INSTITUTE OF GEOPHYSICS
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PUBLICATIONS
OF THE INSTITUTE OF GEOPHYSICS
POLISH ACADEMY OF SCIENCES

C-107 (417)

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BELSK, HEL, HORNSUND
2013

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WARSZAWA 2015

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

Internet Edition

ISBN 978-83-88765-93-3
ISSN 2299-8020

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

A – Physics of the Earth's Interior
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PUBLICATIONS OF THE INSTITUTE OF GEOPHYSICS
POLISH ACADEMY OF SCIENCES
C. Geomagnetism

List of latest issues.

C-99 (398) Monographic Volume: XII IAGA Workshop on Geomagnetic Observatory Instruments, Data Acquisition and Processing, Belsk, 19-24 June 2006.

C-100 (402) Results of geomagnetic observations, Belsk, Hel, Hornsund, 2006.

C-101 (408) Results of geomagnetic observations, Belsk, Hel, Hornsund, 2007.

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

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C-105 (415) (Internet Edition) Results of geomagnetic observations, Belsk, Hel, Hornsund, 2011

C-106 (416) (Internet Edition) Results of geomagnetic observations, Belsk, Hel, Hornsund, 2012

ISBN 978-83-88765-93-3

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PUBLS. INST. GEOPHYS. POL. ACAD. SC., C107(417) (2015)

Results of Geomagnetic Observations Belsk, Hel, Hornsund, 2013

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1. INTRODUCTION

This publication contains basic information on geomagnetic observations carried out in 2013 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, under Norwegian administration.

In 2013, 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 as well as by GEOMAG and LEMI flux-gate magnetometers.

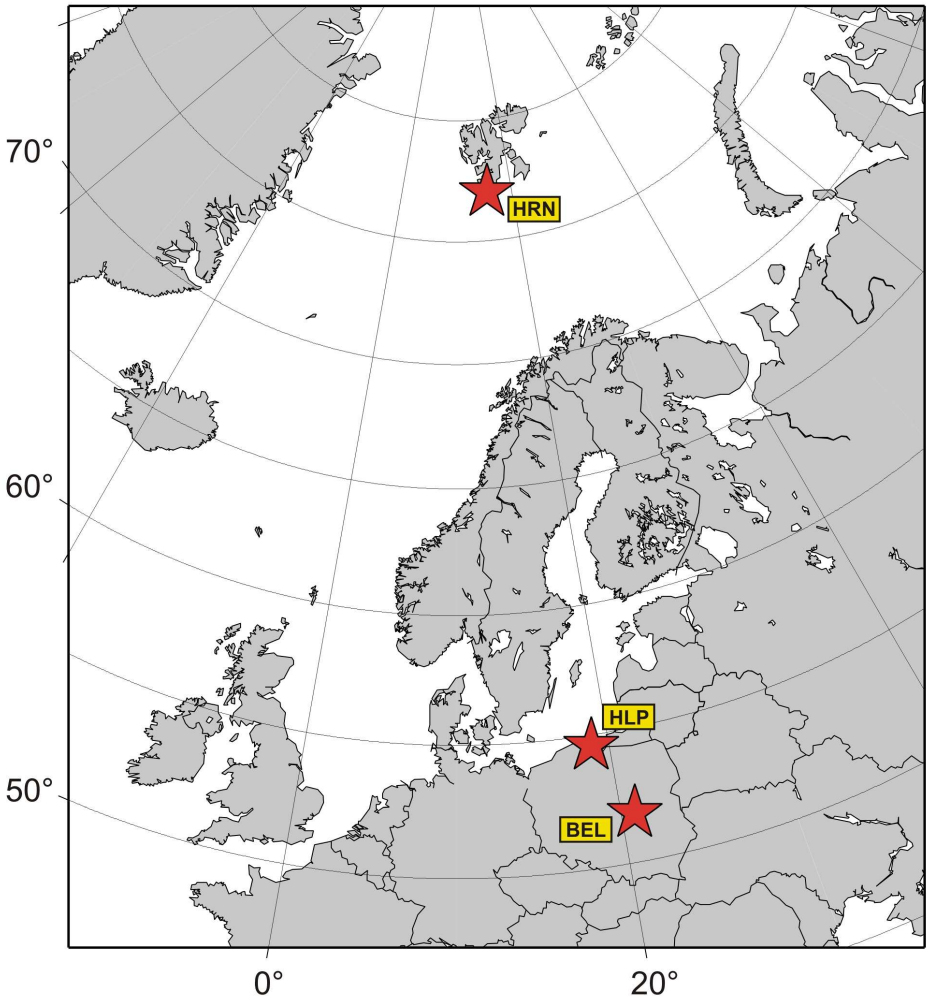

Fig. 1. Location of the Belsk, Hel and Hornsund observatories.

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, gaps in one-minute XYZ elements from Belsk and Hel are practically absent.

It is worth mentioning that in 2013 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 on the internet pages of Grójec district (http://en.wikipedia.org/wiki/Gr%C3%B3jec_County) to which the village Belsk Duży belongs. Relevant information about Belsk Observatory can be found at page http://www.igf.edu.pl/.

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://en.wikipedia.org/wiki/Hel,_Poland .

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://en.wikipedia.org/wiki/Svalbard . 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)	GEOMAG 03, THEO-10B sn: 03-2012	FLUX-9408 THEO-10B sn: 160334	FLUX-9408 THEO-10B sn: 160326
Proton magnetometer	PMP-8 sn: 13/1998	PMP-5 sn: 160	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 GEOMAG-03 / THEO-10B
- Producer ..... GEOMAGNET, Ukraine
- 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 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 2013 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 0.3^{o}C.

Table 4
Mean errors of measurements of B_X, B_Y and B_Z in 2013

Observatory	Element	Number of measurements n	Mean error m_B [nT]
Belsk	B_X	245	0.36
	B_Y	248	0.55
	B_Z	254	0.19
Hel	B_X	155	0.44
	B_Y	155	0.53
	B_Z	155	0.34
Hornsund	B_X	179	1.86
	B_Y	179	2.06
	B_Z	179	0.67

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 equipped with Bobrov's variometers (PSM) or flux-gate sensors (GEOMAG, LEMI) 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.

PSM magnetometers

The PSM magnetometers 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.

LEMI magnetometers

The LEMI magnetometers were designed at the Lviv Centre of the Institute of Space Research (Ukraine). They employ flux-gate sensors. 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.

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-8811-01P	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	NDL TUS Electronics	NDL TUS Electronics
	Sampling interval	1 s	1 s	1 s
SET 2	Name of magnetometer Kind of sensor	PSM Bobrov	PSM Bobrov	LEMI fluxgate
	Type	PSM-8511-06P	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	Lviv Centre of the Institute of Space Research (Ukraine)
	Digital recorder Producer	NDL TUS Electronics	NDL TUS Electronics	NDL TUS Electronics
	Sampling interval	1 s	1 s	1 s
Total field	Name of magnetometer	PMP-8	PMP-8	–
	Producer	Institute of Geophysics PAS	Institute of Geophysics PAS	–
	Sampling interval	30 s	30 s	–

Proton magnetometers PMP-5 and PMP-8

The magnetometers of type 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

NDL digital data loggers

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.

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, GEOMAG and LEMI, parameters of calibration coils of PSMs, and mutual orthogonality of sensors in magnetometers is checked every few years in large calibration coils installed at the Belsk Observatory.

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 (author: M. Neska),
- automatic transmission of data, via the 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 2013 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 2013 data are shown in Figs 8 to 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

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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http://hornsund.igf.edu.pl/
http://www.igf.edu.pl/

5 PERSONNEL TAKING PART IN THE WORK OF BELSK, HEL AND HORNSUND OBSERVATORIES IN 2013

5.1 Belsk

– Jan Reda (project leader of geomagnetic observations in Belsk, Hel, Hornsund)
– Mariusz Neska (data processing)
– Paweł Czubak (data processing)
– Marek Irisik (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)
– Paweł Czubak (data processing)

5.3 Hornsund

– Mariusz Neska (head of geomagnetic observations)
– Piotr Andryszczak (observer in 1-st half-year)
– Łukasz Mazurkiewicz (observer in 2-nd half-year)
– Jan Reda (data processing)
– Paweł Czubak (data processing)

L i t e r a t u r e

Jankowski, J., and C. Sucksdorff (1996), *Guide for Magnetic Measurements and Observatory Practice*, IAGA, Warsaw, 235 pp.

Jankowski, J., J. Marianiuk, A. Ruta, C. Sucksdorff, and M. Kivinen (1984), *Long-term stability of a torque-balance variometer with photoelectric converters in observatory practice*, Geophys. Surv. **6**, 3/4, 367-380.

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Received February 23, 2015

Accepted March 24, 2015

6. TABLES AND PLOTS FOR BELSK OBSERVATORY

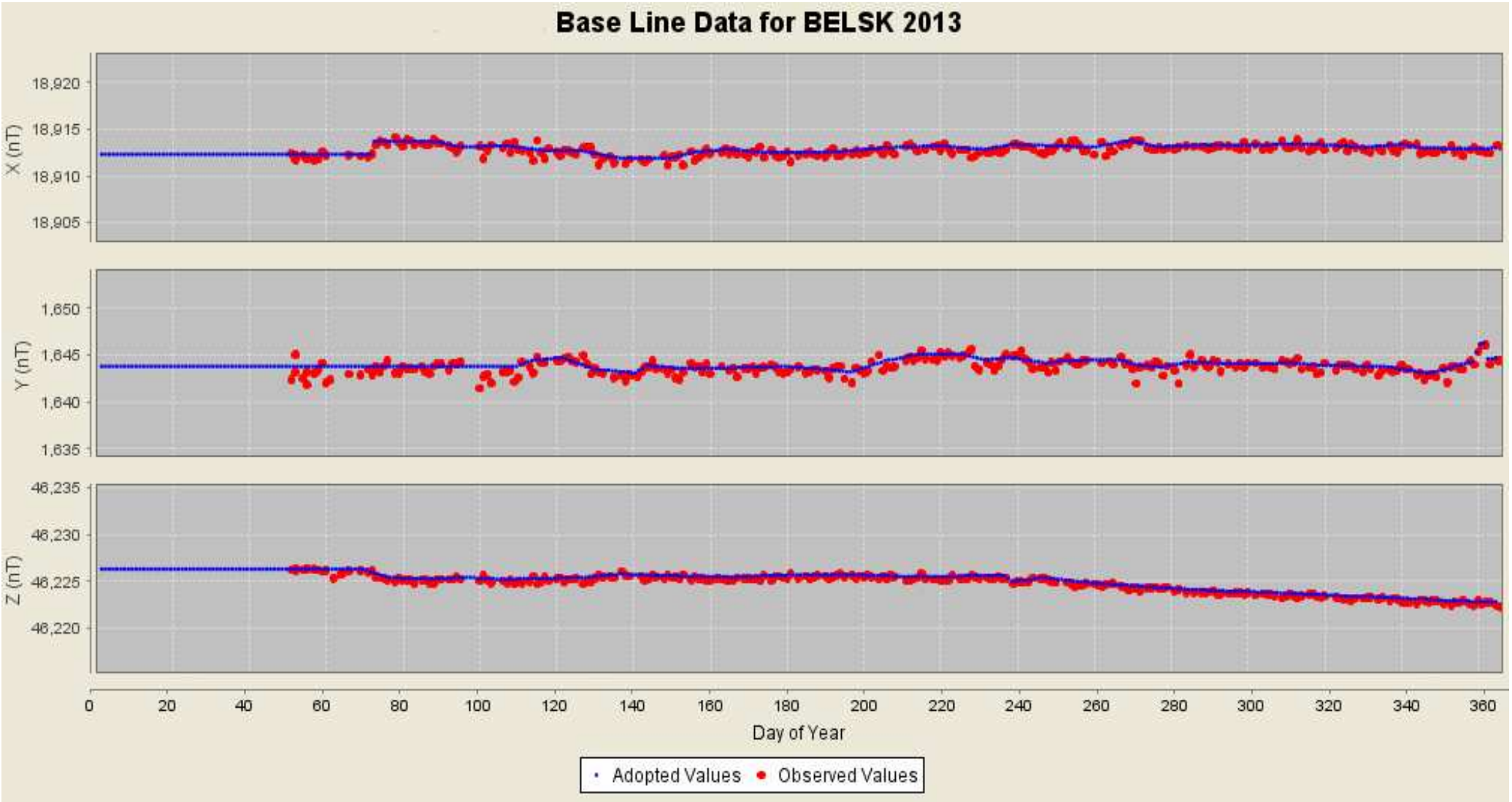

Fig. 2. Base values of set 1, Belsk 2013.

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	45023	18889	683	67 13.6’	48830
2	1967	2 05.6	18906	45048	18894	691	67 14.0	48854
3	1968	2 06.2	18917	45071	18906	695	67 13.8	48880
4	1969	2 06.3	18935	45094	18923	696	6713.3	48908
5	1970	2 06.6	18953	45123	18940	698	67 13.0	48942
6	1971	2 06.6	18976	45146	18963	699	67 12.2	48972
7	1972	2 08.0	18992	45176	18978	707	67 11.9	49006
8	1973	2 10.2	19005	45211	18991	719	67 12.0	49043
9	1974	2 13.3	19016	45246	19002	737	67 12.2	49079
10	1975	2 16.4	19035	45274	19020	755	67 11.7	49112
11	1976	2 18.5	19050	45307	19034	767	67 11.7	49149
12	1977	2 22.0	19062	45337	19046	787	67 11.7	49181
13	1978	2 27.4	19059	45376	19041	817	67 13.0	49216
14	1979	2 32.3	19061	45401	19043	844	67 13.5	49240
15	1980	2 37.2	19063	45418	19043	871	67 13.9	49257
16	1981	2 42.9	19047	45449	19026	902	67 15.7	49279
17	1982	2 48.3	19035	45479	19012	931	67 17.3	49302
18	1983	2 52.4	19033	45499	19009	954	67 18.0	49319
19	1984	2 56.9	19023	45520	18998	978	67 19.2	49335
20	1985	3 00.8	19015	45542	18989	999	67 20.3	49352
21	1986	3 05.1	19003	45570	18976	1023	67 21.8	49374
22	1987	3 08.5	18999	45593	18971	1041	67 22.7	49393
23	1988	3 12.4	18983	45626	18953	1062	67 24.6	49418
24	1989	3 15.9	18966	45662	18935	1080	67 26.6	49444
25	1990	3 18.8	18962	45684	18930	1096	67 27.5	49463
26	1991	3 22.2	18951	45709	18918	1114	67 28.8	49482
27	1992	3 25.3	18954	45726	18921	1131	67 29.1	49499
28	1993	3 29.8	18956	45744	18921	1156	67 29.4	49516
29	1994	3 34.8	18954	45772	18917	1183	67 30.4	49541
30	1995	3 39.8	18959	45797	18921	1212	67 30.7	49566
31	1996	3 45.0	18966	45822	18925	1241	67 30.9	49592
32	1997	3 50.9	18963	45857	18920	1273	67 32.0	49623
33	1998	3 57.3	18956	45897	18911	1308	67 33.6	49658
34	1999	4 02.5	18958	45931	18911	1336	67 34.3	49689
35	2000	4 07.8	18955	45969	18906	1365	67 35.5	49724
36	2001	4 13.0	18962	46005	18911	1394	67 36.0	49760
37	2002	4 18.4	18969	46044	18916	1424	67 36.6	49798
38	2003	4 24.2	18970	46090	18914	1457	67 37.7	49841
39	2004	4 29.4	18980	46121	18922	1486	67 37.9	49874
40	2005	4 34.7	18984	46155	18924	1515	67 38.5	49906
41	2006	4 39.8	18997	46177	18934	1544	67 38.3	49932
42	2007	4 45.8	19007	46207	18942	1578	67 38.4	49963
43	2008	4 52.5	19014	46236	18945	1616	67 38.7	49993
44	2009	4 59.7	19022	46264	18950	1656	67 39.0	50022
45	2010	5 08.0	19018	46301	18941	1701	67 40.2	50055
46	2011	5 16.1	19015	46338	18935	1746	67 41.3	50088
47	2012	5 24.6	19014	46377	18929	1793	67 42.4	50123
48	2013	5 32.8	19020	46411	18931	1838	67 42.9	50157

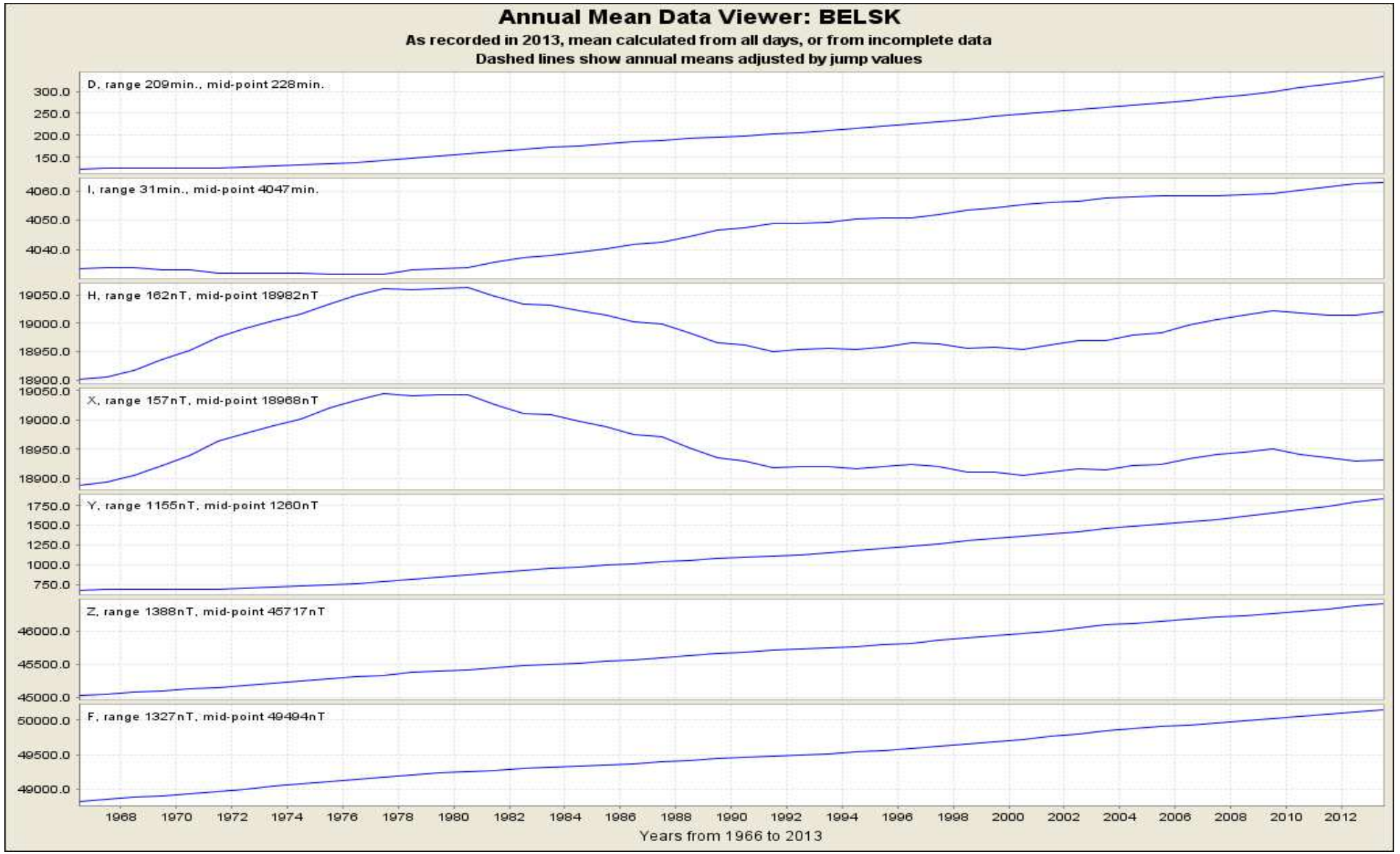

Fig. 3. Secular changes of H, X, Y, Z, F, D and I at Belsk.

MONTHLY AND YEARLY MEAN VALUES OF MAGNETIC ELEMENTS

BEL 2013

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
NORTH COMPONENT: 18500 + ... in nT													
All days	432	433	428	437	431	430	430	431	433	427	427	431	431
Quiet days	435	437	438	440	435	437	433	433	435	430	434	433	435
Disturbed days	425	426	414	437	421	413	412	425	427	416	415	424	421
EAST COMPONENT: 1500 + ... in nT													
All days	318	321	326	329	333	338	341	344	345	351	355	357	338
Quiet days	316	320	323	328	332	337	340	343	345	349	354	357	337
Disturbed days	320	323	329	330	338	343	343	346	347	355	356	357	341
VERTICAL COMPONENT: 46000 + ... in nT													
All days	393	395	400	398	405	412	418	416	417	421	425	427	411
Quiet days	392	394	396	398	404	410	417	415	415	421	424	427	409
Disturbed days	396	397	404	400	409	413	426	417	420	420	427	427	413

Three-hour-range K indices
Belsk, January - March, 2013
The limit of K=9 is 450

Day	January		February		March	
	K	SK	K	SK	K	SK
1	0000 0000	0	2012 1223	13	4344 4555	34
2	0011 1112	7	1222 2242	17	4321 2344	23
3	1100 1000	3	2011 1111	8	2322 2223	18
4	1001 0011	4	1111 1331	12	2111 2111	10
5	1011 0010	4	1111 1010	6	3112 1121	12
6	0001 1122	7	1000 0011	3	1211 1011	8
7	1001 1011	5	1122 2122	13	1111 0101	6
8	1112 1114	12	2222 3222	17	0011 1121	7
9	2101 0011	6	1111 0111	7	3212 2231	16
10	1010 1011	5	2111 1231	12	1111 0213	10
11	0002 1013	7	1111 1132	11	3211 0110	9
12	2111 0110	7	1001 1223	10	1122 2232	15
13	2111 2334	17	3212 1245	20	1111 0122	9
14	3212 3222	17	3333 2233	22	1112 2211	11
15	2111 2030	10	0111 1232	11	1332 1001	11
16	1011 1234	13	1001 2431	12	3322 1221	16
17	3322 3543	25	1122 2341	16	2255 5665	36
18	2322 4234	22	0001 1113	7	3222 2122	16
19	3010 1334	15	0111 2233	13	1110 1124	11
20	3331 3111	16	1112 1231	12	2221 2234	18
21	2001 1111	7	3221 1123	15	5431 1111	17
22	0000 0000	0	2222 2334	20	0112 2233	14
23	0100 0001	2	3112 2143	17	1112 3244	18
24	1000 0000	1	1101 1221	9	3112 2120	12
25	0011 0223	9	0011 1223	10	0011 1121	7
26	4233 4454	29	1112 1131	11	1101 1001	5
27	3211 1321	14	2121 1101	9	1233 3655	28
28	1110 1123	10	1121 2124	14	4212 2323	19
29	1010 1110	5			4333 4543	29
30	0001 0011	3			4422 2143	22
31	0010 0112	5			1110 1123	10

Three-hour-range K indices
Belsk, April - June, 2013
The limit of K=9 is 450

Day	April			May			June		
	K		SK	K		SK	K		SK
1	1122	1212	12	3233	4353	26	4655	5333	34
2	2101	1123	11	3322	2232	19	4333	3333	25
3	0101	1112	7	1111	2221	11	3222	2333	20
4	2212	1111	11	1122	2222	14	3222	1223	17
5	0101	1011	5	2122	2420	15	3112	2121	13
6	1112	2122	12	2123	3323	19	1323	4534	25
7	1112	2320	12	3233	3222	20	5443	3322	26
8	0111	1111	7	3121	1221	13	2333	1111	15
9	1112	0111	8	1111	1110	7	1222	3332	18
10	0122	1113	11	0212	2110	9	2333	3321	20
11	0022	2212	11	1212	1111	10	1112	3312	14
12	2122	2111	12	1212	1111	10	1222	2111	12
13	2212	1123	14	1121	1320	11	2111	1211	10
14	2233	3333	22	1133	3222	17	1112	1121	10
15	1111	2032	11	1123	4322	18	2122	1111	11
16	1000	0233	9	3322	4534	26	0101	1111	6
17	1111	2100	7	3221	2332	18	1112	2111	10
18	1001	0010	3	3522	2242	22	1111	1121	9
19	0001	1101	4	3223	2324	21	2211	2222	14
20	0012	2101	7	2212	3332	18	2212	3344	21
21	0110	0210	5	2111	1122	11	3223	4343	24
22	1111	2211	10	3223	3332	21	3333	2342	23
23	0212	2322	14	1312	3232	17	3333	2443	25
24	3224	5253	26	2223	3354	24	3323	4443	26
25	3223	2342	21	4324	3554	30	3222	1222	16
26	2433	3334	25	4332	3532	25	0101	1211	7
27	2222	2322	17	2323	3443	24	1012	4323	16
28	1002	2233	13	2332	3210	16	3323	4544	28
29	3001	1021	8	0111	1111	7	4543	4454	33
30	2012	2213	13	0001	2110	5	3213	3333	21
31				0012	2434	16			

Three-hour-range K indices
Belsk, July - September, 2013
The limit of K=9 is 450

Day	July			August			September		
	K		SK	K		SK	K		SK
1	3222	2120	14	1112	2310	11	3221	3232	18
2	1111	1211	9	1111	1210	8	1233	3211	16
3	1112	1222	12	1001	2222	10	1112	2123	13
4	1111	1222	11	1123	2545	23	1112	2122	12
5	2212	3342	19	4323	2323	22	1002	1121	8
6	2343	4334	26	3212	2112	14	1111	1132	11
7	4111	1210	11	1111	1110	7	1111	1111	8
8	1211	1221	11	0111	1222	10	2222	2110	12
9	0112	3443	18	1222	3231	16	0121	1111	8
10	4434	4444	31	1122	3221	14	0012	3333	15
11	2333	3452	25	2112	2111	11	2112	2132	14
12	12-2	2333	--	1112	2233	15	3112	2122	14
13	3322	1222	17	2113	2432	18	2222	2431	18
14	3334	4444	29	3221	2234	19	2121	2120	11
15	4332	4222	22	3223	3424	23	1011	1111	7
16	1121	2221	12	3433	4533	28	1121	1101	8
17	012-	1112	--	2232	2212	16	2121	1242	15
18	1123	4452	22	1122	2221	13	2212	2333	18
19	2233	3343	23	2211	2211	12	3233	2232	20
20	3121	1111	11	1011	0113	8	2222	3113	16
21	1112	1122	11	2333	3344	25	2223	2332	19
22	1011	2313	12	4422	2234	23	2121	2111	11
23	2112	2121	12	4233	2332	22	1111	1132	11
24	2111	2221	12	2112	2232	15	2114	4311	17
25	0111	2444	17	1212	2312	14	3121	1111	11
26	4322	3332	22	2111	1123	12	0001	1020	4
27	3223	3333	22	3211	3454	23	0001	0111	4
28	2212	2222	15	3322	2212	17	0000	0020	2
29	1111	2111	9	1101	1111	7	0001	0023	6
30	1112	3221	13	1013	2234	16	2110	0001	5
31	2101	1221	10	4232	3213	20			

Three-hour-range K indices
Belsk, October - December, 2013
The limit of K=9 is 450

Day	October		November		December	
	K	SK	K	SK	K	SK
1	0011 3222	11	2212 1111	11	3321 3101	14
2	5753 3465	38	2101 0112	8	0010 0000	1
3	3000 1220	8	2221 1033	14	1222 3342	19
4	0000 0000	0	0122 1421	13	2110 0121	8
5	0000 0000	0	2122 1201	11	0111 2111	8
6	0011 1112	7	0011 1123	9	1211 1112	10
7	1221 1111	10	1323 3132	18	2121 0133	13
8	0011 1155	14	3112 1110	10	5532 2441	26
9	5443 3424	29	2344 4221	22	1011 2311	10
10	4322 2211	17	3312 2344	22	1211 1100	7
11	1222 2212	14	3333 5431	25	0111 1112	8
12	0111 1133	11	1111 1000	5	0001 0100	2
13	1001 0021	5	0111 2011	7	0000 2211	6
14	0123 4545	24	0001 1111	5	3321 1352	20
15	4324 3124	23	2211 2234	17	2111 1322	13
16	3322 2333	21	3333 2112	18	2221 1112	12
17	3223 3221	18	2212 1121	12	2100 0131	8
18	1010 0120	5	1011 1110	6	1111 1102	8
19	0010 0101	3	0012 1132	10	1100 1332	11
20	0011 0111	5	1212 2010	9	2201 1222	12
21	0010 1110	4	0101 0011	4	1111 0010	5
22	0032 0123	11	1011 0022	7	0001 0100	2
23	1222 1110	10	1232 2120	13	1011 0011	5
24	1112 1010	7	0000 0001	1	0000 0102	3
25	0120 0011	5	0000 0000	0	2112 3221	14
26	0011 0001	3	0001 0111	4	0001 1110	4
27	0111 2110	7	0000 1100	2	0000 0011	2
28	1111 1000	5	0000 0111	3	0001 1111	5
29	0012 2133	12	1212 2241	15	2111 1220	10
30	1122 3344	20	2112 2244	18	0011 1100	4
31	2112 2323	16			1121 2121	11

Three-hour-range E indices
based on power spectrum estimation(*)
Belsk, January - March, 2013

Day	January		February		March	
	E	SE	E	SE	E	SE
1	0000 0000	0	2001 1223	11	4445 4565	37
2	0011 1112	7	1323 2352	21	4331 2454	26
3	1000 0000	1	3001 1111	8	3322 2223	19
4	0001 0001	2	1000 1330	8	3011 1001	7
5	0001 0010	2	0111 1000	4	3012 0121	10
6	0001 0121	5	0000 0011	2	2200 0001	5
7	1001 0001	3	1122 2122	13	0011 0001	3
8	0101 0114	8	2222 3212	16	0011 1020	5
9	2001 1021	7	1101 0011	5	4112 2221	15
10	0000 0000	0	2111 0241	12	0001 0213	7
11	0001 1003	5	1110 0122	8	3211 0100	8
12	2101 0010	5	1001 1223	10	1111 2132	12
13	3011 3435	20	3312 1255	22	1110 0011	5
14	3212 3332	19	4333 3223	23	0112 3111	10
15	1111 2030	9	0101 1343	13	0332 1001	10
16	0001 1234	11	1000 2541	13	4432 1121	18
17	3312 3543	24	0122 3441	17	2165 5666	37
18	2312 4224	20	0001 1014	7	2122 1122	13
19	4010 1235	16	0112 2323	14	1110 1124	11
20	4332 4000	16	1112 2231	13	2221 2245	20
21	3000 1111	7	3221 1134	17	5541 1111	19
22	0000 0000	0	2222 3335	22	0002 1233	11
23	0000 0000	0	3102 3144	18	1012 3354	19
24	1000 0000	1	1101 0212	8	2111 1120	9
25	0011 0224	10	0001 1113	7	0011 0121	6
26	5233 4565	33	1111 1131	10	1101 0000	3
27	4211 1421	16	2121 1101	9	1333 3645	28
28	1000 1133	9	1121 2025	14	4112 1423	18
29	1000 1100	3			4343 4553	31
30	0000 0000	0			5522 2143	24
31	0000 0003	3			0000 0123	6

* - see literature: Reda and Jankowski, 2004

Three-hour-range E indices
based on power spectrum estimation(*)
Belsk, April – June, 2013

Day	April		May		June	
	E	SE	E	SE	E	SE
1	1122 1213	13	3344 5364	32	5665 5343	37
2	2100 0133	10	4312 1242	19	4434 4333	28
3	0001 1011	4	0111 2121	9	3222 2333	20
4	2201 2010	8	2122 1223	15	3222 1122	15
5	0001 1011	4	3122 3420	17	3112 2111	12
6	1112 1122	11	2123 3223	18	1322 4544	25
7	1111 2220	10	4233 3321	21	6544 3322	29
8	0010 0000	1	3121 1221	13	2333 1001	13
9	1112 0111	8	1111 1110	7	1121 3432	17
10	0112 1114	11	0202 2000	6	3323 3320	19
11	0012 1202	8	0202 1011	7	0011 4412	13
12	1111 2110	8	1212 1101	9	1111 1101	7
13	2312 0114	14	0111 1310	8	2101 1100	6
14	2333 2322	20	1023 3221	14	1102 1011	7
15	1011 1032	9	0022 4221	13	2122 0101	9
16	0000 0223	7	4322 4434	26	0001 0110	3
17	1111 2000	6	2311 2342	18	1112 1111	9
18	1001 0010	3	4523 2252	25	0111 1111	7
19	0000 1001	2	5222 2324	22	2211 1223	14
20	0012 2100	6	2111 2322	14	3212 3344	22
21	0000 0210	3	2111 1122	11	4323 3343	25
22	2101 1101	7	4123 3333	22	3332 3253	24
23	0111 2223	12	1412 3232	18	4433 2443	27
24	4324 5354	30	1323 4355	26	3322 4552	26
25	3213 2342	20	4324 4555	32	4222 1222	17
26	2433 2344	25	5442 3542	29	0101 0211	6
27	3121 2322	16	2323 4353	25	1011 4323	15
28	0002 2232	11	3322 2210	15	3323 4644	29
29	4001 1011	8	0000 0000	0	5644 5554	38
30	2002 2213	12	0001 1100	3	4213 3433	23
31			0012 2444	17		

* - see literature: Reda and Jankowski, 2004

Three-hour-range E indices
based on power spectrum estimation(*)
Belsk, July - September, 2013

Day	July		August		September	
	E	SE	E	SE	E	SE
1	4222 1110	13	0101 1300	6	4221 3333	21
2	0000 1210	4	0001 1110	4	1233 3210	15
3	1001 0211	6	0000 1122	6	1112 2124	14
4	1101 1221	9	1122 2645	23	1013 1122	11
5	2211 3342	18	5423 2333	25	0001 0021	4
6	3443 4334	28	3112 2112	13	1111 0133	11
7	4110 1210	10	1110 1010	5	1111 0101	6
8	0211 1120	8	0010 1112	6	2222 2110	12
9	0012 3433	16	0112 3231	13	0111 0100	4
10	5534 4454	34	1122 3111	12	0002 3433	15
11	2343 4552	28	1111 2111	9	2002 2132	12
12	22-2 2333	--	1001 1233	11	3012 1133	14
13	4322 1223	19	2002 1432	14	3221 2431	18
14	3333 4455	30	4221 1234	19	1121 1120	9
15	4433 4222	24	3224 3524	25	1001 0112	6
16	1011 2231	11	4543 4544	33	1111 1101	7
17	001- 1112	--	2222 2112	14	1121 1233	14
18	1023 4552	22	2022 1221	12	2102 2334	17
19	3243 4343	26	1101 1210	7	3233 2332	21
20	3111 0000	6	1000 0114	7	1222 3114	16
21	0011 1222	9	2323 3445	26	2213 3332	19
22	0001 2313	10	5422 2344	26	2120 2100	8
23	2101 2111	9	5232 2442	24	0111 0032	8
24	2011 1111	8	3112 3222	16	2114 4411	18
25	0111 2444	17	1222 2312	15	3121 0000	7
26	4422 3332	23	1111 1023	10	0000 0010	1
27	3223 4334	24	3101 4464	23	0000 0010	1
28	2221 2223	16	4312 3112	17	0000 0010	1
29	1111 2101	8	0001 0111	4	0000 0013	4
30	0112 3221	12	0013 2245	17	2100 0000	3
31	2101 1131	10	5233 3213	22		

* - see literature: Reda and Jankowski, 2004

Three-hour-range E indices
based on power spectrum estimation(*)
Belsk, October - December, 2013

Day	October		November		December	
	E	SE	E	SE	E	SE
1	0011 3123	11	2212 1110	10	4321 3101	15
2	6763 2466	40	2001 0002	5	0000 0000	0
3	4000 0220	8	3221 0033	14	1212 4342	19
4	0000 0000	0	0022 0421	11	2100 0131	8
5	0000 0000	0	1022 0201	8	0111 1110	6
6	0001 0002	3	0011 1123	9	1101 0012	6
7	1211 1111	9	1324 4122	19	2010 0043	10
8	0001 1156	14	4111 0100	8	6532 2542	29
9	5543 4424	31	3444 4221	24	0000 2412	9
10	5412 2201	17	3313 2344	23	1211 1100	7
11	1211 2222	13	4443 5531	29	0011 1002	5
12	0001 1123	8	0011 0000	2	0000 0000	0
13	1000 0021	4	0011 2000	4	0000 2111	5
14	0124 4555	26	0001 1111	5	4421 1462	24
15	5424 2114	23	2111 2345	19	2111 1322	13
16	4322 2432	22	4333 2112	19	2220 0112	10
17	4222 3221	18	2212 1021	11	2100 0140	8
18	0000 0020	2	0011 0100	3	0010 0103	5
19	0000 0100	1	0002 1131	8	2100 1331	11
20	0000 0011	2	1211 2000	7	2201 1232	13
21	0010 0100	2	0000 0001	1	1111 0010	5
22	0021 0123	9	0000 0012	3	0001 0000	1
23	1222 0000	7	0233 3110	13	0000 0011	2
24	0101 0000	2	0000 0000	0	0000 0101	2
25	0010 0001	2	0000 0000	0	2012 3210	11
26	0001 0001	2	0000 0001	1	0000 1100	2
27	0011 1010	4	0000 0100	1	0010 0010	2
28	0000 0000	0	0000 0100	1	0000 0111	3
29	0012 1133	11	1212 1251	15	2101 0210	7
30	0123 3435	21	2012 2234	16	0011 0100	3
31	2012 2323	15			1121 1111	9

* - see literature: Reda and Jankowski, 2004

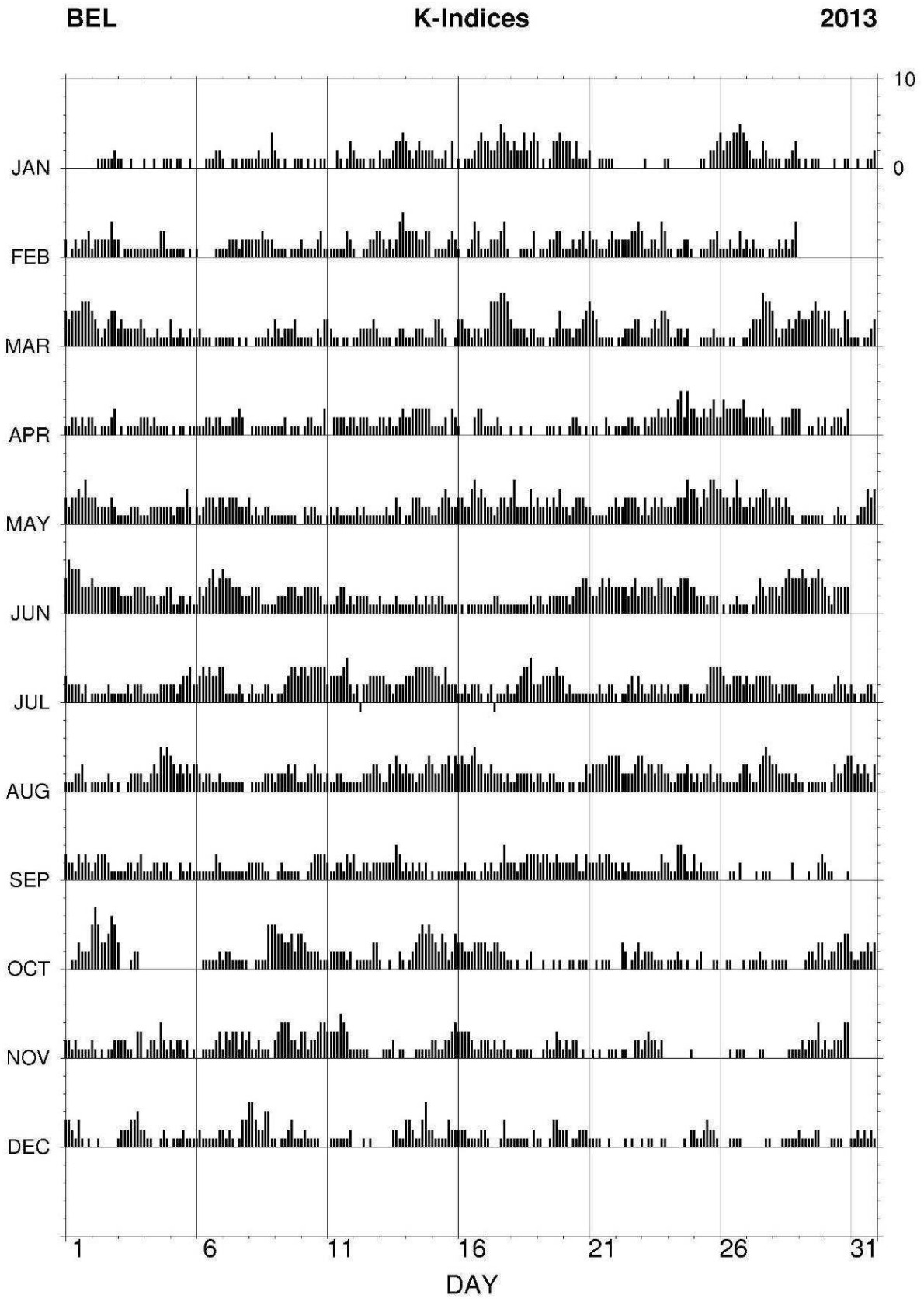

Fig. 4. K-indices in graphical form, Belsk 2013.

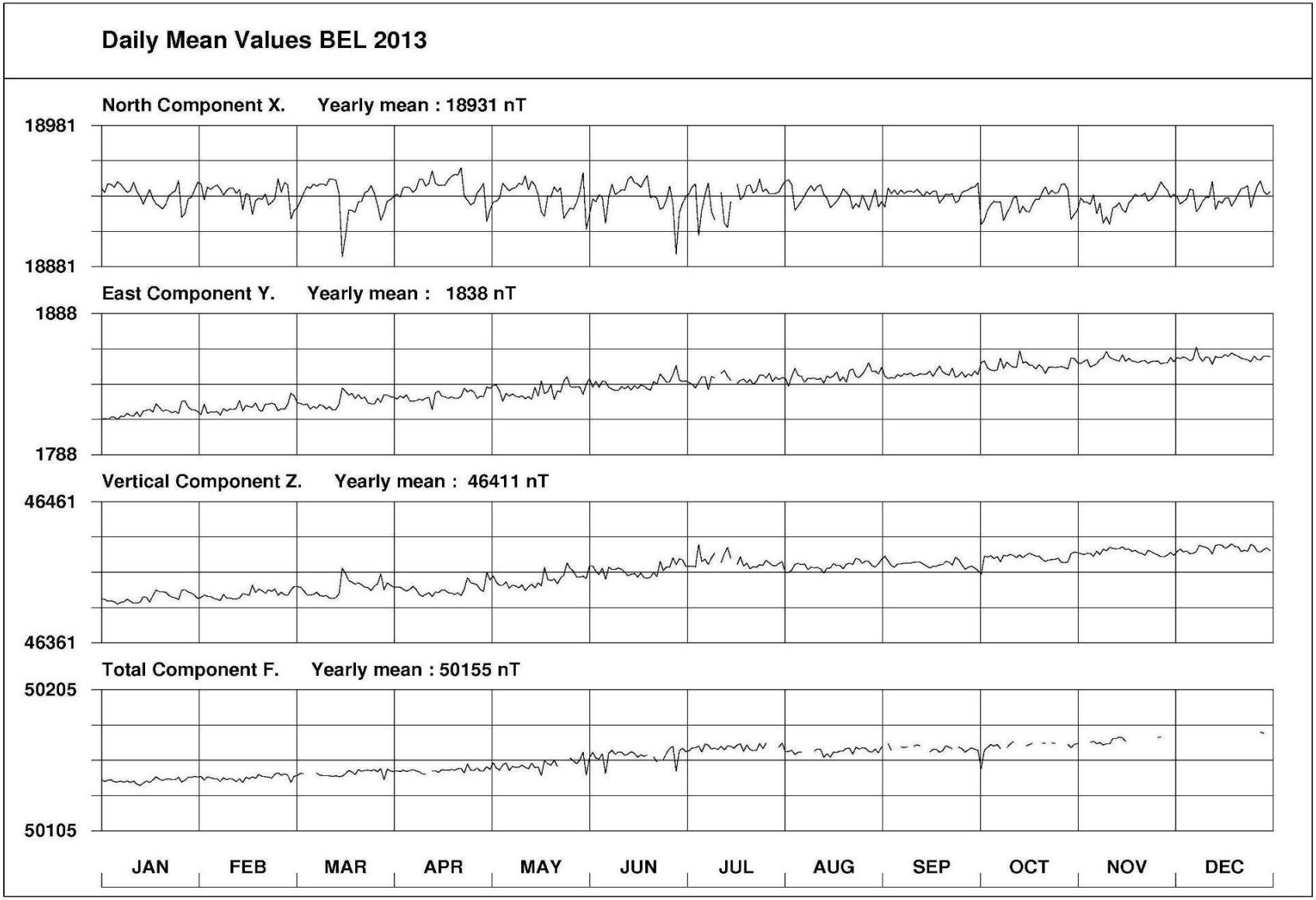

Fig. 5. Daily mean data plot for Belsk 2013.

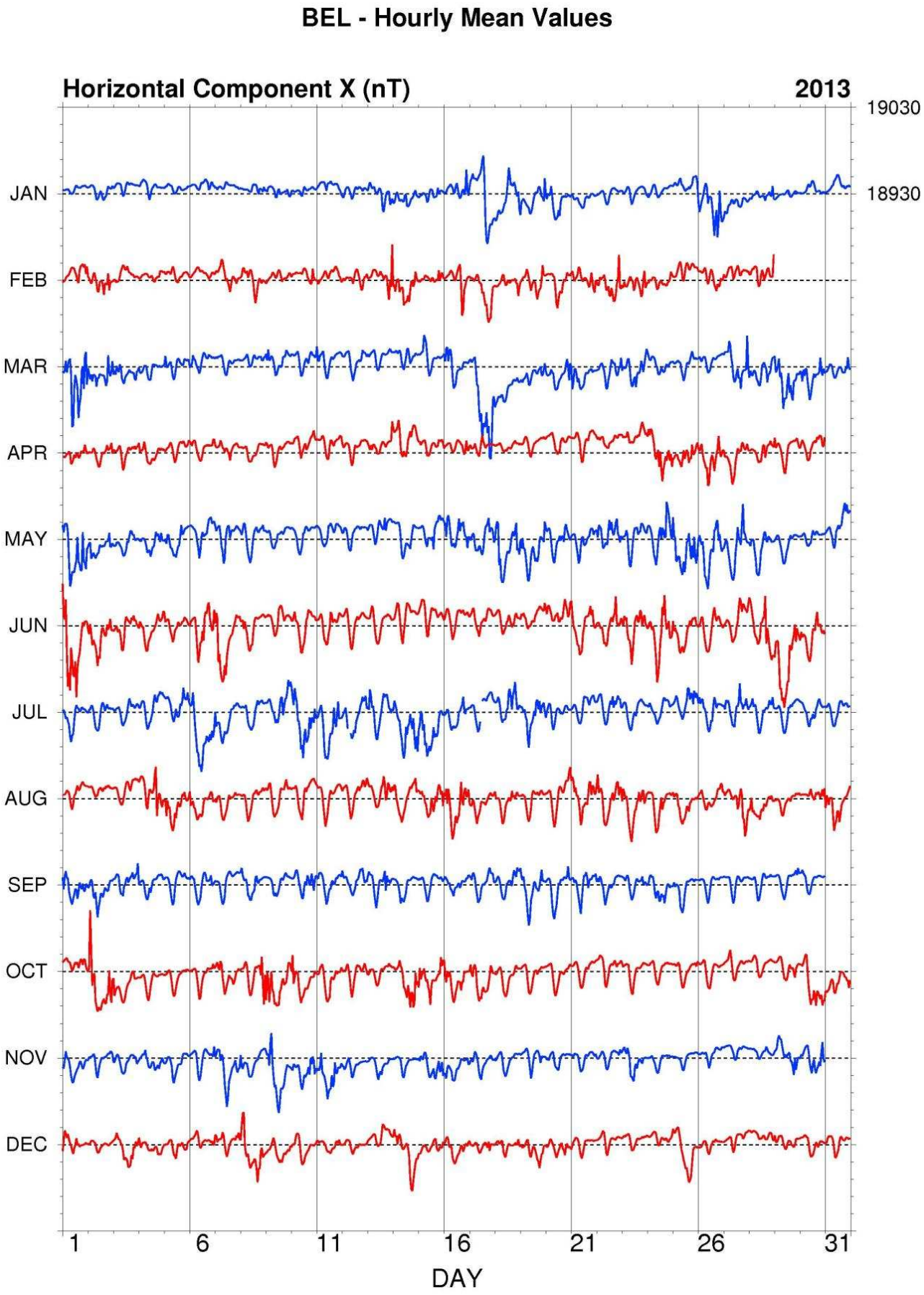

Fig. 6. Hourly mean data plot of X component for Belsk 2013.

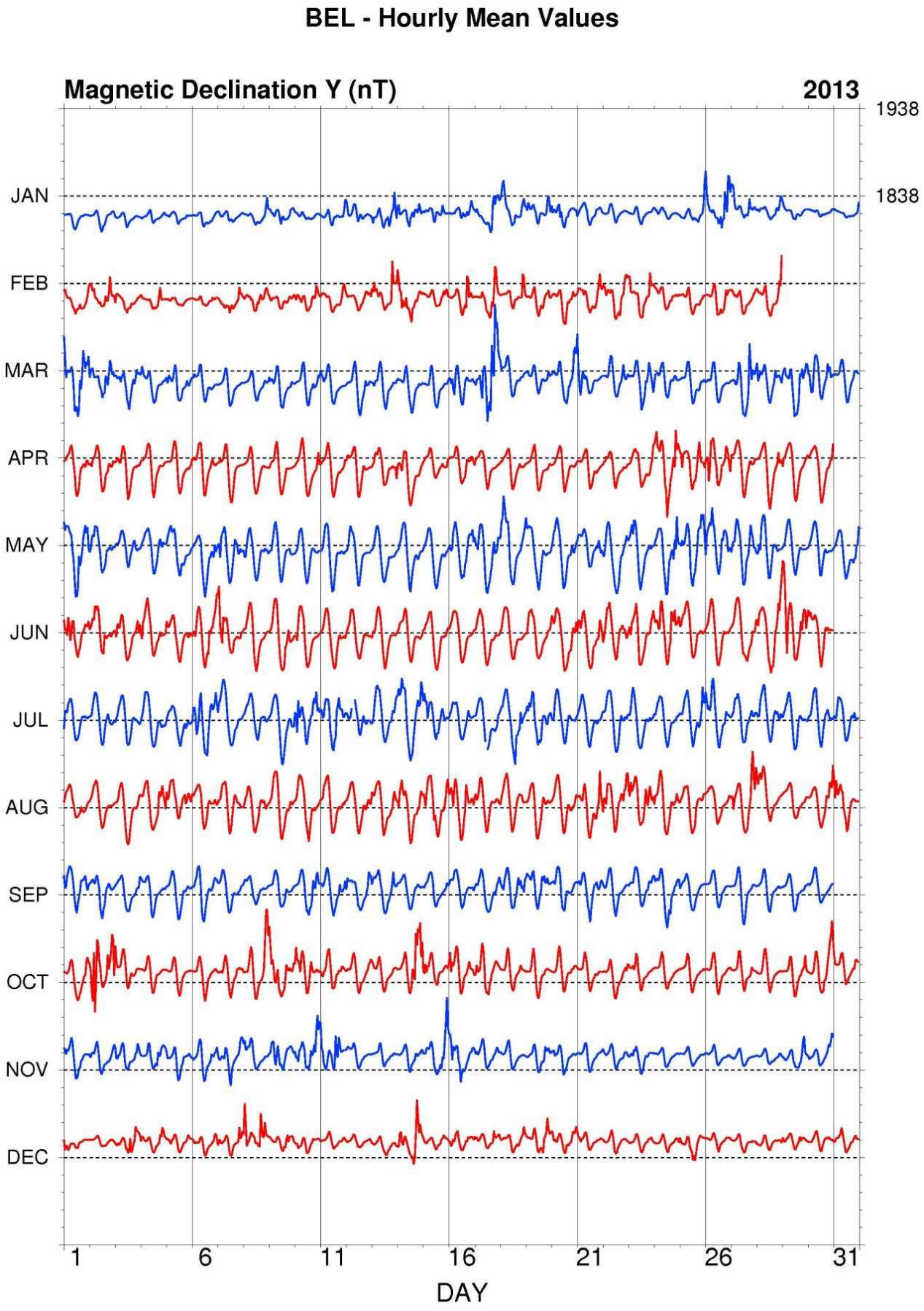

Fig. 7. Hourly mean data plot of Y component for Belsk 2013.

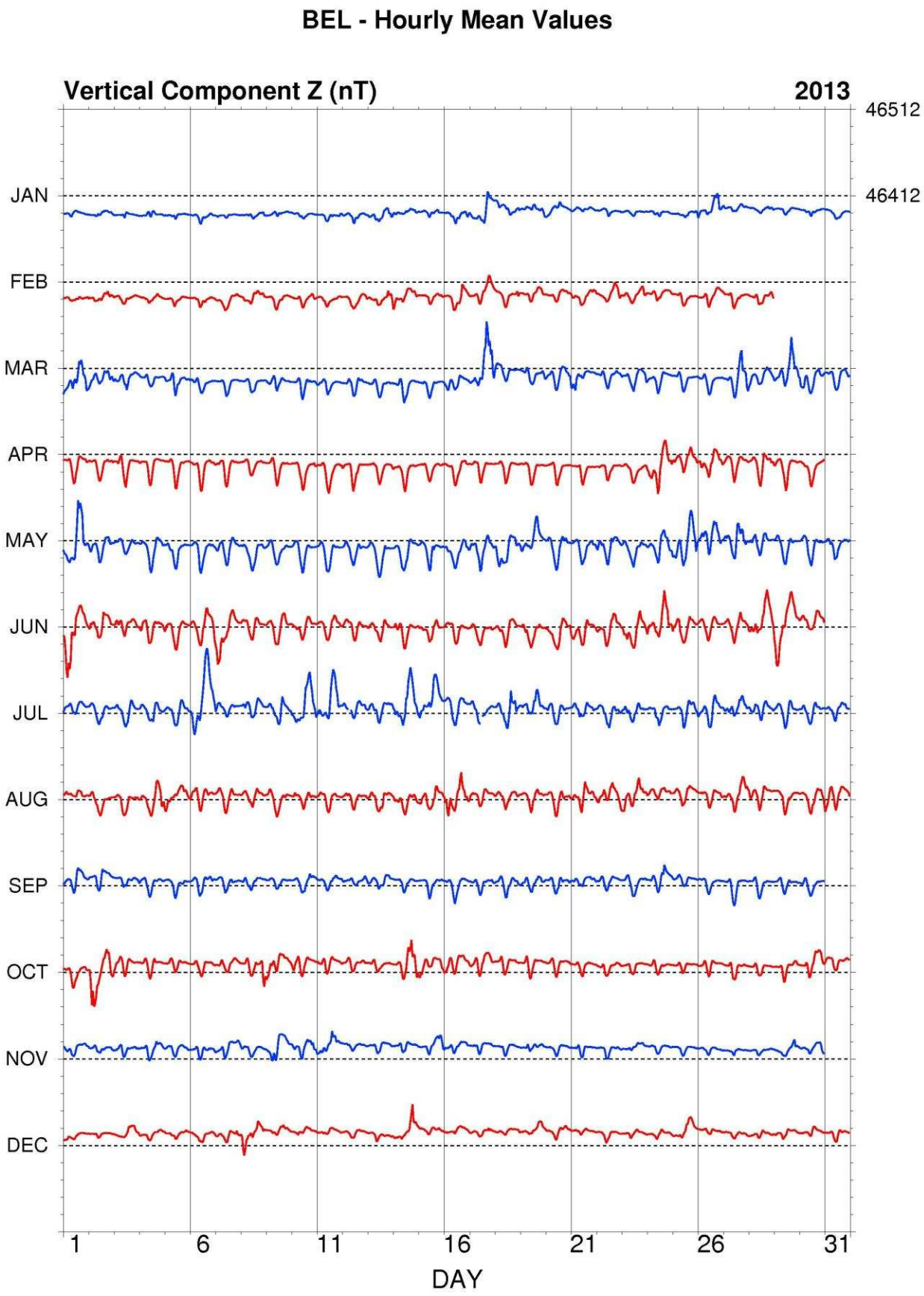

Fig. 8. Hourly mean data plot of Z component for Belsk 2013.

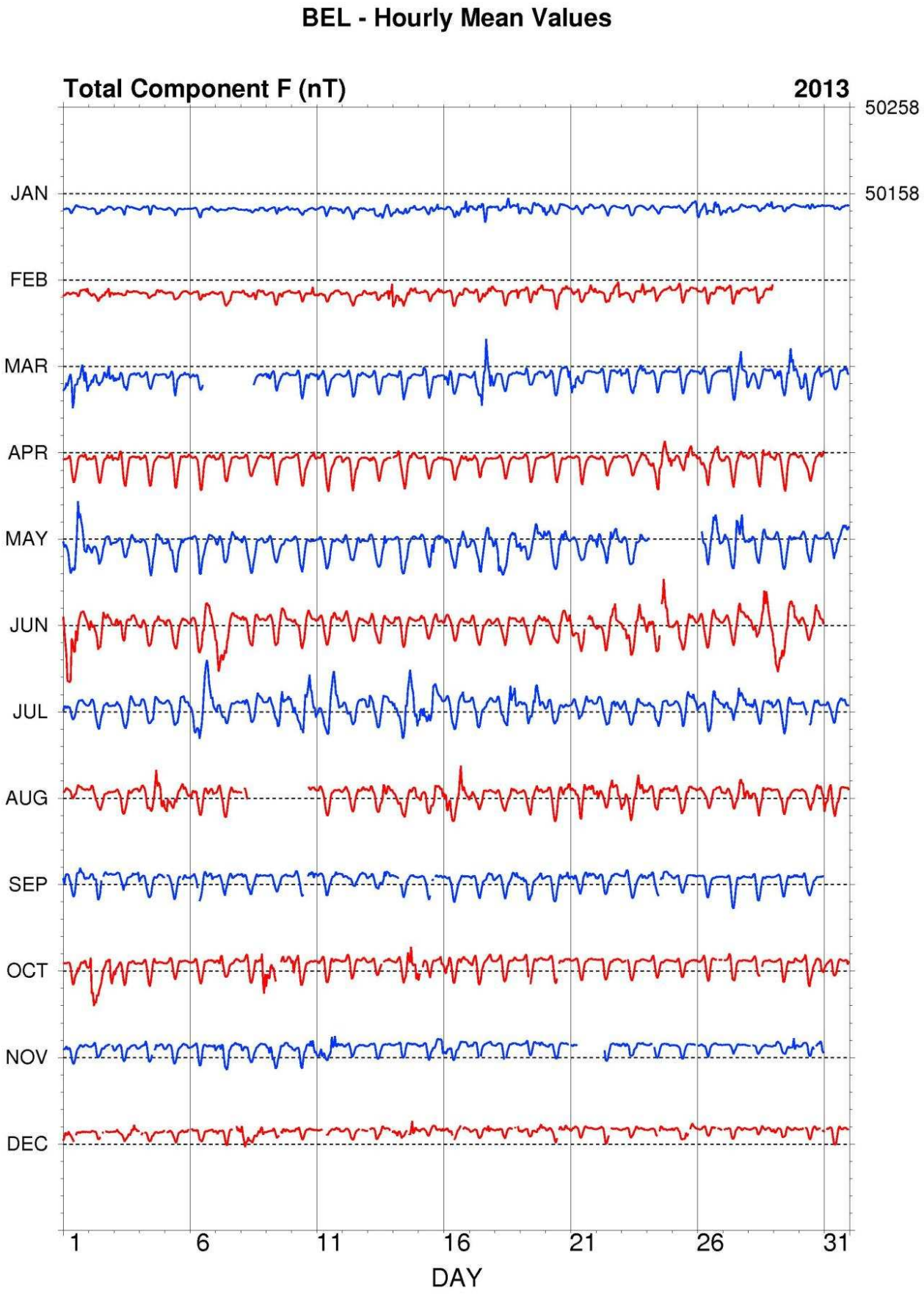

Fig. 9. Hourly mean data plot of F component for Belsk 2013.

7. TABLES AND PLOTS FOR HEL OBSERVATORY

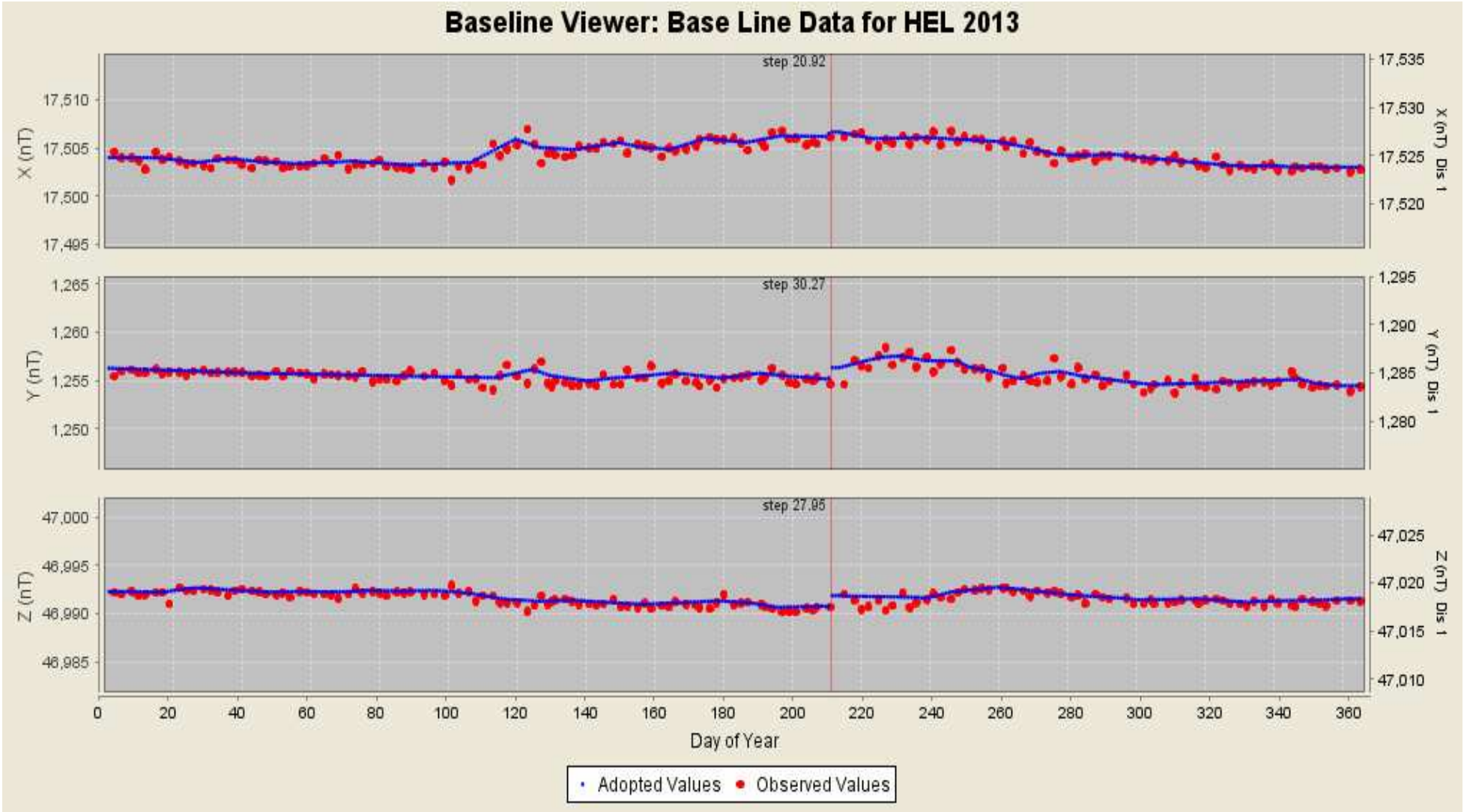

Fig. 10. Base values of set 1, Hel 2013.

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
59	2011	4 09.2	17564	47014	17518	1272	69 30.9	50188
60	2012	4 18.7	17562	47053	17512	1321	69 32.0	50223
61	2013	4 28.2	17567	47084	17513	1369	69 32.4	50254

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

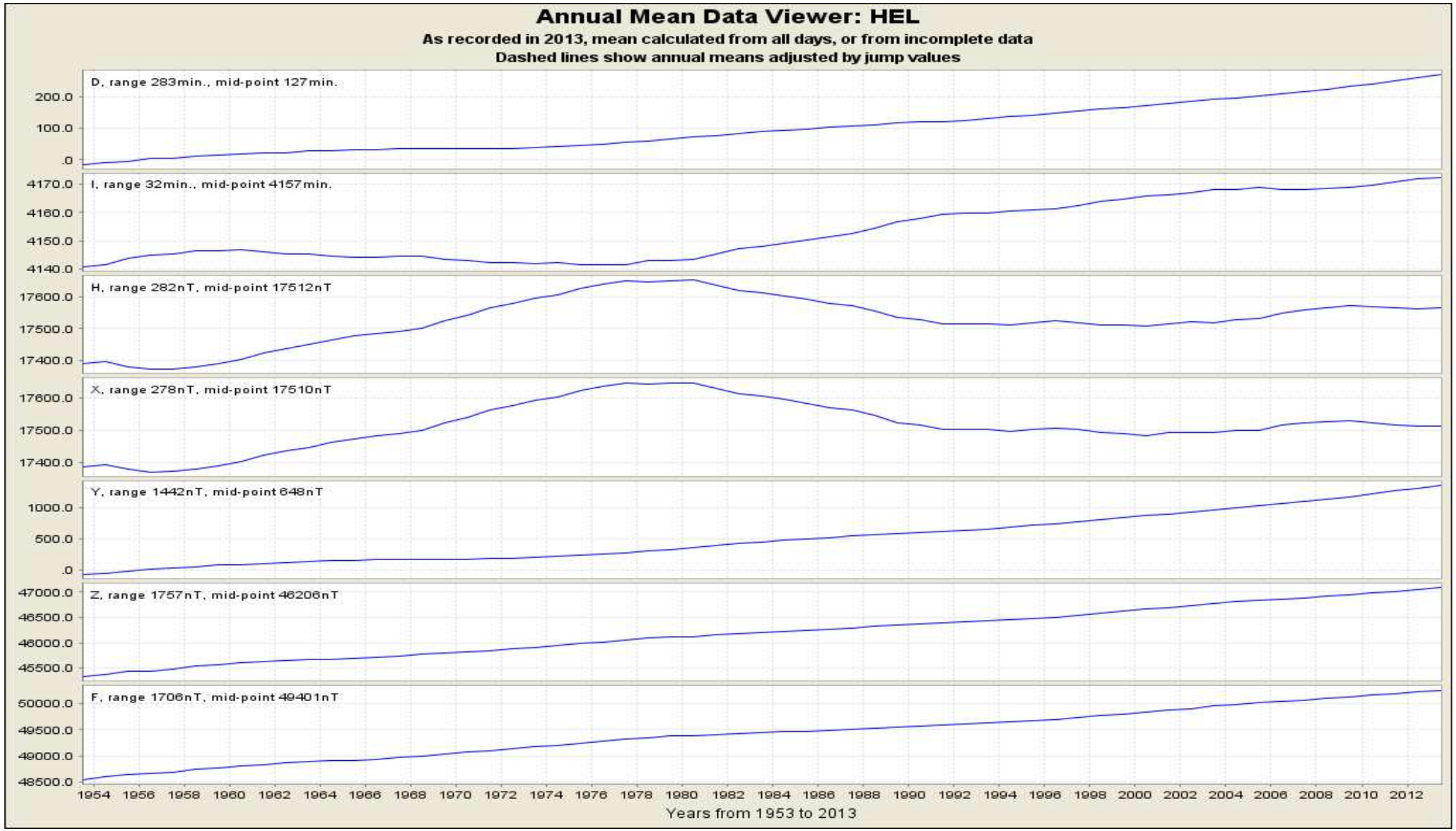

Fig. 11. Secular changes of H, X, Y, Z, F, D and I at Hel.

MONTHLY AND YEARLY MEAN VALUES OF MAGNETIC ELEMENTS

HLP 2013

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
NORTH COMPONENT: 17000 + ... in nT													
All days	515	515	510	518	514	512	514	514	515	509	510	513	513
Quiet days	517	519	520	520	517	519	504	518	514	516	513	517	516
Disturbed days	508	509	496	519	505	496	504	515	515	511	507	511	508
EAST COMPONENT: 1000 + ... in nT													
All days	348	351	356	358	363	369	372	375	377	383	386	389	369
Quiet days	347	350	352	357	363	368	372	371	376	383	385	387	368
Disturbed days	350	353	359	359	368	373	372	373	377	381	387	388	370
VERTICAL COMPONENT: 47000 + ... in nT													
All days	68	69	74	73	79	85	91	88	90	94	99	100	84
Quiet days	67	68	70	72	77	83	94	88	91	93	98	100	83
Disturbed days	70	71	78	73	81	83	94	87	89	90	100	102	85

Three-hour-range K indices
Hel, January - March, 2013
The limit of K=9 is 550

Day	January		February		March	
	K	SK	K	SK	K	SK
1	0000 0000	0	1001 1223	10	4344 4455	33
2	0011 1112	7	1222 2242	17	4321 2343	22
3	0100 1000	2	2011 2111	9	2222 2223	17
4	1000 0001	2	1011 1331	11	2111 2111	10
5	0001 0010	2	0111 1010	5	3112 1121	12
6	0001 1121	6	0010 0011	3	1211 1001	7
7	1000 1001	3	1122 2122	13	1111 1101	7
8	0112 1113	10	2222 2222	16	0011 1120	6
9	2001 0011	5	1111 0011	6	3212 2221	15
10	0000 0010	1	2111 0231	11	1111 0213	10
11	0001 1012	5	1111 1122	10	3211 1110	10
12	2101 0010	5	1002 2223	12	1112 3232	15
13	2111 2334	17	3212 1245	20	1111 0022	8
14	3212 2222	16	3332 2223	20	0102 3211	10
15	1111 2030	9	0001 1232	9	1322 1101	11
16	0001 1134	10	1000 3431	12	3322 2222	18
17	3322 3543	25	1122 2331	15	2255 5665	36
18	2322 4233	21	0001 1013	6	3223 2122	17
19	3010 1334	15	0111 2223	12	1111 1123	11
20	3331 3110	15	1112 2221	12	2211 2234	17
21	2001 0111	6	3221 1123	15	4331 1101	14
22	0000 0000	0	2222 2334	20	1102 2123	12
23	0010 0000	1	3102 2133	15	1011 3244	16
24	1000 0000	1	1001 1211	7	3111 2110	10
25	0011 0123	8	0011 2122	9	0011 1121	7
26	4233 3454	28	2111 1121	10	1101 1001	5
27	3211 1311	13	1111 2001	7	2223 3544	25
28	1110 1123	10	1021 2024	12	4112 1323	17
29	1000 1100	3			3333 4543	28
30	0000 0011	2			4422 2143	22
31	0010 0102	4			1111 1223	12

Three-hour-range K indices
Hel, April - June, 2013
The limit of K=9 is 550

Day	April			May			June		
	K		SK	K		SK	K		SK
1	1122	2102	11	3233	5353	27	4555	5333	33
2	1101	1123	10	3322	2231	18	3333	3333	24
3	0000	1112	5	1111	2221	11	3222	3233	20
4	2112	2110	10	2112	1213	13	3222	2222	17
5	0001	1011	4	2122	3420	16	2112	2121	12
6	1112	2122	12	2123	3323	19	1223	4634	25
7	1112	2310	11	3223	3221	18	5433	3322	25
8	0011	1000	3	3121	2211	13	2333	2101	15
9	1112	1011	8	2111	1110	8	1121	3432	17
10	0122	2113	12	0212	2111	10	2333	3320	19
11	0012	1212	9	0212	1111	9	0012	3312	12
12	1122	2110	10	1112	1200	8	1112	2101	9
13	2212	1113	13	1121	1321	12	2111	1100	7
14	2233	3323	21	1023	3222	15	1002	1121	8
15	1111	2032	11	0023	5321	16	2112	1111	10
16	1000	0233	9	3322	4534	26	0001	1111	5
17	1111	2100	7	2222	2332	18	1112	1111	9
18	1000	0010	2	4522	3242	24	0111	1121	8
19	0001	0001	2	3222	2324	20	2111	2222	13
20	0012	2101	7	2112	3332	17	2112	3333	18
21	0001	0210	4	2121	1122	12	3223	4333	23
22	2111	2211	11	3223	3332	21	2333	2342	22
23	0212	2322	14	1312	3332	18	3333	2543	26
24	3224	5253	26	1223	3354	23	3322	4442	24
25	3213	3332	20	4324	3554	30	3221	1212	14
26	2433	3333	24	4332	3532	25	0101	1201	6
27	2222	2312	16	2323	4442	24	1011	4323	15
28	0002	3333	14	2323	2210	15	3323	4534	27
29	3000	1011	6	0000	0000	0	4543	4444	32
30	1002	3213	12	0000	1210	4	3224	3333	23
31				0112	2434	17			

Three-hour-range K indices
Hel, July - September, 2013
The limit of K=9 is 550

Day	July			August			September		
	K		SK	K		SK	K		SK
1	3222	2110	13	1112	2310	11	3222	3232	19
2	1011	1211	8	0001	1210	5	2232	3211	16
3	1012	1212	10	0001	2222	9	1012	2123	12
4	1111	1222	11	1022	2535	20	2112	2121	12
5	2112	3332	17	4323	2332	22	0002	1011	5
6	2333	4434	26	3112	2112	13	1112	1132	12
7	4110	2210	11	1111	1010	6	1111	1101	7
8	1111	1221	10	0001	1222	8	2222	2110	12
9	0002	3443	16	1112	3231	14	0111	1111	7
10	4434	4443	30	1122	3121	13	0003	3332	14
11	2333	3441	23	1112	2112	11	1112	2132	13
12	1222	2323	17	1012	2223	13	301-	1222	--
13	3332	1222	18	2013	2432	17	2222	2432	19
14	2334	5443	28	3221	2233	18	2122	2111	12
15	4323	4221	21	3223	3424	23	1000	1111	5
16	1022	2221	12	3433	4533	28	1111	1102	8
17	0011	1111	6	2222	2212	15	1121	2232	14
18	1123	4442	21	1122	2221	13	2202	2333	17
19	2233	3343	23	2111	2211	11	3233	2232	20
20	3112	1000	8	1001	0113	7	2222	3113	16
21	1001	1122	8	2323	3444	25	2213	2332	18
22	0011	2313	11	4421	2334	23	1121	2101	9
23	2102	2211	11	4233	2332	22	1111	0132	10
24	2001	1221	9	3122	3222	17	2113	4311	16
25	0111	2444	17	1112	3312	14	2221	1001	9
26	4322	3332	22	2111	2122	12	0001	1010	3
27	3223	3333	22	3111	3454	22	0000	1011	3
28	2211	1222	13	3312	2211	15	0000	0010	1
29	1112	----	--	0001	1111	5	0000	0022	4
30	----	----	--	0013	3234	16	2010	0000	3
31	----	2221	--	4222	3213	19			

Three-hour-range K indices
Hel, October - December, 2013
The limit of K=9 is 550

Day	October			November			December		
	K		SK	K		SK	K		SK
1	0011	2222	10	2211	1111	10	3221	3101	13
2	5653	3365	36	2001	0002	5	0000	0000	0
3	3000	0220	7	2221	0032	12	1212	3232	16
4	0000	0100	1	0022	1321	11	2110	0121	8
5	0000	0000	0	1021	0101	6	0001	1111	5
6	0000	1002	3	0011	0122	7	1100	0012	5
7	1211	1111	9	1223	3122	16	2110	0033	10
8	0001	1155	13	3112	0100	8	5432	2442	26
9	4443	3324	27	3344	3221	22	1000	2311	8
10	3322	2211	16	3212	2344	21	1111	1100	6
11	1111	2211	10	3333	4431	24	0101	1002	5
12	0011	1133	10	1011	0000	3	0000	0000	0
13	1001	0021	5	0011	2011	6	0000	2111	5
14	0123	3445	22	0001	1111	5	3321	1352	20
15	4324	3114	22	2111	1234	15	2111	1321	12
16	3222	2323	19	3333	2112	18	2211	0112	10
17	3223	2221	17	2112	1121	11	2000	0131	7
18	0010	0020	3	0011	0100	3	0010	0102	4
19	0001	0100	2	0001	1132	8	1100	1331	10
20	0001	0011	3	1111	1010	6	2200	1122	10
21	0010	0100	2	0100	0001	2	1101	0010	4
22	0032	0123	11	1000	0022	5	0001	0000	1
23	1221	1000	7	0222	2110	10	0000	0011	2
24	1102	1000	5	0000	0000	0	0000	0102	3
25	0010	0001	2	0000	0000	0	2111	2211	11
26	0001	0001	2	0000	0101	2	0000	1000	1
27	0011	1010	4	0001	1100	3	0000	0010	1
28	1011	0000	3	0000	1000	1	0000	1111	4
29	00--	2133	--	1211	1241	13	1111	0210	7
30	0122	3334	18	2112	2244	18	0001	0000	1
31	2012	2323	15				1221	1111	10

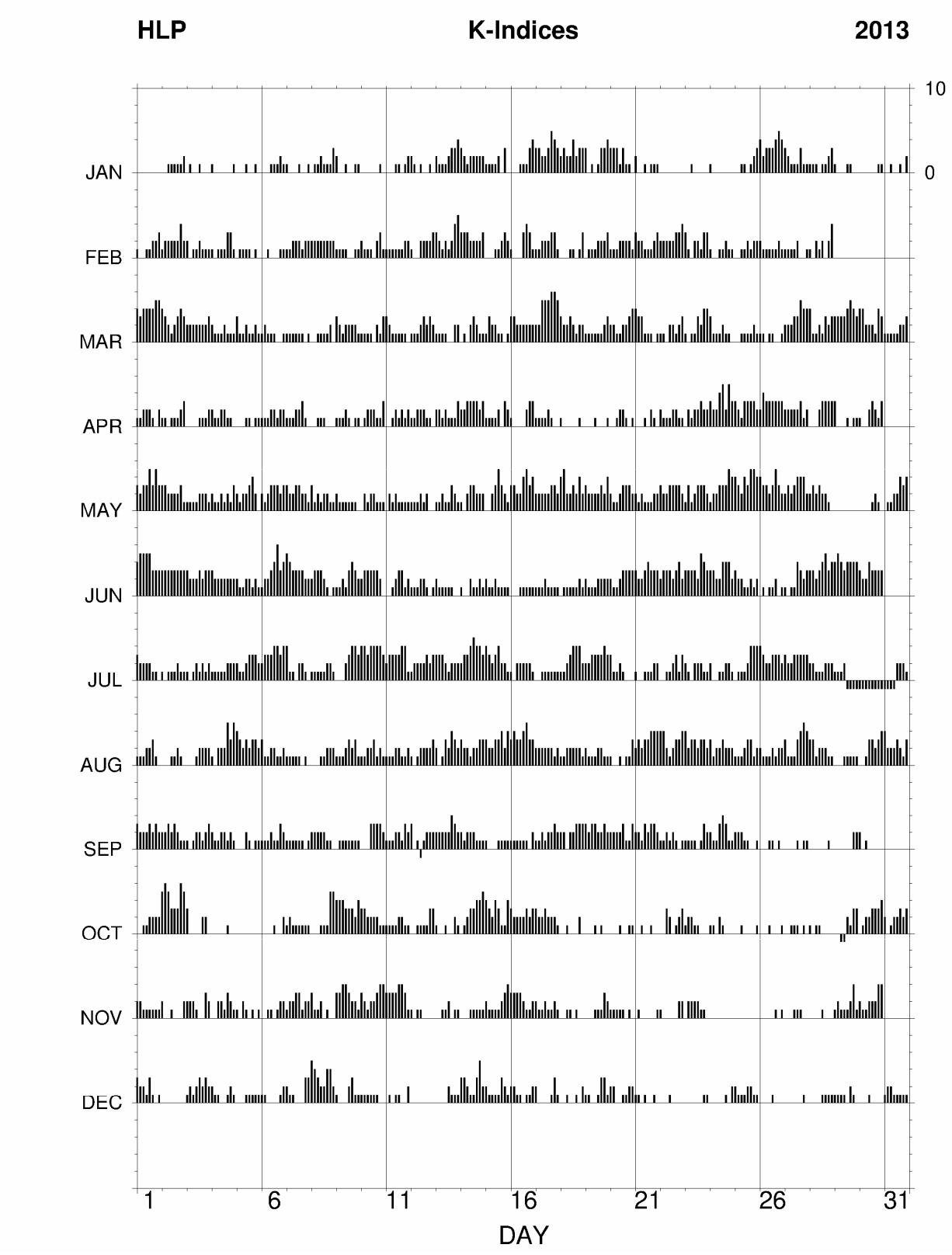

Fig. 12. K-indices in graphical form, Hel 2013.

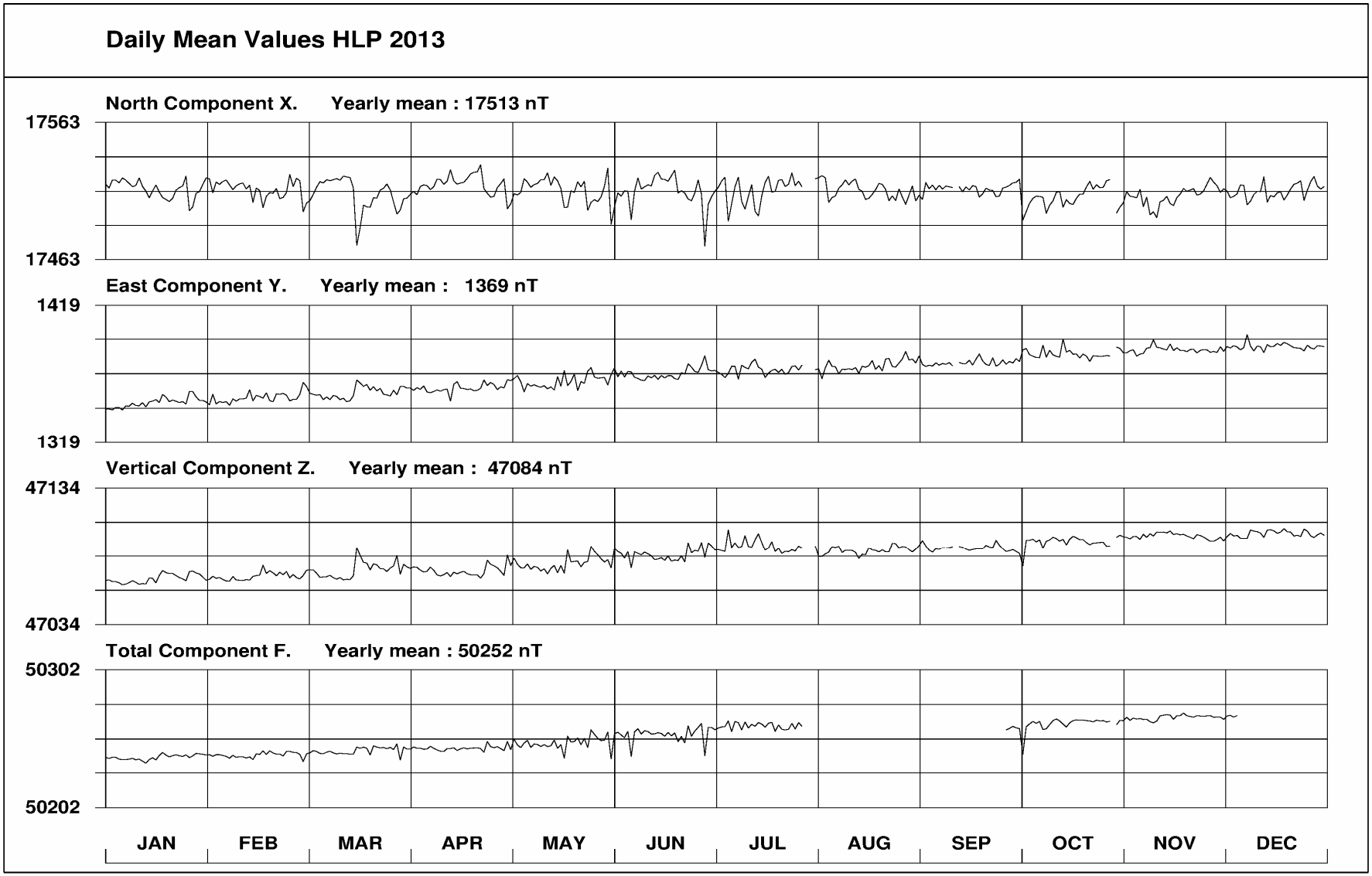

Fig. 13. Daily mean data plot for Hel 2013.

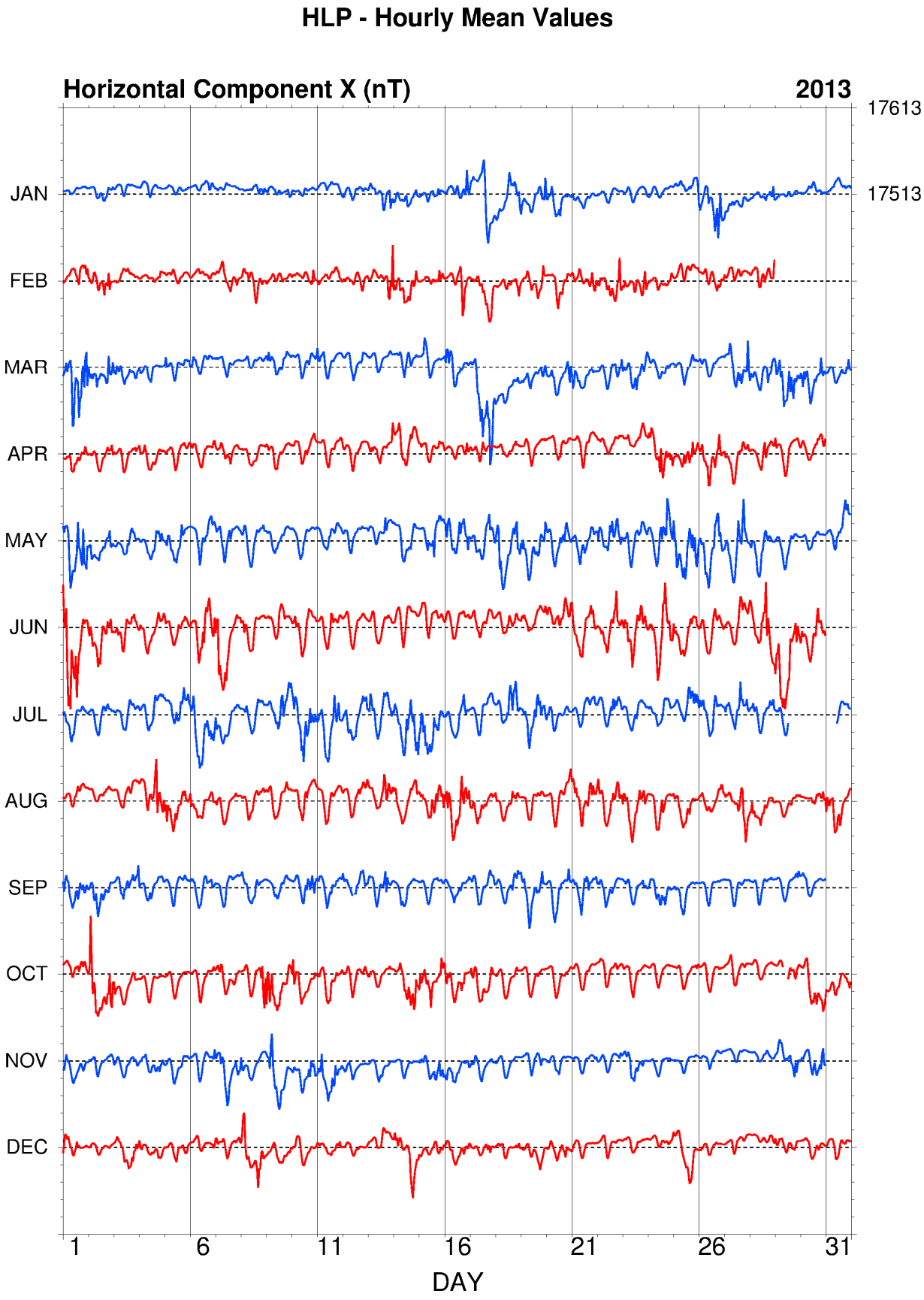

Fig. 14. Hourly mean data plot of X component for Hel 2013.

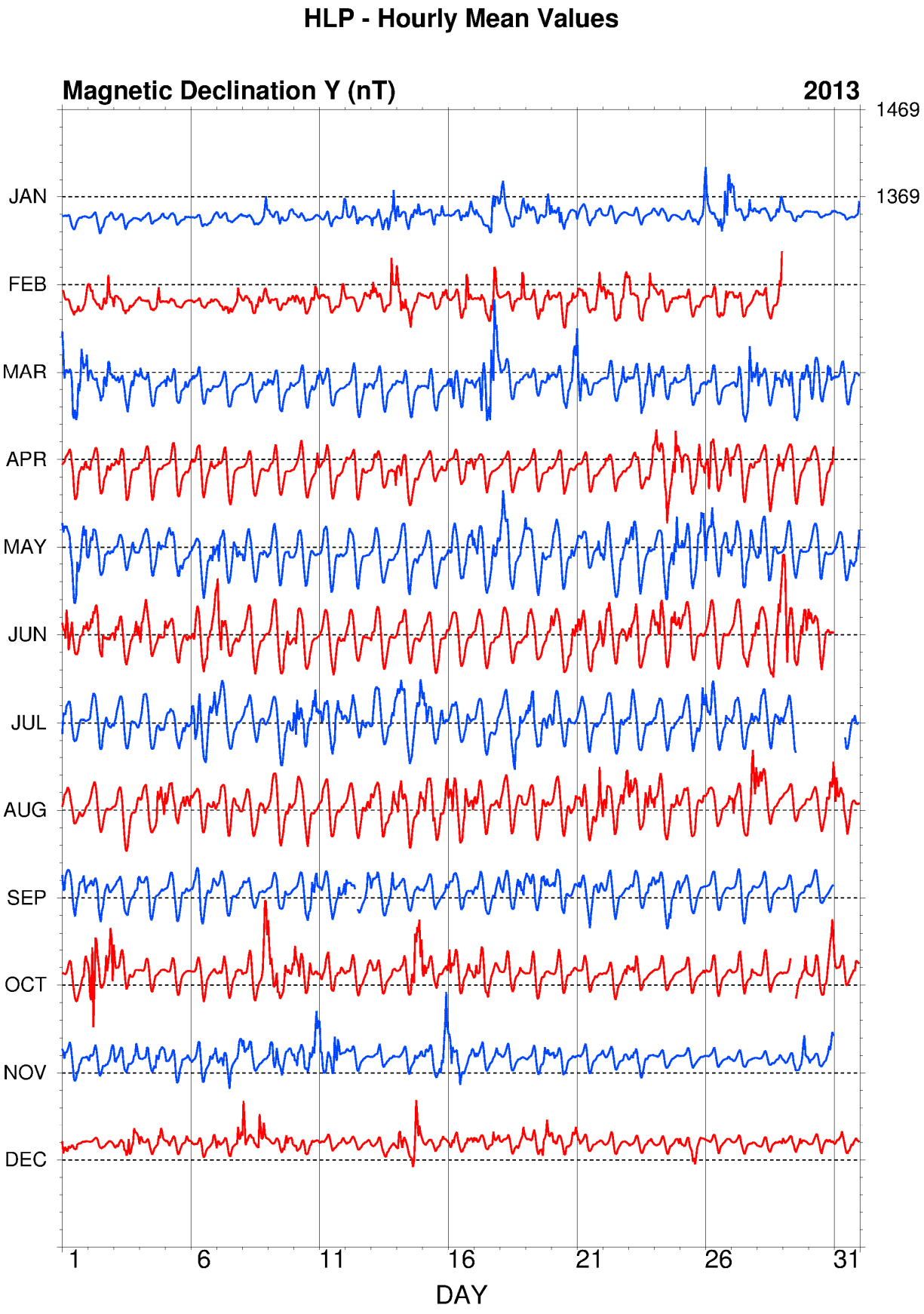

Fig. 15. Hourly mean data plot of Y component for Hel 2013.

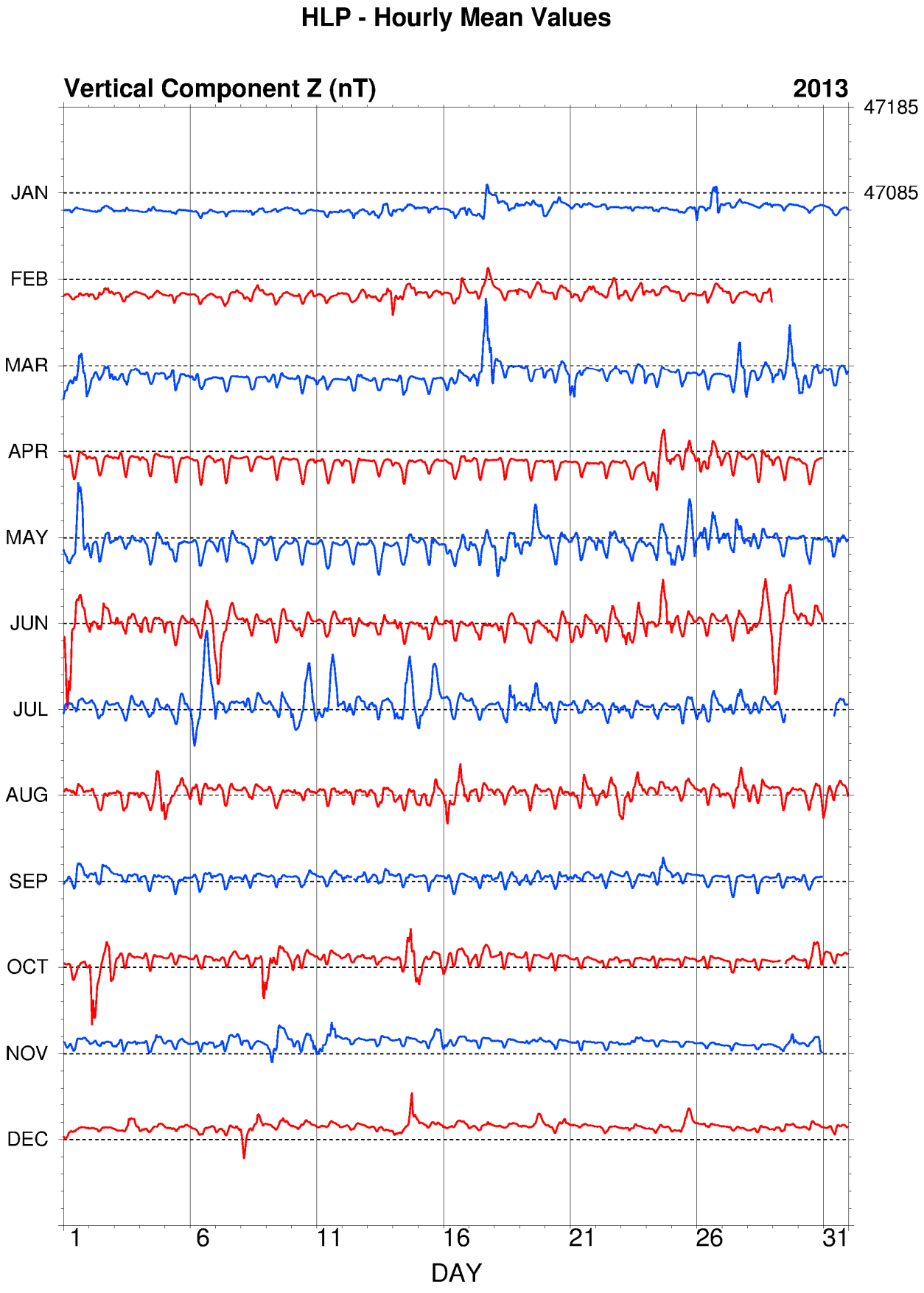

Fig. 16. Hourly mean data plot of Z component for Hel 2013.

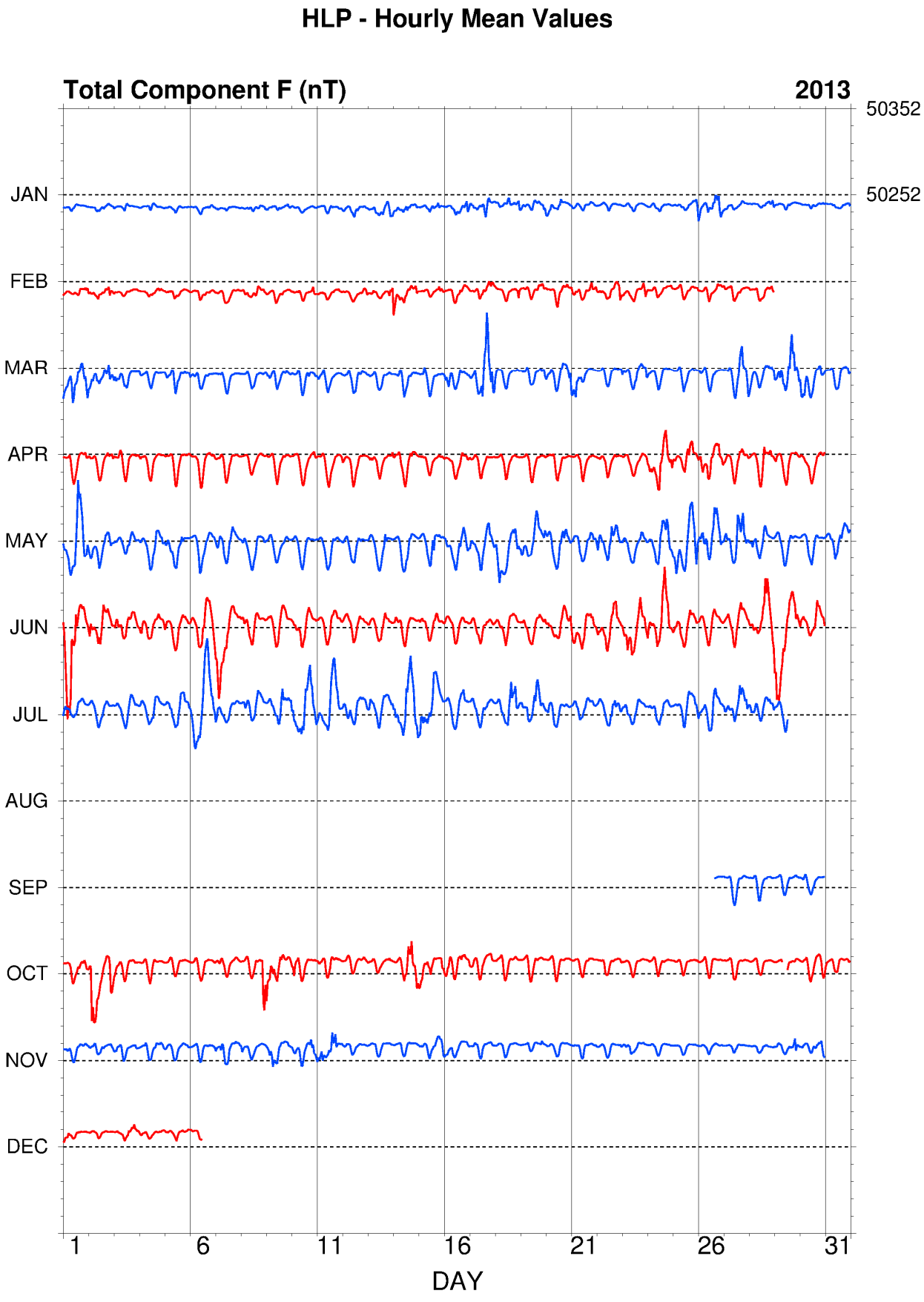

Fig. 17. Hourly mean data plot of F component for Hel 2013.

8. TABLES AND PLOTS FOR HORNSUND OBSERVATORY

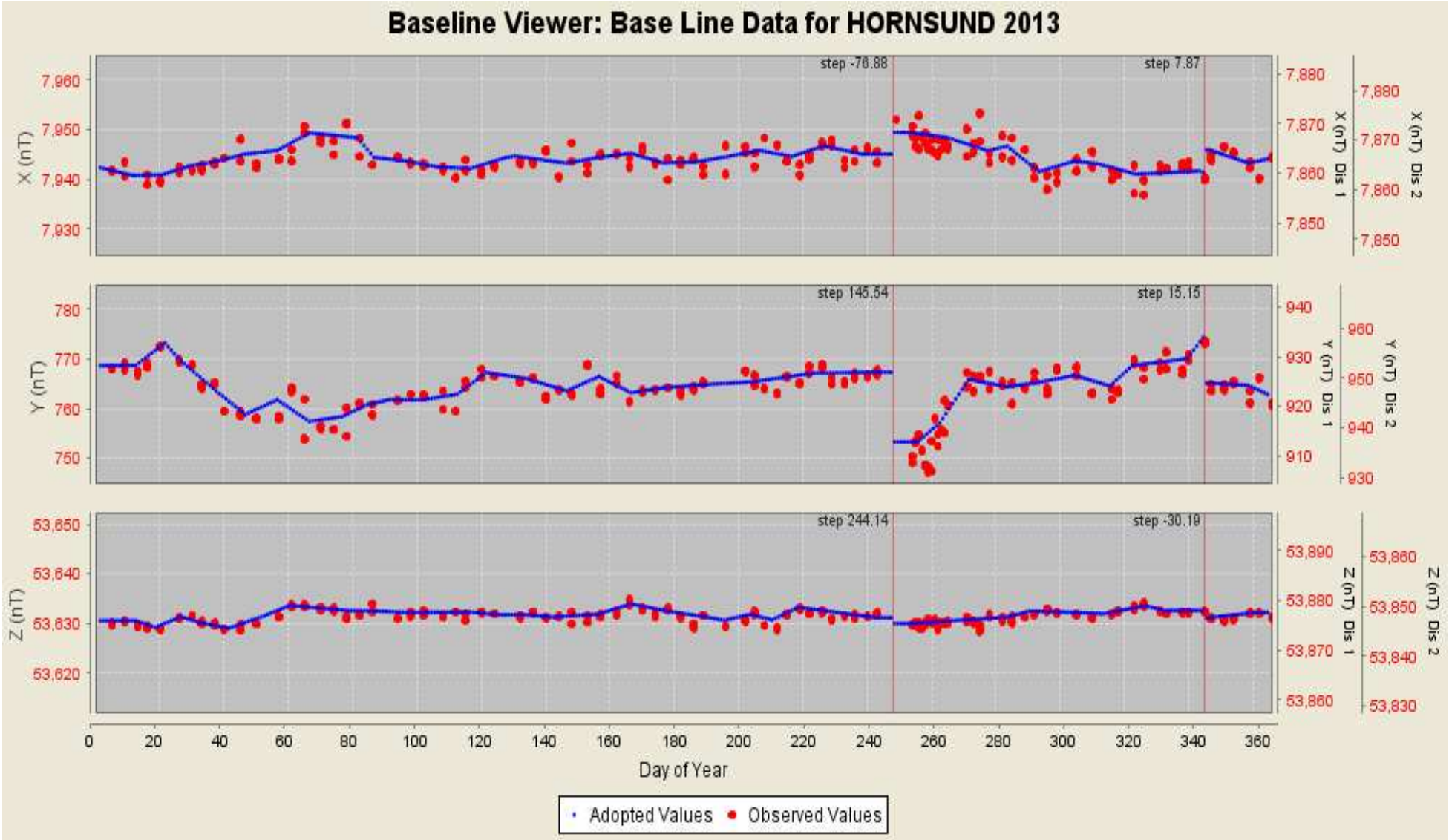

Fig. 18. Base values, Hornsund 2013.

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
2011	6 05.8	7920	53868	7875	841	81 38.2	54447
2012	6 28.2	7910	53900	7860	891	81 39.1	54477
2013	6 50.8	7903	53920	7846	942	81 39.7	54497

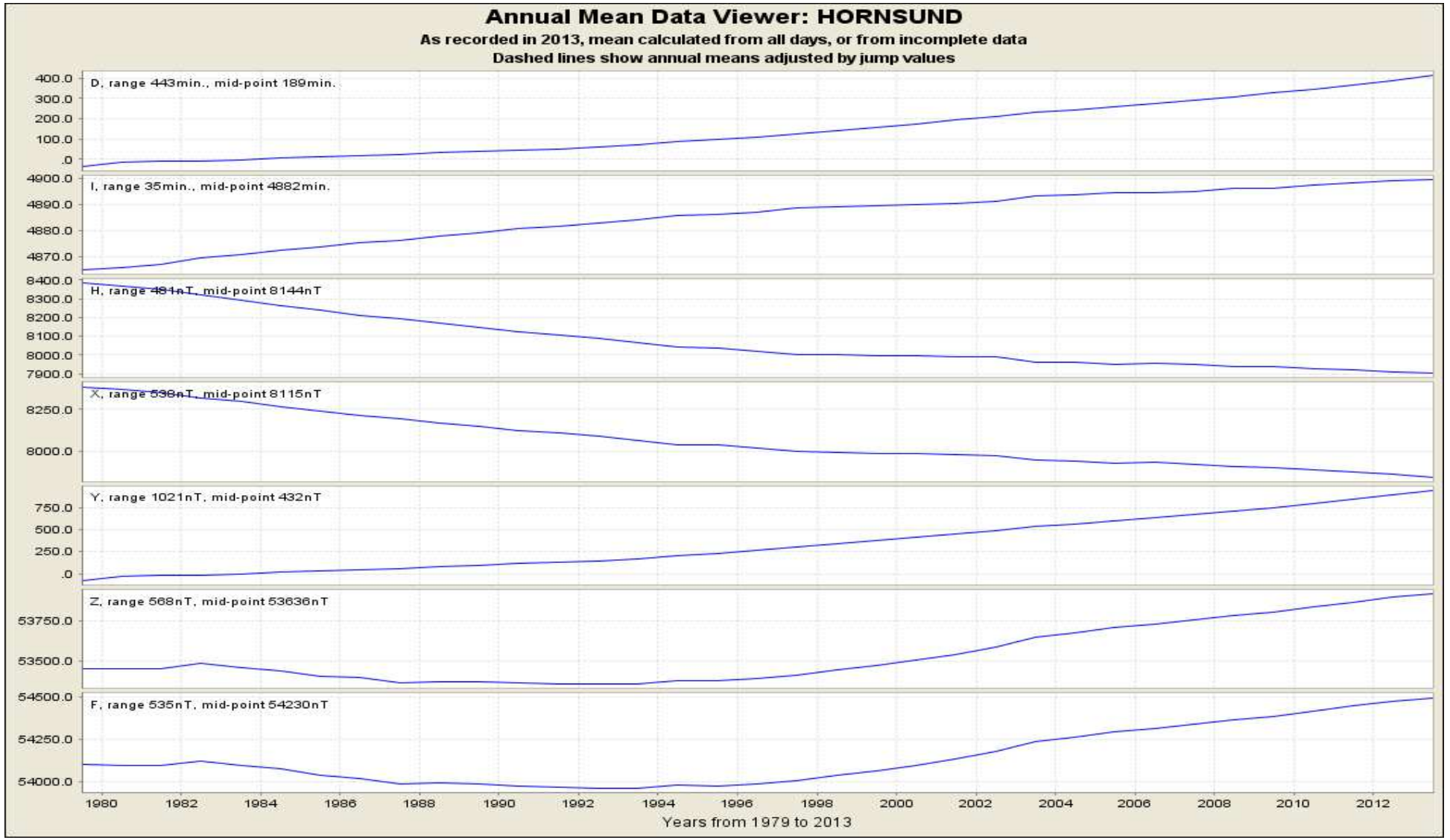

Fig. 19. Secular changes of H, X, Y, Z, F, D and I at Hornsund

MONTHLY AND YEARLY MEAN VALUES OF MAGNETIC ELEMENTS

HRN 2013

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
NORTH COMPONENT: 7500 + ... in nT													
All days	339	344	344	352	361	368	367	357	341	331	327	325	346
Quiet days	346	350	356	356	358	352	371	355	339	334	334	335	349
Disturbed days	319	327	304	351	334	437	355	354	333	303	311	307	336
EAST COMPONENT: 500 + ... in nT													
All days	425	418	423	427	430	435	440	446	452	466	470	473	442
Quiet days	423	420	418	425	434	435	435	447	457	466	467	472	442
Disturbed days	426	420	435	426	433	443	453	451	452	479	483	477	448
VERTICAL COMPONENT: 53500 + ... in nT													
All days	407	408	418	411	414	422	421	421	423	435	432	432	420
Quiet days	402	405	407	409	415	420	415	419	424	427	424	424	416
Disturbed days	415	415	432	416	424	453	429	416	422	458	442	441	430

Three-hour-range K indices
Hornsund, January - March, 2013
The limit of K=9 is 2500

Day	January		February		March	
	K	SK	K	SK	K	SK
1	0000 0001	1	2121 2202	12	3434 4355	31
2	0002 1102	6	1442 2161	21	4332 3364	28
3	2100 2000	5	1222 2113	14	3342 3331	22
4	0100 0002	3	1221 1350	15	2222 2121	14
5	1011 0031	7	0111 1000	4	3122 1131	14
6	1001 1030	6	0000 0030	3	1320 0001	7
7	1113 1001	8	1132 2133	16	0111 1000	4
8	0223 -014	--	2333 2213	19	0021 2021	8
9	3111 0-22	--	1232 1111	12	3332 2211	17
10	1110 0022	7	2222 1143	17	0211 0232	11
11	0011 1002	5	0220 1113	10	2221 0000	7
12	2311 1010	9	1011 1133	11	0232 3220	14
13	2222 2324	19	3332 2036	22	1210 0031	8
14	2333 3225	23	5333 2224	24	0201 2111	8
15	1222 2151	16	1223 1253	19	1342 1001	12
16	0212 1424	16	0121 3431	15	4443 2331	24
17	4422 1223	20	1122 2321	14	2365 4535	33
18	4423 3114	22	0001 2012	6	3332 2011	15
19	2210 2114	13	0122 2222	13	2320 1114	14
20	4332 3100	16	1123 2212	14	2222 3325	21
21	2111 1022	10	3232 2123	18	4542 1000	16
22	1001 0--0	--	2223 3125	20	1212 1144	16
23	0110 2001	5	2112 2124	15	2122 3332	18
24	1100 0000	2	2111 1211	10	2222 2230	15
25	0012 0113	8	0011 2102	7	0211 1100	6
26	4233 3356	29	1122 2120	11	1111 2000	6
27	4332 2231	20	2222 2001	11	1344 3535	28
28	0232 3135	19	0221 2013	11	3232 2322	19
29	2211 2121	12			2344 3432	25
30	0011 1012	6			2543 3253	27
31	1221 0001	7			1322 2114	16

Three-hour-range K indices
Hornsund, April - June, 2013
The limit of K=9 is 2500

Day	April K	April SK	May K	May SK	June K	June SK
1	1232 2214	17	4455 4443	33	5566 4334	36
2	0212 2144	16	4442 2244	26	4355 5354	34
3	1111 -102	--	1222 3231	16	2343 3244	25
4	2212 2100	10	2222 3332	19	4333 2143	23
5	0001 2001	4	2333 3311	19	4222 3233	21
6	1212 1121	11	3244 3322	23	2554 5425	32
7	1322 2200	12	3333 3322	22	5434 4322	27
8	0111 2110	7	2332 3225	22	3343 3011	18
9	1112 1110	8	2333 2120	16	2232 3341	20
10	0122 2103	11	1322 3121	15	2333 3221	19
11	1122 2212	13	1212 2111	11	1123 4322	18
12	3231 3121	16	1233 2122	16	2232 2111	14
13	2323 1123	17	1232 2311	15	1212 2211	12
14	2353 3221	21	2223 3221	17	1222 1031	12
15	1221 1122	12	0123 4211	14	3222 2103	15
16	1000 1222	8	3432 4323	24	1111 1101	7
17	1222 3000	10	2333 3443	25	1313 1112	13
18	1110 1010	5	4454 3143	28	2221 3222	16
19	0010 2001	4	3342 2422	22	2222 2122	15
20	0111 2111	8	2212 2233	17	2343 3232	22
21	0000 0100	1	2333 3143	22	3343 3234	25
22	1111 1100	6	3233 4243	24	3445 3253	29
23	0222 2213	14	3323 3232	21	5544 3345	33
24	4335 4343	29	3344 4345	30	3445 4432	29
25	2223 3332	20	3346 6435	34	3432 1223	20
26	3544 3353	30	3342 3542	26	1221 2122	13
27	2332 3433	23	3333 5453	29	1122 3223	16
28	1113 3223	16	3443 2131	21	3--4 3322	--
29	4111 2023	14	0210 2000	5	4323 5444	29
30	2223 3114	18	1111 1130	9	3334 4543	29
31			0231 2333	17		

Three-hour-range K indices
Hornsund, July - September, 2013
The limit of K=9 is 2500

Day	July			August			September		
	K		SK	K		SK	K		SK
1	3343	3121	20	1322	3210	14	3333	4432	25
2	1232	2211	14	1111	1110	7	233-	----	--
3	2232	2312	17	1221	2113	13	----	----	--
4	1221	2211	12	2243	3443	25	----	----	--
5	3343	3223	23	3444	2432	26	----	----	--
6	3432	2323	22	2233	3214	20	----	----	--
7	322-	-210	--	2322	2111	14	-332	2100	--
8	1332	3211	16	1211	2121	11	2322	2330	17
9	0322	3323	18	2223	3123	18	1221	2131	13
10	3536	4454	34	3323	3121	18	0102	3342	15
11	3534	2453	29	1223	3112	15	1222	2231	15
12	3433	2334	25	1112	2122	12	2222	2211	14
13	3442	1233	22	3012	3322	16	2333	2341	21
14	4453	3322	26	2332	1223	18	2222	3141	17
15	2344	4322	24	1334	3335	25	1110	1011	6
16	2333	3232	21	3544	4653	34	2212	2122	14
17	1230	1121	11	2442	2212	19	1332	2212	16
18	2233	5452	26	2233	2232	19	1123	3434	21
19	2244	3343	25	2132	3222	17	4343	2353	27
20	3333	2112	18	1212	1103	11	2332	3105	19
21	1223	2222	16	2543	4333	27	1322	3334	21
22	1112	1224	14	4443	2265	30	1332	3101	14
23	2312	2232	17	3344	4352	28	1231	2151	16
24	2221	2121	13	3233	4322	22	1215	4311	18
25	1311	2234	17	1322	2232	17	2322	1000	10
26	3433	5333	27	2221	2124	16	0001	1000	2
27	3333	3324	24	2212	3332	18	0000	2011	4
28	3333	4324	25	3323	3112	18	0000	0022	4
29	2222	3222	17	1112	1111	9	0010	0012	4
30	2222	3242	19	1023	3344	20	1200	0001	4
31	2312	2232	17	334-	2223	--			

Three-hour-range K indices
Hornsund, October - December, 2013
The limit of K=9 is 2500

Day	October		November		December	
	K	SK	K	SK	K	SK
1	1122 3323	17	2311 2120	12	4432 2000	15
2	7774 3265	41	1122 0002	8	0000 0000	0
3	3110 0210	8	2332 0044	18	1322 4222	18
4	0000 1000	1	0122 1523	16	2120 0043	12
5	0000 0000	0	1111 0101	6	0111 1011	6
6	0200 1011	5	1212 2142	15	1311 0013	10
7	1211 1111	9	2233 4013	18	2111 1043	13
8	0110 1065	14	4221 0000	9	5532 1453	28
9	3344 3312	23	2532 3111	18	2121 -233	--
10	4332 2211	18	2333 2355	26	132- 1110	--
11	1322 2121	14	4322 6542	28	1123 2023	14
12	0112 2122	11	2212 1000	8	0112 0000	4
13	2021 1001	7	0231 3123	15	0000 3100	4
14	0234 3332	20	0021 1131	9	3231 2233	19
15	2433 1114	19	1211 2223	14	3222 1233	18
16	5433 3232	25	2232 2111	14	2332 2131	17
17	2333 3233	22	1222 1123	14	3110 0153	14
18	1120 1012	8	1121 --00	--	2111 1114	12
19	0001 0022	5	0221 1243	15	1110 0332	11
20	0021 1012	7	122- 2011	--	3311 1232	16
21	1110 1100	5	0211 2012	9	2212 0000	7
22	0021 1012	7	3100 0022	8	0101 0010	3
23	2331 1000	10	0132 2120	11	0101 1024	9
24	0100 0000	1	0010 0010	2	0010 0002	3
25	0110 0000	2	0100 0022	5	3221 2220	14
26	1000 0000	1	0000 0001	1	0010 1000	2
27	1000 0020	3	0000 0000	0	0000 0033	6
28	0100 0000	1	0000 0010	1	0000 0001	1
29	0003 3133	13	0322 3130	14	3221 0211	12
30	1133 3312	17	1222 1225	17	0111 0011	5
31	2022 2113	13			3222 1111	13

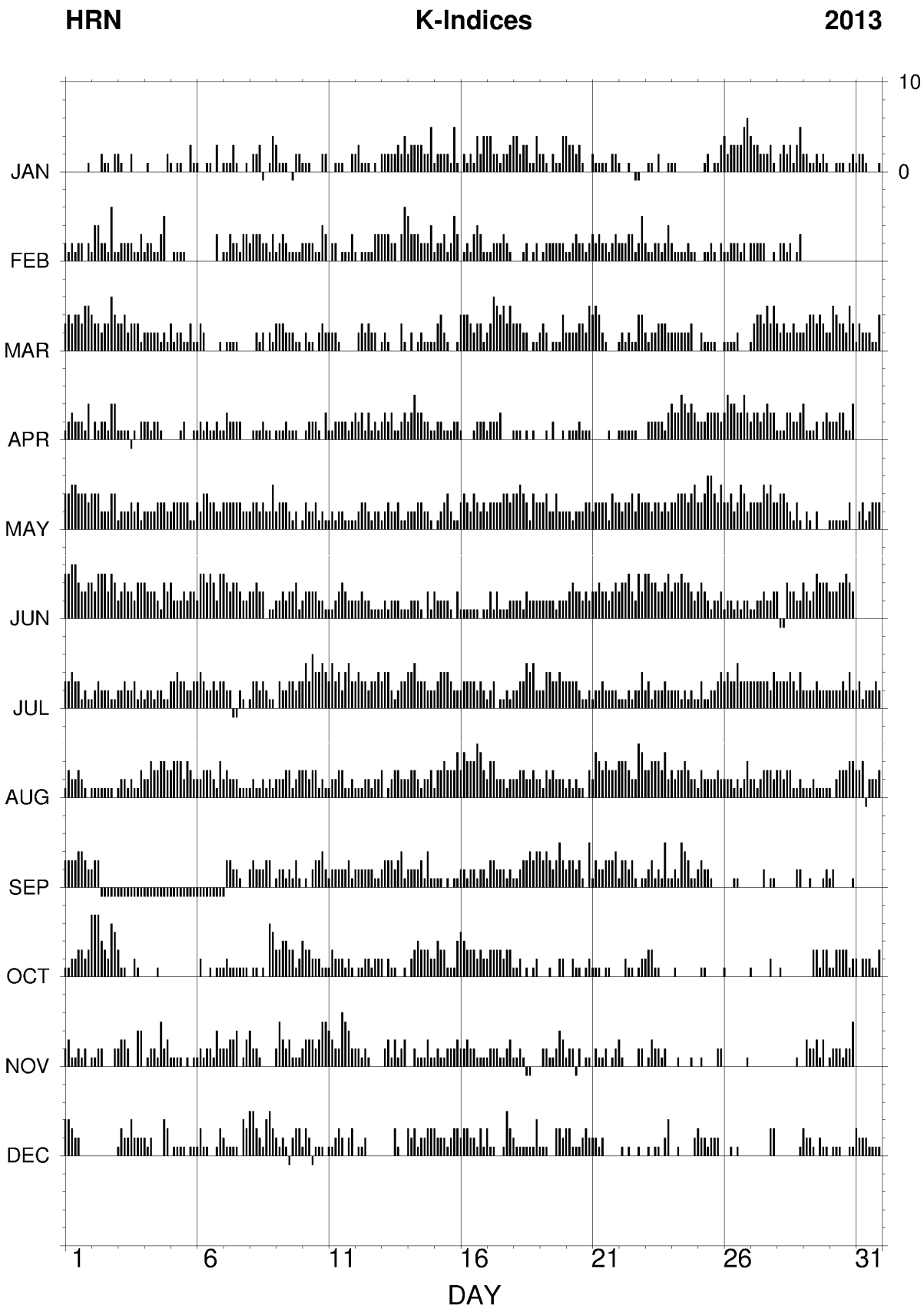

Fig. 20. K-indices in graphical form, Hornsund 2013.

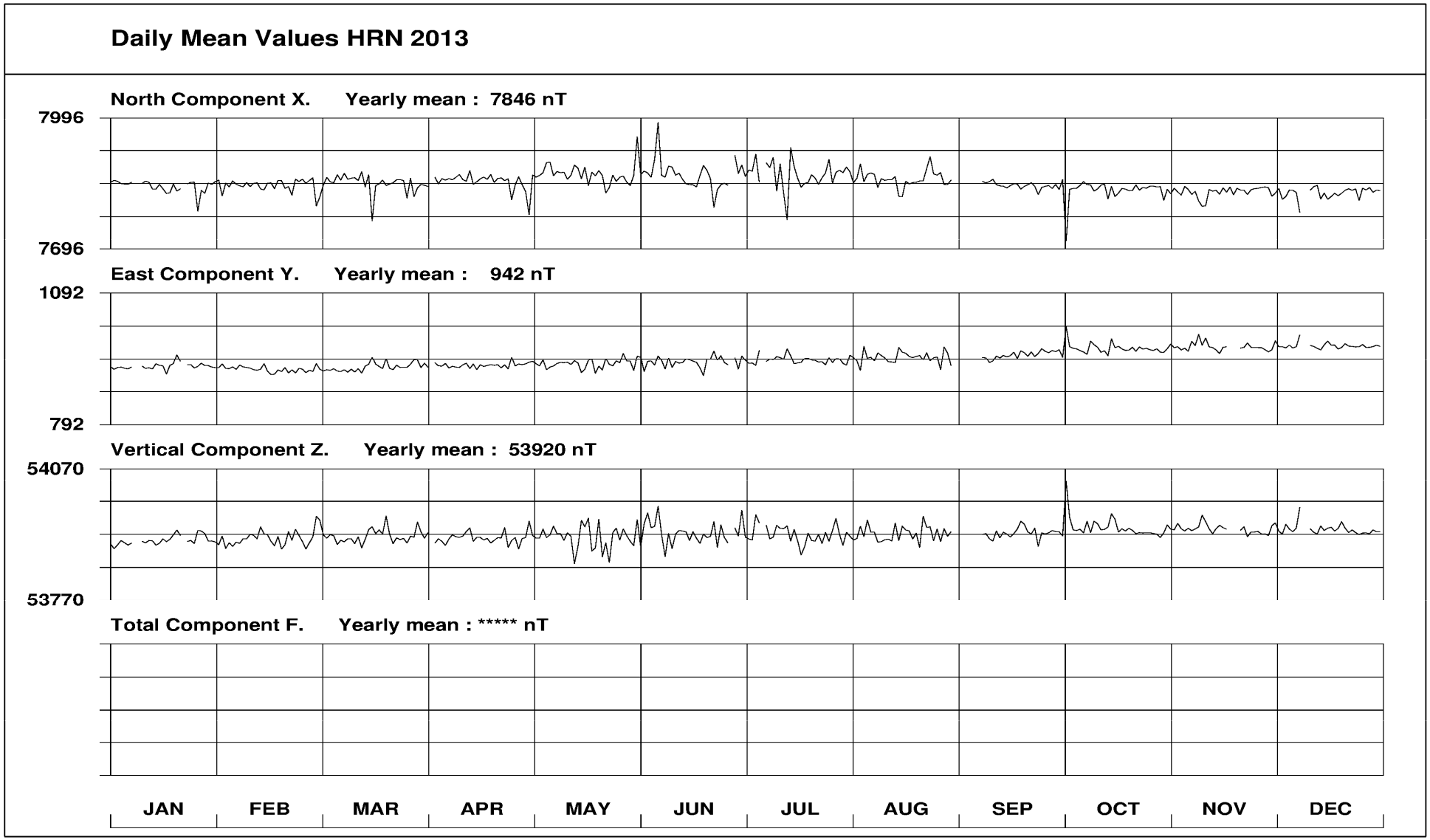

Fig. 21. Daily mean data plot for Hornsund 2013.

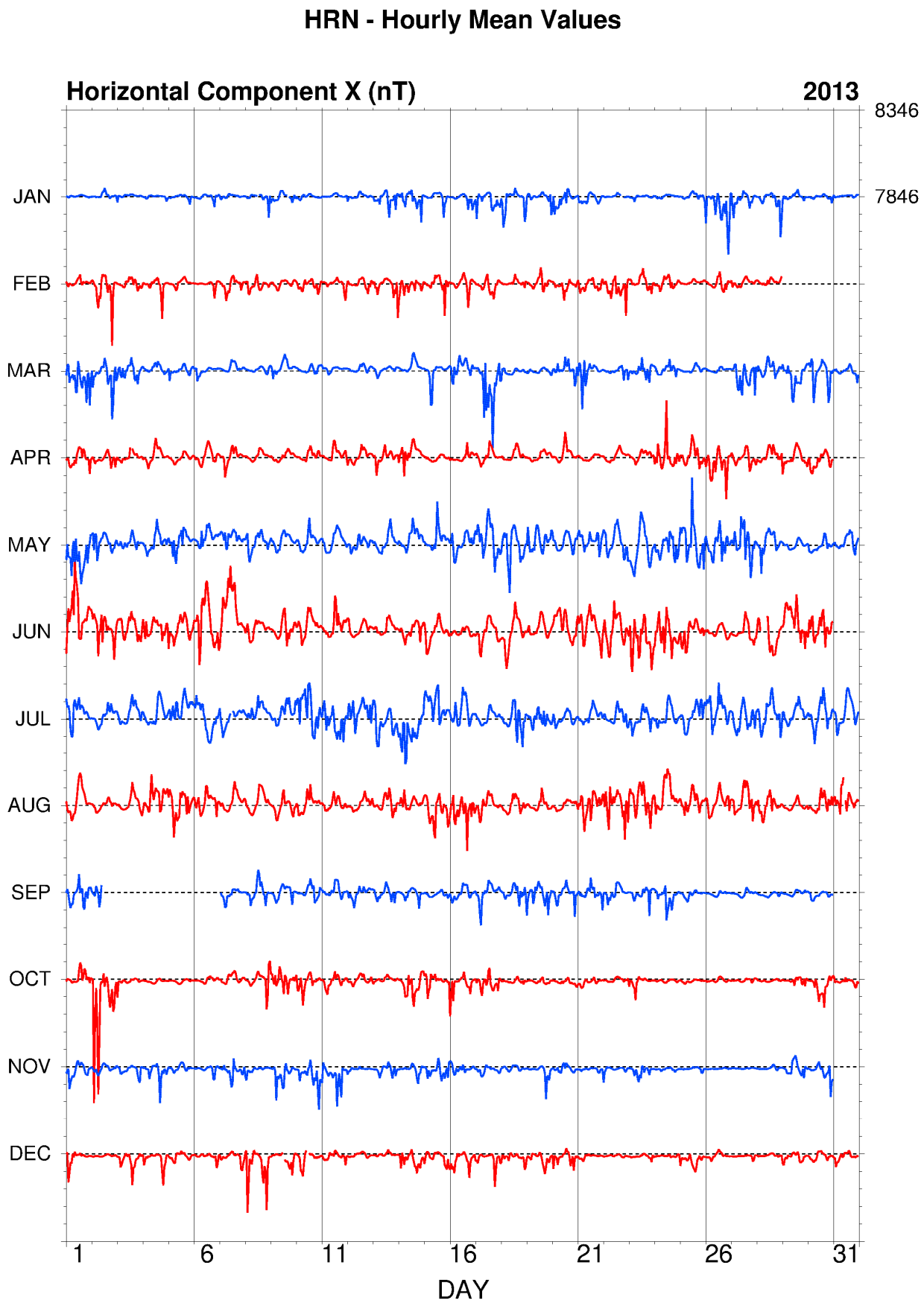

Fig. 22. Hourly mean data plot of X component for Hornsund 2013.

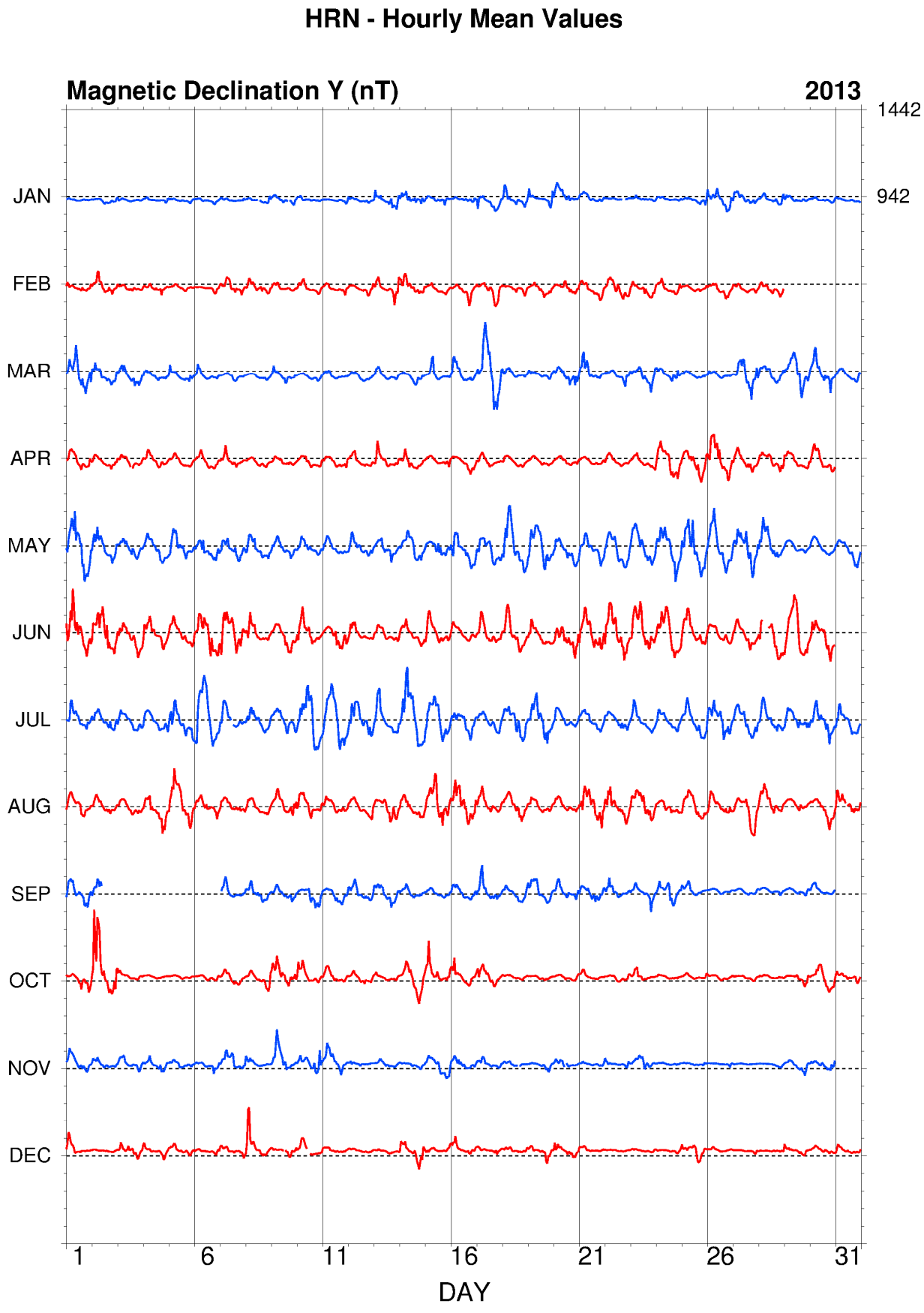

Fig. 23. Hourly mean data plot of Y component for Hornsund 2013.

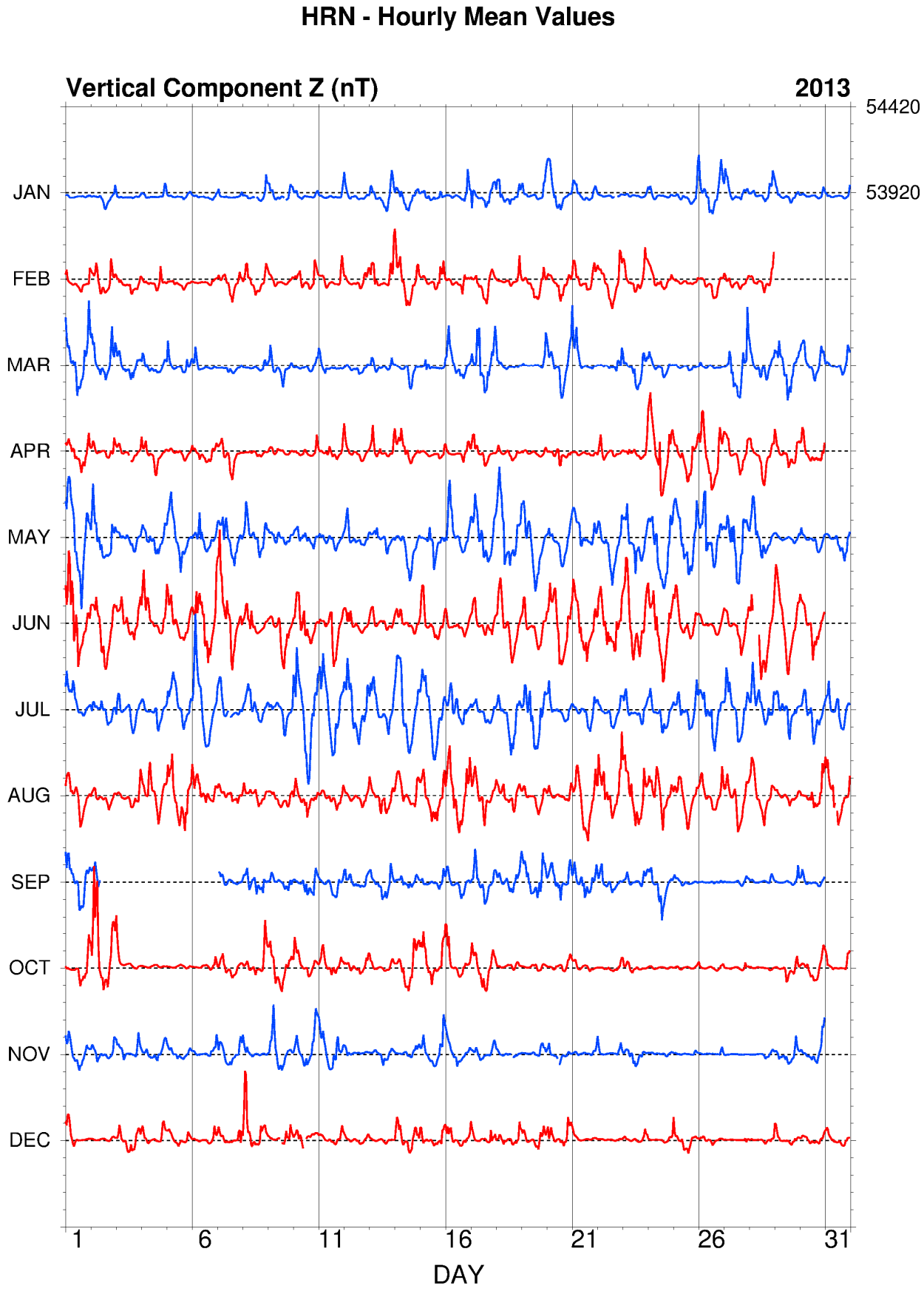

Fig. 24. Hourly mean data plot of Z component for Hornsund 2013.

C O N T E N T S