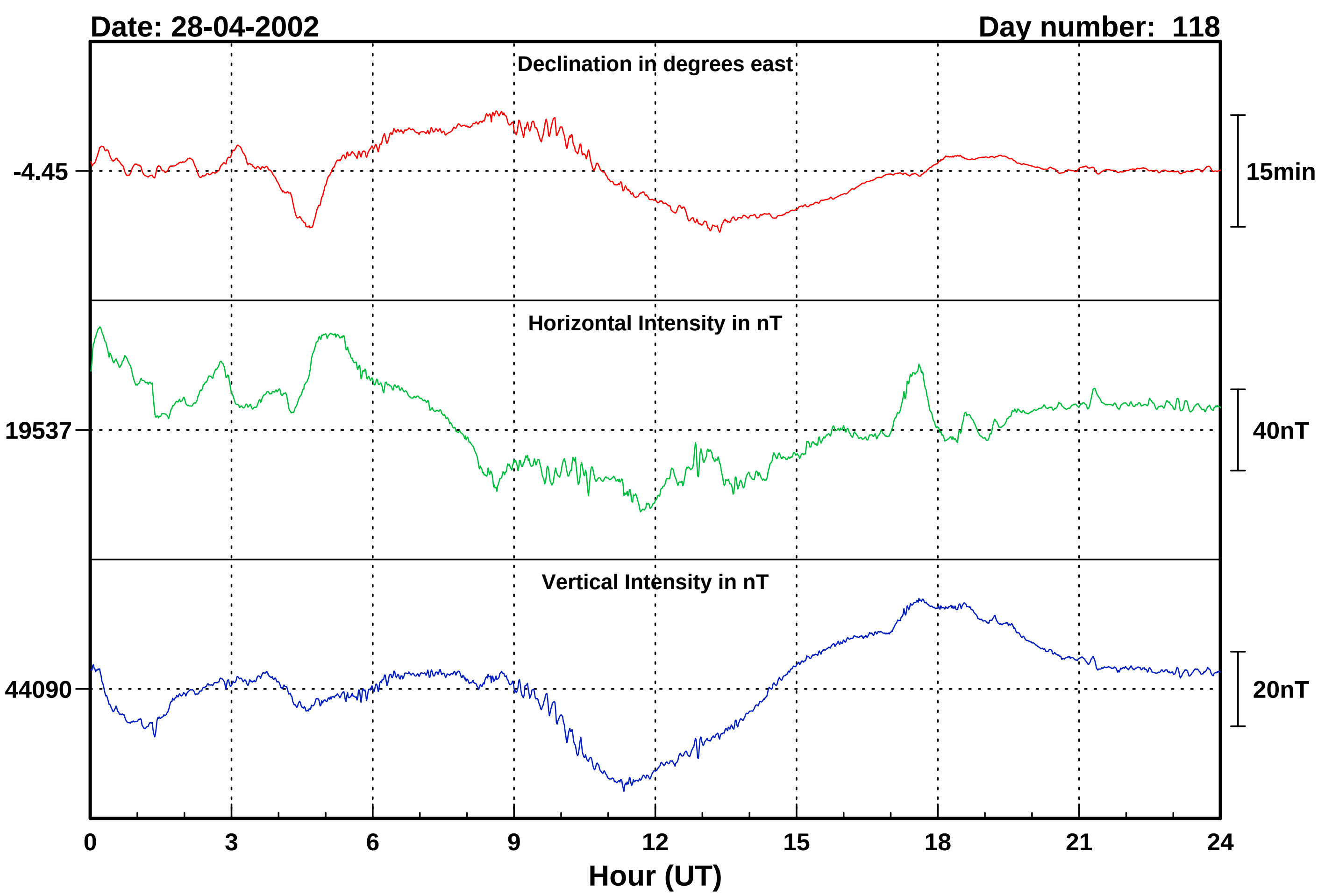
6
9
12
15
18
21
24



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15min
Horizontal Intensity in nT
19537
40nT
Vertical Intensity in nT
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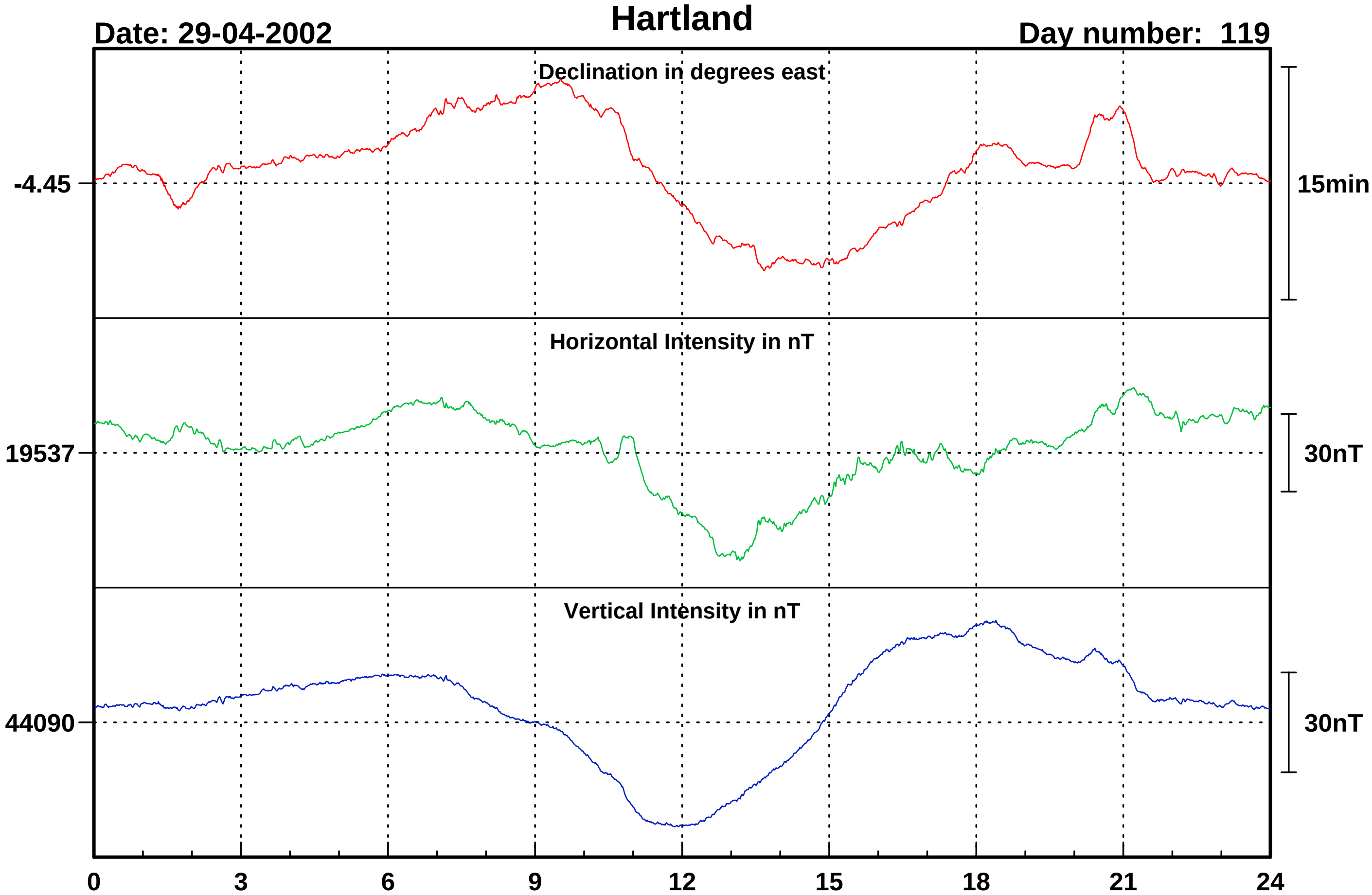
0
3
6
9
12
15
18
21
24
Hour (UT)

Hartland



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Day number: 119
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15min
Horizontal Intensity in nT
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30nT
Vertical Intensity in nT
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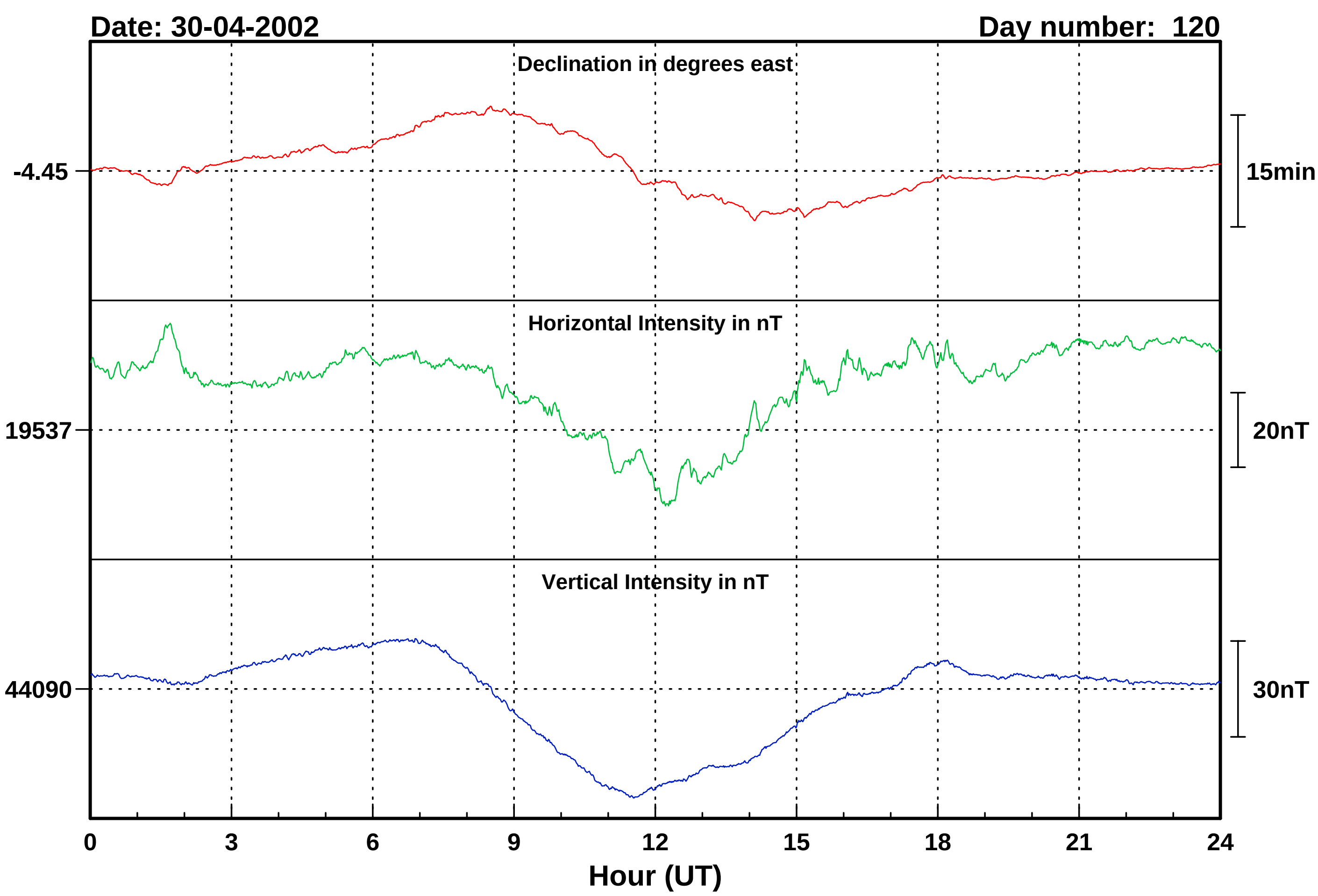

Date: 30-04-2002
Day number: 120
Declination in degrees east
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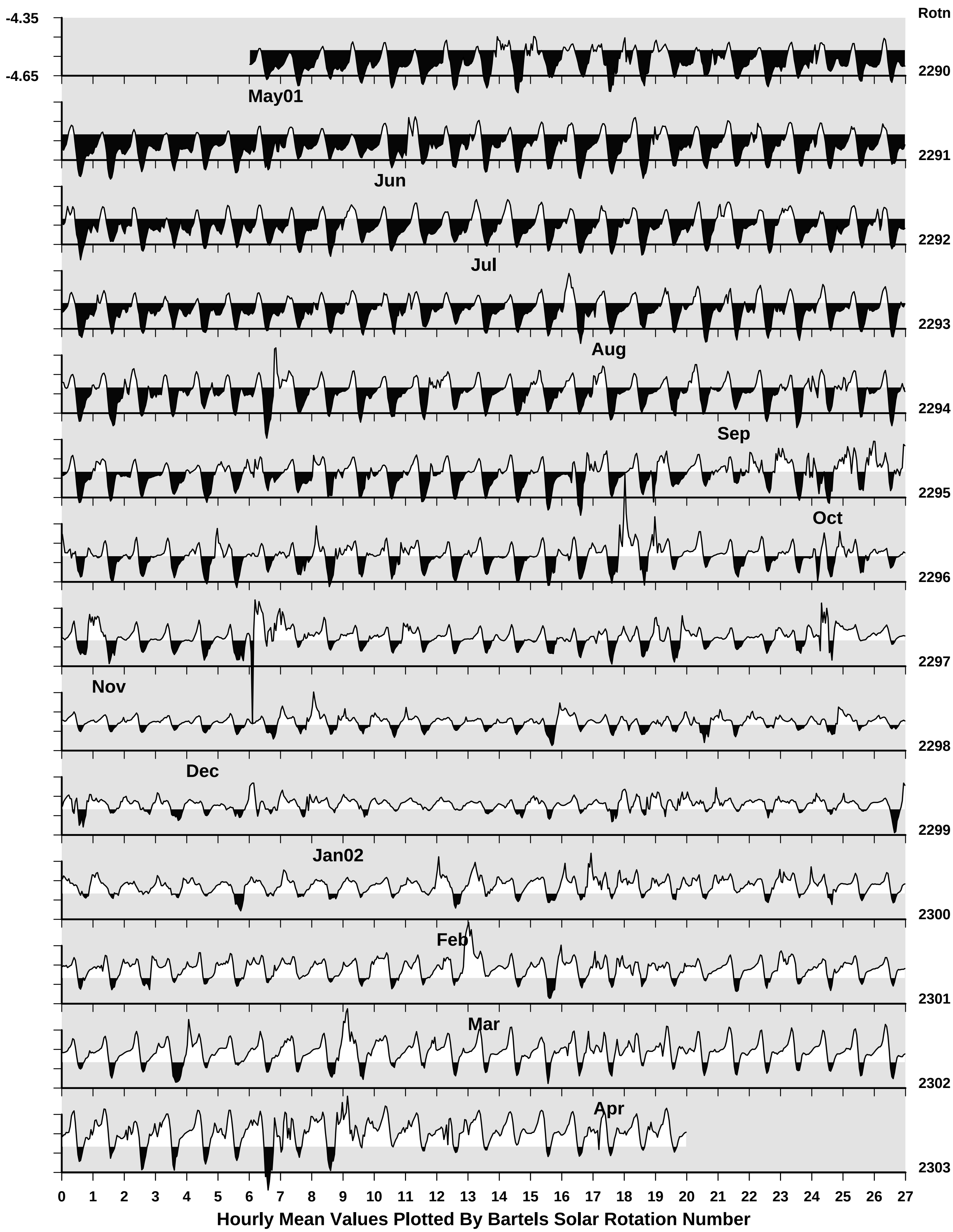
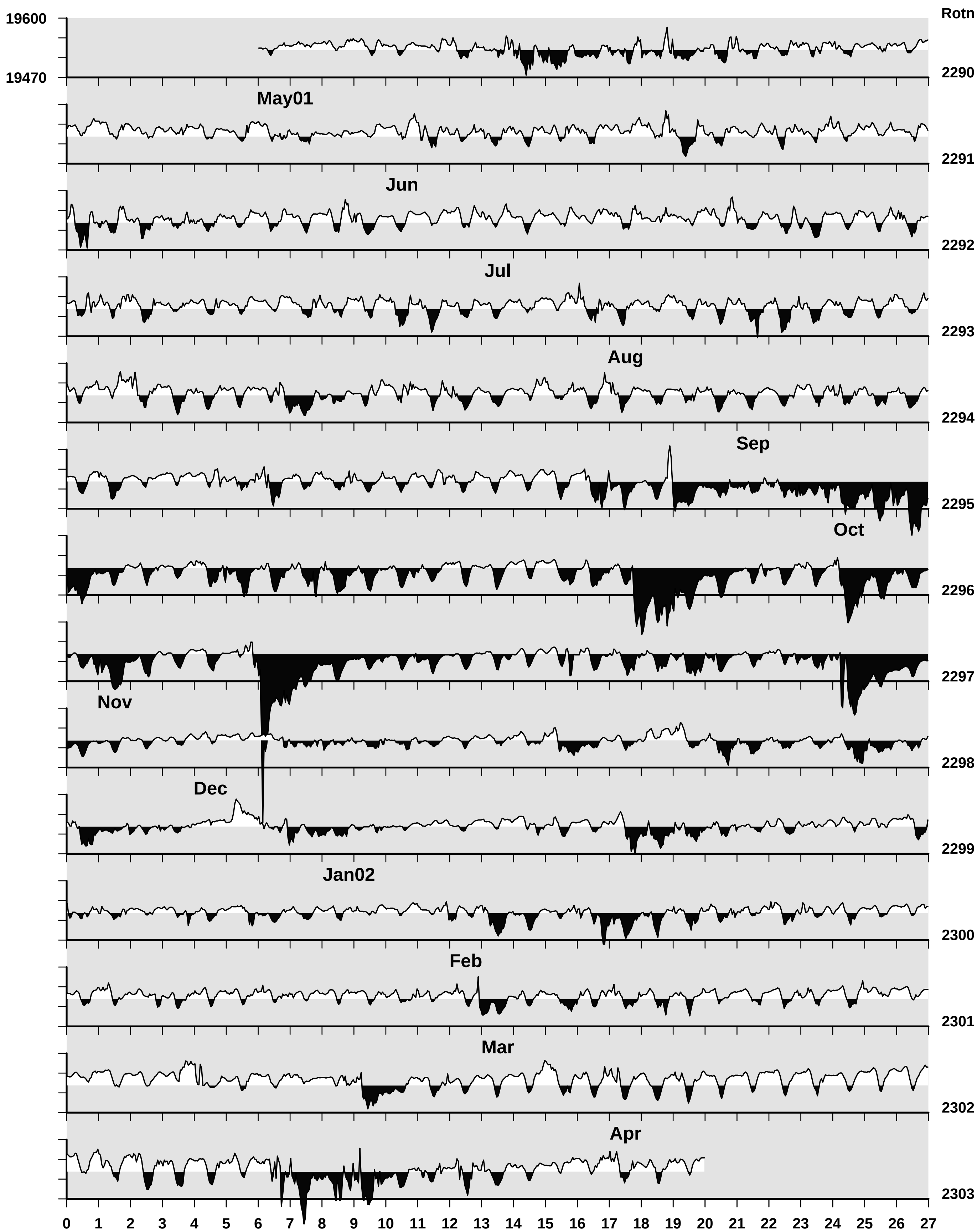
15min
Horizontal Intensity in nT
19537
20nT
Vertical Intensity in nT
44090
30nT
0
3
6
9
12
15
18
21
24
Hour (UT)

Hartland Observatory: Declination (degrees)

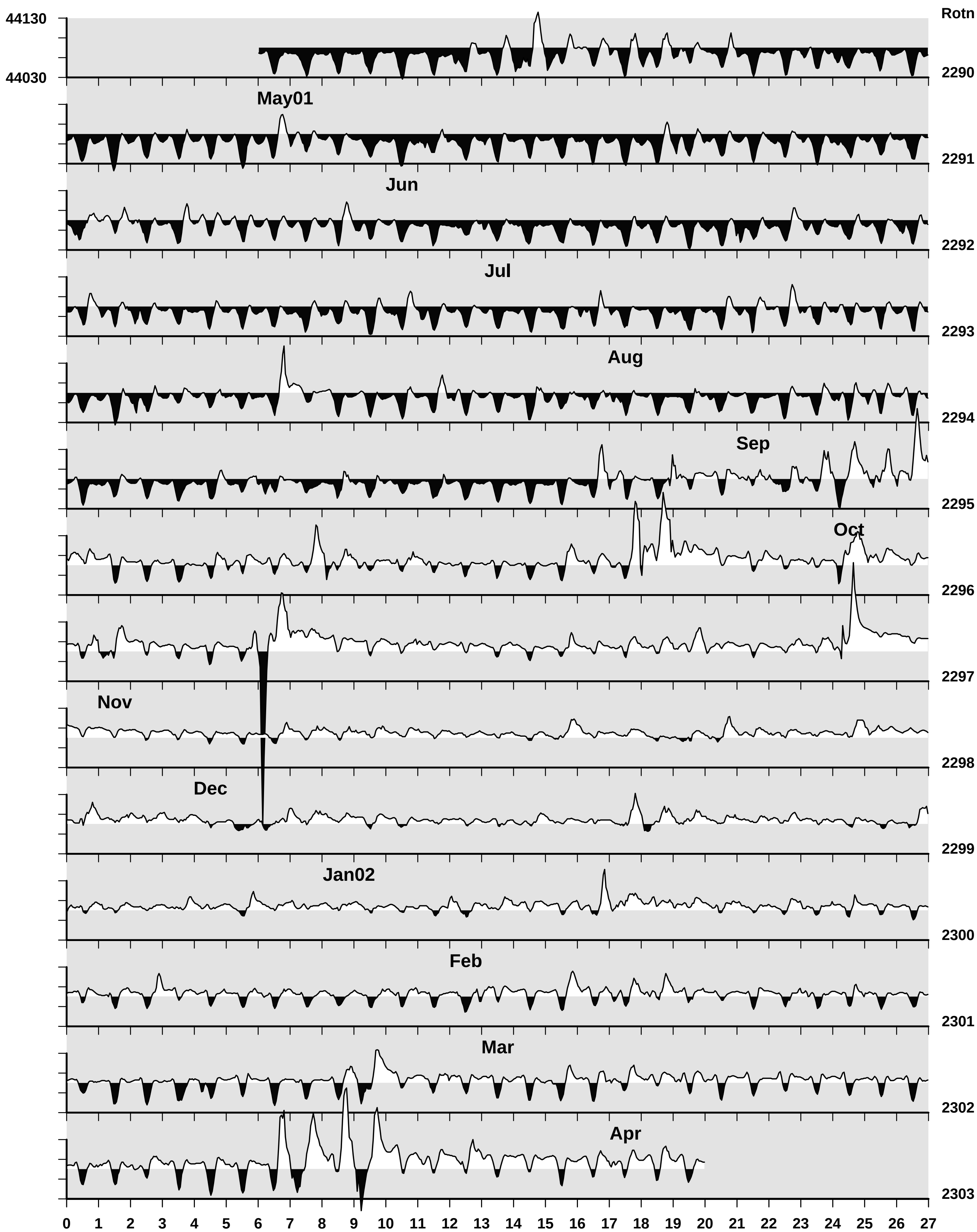


Hartland Observatory: Horizontal Intensity (nT)

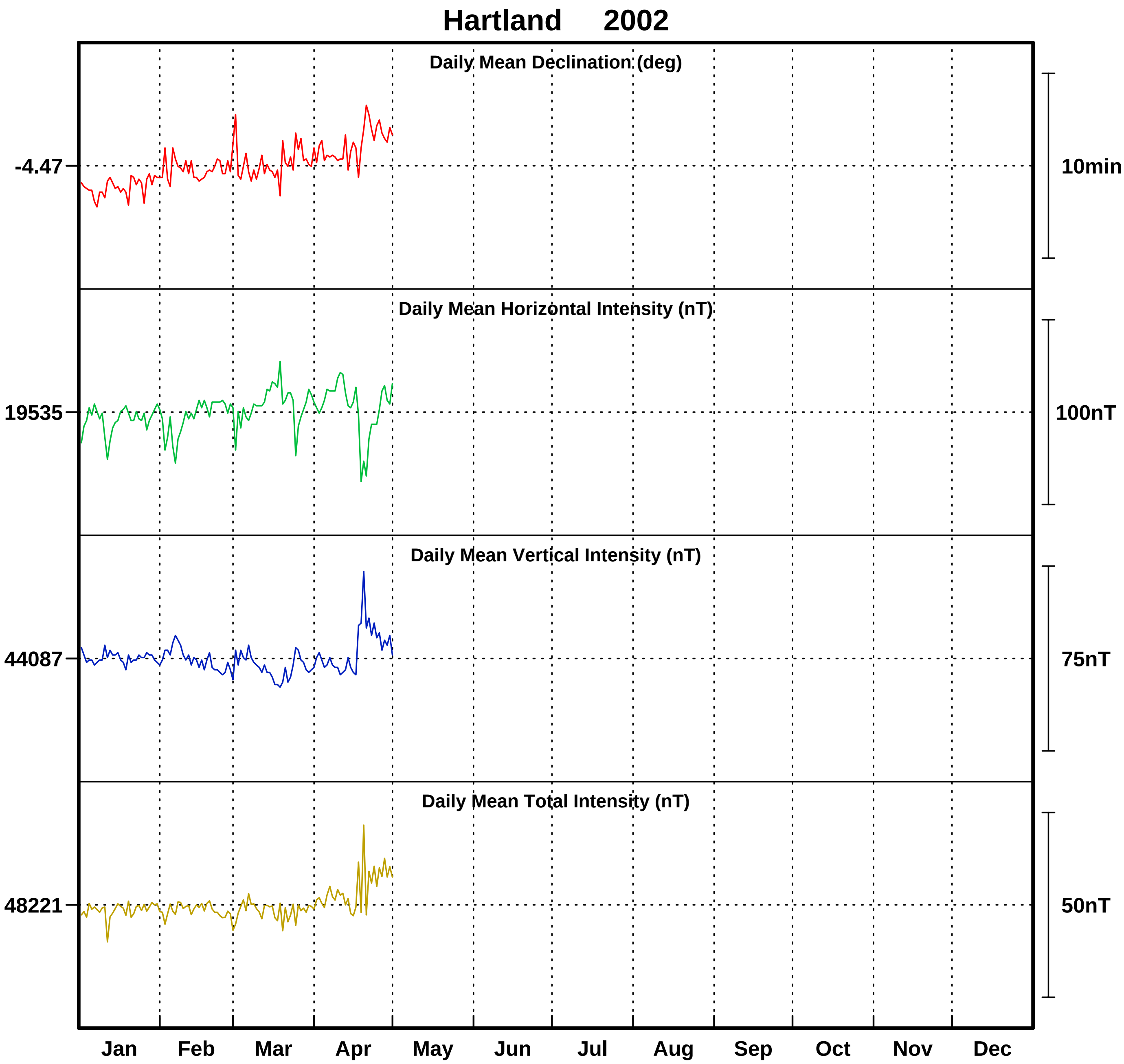


Hourly Mean Values Plotted By Bartels Solar Rotation Number

Hartland Observatory: Vertical Intensity (nT)



Hourly Mean Values Plotted By Bartels Solar Rotation Number


Hartland 2002
Daily Mean Declination (deg)
-4.47
10min
Daily Mean Horizontal Intensity (nT)
19535
100nT
Daily Mean Vertical Intensity (nT)
44087
75nT
Daily Mean Total Intensity (nT)
48221
50nT
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Monthly Mean Values for Hartland Observatory 2002

Month	*D*	*H*	*I*	*X*	*Y*	*Z*	*F*	Data
January	-4° 29.3´	19531 nT	66° 6.4´	19471 nT	-1528 nT	44087 nT	48219 nT	**P**
February	-4° 28.3´	19532 nT	66° 6.3´	19473 nT	-1523 nT	44086 nT	48219 nT	**P**
March	-4° 28.0´	19538 nT	66° 5.8´	19479 nT	-1522 nT	44083 nT	48219 nT	**P**
April	-4° 27.0´	19537 nT	66° 6.1´	19478 nT	-1516 nT	44090 nT	48225 nT	**P**

INDICES OF GEOMAGNETIC ACTIVITY

The K Index

Hartland Observatory April 2002

Day	K - INDICES FOR THREE-HOUR INTERVAL 00-03	03-06	06-09	09-12	12-15	15-18	18-21	21-24	SUM
1	3	3	4	3	4	3	3	1	24
2	2	3	4	4	2	2	2	1	20
3	3	4	4	3	2	2	2	2	22
4	2	2	2	1	2	2	1	1	13
5	1	1	1	0	1	1	1	0	6
6	0	1	0	1	1	1	1	1	6
7	1	1	2	3	4	3	1	0	15
8	0	0	1	1	0	0	1	0	3
9	1	1	1	1	2	1	0	1	8
10	0	0	1	1	3	2	1	2	10
11	2	2	4	5	3	3	3	3	25
12	4	3	3	2	4	3	3	3	25
13	3	3	3	4	3	4	3	3	26
14	3	3	1	1	4	4	1	0	17
15	2	1	1	1	1	2	2	3	13
16	2	3	3	1	1	1	2	1	14
17	3	3	3	5	5	7	6	3	35
18	6	5	4	4	3	4	2	4	32
19	3	3	4	5	5	5	6	5	36
20	5	6	4	4	4	5	4	3	35
21	2	1	1	1	1	1	1	2	10
22	2	3	2	1	2	3	3	1	17
23	1	4	5	3	3	4	3	3	26
24	3	1	2	2	1	2	1	2	14
25	2	1	0	0	0	0	1	0	4
26	0	0	0	1	1	1	2	1	6
27	1	1	1	2	3	3	3	3	17
28	4	4	4	4	3	4	3	2	28
29	2	1	1	3	3	3	3	3	19
30	2	2	1	2	3	2	2	0	14

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)
01-04-02	91	3 3 4 3 4 3 3 1	1 3 4 2 2 2 3 2	35	25	34	26	30
02-04-02	92	2 3 4 4 2 2 2 1	1 3 4 3 2 1 1 2	27	23	37	13	25
03-04-02	93	3 4 4 3 2 2 2 2	2 3 2 3 1 1 2 1	30	17	35	13	24
04-04-02	94	2 2 2 1 2 2 1 1	1 2 2 3 3 0 1 1	13	15	16	12	14
05-04-02	95	1 1 1 0 1 1 1 0	1 1 1 0 1 0 0 0	6	5	6	5	6
06-04-02	96	0 1 0 1 1 1 1 1	1 1 0 2 1 2 0 1	6	9	7	8	8
07-04-02	97	1 1 2 3 4 3 1 0	1 2 2 2 2 1 0 1	20	11	15	17	16
08-04-02	98	0 0 1 1 0 0 1 0	0 0 1 0 0 0 0 0	4	3	4	3	4
09-04-02	99	1 1 1 1 2 1 0 1	0 1 0 0 0 0 0 1	8	4	6	6	6
10-04-02	100	0 0 1 1 3 2 1 2	0 1 0 1 1 1 1 1	11	7	5	13	9
11-04-02	101	2 2 4 5 3 3 3 3	2 1 2 2 2 3 1 2	40	16	31	25	28
12-04-02	102	4 3 3 2 4 3 3 3	3 2 2 3 3 1 1 3	36	22	29	29	29
13-04-02	103	3 3 3 4 3 4 3 3	1 2 2 3 3 2 2 3	38	21	28	31	30
14-04-02	104	3 3 1 1 4 4 1 0	3 2 0 1 5 3 0 0	26	25	17	33	25
15-04-02	105	2 1 1 1 1 2 2 3	2 1 1 0 2 2 1 1	14	10	9	15	12
16-04-02	106	2 3 3 1 1 1 2 1	0 1 2 0 0 0 2 2	16	8	15	10	12
17-04-02	107	3 3 3 5 5 7 6 3	2 2 3 5 5 5 5 3	97	64	45	115	80
18-04-02	108	6 5 4 4 3 4 2 4	4 4 5 5 4 5 4 4	69	76	89	56	72
19-04-02	109	3 3 4 5 5 5 6 5	4 3 4 5 5 5 5 4	87	78	60	105	82
20-04-02	110	5 6 4 4 4 5 4 3	5 5 5 4 3 4 4 3	79	69	94	54	74
21-04-02	111	2 1 1 1 1 1 1 2	2 1 1 0 1 1 1 1	10	8	9	9	9
22-04-02	112	2 3 2 1 2 3 3 1	2 3 1 2 2 3 2 1	20	18	18	20	19
23-04-02	113	1 4 5 3 3 4 3 3	1 5 5 3 3 3 2 2	44	43	56	31	43
24-04-02	114	3 1 2 2 1 2 1 2	2 2 1 1 1 2 2 2	15	13	15	13	14
25-04-02	115	2 1 0 0 0 0 1 0	1 1 0 1 0 0 1 0	5	5	7	4	5
26-04-02	116	0 0 0 1 1 1 2 1	1 1 1 0 0 1 0 2	7	7	5	9	7
27-04-02	117	1 1 1 2 3 3 3 3	1 2 2 2 2 2 2 2	21	15	12	24	18
28-04-02	118	4 4 4 4 3 4 3 2	3 4 4 4 3 3 2 2	46	39	56	29	42
29-04-02	119	2 1 1 3 3 3 3 3	0 1 1 3 2 2 3 2	24	17	14	26	20
30-04-02	120	2 2 1 2 3 2 2 0	0 2 2 2 3 1 1 0	15	13	13	15	14
Monthly mean value =			26.0					

(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

HARLAND RAPID VARIATIONS

SIs and SSCs

Date	Time (UT)	Type	Quality	H (nT)	D (min)	Z (nT)
17-04-02	11:07	SSC*	A	-33.2	-5.65	-
19-04-02	08:35	SSC*	A	-33.5	4.83	-7.9
23-04-02	04:48	SSC*	A	22.1	-8.14	-21.0

SFEs

Date	Start (UT)	Maximum (UT)	End (UT)	H (nT)	D (min)	Z (nT)
04-04-02	15:29	15:33	15:47	-3.7	-1.12	-3.0
09-04-02	12:57	13:01	13:09	-2.8	-0.69	-1.2
10-04-02	12:26	12:32	12:45	-13.7	-	-3.7

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.