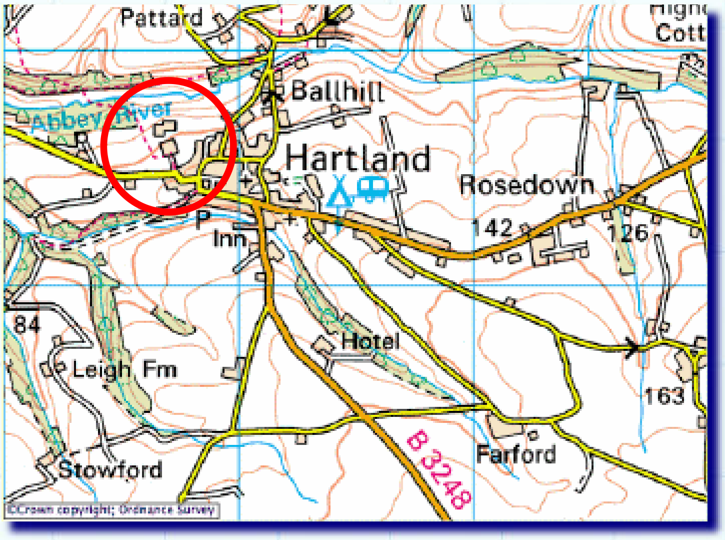
BRITISH GEOLOGICAL SURVEY

Hartland Observatory

Monthly Magnetic Bulletin

December 2006

06/12/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 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:

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) 131 650 0265
E-mail: orba@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° 1.9′ N* *079° 09.4′ E*
Height above mean sea level: *95 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.

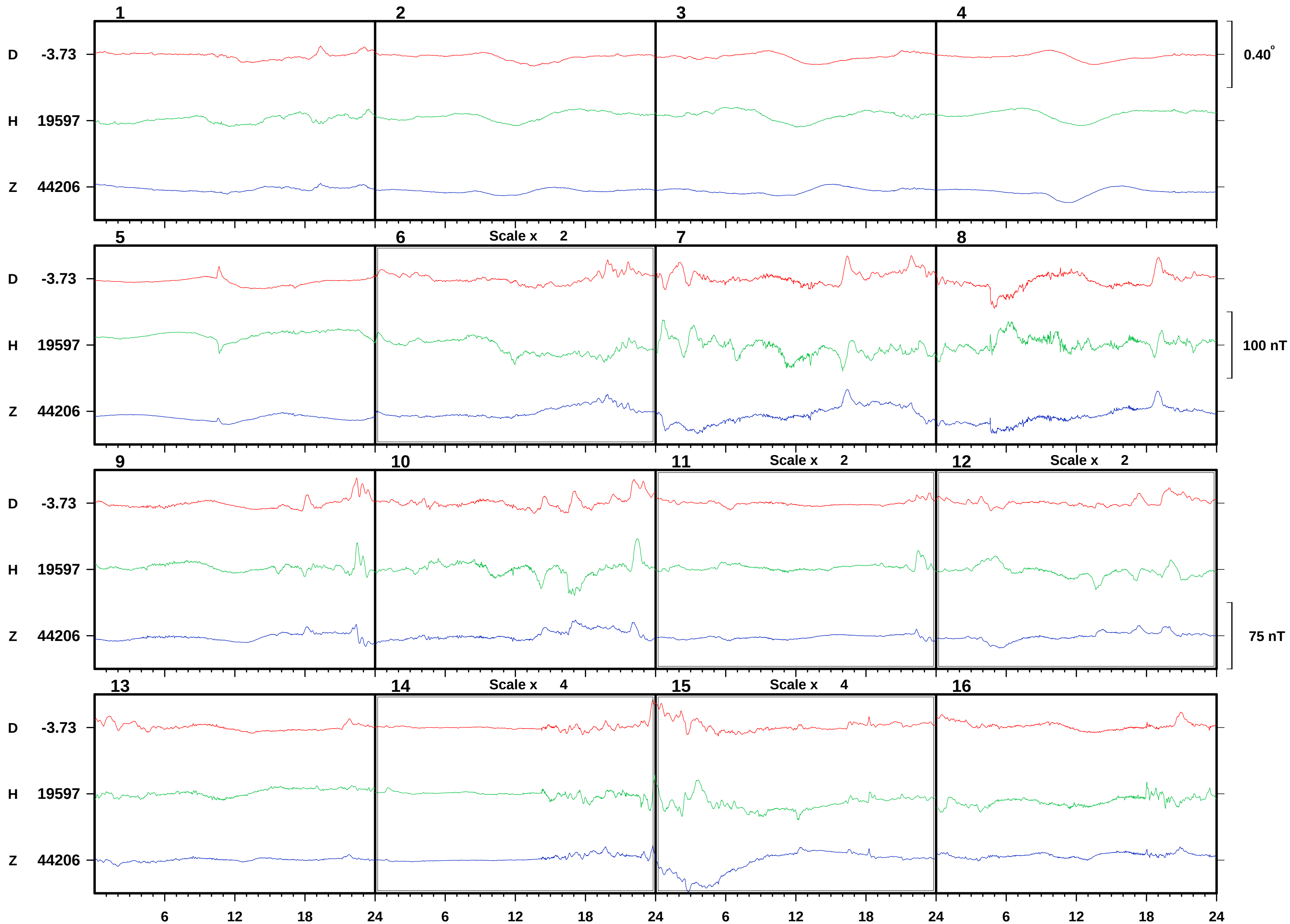
The *aa* indices listed in this publication are provisional only; the definitive values are published by the International Service for Geomagnetic Indices, CRPE/CNET - CNRS, 4 Avenue de Neptune, F-94107 Saint Maur Cedex, France.

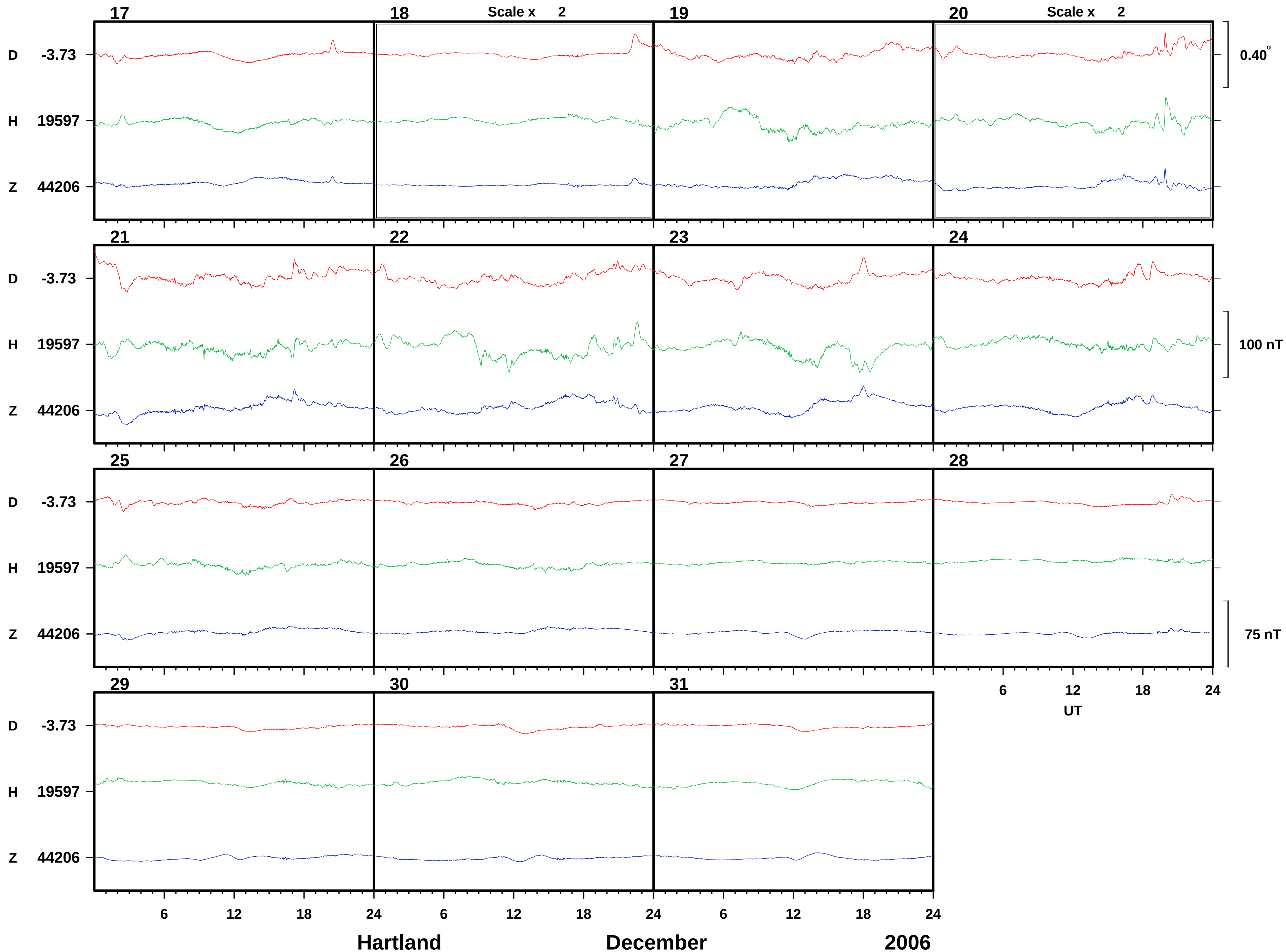
1.4.6 Rapid Variations

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 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.

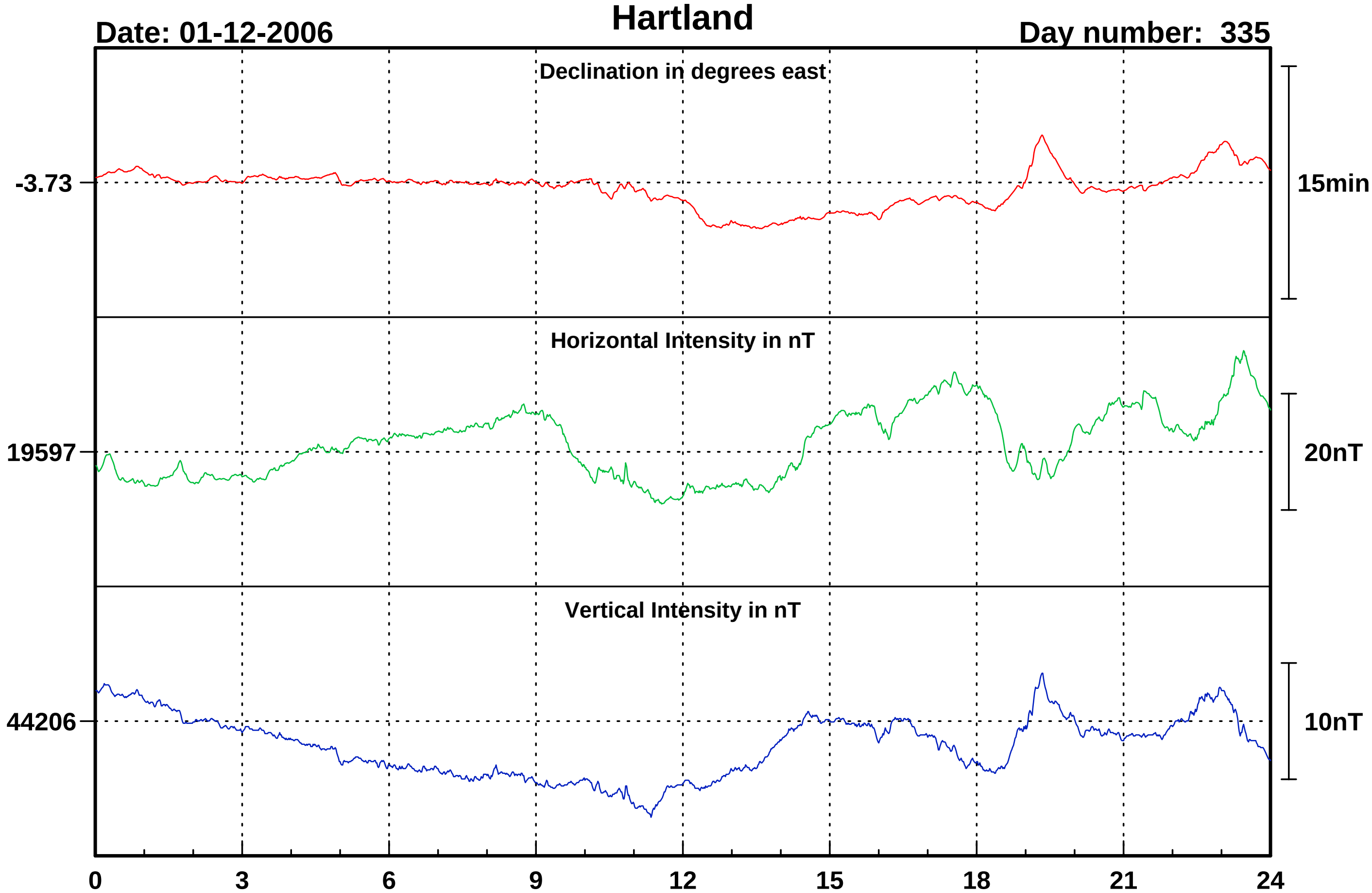
Solar flares, seen at optical wavelengths as a sudden brightening of a small region of the Sun's surface, are also responsible for increased X-ray emissions. The X-rays cause increased ionisation in the ionosphere, which leads to absorption of short-wave radio signals. On an observatory magnetogram a 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 December 2006




17
18
Scale x 2
19
20
Scale x 2
21
22
23
24
25
26
27
28
29
30
31
D -3.73
H 19597
Z 44206
0.40°
100 nT
75 nT
6
12
18
24
UT
Hartland
December
2006

Hartland



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15min
Horizontal Intensity in nT
19597
20nT
Vertical Intensity in nT
44206
10nT
0
3
6
9
12
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18
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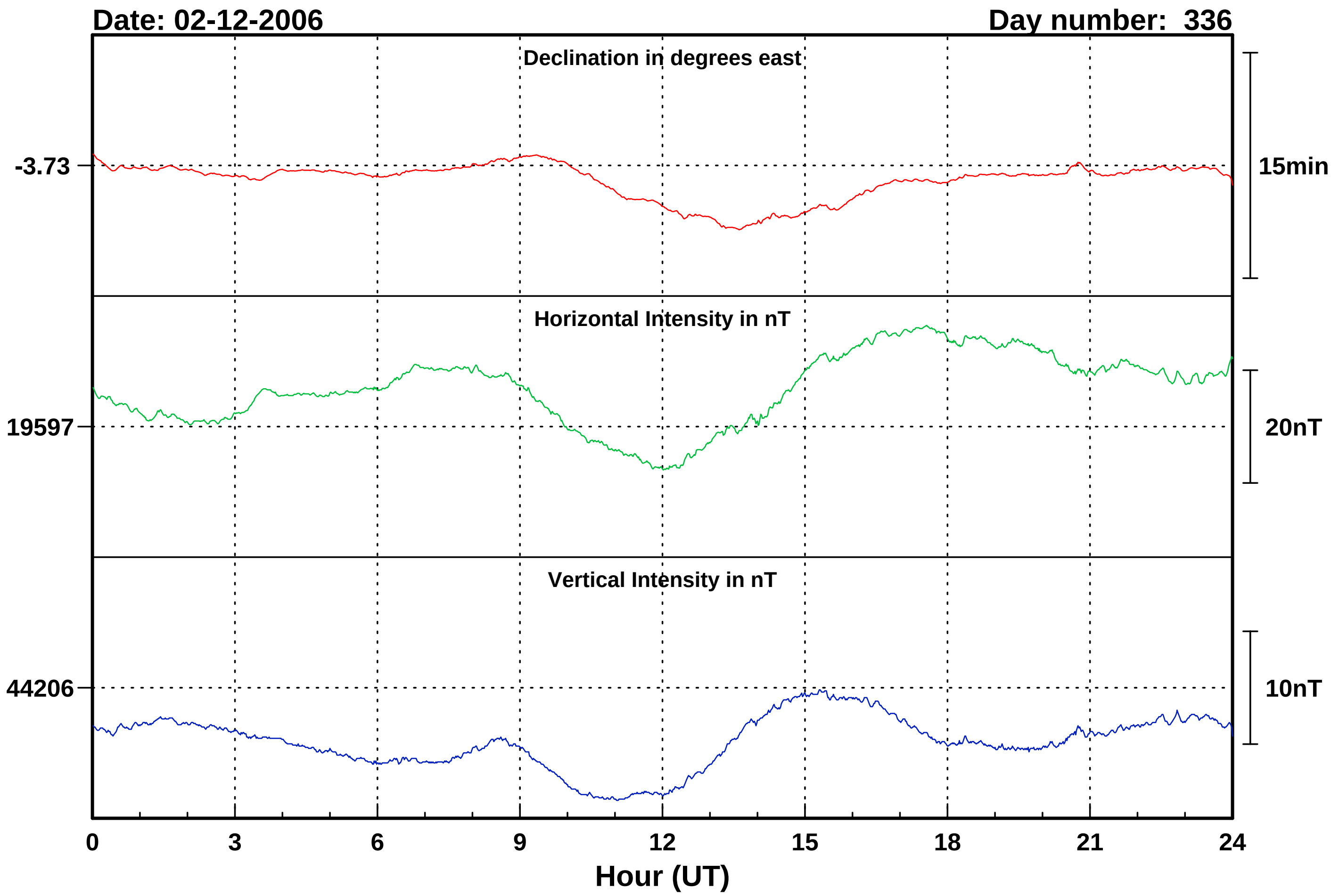
24



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15min
Horizontal Intensity in nT
19597
20nT
Vertical Intensity in nT
44206
10nT
0
3
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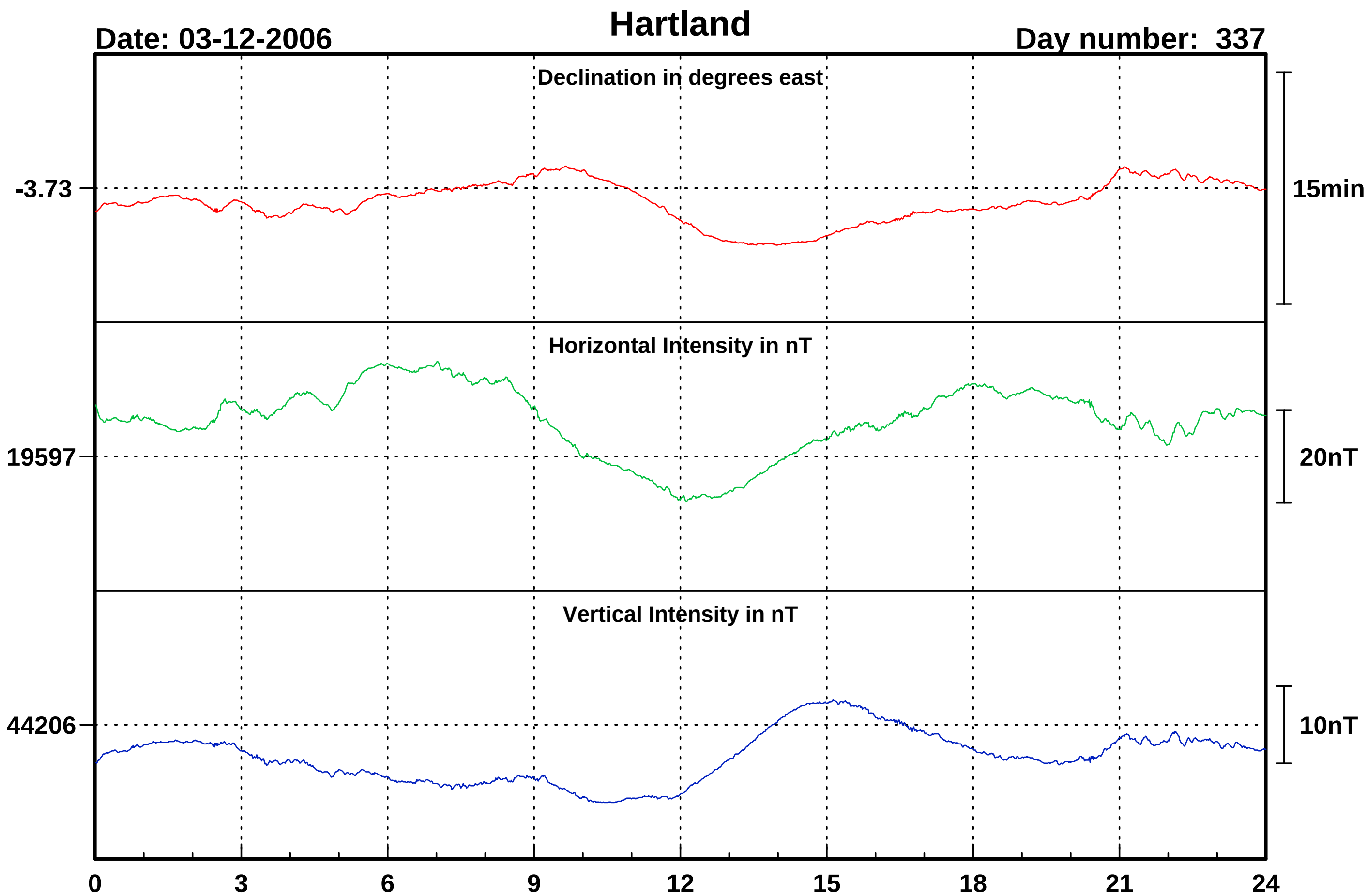
24
Hour (UT)


Hartland
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15min
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Vertical Intensity in nT
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10nT
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3
6
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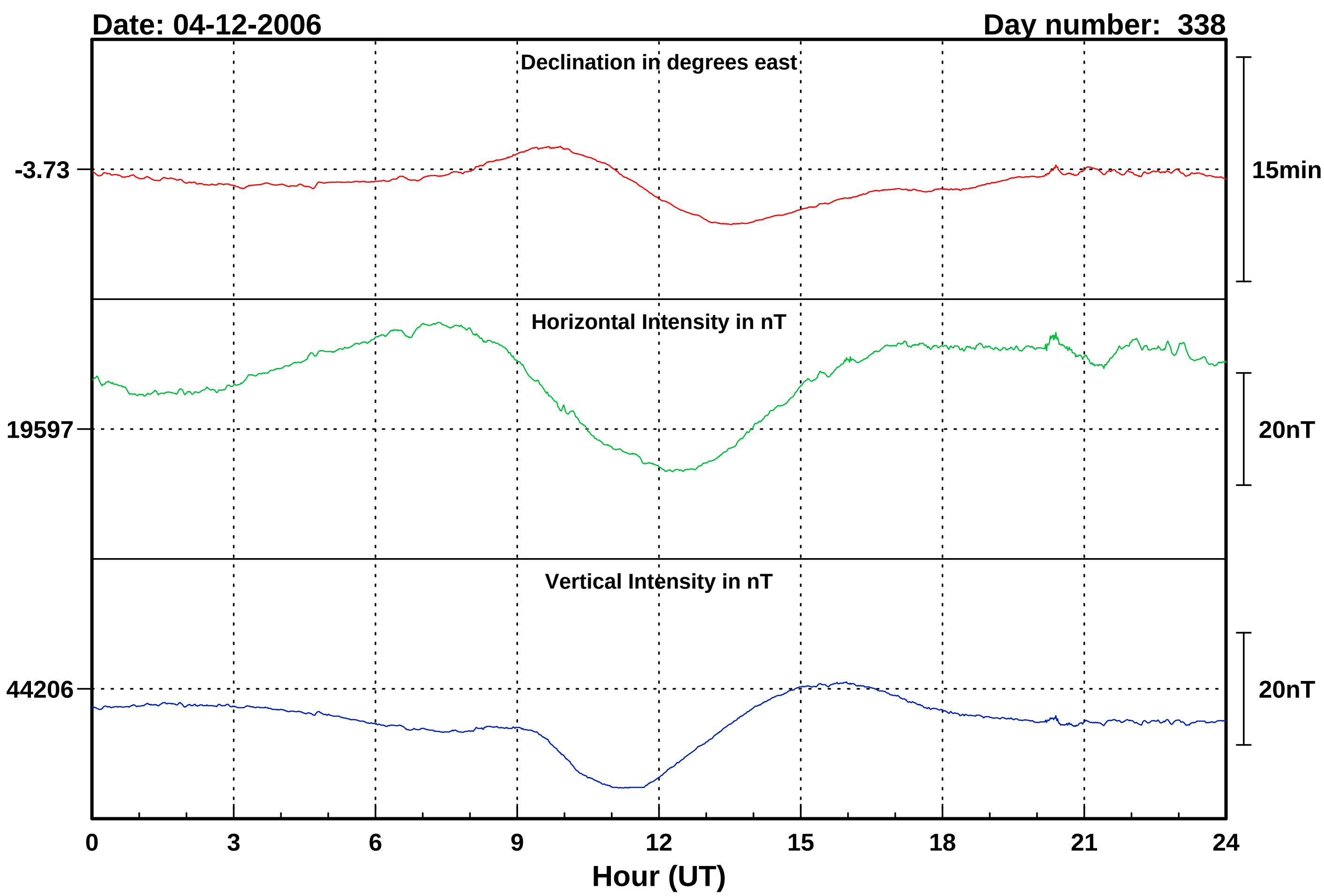
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15min
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20nT
Vertical Intensity in nT
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20nT
0
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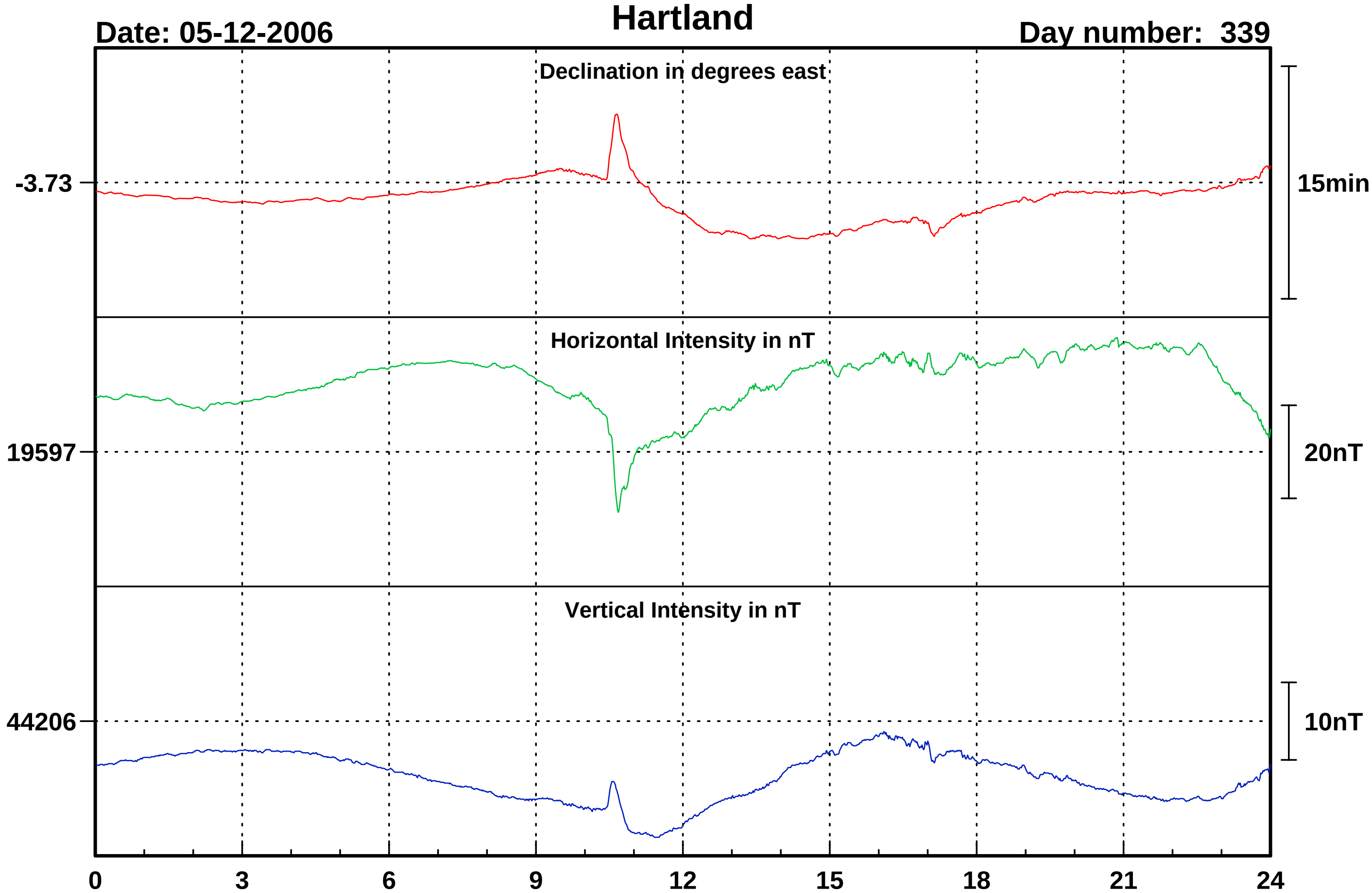
18
21
24
Hour (UT)

Hartland



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15min
Horizontal Intensity in nT
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20nT
Vertical Intensity in nT
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10nT
0
3
6
9
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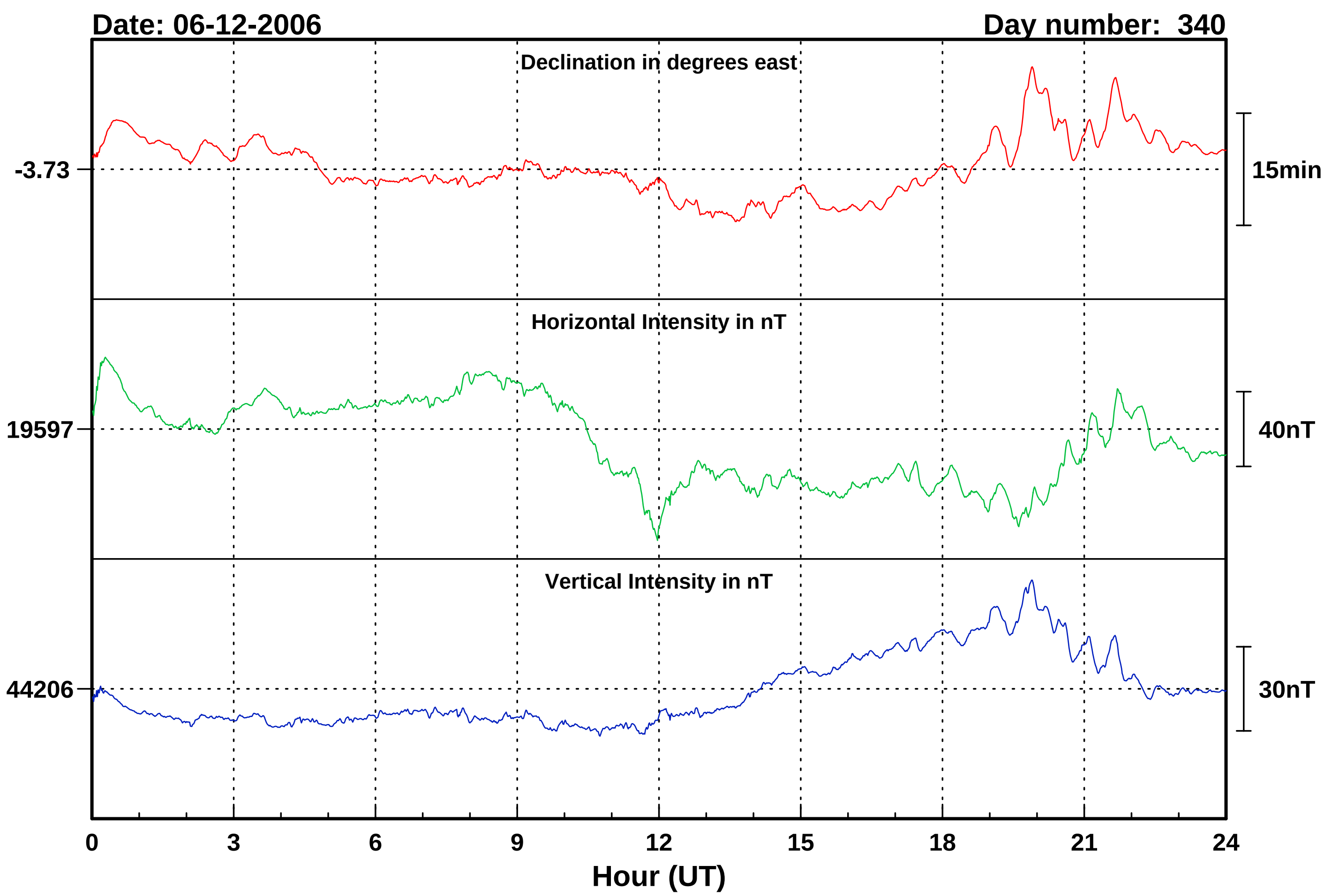

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Declination in degrees east
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15min
Horizontal Intensity in nT
19597
40nT
Vertical Intensity in nT
44206
30nT
0
3
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18
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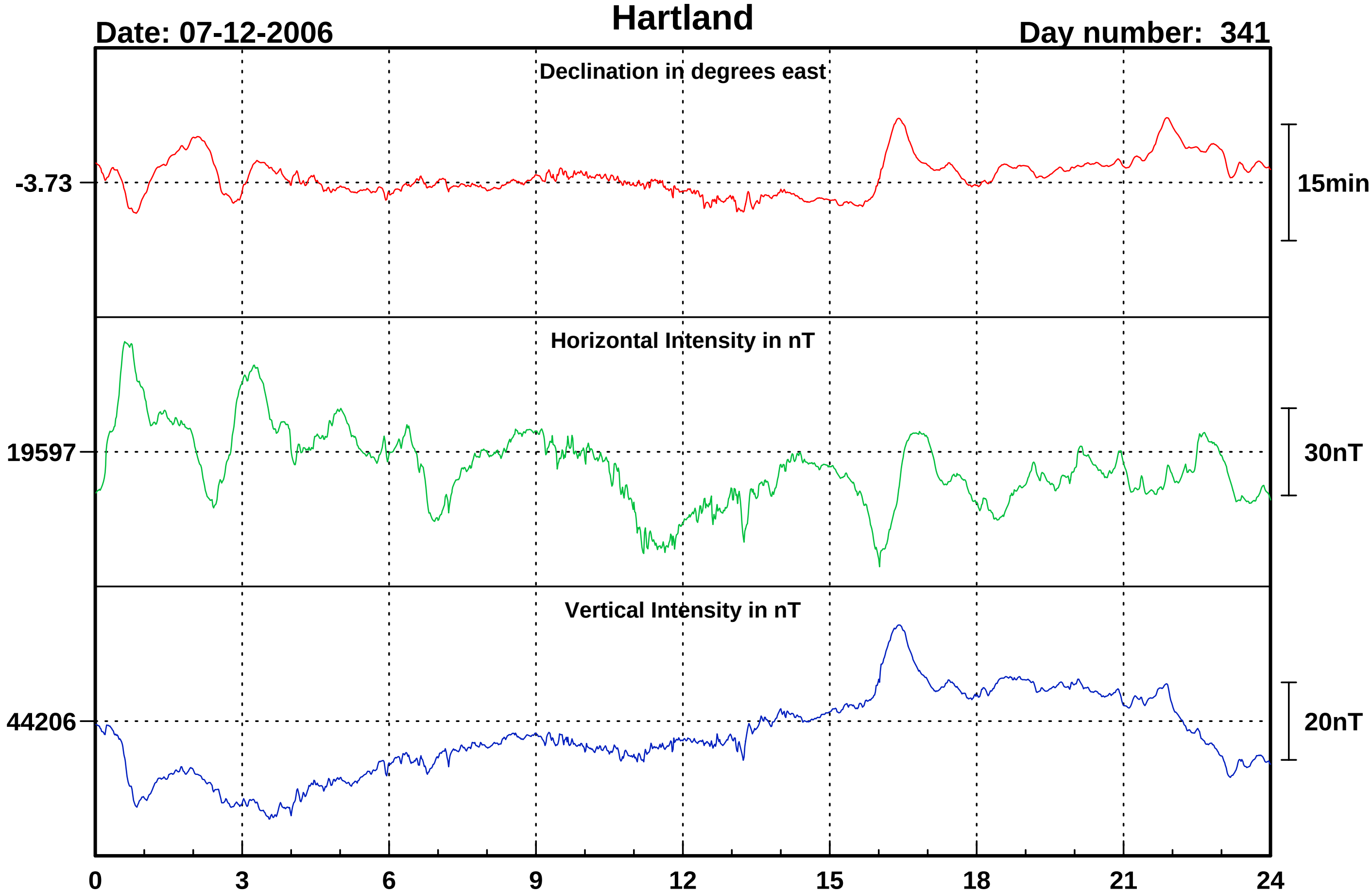
24
Hour (UT)

Hartland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15min
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30nT
Vertical Intensity in nT
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20nT
0
3
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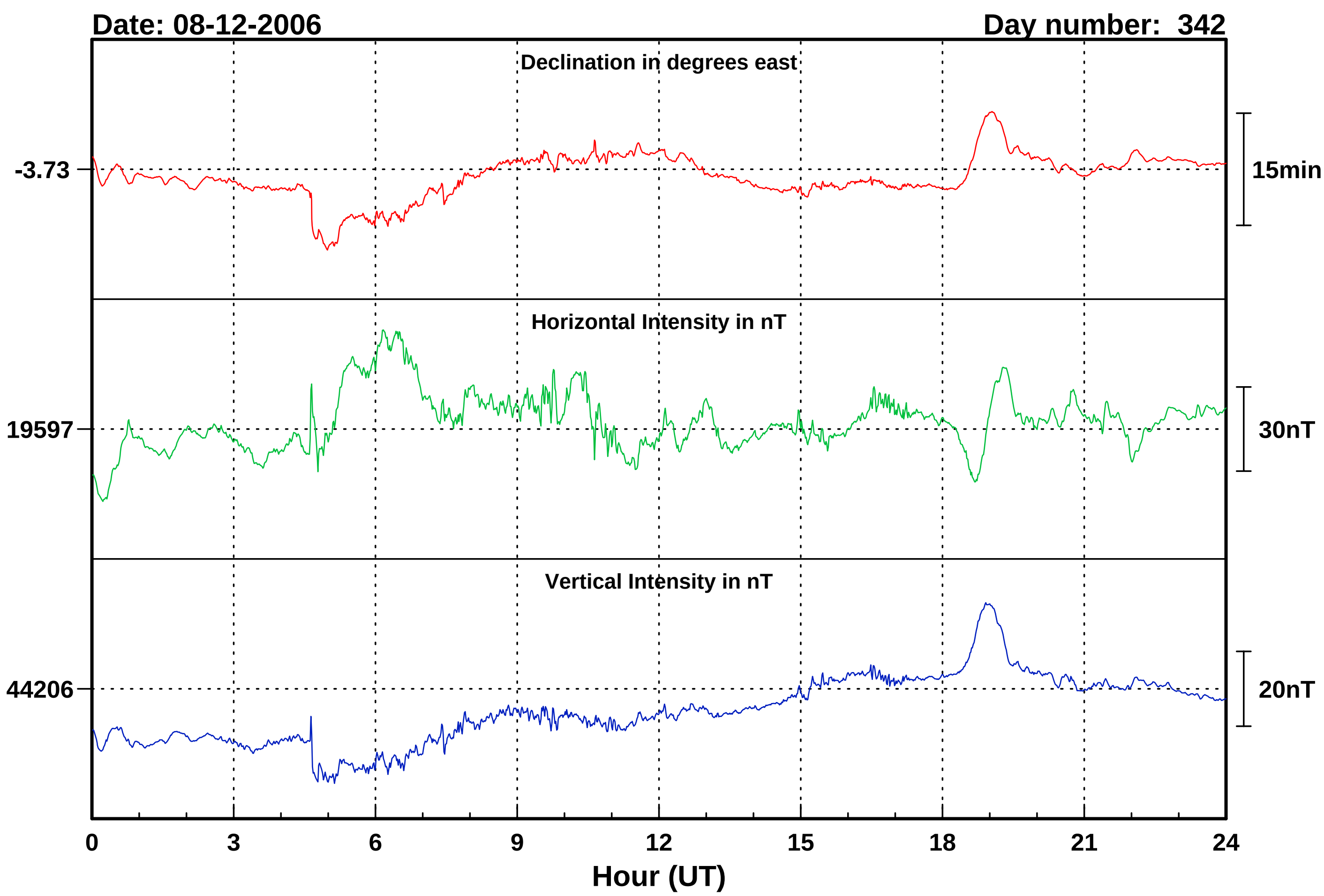
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15min
Horizontal Intensity in nT
19597
30nT
Vertical Intensity in nT
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20nT
0
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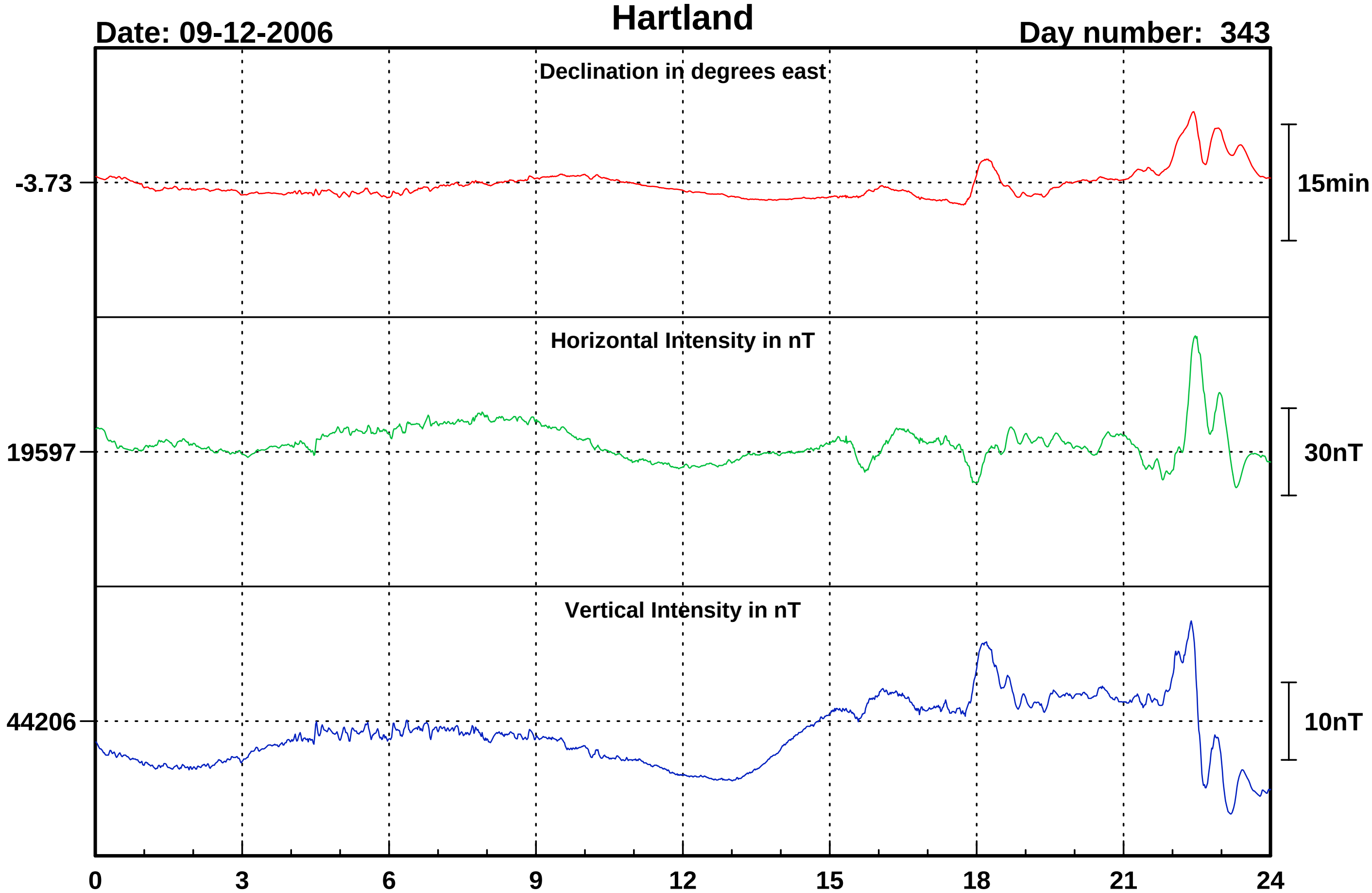
18
21
24
Hour (UT)

Hartland



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Day number: 343
Declination in degrees east
-3.73
15min
Horizontal Intensity in nT
19597
30nT
Vertical Intensity in nT
44206
10nT
0
3
6
9
12
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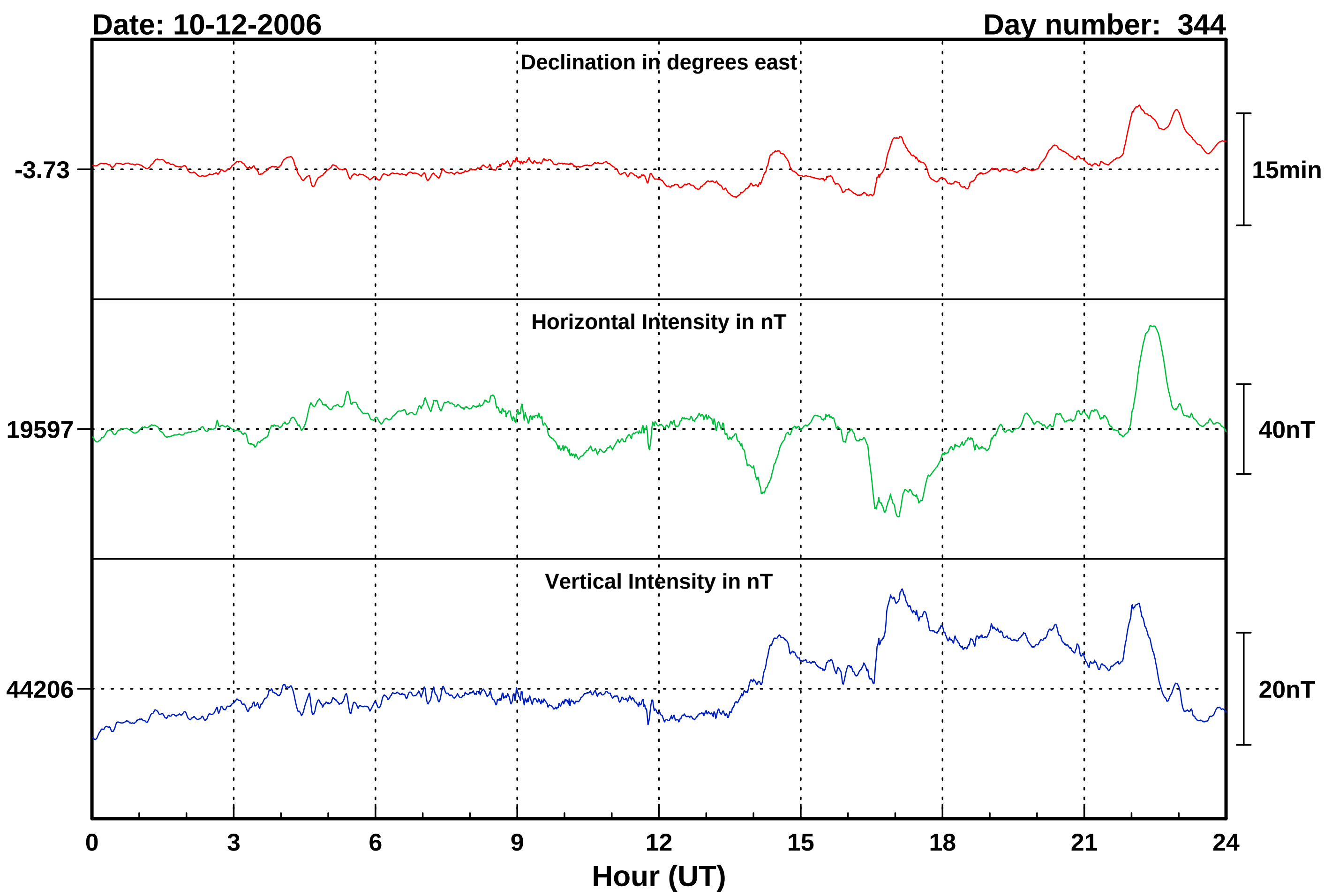

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Day number: 344
Declination in degrees east
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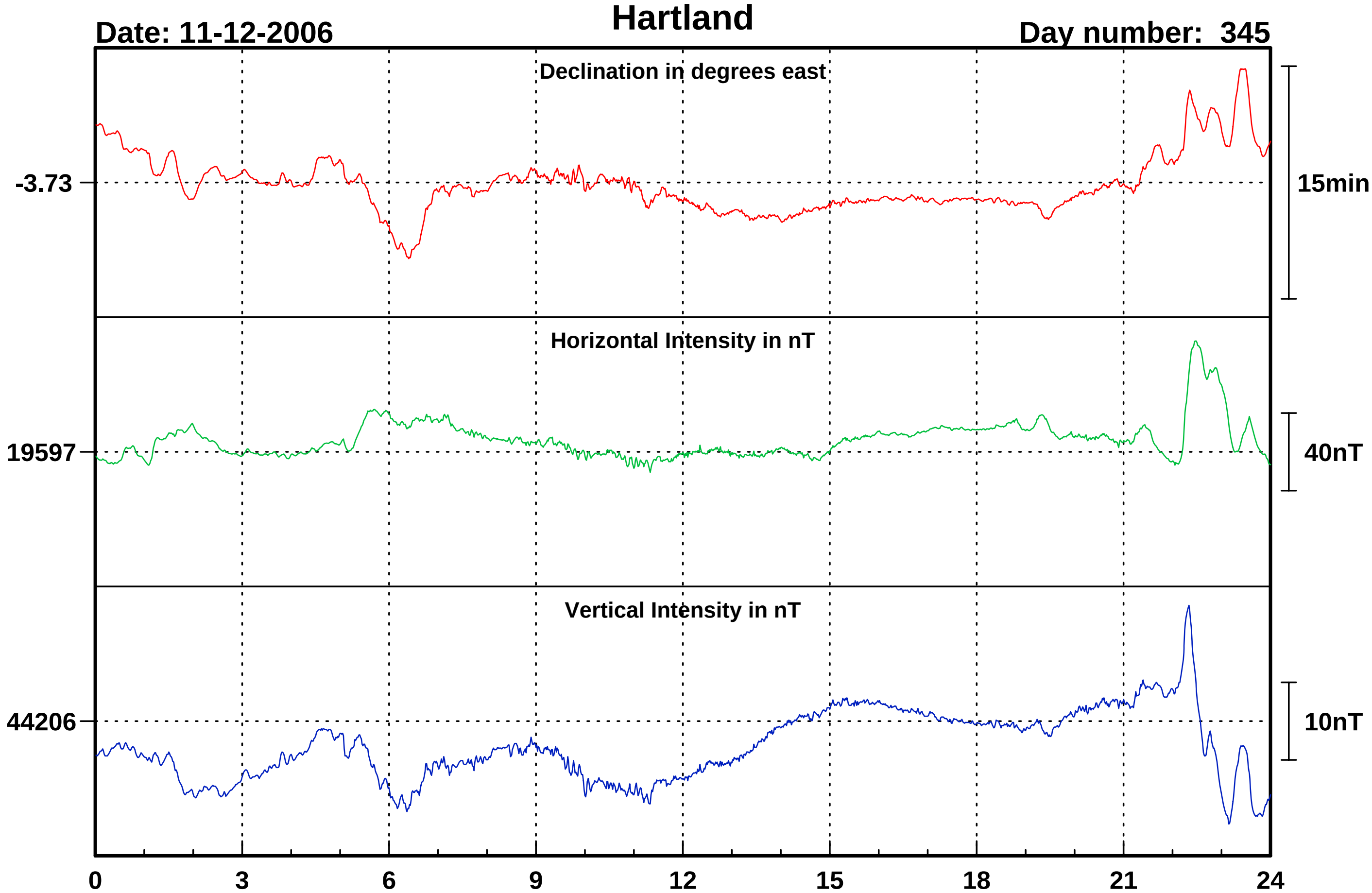
15min
Horizontal Intensity in nT
19597
40nT
Vertical Intensity in nT
44206
20nT
0
3
6
9
12
15
18
21
24
Hour (UT)

Hartland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15min
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40nT
Vertical Intensity in nT
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10nT
0
3
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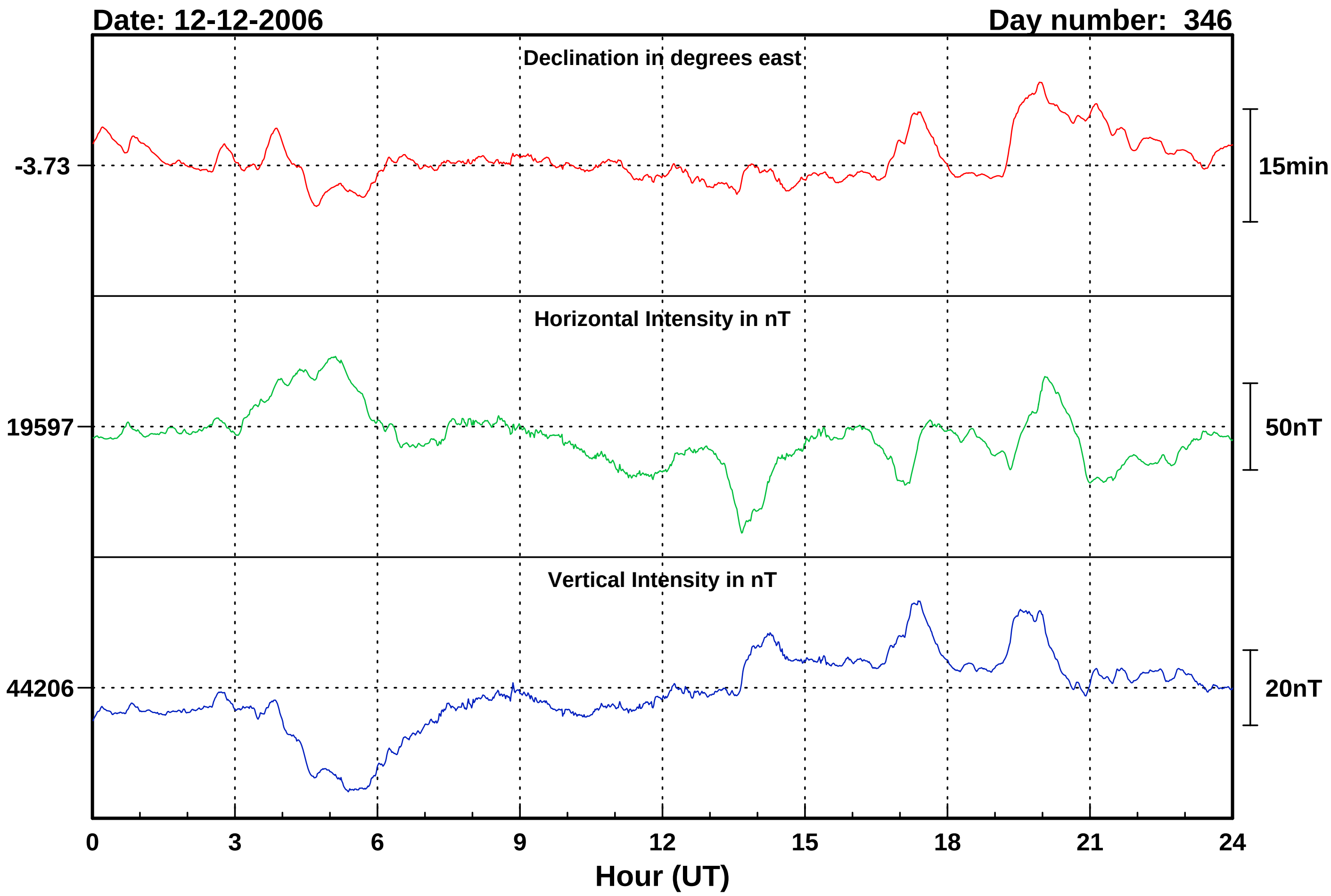
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Declination in degrees east
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15min
Horizontal Intensity in nT
19597
50nT
Vertical Intensity in nT
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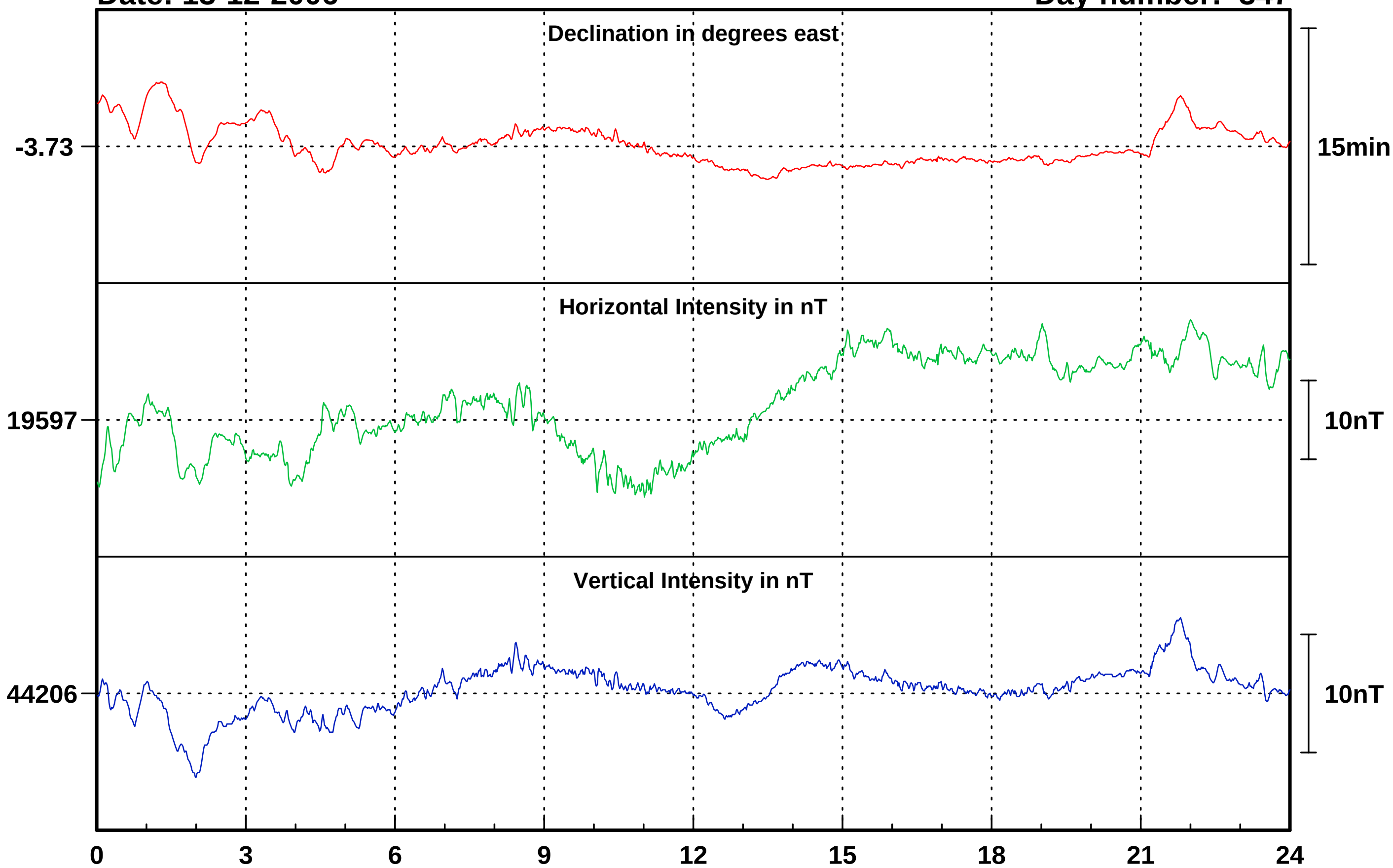
20nT
0
3
6
9
12
15
18
21
24
Hour (UT)

Hartland

Date: 13-12-2006 Day number: 347



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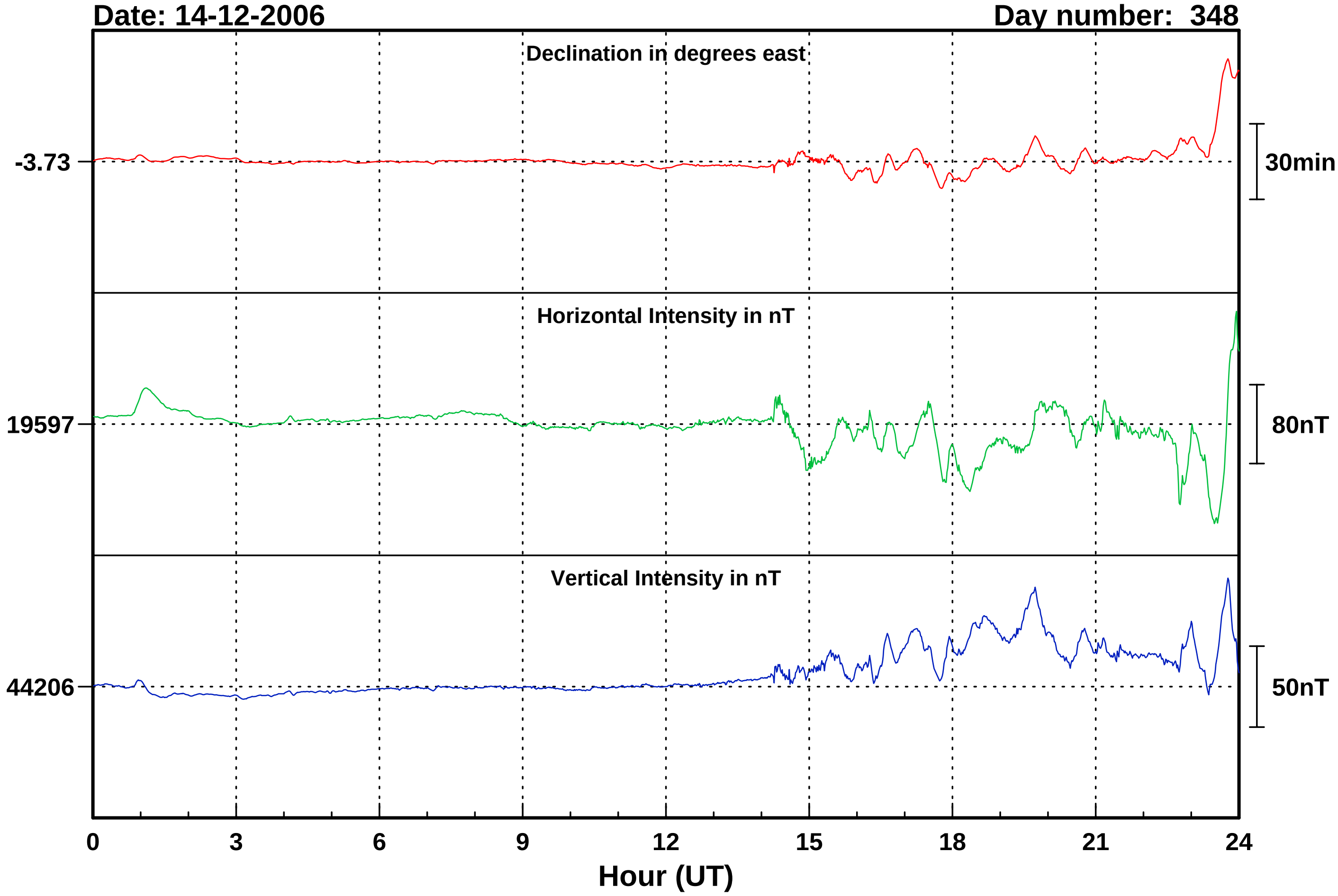

Hartland

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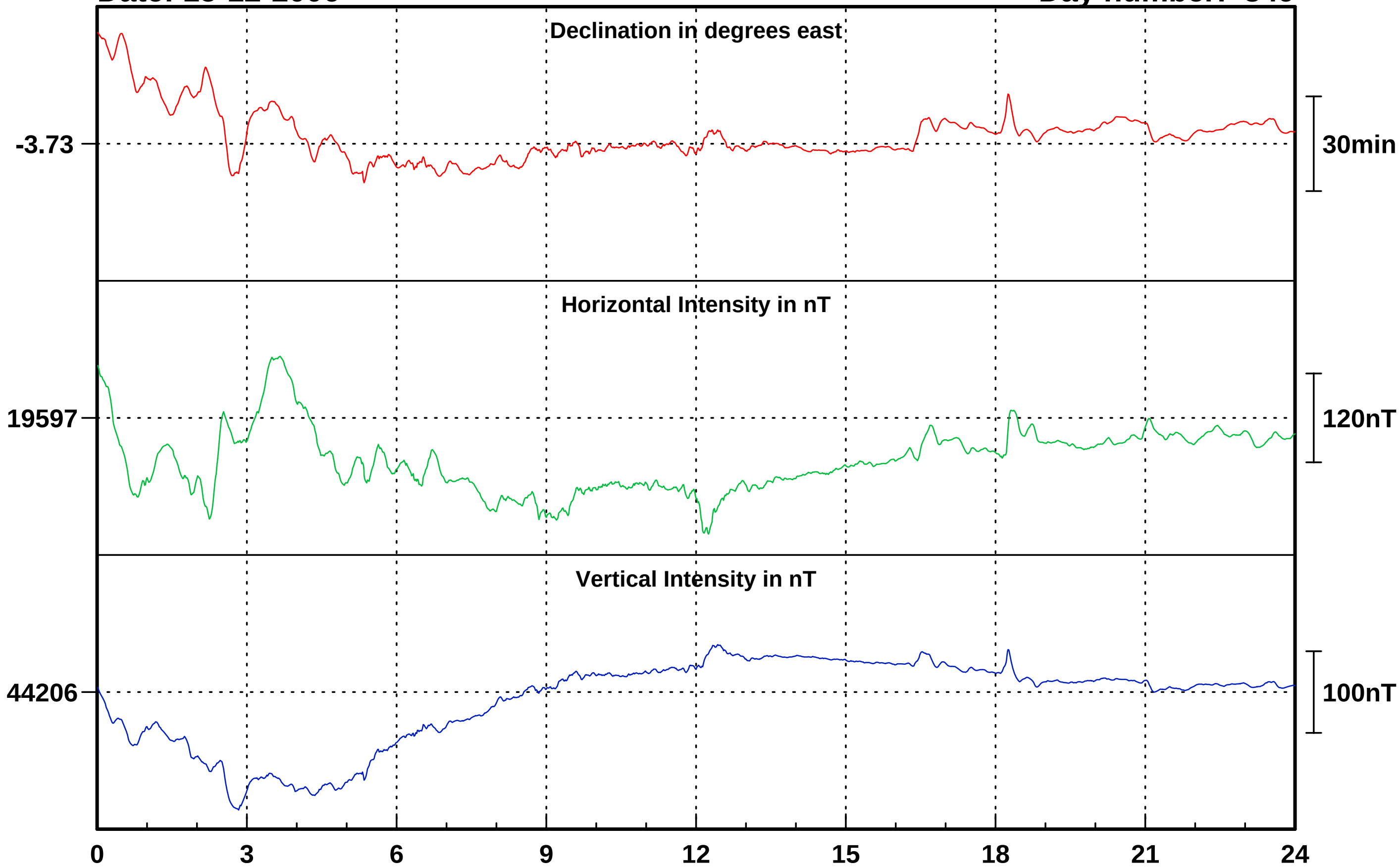

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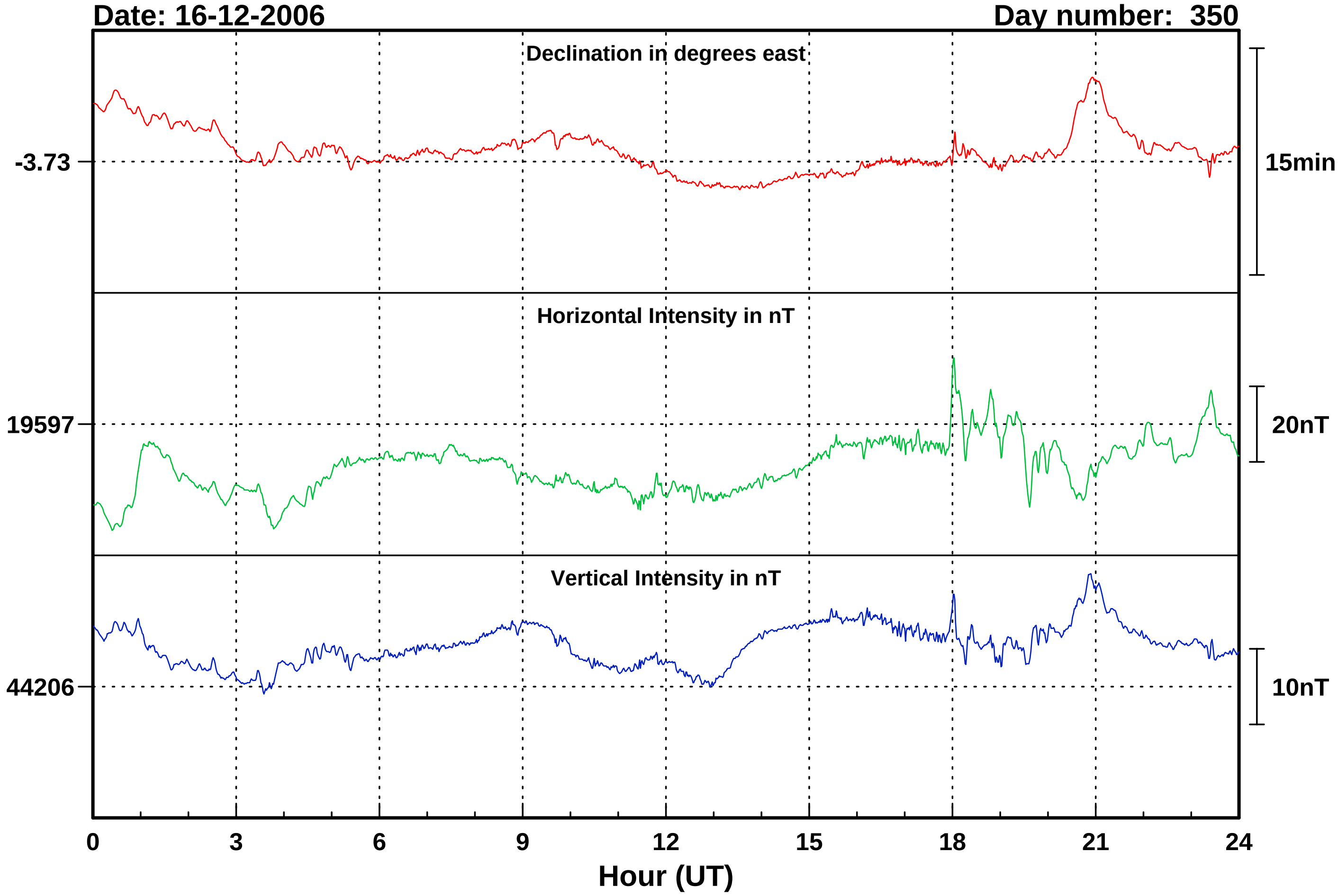

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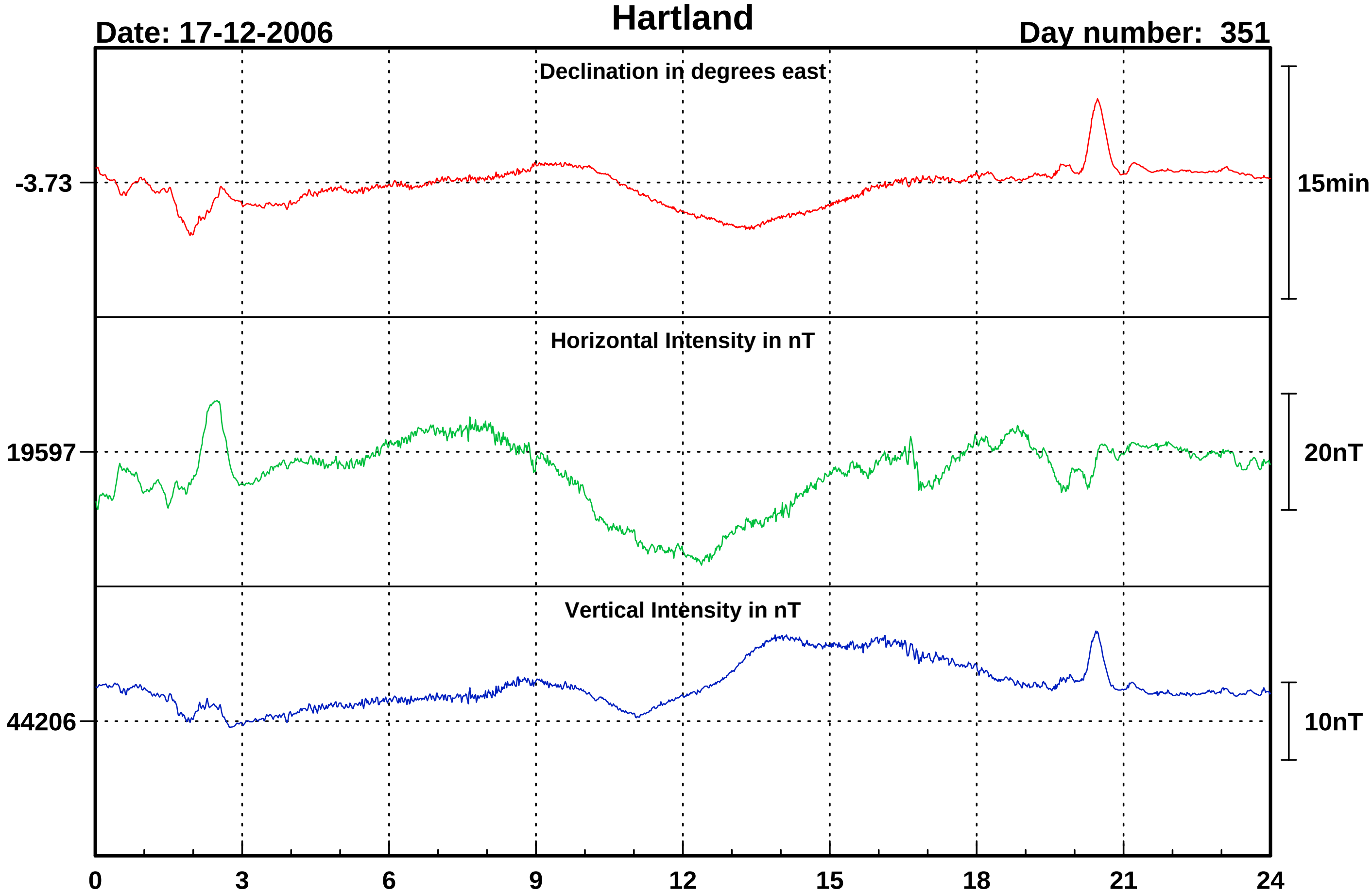
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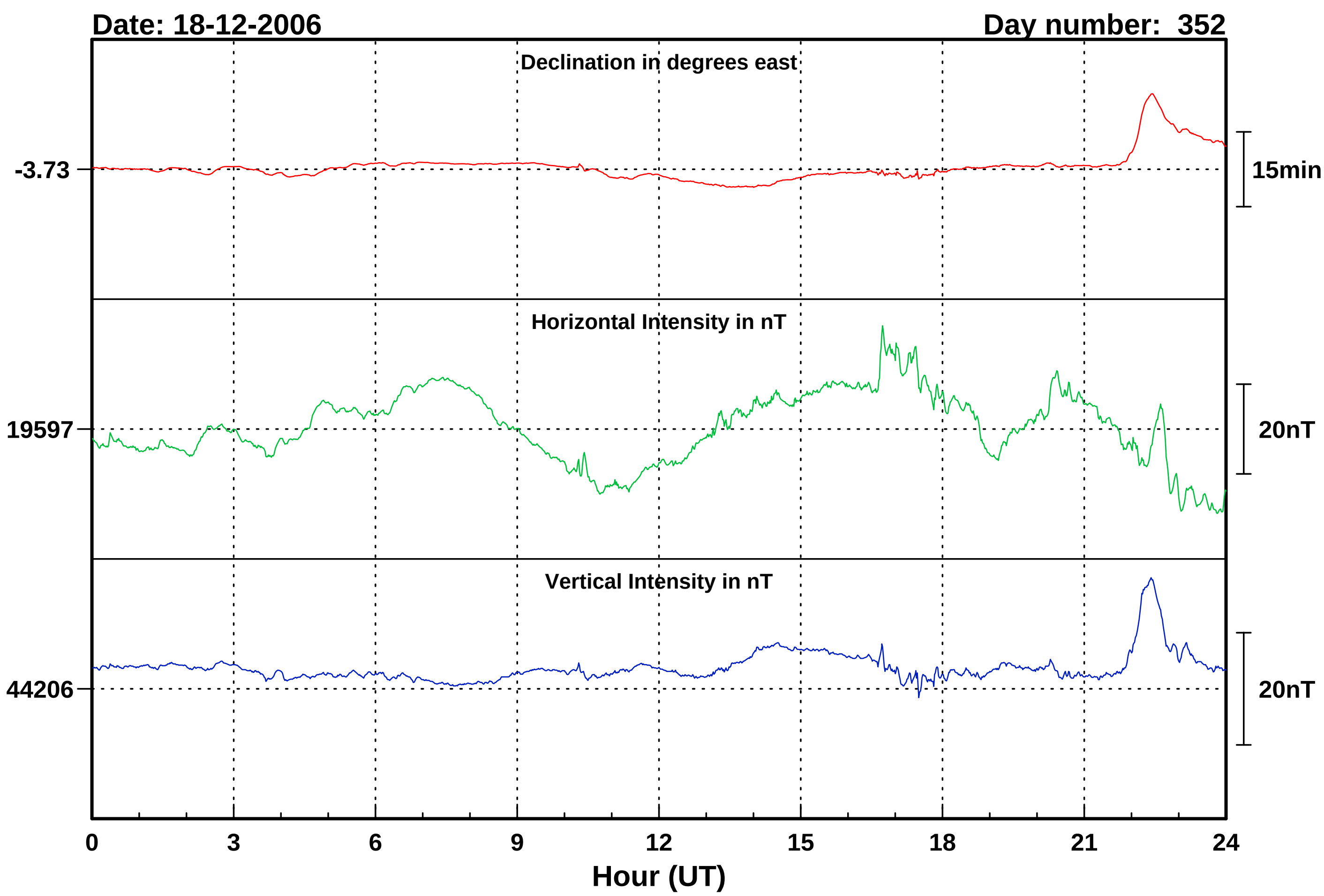
15min
Horizontal Intensity in nT
19597
20nT
Vertical Intensity in nT
44206
10nT
0 3 6 9 12 15 18 21 24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Day number: 352
Declination in degrees east
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20nT
Vertical Intensity in nT
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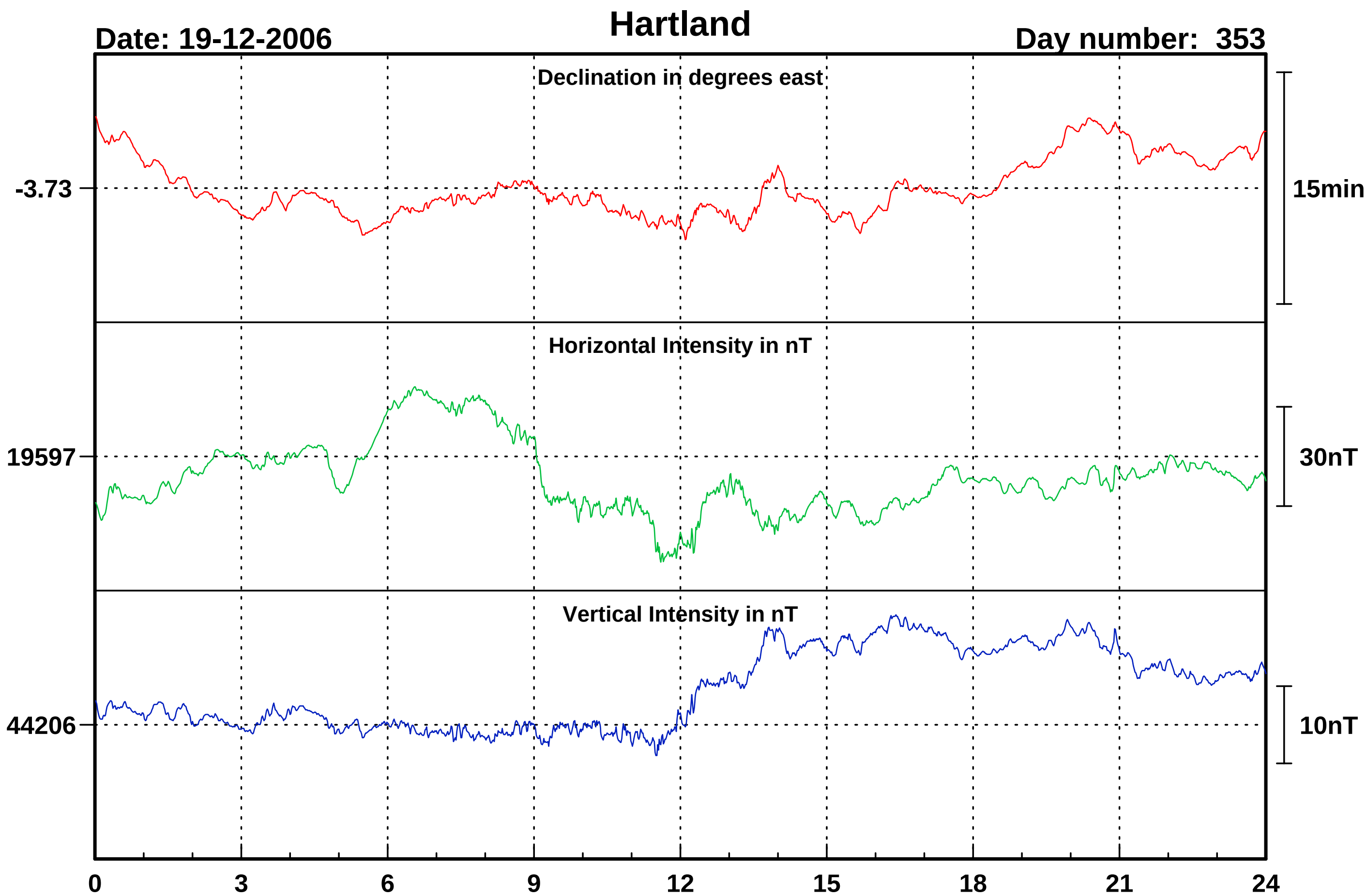
20nT
0 3 6 9 12 15 18 21 24
Hour (UT)


Hartland
Date: 19-12-2006
Day number: 353
Declination in degrees east
-3.73
15min
Horizontal Intensity in nT
19597
30nT
Vertical Intensity in nT
44206
10nT
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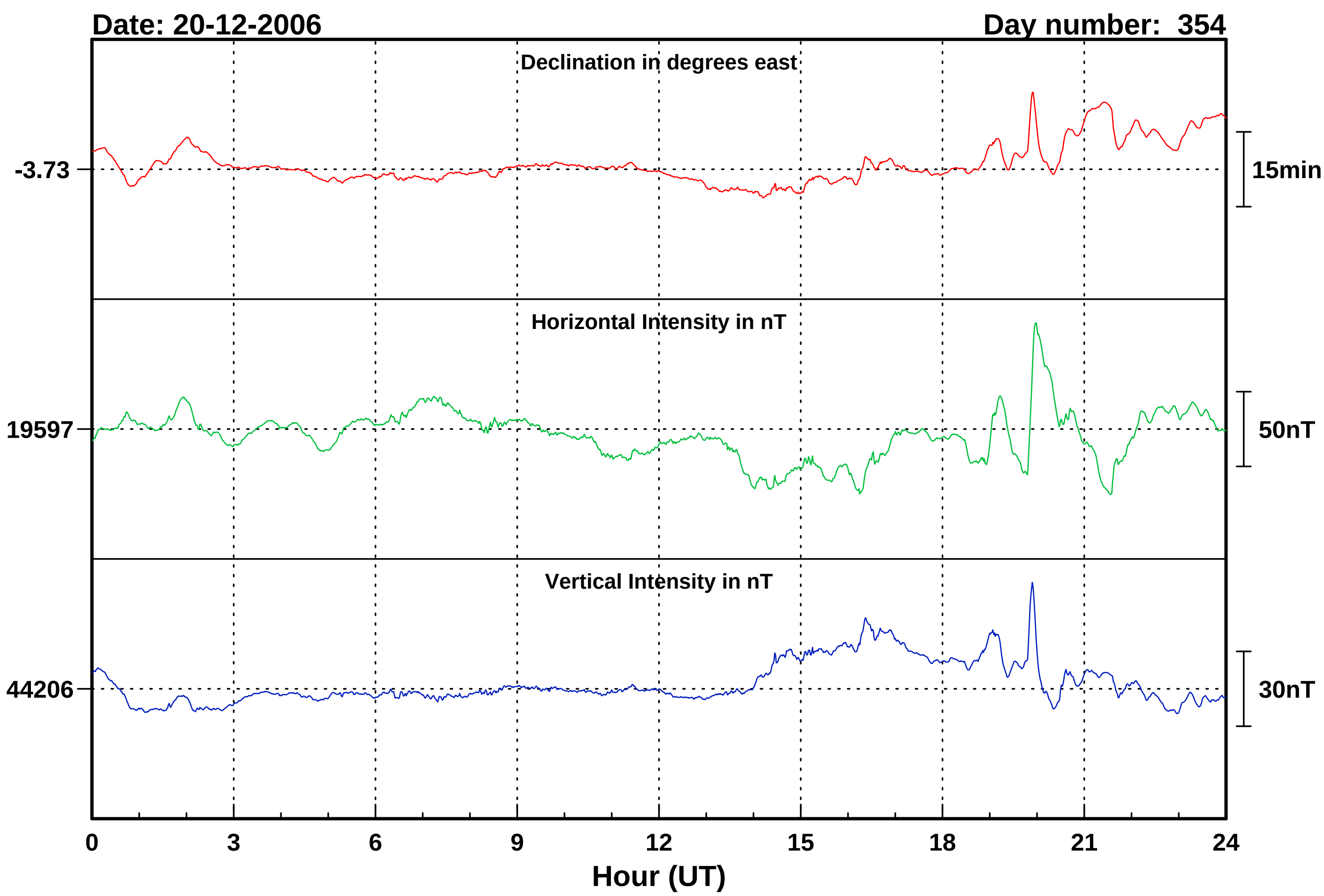
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Day number: 354
Declination in degrees east
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15min
Horizontal Intensity in nT
19597
50nT
Vertical Intensity in nT
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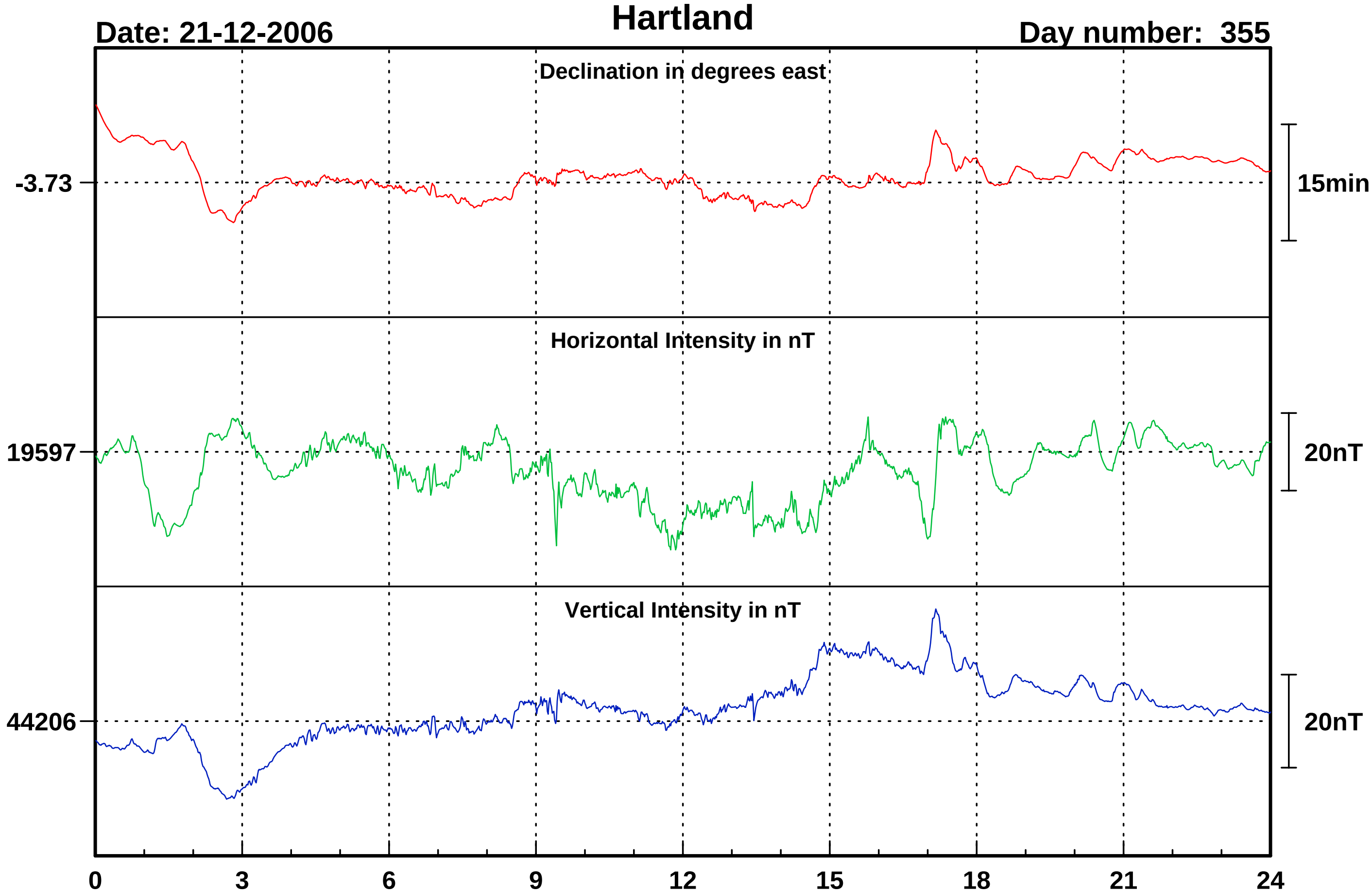
21
24
Hour (UT)

Hartland



Date: 21-12-2006
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15min
Horizontal Intensity in nT
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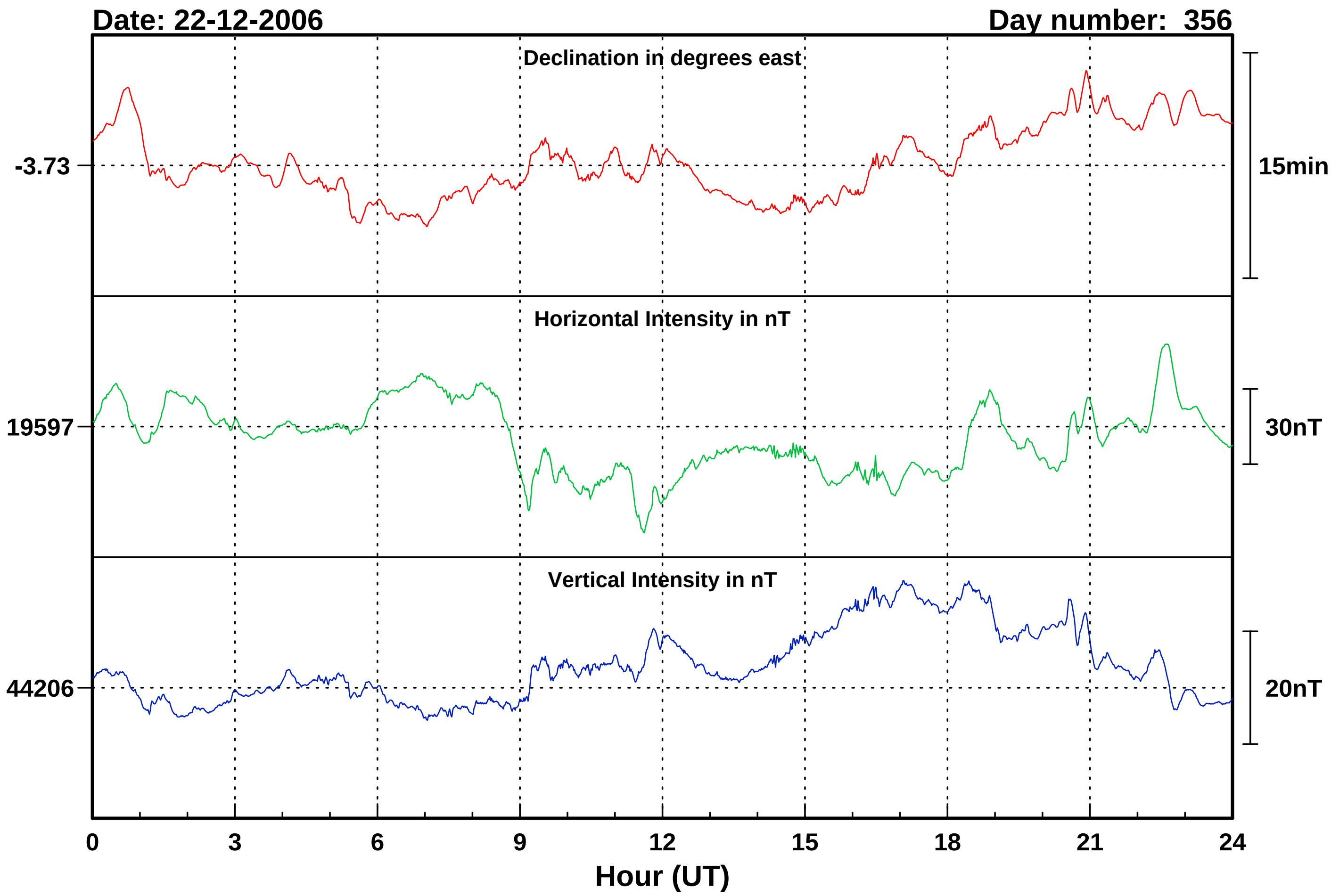
20nT
Vertical Intensity in nT
44206
20nT
0 3 6 9 12 15 18 21 24



Date: 22-12-2006
Day number: 356
Declination in degrees east
-3.73
15min
Horizontal Intensity in nT
19597
30nT
Vertical Intensity in nT
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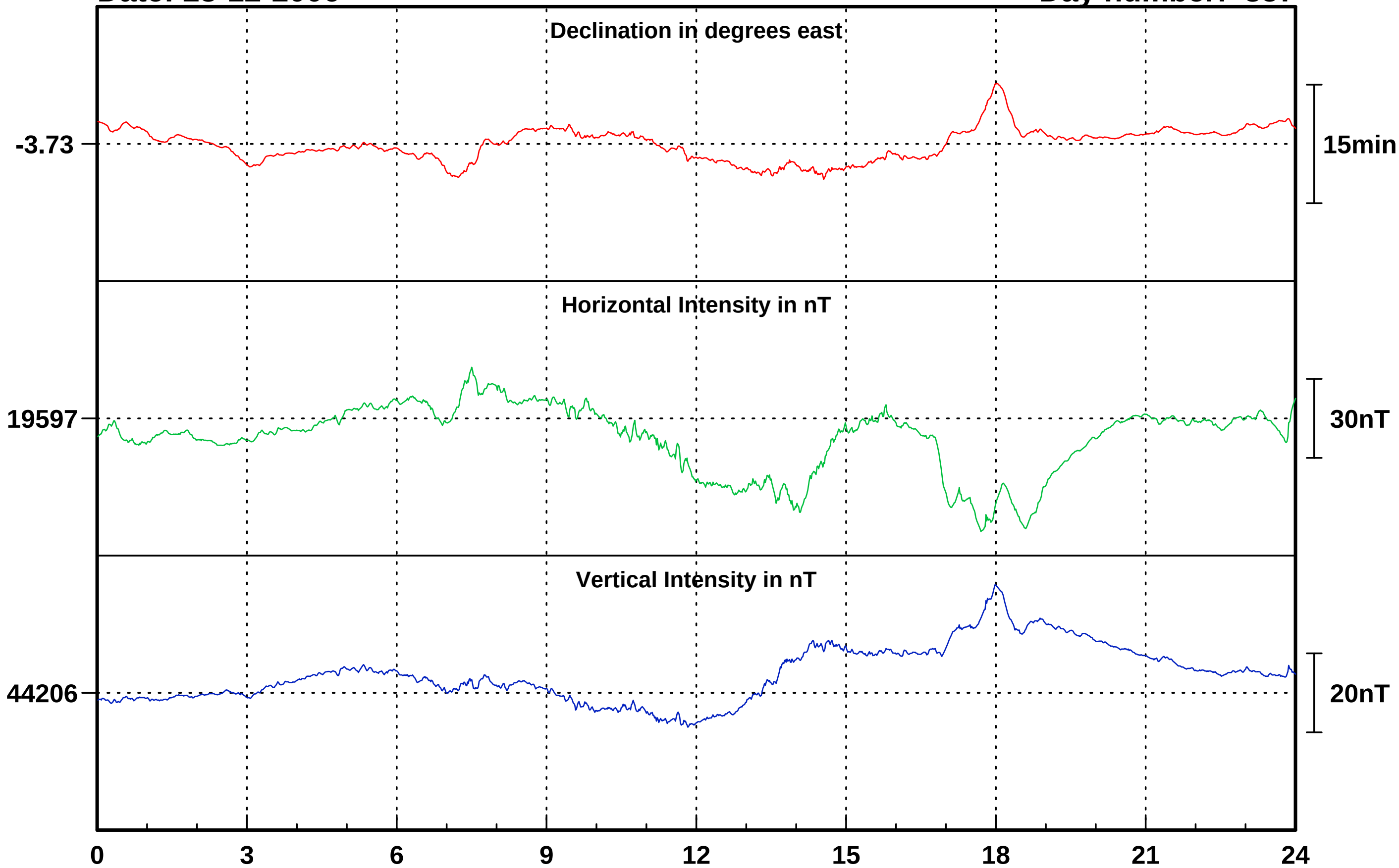
20nT
0 3 6 9 12 15 18 21 24
Hour (UT)

Hartland

Date: 23-12-2006 — Day number: 357



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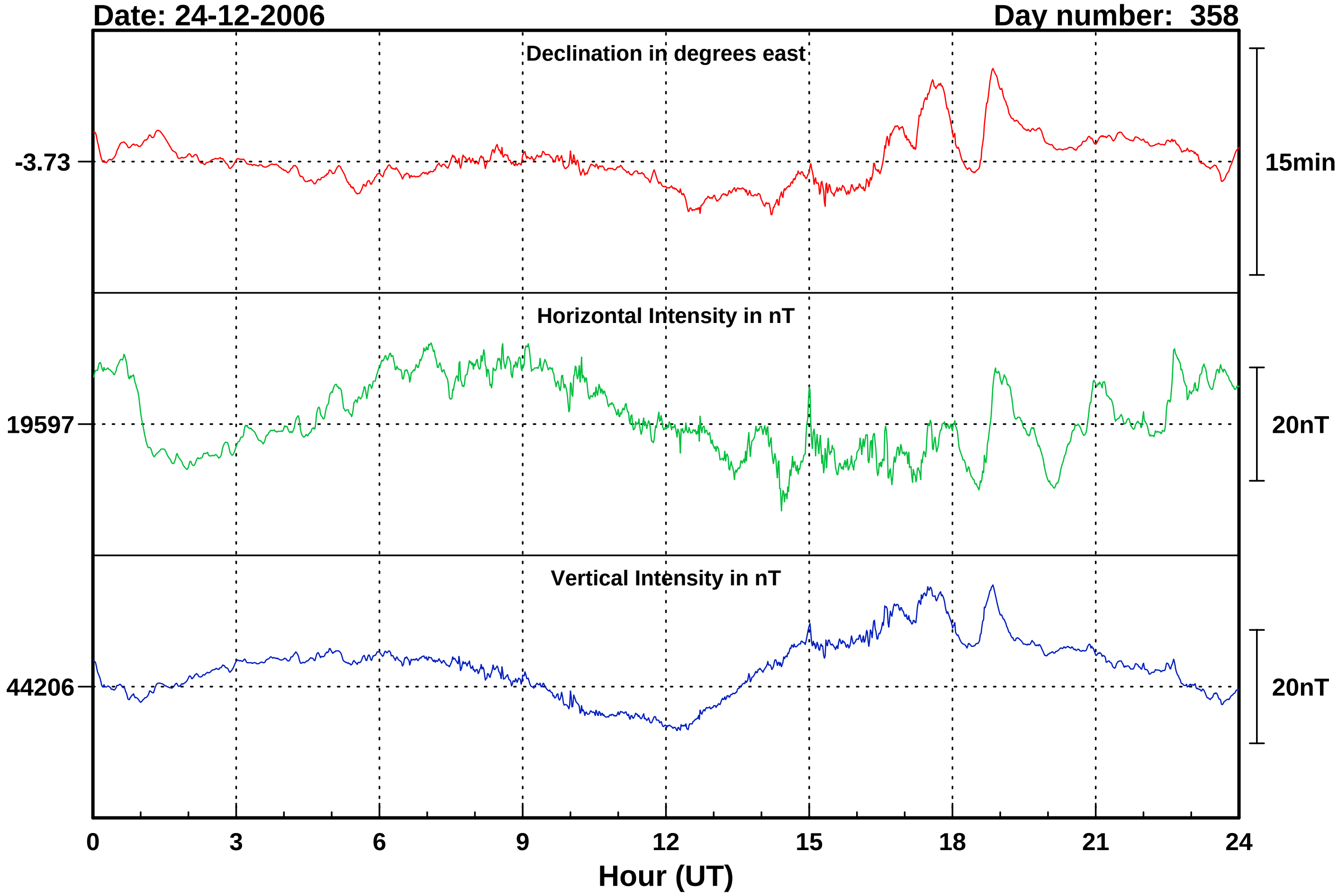

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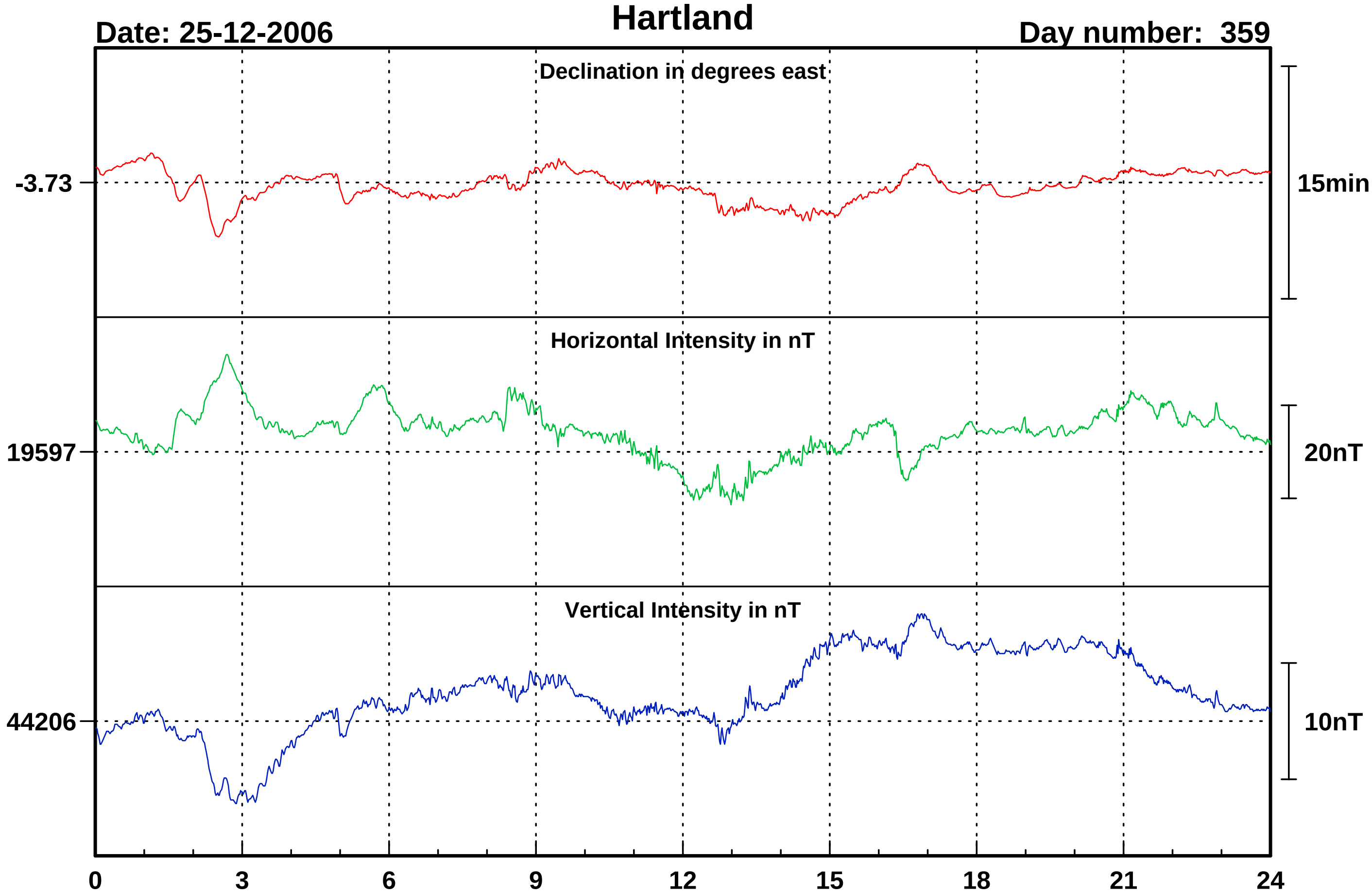

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Day number: 359
Declination in degrees east
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15min
Horizontal Intensity in nT
19597
20nT
Vertical Intensity in nT
44206
10nT
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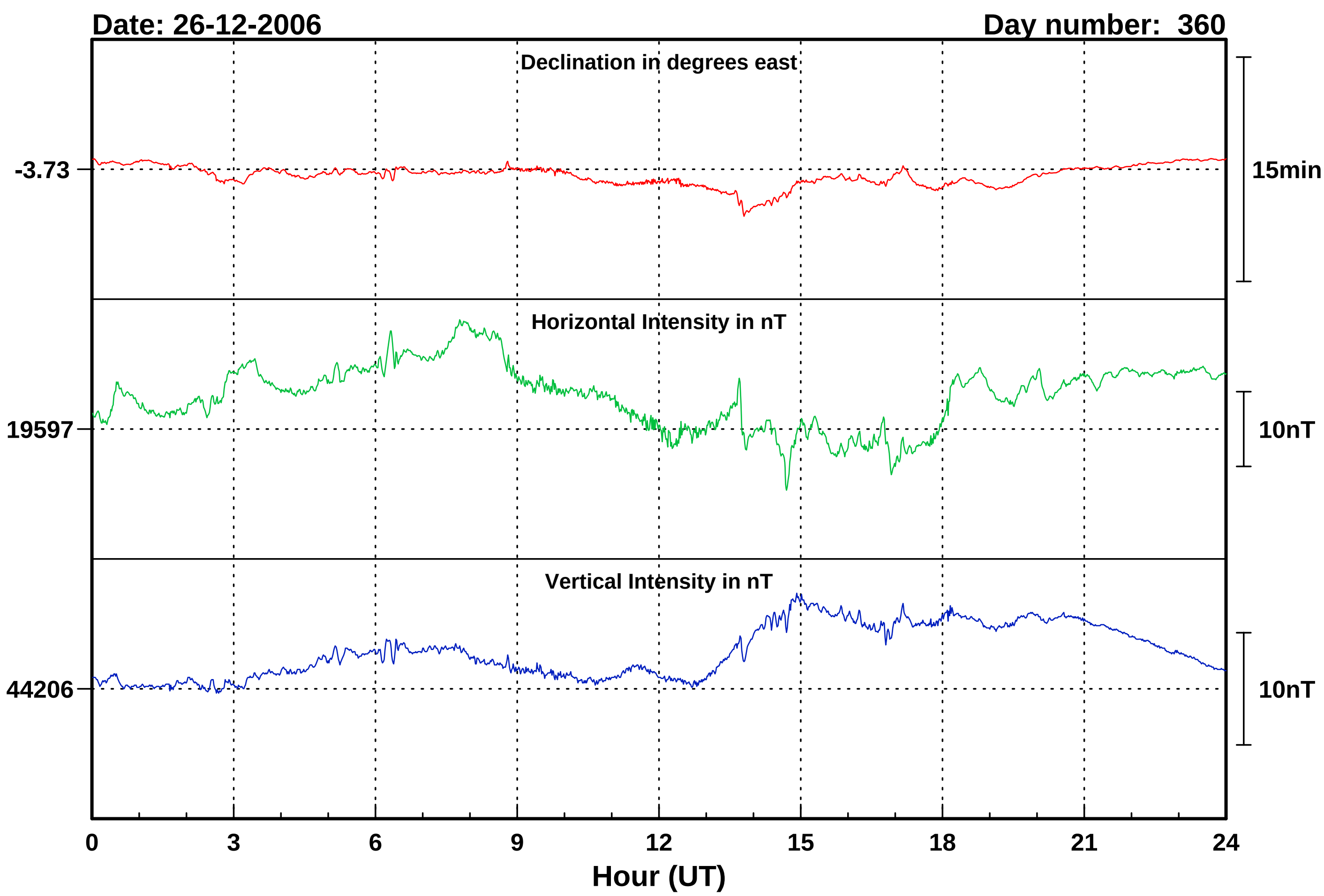

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15min
Horizontal Intensity in nT
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10nT
Vertical Intensity in nT
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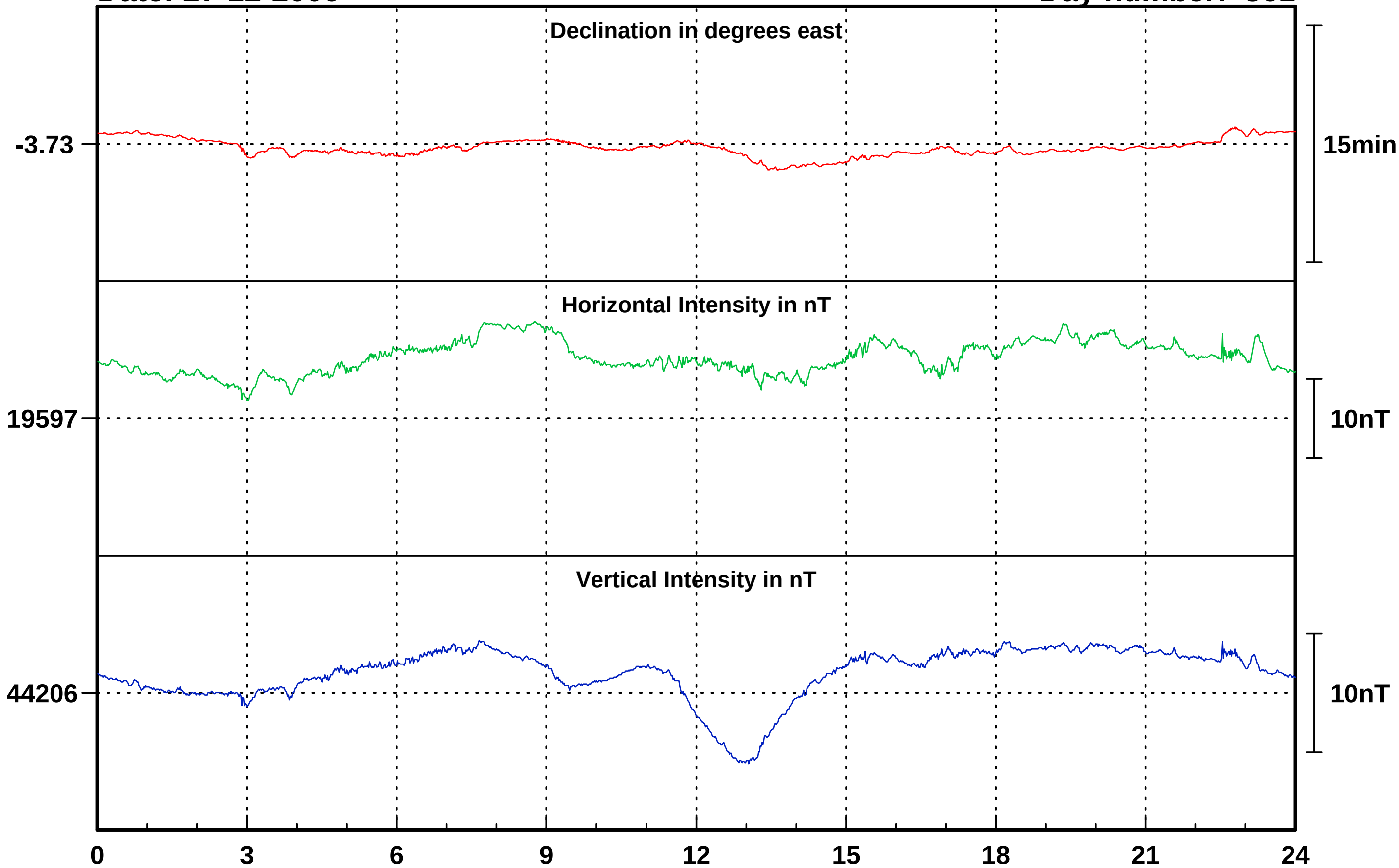
10nT
0
3
6
9
12
15
18
21
24
Hour (UT)

Hartland

Date: 27-12-2006 Day number: 361



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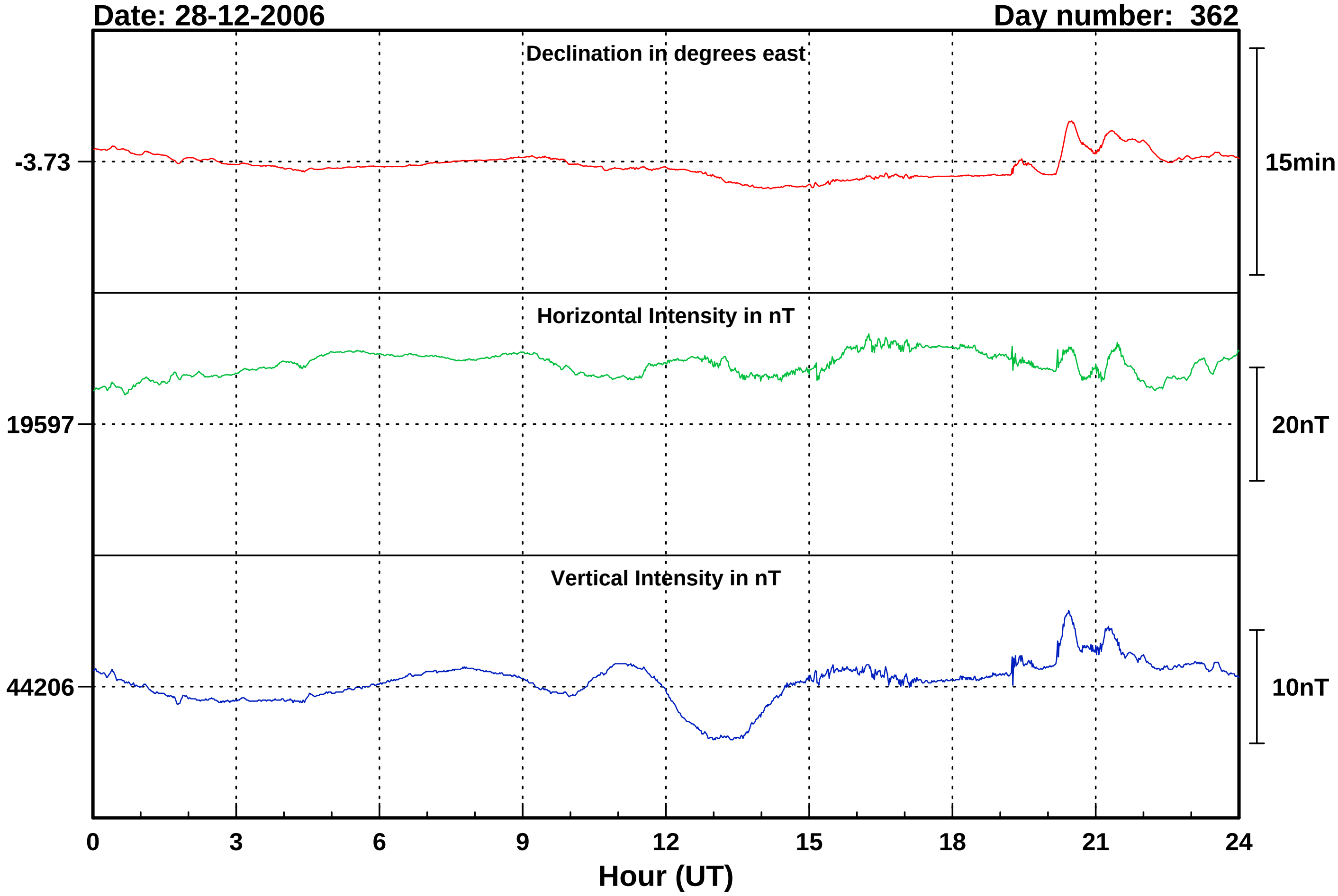
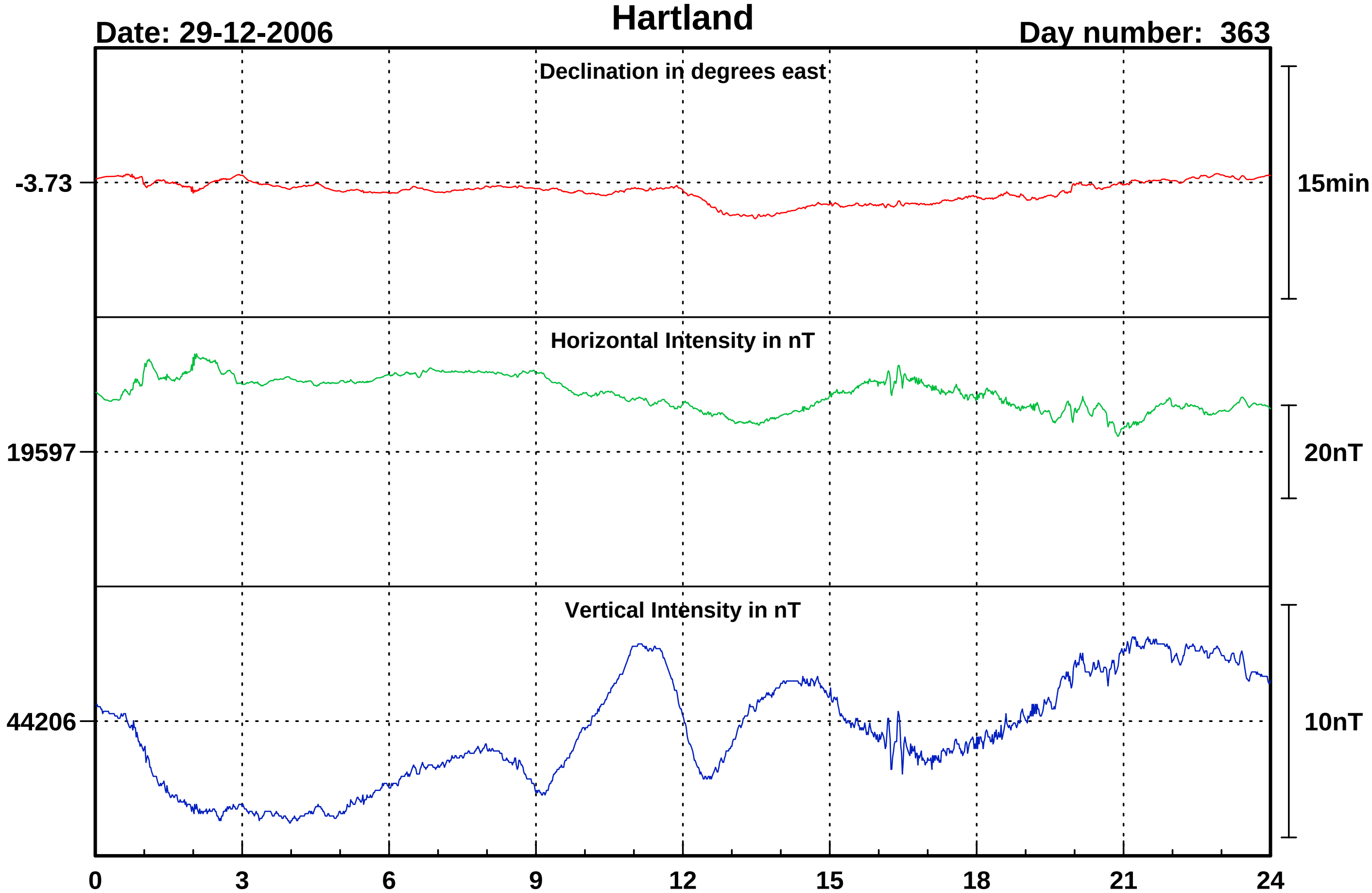


Hartland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15min
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Vertical Intensity in nT
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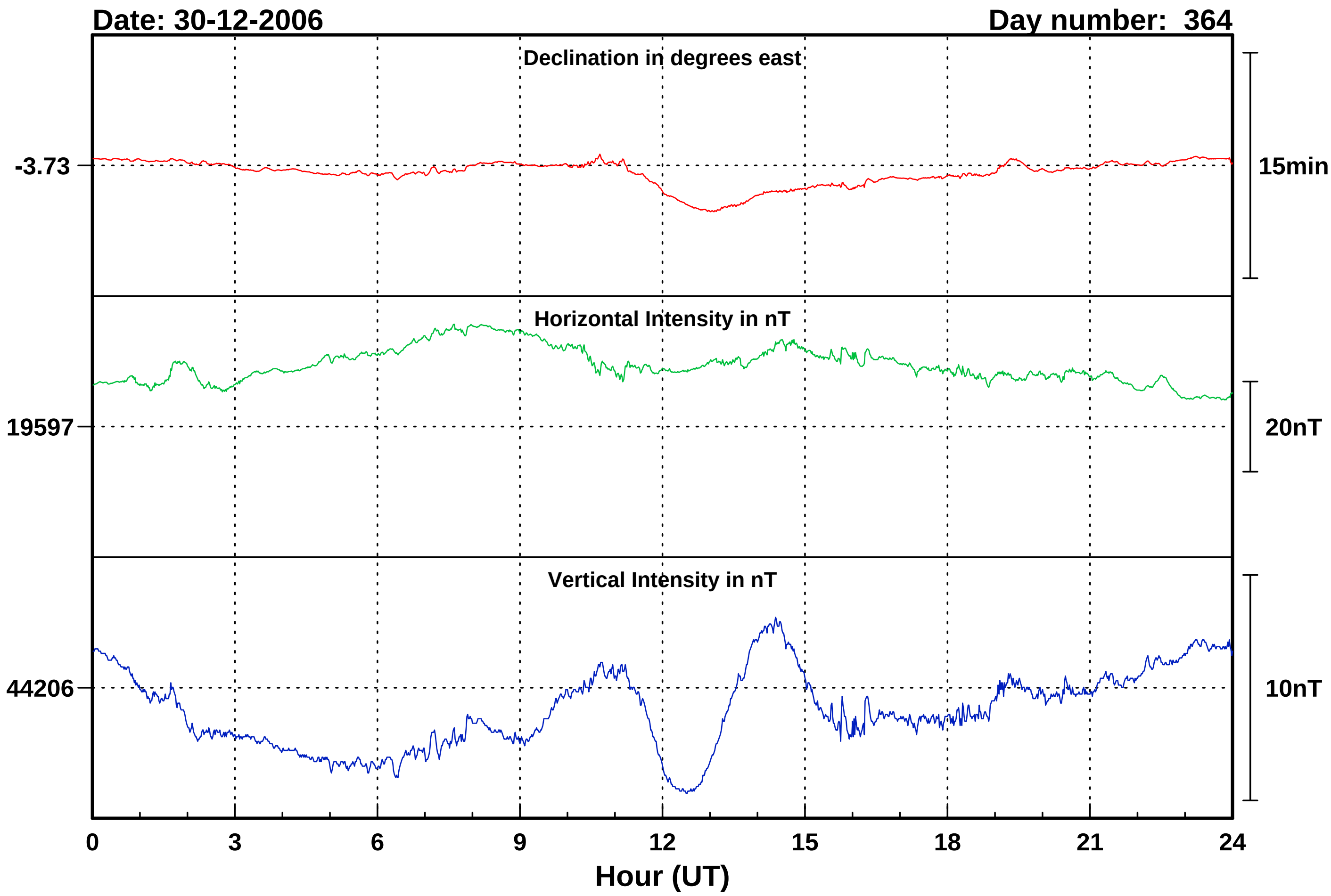
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Vertical Intensity in nT
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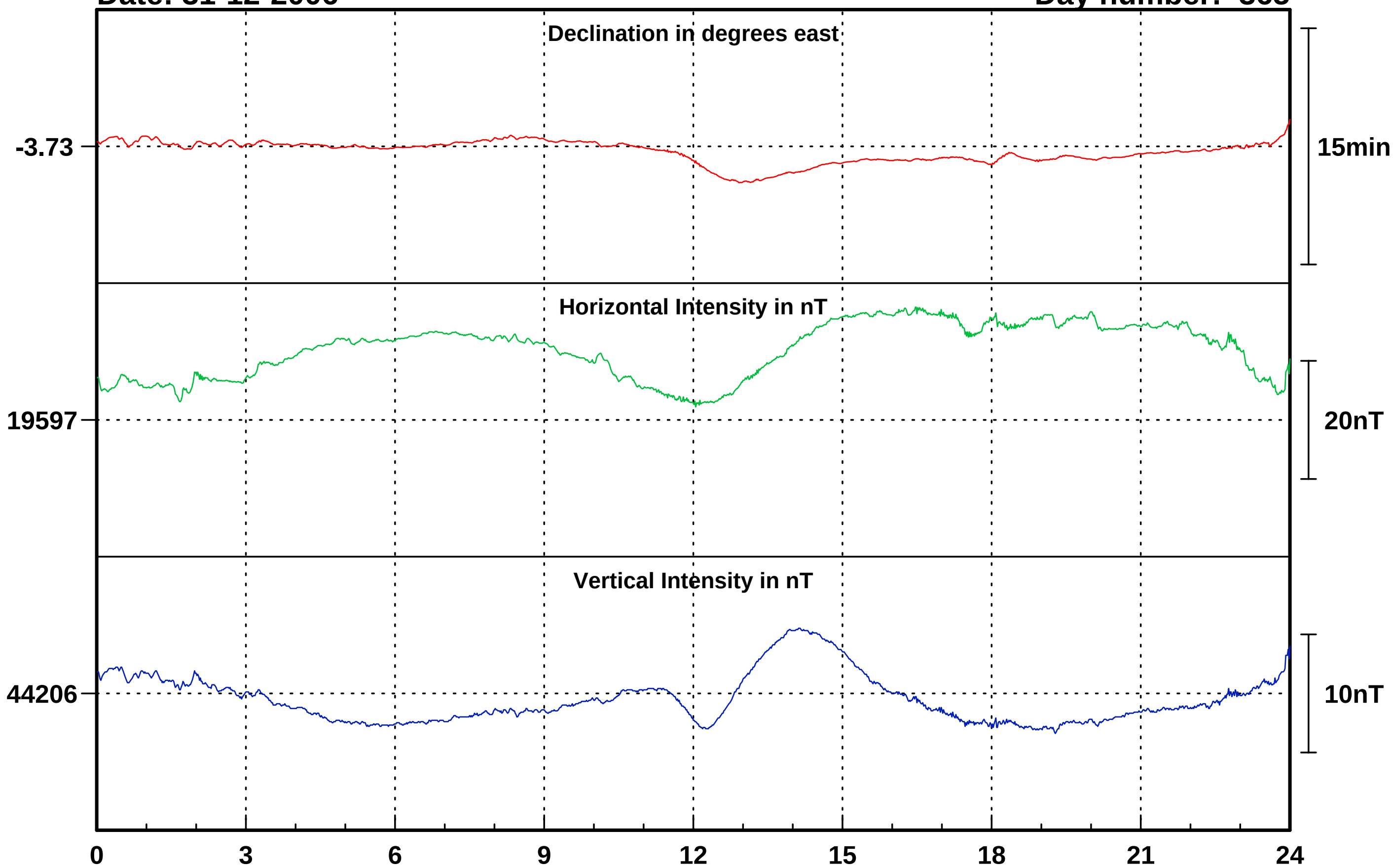
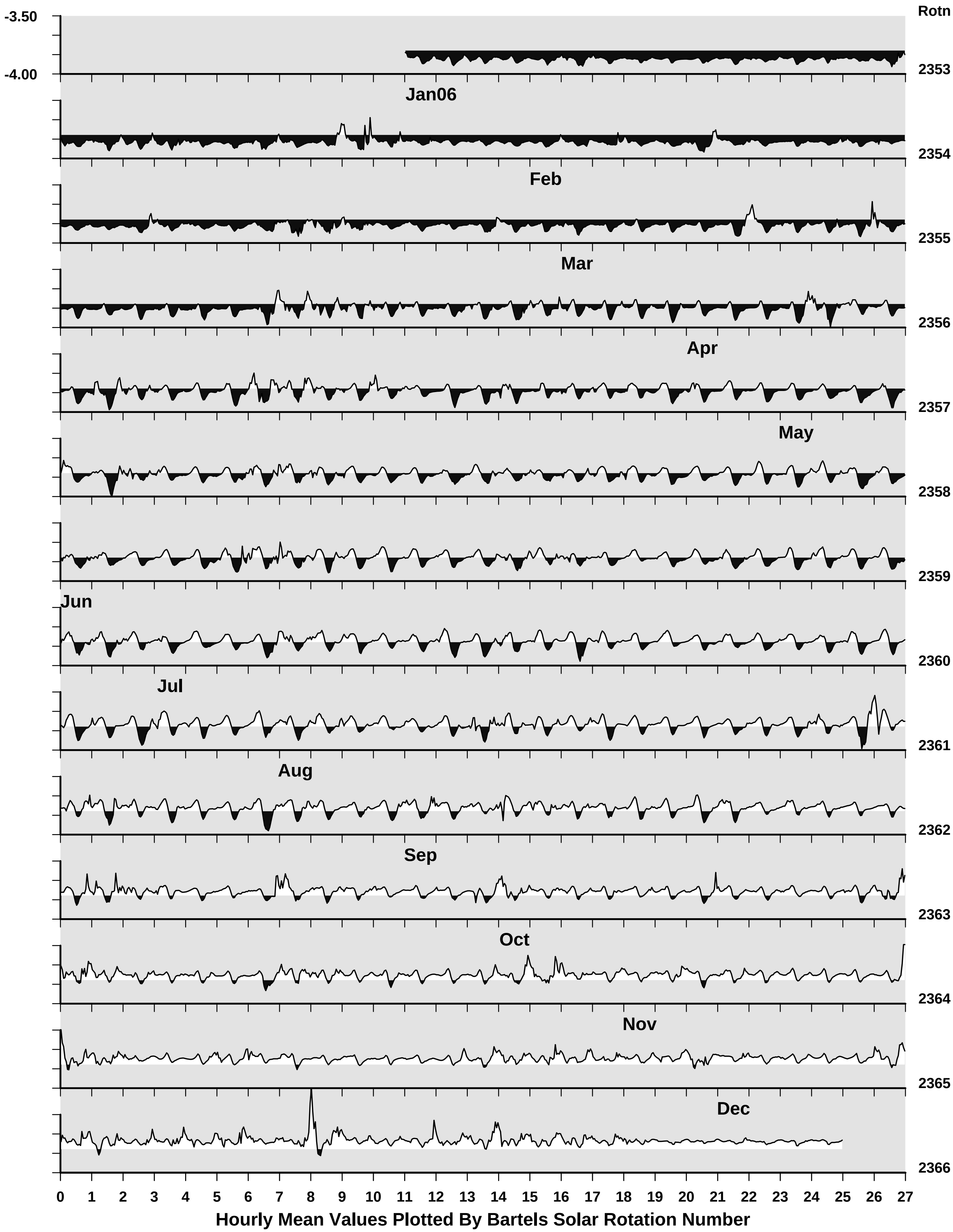
0
3
6
9
12
15
18
21
24
Hour (UT)

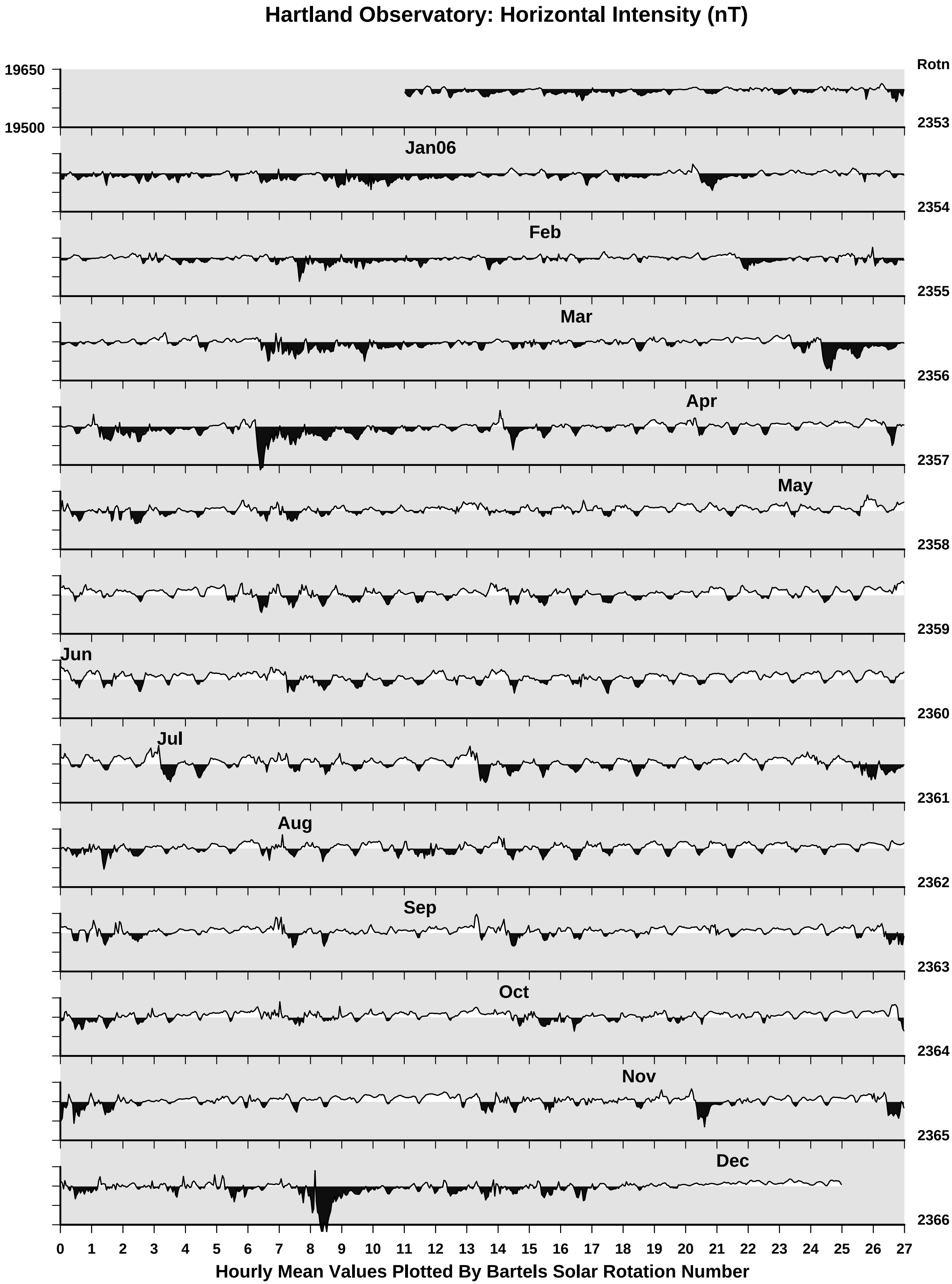
Hartland

Date: 31-12-2006 Day number: 365



Hartland Observatory: Declination (degrees)




Hartland Observatory: Horizontal Intensity (nT)
19650
19500
Rotn
2353
Jan06
2354
Feb
2355
Mar
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Apr
2357
May
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Nov
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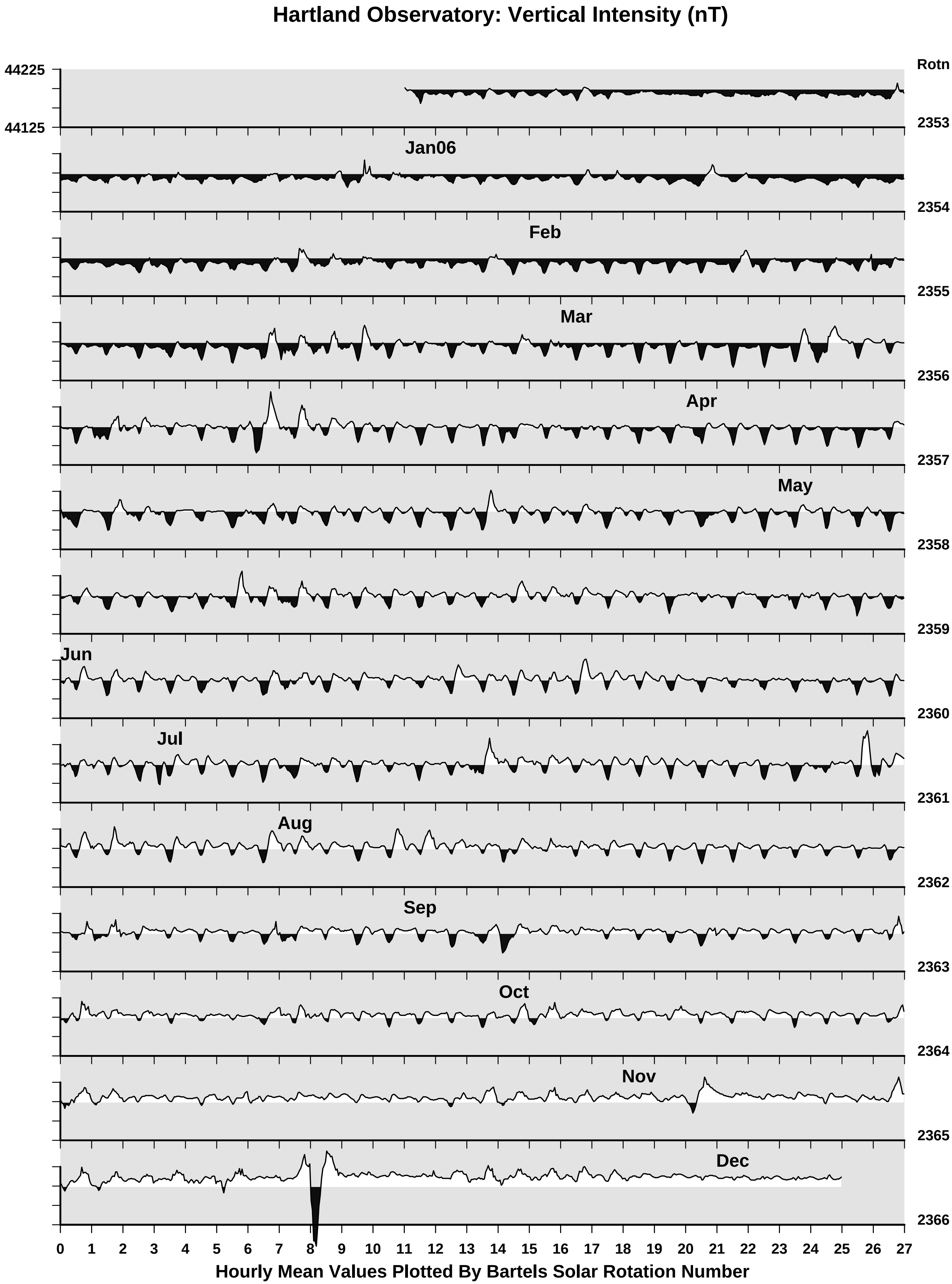
Dec
2366
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted By Bartels Solar Rotation Number


Hartland Observatory: Vertical Intensity (nT)
44225
44125
Rotn
2353
2354
2355
2356
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2358
2359
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2361
2362
2363
2364
2365
2366
Jan06
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Mar
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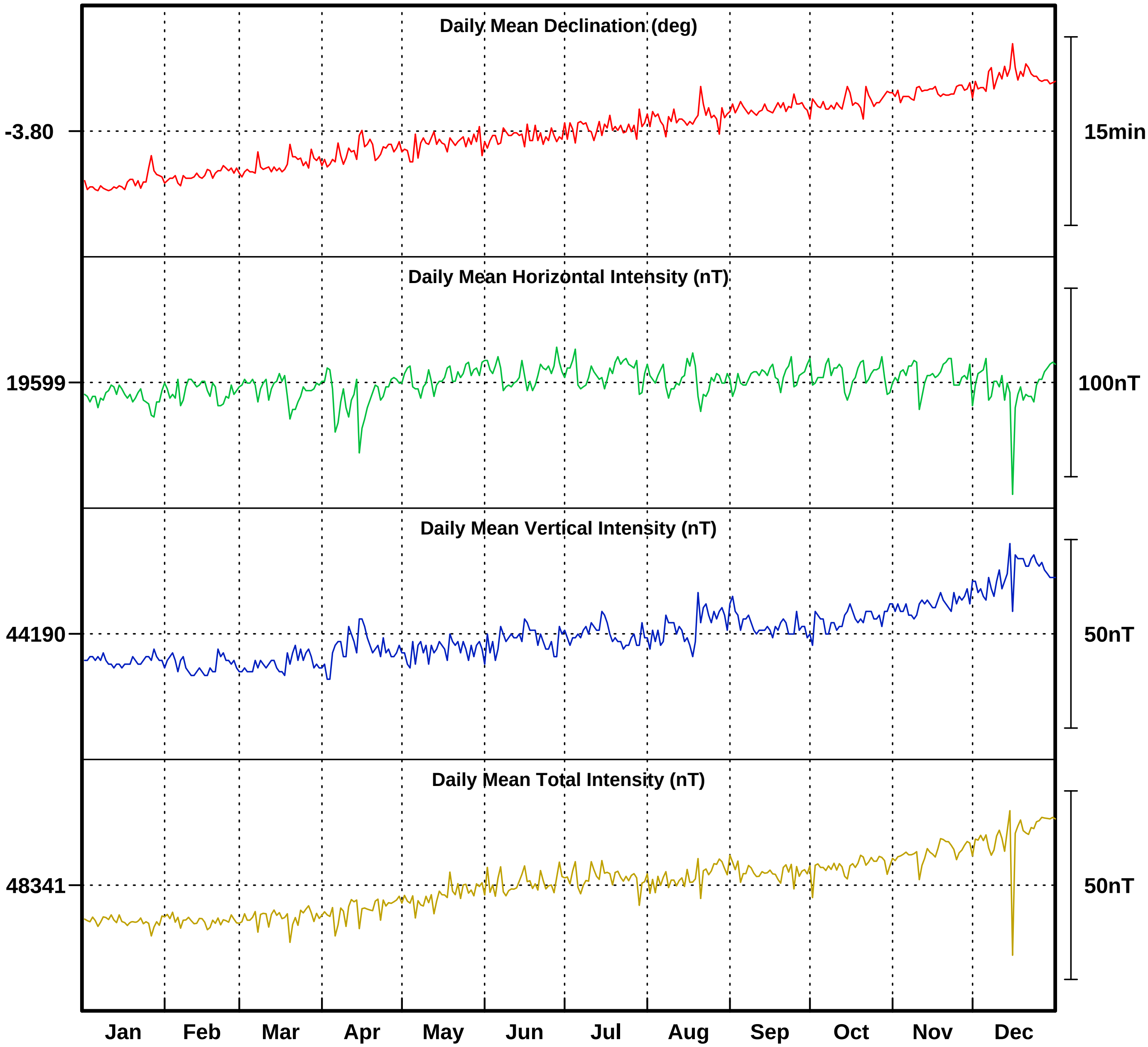
Oct
Nov
Dec
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted By Bartels Solar Rotation Number

Hartland Observatory 2006



Monthly Mean Values for Hartland Observatory 2006

Month	*D*	*H*	*I*	*X*	*Y*	*Z*	*F*
January	-3° 52.0´	19592 nT	66° 5.2´	19547 nT	-1321 nT	44183 nT	48332 nT
February	-3° 51.3´	19595 nT	66° 4.9´	19550 nT	-1318 nT	44182 nT	48332 nT
March	-3° 50.5´	19596 nT	66° 4.9´	19552 nT	-1313 nT	44182 nT	48333 nT
April	-3° 49.4´	19592 nT	66° 5.3´	19548 nT	-1307 nT	44186 nT	48335 nT
May	-3° 48.8´	19603 nT	66° 4.6´	19559 nT	-1304 nT	44186 nT	48339 nT
June	-3° 48.3´	19604 nT	66° 4.6´	19561 nT	-1301 nT	44189 nT	48342 nT
July	-3° 47.6´	19605 nT	66° 4.5´	19562 nT	-1297 nT	44190 nT	48343 nT
August	-3° 46.8´	19600 nT	66° 4.9´	19558 nT	-1292 nT	44192 nT	48344 nT
September	-3° 46.0´	19603 nT	66° 4.7´	19561 nT	-1288 nT	44192 nT	48345 nT
October	-3° 45.5´	19603 nT	66° 4.8´	19561 nT	-1285 nT	44194 nT	48347 nT
November	-3° 44.8´	19603 nT	66° 4.9´	19561 nT	-1281 nT	44198 nT	48350 nT
December	-3° 43.5´	19597 nT	66° 5.5´	19555 nT	-1273 nT	44206 nT	48355 nT

Note

i. The values shown here are provisional.

HARTLAND RAPID VARIATIONS

SIs and SSCs

Date	Time (UT)	Type	Quality	H (nT)	D (min)	Z (nT)
08-12-06	04 35	SSC*	B	23.1	-4.65	-15.2
14-12-06	14 14	SSC*	A	22.1	-3.11	10.0
16-12-06	17 55	SSC*	B	22.7	2.20	4.9
18-12-06	10 14	SSC*	B	2.7	0.62	1.4
28-12-06	19 13	SSC*	C	-4.2	0.40	-2.5

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			
5-12-06	10 26	10 32	11 04	-20.4	4.10	3.3

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

INDICES OF GEOMAGNETIC ACTIVITY

The K Index

Hartland Observatory December 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	1	0	0	1	1	1	3	2	9
2	1	0	0	0	1	1	0	1	4
3	1	1	1	0	0	1	2	2	8
4	0	0	0	0	0	0	1	1	2
5	0	0	0	3	1	1	1	2	8
6	4	3	3	5	3	3	5	4	30
7	4	3	3	4	3	4	3	4	28
8	3	4	4	3	3	3	4	3	27
9	1	1	1	0	0	3	3	4	13
10	2	3	2	3	3	4	3	4	24
11	3	3	3	2	2	1	2	4	20
12	3	4	2	2	4	4	5	4	28
13	3	3	1	1	1	1	1	3	14
14	3	2	2	2	5	5	5	7	31
15	7	6	5	4	5	4	5	4	40
16	3	2	1	1	1	3	3	3	17
17	3	1	1	0	1	1	3	0	10
18	1	2	1	2	1	2	3	5	17
19	3	3	1	2	3	2	3	2	19
20	4	3	3	2	3	4	5	4	28
21	5	3	3	3	3	4	3	3	27
22	3	3	3	3	3	3	3	4	25
23	3	2	3	2	3	4	4	3	24
24	3	2	2	2	3	4	3	2	21
25	3	2	2	1	2	2	1	1	14
26	1	1	1	0	2	1	1	0	7
27	1	1	0	0	1	1	0	1	5
28	0	0	0	0	0	1	2	2	5
29	1	0	0	0	1	1	1	1	5
30	1	0	0	1	1	0	1	0	4
31	1	0	0	0	1	1	0	1	4

Lower bound (nT) for the range for each index value at Hartland Observatory K-Index									
0	1	2	3	4	5	6	7	8	9
0	5	10	20	40	70	120	200	330	500

The aa Index

Date	Day	K-North	K-South	(a)	(b)	(c)	(d)	(e)
01-12-06	335	1 0 0 1 1 1 3 2	1 0 0 2 1 1 1 1	10	8	6	12	9
02-12-06	336	1 0 0 0 1 1 0 1	0 1 1 0 2 0 0 0	5	6	4	6	5
03-12-06	337	1 1 1 0 0 1 2 2	1 1 1 0 0 2 1 1	8	8	6	10	8
04-12-06	338	0 0 0 0 0 0 1 1	0 0 0 0 0 0 0 0	4	2	2	4	3
05-12-06	339	0 0 0 3 1 1 1 2	0 0 0 2 1 3 1 2	10	11	8	13	10
06-12-06	340	4 3 3 5 3 3 5 4	3 2 3 4 4 3 3 3	56	37	45	47	46
07-12-06	341	4 3 3 4 3 4 3 4	3 3 4 3 4 3 1 2	45	34	42	37	40
08-12-06	342	3 4 4 3 3 3 4 3	2 4 4 4 3 2 2 3	42	37	47	31	39
09-12-06	343	1 1 1 0 0 3 3 4	1 3 1 0 1 2 2 3	19	15	10	25	17
10-12-06	344	2 3 2 3 3 4 3 4	2 3 2 2 3 4 2 3	34	28	22	40	31
11-12-06	345	3 3 3 2 2 1 2 4	2 3 3 2 2 1 2 3	26	21	26	21	24
12-12-06	346	3 4 2 2 4 4 5 4	2 3 4 3 4 4 3 2	50	39	33	55	44
13-12-06	347	3 3 1 1 1 1 1 3	4 2 1 1 1 1 1 2	17	16	21	12	17
14-12-06	348	3 2 2 2 5 5 5 7	1 2 1 3 5 6 4 7	83	86	18	151	84
15-12-06	349	7 6 5 4 5 4 5 4	6 5 5 5 5 3 2 2	116	81	136	61	99
16-12-06	350	3 2 1 1 1 3 3 3	2 3 2 2 1 2 3 3	21	21	18	24	21
17-12-06	351	3 1 1 0 1 1 3 0	2 2 2 1 1 1 1 1	12	11	13	10	12
18-12-06	352	1 2 1 2 1 2 3 5	0 2 1 2 2 3 2 3	25	18	11	32	21
19-12-06	353	3 3 1 2 3 2 3 2	2 2 2 4 3 2 2 2	23	24	24	22	23
20-12-06	354	4 3 3 2 3 4 5 4	2 2 2 3 4 3 2 3	48	28	27	49	38
21-12-06	355	5 3 3 3 3 4 3 3	3 3 3 3 3 3 2 2	44	28	41	31	36
22-12-06	356	3 3 3 3 3 3 3 4	2 3 3 4 3 3 2 2	35	30	34	31	32
23-12-06	357	3 2 3 2 3 4 4 3	2 2 3 3 3 3 3 2	34	26	24	37	30
24-12-06	358	3 2 2 2 3 4 3 2	2 2 2 2 3 3 2 2	27	20	18	29	24
25-12-06	359	3 2 2 1 2 2 1 1	2 2 3 2 2 2 0 2	15	17	19	12	16
26-12-06	360	1 1 1 0 2 1 1 0	2 1 1 1 2 2 1 1	7	11	8	10	9
27-12-06	361	1 1 0 0 1 1 0 1	1 1 1 0 1 0 0 0	6	5	6	5	5
28-12-06	362	0 0 0 0 0 1 2 2	0 0 0 0 0 0 0 1	6	3	2	7	5
29-12-06	363	1 0 0 0 1 1 1 1	0 1 0 1 0 0 1 1	6	5	4	6	5
30-12-06	364	1 0 0 1 1 0 1 0	1 1 1 2 2 1 1 0	5	9	8	7	7
31-12-06	365	1 0 0 0 1 1 0 1	1 1 1 0 0 0 0 1	5	5	5	5	5
Monthly mean value =			24.8					

(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