INSTITUTE OF GEOPHYSICS
POLISH ACADEMY OF SCIENCES

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OF THE INSTITUTE OF GEOPHYSICS
POLISH ACADEMY OF SCIENCES

C-104 (414)

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BELSK, HEL, HORNSUND
2010

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WARSZAWA 2012

Editorial Office
Instytut Geofizyki Polskiej Akademii Nauk
ul. Księcia Janusza 64, 01-452 Warszawa, Poland

Internet Edition

ISBN 978-83-88765-88-9

"Publications of the Institute of Geophysics, Polish Academy of Sciences" has been issued in the following series:

A – Physics of the Earth's Interior
B – Seismology
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PUBLICATIONS OF THE INSTITUTE OF GEOPHYSICS
POLISH ACADEMY OF SCIENCES
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C-101 (408) Results of geomagnetic observations, Belsk, Hel, Hornsund, 2007.

C-102 (409) Results of geomagnetic observations, Belsk, Hel, Hornsund, 2008.

C-103 (413) (Internet Edition) Results of geomagnetic observations, Belsk, Hel, Hornsund, 2009

ISBN 978-83-88765-88-9

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PUBLS. INST. GEOPHYS. POL. ACAD. SC., C-104 (414), 2012

Results of Geomagnetic Observations Belsk, Hel, Hornsund, 2010

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1. INTRODUCTION

This publication contains basic information on geomagnetic observations carried out in 2010 in three Polish geophysical observatories: Belsk (BEL), Hel (HLP), and Hornsund (HRN). All these observatories belong to the Institute of Geophysics, Polish Academy of Sciences. Observatories Belsk and Hel are located on the territory of Poland, while Hornsund is in Spitsbergen archipelago, governed by Norway.

In 2010, like in the previous years, the Belsk, Hel and Hornsund observatories have kept a close collaboration with the world network of geomagnetic observatories INTERMAGNET. The Belsk Observatory joined INTERMAGNET in 1992, Hel in 1999, and Hornsund in 2002.

2. DESCRIPTION OF OBSERVATORIES

The location of observatories is shown in Fig. 1 and Table 1. The geomagnetic coordinates in Table 1 were calculated in relation to the geomagnetic pole located at 83.2^{o}N, 118.3^{o}W on the basis of model IGRF-11 from epoch 2010.

The methodology of geomagnetic observations in all the three observatories was very similar, based on the "Guide for Magnetic Measurements and Observatory Practice" (Jankowski and Sucksdorff 1996). The instruments were similar too. Absolute measurements were made with the use of DI-flux magnetometers and proton magnetometers. The magnetic field variations were measured with the use of PSM magnetometers equipped in Bobrov's quartz variometers. The spare sets are equipped in PSM magnetometers or LEMI flux-gate magnetometers.

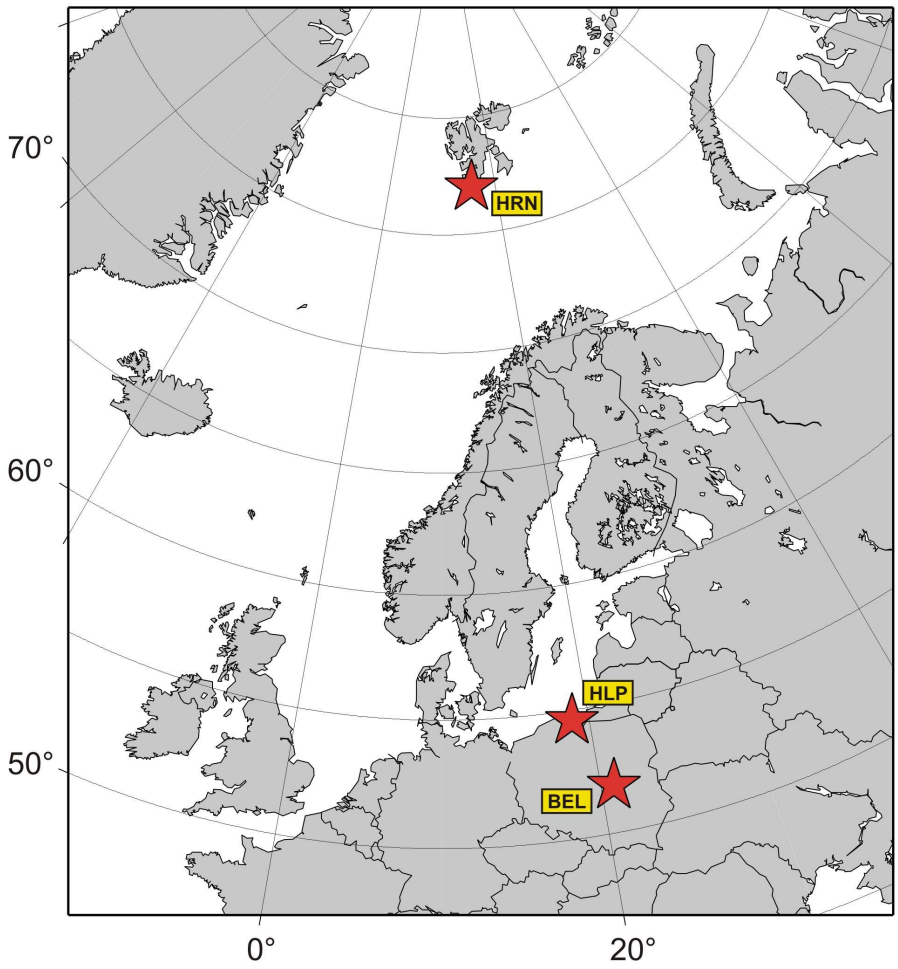

Fig. 1. Location of the Belsk, Hel and Hornsund observatories.

Table 1
Coordinates of the Polish observatories

Observatory	Geographic coordinates		Geomagnetic coordinates		Elevation
	Latitude	Longitude	Latitude	Longitude	[m]
Belsk (BEL)	51° 50.2′ N	20° 47.3′ E	49.9° N	105.1° E	180
Hel (HLP)	54° 36.5′ N	18° 49.0′ E	53.1° N	104.6° E	1
Hornsund (HRN)	77° 0.0′ N	15° 33.0′ E	73.9° N	125.3° E	15

Continuous recording has been made by means of digital loggers type NDL. Owing to the recording system we use and the fact that we strictly obey the procedures relating to the so-called magnetic service, the gaps in one-minute data from Belsk and Hel are practically absent. Short gaps have only occurred in records of the Hornsund station, because the conditions prevailing there are much harder than in Poland.

It is worth mentioning that in 2010 the Belsk and Hornsund Observatories have been continuing the permanent observation of the Schumann resonance. Two horizontal magnetic components and the vertical component of the electric field have been recorded at a frequency of 100 Hz. This recording was initiated in both observatories in 2004 (Neska and Satori 2006).

2.1 Central Geophysical Observatory at Belsk, Central Poland

The Observatory at Belsk began continuous observations of the Earth magnetic field in 1965 (Jankowski and Marianiuk 2007). It continued the activity of the first Polish magnetic Observatory at Świder near Warsaw, working incessantly through the years 1920-1975. The magnetic observations were transferred from Świder to Belsk because of a strong increase of artificial noise from the Warsaw agglomeration, in particular due to the electric railroad passing nearby the Świder Observatory.

The Belsk Observatory is located at a distance of about 50 km south of Warsaw and about 2 km northwest of the village Belsk Duży. The premises of the Observatory, about 10 ha in area, is at the edge of the forest reserve Modrzewina, far away of people's settlements and automobile traffic. The Observatory is surrounded by typically agricultural regions (with fertile soil, mostly apple orchards), so the direct neighborhood is deprived of sources of major artificial geomagnetic field disturbances. It is only the electric railroad (DC powered) situated some 14 km away of the Observatory to the north that produces some small artificial magnetic disturbances, whose average level usually does not exceed 1 nT.

More information about the region in which the Observatory is located can be found, in English, Polish and German, on the internet pages of Grójec district (http://www.grojec.pl) to which the village Belsk Duży belongs. Relevant information about Belsk Observatory can be found at page http://www.igf.edu.pl/en/obserwatoria/cog_belsk.

2.2 Geophysical Observatory at Hel, Northern Poland

The Observatory at Hel began continuous observations of the earth magnetic field in 1932 (Jankowski and Marianiuk 2007). The observations were stopped in 1939, after the outbreak of World War II. During the war, the Observatory as well as its equipment and data were completely destroyed. After reconstruction, continuous observations at Hel were resumed in 1957.

The Hel Observatory is located in a small resort town at the end of Hel Peninsula by the Bay of Gdańsk. It is the area of Seaside Landscape Park (Nadmorski Park Krajobrazowy), weakly industrialized and urbanized. The region, surrounded by water from three sides, lacks any major artificial noise and is a good place for continuous magnetic observations.

The observatory premises, about 4.5 ha in area, is surrounded by mixed forest (mainly pine and birch trees). Pavilions with measurement and recording instruments are located at small clearings.

More information about the town of Hel where the Observatory is located can be found at the address: http://www.hel-miasto.pl/.

2.3 Hornsund, Spitsbergen

The Polish Polar Station Hornsund (PSP Hornsund) is situated on the White Bear Bay (Isbjørnhamna) in Hornsund Fiord, Spitsbergen Island, Svalbard archipelago. More information on the Svalbard Archipelago can be found at the address: http://svalbard.com
The Hornsund station is the northernmost Polish scientific facility carrying out year-round activity. The Hornsund region is situated in a zone of strong magnetic field activity, much stronger than on the magnetic pole. Therefore, it is a very interesting place for magnetic observations.

Polish geomagnetic observations in the Arctic were initiated during the II Polar Year; a magnetic station was then established by S. Siedlecki and C. Centkiewicz on the Bear Island. In the years 1932/33, they had carried out continuous recording of magnetic field and performed absolute measurements. Unfortunately, all data were destroyed during the war. In

the years 1957/58, in the framework of the International Geophysical Year, measurements of magnetic declination and inclination were made by J. Kowalczuk and K. Karaczun in five sites in the Hornsund Fiord region.

Since the beginning of October 1978, continuous magnetic field recording has been put into operation, and systematic absolute measurements have been implemented (Jankowski and Marianiuk 2007). Since then, PSP Hornsund has begun to fulfill all the requirements for geomagnetic observatory.

Since 1993, PSP Hornsund has been participating in the IMAGE (International Monitor for Auroral Geomagnetic Effects) project. In the framework of this project, Hornsund data are being sent to Finnish Meteorological Institute once a month on the average and available on http://www.geo.fmi.fi/image/request.html. Since 2002, PSP Hornsund is included into the global near-real-time magnetic observatory network INTERMAGNET, sending the results, via Internet, to the GIN (Geomagnetic Information Nodes) centers in Edinburgh and Paris.

3. INSTRUMENTATION

3.1 Absolute measurements

In all the three Polish observatories, the absolute measurements used for determination of bases of the recordings are performed by means of DI-flux and proton magnetometers. Di-flux magnetometers measure the absolute values of the angles of declination D and inclination I, while the proton magnetometers measure the absolute values of the total magnetic field vector F. From the measured values of F, D, and I, we can calculate all the remaining magnetic field components, H, X, Y, and Z.

The results of absolute measurements are determined by means of a special computer package ABS (author: M. Neska), which calculates the base values on the basis of data from the measurement protocol.

The instruments for absolute measurements are listed in Table 2, and the basic parameters of the instruments in Table 3.

Table 2
Instruments for absolute measurements

	Belsk	Hel	Hornsund
DI-fluxgate (fluxgate, theodolite)	ELSEC 810, THEO-10B sn: 002208	FLUX-9408 THEO-10B sn: 160334	FLUX-9408 THEO-10B sn: 160326
Proton magnetometer	PMP-8 sn: 13/1998	PMP-8 sn: 21/2006	PMP-5 sn: 115
Frequency of measurements	6 per week	3 per week	2 per week

Table 3
Basic parameters of the instruments for absolute measurements

Fluxgate declinometer/inclinometer ELSEC 810 / THEO-10B
Producer ..... ELSEC Oxford, UK
Mean square error of a horizontal direction ..... $\sigma_D \approx \pm 5''$
Mean square error of a zenith direction ..... $\sigma_I \approx \pm 5''$
Fluxgate declinometer/inclinometer FLUX-9408 / THEO-10B
Producer (FLUX-9408).....Institute of Geophysics Pol. Acad. Sc.
Mean square error of a horizontal direction ..... $\sigma_D \approx \pm 5''$
Mean square error of a zenith direction ..... $\sigma_I \approx \pm 5''$
Proton magnetometer model PMP-8
Producer ..... Institute of Geophysics Pol. Acad. Sc.
Resolution ..... 0.01 nT
Absolute accuracy ..... 0.2 nT
Proton magnetometer model PMP-5
Producer ..... Institute of Geophysics Pol. Acad. Sc.
Resolution ..... 0.1 nT
Absolute accuracy ..... 0.2 nT

Results of base determinations and the smoothed values adopted for further computations are depicted in Figs. 2, 10 and 18 in the chapters describing individual observatories.

The mean random errors of a single base measurement, m_B, and the number of measurements *n* taken in 2010 are listed in Table 4.

Thermal coefficients of magnetic sensors are not taken into account in calculations, with a view to the following facts:

– tests made every few years indicated that the coefficients are very small, less than 0.2 nT/^{o}C,
– the magnetic sensors are located in thermostat-controlled wooden boxes where the daily temperature variations are of the order of 0.1-0.2^{o}C.

Table 4
Mean errors of measurements of B_X, B_Y and B_Z in 2010

Observatory	Element	Number of measurements n	Mean error m_B [nT]
Belsk	B_X	352	0.5
	B_Y	352	0.6
	B_Z	352	0.3
Hel	B_X	158	0.4
	B_Y	158	0.6
	B_Z	158	0.2
Hornsund	B_X	193	0.9
	B_Y	195	0.2
	B_Z	194	0.6

3.3 Recording of geomagnetic field variations

As we already mentioned, the continuous digital recordings of geomagnetic field variations in all the Polish observatories are performed by means of magnetometers PSM and digital loggers NDL In spare sets, we use magnetometers PSM or LEMI. Both the main and spare sets record the components in the rectangular coordinate system X, Y, Z. At Belsk and Hel, continuous recording of the total magnetic field modulus F is performed as well. The basic parameters of the recording systems are listed in Table 5.

Magnetometers PSM

Magnetometers PSM were designed at the Institute of Geophysics PAS with the use of torsion quartz variometers of V. N. Bobrov system (Marianiuk 1977, Jankowski *et al*. 1984). In these magnetometers, the magnet‘s deflections in response to the magnetic field changes are transformed by means of photoelectric converters into the electric current changes. Owing to a strong negative feedback, the voltage changes on the output of the converter are in linear proportion to the magnetic field changes. The magnetometers PSM are characterized by good stability, of about 3-5 nT/year, and small noise, below 10 pT.

Magnetometers LEMI

Magnetometers LEMI were designed at the Lviv Centre of the Institute of Space Research (Ukraine). They employ flux-gate sensors. These magnetometers have been successfully used as auxiliary sets. Their stability is not much less than that of PSM’s, and they are also characterized by good orthogonality of sensors and relatively small self noise.

Proton magnetometers PMP-5 and PMP-8

Magnetometers PMP-5 and PMP-8 were designed at the Institute of Geophysics PAS. These are classical proton magnetometers, in which the precession signal is forced in a cycle of proton polarization by means of direct current. The resolution of magnetometers PMP-5 is 0.1nT, that of PMP-8 being 0.01nT. The stability of both magnetometers is better than 0.3 nT/year. More information about PMP-8 magnetometer can be found on the page:

http://www.igf.edu.pl/pl/zaklady_naukowe/konstrukcji_aparatury/aparatura

Digital loggers NDL

The NDL data logger is designed for recording of analog signals, mainly coming from geophysical phenomena detectors. The instrument is equipped with six independent measuring channels; the analog-to-digital conversion is realized using 24 bit sigma-delta converters. The GPS receiver ensures high time accuracy of recorded signals. The NDL is equipped with ftp server; this allows easy access to NDL via Internet.

Digital loggers DR-02 and DR-03

The digital loggers were designed in the early 1990s by the enterprise EL-LAB (Poland) especially for recording the long-term slow-changing variations. These are independent instruments and their cooperation with the computer resolves itself to the read-out of data via the RS-232 interface. Model DR-03 is equipped in clock synchronized by a GPS.

Table 5
Basic instruments for the magnetic field variations recording

		Belsk	Hel	Hornsund
SET 1	Name of magnetometer Kind of sensor	PSM Bobrov	PSM Bobrov	PSM Bobrov
	Type	PSM-8511-01P	PSM 8511-02P	PSM-8911-05P
	Sensor's orientation	XYZ	XYZ	XYZ
	Range	+/– 850 nT	+/– 850 nT	+/– 5000 nT
	Magnetometer's producer	Institute of Geophysics PAS	Institute of Geophysics PAS	Institute of Geophysics PAS
	Digital recorder Producer	NDL TUS Electronics	DR-03 EL-LAB	NDL TUS Electronics
	Sampling interval	1 s	5 s	1 s
SET 2	Name of magnetometer Kind of sensor	PSM Bobrov	PSM Bobrov	LEMI fluxgate
	Type	PSM-8511-01P	PSM 8511-03P	LEMI-003/95
	Sensor's orientation	XYZ	XYZ	XYZ
	Range	+/– 820 nT	+/– 820 nT	+/– 10,000 nT
	Magnetometer's producer	Institute of Geophysics PAS	Institute of Geophysics PAS	Institute of Geophysics PAS
	Digital recorder Producer	NDL TUS Electronics	DR-02 EL-LAB	NDL TUS Electronics
	Sampling interval	1 s	5 s	1 s
Total field	Name of magnetometer	PMP-8	PMP-5	–
	Producer	Institute of Geophysics PAS	Institute of Geophysics PAS	–
	Sampling interval	30 s	10 s	–

3.4 Calibration of magnetic sensors

The verification of scale values of recording systems in all the three observatories was made by the classical electromagnetic method: electric currents were passed through calibration coils woven over variometers. The currents induce the magnetic field of precisely known intensity. The measurements are made at least few times a year.

The scale values of magnetometers PSM and LEMI, parameters of calibration coils of PSMs, and mutual orthogonality of sensors in PSMs and LEMIs is checked every few years in large calibration coils installed at the Belsk Observatory. Adopted scale values are listed in Table 6.

Table 6
Scale values adopted for computations in 2010

Observatory	Period	Scale values		
		X [nT/bit]	Y [nT/bit]	Z [nT/bit
Belsk	Jan01-Dec31	0.00000607	0.00000605	0.00000609
Hel	Jan01-Dec31	0.0247	0.0247	0.0244
Hornsund	Jan01-Dec31	0.0000356	0.0000367	0.0000360

3.5 Data processing

In processing the results of digital recordings we used the software packet developed for the needs of an observatory operating in the INTERMAGNET network. This software makes it possible to perform, among other things, the following operations:

- conversion of magnetic data into the INTERMAGNET text format IMFV1.22 and creation in this format of daily files containing one-minute means of X, Y, Z and F (authors: M. Neska and Jan Reda),
- automatic transmission of data, via Internet, to the Institute of Geophysics PAS in Warsaw and data centers in Paris and Edinburgh (author: M. Neska),
- archiving of data and plotting of magnetograms (authors: J. Reda, M. Neska, S.Wójcik),
- calculation of results of absolute measurements (author: M. Neska),
- automatic calculation of geomagnetic indices K (Nowożyński *et al*. 1991). The indices are calculated with the use of ASm (Adaptive Smoothed) method, developed at the Institute of Geophysics PAS, and recommended by IAGA in 1991. The currently used program calculates the indices from one-minute means in the INTERMAGNET CD-ROM Data Format or in the IMFV1.22 format. The program for calculation of indices may be taken from the INTERMAGNET page:
  http://www.intermagnet.org/Software_e.php
- test printouts to check various parameters of recording adopted for calculation and a possibility of looking over current and past data curves or tables.

The diagrams illustrating the annual variations of X, Y, and Z, monthly variations of X, Y, Z and F, bases of recording sets as well as plots of K indices for 2010 were prepared with the use of programs imcdview.jar and imagplot.exe provided to us by INTERMAGNET. The diagrams prepared by means of imagplot.exe and other diagrams related to 2010 data are shown in Figs 8 .. 24.

In the present yearbook, as in previous years, we include the E indices calculated for Belsk observatory. The E indices, unlike the K indices, are calculated on the basis of energy analysis. They have been described in detail by Reda and Jankowski (2004).

3.6 Data availability

The newest data from Belsk, Hel and Hornsund observatories can be viewed in graphic form through the WEB application

http://rtbel.igf.edu.pl

described by Nowożyński and Reda (2007).

On this page, the Belsk and Hel data appear with one-hour delay, while the delay for

Hornsund is few hours. The page makes it possible to view the archival data from any observatory belonging to the INTERMAGNET network (in the form of curves on the screen). It offers also a possibility of calculating the K indices according to the ASm method (Nowożyński *et al*. 1991) and E indices (Reda and Jankowski 2004).

The current data (of status REPORTED) from all the three observatories can be found in INTERMAGNET at the Internet address:

http://www.intermagnet.org/apps/dl_data_prel_e.php

Data from Belsk, Hel and Hornsund are also available from the WDCs. Addresses of some WDC pages with magnetic data are the following:

WDC for Geomagnetism, Edinburgh http://www.wdc.bgs.ac.uk/catalog/master.html

WDC for Geomagnetism, Kyoto http://swdc234.kugi.kyoto-u.ac.jp/

All the three observatories have in their archives the original data, whose sampling periods are listed in Table 5. For those interested, these data can be made available on request.

4 CONTACT PERSONS, POSTAL ADDRESSES, CONTACT DETAILS

4.1 Belsk Observatory

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4.2 Hel Observatory

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4.3 Hornsund

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http://hornsund.igf.edu.pl/index_en.php
http://www.igf.edu.pl/en/zaklady_naukowe/zaklad_badan_polarnych/obserwatoria

5 PERSONNEL TAKING PART IN THE WORK OF BELSK, HEL AND HORNSUND OBSERVATORIES IN 2010

5.1 Belsk

– Jan Reda (project leader of geomagnetic observations in Belsk, Hel, Hornsund)
– Mariusz Neska (data processing)
– Paweł Czubak (data processing)
– Michał Sawicki (apparatus service)
– Krzysztof Kucharski (observer)
– Halina Suska (data processing, observer)
– Józef Skowroński (observer)

5.2 Hel

– Stanisław Wójcik (head of Geophysical Observatory)
– Anna Wójcik (observer)
– Mariusz Neska (data processing)
– Jan Reda (data processing)

5.3 Hornsund

– Mariusz Neska (head of geomagnetic observations)
– Szymon Kostka (observer in 1-st half-year)
– Michał Sawicki (observer in 2-nd half-year)
– Jan Reda (data processing)

L i t e r a t u r e

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Belsk, Publs. Inst. Geophys. Pol. Acad. Sc. **C-99 (398)**, 7-19.
Reda, J., and J. Jankowski (2004), *Three hour activity index based on power spectra estim tion*, Geophys. J. Int. **157**, 141-146.
Reda, J. (editor) (2007), *XII IAGA Workshop on Geomagnetic Observatory Instruments, Data Acquisition and Processing, Belsk, 19-24 June 2006, Monographic Volume*, Publs. Inst. Geophys. Pol. Acad. Sc. **C-99 (398)**, 397 pp.

Technical data of PMP-8:
http://www.igf.edu.pl/pl/zaklady_naukowe/konstrukcji_aparatury/aparatura

Received May 10, 2012

Accepted November21, 2012

6. TABLES AND PLOTS FOR BELSK OBSERVATORY

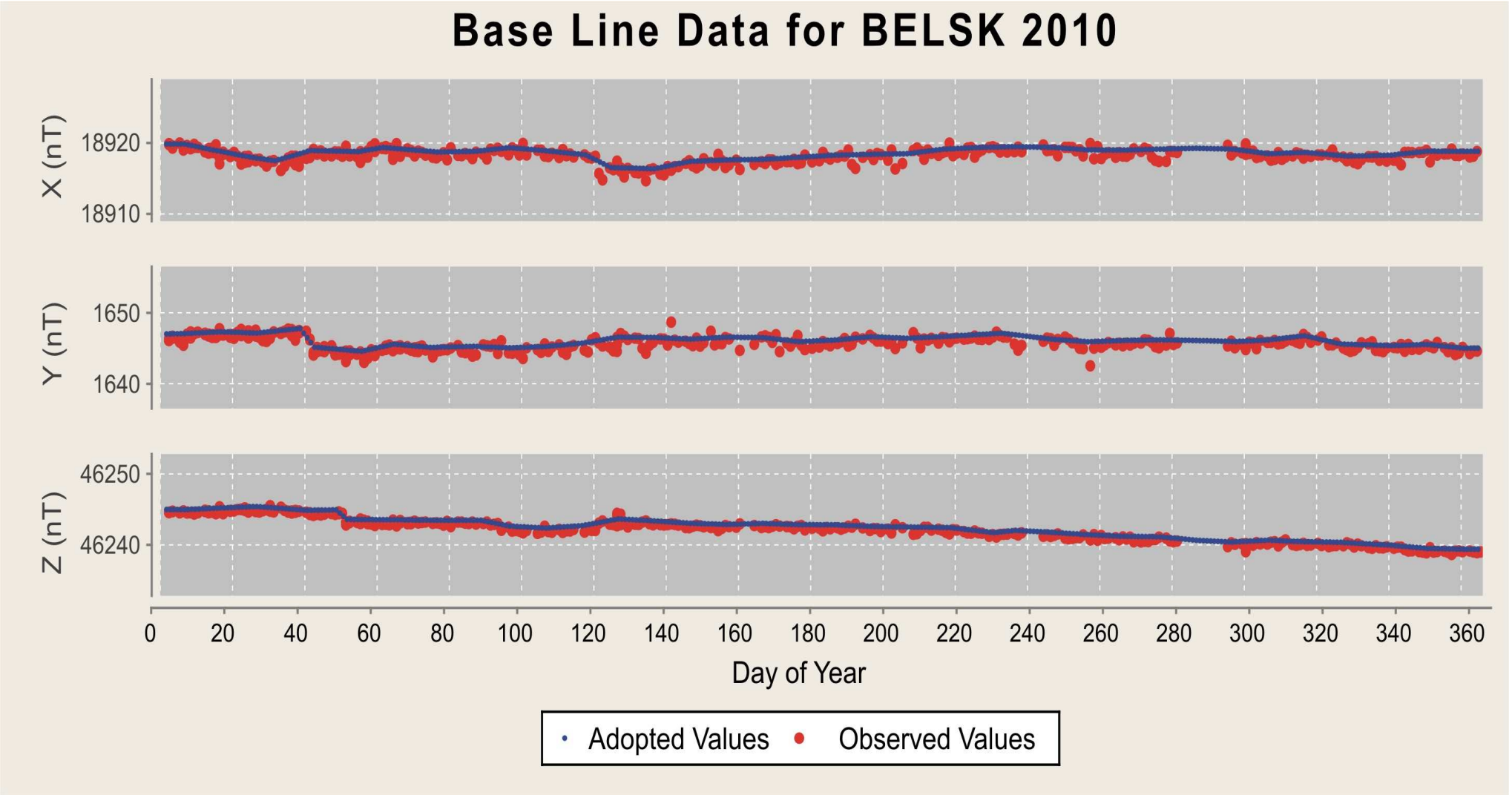

Fig. 2. Base values of set 1, Belsk 2010.

Annual mean values of magnetic elements in Belsk Observatory

No	Year	D [º ‘]	H [nT]	Z [nT]	X [nT]	Y [nT]	I [º ‘]	F [nT]
1	1966	2 04.2	18901.2	45023.3	18888.9	682.8	67 13.6’	48829.8
2	1967	2 05.6	18906.2	45047.7	18893.6	690.7	67 14.0	48854.3
3	1968	2 06.2	18917.8	45071.3	18905.5	694.6	67 13.8	48880.5
4	1969	2 06.3	18935.7	45093.5	18922.9	695.6	6713.3	48907.9
5	1970	2 06.6	18953.0	45123.1	18940.2	697.7	67 13.0	48941.9
6	1971	2 06.6	18975.5	45146.4	18962.6	698.8	67 12.2	48972.1
7	1972	2 08.0	18991.6	45176.3	18978.4	706.7	67 11.9	49005.9
8	1973	2 10.2	19004.6	45210.8	18991.0	719.4	67 12.0	49042.8
9	1974	2 13.3	19016.3	45245.6	19002.0	737.1	67 12.2	49079.3
10	1975	2 16.4	19035.2	45273.5	19020.2	754.9	67 11.7	49112.4
11	1976	2 18.5	19049.7	45306.9	19034.3	767.3	67 11.7	49148.8
12	1977	2 22.0	19062.1	45336.6	19045.8	787.4	67 11.7	49181.0
13	1978	2 27.4	19058.6	45375.7	19041.1	817.1	67 13.0	49215.7
14	1979	2 32.3	19061.4	45401.4	19042.7	844.2	67 13.5	49240.5
15	1980	2 37.2	19063.2	45418.4	19043.3	871.2	67 13.9	49256.8
16	1981	2 42.9	19047.1	45448.9	19025.7	902.0	67 15.7	49278.7
17	1982	2 48.3	19034.8	45478.8	19012.0	931.3	67 17.3	49301.6
18	1983	2 52.4	19032.6	45498.8	19008.7	953.8	67 18.0	49319.2
19	1984	2 56.9	19022.8	45519.8	18997.6	978.4	67 19.2	49334.8
20	1985	3 00.8	19015.2	45542.0	18988.9	999.5	67 20.3	49352.3
21	1986	3 05.1	19003.3	45570.4	18975.8	1022.8	67 21.8	49373.9
22	1987	3 08.5	18999.1	45592.7	18970.6	1041.2	67 22.7	49392.9
23	1988	3 12.4	18983.0	45626.4	18953.3	1062.0	67 24.6	49417.8
24	1989	3 15.9	18966.2	45662.1	18935.4	1080.3	67 26.6	49444.3
25	1990	3 18.8	18961.5	45684.3	18929.8	1095.9	67 27.5	49463.1
26	1991	3 22.2	18950.8	45709.3	18918.0	1114.1	67 28.8	49482.0
27	1992	3 25.3	18954.8	45726.1	18921.0	1131.2	67 29.1	49499.1
28	1993	3 29.8	18956.4	45743.7	18921.1	1156.0	67 29.4	49516.0
29	1994	3 34.8	18953.6	45772.4	18916.6	1183.3	67 30.4	49541.4
30	1995	3 39.8	18959.3	45796.8	18920.6	1211.5	67 30.7	49566.2
31	1996	3 45.0	18965.7	45821.9	18925.1	1240.6	67 30.9	49591.8
32	1997	3 50.9	18962.8	45856.9	18920.0	1272.7	67 32.0	49623.0
33	1998	3 57.3	18955.8	45897.1	18910.6	1307.6	67 33.6	49657.5
34	1999	4 02.5	18957.8	45930.6	18910.6	1336.4	67 34.3	49689.2
35	2000	4 07.8	18955.4	45968.7	18906.2	1365.4	67 35.5	49723.5
36	2001	4 13.0	18962.4	46004.8	18911.1	1394.2	67 36.0	49759.6
37	2002	4 18.4	18969.2	46043.6	18915.6	1424.4	67 36.6	49798.0
38	2003	4 24.2	18970.2	46089.6	18914.2	1456.7	67 37.7	49840.9
39	2004	4 29.4	18980.3	46121.0	18922.0	1486.0	67 37.9	49873.8
40	2005	4 34.7	18984.3	46154.6	18923.7	1515.5	67 38.5	49906.4
41	2006	4 39.8	18996.7	46177.2	18933.8	1544.3	67 38.3	49932.0
42	2007	4 45.8	19007.4	46206.7	18941.8	1578.4	67 38.4	49963.4
43	2008	4 52.5	19014.0	46236.3	18945.2	1615.9	67 38.7	49993.3
44	2009	4 59.7	19022.2	46264.5	18949.9	1656.4	67 39.0	50022.5
45	2010	5 08.0	19017.6	46301.3	18941.4	1701.4	67 40.2	50054.7

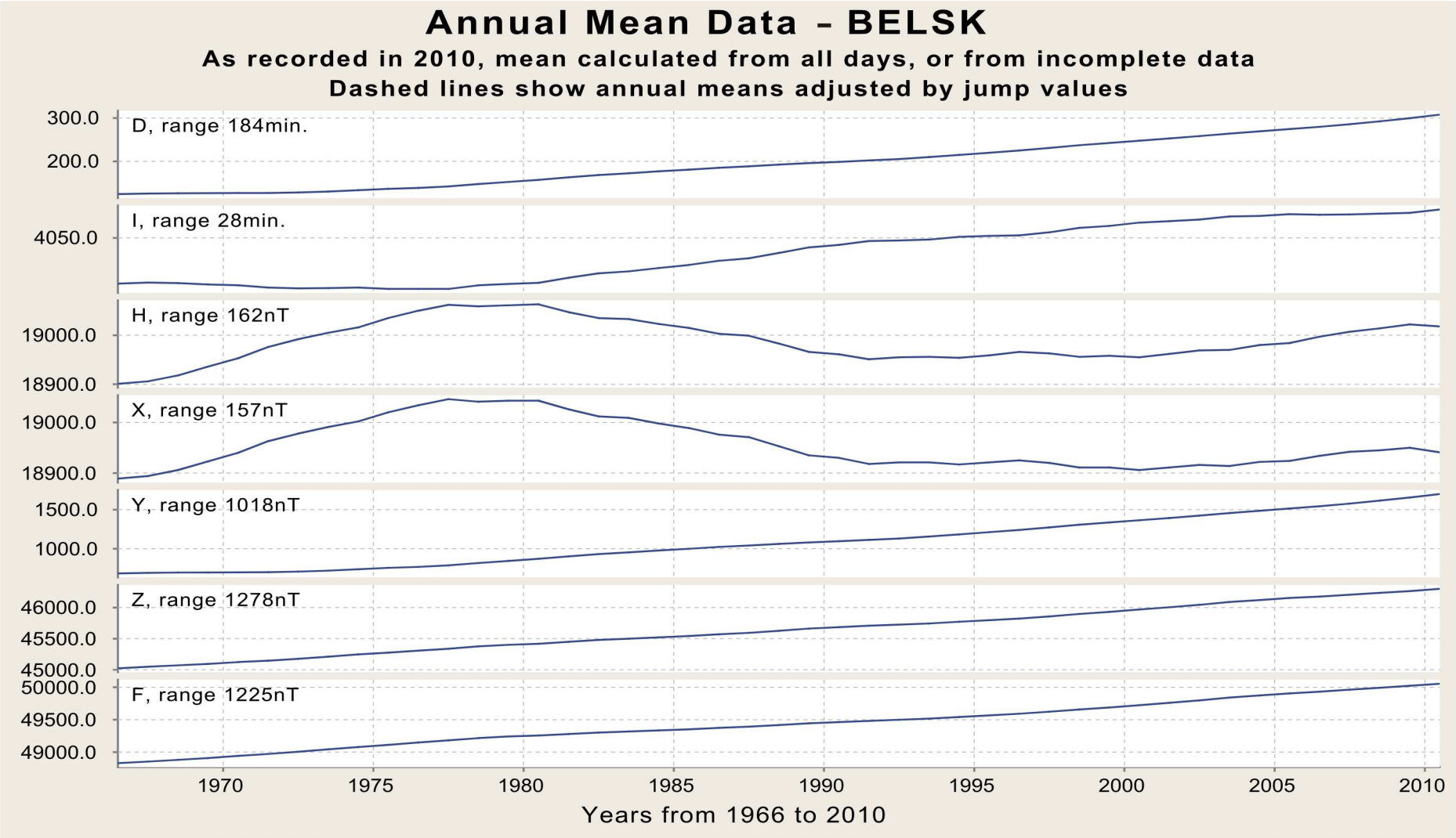

Fig. 3. Secular changes of H, X, Y, Z, F, D and I at Belsk.

MONTHLY AND YEARLY MEAN VALUES OF MAGNETIC ELEMENTS

BEL 2010

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
NORTH COMPONENT: 18500 + ... in nT													
All days	447	444	448	440	442	444	444	438	439	436	437	439	441
Quiet days	450	449	449	445	444	447	443	441	440	443	442	443	445
Disturbed days	443	435	445	423	429	441	442	433	435	425	431	432	435
EAST COMPONENT: 1500 + ... in nT													
All days	181	185	186	193	197	200	203	208	210	214	218	221	201
Quiet days	179	183	186	192	196	199	203	207	210	211	217	220	200
Disturbed days	182	188	187	194	201	202	204	211	212	215	221	223	203
VERTICAL COMPONENT: 46000 + ... in nT													
All days	282	288	288	293	297	300	302	308	309	313	316	319	301
Quiet days	281	286	287	293	296	300	302	307	308	309	314	318	300
Disturbed days	284	290	288	295	305	301	302	308	310	318	318	321	303

Three-hour-range K indices
Belsk, January - March, 2010
The limit of K=9 is 450

Day	January		February		March	
	K	SK	K	SK	K	SK
1	0000 0101	2	1022 3334	18	1011 2122	10
2	0010 1101	4	3112 2224	17	0001 2213	9
3	0112 1101	7	3122 2332	18	1112 3333	17
4	1011 0010	4	2200 0002	6	1221 2212	13
5	0000 1100	2	1100 1211	7	1011 2121	9
6	1111 1000	5	0011 2322	11	3110 0122	10
7	0010 0010	2	1100 0023	7	2321 1011	11
8	1000 0000	1	3101 0002	7	1111 0121	8
9	0001 0001	2	1112 1111	9	0011 1111	6
10	0011 1210	6	1111 1022	9	2111 3434	19
11	1122 2222	14	2112 2112	12	3222 2131	16
12	2111 0022	9	1312 1212	13	3222 3232	19
13	3212 2223	17	1110 0221	8	2011 0122	9
14	2101 2121	10	1001 2013	8	3111 2123	14
15	0110 0243	11	3222 2354	23	1000 0130	5
16	1001 0001	3	3222 1124	17	0121 1123	11
17	0000 0000	0	4211 0004	12	1222 1113	13
18	0111 1211	8	0012 2331	12	3200 1122	11
19	1000 0101	3	1101 1122	9	1011 0123	9
20	1011 2544	18	0000 0100	1	2221 2220	13
21	2221 1001	9	0000 0111	3	1011 1011	6
22	1201 1012	8	1202 1222	12	0000 0000	0
23	3112 2112	13	2101 0111	7	0000 1110	3
24	1111 2211	10	2110 1021	8	0001 2212	8
25	1111 1112	9	2001 0122	8	0112 2331	13
26	2101 0022	8	3111 0000	6	0112 2012	9
27	0001 0011	3	0010 1120	5	2211 1111	10
28	1001 1231	9	0020 1111	6	0222 1211	11
29	1101 0001	4			2011 2213	12
30	2211 1122	12			3211 1233	16
31	2111 1121	10			2112 1112	11

Three-hour-range K indices
Belsk, April - June, 2010
The limit of K=9 is 450

Day	April			May			June		
	K		SK	K		SK	K		SK
1	3212	3323	19	1101	1210	7	3222	3333	21
2	3232	2242	20	1124	5565	29	2311	2233	17
3	3111	2433	18	4333	4443	28	1223	3233	19
4	3232	2344	23	3222	2233	19	4423	2212	20
5	3337	5545	35	3211	2331	16	1221	1222	13
6	4434	4545	33	1222	2442	19	2112	2232	15
7	4243	3454	29	3212	3332	19	2111	3221	13
8	4222	2134	20	2211	2121	12	1111	1210	8
9	3211	1231	14	2110	1111	8	0122	1211	10
10	1011	1111	7	1111	1231	11	2323	1111	14
11	1011	4445	20	2122	2231	15	2211	2211	12
12	5432	2431	24	1213	3202	14	0111	1121	8
13	0011	1113	8	1111	1210	8	1222	2222	15
14	2102	1235	16	1101	1221	9	1111	1111	8
15	3321	2210	14	1111	1100	6	1223	2323	18
16	1111	1121	9	1110	1222	10	3334	3343	26
17	1111	0033	10	2112	2332	16	3233	2332	21
18	2101	0112	8	2112	2211	12	2222	1320	14
19	1212	1211	11	1112	4332	17	1112	1221	11
20	1111	2221	11	4213	3413	21	1002	2102	8
21	1222	3221	15	2211	2221	13	2132	1122	14
22	1111	1232	12	0112	2110	8	1222	2311	14
23	4311	2123	17	1010	1100	4	1212	1220	11
24	3211	1120	11	0110	1110	5	0112	2222	12
25	1111	0111	7	1121	2213	13	2112	2333	17
26	0001	1111	5	1212	2222	14	3333	3333	24
27	3111	1222	13	2111	1110	8	3333	3333	24
28	1110	1102	7	2323	3233	21	2222	2331	17
29	2312	1010	10	2333	4443	26	1222	2234	18
30	1111	1111	8	2233	3454	26	3433	3333	25
31				2233	4433	24			

Three-hour-range K indices
Belsk, July - September, 2010
The limit of K=9 is 450

Day	July		August		September	
	K	SK	K	SK	K	SK
1	2322 3442	22	1122 1112	11	1111 1233	13
2	2222 2233	18	1222 2212	14	2222 1321	15
3	2212 2312	15	2222 2455	24	2101 0010	5
4	2112 2211	12	5436 5365	37	0100 1012	5
5	0121 1021	8	4211 2222	16	0101 1113	8
6	1111 0110	6	2211 2222	14	2322 2233	19
7	0111 1111	7	1111 1211	9	3312 3333	21
8	1111 1122	10	1102 1231	11	2212 4433	21
9	2222 2111	13	3322 3322	20	1002 3312	12
10	0100 1100	3	2221 2223	16	1111 0110	6
11	0111 2312	11	3221 1221	14	0011 1000	3
12	1111 2122	11	2111 1112	10	0010 0100	2
13	1100 1111	6	1111 1211	9	1001 1211	7
14	1212 3334	19	1101 1211	8	1122 2333	17
15	4222 2312	18	3212 2222	16	3213 1112	14
16	1121 3111	11	1111 1231	11	1111 2342	15
17	0011 2100	5	1111 1332	13	2222 2222	16
18	0111 1201	7	1221 1110	9	3111 1111	10
19	0011 2211	8	1111 1111	8	1111 1111	8
20	1122 2222	14	0001 1212	7	1211 1131	11
21	1212 2221	13	1100 1111	6	2221 1101	10
22	1111 2211	10	0101 1000	3	1100 1111	6
23	1123 2333	18	0111 2224	13	1122 3222	15
24	2111 1222	12	4343 4433	28	2232 2424	21
25	2212 1222	14	3423 3423	24	3222 1122	15
26	2212 2123	15	2232 2222	17	2012 3333	17
27	3334 3443	27	2333 3423	23	2111 2234	16
28	4223 3332	22	2232 2222	17	2243 3232	21
29	2222 2221	15	2111 1011	8	1222 1111	11
30	2112 2333	17	1001 0100	3	0012 1102	7
31	2212 3311	15	0021 2122	10		

Three-hour-range K indices
Belsk, October - December, 2010
The limit of K=9 is 450

Day	October		November		December	
	K	SK	K	SK	K	SK
1	1111 1001	6	1121 2111	10	2000 0131	7
2	0001 0000	1	0012 1111	7	2110 0001	5
3	1101 0110	5	2211 1231	13	0100 0011	3
4	0011 1112	7	2111 1101	8	0010 1110	4
5	2123 1210	12	0011 1210	6	0000 0003	3
6	2011 3221	12	0001 1112	6	1011 0121	7
7	1111 1103	9	1010 0121	6	1121 2222	13
8	3111 0212	11	0012 2221	10	2211 1442	17
9	2112 0110	8	0110 0100	3	1111 1111	8
10	0001 1223	9	0010 0233	9	0010 0010	2
11	0223 4443	22	3123 3345	24	1011 1001	5
12	3322 2324	21	3333 4334	26	0000 1323	9
13	2121 1311	12	3111 2233	16	3221 1244	19
14	1000 0001	2	1111 1333	14	2223 4353	24
15	1112 2232	14	2312 1113	14	3221 3321	17
16	3110 1333	15	3212 2311	15	2122 1232	15
17	3332 2133	20	1222 1022	12	2101 1232	12
18	3111 0133	13	1221 2232	15	1211 1111	9
19	2232 2112	15	1211 1000	6	2111 0103	9
20	2212 2121	13	0112 0111	7	1322 3224	19
21	2111 2211	11	2112 1131	12	1011 1211	8
22	0121 1223	12	1122 2222	14	0001 1000	2
23	3334 5445	31	2121 1442	17	1001 1011	5
24	3423 3353	26	2112 1242	15	1110 1211	8
25	2222 3142	18	1111 2111	9	1111 1332	13
26	2122 1343	18	1001 0120	5	1101 1032	9
27	1111 1131	10	0000 1255	13	2000 1002	5
28	1012 1121	9	3322 1232	18	0111 3432	15
29	2111 2200	9	1121 2131	12	2101 1130	9
30	0002 1200	5	2111 1111	9	0011 1332	11
31	0212 3111	11			2101 1111	8

Three-hour-range E indices
based on power spectrum estimation(*)
Belsk, January - March, 2010

Day	January		February		March	
	K	SE	K	SE	K	SE
1	0000 0000	0	1022 3335	19	1011 1112	8
2	0010 0000	1	3212 2225	19	0001 2103	7
3	0001 1101	4	3123 2442	21	2102 3433	18
4	0011 0000	2	2100 0002	5	1321 2212	14
5	0000 1000	1	1000 0101	3	0001 2111	6
6	1001 0000	2	0001 2322	10	4100 0022	9
7	0000 0010	1	1000 0023	6	2321 0000	8
8	1000 0000	1	3101 0001	6	0111 0020	5
9	0001 0000	1	1011 0101	5	0001 1101	4
10	0011 1100	4	1111 0021	7	2111 3435	20
11	1122 3222	15	2212 2102	12	4233 2130	18
12	2111 0012	8	1311 1111	10	3332 3332	22
13	4211 1323	17	0010 0131	6	1001 0132	8
14	2001 2130	9	1000 1003	5	4111 2124	16
15	0100 0143	9	3222 2354	23	0000 0140	5
16	0001 0001	2	3222 0125	17	0121 1023	10
17	0000 0000	0	4211 0005	13	1322 0114	14
18	0001 1210	5	0002 2430	11	3200 1122	11
19	1000 0000	1	1100 1122	8	0010 0133	8
20	1011 2555	20	0000 0000	0	1220 2220	11
21	1221 1000	7	0000 0110	2	1001 0001	3
22	0201 1012	7	1202 0122	10	0000 0000	0
23	3112 1012	11	3101 0110	7	0000 0100	1
24	1112 2121	11	1210 0021	7	0001 1213	8
25	1011 1002	6	3000 0123	9	0212 1341	14
26	2101 0021	7	3000 0000	3	0112 2003	9
27	0000 0001	1	0000 0120	3	2211 0100	7
28	0000 1231	7	0020 0101	4	0222 1311	12
29	1000 0001	2			2011 1203	10
30	2300 1122	11			2211 1233	15
31	2111 1121	10			3101 0113	10

* - see literature: Reda and Jankowski, 2004

Three-hour-range E indices
based on power spectrum estimation(*)
Belsk, April – June, 2010

Day	April K	April SE	May K	May SE	June K	June SE
1	3311 4324	21	1101 0210	6	4222 3343	23
2	3243 2342	23	1124 6566	31	2311 2233	17
3	3111 2543	20	5333 5554	33	1223 4234	21
4	3231 2355	24	4222 3234	22	5424 2213	23
5	3347 5655	38	3211 1441	17	1120 1222	11
6	5444 5655	38	1222 2442	19	2111 2232	14
7	5154 4455	33	4212 3332	20	2101 2221	11
8	4223 1025	19	3211 2121	13	2011 1210	8
9	3211 1231	14	2100 0110	5	0112 0211	8
10	1000 1011	4	0000 1231	7	2223 1111	13
11	1010 4545	20	3122 2141	16	2201 2201	10
12	6432 2441	26	1113 3102	12	0101 0010	3
13	0011 0103	6	1000 0210	4	0223 2212	14
14	2001 1236	15	0101 1210	6	1111 2111	9
15	3311 2200	12	1111 0000	4	1113 2334	18
16	1101 0110	5	1110 1221	9	4434 3443	29
17	1010 0033	8	2112 2332	16	2232 1232	17
18	1001 0011	4	2111 2111	10	1121 1310	10
19	1112 1111	9	1112 4322	16	0101 0121	6
20	0111 2221	10	4212 4413	21	0001 1102	5
21	1222 3221	15	2111 1110	8	1131 1121	11
22	0111 0142	10	0112 1000	5	1212 1311	12
23	5410 1124	18	1000 0000	1	0111 0110	5
24	4211 1110	11	0000 1100	2	0011 2331	11
25	0101 0101	4	1111 1114	11	3112 2334	19
26	0001 0100	2	1212 2211	12	2433 3334	25
27	3110 0222	11	2111 1100	7	3334 3333	25
28	1010 1101	5	2212 4134	19	2222 2431	18
29	3401 1010	10	2443 4453	29	1221 2235	18
30	1100 0111	5	2243 3555	29	4333 4334	27
31			2333 4443	26		

* - see literature: Reda and Jankowski, 2004

Three-hour-range E indices
based on power spectrum estimation(*)
Belsk, July - September, 2010

Day	July		August		September	
	K	SE	K	SE	K	SE
1	1312 2543	21	0012 1112	8	0010 1234	11
2	2222 2233	18	1211 2213	13	2232 1320	15
3	2202 2312	14	3222 2456	26	2001 0010	4
4	2011 1211	9	6445 5465	39	0000 0011	2
5	0011 1011	5	4211 2122	15	0001 0113	6
6	1110 0110	5	2211 2211	12	2321 1233	17
7	0001 0111	4	0111 0101	5	3303 2423	20
8	0011 0121	6	0101 1120	6	3111 4534	22
9	2222 2110	12	3322 3332	21	1002 3302	11
10	0000 0100	1	2222 2214	17	1001 0000	2
11	0000 2312	8	4221 2221	16	0011 1000	3
12	1111 2122	11	3111 1112	11	0010 0000	1
13	0000 1100	2	1111 1111	8	0001 1210	5
14	1113 2324	17	0001 1211	6	1133 1334	19
15	4222 2311	17	2211 2123	14	4213 0012	13
16	0111 2100	6	2111 1331	13	1010 2352	14
17	0000 1100	2	1110 0332	11	2223 2222	17
18	0011 1100	4	1211 1000	6	3111 0111	9
19	0000 1211	5	1111 0001	5	1101 0111	6
20	1021 1222	11	0001 1102	5	1101 0130	7
21	1211 2211	11	0100 0111	4	1321 0000	7
22	1012 2211	10	0000 0000	0	1000 0110	3
23	1123 2323	17	0001 1224	10	0122 2122	12
24	2110 1223	12	4443 4544	32	2242 3535	26
25	3212 1223	16	4423 3524	27	3211 1121	12
26	2212 1123	14	3232 2222	18	1011 2333	14
27	3334 3344	27	2333 3514	24	2011 2244	16
28	5223 4333	25	2132 2123	16	2153 3231	20
29	2222 3112	15	1011 0001	4	1312 1110	10
30	2112 2333	17	0000 0000	0	0001 0001	2
31	2101 3311	12	0010 1112	6		

* - see literature: Reda and Jankowski, 2004

Three-hour-range E indices
based on power spectrum estimation(*)
Belsk, October - December, 2010

Day	October		November		December	
	K	SE	K	SE	K	SE
1	1001 0000	2	0010 1001	3	2000 0040	6
2	0000 0000	0	0011 0100	3	3110 0001	6
3	1001 0000	2	2211 1231	13	0000 0001	1
4	0010 0012	4	2001 1100	5	0000 0020	2
5	2132 1210	12	0000 1200	3	0000 0003	3
6	1012 3231	13	0000 1002	3	0000 0111	3
7	1001 2002	6	1000 0030	4	1011 2232	12
8	3111 0101	8	0011 2220	8	2211 1552	19
9	2112 0210	9	0100 0000	1	1001 0000	2
10	0000 0113	5	0000 0134	8	0000 0000	0
11	0224 4444	24	3114 4455	27	1010 0001	3
12	3422 2424	23	4334 4334	28	0000 0423	9
13	2120 1300	9	3011 1242	14	3221 1353	20
14	0000 0001	1	1101 1334	14	2223 4464	27
15	0012 1242	12	2313 1104	15	3212 3321	17
16	3110 0344	16	4111 2301	13	2222 1232	16
17	2432 2133	20	1221 0012	9	2100 1132	10
18	3111 0033	12	1121 2132	13	1201 1011	7
19	2332 1102	14	1101 0000	3	2101 0003	7
20	2101 2121	10	0111 0000	3	0322 2125	17
21	2101 1210	8	2002 1132	11	1000 0210	4
22	0121 1223	12	1122 2212	13	0000 0000	0
23	3234 6546	33	2131 1452	19	0000 0000	0
24	4423 3453	28	2112 2242	16	0100 1210	5
25	2222 3141	17	1111 2000	6	1111 1332	13
26	3112 1343	18	0000 0030	3	1000 0021	4
27	1011 1040	8	0000 1264	13	3000 0003	6
28	0011 1120	6	4321 1233	19	0101 3542	16
29	2110 1100	6	1011 2140	10	2101 0140	9
30	0002 1100	4	1011 1111	7	0001 1332	10
31	0112 2101	8			2101 1210	8

* - see literature: Reda and Jankowski, 2004

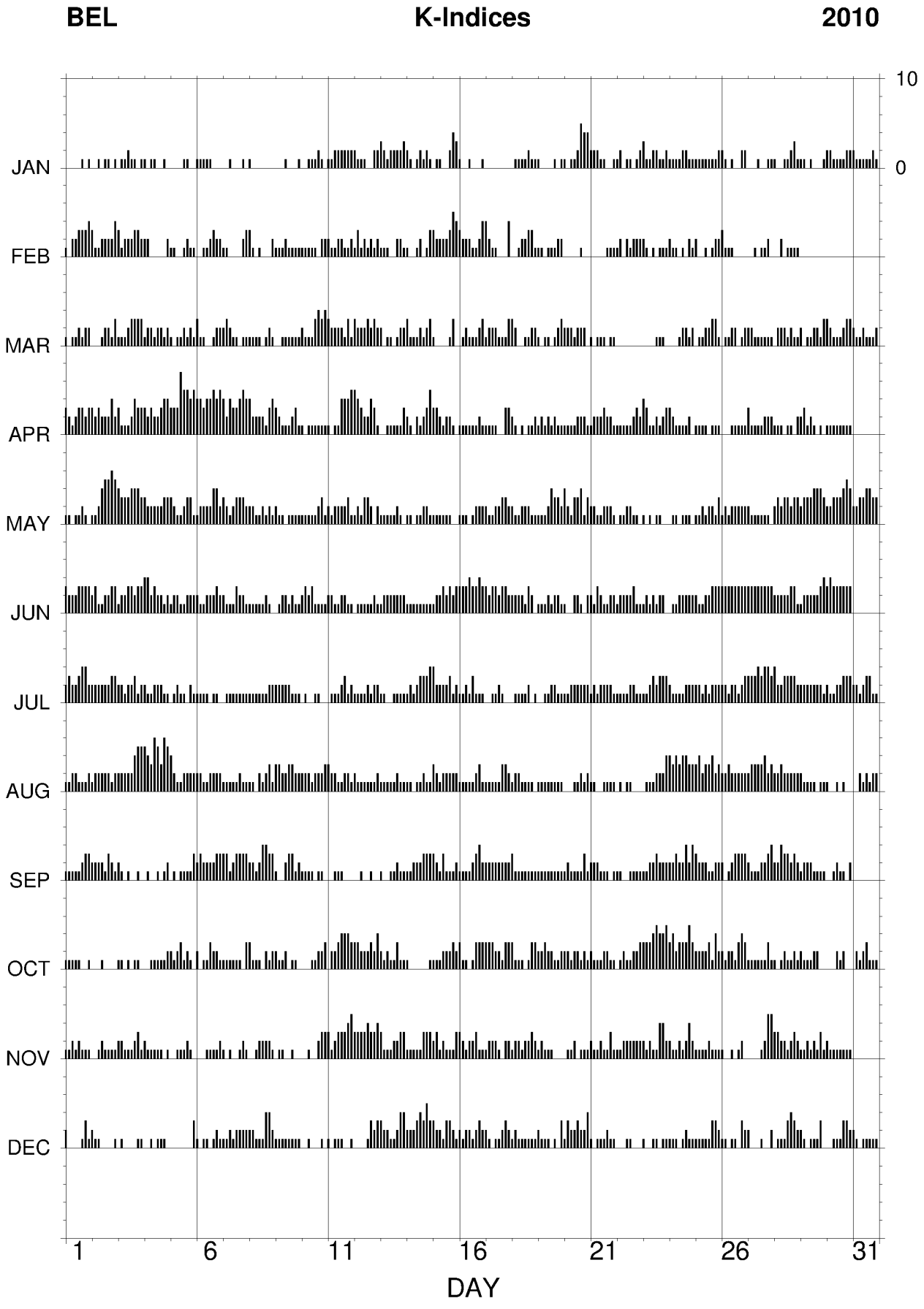

Fig. 4. K-indices in graphical form, Belsk 2010.

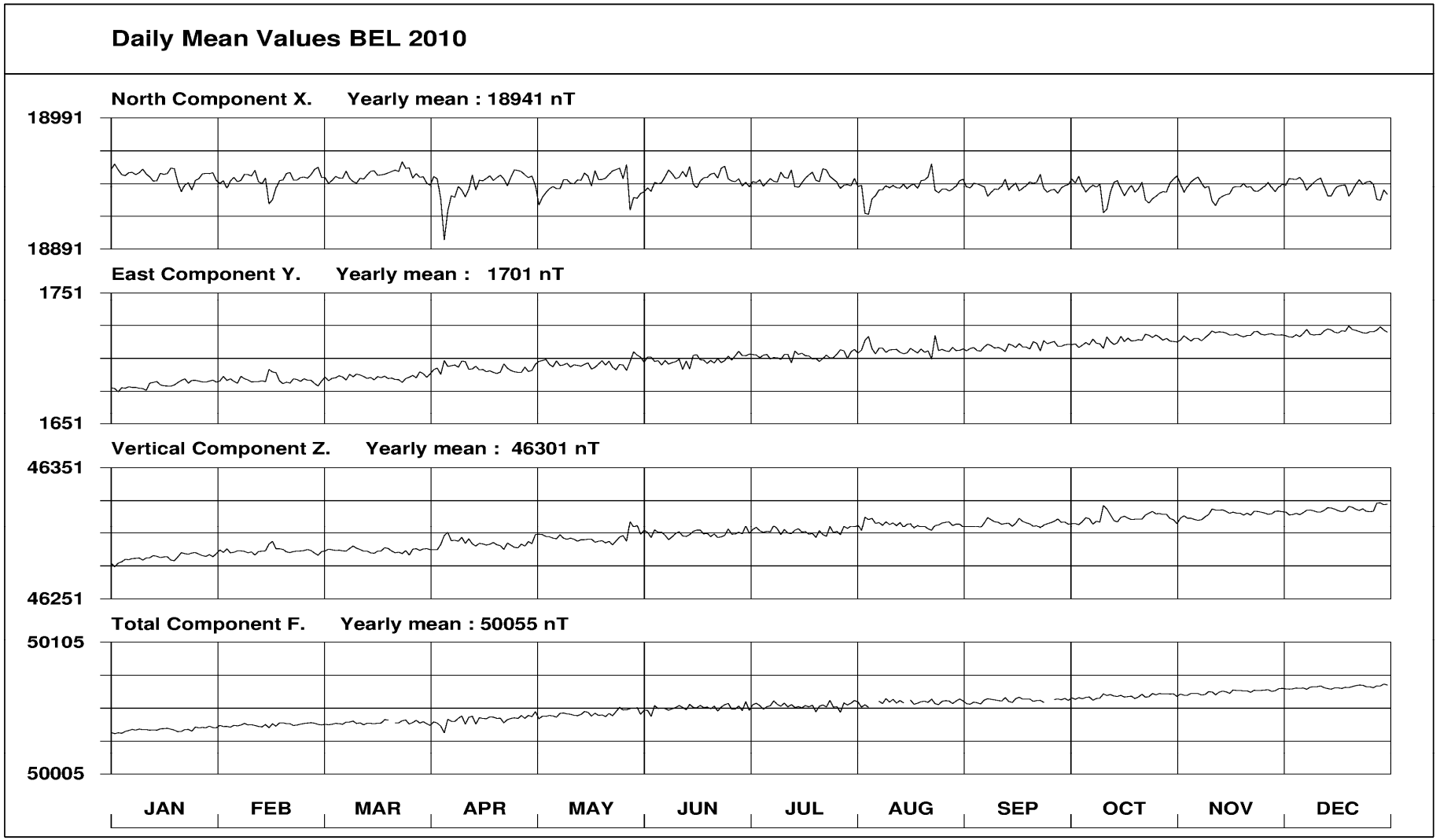

Fig. 5. Daily mean data plot for Belsk 2010.

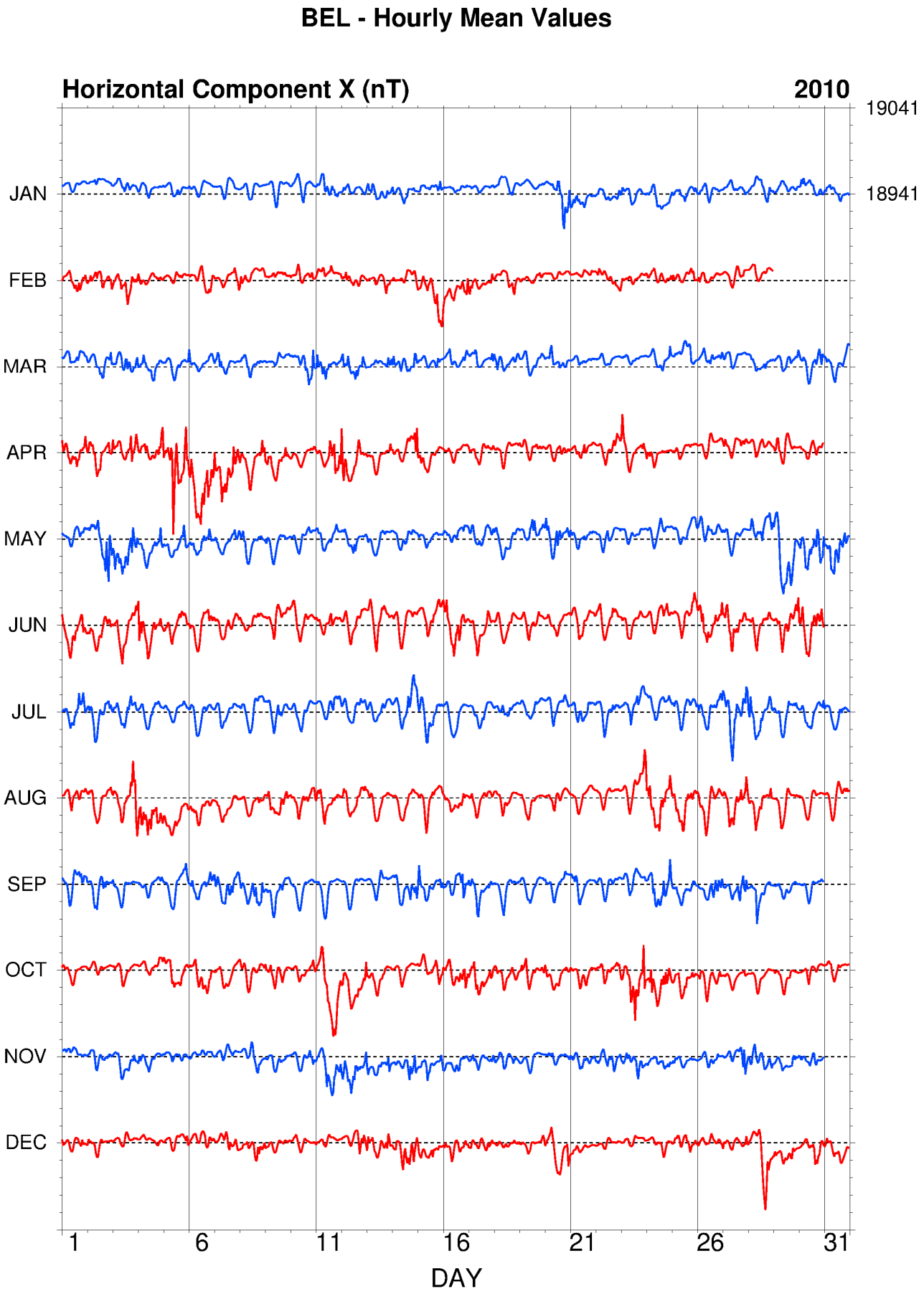

Fig. 6. Hourly mean data plot of X component for Belsk 2010.

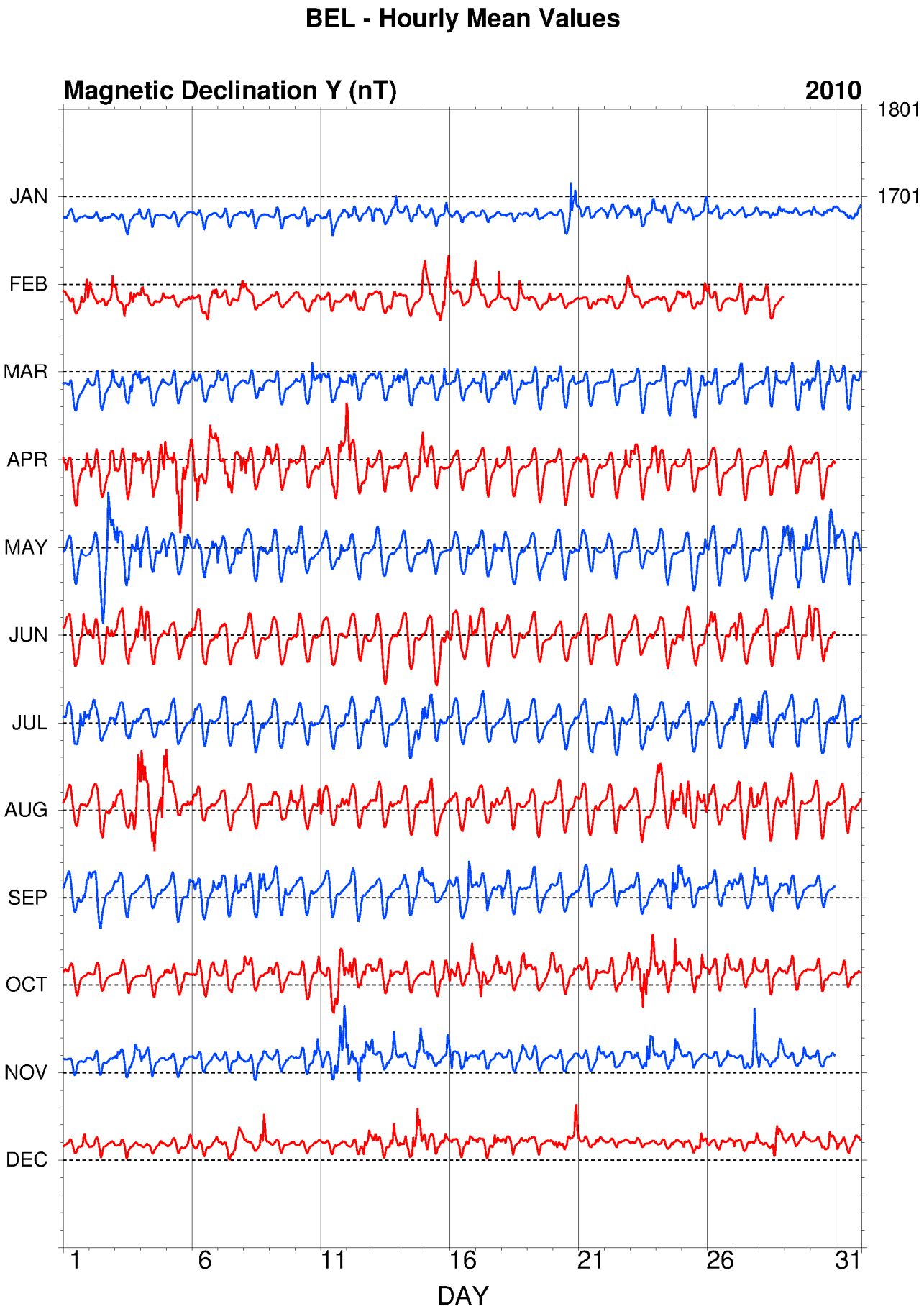

Fig. 7. Hourly mean data plot of Y component for Belsk 2010.

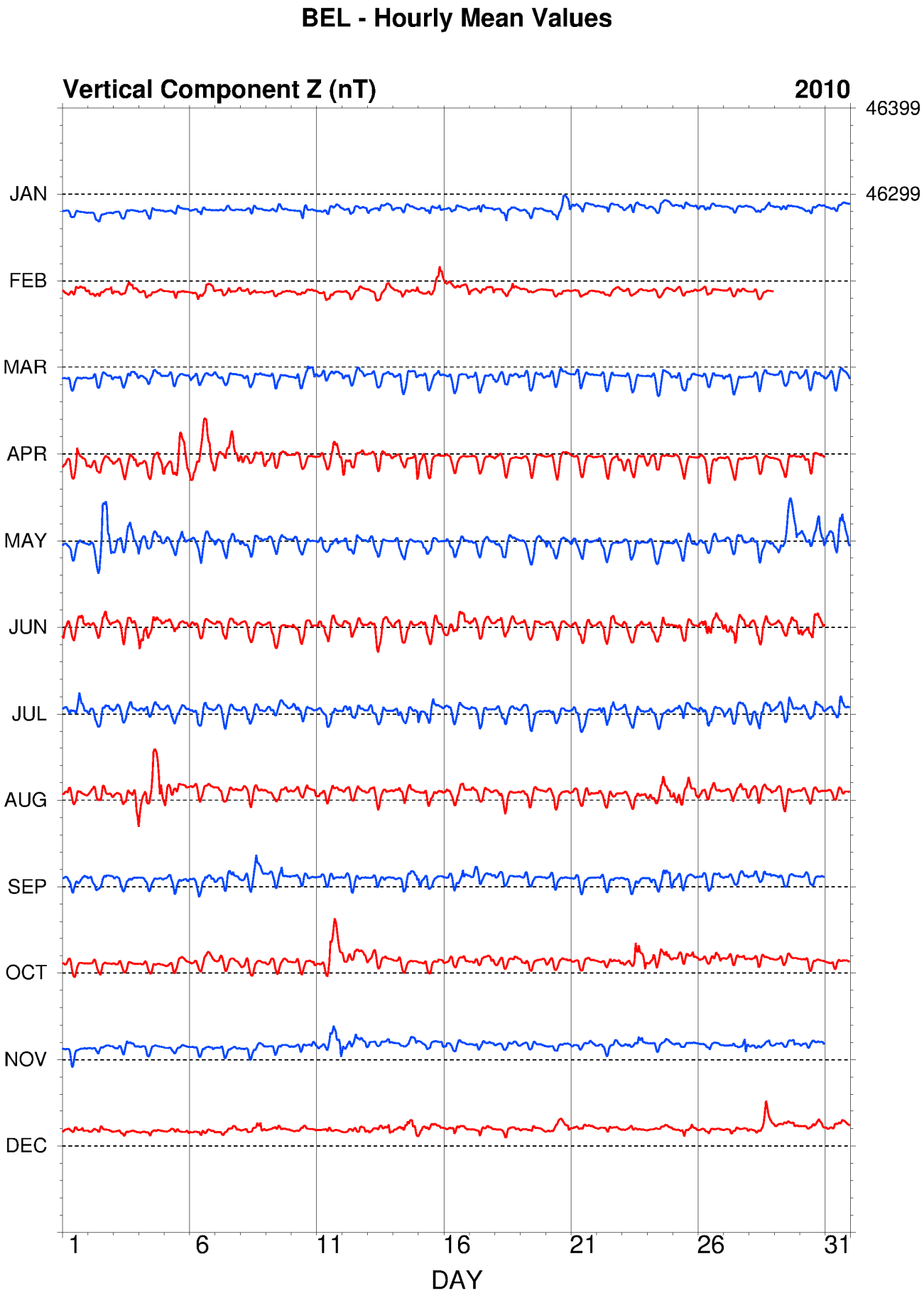

Fig. 8. Hourly mean data plot of Z component for Belsk 2010.

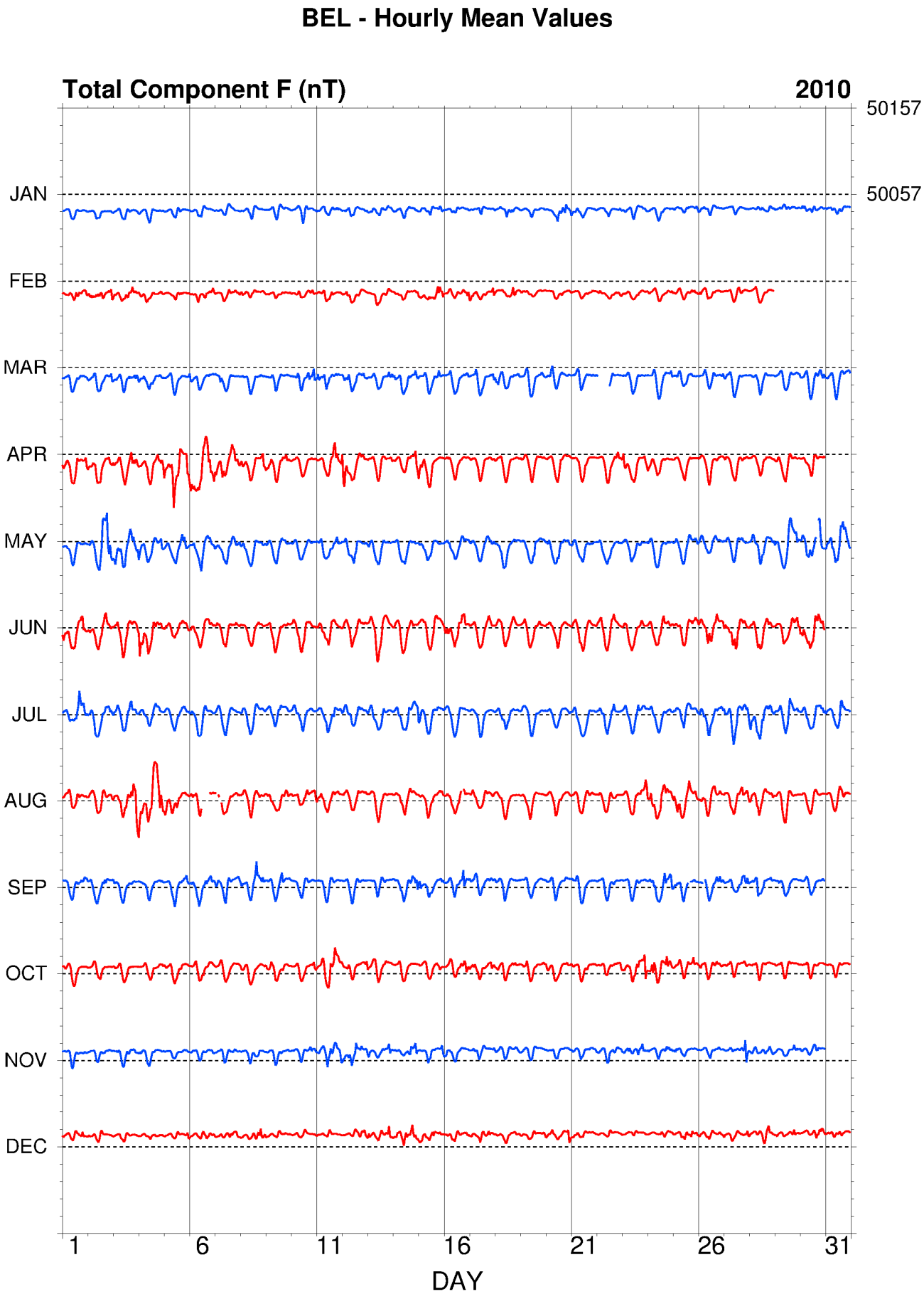

Fig. 9. Hourly mean data plot of F component for Belsk 2010.

7. TABLES AND PLOTS FOR HEL OBSERVATORY

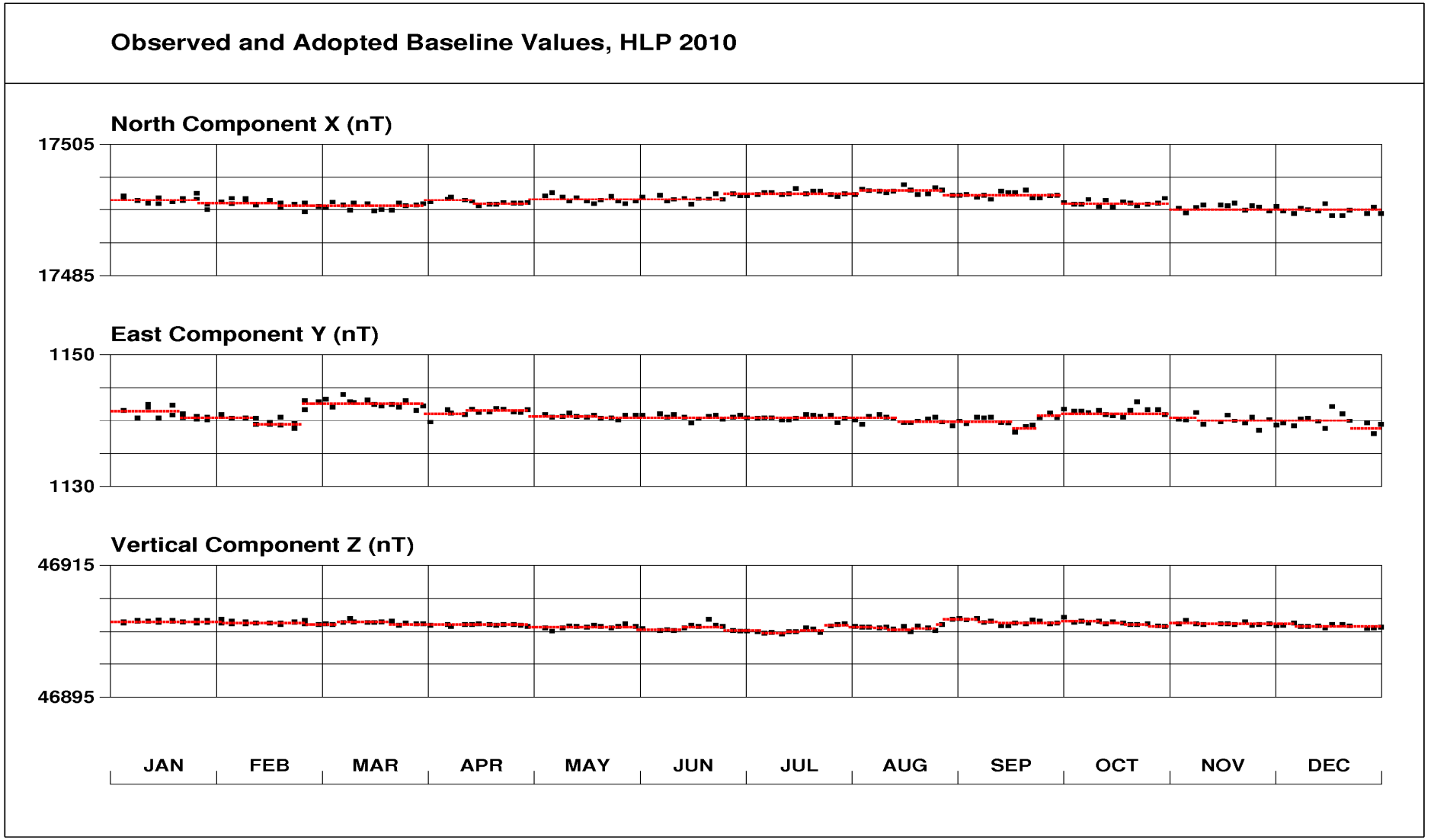

Fig. 10. Base values of set 1, Hel 2010.

Annual mean values of magnetic elements in Hel Observatory

No	Year	D [º ‘]	H [nT]	Z [nT]	X [nT]	Y [nT]	I [º ‘]	F [nT]
1	1953	-0 14.5	17388	45327	17388	-73	69 00.8	48548
2	1954	-0 10.0	17394	45374	17394	-51	69 01.5	48594
3	1955	-0 04.2	17379	45430	17379	-21	69 03.9	48640
4	1956	0 03.9	17371	45450	17371	20	69 05.0	48656
5	1957	0 05.7	17372	45475	17372	29	69 05.5	48680
6	1958	0 10.2	17380	45535	17380	52	69 06.5	48739
7	1959	0 14.7	17390	45565	17390	74	69 06.6	48771
8	1960	0 17.6	17402	45602	17402	89	69 06.8	48810
9	1961	0 19.8	17422	45625	17422	100	69 06.0	48838
10	1962	0 22.7	17438	45647	17438	115	69 05.5	48864
11	1963	0 26.5	17449	45663	17448	134	69 05.2	48883
12	1964	0 28.6	17464	45676	17463	145	69 04.6	48901
13	1965	0 30.0	17476	45692	17475	152	69 04.2	48920
14	1966	0 31.6	17485	45710	17484	161	69 04.0	48940
15	1967	0 33.3	17492	45743	17491	169	69 04.4	48973
16	1968	0 34.4	17502	45769	17501	175	69 04.4	49001
17	1969	0 34.3	17524	45792	17523	175	69 03.5	49030
18	1970	0 34.8	17542	45824	17541	178	69 03.2	49067
19	1971	0 35.7	17565	45849	17564	182	69 02.3	49098
20	1972	0 36.1	17579	45880	17578	184	69 02.1	49132
21	1973	0 38.5	17595	45912	17594	197	69 01.9	49168
22	1974	0 41.9	17606	45951	17605	215	69 02.2	49208
23	1975	0 45.0	17625	45984	17623	231	69 01.7	49246
24	1976	0 49.6	17639	46015	17637	254	69 01.6	49280
25	1977	0 55.0	17651	46045	17649	282	69 01.5	49312
26	1978	1 00.2	17646	46085	17643	309	69 02.9	49349
27	1979	1 05.1	17651	46112	17648	334	69 03.2	49375
28	1980	1 11.5	17653	46127	17649	367	69 03.5	49390
29	1981	1 17.5	17637	46156	17632	398	69 05.2	49411
30	1982	1 23.4	17620	46184	17615	427	69 07.1	49431
31	1983	1 28.6	17614	46200	17608	454	69 07.8	49444
32	1984	1 33.5	17602	46219	17596	479	69 09.1	49457
33	1985	1 37.9	17591	46239	17584	501	69 10.3	49472

34	1986	1 42.7	17579	46263	17571	525	69 11.6	49490
35	1987	1 46.3	17572	46285	17564	543	69 12.6	49508
36	1988	1 51.0	17555	46318	17546	567	69 14.6	49533
37	1989	1 55.5	17535	46352	17525	589	69 16.7	49558
38	1990	1 58.4	17527	46374	17516	604	69 17.8	49575
39	1991	2 00.6	17513	46398	17502	614	69 19.3	49593
40	1992	2 03.9	17515	46416	17504	631	69 19.6	49611
41	1993	2 10.0	17516	46428	17503	662	69 19.8	49622
42	1994	2 15.9	17512	46456	17498	692	69 20.7	49647
43	1995	2 21.3	17518	46481	17503	720	69 21.0	49672
44	1996	2 26.6	17523	46506	17507	747	69 21.2	49698
45	1997	2 32.9	17519	46539	17502	779	69 22.3	49727
46	1998	2 39.8	17512	46581	17493	814	69 23.8	49764
47	1999	2 45.4	17511	46615	17491	842	69 24.7	49796
48	2000	2 51.9	17507	46657	17485	875	69 25.9	49833
49	2001	2 57.7	17515	46692	17492	905	69 26.2	49869
50	2002	3 03.7	17520	46730	17495	936	69 26.9	49906
51	2003	3 10.8	17519	46777	17492	972	69 28.1	49950
52	2004	3 16.6	17529	46809	17500	1002	69 28.2	49983
53	2005	3 22.3	17531	46843	17501	1031	69 28.9	50016
J	2006.0	0 -1.5	-2	9	-2	-8	0 0.6	7
54	2006	3 29.9	17550	46859	17517	1071	69 28.1	50038
55	2007	3 36.7	17559	46887	17524	1106	69 28.2	50067
56	2008	3 43.8	17564	46917	17527	1143	69 28.5	50097
57	2009	3 51.3	17571	46945	17531	1181	69 28.8	50126
58	2010	4 00.5	17568	46980	17525	1228	69 29.8	50157

Note: Since 2006 the observatory has stopped introducing the so-called historical corrections. The corrections were related, among other things, with the variable location of the instruments for absolute measurements. In the 2006.0 line we include the jump value J relating to the neglect of historical corrections. The jump values are defined as follows:

jump value J = old site value - new site value

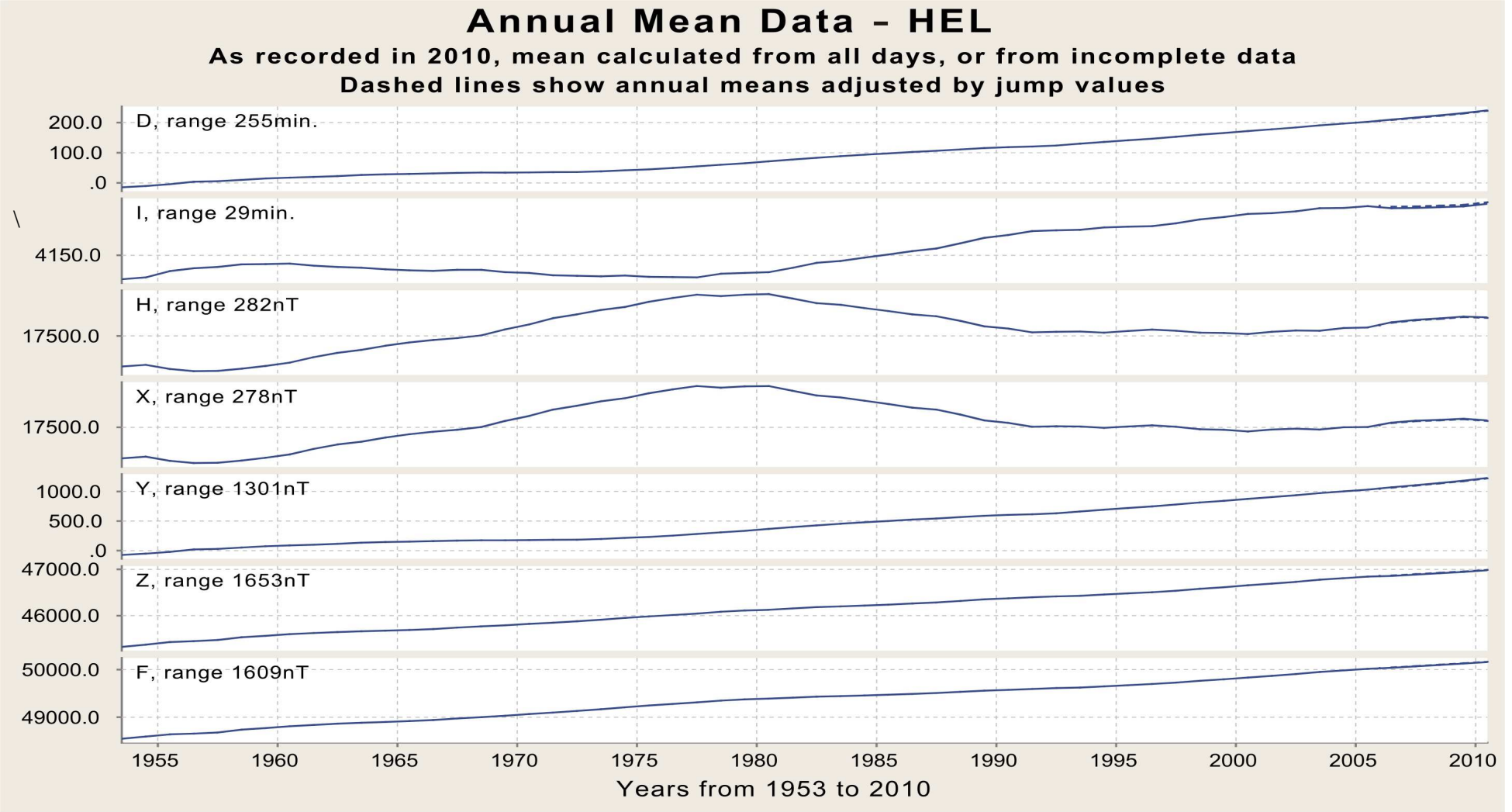

Fig. 11. Secular changes of H, X, Y, Z, F, D and I at Hel.

MONTHLY AND YEARLY MEAN VALUES OF MAGNETIC ELEMENTS

HLP 2010

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
NORTH COMPONENT: 17000 + ... in nT													
All days	529	525	529	522	526	528	528	522	523	520	521	522	525
Quiet days	532	530	530	527	528	531	527	525	524	526	525	526	528
Disturbed days	526	518	527	506	515	526	527	518	520	510	515	516	519
EAST COMPONENT: 1000 + ... in nT													
All days	205	210	215	220	222	226	229	233	236	242	245	248	228
Quiet days	204	209	214	219	222	225	229	233	236	239	244	247	227
Disturbed days	206	212	215	221	226	228	230	237	238	242	248	251	230
VERTICAL COMPONENT: 46500 + ... in nT													
All days	462	467	467	472	476	479	480	484	486	491	493	496	480
Quiet days	461	466	467	473	475	478	480	484	486	487	491	495	479
Disturbed days	463	470	468	474	483	478	479	483	487	496	495	499	48

Three-hour-range K indices
Hel, January - March, 2010
The limit of K=9 is 550

Day	January		February		March	
	K	SK	K	SK	K	SK
1	0000 0001	1	1022 2324	16	1011 2122	10
2	0000 0100	1	3112 2214	16	0002 2112	8
3	0102 2101	7	2112 2331	15	1112 2333	16
4	0011 0000	2	2100 0002	5	1221 2211	12
5	0000 0000	0	0200 0101	4	1001 2111	7
6	1001 0000	2	0001 2322	10	3000 0112	7
7	0000 0010	1	1100 0022	6	2221 1010	9
8	1000 0000	1	3101 0002	7	0111 0011	5
9	0000 0000	0	1012 1111	8	0011 2111	7
10	0001 1200	4	1111 1021	8	1111 3334	17
11	1123 2222	15	2112 2112	12	3222 2121	15
12	2111 0012	8	1312 1112	12	3222 2222	17
13	3211 1223	15	0010 0121	5	1011 0122	8
14	2001 2121	9	1001 2003	7	3111 2113	13
15	0000 0133	7	2212 2244	19	1000 0130	5
16	0000 0001	1	3222 1113	15	0122 1113	11
17	0000 0000	0	4211 0004	12	1222 1113	13
18	0011 1211	7	0012 2330	11	3210 1122	12
19	1000 0001	2	1001 1122	8	0011 1122	8
20	1011 2543	17	0000 0000	0	1121 2220	11
21	1121 1001	7	0000 0111	3	1001 1001	4
22	0101 1012	6	1212 1122	12	0000 0000	0
23	3102 2112	12	2001 0000	3	0000 1110	3
24	1112 2111	10	1110 1021	7	0001 2212	8
25	1011 1101	6	2001 0122	8	0112 2331	13
26	2101 0022	8	2001 0000	3	0112 2002	8
27	0001 0001	2	0000 0110	2	1212 1110	9
28	0000 1120	4	0011 1101	5	0222 1211	11
29	1101 0001	4			2111 2203	12
30	2211 1122	12			2111 1133	13
31	2111 1121	10			2102 1112	10

Three-hour-range K indices
Hel, April - June, 2010
The limit of K=9 is 550

Day	April		May		June	
	K	SK	K	SK	K	SK
1	3212 3323	19	1001 1210	6	3222 3233	20
2	3232 2342	21	1124 5555	28	2221 2222	15
3	2112 2433	18	4333 4443	28	1123 3333	19
4	3231 2244	21	3222 2233	19	4423 2212	20
5	3336 5545	34	3202 2331	16	1111 1222	11
6	4434 4545	33	0222 2332	16	2011 1232	12
7	4243 3454	29	3222 3332	20	2101 2221	11
8	3223 2134	20	2211 2111	11	1001 1210	6
9	2211 1221	12	1000 1111	5	1111 1211	9
10	1011 1112	8	0002 1231	9	2213 2111	13
11	1010 4444	18	2112 2131	13	1201 2201	9
12	5432 2431	24	1213 3202	14	0101 0110	4
13	0011 1003	6	1000 1210	5	0223 3211	14
14	2002 1225	14	1001 1220	7	1111 1111	8
15	3322 2210	15	1101 1100	5	1123 2323	17
16	1111 1110	7	1101 1222	10	3334 3343	26
17	0111 0022	7	2112 2332	16	2223 1332	18
18	1001 0112	6	2112 2211	12	1222 1220	12
19	1112 2211	11	1113 4332	18	0111 1221	9
20	0012 2221	10	3213 3312	18	0002 2201	7
21	1222 3221	15	1111 2210	9	1121 1132	12
22	1111 1232	12	0122 1110	8	1212 2311	13
23	4311 2123	17	1000 0001	2	1111 1210	8
24	3212 2110	12	0010 1100	3	0012 2321	11
25	1111 0101	6	1112 2213	13	2112 2333	17
26	0001 1111	5	1212 2212	13	3333 3323	23
27	2011 1322	12	2001 1100	5	3334 3223	23
28	1100 2101	6	2323 3233	21	1122 2321	14
29	2311 1010	9	2333 4443	26	1222 3224	18
30	1001 1101	5	2233 3454	26	4433 3333	26
31			2233 4433	24		

Three-hour-range K indices
Hel, July - September, 2010
The limit of K=9 is 550

Day	July		August		September	
	K	SK	K	SK	K	SK
1	2222 3442	21	0112 1111	8	0101 1223	10
2	2222 3223	18	1222 2212	14	2122 1311	13
3	2203 3312	16	2222 2445	23	2001 1010	5
4	2112 2211	12	5436 5455	37	0000 1011	3
5	0112 1011	7	4212 3221	17	0001 0113	6
6	1011 1100	5	1212 2221	13	2212 2222	15
7	0100 1111	5	1111 1201	8	3312 3323	20
8	0010 1122	7	0102 1221	9	2212 4423	20
9	2112 2111	11	2222 3422	19	1012 3302	12
10	0000 1100	2	2211 2223	15	1011 0000	3
11	0110 2312	10	3221 1221	14	0011 1000	3
12	1101 2112	9	2101 1112	9	0011 1000	3
13	0000 1100	2	1111 1111	8	1001 1210	6
14	1212 2324	17	0102 1211	8	1122 2333	17
15	4222 2311	17	2212 2222	15	3113 1102	12
16	0111 3101	8	1111 1231	11	1011 2342	14
17	0001 1100	3	1111 1232	12	2223 2222	17
18	0011 1201	6	2221 1100	9	3111 1111	10
19	0001 1211	6	1101 1001	5	1111 1111	8
20	1012 3322	14	0001 1212	7	0111 1130	8
21	1211 2221	12	0000 1111	4	1221 1001	8
22	1011 2211	9	0001 1000	2	1100 1111	6
23	1123 2333	18	0000 2214	9	1123 3122	15
24	2111 2222	13	3343 4423	26	2232 3424	22
25	2112 2212	13	3423 3423	24	3322 2121	16
26	2122 1122	13	2232 3222	18	1012 3233	15
27	3324 3443	26	2333 3413	22	2011 2233	14
28	4223 3322	21	2233 2222	18	2143 3222	19
29	1222 3221	15	1011 1001	5	1212 1110	9
30	2111 2423	16	0001 0000	1	0002 2101	6
31	2212 3311	15	0011 2112	8		

Three-hour-range K indices
Hel, October - December, 2010
The limit of K=9 is 550

Day	October		November		December	
	K	SK	K	SK	K	SK
1	1001 0000	2	1021 2011	8	2000 0031	6
2	0000 0000	0	0012 1010	5	2110 0001	5
3	1101 0000	3	2111 1121	10	0000 0011	2
4	0010 1011	4	2001 1100	5	0000 0010	1
5	2122 1210	11	0001 1210	5	0000 0003	3
6	2011 3121	11	0000 1112	5	0000 0121	4
7	1011 1002	6	1000 0120	4	1121 2222	13
8	3111 0112	10	0011 2221	9	2211 1432	16
9	1112 0110	7	0100 0000	1	0001 0001	2
10	0001 1112	6	0000 0223	7	0000 0000	0
11	0124 4443	22	3113 3344	22	1010 0001	3
12	3322 2323	20	3333 3323	23	0000 1323	9
13	2121 1200	9	2111 1133	13	3121 1243	17
14	0001 0001	2	2101 1333	14	2222 4343	22
15	1012 2232	13	2312 0113	13	2211 2321	14
16	3110 1233	14	3121 2211	13	2112 0222	12
17	2322 1133	17	1221 1022	11	2101 1121	9
18	3111 1033	13	1121 2122	12	1110 1011	6
19	2232 2112	15	1101 0000	3	2100 0102	6
20	2112 2121	12	0111 0011	5	1322 2114	16
21	1111 1211	9	1101 1121	8	1001 0100	3
22	0011 1223	10	1122 2212	13	0001 0000	1
23	3334 5434	29	2121 1442	17	0000 0001	1
24	3423 3353	26	2111 1232	13	1110 1110	6
25	2222 3131	16	1111 1000	5	1111 1232	12
26	2122 1343	18	0000 0020	2	1100 0022	6
27	1111 1131	10	0001 0155	12	2000 0002	4
28	1012 1121	9	3321 1132	16	1111 3431	15
29	1110 1100	5	1111 2130	10	2111 1130	10
30	0002 1200	5	1111 1111	8	0001 1221	7
31	0112 3111	10			2101 0110	6

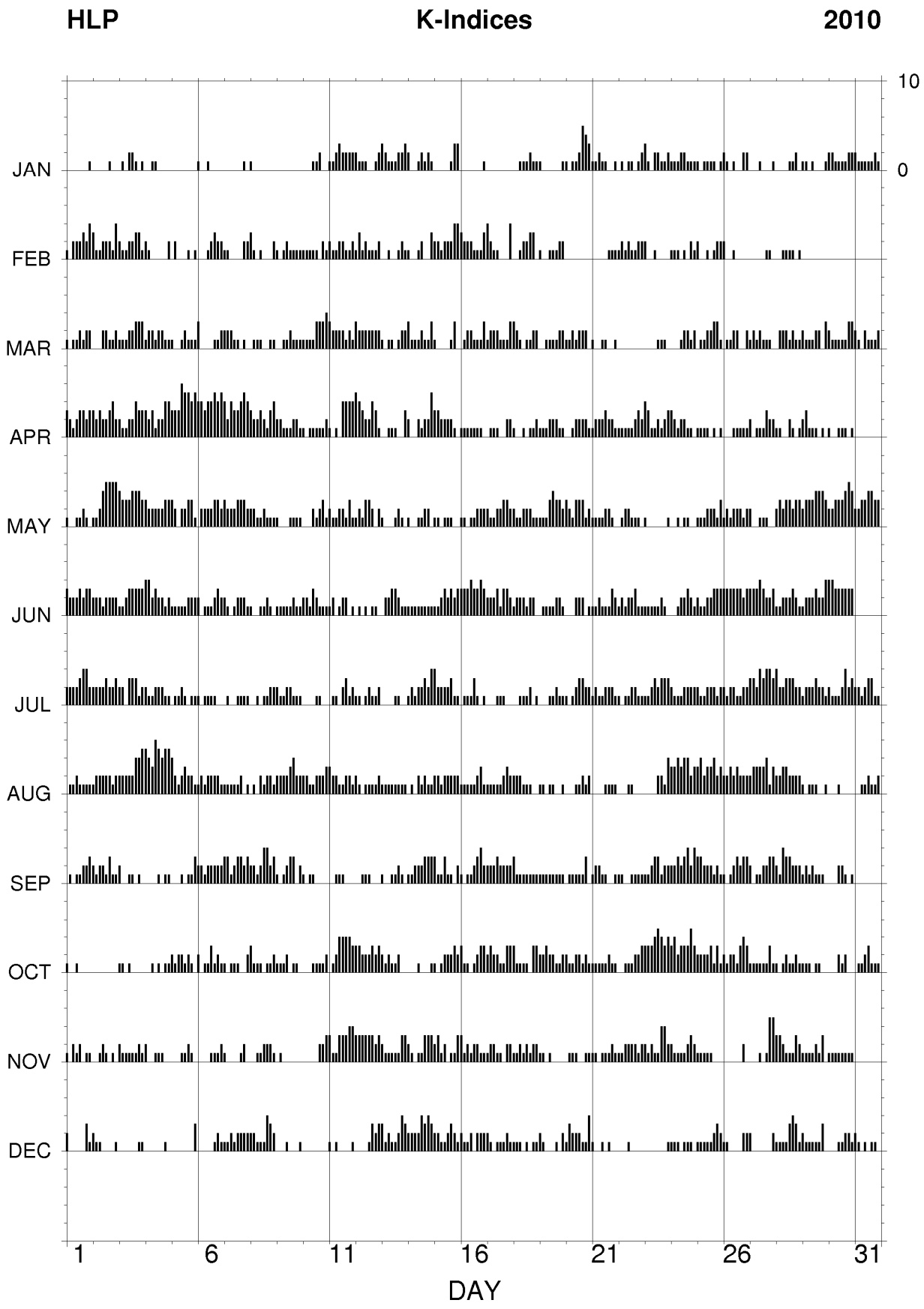

Fig. 12. K-indices in graphical form, Hel 2010.

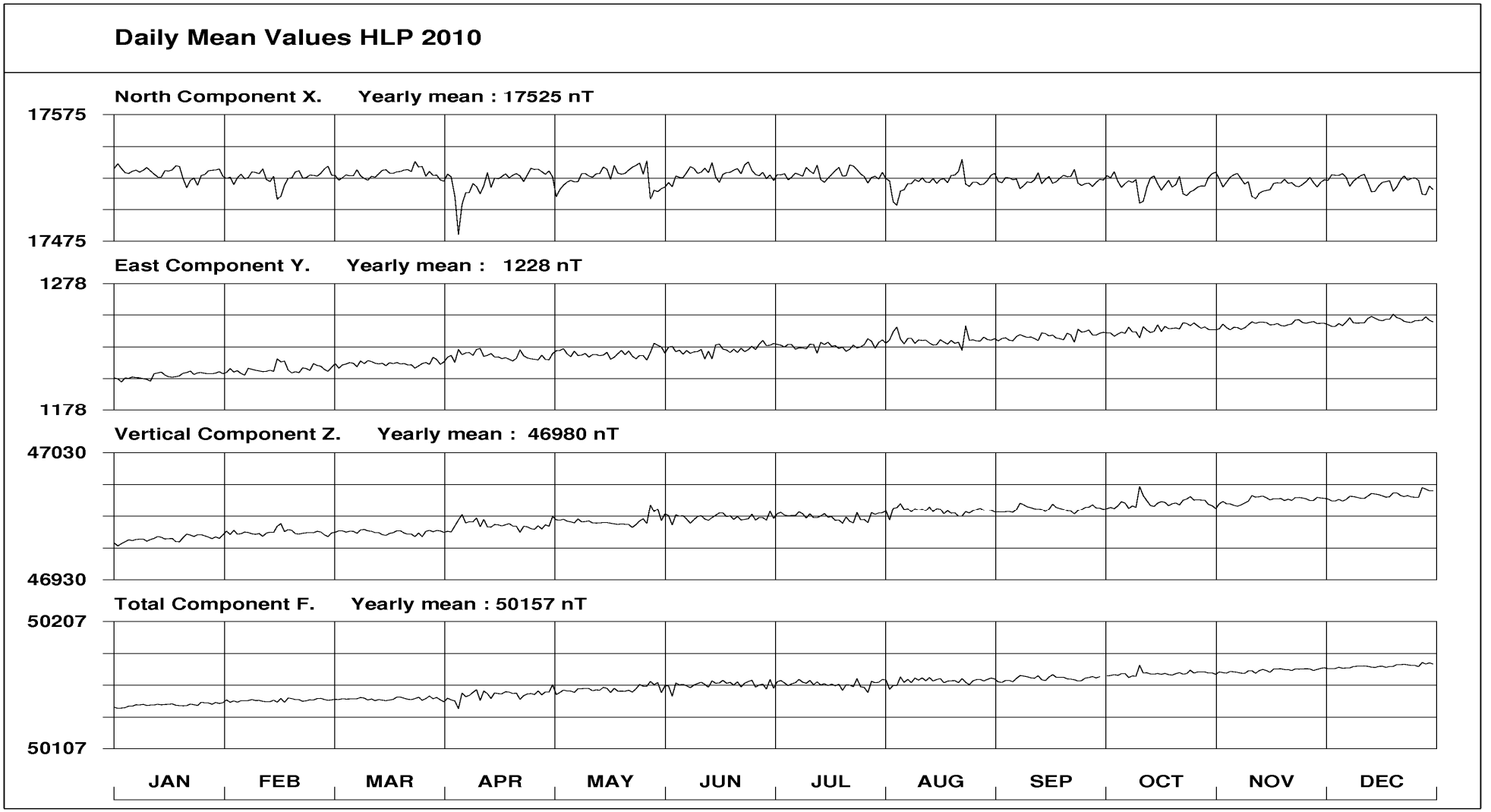

Fig. 13. Daily mean data plot for Hel 2010.

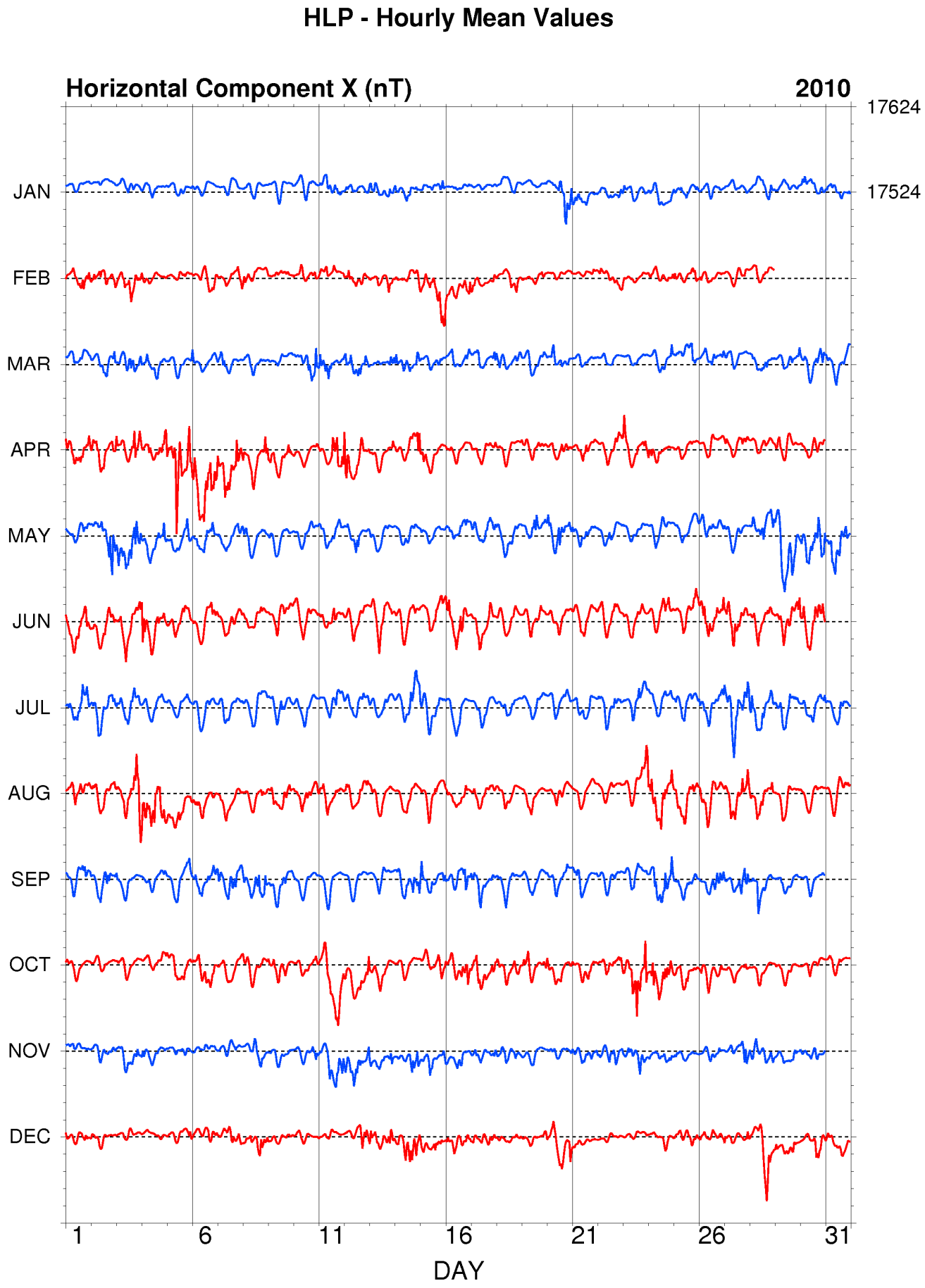

Fig. 14. Hourly mean data plot of X component for Hel 2010.

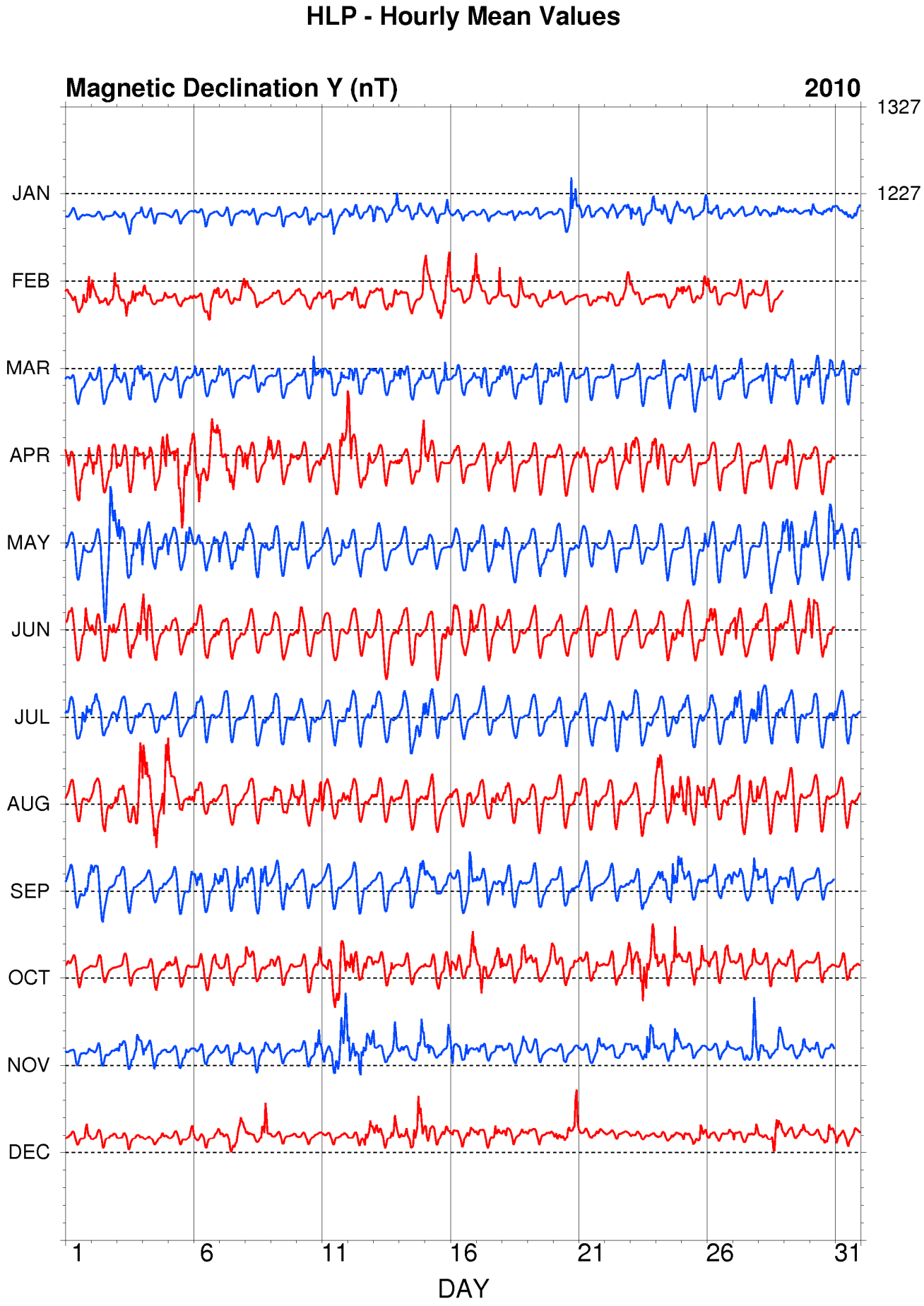

Fig. 15. Hourly mean data plot of Y component for Hel 2010.

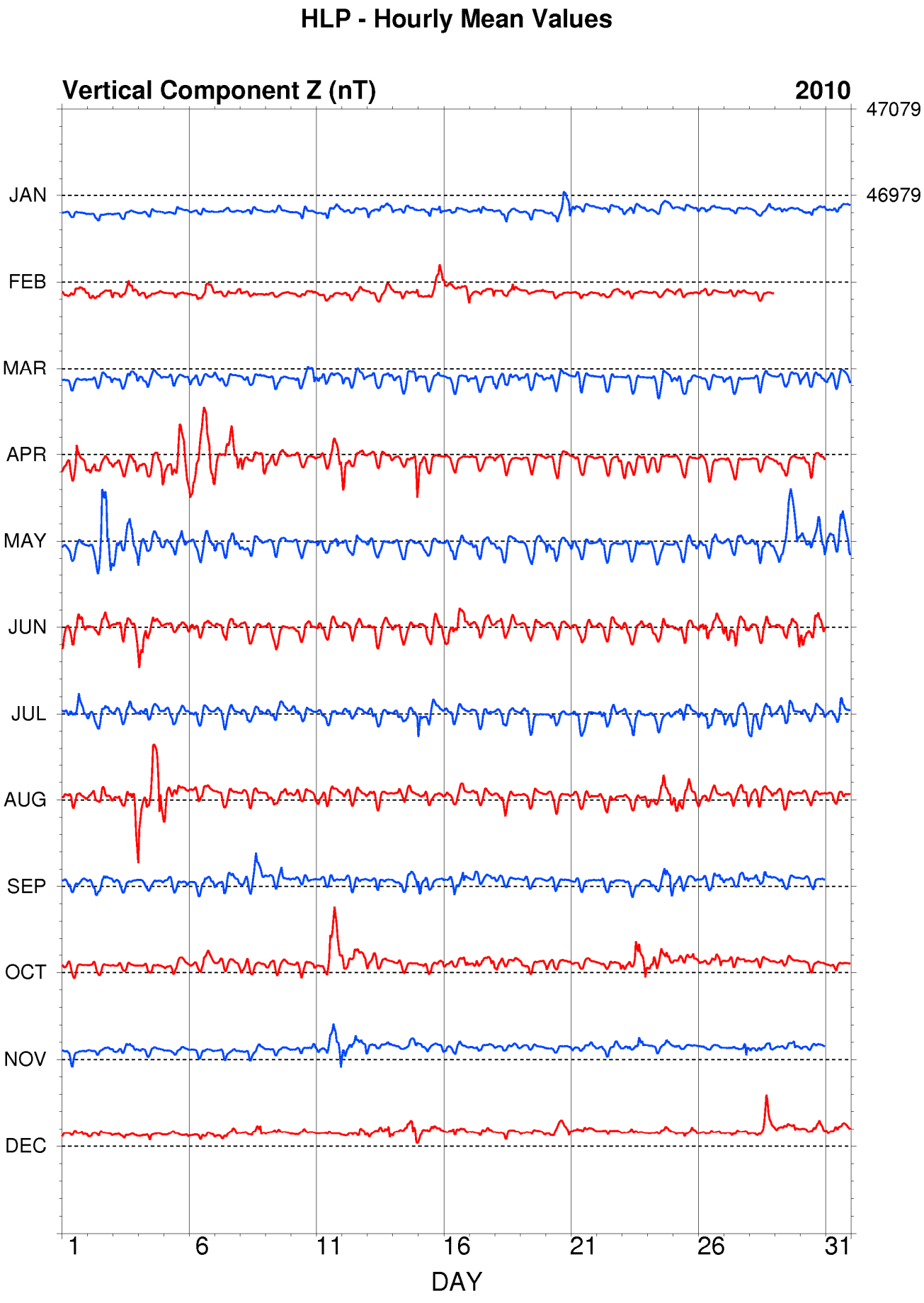

Fig. 16. Hourly mean data plot of Z component for Hel 2010.

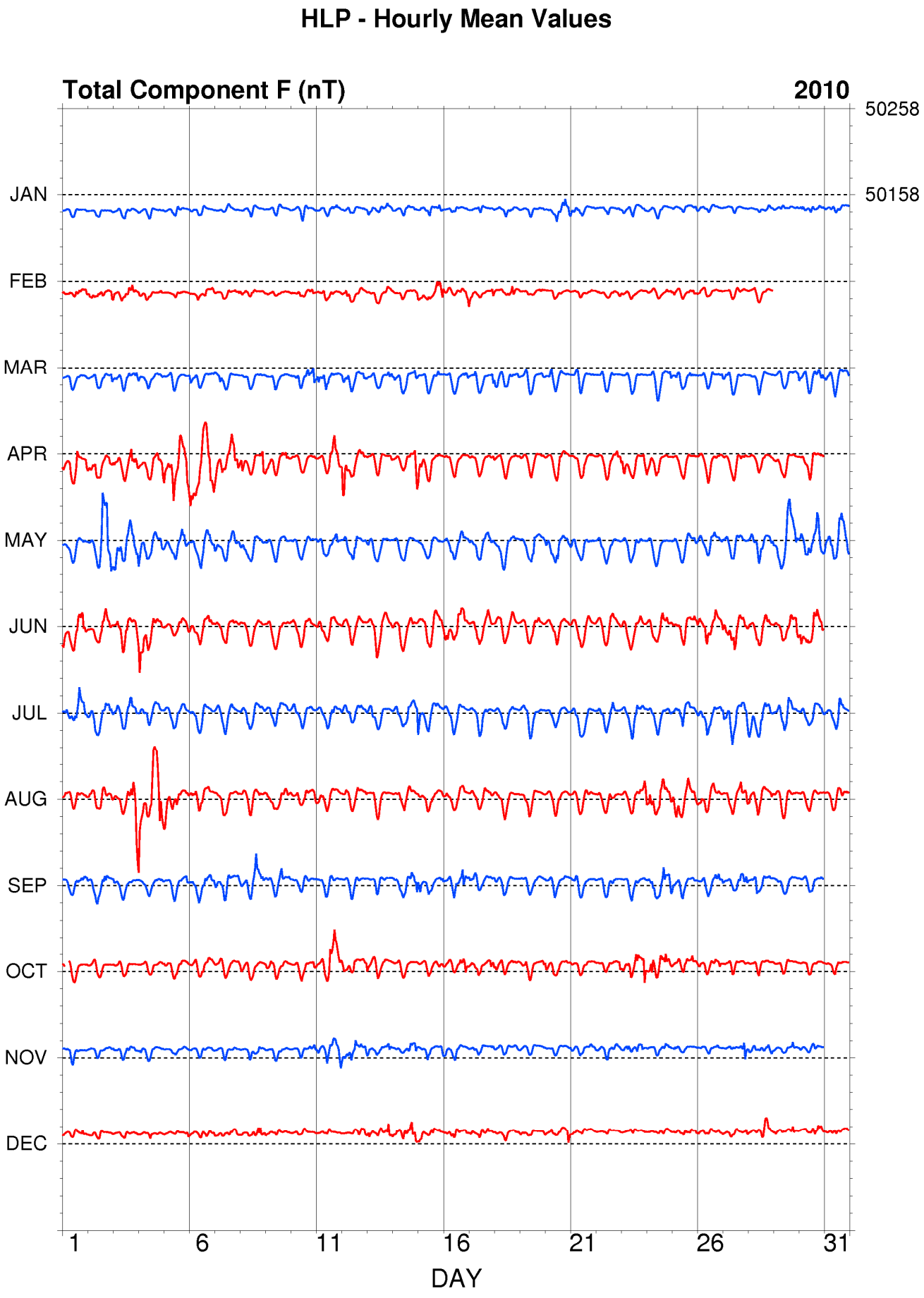

Fig. 17. Hourly mean data plot of F component for Hel 2010.

8. TABLES AND PLOTS FOR HORNSUND OBSERVATORY

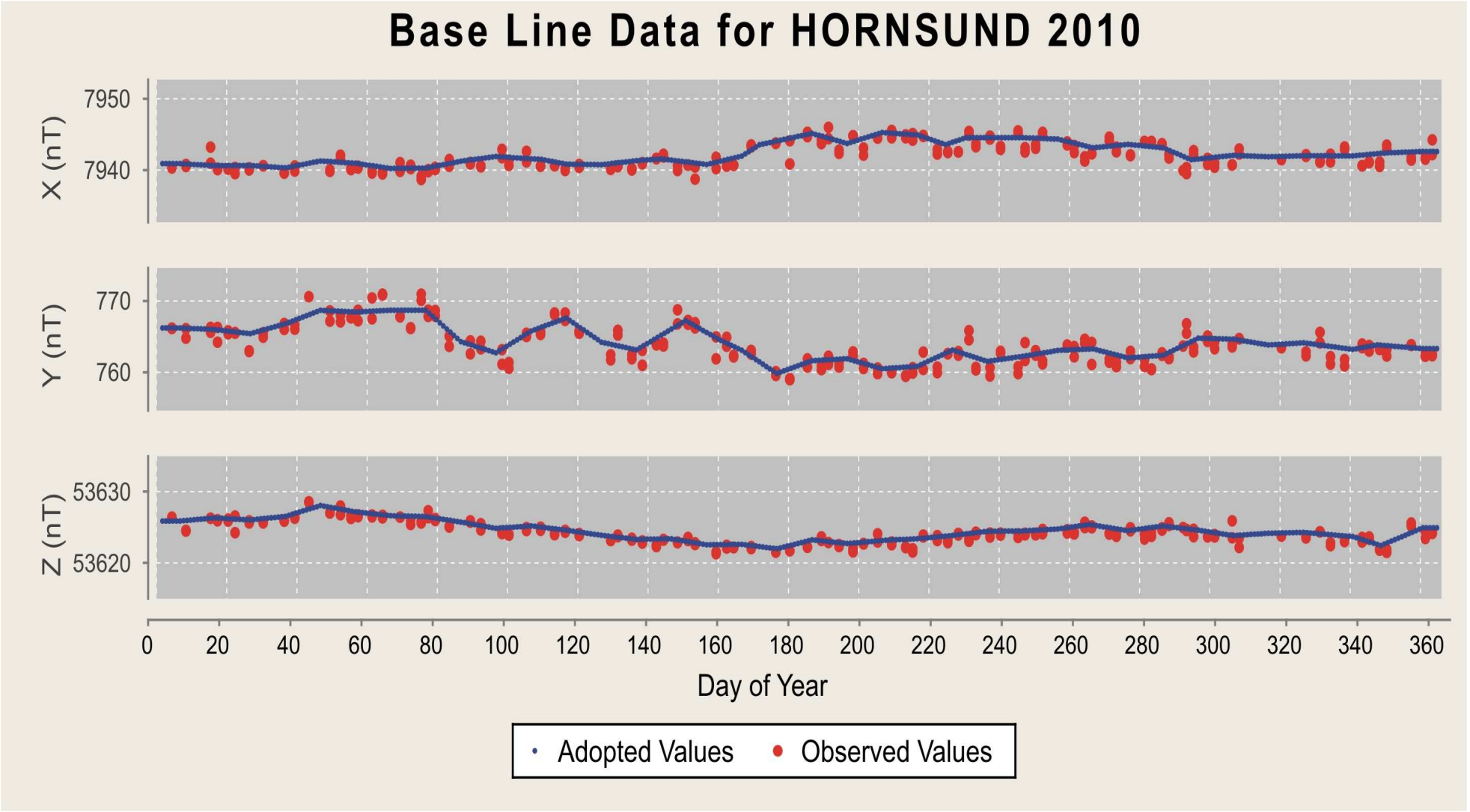

Fig. 18. Base values, Hornsund 2010.

Annual mean values of magnetic elements in Hornsund Observatory

Year	D [°´]	H [nT]	Z [nT]	X [nT]	Y [nT]	I [°´]	F [nT]
1979	-0 32.2	8384	53447	8384	-79	81 05.1	54101
1980	-0 14.2	8370	53447	8370	-35	81 06.0	54098
1981	-0 09.3	8351	53449	8351	-23	81 07.2	54097
1982	-0 09.4	8319	53481	8319	-23	81 09.5	54124
1983	-0 02.0	8295	53457	8295	-5	81 10.8	54097
1984	0 07.7	8266	53439	8266	19	81 12.4	54075
1985	0 14.3	8238	53405	8238	34	81 13.9	54037
1986	0 20.4	8213	53392	8213	49	81 15.3	54020
1987	0 25.6	8193	53360	8193	61	81 16.3	53985
1988	0 34.7	8168	53368	8168	82	81 17.9	53989
1989	0 40.8	8148	53369	8147	97	81 19.2	53987
1990	0 47.2	8122	53360	8121	112	81 20.7	53975
1991	0 53.0	8107	53355	8106	125	81 21.6	53967
1992	1 01.4	8088	53352	8087	144	81 22.8	53962
1993	1 12.9	8065	53356	8063	171	81 24.3	53962
1994	1 25.9	8044	53374	8041	201	81 25.8	53977
1995	1 38.4	8038	53374	8035	230	81 26.1	53976
1996	1 51.4	8023	53385	8019	260	81 27.2	53985
1997	2 07.2	8004	53406	7999	296	81 28.6	54003
1998	2 24.0	8001	53440	7994	335	81 29.1	54036
1999	2 39.1	7998	53471	7989	370	81 29.6	54066
2000	2 55.5	7996	53504	7986	408	81 30.0	54098
2001	3 12.4	7992	53542	7979	447	81 30.6	54135
2002	3 29.7	7989	53585	7974	487	81 31.2	54177
2003	3 49.8	7965	53646	7947	532	81 33.3	54234
2004	4 04.2	7961	53675	7941	565	81 33.8	54262
2005	4 20.5	7953	53707	7930	602	81 34.6	54293
2006	4 36.2	7958	53727	7932	639	81 34.5	54314
2007	4 51.3	7950	53757	7922	673	81 35.2	54342
2008	5 07.9	7941	53785	7909	710	81 36.1	54368
2009	5 25.4	7939	53804	7903	750	81 36.4	54387
2010	5 45.7	7928	53837	7888	796	81 37.4	54418

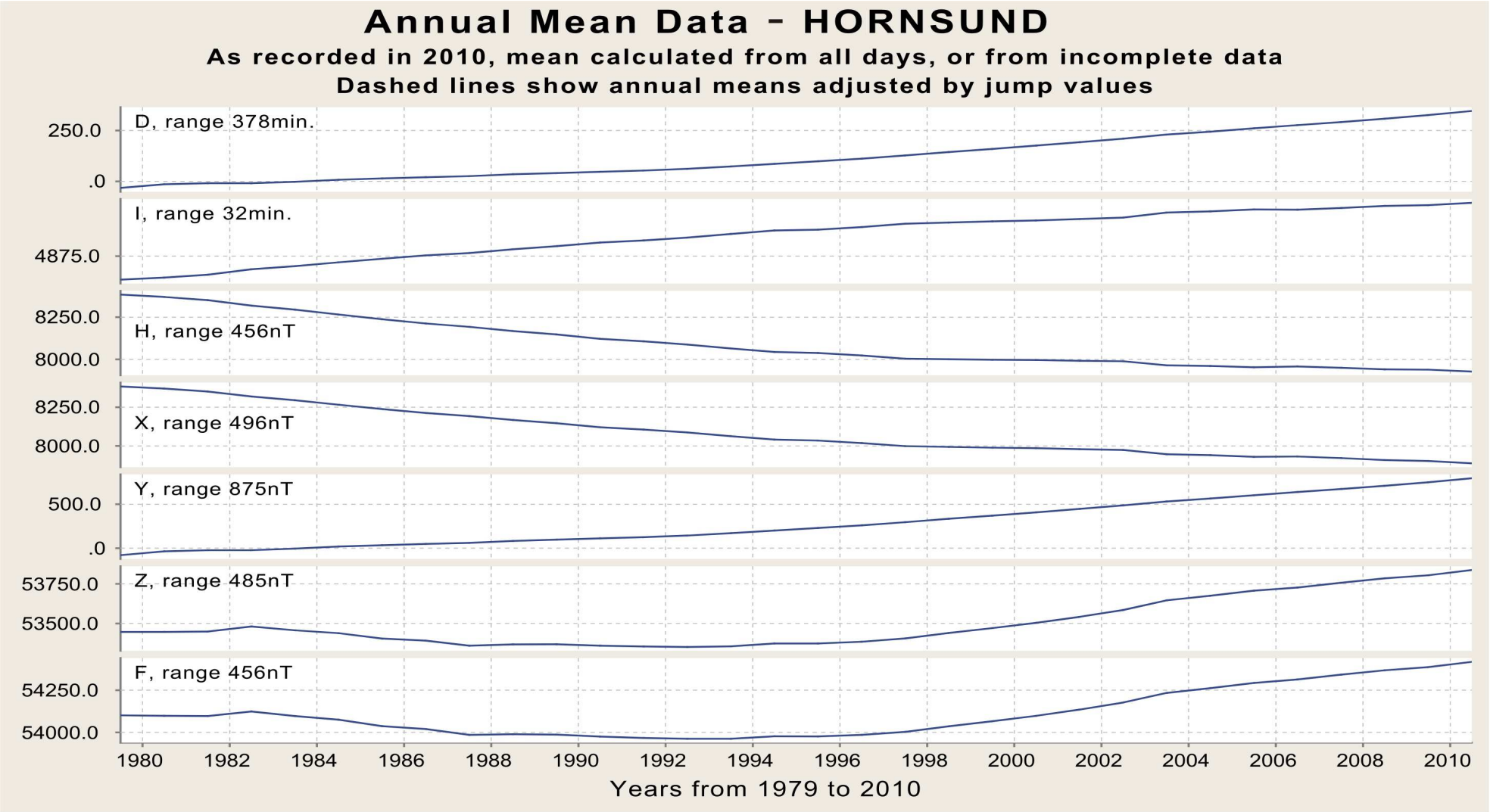

Fig. 19. Secular changes of H, X, Y, Z, F, D and I at Hornsund.

MONTHLY AND YEARLY MEAN VALUES OF MAGNETIC ELEMENTS

HRN 2010

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
NORTH COMPONENT: 7500 + ... in nT													
All days	388	386	391	386	395	403	405	394	384	377	373	371	388
Quiet days	395	392	394	401	405	405	401	393	385	385	384	381	393
Disturbed days	381	371	379	349	363	392	408	364	375	352	356	351	370
EAST COMPONENT: 500 + ... in nT													
All days	277	281	282	286	290	292	294	299	304	310	315	318	296
Quiet days	275	278	283	285	287	288	295	302	306	309	312	318	295
Disturbed days	278	282	283	295	299	303	298	300	303	316	319	322	300
VERTICAL COMPONENT: 53500 + ... in nT													
All days	317	330	327	346	332	333	330	344	341	348	349	348	337
Quiet days	312	321	322	336	330	335	330	334	341	339	344	343	332
Disturbed days	314	335	330	368	352	342	336	354	340	360	362	348	345

Three-hour-range K indices
Hornsund, January - March, 2010
The limit of K=9 is 2500

Day	January		February		March	
	K	SK	K	SK	K	SK
1	0000 0000	0	2133 2335	22	0222 2111	11
2	0000 0001	1	5223 3234	24	0102 2103	9
3	1121 2100	8	4233 3243	24	2222 3343	21
4	0111 0000	3	3222 1003	13	1432 2101	14
5	0000 1000	1	1311 1214	14	0112 2221	11
6	2221 0001	8	0001 2421	10	4221 1240	16
7	001- 0010	--	1210 0014	9	2321 1010	10
8	3000 0011	5	3212 0000	8	0220 1011	7
9	0100 1000	2	1122 1002	9	0112 2110	8
10	0000 1100	2	2211 1143	15	2122 2423	18
11	1233 2133	18	2222 2113	15	3233 3133	21
12	2222 1034	16	23-- -312	--	3442 3334	26
13	3332 2244	23	1110 1111	7	2121 1132	13
14	4211 2053	18	1011 2012	8	3222 3114	18
15	1211 1155	17	3322 2322	19	1110 0120	6
16	1211 0002	7	1221 1123	13	0231 2103	12
17	1101 0000	3	4321 1004	15	2333 2103	17
18	0112 2422	14	1112 3651	20	3220 1112	12
19	1001 0000	2	0112 2113	11	1121 1144	15
20	1012 3733	20	0000 0000	0	1332 3130	16
21	0232 1000	8	0000 0033	6	0231 1002	9
22	1210 0023	9	0423 2133	18	0010 0000	1
23	2223 2114	17	3211 2000	9	0110 1010	4
24	2323 1231	17	1212 1143	15	0001 2211	7
25	1112 1004	10	3111 0123	12	0112 1221	10
26	4111 0022	11	4101 0000	6	0122 2004	11
27	0101 1002	5	0000 0022	4	4310 1000	9
28	1112 1131	11	0120 1000	4	0231 2321	14
29	1201 10-3	--			1211 2112	11
30	2311 1232	15			1321 1143	16
31	4222 1212	16			3211 1434	19

Three-hour-range K indices
Hornsund, April - June, 2010
The limit of K=9 is 2500

Day	April			May			June		
	K		SK	K		SK	K		SK
1	2322	4315	22	1111	1130	9	5333	3333	26
2	4453	2223	25	1225	5355	28	3432	3334	25
3	2222	2532	20	3545	3554	34	2324	3244	24
4	3332	3255	26	3433	3345	28	4533	3234	27
5	3355	4355	33	2323	3453	25	1222	0113	12
6	3222	3635	26	1244	3343	24	2212	1232	15
7	5435	4454	34	2333	3222	20	2222	3211	15
8	5543	2125	27	3332	2233	21	2112	2221	13
9	4332	2143	22	2211	1121	11	2221	2101	11
10	2121	2011	10	1211	2111	10	3334	2221	20
11	1111	3423	16	2222	2242	18	1222	3301	14
12	5432	2221	21	1313	3212	16	1211	1111	9
13	1122	1114	13	1221	1111	10	2232	2222	17
14	2213	1126	18	1121	1221	11	2222	1122	14
15	4332	2110	16	2311	2000	9	2223	3333	21
16	1212	2111	11	1211	1311	11	3455	4352	31
17	1221	0042	12	2322	2333	20	2343	2223	21
18	1221	1011	9	3233	2212	18	2343	3320	20
19	2323	2122	17	2113	3232	17	1112	2122	12
20	1223	2121	14	3243	3313	22	1111	2203	11
21	2333	3211	18	4322	2111	16	2231	1111	12
22	1222	1243	17	1222	1101	10	1222	2223	16
23	6432	2114	23	1111	1011	7	2211	2121	12
24	2222	3120	14	0001	2120	6	1111	2332	14
25	1212	2101	10	2121	2114	14	2223	2222	17
26	0101	2100	5	1232	2121	14	2553	2233	25
27	2222	1110	11	2111	1100	7	2543	3233	25
28	0112	1111	8	2322	3114	18	2334	3433	25
29	2411	2122	15	5522	2343	26	3343	3324	25
30	2111	2211	11	3353	3344	28	4553	4544	34
31				3344	4443	29			

Three-hour-range K indices
Hornsund, July - September, 2010
The limit of K=9 is 2500

Day	July			August			September		
	K		SK	K		SK	K		SK
1	2433	3554	29	1333	3222	19	1110	1112	8
2	3333	3243	24	2443	2212	20	3233	2131	18
3	2313	2424	21	2332	2335	23	1211	2000	7
4	2332	2231	18	6435	4345	34	0110	2021	7
5	1332	2132	17	4322	3312	20	0211	0013	8
6	2221	1111	11	1333	2331	19	2323	2223	19
7	1111	1121	9	1223	2200	12	2234	3422	22
8	1120	2122	11	1211	1111	9	2322	7632	27
9	1322	2211	14	2442	3333	24	1012	3402	13
10	1121	1010	7	2322	3232	19	2231	0000	8
11	0111	2212	10	3332	2233	21	1131	1000	7
12	1211	2212	12	2231	1111	12	0111	1011	6
13	1121	2001	8	1122	1111	10	1011	2110	7
14	1223	2223	17	1222	2213	15	0232	1242	16
15	5333	3221	22	2212	2112	13	3223	1002	13
16	1233	4111	16	1322	2451	20	1111	2251	14
17	1121	2102	10	2122	2321	15	2233	2211	16
18	1011	2210	8	2332	2100	13	2322	1230	15
19	1100	1100	4	2222	1112	13	2201	1102	9
20	1121	2212	12	1001	1112	7	1210	1111	8
21	1221	2222	14	0111	2100	6	1333	1000	11
22	2222	3211	15	0002	1000	3	0110	0001	3
23	1333	3111	16	0000	2112	6	1222	1122	13
24	2120	2324	16	3443	3344	28	2342	2545	27
25	2223	2242	19	3544	3533	30	3433	2233	23
26	2233	2222	18	2443	2213	21	1123	3243	19
27	3444	3344	29	2344	2534	27	2223	2252	20
28	4344	3344	29	2243	2133	20	1333	3322	20
29	2333	3113	19	1112	1000	6	1322	2200	12
30	2323	2333	21	0001	1000	2	0002	2001	5
31	2222	3212	16	0120	2003	8			

Three-hour-range K indices
Hornsund, October - December, 2010
The limit of K=9 is 2500

Day	October		November		December	
	K	SK	K	SK	K	SK
1	2211 0001	7	0011 1010	4	1210 0043	11
2	0001 0000	1	0112 1110	7	2220 0011	8
3	0101 0000	2	1222 1142	15	0111 0011	5
4	0000 1000	1	1211 1100	7	0112 1030	8
5	1221 2321	14	0101 1100	4	0100 0003	4
6	1111 3331	14	0010 1003	5	1111 1111	8
7	1121 3101	10	0000 0041	5	1122 2243	17
8	4222 2100	13	1011 2341	13	2221 1452	19
9	2221 1232	15	0221 0000	5	1111 0000	4
10	1001 1134	11	0000 0241	7	0110 0000	2
11	1233 3221	17	2223 3332	20	1131 1013	11
12	3442 2214	22	3433 3245	27	1210 0204	10
13	2242 1200	13	4222 1154	21	4332 2264	26
14	0211 0000	4	2222 1245	20	3333 3365	29
15	0232 2131	14	3333 1116	21	4432 2513	24
16	2221 1332	16	3333 2210	17	4333 1234	23
17	1223 2153	19	1432 1032	16	3323 1254	23
18	3221 1033	15	1333 2143	20	1321 1032	13
19	3332 2003	16	1322 1000	9	2312 0014	13
20	3222 3133	19	0133 1012	11	2441 2235	23
21	3121 2211	13	4321 1132	17	1111 0133	11
22	0332 2104	15	1233 2111	14	0101 0002	4
23	2454 4325	29	2343 1453	25	0100 0000	1
24	3433 3364	29	1222 1153	17	0221 1110	8
25	3343 3151	23	1333 2011	14	2212 1142	15
26	2333 2443	24	1100 0050	7	0211 1054	14
27	1233 2053	19	0000 1165	13	1010 0024	8
28	1122 1132	13	3322 0055	20	1212 2320	13
29	1231 1103	12	1212 2160	15	1312 1051	14
30	0002 1100	4	2212 0110	9	0111 2213	11
31	0212 2001	8			1211 2112	11

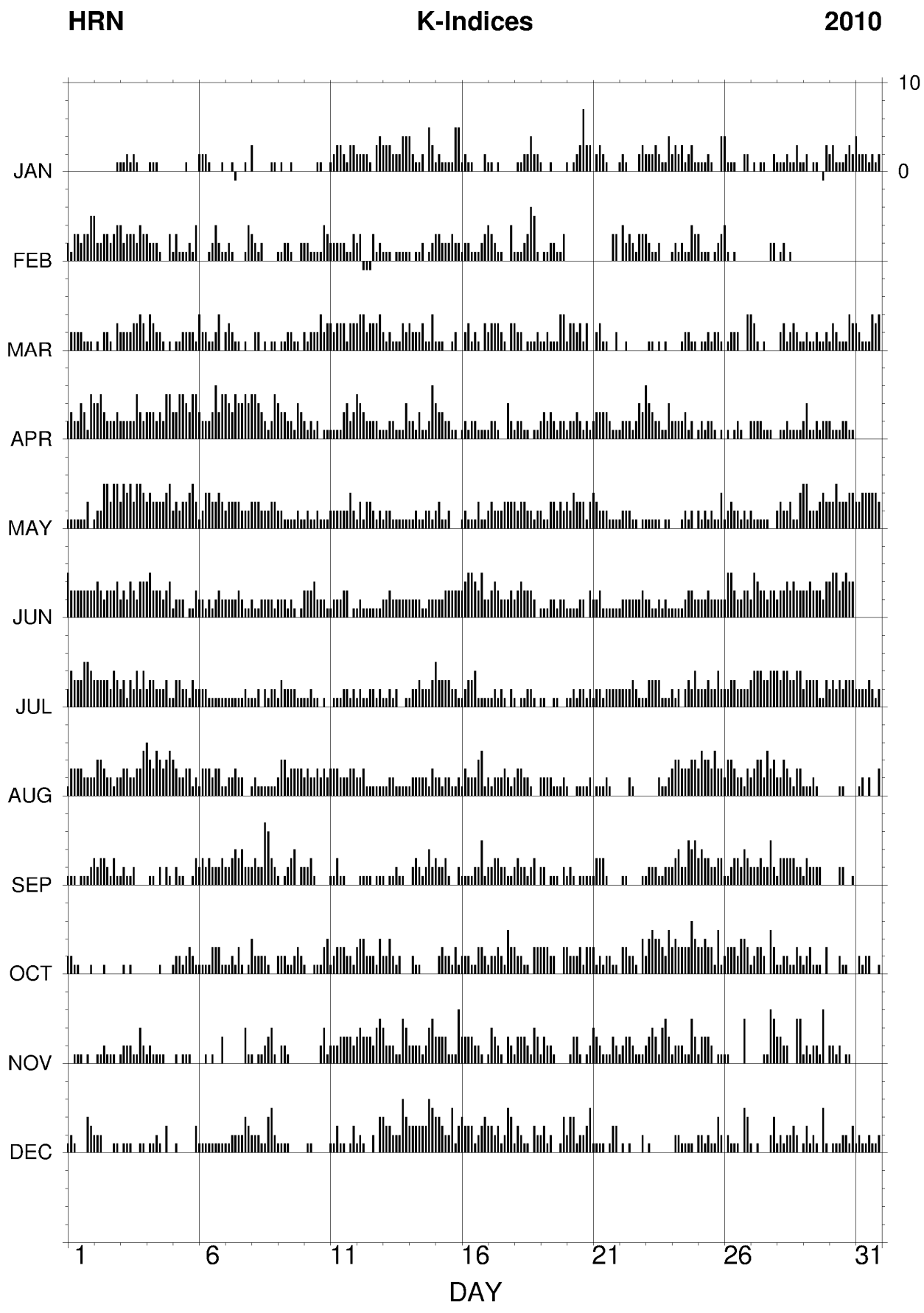

Fig. 20. K-indices in graphical form, Hornsund 2010.

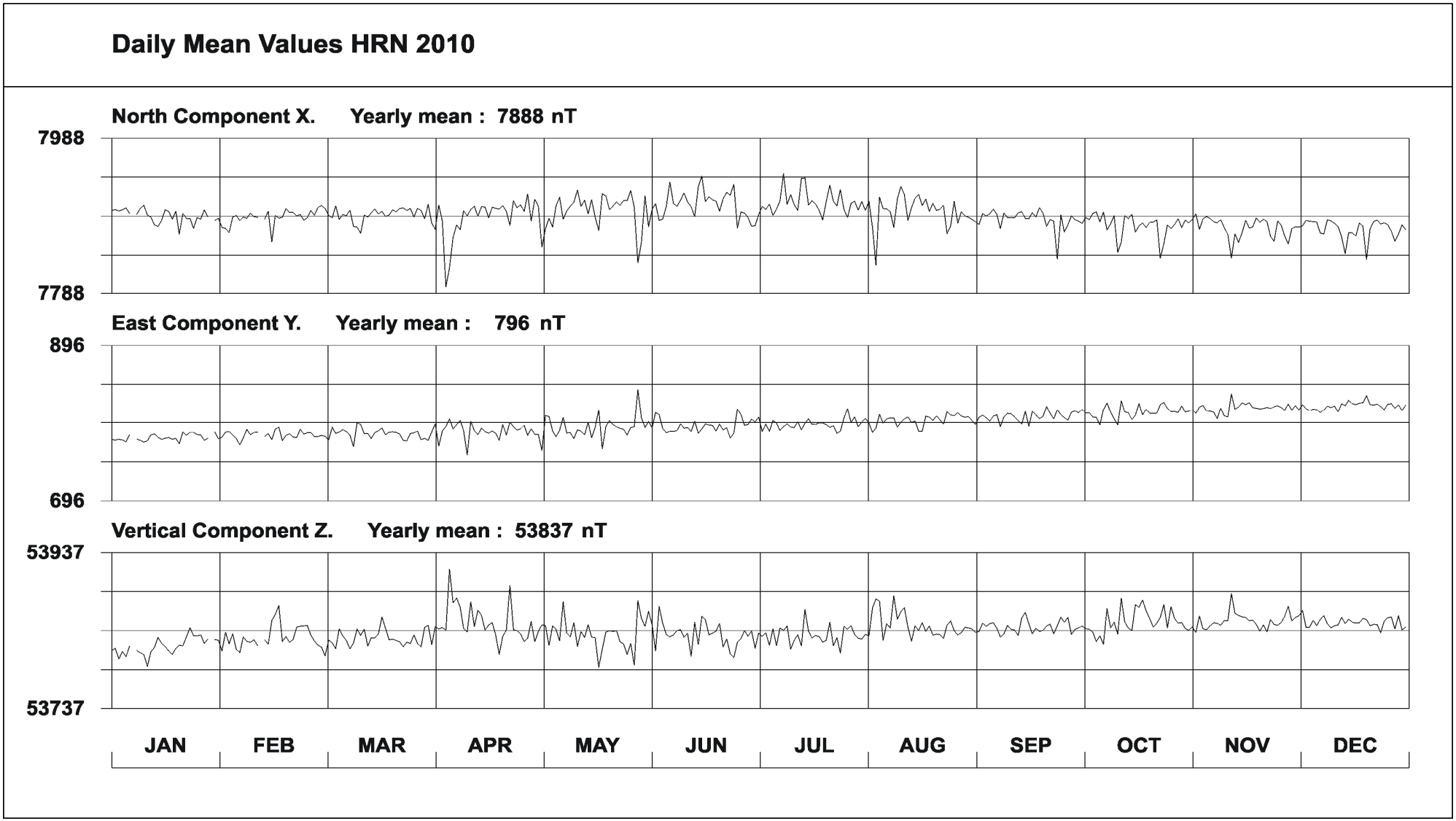

Fig. 21. Daily mean data plot for Hornsund 2010.

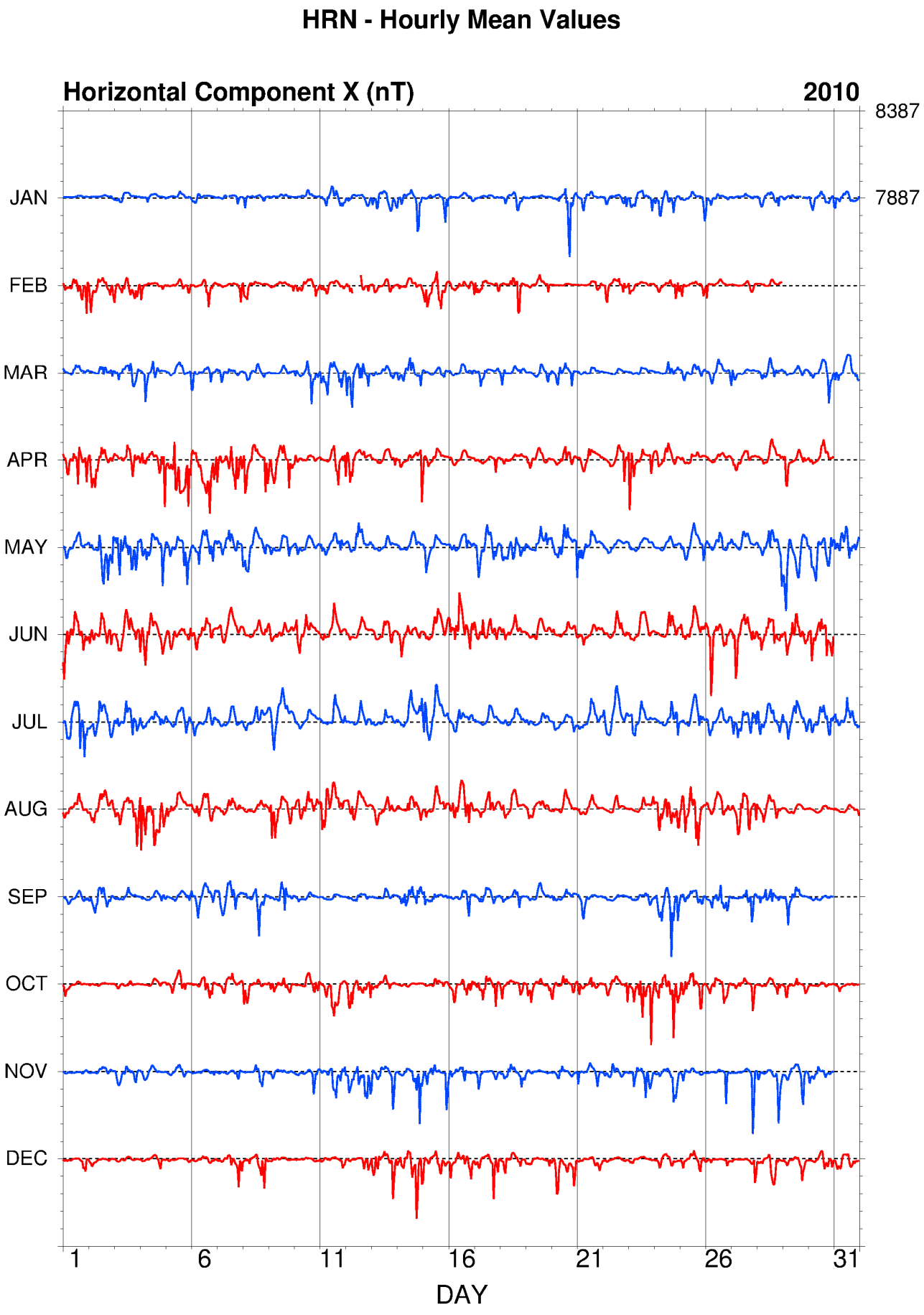

Fig. 22. Hourly mean data plot of X component for Hornsund 2010.

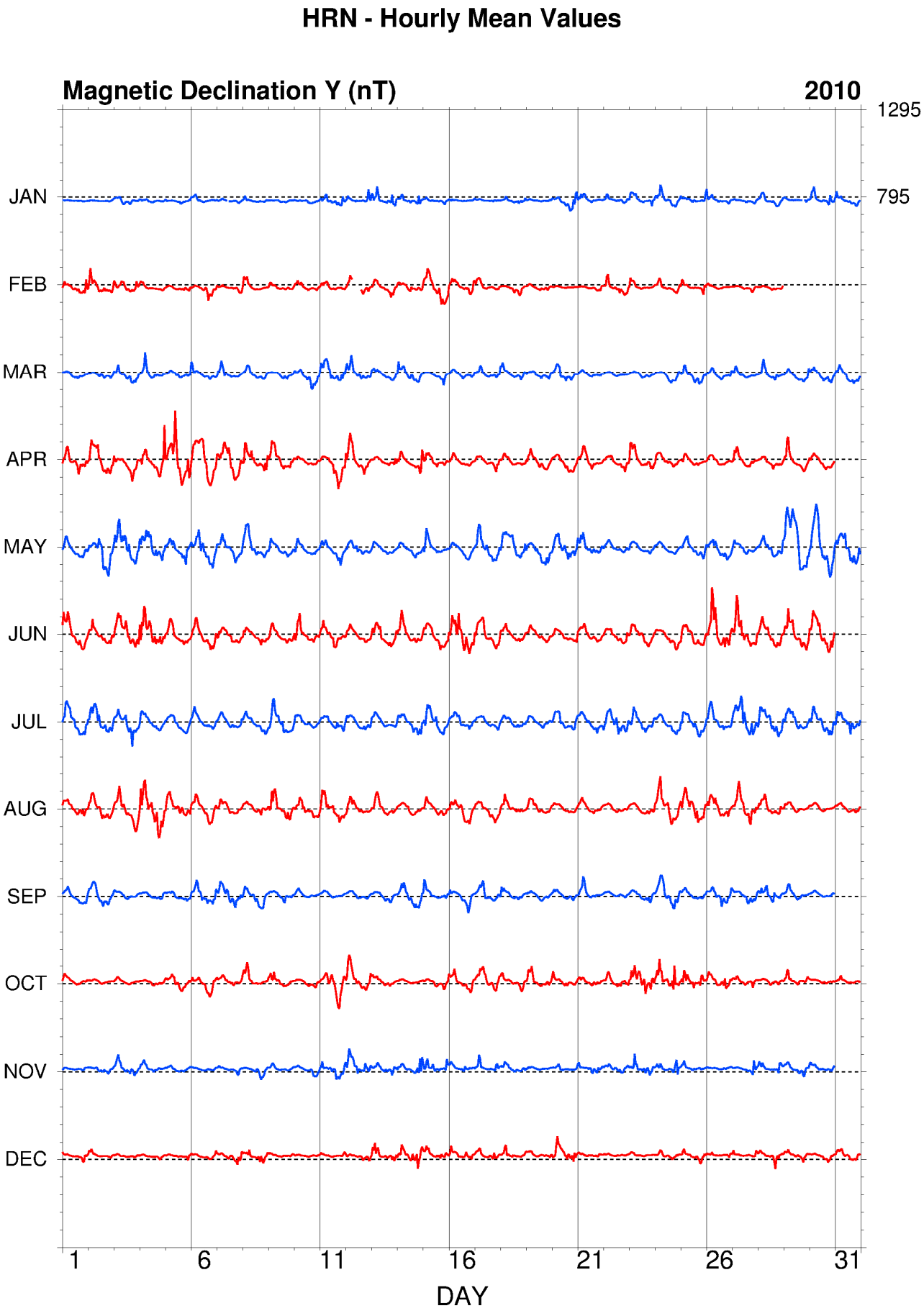

Fig. 23. Hourly mean data plot of Y component for Hornsund 2010.

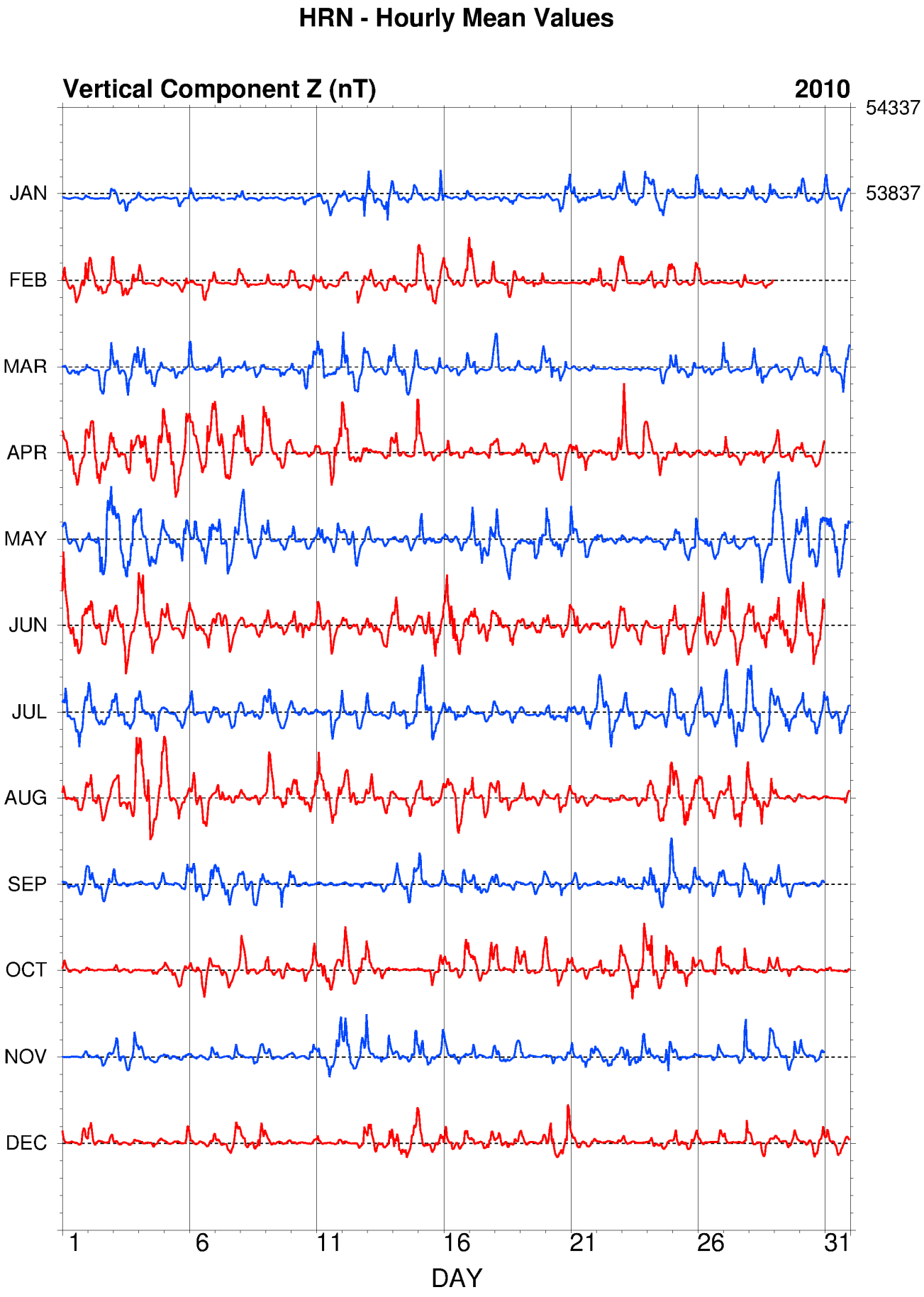

Fig. 24. Hourly mean data plot of Z component for Hornsund 2010.

C O N T E N T S