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Geophysical Data Bases, Processing and Instrumentation

454 (C-119)

Results of Geomagnetic Observations: Belsk, Hel, Hornsund, 2024

Warsaw 2025 (Issue 3)

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Figure on the front cover:
“PMW-344-74 vector proton magnetometer, used in Belsk and Hel (1970s–1990s) for absolute measurements of Earth's magnetic field”
by Jan Reda

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Results of Geomagnetic Observations Belsk, Hel, Hornsund, 2024

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1. INTRODUCTION

This publication provides basic information on geomagnetic observations conducted in 2024 at three Polish geophysical observatories: Belsk, Hel, and Hornsund. Their respective IAGA codes are BEL, HLP, and HRN. All three observatories are operated by the Institute of Geophysics, Polish Academy of Sciences (IG PAS). The Belsk and Hel observatories are located in Poland, whereas the Hornsund Observatory is situated on Spitsbergen, under Norwegian administration.

In 2024, as in previous years, the Belsk, Hel, and Hornsund observatories actively collaborated with INTERMAGNET, the global network of geomagnetic observatories. The Belsk Observatory joined INTERMAGNET in 1992, Hel in 1999, and Hornsund in 2002. Data for the geomagnetic field components (X, Y, Z, and F) were transmitted in real time to the INTERMAGNET center and made publicly available online. At the beginning of 2025, the final dataset (Definitive Data) for the entire year 2024 was prepared. These definitive data are also published on the INTERMAGNET website.

Both the Polish Polar Station Hornsund and Hel Observatory are working for the IMAGE program. The primary objective of IMAGE is to study auroral electrojets and moving two-dimensional current systems.

The Belsk and Hel observatories also provide both real-time and definitive data to the EMMA network (European quasi-Meridional Magnetometer Array), which is used primarily for investigating the dynamics of the plasmasphere.

2. WHAT IS OBSERVED

Magnetic observatories continuously measure the strength and direction of the Earth's magnetic field over many years. (Macmillan 2007).

The Earth's magnetic field can be divided into two components:

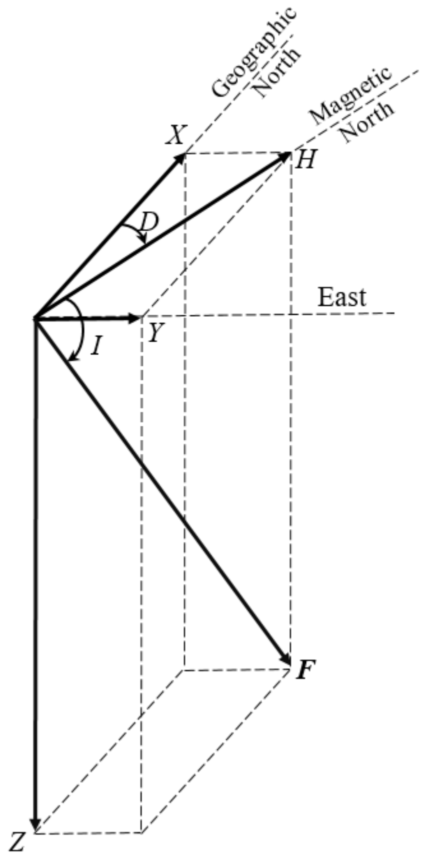
- a slowly changing large part called the main field,
- the external field, which usually has 1–10% of the main field and is characterized by relatively rapid variations.

For this reason, the instrumentation of geomagnetic observatories is twofold. Extensive effort is made to obtain highly accurate absolute measurements of the Earth's magnetic field, which are essential for monitoring the main field. It is mainly thanks to absolute measurements that we can reliably observe the secular changes of the Earth's magnetic field. On the other hand, changes of the geomagnetic field are recorded with relative instruments, the so-called variometers (Geese 2011).

At all three Polish observatories, changes in the *X*, *Y*, *Z*, and *F* components of the geomagnetic field are recorded (Fig. 1), and absolute measurements of declination (*D*), inclination (*I*), and total intensity (*F*) are performed.

The described duality is also reflected in the observatory buildings. Absolute measurements and recording of magnetic field variations are carried out in separate non-magnetic buildings: the absolute house (e.g. Figs. 3 and 5) and the variometer house (e.g. Fig. 5).

One of the most important products of a multi-stage observational effort is time series data of the Definitive type. It is type of combination of data from variometers and absolute measurements. This involves correcting variometer data with adopted baselines obtained from absolute measurements. This publication is prepared based on Definitive-type data.



$$H = \sqrt{X^2 + Y^2}$$
$$F = X^2 + Y^2 + Z^2$$
$$H = F \times \cos(I)$$
$$Z = F \times \sin(I)$$
$$X = H \times \cos(D)$$
$$Y = H \times \sin(D)$$

where:

X – north component
Y – east component
Z – vertical component
H – horizontal component
F – total intensity
D – magnetic declination
I – magnetic inclination

Fig. 1. Components of the Earth's magnetic field and the relations between them.

3. DESCRIPTION OF OBSERVATORIES

The locations of the observatories are shown in Fig. 2 and Table 1. The geomagnetic coordinates listed in Table 1 were calculated using the IGRF-14 model for the epoch 2024.5 (http://www.geomag.bgs.ac.uk/data_service/models_compass/coord_calc.html).

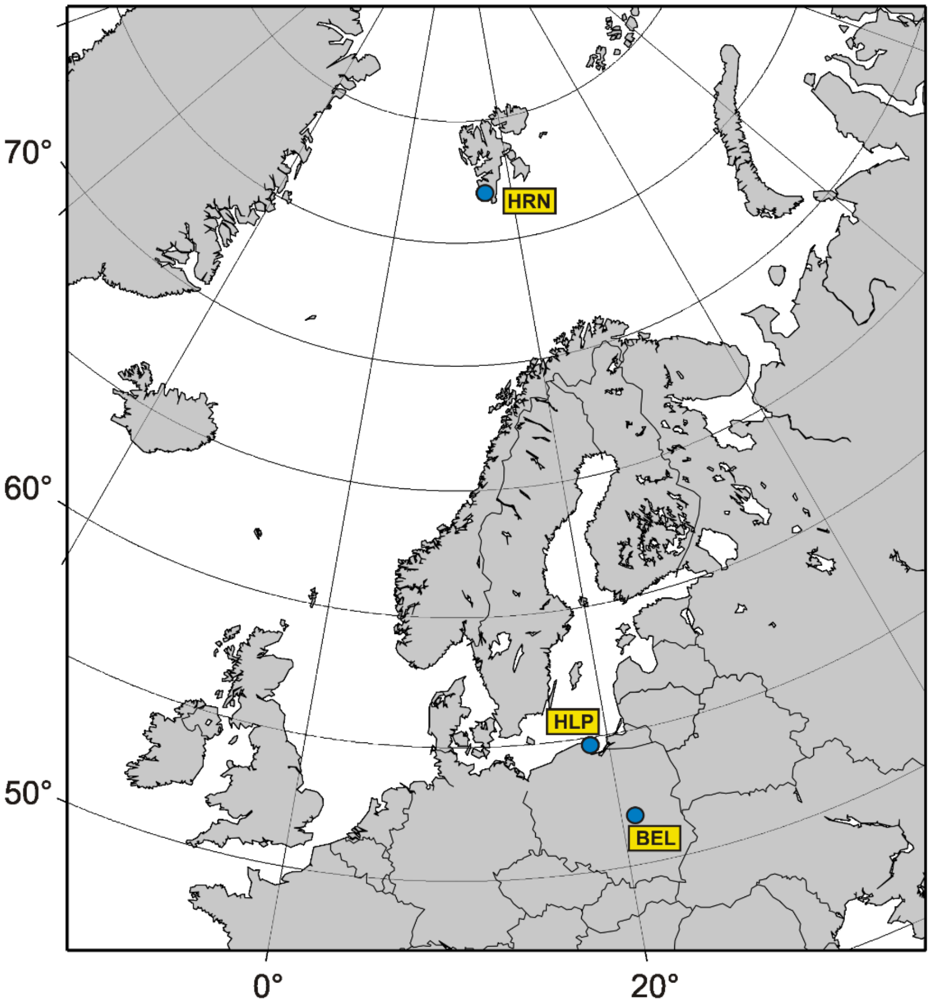


Fig. 2. Location of the Belsk, Hel, and Hornsund observatories.

Table 1
Coordinates of the Polish observatories

Observatory	Geographic coordinates		Geomagnetic coordinates		Elevation [m]
	Latitude	Longitude	Dipole latitude	Dipole longitude	
Belsk (BEL)	51° 50.2′ N	20° 47.3′ E	50.36° N	104.80° E	180
Hel (HLP)	54° 36.2′ N	18° 48.6′ E	53.34° N	104.11° E	1
Hornsund (HRN)	77° 0.0′ N	15° 33.0′ E	74.36° N	123.48° E	15

The methodology of geomagnetic observations at all three observatories was very similar and followed the *Guide for Magnetic Measurements and Observatory Practice* (Jankowski and Sucksdorff 1996). The instruments were similar too. Absolute measurements were conducted using *DI*-flux and proton magnetometers. In turn, the magnetic field variations were measured with the use of GEOMAG and LEMI flux-gate magnetometers.

It is worth mentioning that in 2024 the Hornsund and Suwałki stations have been continuing the permanent observation of the Schumann resonance phenomenon. Two horizontal magnetic components have been recorded at a frequency of 100 Hz. This recording was initiated in 2004 (Neska and Satori 2006).

3.1 Central Geophysical Observatory at Belsk, Central Poland

The Observatory at Belsk began continuous observations of the Earth's 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.

Fig. 3. Belsk Observatory – Absolute House.

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 from 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 from 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 where the Observatory is located can be found on the website of the Grójec district (https://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/.

3.2 Geophysical Observatory at Hel, Northern Poland

The Observatory at Hel (Fig. 4) began continuous observations of the Earth's 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's facilities, equipment, and data were destroyed or lost under undocumented circumstances, making any reconstruction of the events or recovery of materials impossible. After reconstruction, continuous observations at Hel were reasumed in 1953.

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.

Fig. 4. Hel Observatory – Variometer House.

3.3 Polish Polar Station Hornsund, Spitsbergen

The Polish Polar Station Hornsund (PSP Hornsund, Fig. 5) is situated on the White Bear Bay (Isbjørnhamna) in Hornsund Fiord, Spitsbergen Island, part of Svalbard archipelago. More information on the Svalbard Archipelago can be found at the address: http://en.wikipedia.org/wiki/Svalbard. PSP Hornsund is the northernmost Polish scientific facility operating year-round. 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 1932–1933, they had carried out continuous recording of magnetic field and performed absolute measurements. Unfortunately, all data were destroyed during the war. In the years 1957–1958, 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.

Fig. 5. The Variometer House (left) and the Absolute House (right) in PSP Hornsund, Spitsbergen.

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 average and available on http://www.geo.fmi.fi/image/request.html. Since 2002, PSP Hornsund has been included into the global near-real-time magnetic observatory network INTERMAGNET, sending the results, via Internet, to the GIN (Geomagnetic Information Nodes) center in Edinburgh.

More informations about Hornsund Station can be found at the homepage: https://hornsund.igf.edu.pl/

4. INSTRUMENTATION

4.1 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 ABM written in Java (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-010B sn: 07-2019	FLUX-9408 THEO-010B sn: 160334	GEOMAG-03 THEO-010B sn: 03-2012
Proton magnetometer	GSM-90 sn: 9038262/96334	PMP-8 sn: 21/2006	PMP-5 sn: 115
Frequency of measurements	3, 4 per week	3 per week	2 per week

Table 3
Basic parameters of the instruments for absolute measurements

Fluxgate declinometer/inclinometer GEOMAG-03 / THEO-010B	
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-010B	
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-010B	
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-5	
Producer	Institute of Geophysics Pol. Acad. Sc.
Resolution	0.1 nT
Absolute accuracy	0.2 nT
Proton magnetometer model PMP-8	
Producer	Institute of Geophysics Pol. Acad. Sc.
Resolution	2.01 nT
Absolute accuracy	0.2 nT
Overhauser magnetometer model GSM-90	
Producer	GEM Systems, Canada
Resolution	0.01 nT
Absolute accuracy	0.2 nT

The results of base determinations and the smoothed values adopted for further computations are depicted in Figs. 6, 9, and 12 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 2024 are listed in Table 4.

Table 4
Mean errors of measurements of B_X, B_Y, B_Z, and B_F in 2024

Observatory	Component	Number of measurements n	Mean error m_B [nT]
Belsk	B_X	195	0.50
	B_Y	194	0.62
	B_Z	199	0.23
Hel	B_X	153	0.56
	B_Y	153	0.42
	B_Z	146	0.41
Hornsund	B_X	223	1.27
	B_Y	220	0.17
	B_Z	221	0.44

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/°C,
- the magnetic sensors are located in thermostat-controlled wooden boxes where the daily temperature variations are of the order of 0.3°C.

4.2 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 flux-gate sensors (GEOMAG, LEMI) and digital loggers NDL. In spare sets, we use LEMI magnetometers. Both the main and spare sets record the components in the rectangular coordinate system X, Y, Z. In all three observatories, the total field F is recorded using GSM-90 Overhauser proton magnetometers. The basic parameters of the recording systems are listed in Tables 5a, 5b, and 5c.

GEOMAG and LEMI magnetometers

The magnetometers of GEOMAG and LEMI type were designed at the GEOMAGNET company and the Lviv Centre of the Institute of Space Research, respectively, in Ukraine. They employ flux-gate sensors. They are characterized by good orthogonality of sensors and relatively small self noise.

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 0.1 nT, that of PMP-8 being 0.01 nT. The stability of both magnetometers is better than 0.3 nT/year. The calibration of proton magnetometers is performed according to the method described by Reda and Neska (2007).

Table 5a
Basic instruments for the magnetic field variations recording in Belsk Observatory

Set / Period	Parameter name	Value
Set 1 Vector magnetometer	Name of magnetometer	GEOMAG-02
	Kind of sensor	Fluxgate
	Serial No.	No. 37
	Sensor's orientation	*XYZ*
	Range	+/– 3200 nT
	Magnetometer's producer	GEOMAGNET
	Digital recorder	NDL
	Producer	TUS Electronics
	Sampling interval	1 s
Set 2 Vector magnetometer	Name of magnetometer	LEMI-008
	Kind of sensor	Fluxgate
	Serial No.	No. 10
	Sensor's orientation	*XYZ*
	Range	+/– 3200 nT
	Magnetometer's producer	Lviv Centre of the Institute of Space Research
	Digital recorder	NDL
	Producer	TUS Electronics
	Sampling interval	1 s
Set 1 Scalar magnetometer	Name of magnetometer	GSM-90
	Kind of sensor	Overhauser proton magnetometer
	Serial No.	No. 9038261
	Magnetometer's producer	GEM Systems
	Sampling interval	1 s

GSM-90 scalar magnetometer

The Canadian GSM-90 is a scalar Overhauser effect magnetometer characterized by high absolute accuracy (0.2 nT) and a low long-term drift (0.05 nT/year). Therefore it is ideally suited for continuous recording of total field F in magnetic observatories.

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.

Table 5b
Basic instruments for the magnetic field variations recording in Hel Observatory

Set / Period	Parameter name	Value
Set 1 Vector magnetometer	Name of magnetometer	GEOMAG-02
	Kind of sensor	Fluxgate
	Serial No.	No. 25
	Sensor's orientation	*XYZ*
	Range	+/– 3200 nT
	Magnetometer's producer	GEOMAGNET
	Digital recorder	NDL
	Producer	TUS Electronics
	Sampling interval	1 s
Set 2 Vector magnetometer	Name of magnetometer	LEMI-03/95
	Kind of sensor	Fluxgate
	Serial No.	No. 03
	Sensor's orientation	*XYZ*
	Range	+/– 1000 nT
	Magnetometer's producer	Lviv Centre of the Institute of Space Research
	Digital recorder	LB-480
	Producer	LAB-EL
	Sampling interval	1 s
Set 1 Scalar magnetometer	Name of magnetometer	GSM-90
	Kind of sensor	Overhauser proton magnetometer
	Serial No.	No. 9038264
	Magnetometer's producer	GEM Systems
	Sampling interval	1 s

LB-480 digital data loggers

The LB-480 digital data logger is equipped with a 24-bit sigma-delta A/D converter, a GPS receiver, Ethernet and USB interfaces, and a GSM modem. It allows for the simultaneous recording of up to six analog signals and is suitable for applications in geophysics.

4.3 Calibration of magnetic sensors

The verification of scale values of recording systems in all 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.

Table 5c
Basic instruments for the magnetic field variations recording in Hornsund Observatory

Set / Period	Parameter name	Value
Set 1 Vector magnetometer	Name of magnetometer	GEOMAG-02
	Kind of sensor	Fluxgate
	Serial No.	No. 40
	Sensor's orientation	*XYZ*
	Range	+/– 3200 nT
	Magnetometer's producer	GEOMAGNET
	Digital recorder	NDL
	Producer	TUS Electronics
	Sampling interval	1 s
Set 2 Vector magnetometer	Name of magnetometer	LEMI-03
	Kind of sensor	Fluxgate
	Serial No.	No. 12
	Sensor's orientation	*XYZ*
	Range	+/– 3200 nT
	Magnetometer's producer	Lviv Centre of the Institute of Space Research
	Digital recorder	NDL
	Producer	TUS Electronics
	Sampling interval	1 s
Set 1 Scalar magnetometer	Name of magnetometer	GSM-90
	Kind of sensor	Overhauser proton magnetometer
	Serial No.	No. 9038263
	Magnetometer's producer	GEM Systems
	Sampling interval	1 s

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

4.4 Data processing

The results of digital recordings were processed using a software package developed to meet the requirements of observatories operating within the INTERMAGNET network. This software makes it possible to perform, among other things, the following operations:

- conversion of 1-s magnetic data from the internal DDF format to the INTERMAGNET IAF format, which contains 1-min mean values of the X, Y, Z magnetic field components and ΔF (by M. Neska), where ΔF is the difference between the total magnetic field calculated from the *X*, *Y*, and *Z* components and the total field recorded by a proton magnetometer,

- conversion of 1-s data from the DDF format to the INTERMAGNET ImagCDF format, which contains 1-s values of the *X*, *Y*, *Z* magnetic field components and ΔF (by M. Neska),
- automatic real-time data transmission via the Internet to the Institute of Geophysics PAS in Warsaw and to the Geomagnetic Information Node (GIN) of the INTERMAGNET network in Edinburgh (by M. Neska),
- automatic transmission of data, via the Internet, to the Institute of Geophysics PAS in Warsaw and data centers in 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 IAF Format (INTERMAGNET Archive Format) or in the IMFV1.23 format. The program for calculation of indices may be taken from the INTERMAGNET page: http://www.intermagnet.org/publication-software/software-eng.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* (Figs. 7, 10, and 13), bases of recording sets as well as plots of *K* indices for 2024 (Figs. 8, 11, and 14) were prepared with the use of program imcdview.jar.

As in previous years, we include the *E* indices calculated for Belsk observatory in the present yearbook (Tables 12–15). 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).

Annual mean values for Belsk, Hel, and Hornsund are listed in Tables 6, 16, and 22, respectively. The monthly mean values of 2024 for Belsk, Hel, and Hornsund are listed in Tables 7, 17, and 23, respectively.

Three-hour-range *K* indices for Belsk are listed in Tables 8–11, for Hel in Tables 18–21, and for Hornsund in Tables 24–27.

4.5 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 website, data from all three observatories, as well as from permanent geomagnetic stations operated by the IG PAS, are displayed in graphical form with a delay of several to several dozen minutes. In addition, the web page offers the possibility of viewing *K* indices calculated using the ASm method (Nowożyński et al. 1991) and *E* indices derived from the energy of variations in the horizontal components of the geomagnetic field (Reda and Jankowski 2004).

The current data (of status REPORTED) from all 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 https://wdc.kugi.kyoto-u.ac.jp/.

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

5. CONTACT PERSONS, POSTAL ADDRESSES, CONTACT DETAILS

5.1 Belsk Observatory

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5.2 Hel Observatory

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5.3 Hornsund Observatory

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

6. PERSONNEL TAKING PART IN THE WORK OF BELSK, HEL, AND HORNSUND OBSERVATORIES IN 2024

Jan Reda (project leader of geomagnetic observations in Belsk, Hel, Hornsund)
Paweł Czubak
Łukasz Mazurkiewicz (Hornsund, observer from June to September 2024)
Anne Neska
Mariusz Neska
Krzysztof Kucharski
Rafał Potoczek (Hornsund, observer from September to December 2024)
Szymon Szyszko (Hornsund, observer from January to June 2024)
Anna Wójcik
Stanisław Wójcik

7. TABLES AND PLOTS FOR BELSK OBSERVATORY

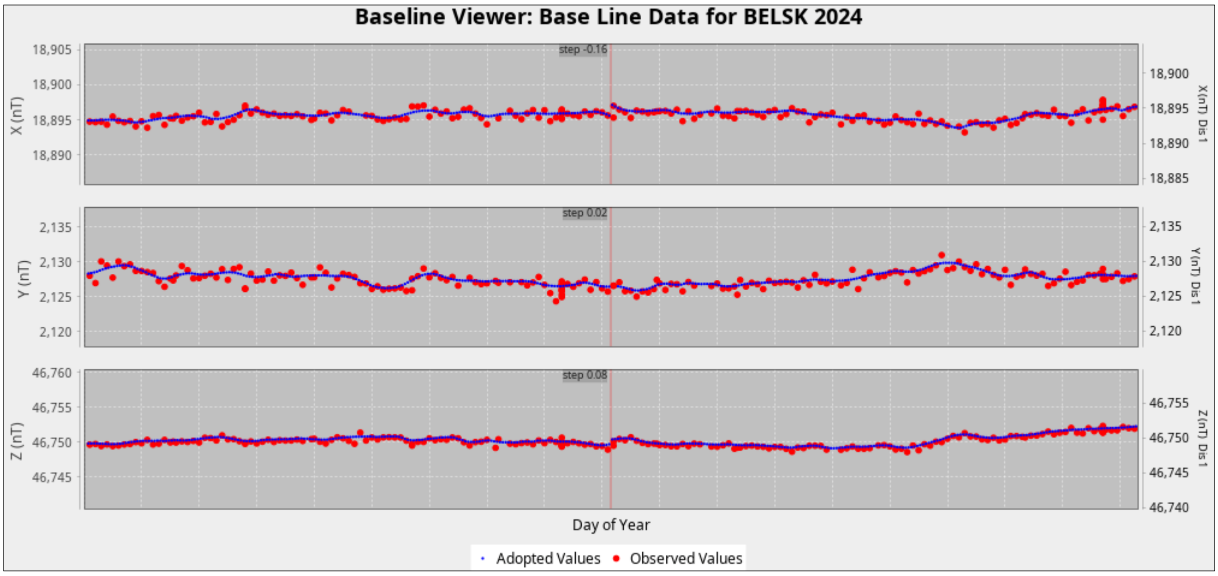

Fig. 6. Base values of set 1, Belsk 2024.

Table 6
Annual mean values of magnetic components in Belsk Observatory

No.	Year	*D* [° ‘]	*H* [nT]	*Z* [nT]	*X* [nT]	*Y* [nT]	*I* [° ‘]	*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

to be continued

Table 6 (continuation)
Annual mean values of magnetic components in Belsk Observatory

No.	Year	*D* [° ‘]	*H* [nT]	*Z* [nT]	*X* [nT]	*Y* [nT]	*I* [° ‘]	*F* [nT]
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
49	2014	5 40.3	19025	46446	18932	1880	67 43.5	50191
50	2015	5 48.8	19019	46495	18922	1926	67 45.1	50235
51	2016	5 57.2	19027	46538	18924	1974	67 45.8	50277
52	2017	6 06.4	19026	46592	18918	2024	67 47.2	50327
53	2018	6 15.5	19032	46648	18918	2075	67 48.3	50381
54	2019	6 24.9	19033	46712	18914	2127	67 49.9	50441
55	2020	6 33.4	19029	46775	18905	2173	67 51.7	50497
56	2021	6 41.3	19024	46840	18894	2216	67 53.8	50556
57	2022	6 49.5	19015	46907	18880	2259	67 56.0	50614
58	2023	6 56.7	19011	46966	18872	2299	67 57.7	50668
59	2024	7 03.3	19013	47023	18869	2335	67 59.1	50721

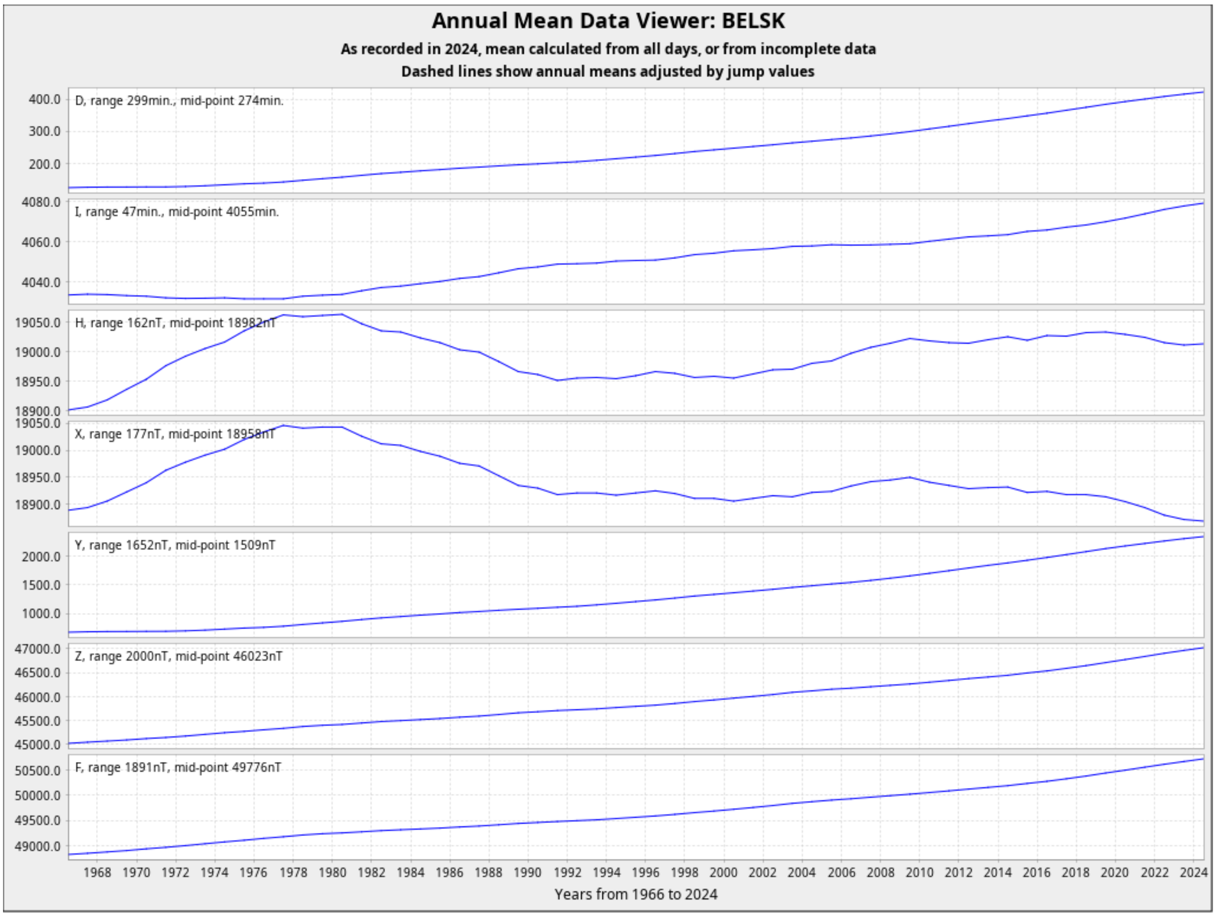

Fig. 7. Secular changes of *H*, *X*, *Y*, *Z*, *F*, *D* and *I* at Belsk.

Table 7
Monthly and yearly mean values of magnetic components
BEL 2024

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
North component: 18500 + ... in nT													
All days	377	380	371	372	360	376	381	364	360	353	363	369	369
Quiet days	379	382	383	380	377	382	384	369	371	366	371	376	377
Disturbed days	376	377	354	360	320	368	373	359	333	309	344	367	353
East component: 2000 + ... in nT													
All days	316	319	325	327	336	332	335	340	343	348	347	348	335
Quiet days	316	318	323	326	330	332	333	338	339	344	347	348	333
Disturbed days	316	321	328	331	351	329	335	345	354	365	351	349	340
Vertical component: 46500 + ... in nT													
All days	492	492	501	506	520	521	521	534	539	548	550	550	523
Quiet days	491	492	496	502	515	519	520	531	536	544	549	549	520
Disturbed days	493	493	512	512	526	524	526	542	546	554	556	551	528

Table 8
Three-hour-range *K* indices
Belsk, January–March 2024
The limit of *K* = 9 is 450

Day	January		February		March	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	0012 2245	16	1122 1331	14	3211 1222	14
2	2112 2332	16	1111 1100	6	2111 2111	10
3	3212 2343	20	0011 1101	5	3113 4464	26
4	1121 1114	12	1111 1213	11	3122 1113	14
5	2111 2211	11	0122 2223	14	3122 2131	15
6	0100 0011	3	3222 1221	15	1212 2201	11
7	0000 0100	1	0112 1212	10	3123 2343	21
8	0001 2123	9	0112 2221	11	3321 2124	18
9	3121 1202	12	1012 3113	12	4322 2242	21
10	1112 2223	14	1122 2110	10	1123 2331	16
11	1112 2113	12	4333 2322	22	2122 1101	10
12	0111 1111	7	2121 1000	7	2122 2210	12
13	1011 0112	7	1222 2524	20	2032 2331	16
14	0113 2223	14	4211 1111	12	1222 1224	16
15	1112 2122	12	1111 1121	9	4221 2111	14
16	3211 1111	11	2022 2102	11	0001 1100	3
17	1011 1121	8	1112 2012	10	0011 0100	3
18	1112 2243	16	3212 1010	10	0011 1133	10
19	1222 2213	15	0010 1111	5	2222 1112	13
20	2211 2221	13	1122 2223	15	2121 1113	12
21	0112 2112	10	1011 1121	8	2232 4545	27
22	1111 2244	16	2112 1120	10	3224 1210	15
23	2221 1113	13	0011 2112	8	2433 4455	30
24	3332 1111	15	1111 2323	14	4334 6754	36
25	0112 2223	13	2222 3233	19	4444 4322	27
26	1211 2223	14	3323 2223	20	3213 2333	20
27	2111 1111	9	3432 1242	21	2122 1111	11
28	1122 2143	16	1122 1122	12	1122 3222	15
29	3211 2232	16	0012 2111	8	2122 2110	11
30	2212 1232	15			0101 2213	10
31	2222 1222	15			4222 1213	17

Table 9
Three-hour-range *K* indices
Belsk, April–June 2024
The limit of *K* = 9 is 450

Day	April		May		June	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	2332 2232	19	4222 2232	19	3122 2210	13
2	1222 2221	14	2223 5554	28	0111 2222	11
3	3221 2211	14	4212 2121	15	2112 2224	16
4	0123 2434	19	1111 1224	13	3323 2111	16
5	2223 3233	20	2121 2235	18	0122 3223	15
6	3232 2222	18	5223 4332	24	2221 3211	14
7	1112 2323	15	2222 3322	18	1324 6633	28
8	2232 0210	12	1223 3211	15	4323 3422	23
9	0232 1133	15	1212 2132	14	1111 3222	13
10	2222 2322	17	3332 3889	39	2112 2442	18
11	2211 2111	11	8889 8877	63	4322 2312	19
12	2221 1012	11	5635 3346	35	1111 2212	11
13	1111 2212	11	4534 4432	29	1102 2221	11
14	2022 2222	14	1213 3220	14	1022 2122	12
15	1212 2223	15	1233 3233	20	3213 5434	25
16	3333 3565	31	2354 5321	25	3123 4442	23
17	3112 2222	15	1312 5565	28	2223 3434	23
18	2011 1112	9	3323 2321	19	2333 3312	20
19	1234 4564	29	1213 3332	18	3322 3321	19
20	2222 2223	17	1321 3112	14	1222 2222	15
21	3223 4433	24	2113 4322	18	2211 1121	11
22	2222 2222	16	2111 1122	11	2111 2211	11
23	1112 2232	14	1223 4224	20	1233 4332	21
24	1111 1101	7	2333 2211	17	2111 1122	11
25	0011 1112	7	2221 2313	16	1112 2421	14
26	2322 4542	24	2213 3331	18	1233 3322	19
27	3321 3332	20	1023 3222	15	2122 3333	19
28	4212 1111	13	2221 1121	12	4435 7543	35
29	2112 1331	14	0122 2232	14	3323 2333	22
30	2112 3445	22	1113 3423	18	2313 4422	21
31			3322 2321	18		

Table 10
Three-hour-range *K* indices
Belsk, July–September 2024
The limit of $K = 9$ is 450

Day	July		August		September	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	2222 2211	14	5433 4333	28	4322 4432	24
2	1211 2211	11	2322 2223	18	2212 2221	14
3	1121 2212	12	1212 3323	17	1222 1222	14
4	2221 3333	19	3334 6634	32	1124 4322	19
5	2313 4311	18	2233 3222	19	1212 1112	11
6	1111 1101	7	2110 1221	10	1113 3112	13
7	2211 2232	15	1213 2222	15	2122 3221	15
8	2224 4322	21	3223 2121	16	2222 3223	18
9	2213 3222	17	2213 3322	18	2122 2333	18
10	2112 2212	13	1211 3322	15	2222 2132	16
11	2221 2222	15	2245 5544	31	1122 3423	18
12	2222 2212	15	6555 6655	43	2345 6665	37
13	1112 2221	12	3322 2134	20	5333 3445	30
14	1112 2112	11	4321 2212	17	4323 3134	23
15	1211 1123	12	1111 2223	13	2333 3431	22
16	4222 2432	21	3222 3211	16	4333 3214	23
17	1222 3221	15	1111 4645	23	7534 5344	35
18	1112 2221	12	2224 4232	21	3212 2314	18
19	0112 2221	11	1212 3333	18	4224 3441	24
20	2222 2321	16	3122 3322	18	0112 1114	11
21	1011 2222	11	4122 2211	15	1222 2221	14
22	2113 3232	17	3223 2323	20	1113 2221	13
23	0111 2131	10	1122 3122	14	1123 4521	19
24	2222 2222	16	2223 2322	18	3222 2244	21
25	1212 3334	19	3332 1112	16	4333 3445	29
26	4533 4533	30	2111 1210	9	4222 3231	19
27	1223 4421	19	0133 3334	20	1112 2010	8
28	1122 3232	16	5342 3323	25	0022 2313	13
29	1222 2222	15	2112 2111	11	3233 4323	23
30	4544 4322	28	1143 5455	28	3221 2233	18
31	2112 4453	22	4432 4443	28		

Table 11
Three-hour-range *K* indices
Belsk, October–December 2024
The limit of *K* = 9 is 450

Day	October		November		December	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	2211 1211	11	2223 2010	12	2121 1133	14
2	2212 2122	14	0123 3233	17	2211 1122	12
3	1222 4132	17	1112 0355	18	3322 2342	21
4	1113 2223	15	4332 2213	20	1112 2232	14
5	3122 2221	15	2123 2233	18	2221 1111	11
6	1122 3435	21	3322 3233	21	2211 1111	10
7	5334 5465	35	1123 1334	18	1112 2122	12
8	5533 2544	31	3222 2243	20	0112 2221	11
9	3333 3323	23	3333 4544	29	4222 2344	23
10	1212 3689	32	3422 3473	28	2222 2222	16
11	7666 5434	41	2222 2421	17	2211 2122	13
12	3225 4333	25	1221 1221	12	2211 1221	12
13	0012 2222	11	1112 3221	13	0011 1211	7
14	0111 1134	12	1312 2333	18	1112 1233	14
15	2232 3422	20	3322 3233	21	3222 3242	20
16	2223 3333	21	3112 1001	9	1222 2344	20
17	2221 1243	17	0222 3111	12	4554 4423	31
18	3211 3324	19	1101 1112	8	3223 3441	22
19	5333 3253	27	1112 2331	14	3321 2134	19
20	3211 1012	11	0222 2112	12	3322 3442	23
21	1122 1233	15	0222 2243	17	3323 2343	23
22	1122 2322	15	2212 3434	21	1223 3333	20
23	2223 2122	16	2222 3232	18	3222 2334	21
24	2332 1222	17	1221 1125	15	2221 3234	19
25	2110 0001	5	3223 3322	20	2222 1121	13
26	1112 2344	18	3111 1012	10	0011 1001	4
27	3123 2333	20	1111 1113	10	0111 1211	8
28	2443 3322	23	2211 1020	9	0122 1121	10
29	3222 2352	21	2223 2123	17	1012 2101	8
30	4333 3222	22	5331 1112	17	0122 1123	12
31	1122 1234	16			0112 1445	18

Table 12
Three-hour-range *E* indices
based on power spectrum estimation (*)
Belsk, January–March 2024

Day	January		February		March	
	E	*SE*	*E*	*SE*	*E*	*SE*
1	0002 2345	16	1122 1321	13	3221 1232	16
2	2112 3331	16	0011 1000	3	2101 2011	8
3	4212 2353	22	0011 0101	4	3114 5564	29
4	1111 1114	11	0112 0124	11	4131 1113	15
5	2111 1200	8	0122 1222	12	4122 1141	16
6	0100 0011	3	4222 1220	15	0212 2200	9
7	0000 0000	0	0012 1112	8	2123 2443	21
8	0001 2123	9	0112 2310	10	3321 2125	19
9	3121 1202	12	0012 3013	10	5322 2142	21
10	1112 2233	15	1122 2000	8	1123 2331	16
11	1111 2113	11	4343 2323	24	1121 1101	8
12	0001 0111	4	2120 0000	5	3112 1200	10
13	0000 0101	2	1322 2514	20	2043 2431	19
14	0012 2223	12	4211 0001	9	0222 1224	15
15	1112 2022	11	1011 0031	7	4221 1101	12
16	3211 1011	10	1021 2101	8	0000 1100	2
17	0001 1011	4	1012 2013	10	0000 0000	0
18	1112 2153	16	4113 1010	11	0000 0133	7
19	1221 2314	16	0000 0001	1	3222 1112	14
20	2311 2321	15	0022 2223	13	2121 0014	11
21	0112 2012	9	0011 1130	7	2232 4546	28
22	1011 2235	15	2112 1110	9	3233 1200	14
23	2221 1113	13	0011 1002	5	2433 4556	32
24	4332 1001	14	1111 2223	13	4333 6864	37
25	0112 2224	14	2322 3133	19	4544 4322	28
26	1101 3223	13	4323 2113	19	3313 2343	22
27	2101 1110	7	4531 1141	20	2121 1111	10
28	1122 2144	17	1123 0122	12	1121 2222	13
29	3211 2332	17	0012 2100	6	2112 2100	9
30	2122 1132	14			0001 1213	8
31	2211 1221	12			5231 1213	18

*) see Reda and Jankowski (2004)

Table 13
Three-hour-range *E* indices
based on power spectrum estimation (*)
Belsk, April–June 2024

Day	April		May		June	
	E	*SE*	*E*	*SE*	*E*	*SE*
1	2331 2232	18	4211 1232	16	3112 2210	12
2	2123 2221	15	3223 5654	30	0101 2223	11
3	3211 2210	12	5212 1121	15	1112 2225	16
4	0023 2444	19	0011 1214	10	3323 2100	14
5	2323 3233	21	1021 2235	16	0122 3222	14
6	4331 2232	20	5234 4332	26	2231 2200	12
7	1113 2423	17	1222 3322	17	2324 5533	27
8	2232 0210	12	0123 3201	12	4423 2421	22
9	0232 1243	17	0203 1132	12	1011 3121	10
10	2222 1322	16	3232 3889	38	2011 1442	15
11	2311 2111	12	8788 8876	60	4422 1312	19
12	2222 1011	11	6634 2356	35	0111 2212	10
13	2110 2112	10	5533 4322	27	1001 1220	7
14	2012 1122	11	1113 3230	14	0022 2123	12
15	1112 1233	14	1233 3334	22	3322 6424	26
16	4344 3565	34	3365 4321	27	2123 4452	23
17	2002 2212	11	1312 4565	27	2223 3444	24
18	1001 1102	6	4423 2311	20	2333 3321	20
19	1244 5564	31	0313 4331	18	3322 4431	22
20	2122 2323	17	0211 2112	10	2222 2122	15
21	3323 4534	27	1114 4422	19	2111 1021	9
22	2221 2223	16	2100 1122	9	2111 1211	10
23	1122 1132	13	1223 3334	21	1234 4332	22
24	1001 1000	3	2334 2202	18	2111 1112	10
25	0001 1102	5	2221 2314	17	1112 2421	14
26	1332 3652	25	2313 3341	20	1133 4332	20
27	4321 4333	23	1034 3212	16	2112 3333	18
28	4212 1011	12	2221 1120	11	5434 7554	37
29	2111 1231	12	0122 3232	15	4323 3343	25
30	2102 3445	21	0113 3423	17	2314 4422	22
31			3421 2321	18		

*) see Reda and Jankowski (2004)

Table 14
Three-hour-range *E* indices
based on power spectrum estimation (*)
Belsk, July–September 2024

Day	July		August		September	
	E	*SE*	*E*	*SE*	*E*	*SE*
1	2221 2310	13	5444 3332	28	4412 4432	24
2	1111 2111	9	2322 2323	19	3212 2221	15
3	1120 2112	10	1212 3323	17	1123 1111	11
4	2221 3433	20	3344 6635	34	0015 5322	18
5	2312 4310	16	3232 3232	20	1112 1112	10
6	1111 1000	5	2110 1232	12	0013 4113	13
7	2211 2233	16	1213 2213	15	2112 3221	14
8	2214 4332	21	3223 1121	15	2222 3323	19
9	2212 4222	17	2212 3322	17	3122 1333	18
10	2211 2212	13	1211 3331	15	3122 1132	15
11	3211 3222	16	2255 5545	33	1122 3423	18
12	3222 2111	14	6665 6655	45	2355 6676	40
13	1112 2120	10	4222 1135	20	5443 3556	35
14	1122 2112	12	5321 1213	18	5424 3135	27
15	1121 1123	12	1000 2123	9	1333 4531	23
16	4222 2422	20	3222 3211	16	4433 4214	25
17	1222 3221	15	0011 4746	23	7644 5445	39
18	1012 1210	8	2224 4242	22	4112 2314	18
19	0112 1221	10	1112 3333	17	5224 3441	25
20	2222 1331	16	3223 4322	21	0002 0114	8
21	1000 1232	9	4122 2321	17	1222 1131	13
22	3113 3232	18	4322 2323	21	0013 2111	9
23	0011 1131	8	1132 3232	17	1023 5611	19
24	2222 2122	15	2223 2412	18	3222 3354	24
25	1211 3444	20	3321 0002	11	4444 4555	35
26	4542 3533	29	2101 1200	7	4222 3231	19
27	2223 4421	20	0023 3334	18	2111 2000	7
28	1121 3242	16	6342 3223	25	0012 2313	12
29	1212 2222	14	2012 2111	10	2233 4324	23
30	5554 4422	31	1144 4555	29	4311 2233	19
31	1111 4554	22	4442 4553	31		

*) see Reda and Jankowski (2004)

Table 15
Three-hour-range *E* indices
based on power spectrum estimation (*)
Belsk, October–December 2024

Day	October		November		December	
	E	*SE*	*E*	*SE*	*E*	*SE*
1	1211 1210	9	2213 2010	11	1121 1124	13
2	2212 2021	12	0024 3233	17	2200 0022	8
3	1222 4132	17	2101 0255	16	3322 2441	21
4	1113 2324	17	5423 2104	21	1102 2232	13
5	4122 2122	16	2033 2242	18	2211 0101	8
6	1023 3445	22	3322 3233	21	2311 1111	11
7	6434 5565	38	1123 1345	20	1112 2122	12
8	6644 3545	37	2112 2254	19	0111 2231	11
9	4433 4323	26	4433 5545	33	5222 2445	26
10	1212 3779	32	4412 3474	29	1222 1122	13
11	7676 6444	44	2132 2421	17	2211 1122	12
12	3125 4243	24	1110 0211	7	2211 1221	12
13	0002 2131	9	1112 3231	14	0011 1211	7
14	0111 1144	13	1402 2443	20	1112 1244	16
15	3222 3422	20	3422 4334	25	3113 4252	21
16	2323 3444	25	4112 1000	9	1232 2355	23
17	2320 0243	16	0212 4111	12	4554 4424	32
18	3201 4435	22	1100 0113	7	4223 3451	24
19	6433 3264	31	0012 2431	13	4221 2033	17
20	3210 1012	10	0222 2111	11	4312 4443	25
21	0022 0123	10	0122 2243	16	3323 3354	26
22	1112 3422	16	2212 4434	22	1123 3443	21
23	2223 3021	15	2122 3232	17	4222 2434	23
24	3332 0223	18	1220 0125	13	2321 3335	22
25	1000 0001	2	4223 3322	21	2221 1010	9
26	1022 2444	19	4111 1012	11	0011 0001	3
27	3113 2443	21	1111 0113	9	0011 1211	7
28	3542 3323	25	1101 0020	5	0022 0121	8
29	3123 2452	22	1223 2024	16	1012 2101	8
30	5334 3322	25	5320 1002	13	0021 1033	10
31	1121 1245	17			0112 1545	19

*) see Reda and Jankowski (2004)

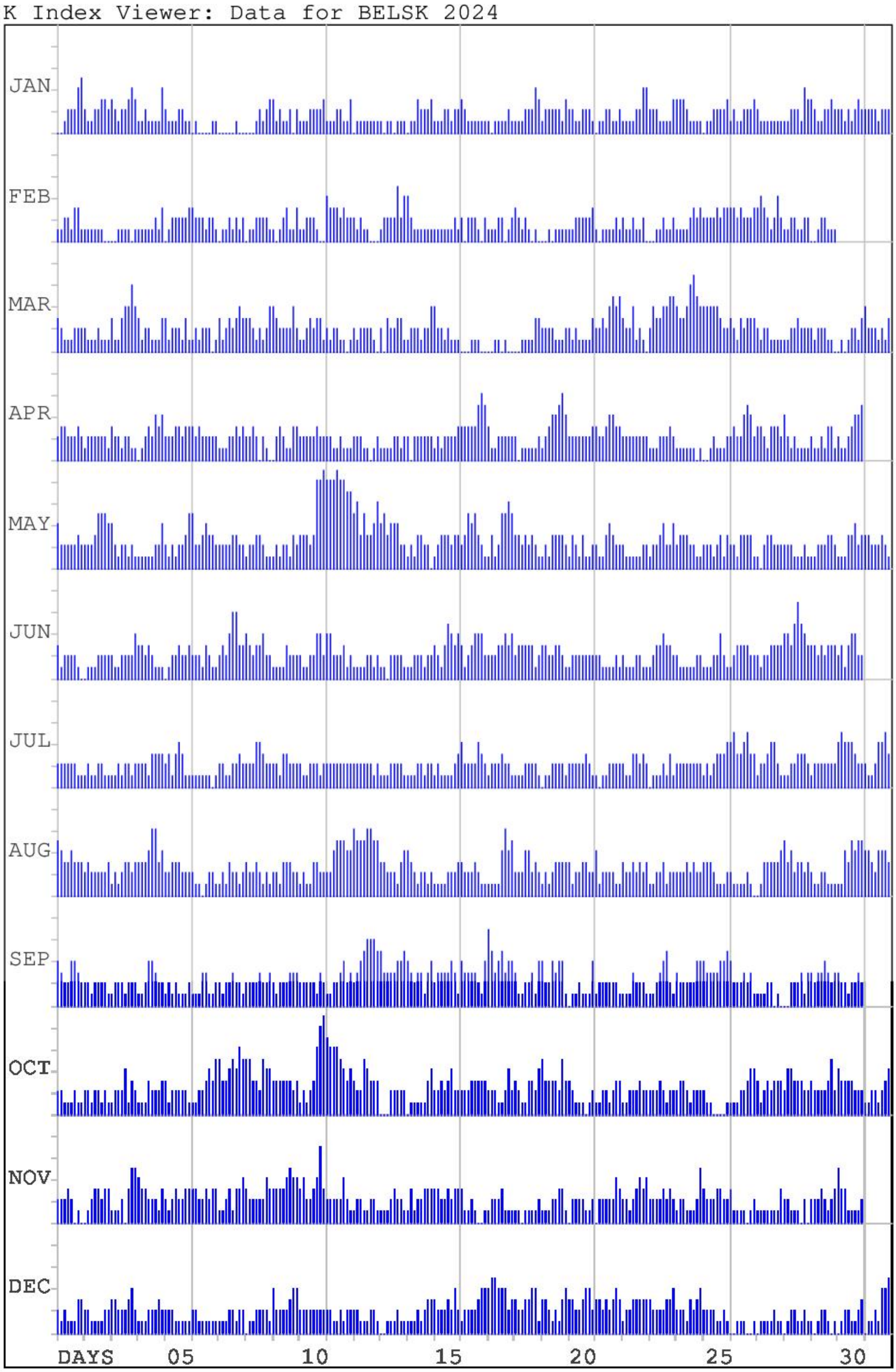

Fig. 8. *K*-indices in graphical form, Belsk 2024.

8. TABLES AND PLOTS FOR HEL OBSERVATORY

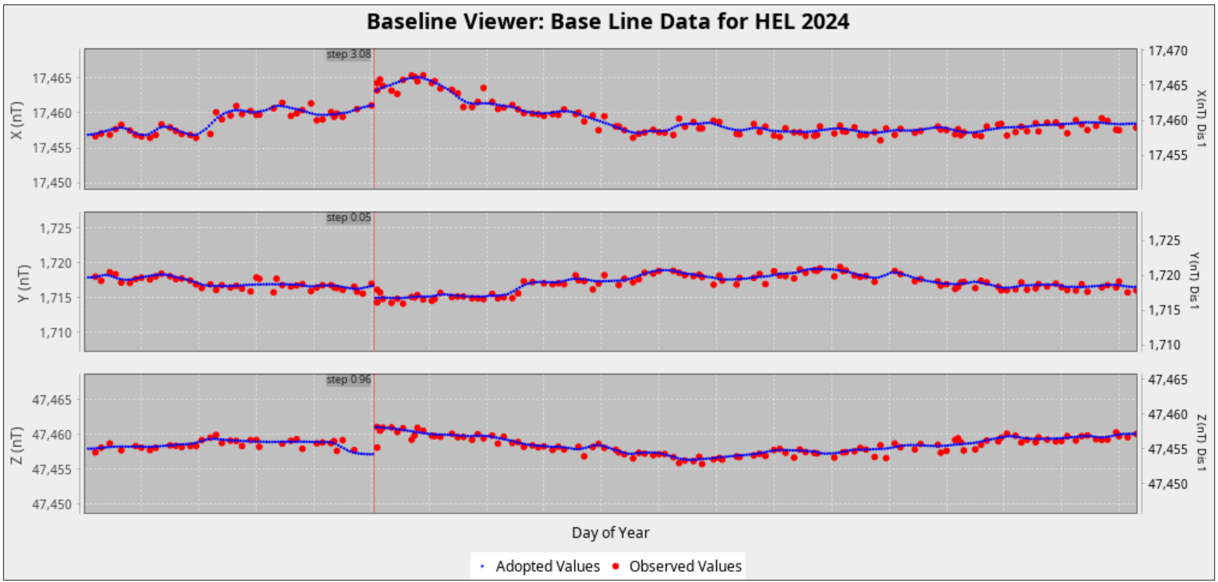

Fig. 9. Base values of set 1, Hel 2024.

Table 16
Annual mean values of magnetic components in Hel Observatory

No.	Year	*D* [° ʿ]	*H* [nT]	*Z* [nT]	*X* [nT]	*Y* [nT]	*I* [° ʿ]	*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

to be continued

Table 16 (continuation)
Annual mean values of magnetic components in Hel Observatory

No.	Year	*D* [° ‘]	*H* [nT]	*Z* [nT]	*X* [nT]	*Y* [nT]	*I* [° ‘]	*F* [nT]
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

to be continued

Table 16 (continuation)
Annual mean values of magnetic components in Hel Observatory

No.	Year	*D* [° ‘]	*H* [nT]	*Z* [nT]	*X* [nT]	*Y* [nT]	*I* [° ‘]	*F* [nT]
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
62	2014	4 36.3	17571	47117	17514	1411	69 32.9	50286
63	2015	4 45.5	17565	47163	17504	1457	69 34.4	50328
64	2016	4 54.7	17569	47203	17504	1504	69 35.1	50367
65	2017	5 05.5	17567	47253	17498	1559	69 36.4	50413
66	2018	5 15.7	17570	47305	17496	1611	69 37.4	50463
J	2019.0	0 –0.2	5	–2	5	–1	0 –0.4	0
67	2019	5 26.1	17564	47366	17485	1664	69 39.3	50518
68	2020	5 35.6	17560	47425	17477	1712	69 40.9	50571
69	2021	5 44.7	17553	47487	17464	1757	69 42.9	50627
70	2022	5 53.7	17543	47550	17450	1802	69 45.0	50683
71	2023	6 2.2	17536	47607	17439	1844	69 467.7	50735
72	2024	6 10.1	17535	47662	17434	1884	69 48.1	50786

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

2019.0 – jump caused by change the method for measuring declination/inclination from residual to zero method.

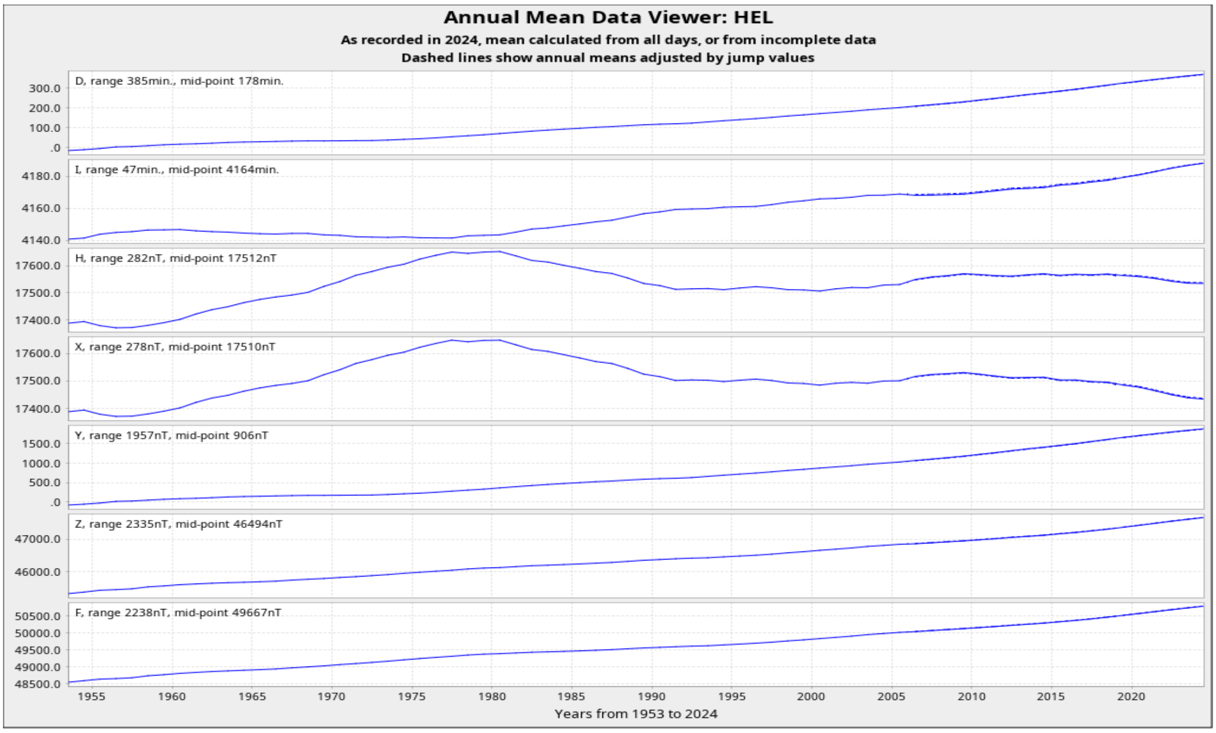

Fig. 10. Secular changes of *H*, *X*, *Y*, *Z*, *F*, *D* and *I* at Hel.

Table 17
Monthly and yearly mean values of magnetic components
HLP 2024

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
North component: 17000 + ... in nT													
All days	442	444	436	438	425	441	446	430	424	417	428	434	434
Quiet days	444	446	448	444	441	446	448	432	434	430	435	440	441
Disturbed days	441	441	422	428	382	434	439	429	399	373	410	432	419
East component: 1500 + ... in nT													
All days	364	367	373	376	384	380	384	389	393	399	398	400	384
Quiet days	364	366	371	375	378	381	381	387	389	395	398	399	382
Disturbed days	365	370	375	380	401	377	384	393	404	415	401	400	389
Vertical component: 47000 + ... in nT													
All days	634	633	643	646	659	660	658	671	677	686	689	689	662
Quiet days	633	633	638	642	655	658	657	669	674	683	687	688	660
Disturbed days	635	634	657	652	660	662	663	681	682	688	696	688	667

Table 18
Three-hour-range *K* indices
Hel, January–March 2024
The limit of *K* = 9 is 550

Day	January		February		March	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	0012 2344	16	1122 1221	12	2211 1222	13
2	2112 2331	15	0011 1000	3	1111 2011	8
3	3212 2243	19	0011 0101	4	3113 4564	27
4	1121 1114	12	1111 1213	11	3122 1113	14
5	1101 2100	6	0112 2223	13	3112 2131	14
6	0000 0011	2	3222 1221	15	1212 2201	11
7	0000 0000	0	0112 1112	9	3123 1343	20
8	0001 1123	8	0012 2220	9	2221 2124	16
9	2121 1102	10	0022 2013	10	4322 2142	20
10	1101 2123	11	1122 2000	8	1012 2331	13
11	1111 2112	10	5333 2322	23	1111 1100	6
12	0001 1101	4	1110 1000	4	2022 2200	10
13	1000 0101	3	2212 1514	18	2032 2321	15
14	0012 1222	10	4211 1001	10	1122 1214	14
15	1111 2022	10	1011 1020	6	4121 2101	12
16	2211 1111	10	1012 2102	9	0000 1000	1
17	0011 1111	6	1102 2012	9	0011 0000	2
18	0101 1143	11	3112 1110	10	0001 1032	7
19	1222 2213	15	0000 1011	3	2122 1112	12
20	2211 2211	12	0012 2113	10	2111 1013	10
21	0011 2011	6	0011 1120	6	3232 4445	27
22	1111 2244	16	2112 1111	10	3224 1210	15
23	2211 1122	12	0011 2102	7	2334 5455	31
24	3331 1010	12	1111 1222	11	3334 6863	36
25	0012 1223	11	2222 3133	18	4544 4322	28
26	1201 2222	12	3223 2222	18	3213 2333	20
27	2101 1111	8	3421 1132	17	2122 1111	11
28	1122 2143	16	1122 0012	9	1112 3222	14
29	2211 2232	15	0012 2100	6	2122 2100	10
30	2112 1132	13			0001 2212	8
31	1212 1221	12			4222 2112	16

Table 19
Three-hour-range *K* indices
Hel, April–June 2024
The limit of *K* = 9 is 550

Day	April		May		June	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	2332 2132	18	4222 2232	19	3012 2210	11
2	1122 2221	13	2123 5554	27	0111 1222	10
3	2111 3211	12	4212 2121	15	1112 2224	15
4	0123 2333	17	1011 1224	12	2322 2100	12
5	2222 2223	17	2121 2235	18	0122 3223	15
6	3232 3222	19	5123 4331	22	1121 3210	11
7	1112 2323	15	2122 3322	17	1224 7633	28
8	2222 1210	12	1223 3311	16	4333 3322	23
9	0231 1133	14	0212 2132	13	1111 3122	12
10	2212 2322	16	3322 3889	38	2111 1442	16
11	2211 2111	11	9989 9977	67	4322 1212	17
12	1222 1112	12	6635 3346	36	1101 2212	10
13	1111 2212	11	4534 4422	28	1001 1220	7
14	2022 2212	13	1213 3320	15	1022 2122	12
15	1112 1223	13	1224 3233	20	3223 5424	25
16	3233 3554	28	2454 5321	26	2123 4332	20
17	2112 1222	13	1313 5555	28	2222 3434	22
18	1001 1112	7	3323 3321	20	2333 3311	19
19	1234 5564	30	0212 3332	16	3322 3321	19
20	2322 2223	18	1320 3111	12	1222 2222	15
21	3223 4433	24	1113 4322	17	2211 1021	10
22	2222 2222	16	2100 0122	8	2110 1111	8
23	1112 2232	14	1113 4223	17	1233 4332	21
24	0002 2101	6	2333 3201	17	2100 1122	9
25	0001 1112	6	1221 2313	15	1112 2321	13
26	1322 4642	24	1213 3331	17	1123 3321	16
27	3222 4332	21	1123 3212	15	1112 3333	17
28	4212 1111	13	2221 1111	11	4335 8543	35
29	2122 2331	16	0123 2332	16	3322 2333	21
30	2102 3444	20	0112 3423	16	2213 3322	18
31			3422 2221	18		

Table 20
Three-hour-range *K* indices
Hel, July–September 2024
The limit of *K* = 9 is 550

Day	July		August		September	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	2222 3210	14	5433 4332	27	4312 4432	23
2	1111 2111	9	2322 2223	18	2212 2221	14
3	1111 2111	9	1212 3323	17	1123 1222	14
4	2212 3333	19	2233 6634	29	1025 4322	19
5	2312 4311	17	3233 3222	20	2212 1112	12
6	1111 1101	7	2111 1221	11	1013 3112	12
7	1211 2232	14	1212 2212	13	2112 3221	14
8	2223 4322	20	3223 2121	16	2222 3223	18
9	2212 3222	16	2112 3222	15	2122 2332	17
10	2112 2212	13	1211 3322	15	2222 2132	16
11	2221 2222	15	1245 6544	31	1112 4422	17
12	2222 2211	14	5565 7755	45	2345 6665	37
13	1111 1121	9	4322 2134	21	5333 3445	30
14	1112 2112	11	4321 2213	18	4323 3134	23
15	1111 1113	10	1111 2222	12	2334 4431	24
16	4222 2322	19	3222 3211	16	3332 3214	21
17	1222 3211	14	1111 5645	24	6544 5344	35
18	1102 1221	10	2324 4332	23	3113 2314	18
19	0111 2221	10	1212 3333	18	4224 3440	23
20	2222 2321	16	3123 3322	19	0011 1113	8
21	1001 2222	10	4112 2211	14	1222 2121	13
22	2113 3222	16	3213 2322	18	1112 2221	12
23	0011 1131	8	1122 2121	12	1123 4521	19
24	2222 2212	15	2223 2322	18	3222 3244	22
25	1212 3334	19	3222 1001	11	4333 3444	28
26	4433 4532	28	1101 2200	7	4222 3231	19
27	1223 4321	18	0033 3334	19	1111 3000	7
28	1112 3232	15	5332 2322	22	0022 2312	12
29	1212 2222	14	1112 2111	10	2233 4323	22
30	4443 4322	26	1144 5455	29	3221 2132	16
31	1112 4453	21	4432 4543	29		

Table 21
Three-hour-range *K* indices
Hel, October–December 2024
The limit of *K* = 9 is 550

Day	October		November		December	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	1211 2211	11	2223 2010	12	2121 1123	13
2	2212 1121	12	0013 3233	15	2200 1122	10
3	1122 3122	14	2012 0345	17	3222 2341	19
4	2112 2223	15	3332 2103	17	1101 2132	11
5	2122 2121	13	2123 2233	18	2221 1101	10
6	1022 3334	18	3222 2222	17	1211 1112	10
7	5334 5465	35	0112 1334	15	1111 1221	10
8	5543 3444	32	2212 2243	18	0102 2121	9
9	4323 3323	23	3333 4544	29	4222 2344	23
10	1213 2689	32	3422 3473	28	1222 1112	12
11	7667 5433	41	2122 2321	15	2111 1112	10
12	3124 4333	23	1120 1111	8	2111 1121	10
13	0002 2122	9	1112 3221	13	0001 1211	6
14	0111 1133	11	1312 2333	18	1112 1233	14
15	2222 3322	18	3322 3233	21	3122 3243	20
16	2223 3333	21	3112 1000	8	1222 2344	20
17	2211 1133	14	0212 3011	10	3544 4423	29
18	2211 3324	18	1101 0112	7	3223 3341	21
19	5333 3253	27	1112 2331	14	4322 2133	20
20	3111 1011	9	0222 2112	12	3322 3342	22
21	1012 1233	13	0112 1243	14	3323 2333	22
22	1112 2322	14	2212 3433	20	1222 3333	19
23	2223 2022	15	2222 2122	15	3222 2334	21
24	2332 1222	17	1221 1124	14	2221 3234	19
25	1101 0001	4	3222 2322	18	2122 1111	11
26	1012 2333	15	3111 1012	10	0001 0001	2
27	3123 2333	20	1111 0112	8	0001 1111	5
28	3432 3322	22	2101 1010	6	0112 0111	7
29	2222 2352	20	1212 2023	13	1012 2100	7
30	4333 3221	21	5321 2012	16	0121 1122	10
31	1122 1234	16			0111 1445	17

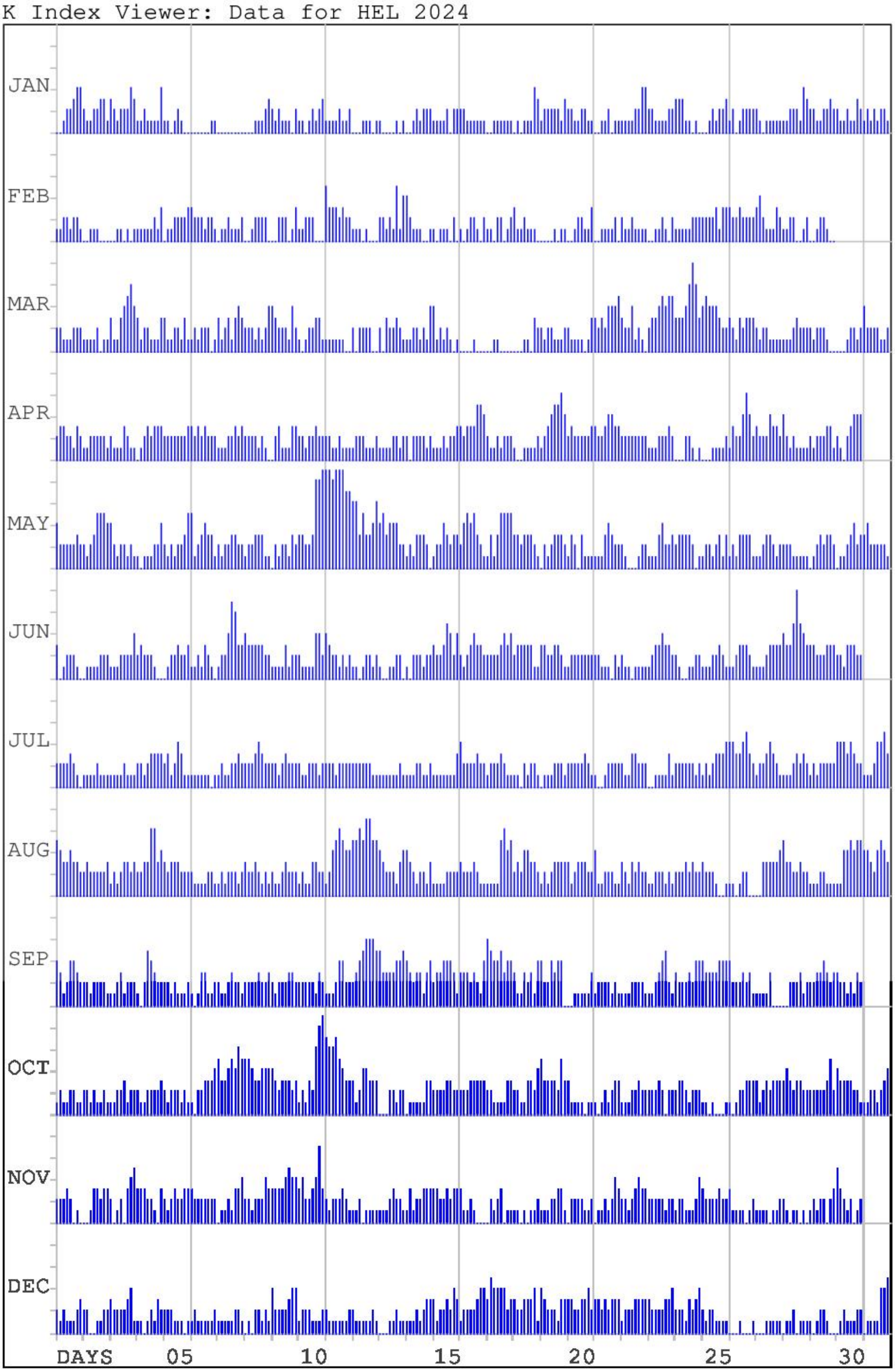

Fig. 11. *K*-indices in graphical form, Hel 2024.

9. TABLES AND PLOTS FOR HORNSUND OBSERVATORY

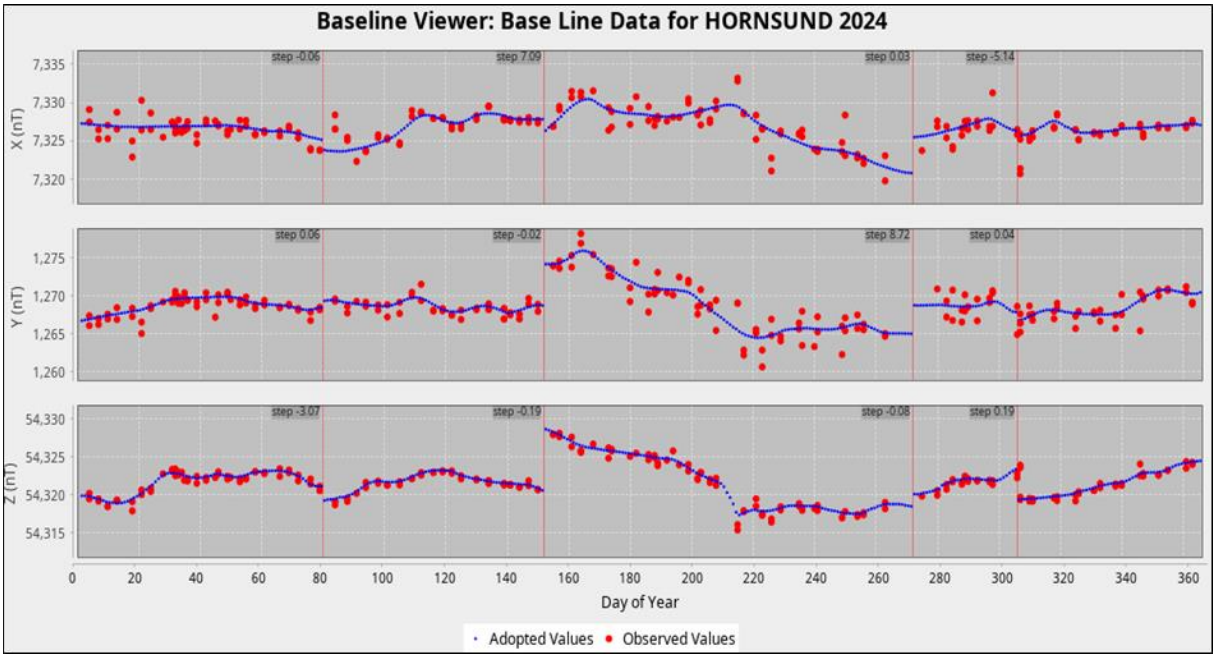

Fig. 12. Base values, Hornsund 2024.

Table 22
Annual mean values of magnetic components in Hornsund Observatory

No.	Year	*D* [° ']	*H* [nT]	*Z* [nT]	*X* [nT]	*Y* [nT]	*I* [° ']	*F* [nT]
1	1979	–0 32.2	8384	53447	8384	–79	81 05.1	54101
2	1980	–0 14.2	8370	53447	8370	–35	81 06.0	54098
3	1981	–0 09.3	8351	53449	8351	–23	81 07.2	54097
4	1982	–0 09.4	8319	53481	8319	–23	81 09.5	54124
5	1983	–0 02.0	8295	53457	8295	–5	81 10.8	54097
6	1984	0 07.7	8266	53439	8266	19	81 12.4	54075
7	1985	0 14.3	8238	53405	8238	34	81 13.9	54037
8	1986	0 20.4	8213	53392	8213	49	81 15.3	54020
9	1987	0 25.6	8193	53360	8193	61	81 16.3	53985
10	1988	0 34.7	8168	53368	8168	82	81 17.9	53989
11	1989	0 40.8	8148	53369	8147	97	81 19.2	53987
12	1990	0 47.2	8122	53360	8121	112	81 20.7	53975
13	1991	0 53.0	8107	53355	8106	125	81 21.6	53967
14	1992	1 01.4	8088	53352	8087	144	81 22.8	53962
15	1993	1 12.9	8065	53356	8063	171	81 24.3	53962
16	1994	1 25.9	8044	53374	8041	201	81 25.8	53977
17	1995	1 38.4	8038	53374	8035	230	81 26.1	53976

to be continued

Table 22 (continuation)
Annual mean values of magnetic components in Hornsund Observatory

No.	Year	*D* [° ‘]	*H* [nT]	*Z* [nT]	*X* [nT]	*Y* [nT]	*I* [° ‘]	*F* [nT]
18	1996	1 51.4	8023	53385	8019	260	81 27.2	53985
19	1997	2 07.2	8004	53406	7999	296	81 28.6	54003
20	1998	2 24.0	8001	53440	7994	335	81 29.1	54036
21	1999	2 39.1	7998	53471	7989	370	81 29.6	54066
22	2000	2 55.5	7996	53504	7986	408	81 30.0	54098
23	2001	3 12.4	7992	53542	7979	447	81 30.6	54135
24	2002	3 29.7	7989	53585	7974	487	81 31.2	54177
25	2003	3 49.8	7965	53646	7947	532	81 33.3	54234
26	2004	4 04.2	7961	53675	7941	565	81 33.8	54262
27	2005	4 20.5	7953	53707	7930	602	81 34.6	54293
28	2006	4 36.2	7958	53727	7932	639	81 34.5	54314
29	2007	4 51.3	7950	53757	7922	673	81 35.2	54342
30	2008	5 07.9	7941	53785	7909	710	81 36.1	54368
31	2009	5 25.4	7939	53804	7903	750	81 36.4	54387
32	2010	5 45.7	7928	53837	7888	796	81 37.4	54418
33	2011	6 05.8	7920	53868	7875	841	81 38.2	54447
34	2012	6 28.2	7910	53900	7860	891	81 39.1	54477
35	2013	6 50.8	7903	53920	7846	942	81 39.7	54497
36	2014	7 08.8	7895	53947	7833	982	81 40.4	54521
37	2015	7 30.6	7881	53988	7813	1030	81 41.7	54560
38	2016	7 53.5	7862	54021	7787	1079	81 43.2	54590
39	2017	8 17.6	7844	54064	7762	1131	81 44.7	54630
40	2018	8 40.6	7830	54098	7740	1181	81 45.9	54662
41	2019	9 04.5	7814	54141	7717	1233	81 47.2	54702
42	2020	9 28.2	7797	54189	7691	1283	81 48.7	54747
43	2021	9 49.5	7780	54238	7666	1327	81 50.2	54793
44	2022	10 12.3	7770	54291	7647	1376	81 51.3	54844
45	2023	10 34.8	7760	54333	7628	1425	81 52.3	54885
46	2024	10 56.9	7757	54370	7616	1473	81 52.8	54920

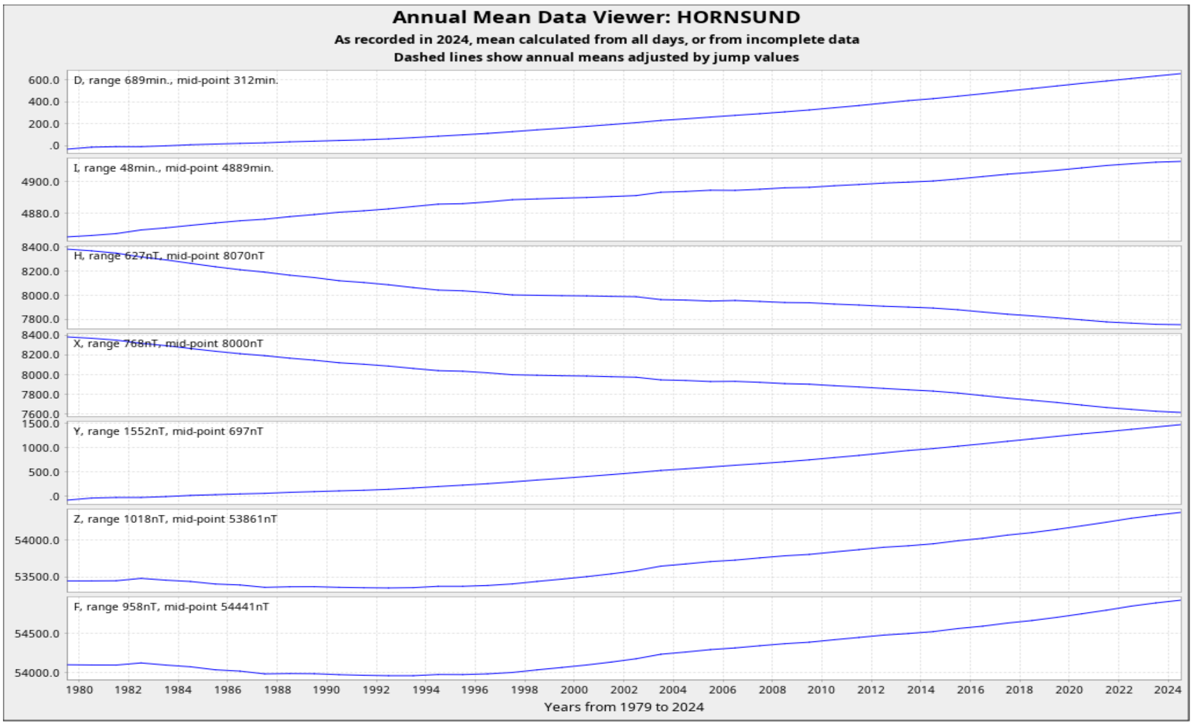

Fig. 13. Secular changes of *H*, *X*, *Y*, *Z*, *F*, *D* and *I* at Hornsund.

Table 23
Monthly and yearly mean values of magnetic components
HRN 2024

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
North component: 7500 + ... in nT													
All days	109	111	113	123	138	147	142	133	113	95	89	83	116
Quiet days	116	117	118	126	127	132	133	117	107	98	96	94	115
Disturbed days	98	92	96	114	116	133	155	128	120	85	70	60	106
East component: 1000 + ... in nT													
All days	403	408	413	414	412	418	419	426	435	443	448	454	425
Quiet days	402	409	405	410	414	407	419	424	434	441	445	450	422
Disturbed days	414	417	424	428	417	430	430	428	447	457	453	464	434
Vertical component: 5400 + ... in nT													
All days	350	347	357	354	373	356	361	362	376	400	401	398	370
Quiet days	349	344	356	357	363	354	366	374	377	397	399	388	369
Disturbed days	349	356	342	350	401	368	367	354	384	434	417	411	378

Table 24
Three-hour-range *K* indices
Hornsund, January–March 2024
The limit of *K* = 9 is 2500

Day	January		February		March	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	1111 2145	16	1132 1121	12	4321 2221	17
2	2222 2323	18	0121 2100	7	3012 1120	10
3	3332 3254	25	0011 0101	4	2213 4332	20
4	1232 2212	15	1122 0024	12	3232 2124	19
5	2232 2211	15	0122 1112	10	3332 2120	16
6	1111 0022	8	2122 1120	11	1322 3200	13
7	1011 0101	5	0121 1103	9	2244 3222	21
8	0111 0113	8	1122 1230	12	4332 2114	20
9	3122 1111	12	0022 0001	5	5332 3132	22
10	1212 3122	14	1221 2000	8	1222 2551	20
11	2221 2113	14	3333 1344	24	0222 1100	8
12	1111 2101	8	3330 0000	9	3232 2100	13
13	1121 1011	8	1432 1533	22	1132 2411	15
14	0122 2223	14	4222 1110	13	1222 2223	16
15	3123 1011	12	1111 1141	11	5232 3101	17
16	2110 1000	5	1122 2101	10	1110 1101	6
17	0222 2111	11	1000 2111	6	0010 0000	1
18	0221 2133	14	2121 0110	8	0010 0123	7
19	1321 2113	14	0000 0110	2	2111 2111	10
20	2321 2231	16	0111 2112	9	1222 1**2	*
21	1122 2013	12	1011 1121	8	2233 3443	24
22	0122 3235	18	1221 1101	9	2334 2102	17
23	3232 2114	18	0111 1001	5	2323 3333	22
24	5342 1000	15	1*11 2113	*	3355 5765	39
25	0222 2212	13	2333 3111	17	4454 3333	29
26	1221 2121	12	2322 2102	14	4523 3335	28
27	2121 1100	8	4532 1151	22	2232 2111	14
28	0111 1121	8	1132 1022	12	0223 3110	12
29	3321 2344	22	0022 2000	6	0332 2100	11
30	2222 1034	16			0011 1223	10
31	1332 1122	15			3232 2102	15

Table 25
Three-hour-range *K* indices
Hornsund, April–June 2024
The limit of *K* = 9 is 2500

Day	April		May		June	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	1333 3221	18	3331 1122	16	2223 2210	14
2	1123 2211	13	2345 4443	29	1223 2222	16
3	3232 3100	14	4223 2012	16	3222 2222	17
4	0123 3334	19	1112 1114	12	3454 3101	21
5	2343 2222	20	2222 1123	15	2332 3222	19
6	4342 3232	23	4355 4221	26	2342 2210	16
7	2222 2313	17	2323 3332	21	2435 4422	26
8	1342 1210	14	2333 3221	19	5445 3232	28
9	1233 3232	19	1222 2232	16	2332 3222	19
10	2223 3321	18	4433 3676	36	2222 3343	21
11	2222 2110	12	5667 6645	45	3343 2212	20
12	1232 2000	10	7544 3356	37	2222 2222	16
13	1211 3212	13	3544 3212	24	1111 2110	8
14	1122 2110	10	2223 3321	18	1233 3123	18
15	1332 2232	18	2344 4243	26	3343 5332	26
16	3235 3322	23	2455 4221	25	3233 4342	24
17	2223 3211	16	1332 4443	24	2233 2333	21
18	1121 1101	8	3345 3212	23	2344 4321	23
19	1246 5432	27	1333 4321	20	2344 5432	27
20	2345 3432	26	2432 2212	18	2333 2232	20
21	3235 4542	28	2334 4222	22	2222 2122	15
22	2342 2222	19	3211 1111	11	2221 1111	11
23	2233 3132	19	1344 3323	23	1355 3222	23
24	2211 1010	8	3555 4222	28	2221 1112	12
25	0112 1111	8	2332 2223	19	2244 2221	19
26	2354 3432	26	2433 4322	23	2244 4321	22
27	2333 4222	21	2244 3223	22	2232 3422	20
28	2332 2111	15	2331 2111	14	4344 6333	30
29	2232 2221	16	1222 2232	16	3344 5333	28
30	1213 3224	18	1324 2343	22	3335 4423	27
31			2532 2321	20		

Table 26
Three-hour-range *K* indices
Hornsund, July–September 2024
The limit of *K* = 9 is 2500

Day	July		August		September	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	3333 4322	23	3443 3222	23	3322 3332	21
2	2332 2222	18	2333 3322	21	2232 3332	20
3	2331 3111	15	2235 3323	23	1233 2100	12
4	2333 4322	22	2254 3442	26	0124 4211	15
5	2423 3311	19	4453 4223	27	2222 2112	14
6	2222 2110	12	1222 2233	17	1123 3112	14
7	2232 3223	19	2333 3112	18	2223 3111	15
8	2335 5232	25	2333 2121	17	2232 3211	16
9	1234 3222	19	3222 3212	17	2132 1332	17
10	2223 3223	19	2331 3332	20	3333 2123	20
11	2332 3112	17	**** ****	*	1123 3222	16
12	2333 2212	18	**** 3432	*	1456 5443	32
13	2231 2021	13	4332 2133	21	3344 3534	29
14	2222 2102	13	3422 2212	18	3344 3252	26
15	2221 2223	16	1211 2111	10	2244 4332	24
16	3332 2222	19	3343 3221	21	4444 32*2	*
17	2333 4221	20	1233 3543	24	5344 5334	31
18	1233 3211	16	2334 3222	21	2223 3322	19
19	0222 3232	16	2223 3342	21	4335 3432	27
20	2233 1222	17	2234 3322	21	2222 2213	16
21	2100 2222	11	3333 3321	21	1332 2111	14
22	3223 3222	19	3234 3223	22	0133 3210	13
23	1112 3122	13	2343 3122	20	1233 4421	20
24	3222 2211	15	2345 4322	25	2232 1226	20
25	2221 2433	19	1333 2111	15	6355 4534	35
26	4545 4432	31	1221 1321	13	4333 3121	20
27	2455 3222	25	1132 3323	18	1221 1000	7
28	3333 3243	24	4134 4322	23	0123 2321	14
29	3323 3221	19	2211 2112	12	1233 3322	19
30	4554 3222	27	3135 4323	24	4332 3232	22
31	2333 3433	24	2232 3322	19		

Table 27
Three-hour-range *K* indices
Hornsund, October–December 2024
The limit of *K* = 9 is 2500

Day	October		November		December	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	1321 1111	11	2212 2010	10	1111 1034	12
2	1222 3111	13	0023 2121	11	0210 1103	8
3	1222 3112	14	2100 0123	9	4312 2451	22
4	1222 2213	15	3322 2102	15	1122 2132	14
5	2122 2112	13	3222 2251	19	2221 1000	8
6	1122 3323	17	2322 2252	20	0221 1002	8
7	5533 4233	28	1222 1243	17	1231 2120	12
8	3334 2333	24	2311 1231	14	0211 2111	9
9	2345 4323	26	4222 3222	19	4322 1324	21
10	2234 4655	31	2332 2342	21	2221 1123	14
11	4344 4212	24	1222 2430	16	3212 2111	13
12	1224 3222	18	0221 1101	8	2232 1120	13
13	1013 3153	17	0111 2210	8	0021 1221	9
14	1142 2132	16	0321 2311	13	1222 2222	15
15	1223 3422	19	1321 3321	16	2222 2152	18
16	2344 3422	24	2211 1000	7	1322 1124	16
17	1221 1243	16	0221 2212	12	3654 3315	30
18	2212 2222	15	1110 0032	8	4333 2452	26
19	3533 3132	23	1122 2211	12	4433 1125	23
20	3222 2001	12	0222 1110	9	5332 3342	25
21	1212 0123	12	0112 2023	11	3433 2355	28
22	1022 2111	10	2222 2214	17	2233 3233	21
23	1132 1011	10	2222 2211	14	4242 2415	24
24	2232 0111	12	1331 0104	13	1322 2225	19
25	1210 0000	4	3232 2332	20	4233 1023	18
26	2112 2323	16	5332 *002	*	1012 0001	5
27	3323 3322	21	1221 0001	7	2111 3100	9
28	3455 4323	29	1111 0000	4	0022 0011	6
29	4443 3351	27	1221 1023	12	1112 1100	7
30	4244 3323	25	4221 0002	11	0121 1112	9
31	2221 2223	16			1222 2444	21

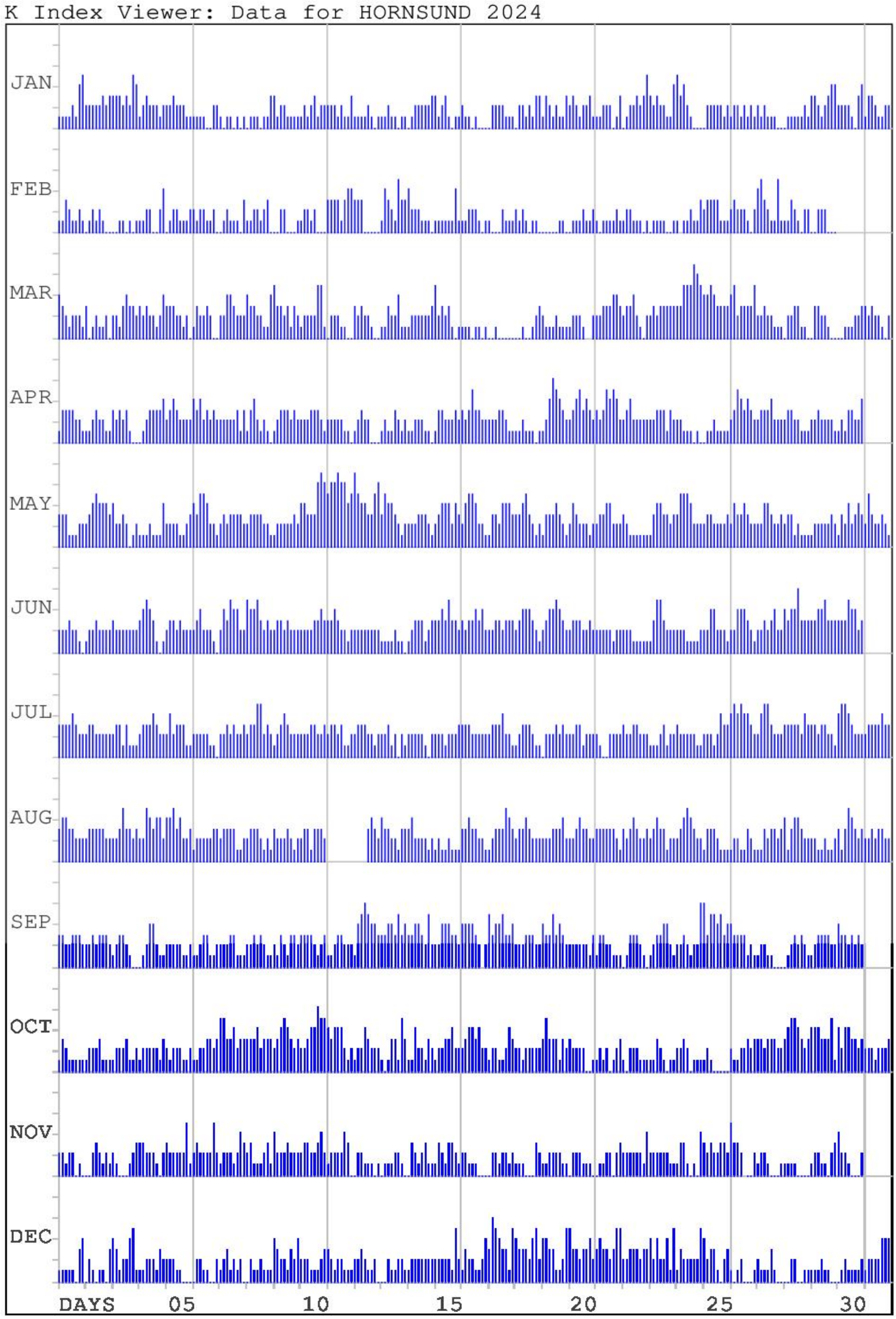

Fig. 14. *K*-indices in graphical form, Hornsund 2024.

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