Institute of Geophysics
Polish Academy of Sciences

PUBLICATIONS
OF THE INSTITUTE OF GEOPHYSICS
POLISH ACADEMY OF SCIENCES

Geophysical Data Bases, Processing and Instrumentation

440 (C-115)

Results of Geomagnetic Observations:
Belsk, Hel, Hornsund, 2020

Warsaw 2022 (Issue 2)

INSTITUTE OF GEOPHYSICS
POLISH ACADEMY OF SCIENCES

PUBLICATIONS
OF THE INSTITUTE OF GEOPHYSICS
POLISH ACADEMY OF SCIENCES

Geophysical Data Bases, Processing and Instrumentation

440 (C-115)

Results of Geomagnetic Observations:
Belsk, Hel, Hornsund, 2020

Warsaw 2022

Honorary Editor
Roman TEISSEYRE

Editor-in-Chief
Marek KUBICKI

Advisory Editorial Board
Janusz BORKOWSKI (Institute of Geophysics, PAS)
Tomasz ERNST (Institute of Geophysics, PAS)
Maria JELEŃSKA (Institute of Geophysics, PAS)
Andrzej KIJKO (University of Pretoria, Pretoria, South Africa)
Natalia KLEIMENOVA (Institute of Physics of the Earth, Russian Academy of Sciences, Moscow, Russia)
Zbigniew KŁOS (Space Research Center, Polish Academy of Sciences, Warsaw, Poland)
Jan KOZAK (Geophysical Institute, Prague, Czech Republic)
Antonio MELONI (Instituto Nazionale di Geofisica, Rome, Italy)
Hiroyuki NAGAHAMA (Tohoku University, Sendai, Japan)
Kaja PIETSCH (AGH University of Science and Technology, Cracow, Poland)
Paweł M. ROWIŃSKI (Institute of Geophysics, PAS)
Steve WALLIS (Heriot Watt University, Edinburgh, United Kingdom)
Wacław M. ZUBEREK (University of Silesia, Sosnowiec, Poland)

Associate Editors
Łukasz RUDZIŃSKI (Institute of Geophysics, PAS) – **Solid Earth Sciences**
Jan WISZNIOWSKI (Institute of Geophysics, PAS) – **Seismology**
Jan REDA (Institute of Geophysics, PAS) – **Geomagnetism**
Krzysztof MARKOWICZ (Institute of Geophysics, Warsaw University) – **Atmospheric Sciences**
Mark GOŁKOWSKI (University of Colorado Denver) – **Ionosphere and Magnetosphere**
Andrzej KUŁAK (AGH University of Science and Technology) – **Atmospheric Electricity**
Marzena OSUCH (Institute of Geophysics, PAS) – **Hydrology**
Adam NAWROT (Institute of Geophysics, PAS) – **Polar Sciences**

Managing Editor
Anna DZIEMBOWSKA

Technical Editor
Marzena CZARNECKA

Published by the Institute of Geophysics, Polish Academy of Sciences

ISBN 978-83-66254-11-4 eISSN-2299-8020
DOI: 10.25171/InstGeoph_PAS_Publs-2022-018

Photo on the front cover by Jan Reda

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

Publications of the Institute of Geophysics, Polish Academy of Sciences
Geophysical Data Bases, Processing and Instrumentation
vol. 440 (C-115), 2022, pp. 1-44
DOI: 10.25171/InstGeoph_PAS_Publs-2022-018

Results of Geomagnetic Observations Belsk, Hel, Hornsund, 2020

Jan REDA✉, Mariusz NESKA, Stanisław WÓJCIK, and Paweł CZUBAK

Institute of Geophysics, Polish Academy of Sciences, Warsaw, Poland
✉ jreda@igf.edu.pl

1. INTRODUCTION

This publication contains basic information on geomagnetic observations carried out in 2020 in three Polish geophysical observatories: Belsk, Hel, and Hornsund. IAGA codes are, respectively: BEL, HLP, and 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 2020, 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. Data of geomagnetic field elements XYZF have been sent to the INTERMAGNET centre in real time so they are publicly available on the Internet. At the beginning of 2021, the final data (status Definitive) for the whole 2020 year observations have been prepared. Definitive Data are published on INTERMAGNET website too.

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 are providing their data, both real-time and final, to EMMA network (European quasi-Meridional Magnetometer Array). These data are exploited for investigation of the plasmasphere.

2. DESCRIPTION OF OBSERVATORIES

The location of observatories is shown in Fig. 1 and Table 1. The geomagnetic coordinates in Table 1 were calculated on the basis of model IGRF-13 from epoch 2020.5 (http://www.geomag.bgs.ac.uk/data_service/models_compass/coord_calc.html).

The methodology of geomagnetic observations in all 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

© 2022 The Author(s). Published by the Institute of Geophysics, Polish Academy of Sciences.
This is an open access article under the CC BY license 4.0.

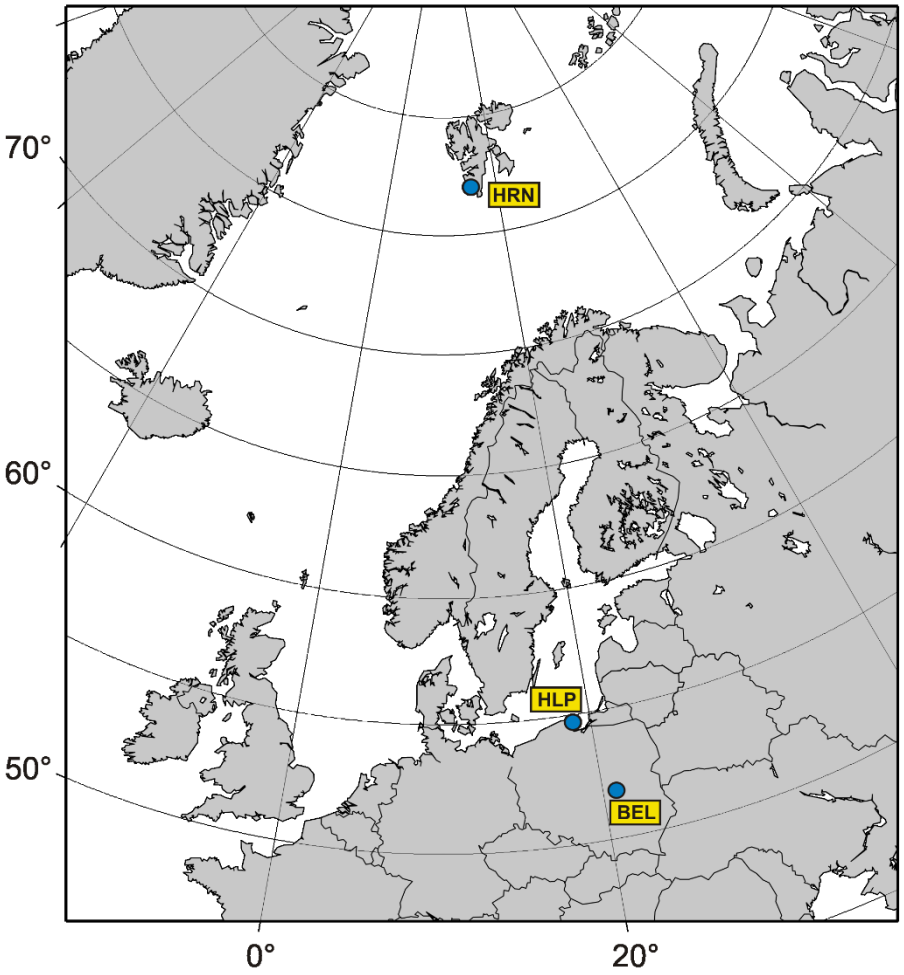

Fig. 1. Location of the Belsk, Hel, and Hornsund observatories.

were measured with the use of PSM magnetometers equipped in Bobrov's quartz variometers as well as by GEOMAG and LEMI flux-gate magnetometers.

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 2020 the Hornsund and Suwałki stations have been continuing the permanent observation of the Schumann resonance. Two horizontal magnetic components have been recorded at a frequency of 100 Hz. This recording was initiated in 2004 (Neska and Satori 2006).

Table 1

Coordinates of the Polish observatories

Observatory	Geographic coordinates		Geomagnetic coordinates		Elevation [m]
	Latitude	Longitude	Latitude	Longitude	
Belsk (BEL)	51° 50.2′ N	20° 47.3′ E	50.33° N	104.91° E	180
Hel (HLP)	54° 36.2′ N	18° 48.6′ E	53.32° N	104.24° E	1
Hornsund (HRN)	77° 0.0′ N	15° 33.0′ E	74.29° N	123.88° E	15

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 (Fig. 2) 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 (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/.

Fig. 2. Belsk Observatory – Absolute House.

2.2 Geophysical Observatory at Hel, Northern Poland

The Observatory at Hel (Fig. 3) 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 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. 3. Hel Observatory – the main gate.

2.3 Polish Polar Station Hornsund, Spitsbergen

The Polish Polar Station Hornsund (PSP Hornsund, Fig. 4) 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 1932–1933, 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. 4. 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 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) center in Edinburgh.

3. INSTRUMENTATION

3.1 Absolute measurements

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

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

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

Table 2

Instruments for absolute measurements

	Belsk	Hel	Hornsund
DI-fluxgate (fluxgate, theodolite)	ELSEC 810, THEO-10B sn: 002208	FLUX-9408 THEO-10B sn: 160334	GEOMAG-03 THEO-010B sn: 06-2016
Proton magnetometer	GSM-90 sn: 9038262	PMP-5 sn: 160	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
Overhauser magnetometer model GSM-90	
Producer	GEM Systems, Canada
Resolution	0.01 nT
Absolute accuracy	0.2 nT

Results of base determinations and the smoothed values adopted for further computations are depicted in Figs. 5, 8, and 11 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 2020 are listed in Table 4.

Table 4

Mean errors of measurements of B_X, B_Y, B_Z, and B_F in 2020

Observatory	Element	Number of measurements n	Mean error m_B [nT]
Belsk	B_X	169	0.34
	B_Y	166	0.37
	B_Z	174	0.16
Hel	B_X	151	0.32
	B_Y	150	0.26
	B_Z	152	0.23
Hornsund	B_X	113	1.15
	B_Y	110	0.57
	B_Z	116	0.32

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.

3.2 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 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 in Belsk, Hel, and Hornsund are listed in Tables 5a, 5b, and 5c, respectively.

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.

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. 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 5a

Basic instruments for the magnetic field variations recording in Belsk Observatory

Set / Period	Parameter name	Value
Set 1 Vector magnetometer Jan 1 – Jun 18	Name of magnetometer	PSM
	Kind of sensor	Bobrov
	Serial No.	PSM 8811-01P
	Sensor's orientation	XYZ
	Range	+/– 5000 nT
	Magnetometer's producer	Institute of Geophysics PAS
	Digital recorder	NDL
	Producer	TUS Electronics
	Sampling interval	1 s
Set 1 Vector magnetometer Jun 19 – Dec 31	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-03
	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	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

Table 5b

Basic instruments for the magnetic field variations recording in Hel Observatory

Set / Period	Parameter name	Value
Set 1 Vector magnetometer Jan 1 – Nov 25	Name of magnetometer	PSM torsion photoelectric magnetometer
	Kind of sensor	Bobrov
	Serial No.	PSM 8511-02P
	Sensor's orientation	XYZ
	Range	+/– 5000 nT
	Magnetometer's producer	Institute of Geophysics PAS
	Digital recorder	NDL
	Producer	TUS Electronics
	Sampling interval	1 s
Set 1 Vector magnetometer Nov 26 – Dec 31	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	PSM torsion photoelectric magnetometer
	Kind of sensor	Bobrov
	Serial No.	PSM 8511-03P
	Sensor's orientation	XYZ
	Range	+/– 5000 nT
	Magnetometer's producer	Institute of Geophysics PAS
	Digital recorder	NDL
	Producer	TUS Electronics
	Sampling interval	1 s
Set 1 Scalar magnetometer	Name of magnetometer	PMP-8
	Kind of sensor	Proton magnetometer
	Serial No.	No. 021/2006
	Magnetometer's producer	Institute of Geophysics PAS
	Sampling interval	30 s

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. 24
	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	+/– 10000 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 Jul 24 – Dec 31	Name of magnetometer	GSM-90
	Kind of sensor	Overhauser proton magnetometer
	Serial No.	No. 9038263
	Magnetometer's producer	GEM Systems
	Sampling interval	1 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 0.1 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).

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.

3.3 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.

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

3.4 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 binary format IAF and creation in this format of monthly files containing one-minute means of X, Y, Z, and ΔF (author: 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 Adaptive Smoothed method (ASm), 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 Archive Format (IAF) or 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. 6, 9, and 12), bases of recording sets as well as plots of K indices for 2020 (Figs. 7, 10, and 13) 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. Monthly mean values of 2020 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.

3.5 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 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 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 Tables 5a, 5b, 5c. For those interested, these data can be made available on request.

4. CONTACT PERSONS, POSTAL ADDRESSES, CONTACT DETAILS

4.1 Belsk Observatory

Jan Reda, Mariusz Neska
Central Geophysical Observatory
05-622 Belsk
Poland
Tel.: +48 486610830
e-mails: jreda@igf.edu.pl (J. Reda), nemar@igf.edu.pl (M. Neska)
http://www.igf.edu.pl/

4.2 Hel Observatory

Stanisław Wójcik
Geophysical Observatory
ul. Sosnowa 1
84-150 Hel
Poland
Tel./Fax +48 58 6750480
e-mail: hel@igf.edu.pl
http://www.igf.edu.pl/

4.3 Hornsund Observatory

Mariusz Neska, Paweł Czubak
Central Geophysical Observatory
05-622 Belsk
Poland
Tel.: +48 486610833
e-mails: nemar@igf.edu.pl (M. Neska), pczubak@igf.edu.pl (P. Czubak)
http://hornsund.igf.edu.pl/
http://www.igf.edu.pl/

5. PERSONNEL TAKING PART IN THE WORK OF BELSK, HEL, AND HORNSUND OBSERVATORIES IN 2020

Jan Reda (project leader of geomagnetic observations in Belsk, Hel, Hornsund)
Paweł Czubak
Krzysztof Kucharski
Grzegorz Kwolek (Hornsund, observer in 2-nd half-year)
Anna Myśliwiec (Hornsund, observer in1-st half-year)
Mariusz Neska
Anna Wójcik
Stanisław Wójcik

6. TABLES AND PLOTS FOR BELSK OBSERVATORY

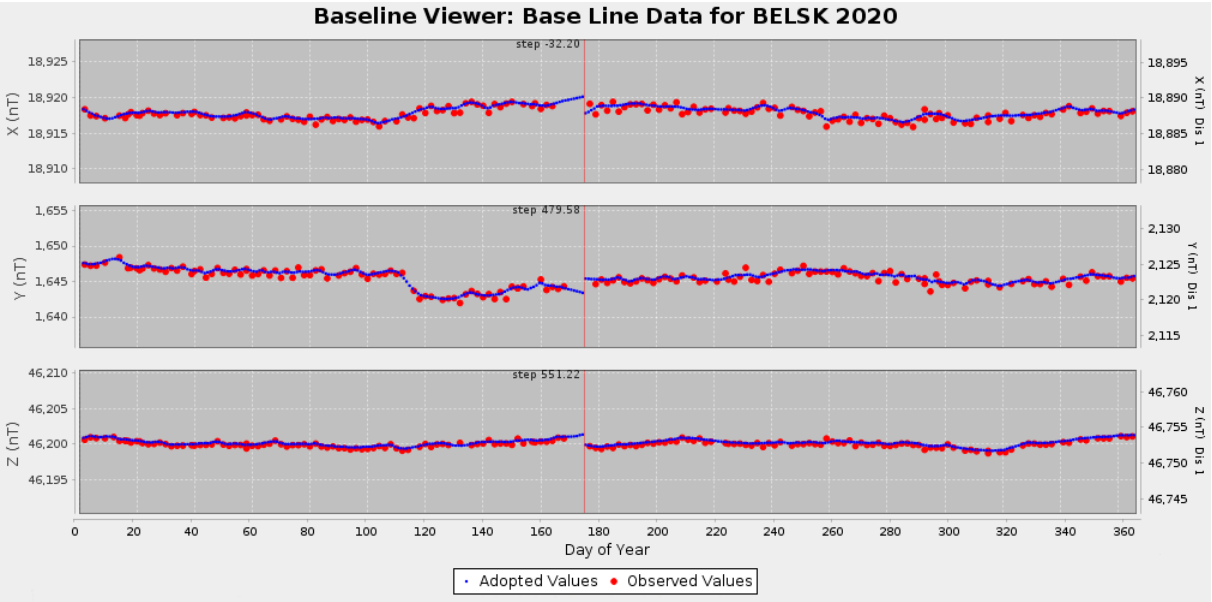

Fig. 5. Base values of set 1, Belsk 2020.

Table 6

Annual mean values of magnetic elements 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 elements 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

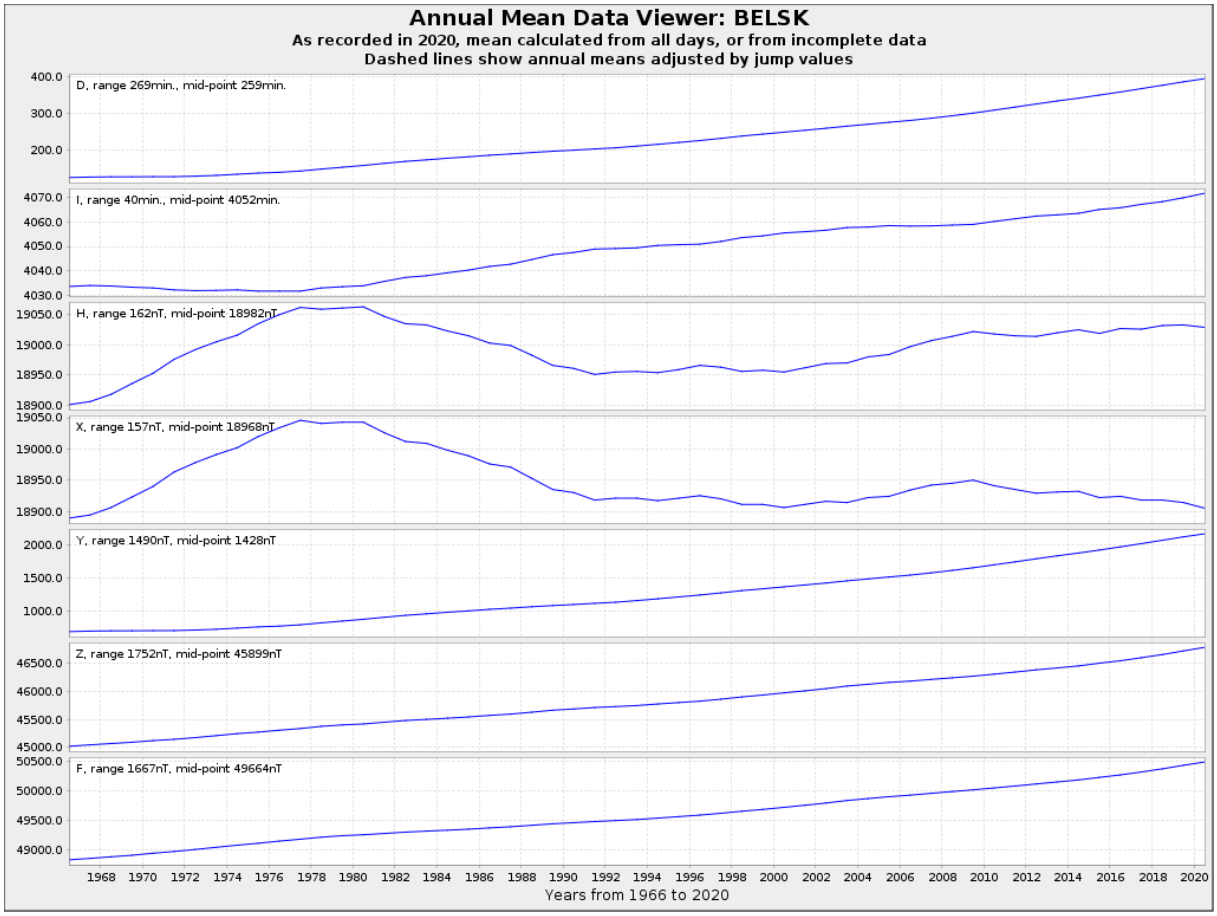

Fig. 6. Secular changes of *H*, *X*, *Y*, *Z*, *F*, *D* and *I* at Belsk.

Table 7

Monthly and yearly mean values of magnetic elements
BEL 2020

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
North component: 18500 + ... in nT													
All days	408	405	407	406	411	411	409	406	398	398	397	399	405
Quiet days	410	409	411	408	413	412	412	407	407	404	402	400	408
Disturbed days	402	398	402	404	409	410	406	403	386	392	386	397	399
East component: 2000 + ... in nT													
All days	153	157	160	164	166	171	174	178	182	185	188	192	173
Quiet days	153	156	158	164	165	171	173	177	180	183	186	191	171
Disturbed days	156	158	164	164	167	171	175	179	188	188	192	194	175
Vertical component: 46500 + ... in nT													
All days	247	253	256	262	264	269	275	281	288	294	300	305	275
Quiet days	247	252	254	262	264	269	274	281	285	292	298	304	273
Disturbed days	249	256	258	262	265	269	275	282	291	298	304	307	276

Table 8

Three-hour-range *K* indices
Belsk, January–March 2020
The limit of *K* = 9 is 450

Day	January		February		March	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	0001 1221	7	1011 2323	13	4212 1112	14
2	0001 0112	5	2111 1233	14	2101 2111	9
3	0122 2112	11	1111 0121	8	1102 2213	12
4	1011 1333	13	2211 2224	16	0111 2422	13
5	2111 2342	16	2212 1111	11	1011 2110	7
6	2222 1242	17	1233 3363	24	1012 2210	9
7	1111 1223	12	3321 3344	23	0111 2111	8
8	1101 2323	13	3111 2222	14	1110 1222	10
9	2232 2332	19	3111 1232	14	0211 1231	11
10	1122 2221	13	1111 0122	9	2111 1102	9
11	2222 0212	13	3211 1013	12	2001 1001	5
12	1211 1101	8	1222 1002	10	1112 2231	13
13	1110 1012	7	0011 0112	6	2222 2222	16
14	0111 0100	4	1110 0001	4	0001 1121	6
15	0001 0212	6	2012 3111	11	0012 2122	10
16	0121 1111	8	2101 1000	5	2012 2221	12
17	1010 1210	6	2111 2244	17	2112 2223	15
18	1110 0111	6	1232 3333	20	0110 2331	11
19	0100 0111	4	3433 2223	22	4222 2222	18
20	0010 1111	5	2111 1133	13	2120 1334	16
21	0012 2332	13	4233 2424	24	2132 2223	17
22	2211 1114	13	3112 2232	16	2212 2232	16
23	1210 0032	9	1011 0233	11	2323 2243	21
24	2000 1111	6	2211 1112	11	3111 0001	7
25	0210 1010	5	1000 1001	3	2001 2112	9
26	1101 2210	8	0110 1132	9	1112 2213	13
27	0111 0000	3	2001 1111	7	2111 1330	12
28	0111 0113	8	2212 2213	15	0021 2123	11
29	3311 1223	16	2212 2334	19	1022 3322	15
30	2222 2354	22			1211 2445	20
31	2322 1102	13			3332 3332	22

Table 9

Three-hour-range *K* indices
Belsk, April–June 2020
The limit of *K* = 9 is 450

Day	April		May		June	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	2111 1212	11	0122 *211	*	1111 1233	13
2	1121 1133	13	0222 1212	12	2312 2122	15
3	2111 1234	15	1111 1133	12	1111 2201	9
4	2112 1122	12	2112 2202	12	1111 1221	10
5	2112 1212	12	2112 2322	15	0111 2211	9
6	1101 1000	4	3211 1111	11	1112 21*0	*
7	0011 0033	8	1111 1110	7	1112 2**3	*
8	1222 3424	20	1121 2011	9	2211 1220	11
9	2112 1032	12	1000 1110	4	1211 1223	13
10	0012 2320	10	1010 1223	10	2223 21*2	*
11	1111 2333	15	1222 1111	11	2211 2110	10
12	1111 3232	14	1111 2103	10	1111 2210	9
13	1111 2233	14	1001 1212	8	0101 2100	5
14	2222 1113	14	1111 1110	7	0111 0111	6
15	3222 2112	15	1112 1100	7	0212 1110	8
16	2111 0221	10	0111 2211	9	1222 1232	15
17	1111 1112	9	0101 1112	7	2112 *200	*
18	1111 1100	6	1001 2331	11	1212 *221	*
19	0011 1110	5	1223 2112	14	1112 *222	*
20	2334 4311	21	1100 1111	6	3222 12*1	*
21	1112 2422	15	1212 1222	13	1112 *210	*
22	3212 2222	16	2211 3331	16	0111 111*	*
23	1112 111*	*	2221 1211	12	*121 2111	*
24	*211 2323	*	0011 3321	11	1112 2211	11
25	2211 1200	9	2111 3223	15	1211 1211	10
26	1212 2233	16	1112 1113	11	2011 1*33	*
27	3111 2321	14	1122 2120	11	3223 4212	19
28	3212 1212	14	0211 1201	8	1111 1111	8
29	1000 2111	6	1110 1112	8	1101 ***1	*
30	2010 1010	5	2334 4344	27	2322 1211	14
31			1111 2212	11		

Table 10

Three-hour-range *K* indices
Belsk, July–September 2020
The limit of *K* = 9 is 450

Day	July		August		September	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	1211 1132	12	0221 1221	11	2423 3433	24
2	2111 1211	10	1113 4323	18	3223 3222	19
3	1111 2211	10	3333 3444	27	0011 2102	7
4	1122 3233	17	2322 1222	16	3112 2230	14
5	2333 2233	21	1111 1232	12	2112 21*1	*
6	2111 2320	12	0111 2313	12	2111 1123	12
7	1221 1111	10	2101 1112	9	111* 1211	*
8	0111 1111	7	2111 2211	11	1012 0221	9
9	1111 1210	8	0012 1101	6	1001 0100	3
10	0111 *1**	*	1110 1111	7	001* 1111	*
11	1111 1111	8	1101 0111	6	0011 1111	6
12	0111 1100	5	1111 1111	8	2121 1122	12
13	1232 1223	16	2111 2112	11	0111 2224	13
14	3432 2111	17	1211 1122	11	4323 3113	20
15	0222 2310	12	0011 1111	6	3211 0122	12
16	0112 1121	9	1122 1211	11	0012 0221	8
17	1111 2312	12	1112 1112	10	1121 1012	9
18	2111 2112	11	1112 2124	14	1001 2220	8
19	1111 2122	11	2211 0111	9	0111 1220	8
20	1211 1*11	*	0111 2111	8	0002 2112	8
21	1111 1213	11	1011 1132	10	1101 0121	7
22	1110 1220	8	1222 **22	*	1222 1112	12
23	1111 2*11	*	2223 3213	18	2122 4343	21
24	1332 *433	*	1111 1210	8	3354 4312	25
25	3221 3324	20	1111 1111	8	3233 1555	27
26	1111 1001	6	1213 2313	16	3434 5224	27
27	1111 2221	11	2122 4222	17	2422 2355	25
28	2111 1**1	*	0112 3523	17	4433 3455	31
29	3121 2121	13	4232 2244	23	4223 3344	25
30	2121 1111	10	**22 2324	*	4233 3244	25
31	1101 1211	8	4434 4443	30		

Table 11

Three-hour-range *K* indices
Belsk, October–December 2020
The limit of *K* = 9 is 450

Day	October		November		December	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	2123 3432	20	1012 3421	14	2000 0001	3
2	2113 3232	17	0010 0122	6	2111 0101	7
3	2112 1122	12	2111 1102	9	0001 2210	6
4	0111 2212	10	1011 1111	7	0000 1000	1
5	011* ****	*	0011 2122	9	0001 2131	8
6	2311 2112	13	2122 2332	17	2011 2132	12
7	1112 *112	*	2112 1334	17	0010 0110	3
8	1111 1112	9	1122 1210	10	1111 1112	9
9	1110 0100	4	*000 0010	*	2221 1241	15
10	0001 *110	*	0011 0000	2	3211 1123	14
11	0011 1112	7	0001 1213	8	3211 1232	15
12	1011 1212	9	2011 1111	8	1111 1123	11
13	1111 121*	*	1121 1111	9	3101 1122	11
14	0001 0010	2	0101 1131	8	0000 0122	5
15	0000 0122	5	2100 1100	5	2110 0022	8
16	1122 1113	12	0000 1100	2	1100 1112	7
17	1121 1122	11	0001 2002	5	0100 0101	3
18	1010 0012	5	1011 011*	*	0011 1111	6
19	1122 3232	16	*111 0012	*	2112 2121	12
20	2111 0122	10	2212 1131	13	1111 1212	10
21	2232 1122	15	2111 3334	18	2222 2135	19
22	3111 1132	13	2334 5544	30	3332 3342	23
23	1111 2355	19	1222 1322	15	3422 2122	18
24	3343 2433	25	1111 1201	8	1212 3412	16
25	2122 4453	23	1212 1234	16	2111 2100	8
26	2333 4243	24	2111 3233	16	0211 1133	12
27	2133 1133	17	1122 3211	13	1212 2123	14
28	2222 3442	21	3322 2222	18	2222 2132	16
29	1223 2523	20	0121 1200	7	2211 1223	14
30	1011 1123	10	1333 1212	16	2222 2114	16
31	1122 2301	12			1111 1111	8

Table 12

Three-hour-range *E* indices
based on power spectrum estimation (*)
Belsk, January–March 2020

Day	January		February		March	
	E	*SE*	*E*	*SE*	*E*	*SE*
1	0001 1220	6	1011 2334	15	4112 0012	11
2	0000 0112	4	3011 0143	13	2101 2100	7
3	0122 1112	10	1100 0020	4	1101 2314	13
4	1011 1343	14	1211 1225	15	0111 1421	11
5	1111 3253	17	1212 1101	9	0001 1110	4
6	3221 0142	15	0143 3364	24	1022 2200	9
7	1111 0123	10	3222 3354	24	0011 2100	5
8	1100 2333	13	3101 2222	13	1010 0233	10
9	3242 3332	22	3111 1133	14	0111 1232	11
10	1122 2321	14	2110 0011	6	3110 0103	9
11	2222 0201	11	3311 0013	12	2000 0000	2
12	1210 0000	4	1212 1002	9	1111 2240	12
13	0110 0011	4	0010 0012	4	2322 1212	15
14	0001 0100	2	2000 0001	3	0000 0121	4
15	0002 0211	6	1001 2111	7	0002 1123	9
16	0221 1101	8	2001 1000	4	3002 1221	11
17	1000 0210	4	2011 1144	14	2012 1213	12
18	1100 0000	2	1233 3343	22	0000 2341	10
19	0000 0000	0	3433 2213	21	5232 3222	21
20	0000 0000	0	2111 1133	13	3020 0434	16
21	0001 1342	11	4234 2414	24	2132 2333	19
22	2212 2014	14	4112 2342	19	2211 1242	15
23	1200 0031	7	0001 0233	9	2313 3351	21
24	2000 1100	4	3200 0012	8	3111 0000	6
25	0200 0000	2	2000 1001	4	2000 1012	6
26	1000 1210	5	0010 1041	7	0011 2214	11
27	0000 0000	0	3001 0111	7	2111 0230	10
28	0111 0113	8	2111 1113	11	0011 1034	10
29	3411 0223	16	1112 2435	19	0022 3422	15
30	2222 3464	25			1211 2445	20
31	2412 1002	12			3442 3342	25

*) see Reda and Jankowski (2004)

Table 13

Three-hour-range *E* indices
based on power spectrum estimation (*)
Belsk, April–June 2020

Day	April		May		June	
	E	*SE*	*E*	*SE*	*E*	*SE*
1	2110 0212	9	0122 *201	*	1111 1234	14
2	0221 0133	12	0112 1111	8	3312 2121	15
3	3101 1235	16	0101 1024	9	1100 1200	5
4	2002 0022	8	2112 2102	11	0111 0221	8
5	1112 1202	10	2111 1322	13	0111 1110	6
6	0000 1000	1	4201 0110	9	0111 20*0	*
7	0000 0043	7	0110 1000	3	0111 1**3	*
8	1323 4525	25	1011 2002	7	2211 0110	8
9	2001 1032	9	0000 0110	2	1101 1224	12
10	0012 1410	9	0000 1223	8	1223 11*1	*
11	1011 2334	15	1221 0011	8	1101 1100	5
12	0111 3242	14	0100 1103	6	0111 1110	6
13	1101 1233	12	1001 0112	6	0101 2100	5
14	2322 1103	14	1000 0010	2	0100 0110	3
15	4211 1112	13	1112 1100	7	0212 1110	8
16	3111 0211	10	0001 3211	8	0111 1222	10
17	1000 1002	4	0001 0111	4	2112 *200	*
18	1111 1000	5	1000 1320	7	1211 *111	*
19	0000 1100	2	1113 2012	11	1111 *222	*
20	2324 4311	20	1000 1111	5	3221 12*1	*
21	1112 3423	17	1211 1122	11	1111 *110	*
22	3211 2123	15	2110 3331	14	0010 111*	*
23	0001 101*	*	1111 1110	7	*111 1111	*
24	*111 1333	*	0001 3321	10	1112 1101	8
25	2110 1100	6	2111 2213	13	1101 1112	8
26	1202 2223	14	1111 1113	10	2001 1*34	*
27	3111 2421	15	0112 2120	9	3224 4112	19
28	3102 1202	11	0100 1101	4	1111 0111	7
29	1000 1111	5	0010 1002	4	1100 ***0	*
30	2000 0000	2	2344 4344	28	2211 1101	9
31			1101 1111	7		

*) see Reda and Jankowski (2004)

Table 14

Three-hour-range *E* indices
based on power spectrum estimation (*)
Belsk, July–September 2020

Day	July		August		September	
	E	*SE*	*E*	*SE*	*E*	*SE*
1	1211 0023	10	0111 1111	7	2423 4434	26
2	1100 0211	6	1113 4423	19	3222 4222	19
3	0111 1111	7	4433 3434	28	0011 1102	6
4	1112 3234	17	2322 1222	16	3112 2240	15
5	2333 1233	20	2111 1132	12	2112 21*1	*
6	2111 2220	11	0101 2313	11	2011 0013	8
7	0220 1010	6	2100 0012	6	111* 1200	*
8	0100 0000	1	2211 2110	10	0011 0210	5
9	0012 1110	6	0001 0001	2	0000 0000	0
10	0011 *1**	*	0110 0101	4	000* 0010	*
11	1001 0111	5	1101 0000	3	0000 0112	4
12	0011 1100	4	0111 1110	6	1121 0122	10
13	1222 0224	15	2001 1002	6	0011 0215	10
14	4432 2210	18	1210 0021	7	5333 3112	21
15	0221 2200	9	0011 0110	4	3211 0132	13
16	0111 1111	7	1122 1111	10	0011 0120	5
17	1101 2311	10	1112 1111	9	0021 0002	5
18	2111 2102	10	0112 2024	12	1001 2120	7
19	0111 1112	8	2211 0001	7	0001 0110	3
20	0210 1*01	*	0110 2001	5	0002 1113	8
21	1101 1213	10	1001 0132	8	0001 0011	3
22	0000 0110	2	1222 **23	*	1222 1110	10
23	0011 2*00	*	2212 3214	17	2112 4354	22
24	1332 *533	*	1000 1100	3	3364 4302	25
25	4221 2325	21	0000 1111	4	3333 1635	27
26	1001 1001	4	1213 1313	15	4434 5335	31
27	1011 1111	7	3122 4222	18	2422 2465	27
28	3011 1**0	*	0011 3624	17	4533 4556	35
29	3121 2111	12	4242 2254	25	4322 3444	26
30	2111 0000	5	**21 2314	*	4333 3254	27
31	1101 1210	7	4535 4553	34		

*) see Reda and Jankowski (2004)

Table 15

Three-hour-range *E* indices
based on power spectrum estimation (*)
Belsk, October–December 2020

Day	October		November		December	
	E	*SE*	*E*	*SE*	*E*	*SE*
1	2123 4542	23	0012 4431	15	2000 0001	3
2	2113 3343	20	0010 0022	5	0011 0001	3
3	2102 0122	10	2000 0002	4	0000 1200	3
4	0111 2212	10	1011 1000	4	0000 0000	0
5	001* ****	*	0011 1113	8	0001 2141	9
6	3411 2101	13	2222 2342	19	2001 2132	11
7	0111 *112	*	1111 1244	15	0000 0100	1
8	0001 0012	4	1121 1210	9	0111 1012	7
9	1010 0000	2	*000 0000	*	2221 0251	15
10	0001 *100	*	0011 0000	2	3211 1123	14
11	0001 0012	4	0001 1213	8	4211 1231	15
12	1000 1112	6	1011 1000	4	1011 0113	8
13	1110 010*	*	1121 0011	7	4000 1023	10
14	0000 0000	0	0000 1031	5	0000 0122	5
15	0000 0012	3	2100 0100	4	2000 0012	5
16	1111 1113	10	0000 0000	0	0000 0101	2
17	1121 1112	10	0001 2001	4	0100 0001	2
18	0010 0011	3	1000 001*	*	0000 0000	0
19	0111 2232	12	*002 0003	*	3012 2021	11
20	2111 0021	8	3312 1131	15	1111 1203	10
21	3242 1112	16	2111 3344	19	1222 2035	17
22	4111 0032	12	2435 5554	33	3322 4342	23
23	1100 2356	18	1222 1332	16	2422 2123	18
24	4343 2534	28	1001 0201	5	0212 3412	15
25	3113 5563	27	1202 1235	16	2011 2100	7
26	2433 5254	28	1001 3233	13	0100 0133	8
27	2033 0033	14	1222 3101	12	1112 2113	12
28	2212 3552	22	4321 2332	20	2223 3132	18
29	0123 2523	18	0111 1200	6	2211 1223	14
30	2011 0014	9	1322 1112	13	3222 3114	18
31	1022 2401	12			1101 1101	6

*) see Reda and Jankowski (2004)

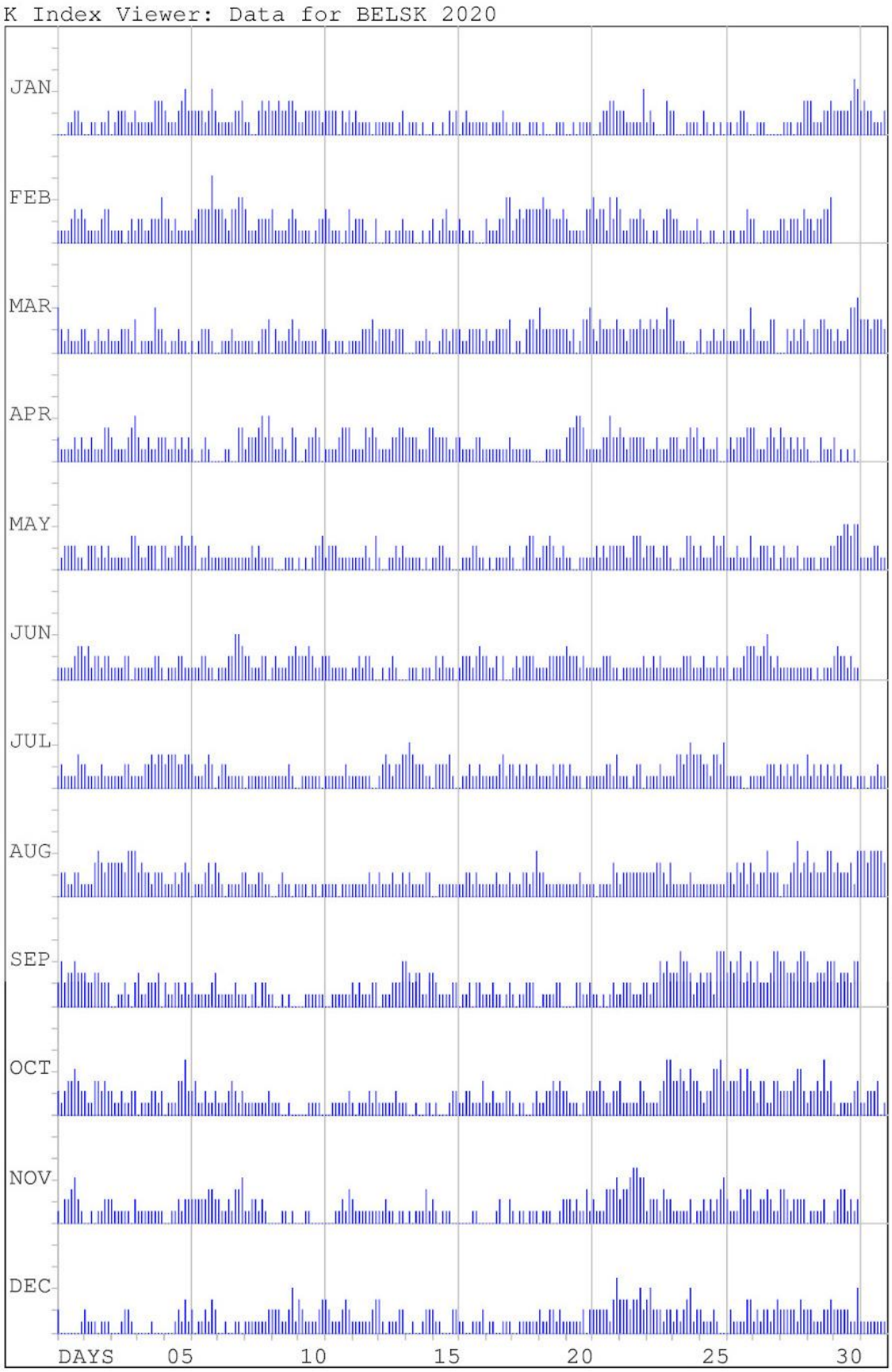

Fig. 7. *K*-indices in graphical form, Belsk 2020.

7. TABLES AND PLOTS FOR HEL OBSERVATORY

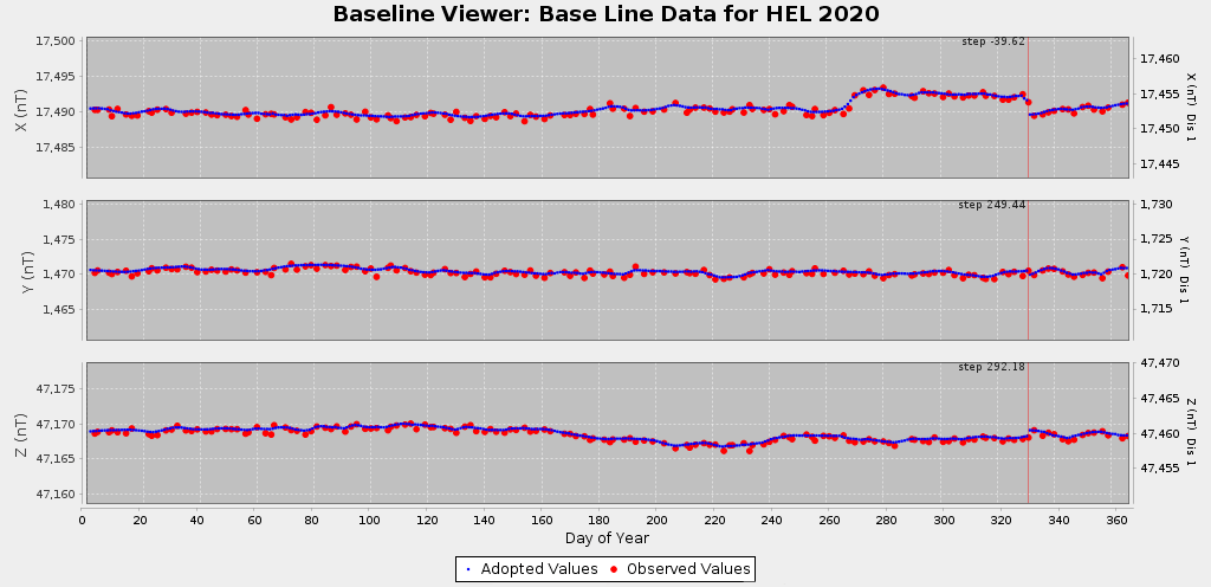

Fig. 8. Base values of set 1, Hel 2020.

Table 16

Annual mean values of magnetic elements in Hel Observatory

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

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.

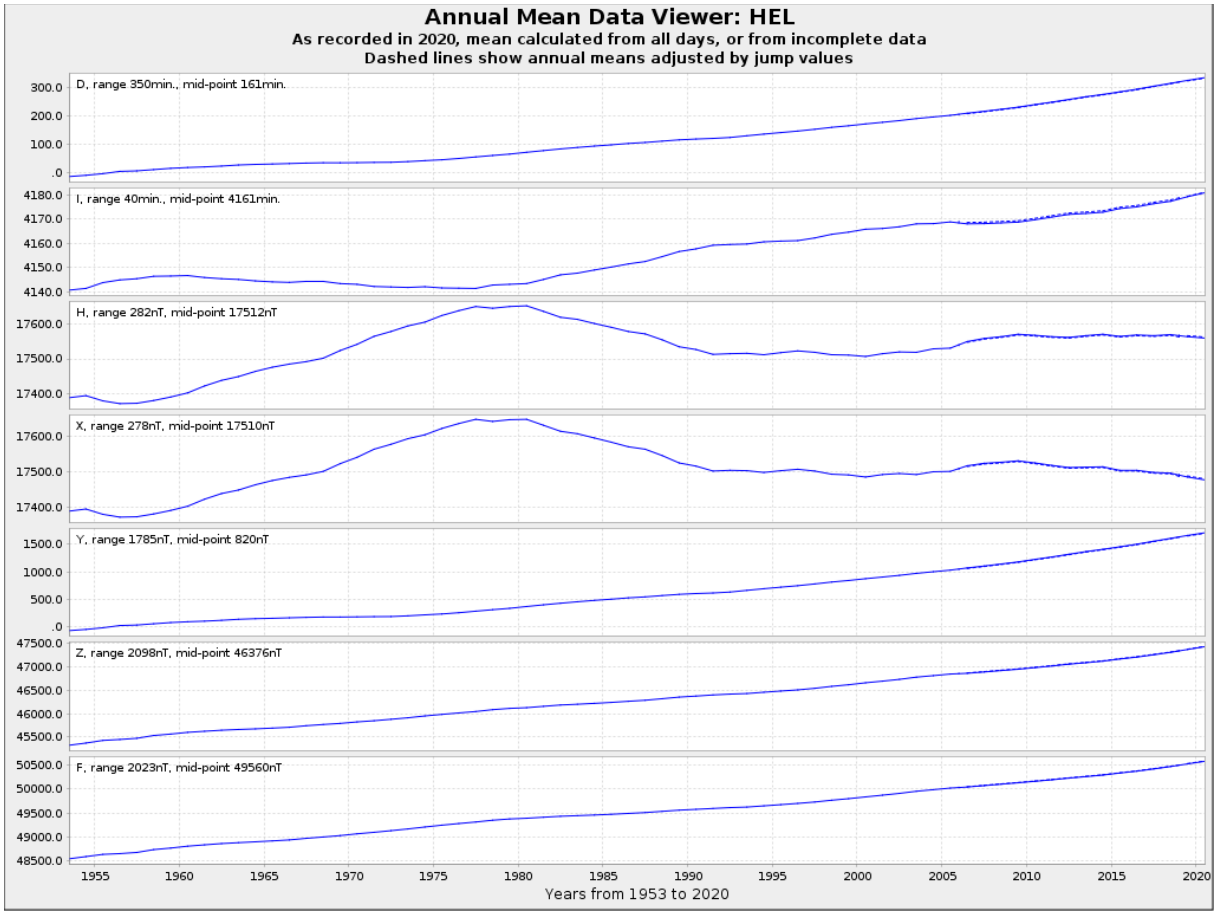

Fig. 9. Secular changes of *H*, *X*, *Y*, *Z*, *F*, *D* and *I* at Hel.

Table 17

Monthly and yearly mean values of magnetic elements
HLP 2020

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
North component: 17000 + ... in nT													
All days	480	477	478	477	483	482	481	478	470	470	469	471	476
Quiet days	482	481	482	479	484	484	483	478	478	476	473	472	479
Disturbed days	475	470	474	476	481	481	479	475	458	464	459	469	472
East component: 1500 + ... in nT													
All days	191	195	198	202	204	209	313	316	222	225	229	233	211
Quiet days	190	194	196	201	203	209	211	215	219	224	227	231	210
Disturbed days	193	195	202	201	205	209	214	217	227	229	233	235	213
Vertical component: 47000 + ... in nT													
All days	399	405	407	413	415	419	424	429	437	444	450	454	425
Quiet days	399	404	405	413	414	419	423	429	435	441	447	454	424
Disturbed days	401	408	409	414	415	419	423	430	439	447	454	456	426

Table 18

Three-hour-range *K* indices
Hel, January–March 2020
The limit of $K = 9$ is 550

Day	January		February		March	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	1001 1221	8	1121 2234	16	4212 1012	13
2	0001 0212	6	3111 0243	15	2102 2212	12
3	1122 2112	12	2111 0121	9	2102 2213	13
4	1111 1343	15	1211 1224	14	1112 2422	15
5	2112 2343	18	2212 1111	11	1011 2110	7
6	3222 1142	17	1233 3364	25	1022 3210	11
7	1111 1223	12	3332 3344	25	0011 2111	7
8	2201 2323	15	3111 2222	14	1110 1233	12
9	3332 2332	21	3211 1232	15	1121 2232	14
10	1122 2321	14	1111 0012	7	3111 1113	12
11	2212 0212	12	3221 1013	13	2001 1101	6
12	1211 1001	7	1222 1002	10	1111 2331	13
13	1111 1012	8	0011 0012	5	2323 2222	18
14	0111 0100	4	2110 0002	6	0011 1121	7
15	1012 0212	9	2012 3111	11	0012 2123	11
16	1221 1111	10	2101 1000	5	3112 2231	15
17	1010 1220	7	2111 2244	17	2112 2223	15
18	1110 0011	5	1232 3343	21	1111 2332	14
19	0100 0111	4	3433 2223	22	5232 3223	22
20	0100 1011	4	2121 2133	15	3120 1434	18
21	0012 1333	13	4233 2424	24	2232 2322	18
22	2212 1114	14	3122 2332	18	2222 2232	17
23	2210 0032	10	1011 0233	11	2323 3243	22
24	2000 1111	6	2211 1012	10	3111 0001	7
25	0111 1000	4	2010 1001	5	2011 2012	9
26	1111 1210	8	1111 2132	12	1112 2314	15
27	0111 0000	3	2011 1111	8	3121 2331	16
28	1111 0113	9	2222 2213	16	0122 2133	14
29	3321 0223	16	2222 2334	20	1022 3322	15
30	2222 3354	23			1211 2445	20
31	2322 1102	13			3442 3332	24

Table 19

Three-hour-range *K* indices
Hel, April–June 2020
The limit of *K* = 9 is 550

Day	April		May		June	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	2111 1223	13	1122 3211	13	1112 1233	14
2	1221 1233	15	0222 2212	13	2312 2232	17
3	3212 1234	18	1111 2133	13	2101 2201	9
4	2102 1222	12	2122 3202	14	1111 1231	11
5	2212 2112	13	2112 2322	15	0112 2211	10
6	1001 2100	5	3201 1211	11	1012 3110	9
7	0111 0033	9	1121 1111	9	1222 2443	20
8	1223 4435	24	1121 2012	10	2211 1210	10
9	2112 2032	13	1001 1110	5	1211 1233	14
10	1012 2321	12	1011 1223	11	2223 2212	16
11	1112 3333	17	1222 1112	12	2211 2110	10
12	1121 3242	16	1121 2213	13	1122 2210	11
13	1211 2233	15	2101 0212	9	0101 3100	6
14	2322 1113	15	0111 1111	7	0111 1211	8
15	3222 2112	15	1123 1100	9	1212 1110	9
16	2110 1221	10	0012 3211	10	1222 1232	15
17	1111 2113	11	0101 1212	8	2112 3200	11
18	1111 1100	6	1001 2331	11	1222 2221	14
19	0001 1110	4	2223 2112	15	1112 2222	13
20	2344 4311	22	1101 2111	8	3222 2312	17
21	2212 3423	19	2212 2222	15	2112 3111	12
22	3212 2222	16	2221 3331	17	0101 1112	7
23	1102 1112	9	2222 2211	14	1122 2122	13
24	2212 2333	18	1001 3321	11	2112 2211	12
25	2211 2200	10	2111 3322	15	1111 1212	10
26	1212 3332	17	2112 1213	13	2101 1234	14
27	3112 2321	15	1112 2120	10	3224 4112	19
28	3202 2212	14	1211 2211	11	1111 1111	8
29	1111 2111	9	1011 2012	8	1111 0101	6
30	2001 0000	3	2334 4344	27	2322 1202	14
31			1111 2212	11		

Table 20

Three-hour-range *K* indices
Hel, July–September 2020
The limit of *K* = 9 is 550

Day	July		August		September	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	1211 1133	13	0212 2221	12	2423 4534	27
2	1211 1211	10	1123 4423	20	3223 3323	21
3	1211 1211	10	3433 3444	28	1012 2202	10
4	1123 3233	18	3323 2322	20	3112 2230	14
5	2334 2233	22	2122 1232	15	2112 2121	12
6	2211 3320	14	0202 3312	13	2112 1123	13
7	1221 1111	10	2101 1112	9	1121 1211	10
8	1111 1110	7	2222 2211	14	1022 1220	10
9	1111 1210	8	1101 1102	7	1001 1100	4
10	0111 1210	7	1111 1101	7	0011 1110	5
11	1101 1111	7	2111 0110	7	0011 0112	6
12	1111 1100	6	0111 2210	8	2121 1122	12
13	1333 2223	19	2012 3112	12	0111 3224	14
14	4432 3211	20	2211 2121	12	4223 3213	20
15	1222 2310	13	0011 1111	6	3221 1122	14
16	0112 2222	12	1122 1211	11	0113 1221	11
17	1101 3312	12	1112 2112	11	0121 0012	7
18	2112 2112	12	1123 3124	17	1011 3220	10
19	1111 2222	12	2211 1112	11	0111 1220	8
20	1210 2211	10	0101 2212	9	0013 2113	11
21	1101 2213	11	1111 1232	12	1102 1121	9
22	1000 1221	7	1223 2222	16	1321 1112	12
23	1111 3210	10	2223 3314	20	2123 4343	22
24	1333 3433	23	1111 2210	9	3354 4302	24
25	4222 3325	23	1011 2211	9	3233 2555	28
26	1112 1102	9	2223 2313	18	4434 5334	30
27	1111 2221	11	3123 4222	19	2322 2355	24
28	3122 2211	14	0012 3524	17	4433 4466	34
29	3121 3221	15	4232 2344	24	4233 3344	26
30	2221 1101	10	2333 2324	22	4333 3254	27
31	1112 1211	10	4435 4544	33		

Table 21

Three-hour-range *K* indices
Hel, October–December 2020
The limit of *K* = 9 is 550

Day	October		November		December	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	2123 3432	20	0012 3431	14	2000 0002	4
2	2213 3343	21	0021 0022	7	2112 0111	9
3	2112 1121	11	2011 0002	6	0001 2200	5
4	1111 2212	11	1011 2110	7	0000 0000	0
5	0012 3452	17	0011 2123	10	0001 2132	9
6	3312 2111	14	2222 2332	18	2012 2132	13
7	1112 3212	13	2112 1334	17	1011 0100	4
8	1111 1112	9	1121 1220	10	1111 1112	9
9	1010 0000	2	0000 0000	0	3221 1251	17
10	0001 1100	3	0010 0000	1	3211 1123	14
11	0011 1113	8	0001 1223	9	3211 1232	15
12	1011 2212	10	2111 1111	9	1121 0112	9
13	1121 0211	9	1121 0011	7	3100 1122	10
14	0001 0000	1	0000 1131	6	0101 0132	8
15	0000 0122	5	2100 0100	4	2100 0012	6
16	1122 2113	13	0000 0100	1	1000 0111	4
17	1122 2122	13	0001 1002	4	0100 0001	2
18	1011 1012	7	1001 0011	4	0000 0110	2
19	1122 3232	16	0012 0012	6	2112 2111	11
20	2211 0122	11	3222 1231	16	1111 1202	9
21	3232 2123	18	2111 3344	19	2322 2135	20
22	4111 1132	14	2334 5554	31	4332 3342	24
23	2111 3455	22	2222 1232	16	3422 2223	20
24	3343 2433	25	1101 1202	8	1212 3422	17
25	3123 4454	26	1212 123*	*	2111 2210	10
26	2433 4343	26	*111 3233	*	0211 1133	12
27	3133 1133	18	1222 3212	15	2202 2113	13
28	2222 3442	21	4222 2232	19	2222 2132	16
29	1223 3523	21	0111 1200	6	3211 1223	15
30	2021 1023	11	1332 1112	14	3222 2114	17
31	1122 2301	12			2101 1111	8

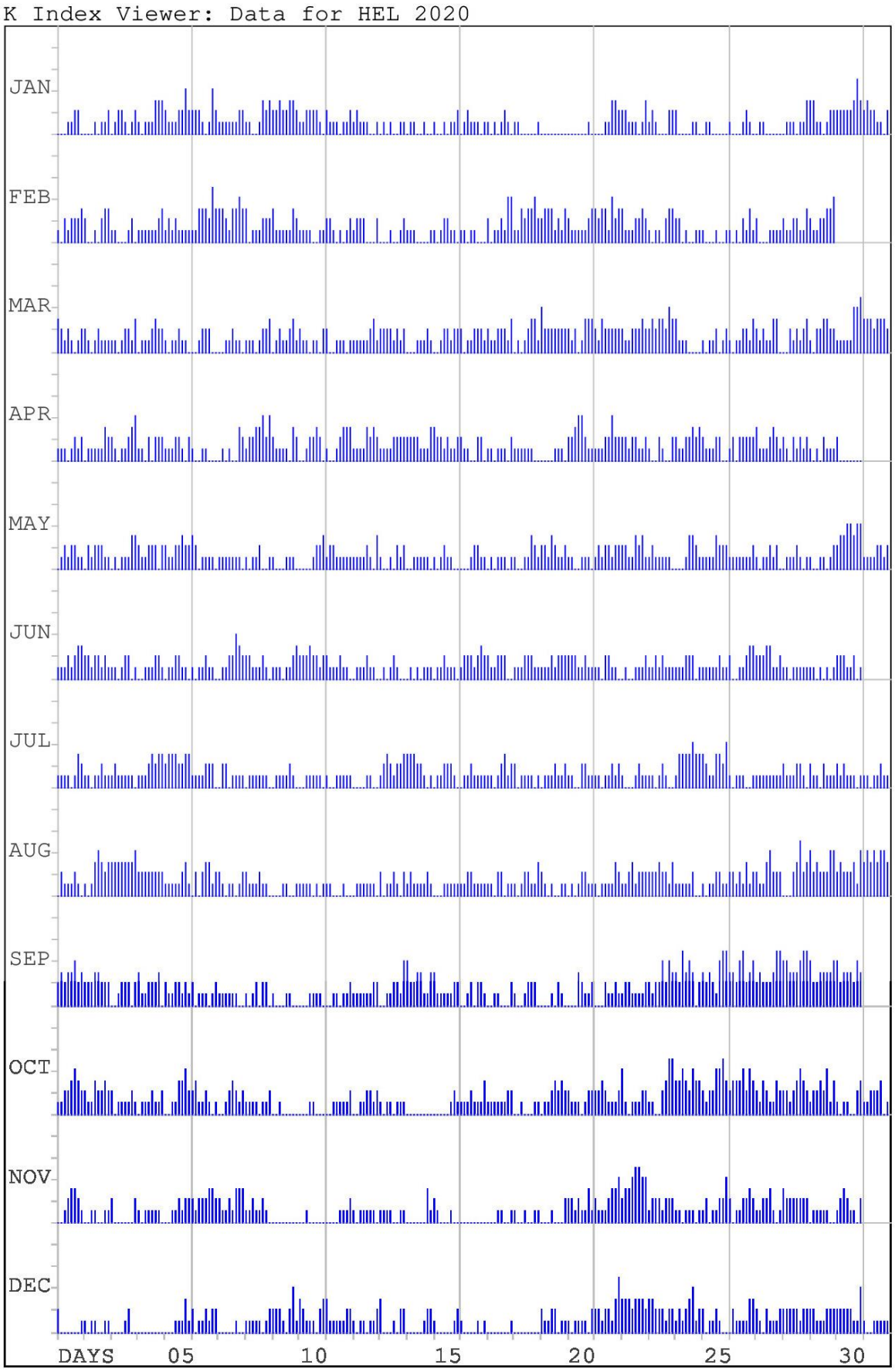

Fig. 10. *K*-indices in graphical form, Hel 2020.

8. TABLES AND PLOTS FOR HORNSUND OBSERVATORY

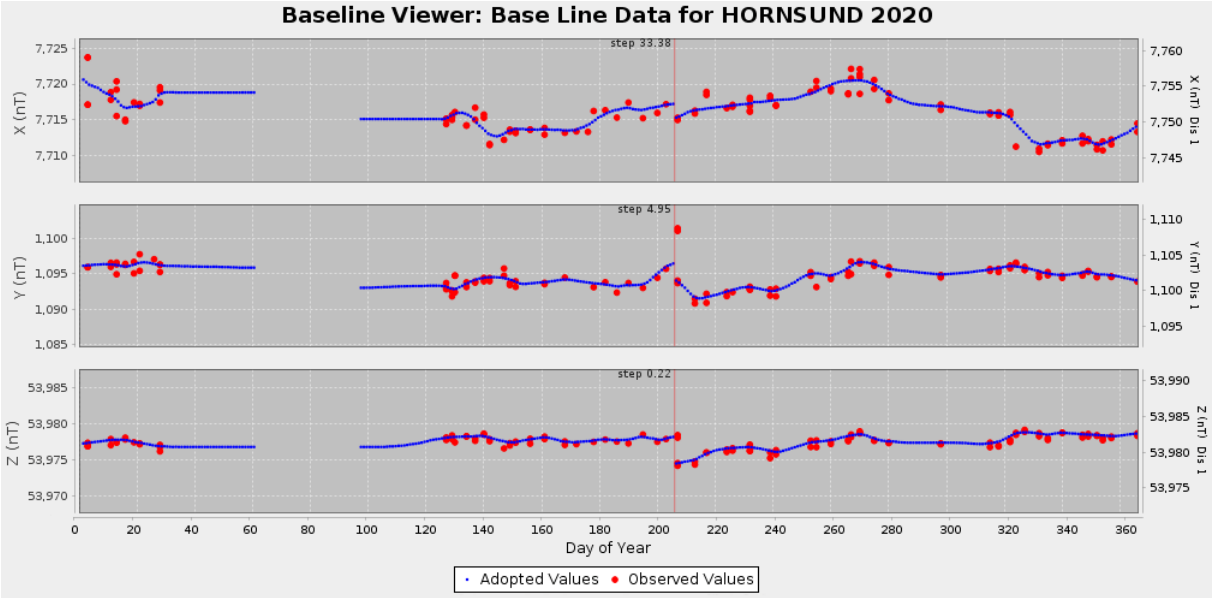

Fig. 11. Base values, Hornsund 2020.

Table 22

Annual mean values of magnetic elements 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
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

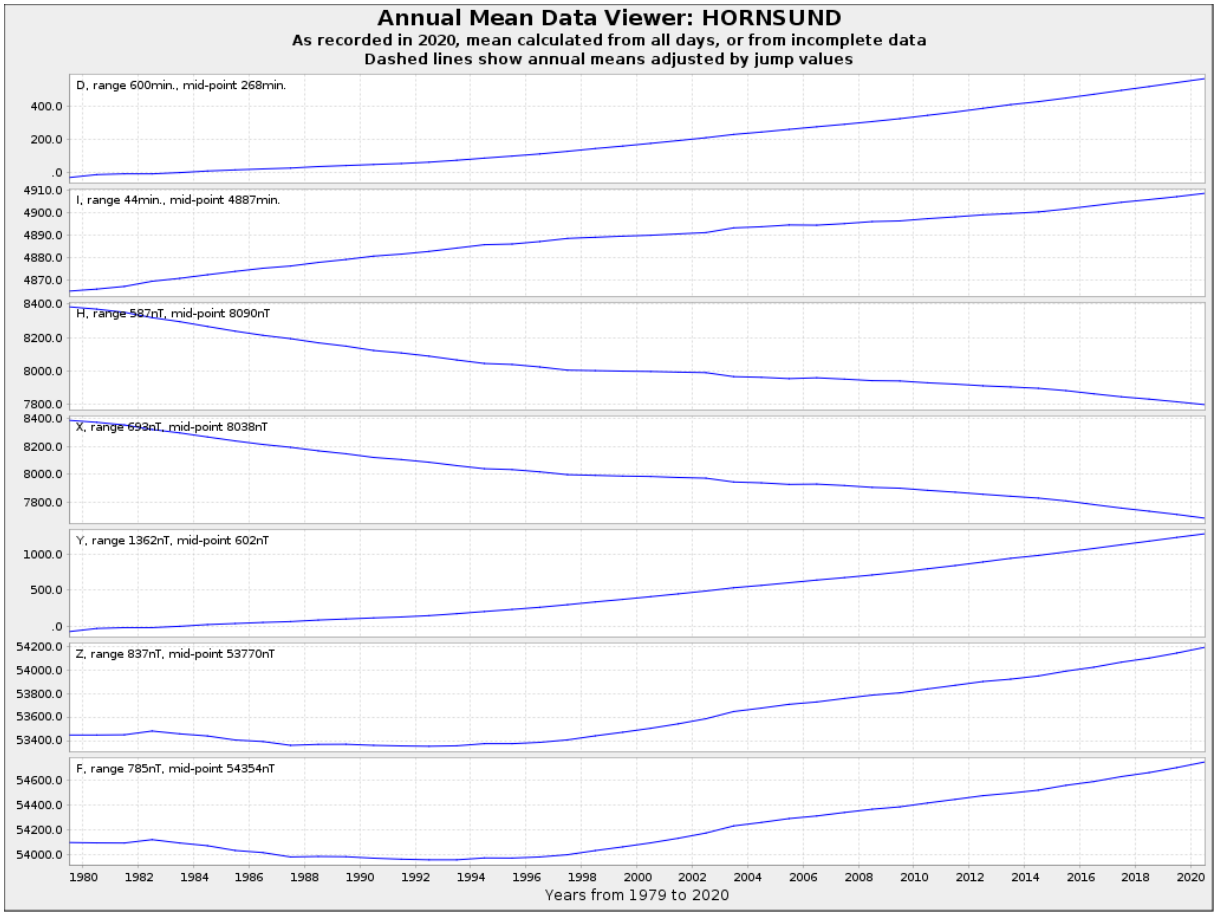

Fig. 12. Secular changes of *H*, *X*, *Y*, *Z*, *F*, *D* and *I* at Hornsund.

Table 23

Monthly and yearly mean values of magnetic elements
HRN 2020

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
North component: 7500 + ... in nT													
All days	195	189	-	195	204	206	205	197	184	175	175	174	191
Quiet days	202	203	-	198	213	206	201	197	189	184	184	181	198
Disturbed days	181	161	-	184	187	200	212	195	165	151	156	161	179
East component: 1000 + ... in nT													
All days	261	267	-	270	273	277	281	285	293	296	302	305	283
Quiet days	260	267	-	271	271	274	277	284	289	296	299	303	279
Disturbed days	264	274	-	274	275	282	280	284	302	299	303	310	284
Vertical component: 5400 + ... in nT													
All days	165	173	-	174	175	181	187	195	206	206	207	208	189
Quiet days	163	170	-	178	173	174	180	192	192	198	202	205	182
Disturbed days	180	180	-	162	177	198	206	204	231	221	219	214	198

Table 24

Three-hour-range *K* indices
Hornsund, January–March 2020
The limit of *K* = 9 is 2500

Day	January		February		March	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	3334 3536	30	3455 5558	40	**** ****	*
2	2324 2437	27	6566 4586	46	**** ****	*
3	5565 4327	37	5664 3442	34	**** ****	*
4	6454 5458	41	3565 5458	41	**** ****	*
5	7556 **76	*	4555 5433	34	**** ****	*
6	5665 3396	43	3586 6568	47	**** ****	*
7	4565 5478	44	5875 6999	58	**** ****	*
8	4544 5569	42	8566 4456	44	**** ****	*
9	7665 5554	43	4665 5488	46	**** ****	*
10	4566 5465	41	4555 4342	32	**** ****	*
11	4556 4435	36	5664 4125	33	**** ****	*
12	7645 5224	35	3645 4225	31	**** ****	*
13	3544 3256	32	4343 2244	26	**** ****	*
14	4553 3332	28	3443 4113	23	**** ****	*
15	3334 4444	29	4555 5344	35	**** ****	*
16	3564 4235	32	4434 5321	26	**** ****	*
17	3432 3453	27	5445 5367	39	**** ****	*
18	3543 4322	26	4566 6555	42	**** ****	*
19	2443 3234	25	4966 6568	50	**** ****	*
20	1543 3333	25	6566 6466	45	**** ****	*
21	2334 5656	34	9877 5646	52	**** ****	*
22	5665 5438	42	5676 6599	53	**** ****	*
23	4543 3255	31	3554 **67	*	**** ****	*
24	6244 3333	28	5555 5234	34	**** ****	*
25	2444 3222	23	4454 4225	30	**** ****	*
26	3344 4332	26	3463 5286	37	**** ****	*
27	3443 3222	23	5344 4344	31	**** ****	*
28	2553 2*34	*	6664 5426	39	**** ****	*
29	7764 3567	45	4555 664*	*	**** ****	*
30	5666 5677	48			**** ****	*
31	6975 4424	41			**** ****	*

Table 25

Three-hour-range *K* indices
Hornsund, April–June 2020
The limit of *K* = 9 is 2500

Day	April		May		June	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	**** ****	*	3557 6433	36	4555 5556	40
2	**** ****	*	3665 5434	36	6886 5444	45
3	**** ****	*	4544 5366	37	4644 5444	35
4	**** ****	*	4455 5434	34	4454 4566	38
5	**** ****	*	5544 6753	39	4446 5644	37
6	*445 5322	*	7755 4443	39	4356 6544	37
7	2443 3458	33	4555 5443	35	4645 5565	40
8	4667 6748	48	4455 5234	32	5665 4653	40
9	4444 6485	39	4434 4332	27	4644 4567	40
10	3455 5864	40	3343 3546	31	5776 6554	45
11	4445 7545	38	4745 4435	36	4754 5544	38
12	3565 7554	40	4564 6554	39	4655 5566	42
13	4555 5487	43	5444 5434	33	3544 6444	34
14	5765 4335	38	3554 4333	30	3443 3455	31
15	6676 5346	43	3445 4532	30	4556 5454	38
16	6664 4773	43	3345 5433	30	4575 4465	40
17	4555 5335	35	3423 5544	30	5455 5533	35
18	4654 4422	31	5334 5554	34	5656 5445	40
19	2344 5554	32	4567 5534	39	5534 4545	35
20	5576 8653	45	4434 3345	30	6575 4534	39
21	4447 6765	43	4545 5545	37	4435 5463	34
22	7745 5477	46	6644 6754	42	4444 4334	30
23	3545 4323	29	5555 5574	41	4374 4544	35
24	6554 5557	42	5534 6756	41	5554 5444	36
25	5665 5331	34	5654 5435	37	4445 *554	*
26	4664 6655	42	5445 3355	34	5555 5466	41
27	5656 6874	47	4344 5443	31	7565 6436	42
28	7545 6434	38	4545 5543	35	5544 5345	35
29	4543 5343	31	3444 5434	31	4543 2345	30
30	4325 3222	23	5797 6568	53	5664 5534	38
31			5645 6445	39		

Table 26

Three-hour-range *K* indices
Hornsund, July–September 2020
The limit of *K* = 9 is 2500

Day	July		August		September	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	5564 4345	36	3554 5566	39	5676 8886	54
2	5544 4544	35	5347 8666	45	6766 7654	47
3	3554 5454	35	9688 6689	60	4555 6437	39
4	4555 6556	41	5667 6657	48	7665 6574	46
5	7687 5557	50	4565 5467	42	5566 5344	38
6	5556 6655	43	4654 6748	44	5455 4465	38
7	4675 4444	38	5534 3446	34	5565 5543	38
8	4644 5434	34	6555 5545	40	3465 5552	35
9	3455 5443	33	3555 4454	35	2333 3313	21
10	4454 4465	36	5553 5434	34	2343 3*43	*
11	5444 3455	34	4454 4333	30	3433 3344	27
12	4344 4343	29	4665 5454	39	3565 4556	39
13	4776 5557	46	5444 6345	35	3445 4536	34
14	8786 5535	47	5544 4544	35	6656 5335	39
15	4676 6643	42	3232 4443	25	6665 3476	43
16	3456 6764	41	3665 4433	34	3546 3373	34
17	4445 5545	36	3445 4334	30	3545 4225	30
18	5454 5445	36	3455 5457	38	4455 6331	31
19	4445 5455	36	5544 4334	32	3444 3673	34
20	4653 5437	37	3434 5343	29	2334 4435	28
21	4544 5547	38	3463 4465	35	3433 323*	*
22	6533 3544	33	4566 4664	41	3555 4544	35
23	4444 634*	*	4656 6546	42	5456 7485	44
24	*786 7856	*	4564 5433	34	4777 7635	46
25	8576 6555	47	3344 5533	30	7666 6878	54
26	4545 4234	31	4655 4757	43	8666 7578	53
27	4555 4434	34	5646 6557	44	6976 6797	57
28	6465 4*63	*	3556 6846	43	7787 7987	60
29	5553 6543	36	5667 5697	51	6688 7699	59
30	4554 4323	30	6676 6667	50	7677 6789	57
31	3545 5654	37	7877 7998	62		

Table 27

Three-hour-range *K* indices
Hornsund, October–December 2020
The limit of *K* = 9 is 2500

Day	October		November		December	
	K	*SK*	*K*	*SK*	*K*	*SK*
1	5586 6997	55	3356 6766	42	6333 2227	28
2	5666 6685	48	2343 32*6	*	7454 **32	*
3	4555 5556	40	3444 3236	29	4223 4443	26
4	3754 5354	36	4345 6221	27	3222 3334	22
5	3465 7664	41	1245 5433	27	3333 4474	31
6	4664 4333	33	3556 5454	37	4454 6497	43
7	3434 6434	31	4556 4788	47	*3*3 *342	*
8	2553 3443	29	5576 5552	40	5644 5234	33
9	3453 3101	20	3222 2221	16	4686 3466	43
10	1333 4322	21	122* 2122	*	7644 4379	44
11	2233 3245	24	3224 4534	27	8664 3476	44
12	3443 3225	26	545* 4213	*	5565 3337	37
13	4333 2213	21	3564 3245	32	7433 5347	36
14	2322 1132	16	3233 **63	*	3444 2465	32
15	2221 2123	15	35*3 2432	*	6444 4145	32
16	3433 3226	26	1333 2333	21	3324 3333	24
17	3555 4334	32	2233 3224	21	4342 1235	24
18	3423 3124	22	6444 4233	30	3333 3332	23
19	4344 5375	35	2434 2116	23	4536 5232	30
20	4545 3385	37	5554 6476	42	4445 5447	37
21	7766 5554	45	3545 5558	40	4655 5389	45
22	5433 4377	36	5767 8798	57	7685 6595	51
23	3545 5399	43	5675 5677	48	5775 5545	43
24	6776 6978	56	4546 4524	34	4676 6967	51
25	5577 6996	54	5675 5567	46	7555 53*2	*
26	4876 7498	53	6555 6356	41	2754 3497	41
27	5576 4277	43	5564 64*2	*	3555 4446	36
28	4765 6695	48	776* 5687	*	5564 4377	41
29	4667 6956	49	4565 5423	34	6555 4558	43
30	6454 4345	35	3876 3336	39	6866 6338	46
31	4556 4533	35			6545 6433	36

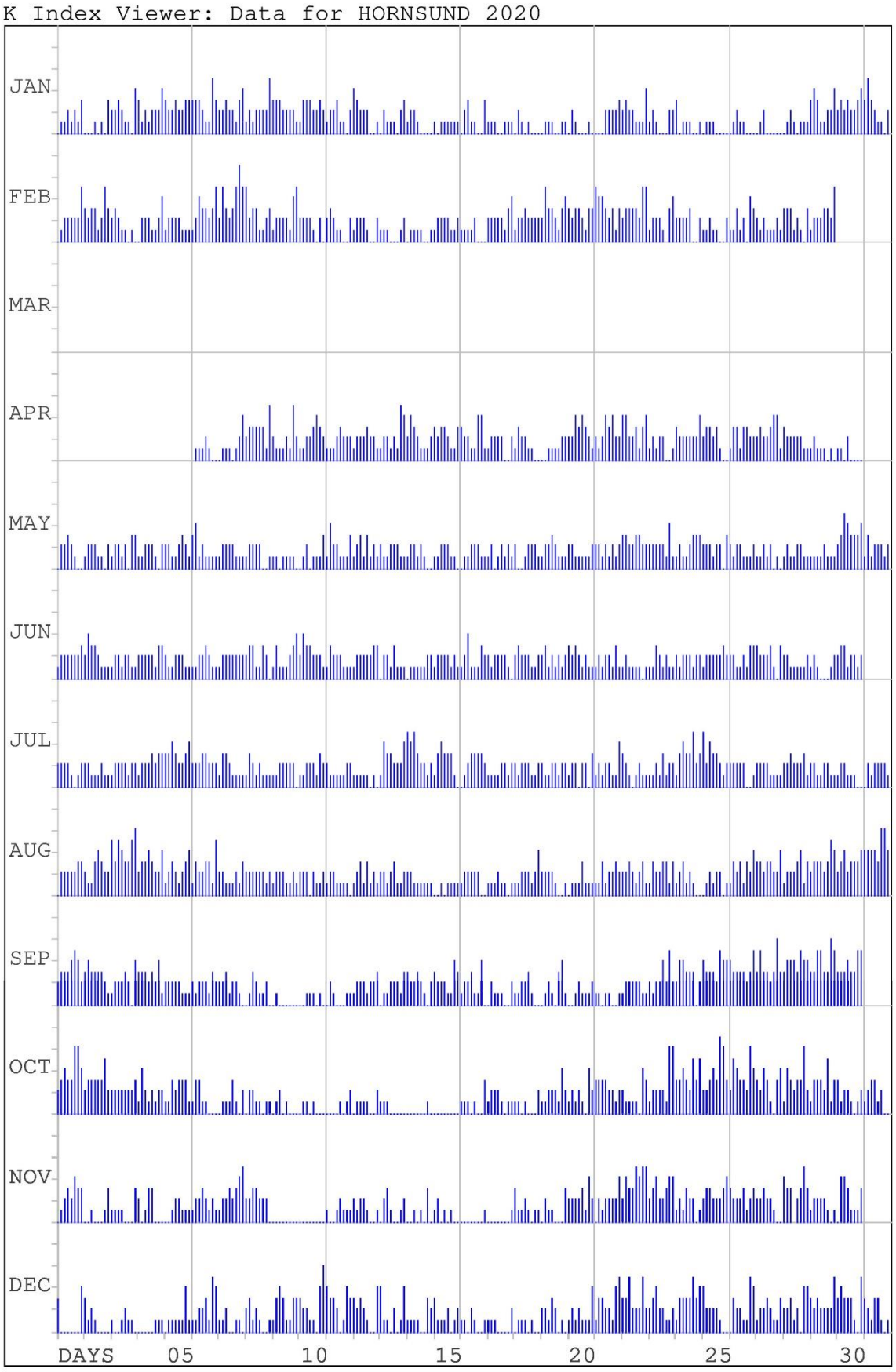

Fig. 13. *K*-indices in graphical form, Hornsund 2020.

Acknowledgments. This work is supported by the Ministry of Science and Higher Education of Poland for the statutory activities of the Institute of Geophysics, Polish Academy of Sciences, Grant No. 3841/E-41/S/2020 as well as by SPUB funds, Decision No. 13/E-41/SPUB/SP/2020 (Specjalne Urządzenie Badawcze). The study was financially supported by the project called EPOS-PL (No. POIR.04.02.00-14-A003/16) co-financed by the European Union from the funds of the European Regional Development Fund (ERDF).

References

Jankowski, J., and J. Marianiuk (2007), Past and present of Polish geomagnetic observatories, *Publs. Inst. Geoph. PAS* **C-99 (398)**, 20–31.

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.

Marianiuk, J. (1977), Photoelectric converter for recording the geomagnetic field elements: construction and principle of operation, *Publs. Inst. Geoph. PAS* **C-4 (114)**, 57–73.

Neska, M., and G. Satori (2006), Schumann resonance observation at Polish Polar Station at Spitsbergen and Geophysical Observatory in Belsk, *Prz. Geofiz.* **3-4**, 189–198 (in Polish).

Nowożyński, K., and J. Reda (2007), Comparison of observatory data in quasi-real time, *Publs. Inst. Geoph. PAS* **C-99 (398)**, 123–127.

Nowożyński, K., T. Ernst, and J. Jankowski (1991), Adaptive smoothing method for computer derivation of K-indices, *Geophys. J. Int.* **104**, 1, 85–93, DOI: 10.1111/j.1365-246X.1991.tb02495.x.

Reda, J., and J. Jankowski (2004), Three-hour activity index based on power spectra estimation, *Geophys. J. Int.* **157**, 1, 141–146, DOI: 10.1111/j.1365-246X.2004.02241.x.

Reda, J., and M. Neska (2007), Measurement Session during the XII IAGA Workshop at Belsk, *Publs. Inst. Geoph. PAS* **C-99 (398)**, 7–19.

Received 3 June 2022
Accepted 1 August 2022

C O N T E N T S

"Publications of the Institute of Geophysics, Polish Academy of Sciences: Geophysical Data Bases, Processing and Instrumentation" appears in the following series:

A – Physics of the Earth's Interior

B – Seismology

C – Geomagnetism

D – Physics of the Atmosphere

E – Hydrology (formerly Water Resources)

P – Polar Research

M – Miscellanea

Every volume has two numbers: the first one is the consecutive number of the journal and the second one (in brackets) is the current number in the series.