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Magnetic results for 2003

Kakadu

Charters Towers

Learmonth

Alice Springs

Gnangara

Canberra

Macquarie Island

Casey

Mawson

– & –

Australian Repeat Station Network

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SUMMARY

During 2003 Geoscience Australia operated geomagnetic observatories at **Kakadu** and **Alice Springs** in the Northern Territory, **Charters Towers** in Queensland, **Learmonth** and **Gnangara** in Western Australia, **Canberra** in the Australian Capital Territory, **Macquarie Island**, Tasmania, in the sub-Antarctic, and **Casey** and **Mawson** in the Australian Antarctic Territory.

The operations at Macquarie Island and Casey were the joint responsibility of the Australian Antarctic Division of the Commonwealth Department of the Environment and Heritage and GA. Operations at Mawson were the joint responsibility of the Australian Bureau of Meteorology of the Commonwealth Department of the Environment and Heritage and GA.

The absolute magnetometers in routine service at the Canberra Magnetic Observatory also served as the Australian standards. The calibration of these instruments can be traced to International Standards. Absolute magnetometers at all the other Australian observatories are standardised against those at Canberra

Magnetic mean value data at resolutions of 1-minute and 1-hour were provided to the World Data Centres for Geomagnetism at Boulder, USA (WDC-A) and at Copenhagen, Denmark (WDC-C1), as well as to the INTERMAGNET program. K indices and principal magnetic storms were scaled with computer assistance, and rapid variations were hand-scaled, for the Canberra and Gnangara observatories. The scaled data were provided regularly to the International Service of Geomagnetic Indices. K indices were digitally scaled for the Mawson observatory.

K indices from Canberra contributed to the southern hemisphere Ks index and the global Kp, am and aa indices, while those from Gnangara contributed to the global am index.

Three repeat stations were re-occupied during a field survey in Papua New Guinea and the south-western Pacific in October 2003.

To assist the geomagnetism program in Indonesia, data were routinely received from the Tangerang and Tondano observatories for processing. These observatories were most recently upgraded by GA's Geomagnetism personnel in 2001 under an AusAID grant that also included the purchase of instrumentation and the training of staff from Indonesia's BMG.

This report describes instrumentation and activities, and presents monthly and annual mean magnetic values, plots of hourly mean magnetic values and K indices at the magnetic observatories and repeat stations operated by GA during calendar year 2003.

ACRONYMS and ABBREVIATIONS

AAD	Australian Antarctic Division
ACRES	Australian Centre for Remote Sensing
ACT	Australian Capital Territory
A/D	Analogue to Digital (data conversion)
ADAM	Data acquisition module produced by Advantech Co. Ltd.
AGR	Australian Geomagnetism Report
AGRF	Australian Geomagnetic Reference Field
AGSO	Australian Geological Survey Organisation (formerly BMR)
AMO	Automatic Magnetic Observatory
ANARE	Australian National Antarctic Research Expedition
ANARESAT	ANARE satellite (communication)
ASP	- Alice Springs (Magnetic Observatory) - Atmospheric & Space Physics (a program of the AAD)
AusAID	Australian Agency for International Development
BGS	British Geological Survey (Edinburgh)
BMR	Bureau of Mineral Resources, Geology, and Geophysics (Now Geoscience Australia)
BMG	Badan Meteorologi dan Geofisika (Indonesia)
BoM	(Australian) Bureau of Meteorology
CD-ROM	Compact Disk - Read Only Memory
CNB	Canberra (Magnetic Observatory)
CODATA	Committee on Data for Science and Technology
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSY	Casey (Variation Station)
CTA	Charters Towers (Magnetic Observatory)
D	Magnetic Declination (variation)
DC	Direct Current
DEH	Department of the Environment and Heritage
DIM	Declination & Inclination Magnetometer (D,I-fluxgate magnetometer)
DMI	Danish Meteorological Institute
DOS	Disk operating system (for the PC)
DVS	Davis (Variation Station)
EDA	EDA Instruments Inc., Canada
e-mail	electronic mail
F	Total magnetic intensity
ftp	file transfer protocol
GA	Geoscience Australia
GIN	Geomagnetic Information Node
GNA	Gnangara (Magnetic Observatory)
GPS	Global Positioning System
GSM	GEM Systems magnetometer
H	Horizontal magnetic intensity
HDD	Hard disk drive (in a PC)
I	Magnetic Inclination (dip)
INTER-MAGNET	International Real-time Magnetic observatory Network
IAGA	International Association of Geomagnetism and Aeronomy
IBM	International Business Machines
IGRF	International Geomagnetic Reference Field
IGY	International Geophysical Year (1957-58)
IPGP	Institute de Physique du Globe de Paris
IPS	IPS Radio & Space Services (formerly the Ionospheric Prediction Service)
ISGI	International Service of Geomagnetic Indices
K	kennziffer (German: logarithmic index; code no.) Index of geomagnetic activity.
KDU	Kakadu, N.T. (Magnetic Observatory)
LRM	Learmonth, W.A. (Magnetic Obsv'ty)
LSO	Learmonth Solar Observatory
mA	milli-Amperes
MAW	Mawson (Magnetic Observatory)
MCQ	Macquarie Is. (Magnetic Observatory)
MGO	Mundaring Geophysical Observatory
MNS	Magnetometer Nuclear Survey (PPM)
nT	nanoTesla
N.T.	Northern Territory
OIC	Officer in Charge
PC	Personal Computer (IBM-compatible)
PGR	Proton Gyromagnetic Ratio
PPM	Proton Procession Magnetometer
PVC	poly-vinyl chloride (plastic)
PVM	Proton Vector Magnetometer
QHM	Quartz Horizontal Magnetometer
Qld.	Queensland
RCF	Ring-core fluxgate (magnetometer)
SC	Sudden (storm) commencement
sfe	Solar flare effect
ssc	Sudden storm commencement
Tas.	Tasmania
UPS	Uninterruptible Power Supply
UT/UTC	Universal Time Coordinated
W.A.	Western Australia
WDC	World Data Centre
WWW	World Wide Web (Internet)
X	North magnetic intensity
Y	East magnetic intensity
Z	Vertical magnetic intensity

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End of Part 1

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Part 2

End of Part 2

The *Australian Geomagnetism Report* has been published in electronic format since Volume 47 for calendar year 1999.

These volumes are available on Geoscience Australia's web site: http://www.ga.gov.au/

The final volume that was produced in printed format was the *Australian Geomagnetism Report 1998,* Volume 46.

Part 2

CANBERRA OBSERVATORY

The Canberra Magnetic Observatory is located in the Australian Capital Territory, approximately 30km east of the city of Canberra. The Canberra observatory is the successor to the Rossbank (1840-1854), Melbourne (1858-1919), Toolangi (1919-1979) observatory sequence of sites in south eastern Australia (McGregor, 1979; Hopgood, 1993).

Recording at the Canberra Magnetic Observatory commenced in 1978 after which it replaced Toolangi as the principal magnetic observatory in the region. A detailed history of the observatory is in *AGR 1994*.

Situated on an approximately 8 hectare site, the observatory comprises a complex of buildings and structures: a RECORDER HOUSE 60m north of the entry gate; a SECONDARY VARIOMETER HOUSE (formerly known as the (PPM) Sensor House) 75m to its west; an ABSOLUTE HOUSE 60m NE of the Recorder House; a COMPARISON HOUSE 10m west of the Absolute House; a VARIOMETER HOUSE 80m NW of the Recorder House; a TEST HOUSE 220m north of the Recorder House; and the *AUSTRALIAN MAGNETIC CALIBRATION FACILITY* 100m SE of the Recorder House.

Other structures on the site include a sheltered external observation site, four azimuth pillars and a seismic vault. The latter houses seismometers operated by GA's earthquake seismology and nuclear monitoring group.

Key data for the principal observation pier (Absolute-House: AW) at the observatory are:

- 3-character IAGA code: CNB
- Commenced operation 1978
- Geographic latitude: 35° 18' 52.6" S
- Geographic longitude: 149° 21' 45.4" E
- Geomagnetic† : Lat. -42.53°; Long. 226.79°
  † Based on the IGRF 2000.0 model updated to 2003.5
- Elevation above mean sea level (top of pier): 859 metres
- Lower limit for K index of 9: 450 nT.
- Azimuth of principal reference pillar (NW) from pier AW: 328° 37' 03"
- Distance to NW Pillar: 137.3 metres
- Observer in Charge: Liejun Wang (GA)

Variometers

During 2003 (since November 1995) a Narod ring-core fluxgate (RCF) variometer operated as the principal variometer at the observatory. It was located on the pier in the eastern room of the VARIOMETER HOUSE. It measured variations in three orthogonal components of the magnetic field, and was aligned to measure the (magnetic) north-west; north-east and vertical field components, denoted A, B and Z respectively.

A GEM Systems GSM-90 Overhauser effect magnetometer (electronics no. 803810, sensor no. 81225) measured variations in Total Intensity. Until 16 November 2003 it was located in the SECONDARY VARIOMETER HOUSE with its sensor within a Helmholtz coil system (of the Littlemore AMO, decommissioned in 1995). It was moved to the western room of the VARIOMETER HOUSE on 17 Nov 2003 with its sensor mounted on a standard PPM tripod.

Late in November 2001 a LEMI 3-component fluxgate variometer was installed on a pier in the western room of the VARIOMETER HOUSE to serve as a reserve instrument should the principal variometer become unserviceable. It continued to operate there until 21 August 2003, then from 17 November to the end of 2003. Between 22 August and 16 November 2003 it operated in the MAGNETIC CALIBRATION FACILITY.

During the interval 5 − 8 Nov when building maintenance work was carried out in VARIOMETER HOUSE where the (principal) Narod fluxgate variometer was housed, data from the LEMI variometer, running in MAGNETIC CALIBRATION FACILITY, replaced the Narod variometer data.

The LEMI variometer stopped at 23:15:29 and re-started at 23:16:39 on 5 Nov 2003, resulting 1 minute data loss at 23:16. The lost data were recovered using the Narod variometer.

During the 4 minute period 00:39:00 − 00:42:00 on 18 November, and the 4 minute period 01:16:00 − 01:19 01 December 2003, the Narod data were contaminated by nearby activities. The data were recovered using the LEMI variometer data.

Absolute Instruments and Corrections

Throughout 2003 absolute observations were regularly performed at Canberra with a Declination & Inclination Magnetometer (DIM) and a total field magnetometer.

The principal DIM used was an Elsec 810 (no. 200) electronics and sensor with a Zeiss 020B (no. 353756) non-magnetic theodolite. This instrument was routinely used on ABSOLUTE HOUSE pier AW. In consideration of numerous intercomparisons between DIMs (and other magnetometers), zero corrections have been applied to absolute observations performed with the DIM Elsec 810/200; Zeiss 020B/353756.

The principal total field instrument used in 2003 was GSM90 Overhauser magnetometer with electronics no. 905926 and sensor no. 21867. (This sensor replaced no. 81241 in September 2002.) During 2003 this GSM90 magnetometer was used during regular absolute observations on pier AW in the ABSOLUTE HOUSE.

Observations with the GSM90 standard are used without correction.

The principal absolute magnetometers at the Canberra Magnetic Observatory also serve as the reference standards for the Australian observatory network. Their standardizations are traceable to classical instruments that were regularly calibrated by comparison the international standard. (See the *Magnetic Standards* section near the beginning of this report.)

Baselines

The variometers remained reasonably stable throughout 2003. Over the year baselines drifted by approximately:

7.4nT in X; 6.4nT in Y; and 3.5nT in Z.

With drift corrections applied to the baselines, the mean value and standard deviation in the difference of absolute observations from a final variometer model were:

−0.08 ± 0.67 in X; −0.01 +/-0.67 in Y; −0.03 +/-0.38 in Z.

CNB – Baselines (cont.)

There was less than 1.5 nT variation throughout the year in the F check calculated as the difference between F measured with the fluxgate (the final variometer model with drifts applied) and the variometer PPM.

There was a change of adopted baseline values on 05 and 08 Nov 2003 as the two variometers had different variometer models.

Operations

Absolute observations were performed weekly (routinely on Tuesdays) by staff of the Geomagnetism Section on a roster. The rostered duties also included the computer-assisted hand-scaling and distribution of the previous week's K indices, and ensuring the transmission of 1-minute data from CNB (and other observatories) to INTERMAGNET.

The Narod RCF variometer was situated on pier (VE) in the VARIOMETER HOUSE that was maintained at a temperature of 26.5 ± 0.5°C throughout 2003 for baseline stability. The temperature variation of the principal variometer sensors was 25 ± 0.5°C. Data from the RCF were transmitted via optical fibre to the RECORDER HOUSE where they were recorded on an acquisition PC.

At the beginning of 2003 the GSM90 Total Intensity variometer, serving as an F-check on the vector variometer model, was located in the SECONDARY VARIOMETER HOUSE with its sensor positioned in the old AMO coil assembly. It was controlled from the RECORDER HOUSE, to where the data were transmitted via optical fibre and recorded on the acquisition computer. On 17 Nov 2003 it was relocated to VARIOMETER HOUSE.

See the CNB *Variometers* section of this report for a description of the relocation of the GSM90 to the VARIOMETER HOUSE and the deployment of a LEMI fluxgate variometer to serve as secondary vector instrument.

Since the beginning of 2001, digital data were retrieved automatically every 10 minutes from the CNB observatory to GA via a real-time data link using modems and the telephone line that was established on 20 July 2000. From 23 April 2001 data telemetry was via a radio modem link.

Once the raw data were received at GA, processing was automatically scheduled, after which processed 1-minute resolution data were provided by e-mail to ISGI, France every 10 minutes (to enable the production of a real-time aa-index) and daily to the Edinburgh INTERMAGNET GIN.

System power was backed up with a UPS with an approximately 4-hour capacity.

Significant Events, CNB 2003

09 Jan	0010: Sudden change in F-check and F, probably caused by an internal door of Secondary Variometer House being left open.
13 Jan	~0130: The door of Secondary Variometer House closed, resulting in a change in F-check.
10 Feb	(late UT) to 11th: Tilers working on roof of Comparison and Absolute houses.
14 Apr	07:30−11:30 LT: Roof tilers working on Variometer House.
05 Jul	0215: Heater removed from Secondary Variometer House. This had no effect on the PPM data.
22 Jul	0230: The heater removed from the Seconday Variometer House was returned. Three ceiling light bulbs were replaced in Variometer House, causing two spikes in variometer data.
22 Aug	0020: LEMI vector variometer was installed in the *Magnetic Calibration Facility* and calibrated.

CNB – Significant Events (cont.)

05 Nov	to 08th: Tradesmen working near Variometer House caused contamination of Narod variometer data. During this period LEMI variometer data was used.
17 Nov	PPM was relocated to the room next to the Narod variometer in Variometer House. LEMI variometer was relocated to Secondary Variometer House from the Magnetic Calibration Facility. All work completed by 0300.
18 Nov	0039−0042: Contamination of Narod variometer data due to persons cleaning the room. LEMI variometer data was used.
01 Dec	0116−0119: Narod variometer data comtaminated by person(s) walking near the Variometer House. LEMI variometer data was used.

CNB Data losses in 2003

There were no 3-axis fluxgate variometer data lost in 2003 at the Canberra observatory as any data lost to the primary instrument were recovered from the secondary instrument.

The following total intensity variometer data were lost in 2003:

28 Mar	0508−0558 (51m)
24 Aug	0515−0733 (2h 19m)
	0735−1007 (2h 33m)
19 Sep	0626−0949 (3h 24m)
25 Oct	0216 to 27th / 2333 (2d 21h 18m)
27 Oct	2338−2341 (4m), 2343−2344 (2m), 2346 (1m), 2348−2349 (2m)
16 Nov	2333 to 17th / 0024 (52m)
17 Nov	0026 (1m), 0029−0030 (2m)

Distribution of CNB data during 2003

K indices - weekly by e-mail

- IPS Radio & Space Services, Sydney.
- British Geological Survey, Edinburgh.
- International Service of Geomagnetic Indices, Paris.
- Royal Observatory of Belgium, Brussels
- CLS, CNES (French Space Agency), Toulouse

K indices - semi-monthly by e-mail

- Adolph-Schmidt-Observatory Niemegk, Germany

K indices with Principal Magnetic Storms & Rapid Variations - monthly by email.

- World Data Center-A, Boulder, USA
- WDC-C2, Kyoto, Japan
- Ebro Observatory, Roquetas, Spain

Preliminary Monthly Means for Project Ørsted

- Sent monthly by email to IPGP.

Preliminary 1-minute values

- Sent every 10 minutes to ISGI, France throughout 2003

1-minute & Hourly Mean Values

- 2002: WDC-A, Boulder, USA (19 March 2003)
- 2003: WDC-A, Boulder, USA (19 January 2004)

1-minute Values for Project INTERMAGNET

- Preliminary data daily to the Edinburgh GIN by e-mail.
- Definitive data for CD-ROM sent to the INTERMAGNET GIN, Paris.
- 2002 data sent to Paris GIN: 19 March 2003
- 2003 data sent to Paris GIN: 19 March 2004

Canberra 2003 – Principal Magnetic Storms:

Commencement			SC amplitudes			Maximum 3 hr. K index		Ranges			U.T. End	
Mth.Day	Hr.Min.	Type	D(')	H(nT)	Z(nT)	Day (3 hr. periods)	K	D(')	H(nT)	Z(nT)	Day	Hr.
Feb. 01	13 ··	···	··	··	··	02(3)	6	21	135	64	05	18
18	02 ··	···	··	··	··	18(2)	6	16	112	21	18	18
Mar. 06	03 ··	···	··	··	··	06(5,6)	5	15	120	40	07	06
31	00 ··	···	··	··	··	31(5,6)	5	18	120	48	**01**	03
Apr. 29	12 ··	···	··	··	··	**01**(1,4,5)	5	17	164	51	**01**	21
May 06	06 ··	···	··	··	··	06(5,6), 07(3,4), 08(4), 09(3,4)	5	20	132	46	09	18
10	15 ··	···	··	··	··	10(3), 11(3,4,5)	5	14	88	38	11	21
27	15 ··	···	··	··	··	29(7,8)	7	40	321	89	31	18
Jun. 01	22 ··	···	··	··	··	02(3,4)	5	15	145	73	02	21
14	06 ··	···	··	··	··	14(4,5)	5	21	109	45	14	21
16	00 ··	···	··	··	··	18(4)	7	40	226	105	19	00
24	00 ··	···	··	··	··	24(4,5)	5	11	86	31	24	18
28	03 ··	···	··	··	··	28(4)	6	24	124	55	30	21
Jul. 11	03 ··	···	··	··	··	11(3,4), 12(1,2,3)	5	18	174	73	12	21
15	18 ··	···	··	··	··	16(4)	6	32	168	65	17	06
28	09 ··	···	··	··	··	30(5), 31(4), **01**(4,5)	5	20	121	53	**02**	03
Aug. 07	12 ··	···	··	··	··	07(7,8), 08(2)	5	16	134	45	08	21
17	14 22	ssc*	0.8*	36	-4	18(4)	6	36	245	111	19	03
21	00 ··	···	··	··	··	21(3,6,7,8), 22(4,5), 23(3,5)	5	24	127	71	23	21
Sep. 15	19 ··	···	··	··	··	16(5)	6	24.5	137	69	20	18
Oct. 14	06 ··	···	··	··	··	14(5,7,8), 15(3,4), 16(4), 17(4)	5	21	127	53	17	18
24	00 ··	···	··	··	··	24(6,8)	6	23	120	63	25	18
28	21 ··	···	··	··	··	29(3)	9	51	947	294	31	21
Nov. 09	06 ··	···	··	··	··	13(5)	6	23.9	203	70	17	03
20	08 02	ssc	11	106	34	20(6)	8	61.3	627	269	23	09
Dec. 05	02 ··	···	··	··	··	05(2,3,4,5,6)	5	21.6	147	55	06	21
08	06 ··	···	··	··	··	08(4,5), 09(3)	5	14.9	111	39	09	18

No Principal Magnetic Storms reported for Canberra in: Jan. 2003

CNB 2003 – Rapid Variation Phenomena

Sudden Storm Commencements (ssc) - CNB 2003

Month & date	U.T.	Type & Quality		Chief movement (nT) H	D	Z
Mar 20	0444	ssc	B	+24	+8	+1
Apr 08	0110	ssc	B	+32	+13	+12
Aug 17	1422	ssc*	A	+36	+6 *	-4
Oct 26	1908	ssc*	B	+10	+14 *	+1
29	0610	ssc*	A	+158 *	+48 *	+30 *

continued …

Month & date	U.T.	Type & Quality		Chief movement (nT) H	D	Z
Nov 04	0625	ssc	A	+133	+20	+18
15	0550	ssc	C	+49	+11	+4
20	0802	ssc	A	+106	+76	+34

No *ssc* reported: Jan., Feb., May, Jun., Jul., Sep., Dec.2003

CNB 2003 – Rapid Variation Phenomena (cont.)

Solar Flare Effects (sfe) - CNB 2003

Month & date	U.T. of movement Start	Max.	End	Amplitude(nT) H	D	Z	Confir-mation
Jan 07	2329	2334	2359	+2	+8	+2	solar

No *sfe* reported: Feb., Mar., Apr., May., Jun., Jul., Aug., Sep., Oct., Nov., Dec. in 2003.

K indices

K indices from the Canberra Magnetic Observatory contribute to the global Kp and aa indices, the southern hemisphere Ks index, and all their derivatives.

The table on the next page shows K indices for Canberra for 2003.

From 01 December 2002 K indices for Canberra were derived using a computer assisted method developed at GA. The method, based on the IAGA accepted LRNS algorithm, is described the *Data Distribution* section near the beginning of this report. (Before this K indices were derived by the hand scaling of H and D traces on magnetograms produced from the digital data, using the method described by Mayaud (1967).)

Canberra Annual Mean Values

The table below gives annual mean values calculated using the monthly mean values over **All** days, the 5 International **Quiet** days and the 5 International **Disturbed** days in each month. Plots of these data with secular variation in H, D, Z & F are on pages 70-71.

Year	Days	D (Deg	Min)	I (Deg	Min)	H (nT)	X (nT)	Y (nT)	Z (nT)	F (nT)	Elts*
1979.5	A	12	5.6	-66	5.9	23833	23305	4993	-53778	58822	DFI
1980.5	A	12	8.6	-66	6.9	23808	23275	5009	-53767	58801	DFI
1981.5	A	12	11.2	-66	9.1	23770	23234	5018	-53771	58791	DFI
1982.5	A	12	14.0	-66	10.8	23736	23197	5030	-53769	58775	DFI
1983.5	A	12	16.6	-66	11.3	23723	23180	5044	-53756	58758	DFI
1984.5	A	12	18.4	-66	11.7	23709	23164	5054	-53741	58739	DFI
1985.5	A	12	20.7	-66	11.6	23703	23155	5067	-53726	58723	DFI
1986.5	A	12	23.2	-66	12.1	23689	23137	5081	-53716	58707	DFI
1987.5	A	12	25.5	-66	12.0	23684	23129	5096	-53699	58690	DFI
1988.5	A	12	27.6	-66	12.8	23665	23107	5106	-53690	58674	DFI
1989.5	A	12	29.0	-66	13.8	23644	23085	5111	-53683	58659	DFI
1990.5	A	12	30.7	-66	13.6	23641	23079	5121	-53667	58643	DFI
1991.5	A	12	31.8	-66	13.9	23628	23066	5126	-53652	58624	DFI
1992.5	A	12	32.4	-66	12.8	23637	23073	5132	-53625	58603	DFI
1993.5	A	12	33.0	-66	11.6	23646	23081	5138	-53597	58581	DFI
1994.5	A	12	33.5	-66	10.8	23649	23083	5142	-53571	58559	DFI
1995.5	A	12	33.8	-66	9.2	23665	23098	5148	-53540	58537	DFI
1996.5	A	12	34.2	-66	7.4	23684	23108	5154	-53507	58514	ABC
1997.5	A	12	34.2	-66	6.1	23695	23127	5157	-53476	58491	ABC
1998.5	A	12	34.2	-66	5.2	23698	23130	5157	-53444	58463	ABC
1999.5	A	12	34.1	-66	3.7	23709	23140	5159	-53403	58429	ABC
2000.5	A	12	34.2	-66	2.9	23706	23139	5160	-53367	58396	ABC
2001.5	A	12	34.7	-66	1.5	23716	23146	5164	-53327	58362	ABC
2002.5	A	12	35.1	-66	0.5	23718	23148	5168	-53291	58331	ABC
2003.5	A	12	35.5	-66	0.3	23710	23139	5169	-53264	58303	ABC
1979.5	Q	12	5.5	-66	5.3	23844	23315	4995	-53775	58824	DFI
1980.5	Q	12	8.6	-66	6.8	23813	23280	5010	-53769	58806	DFI
1981.5	Q	12	11.4	-66	8.3	23783	23246	5022	-53767	58792	DFI
1982.5	Q	12	14.1	-66	10.1	23749	23210	5033	-53766	58778	DFI
1983.5	Q	12	16.5	-66	10.7	23734	23191	5046	-53753	58760	DFI
1984.5	Q	12	18.5	-66	11.1	23719	23174	5056	-53739	58741	DFI
1985.5	Q	12	20.7	-66	11.1	23713	23164	5070	-53724	58724	DFI
1986.5	Q	12	23.2	-66	11.6	23697	23146	5083	-53714	58709	DFI
1987.5	Q	12	25.5	-66	11.6	23690	23136	5097	-53698	58691	DFI
1988.5	Q	12	27.7	-66	12.2	23675	23118	5109	-53687	58676	DFI
1989.5	Q	12	29.1	-66	13.0	23657	23098	5114	-53680	58662	DFI
1990.5	Q	12	30.8	-66	12.8	23653	23092	5125	-53663	58645	DFI
1991.5	Q	12	31.8	-66	12.9	23645	23082	5130	-53647	58627	DFI
1992.5	Q	12	32.5	-66	12.1	23649	23085	5135	-53622	58605	DFI
1993.5	Q	12	33.0	-66	11.1	23655	23090	5140	-53594	58583	DFI
1994.5	Q	12	33.6	-66	10.2	23661	23095	5145	-53568	58561	DFI
1995.5	Q	12	33.9	-66	8.7	23675	23108	5150	-53537	58538	DFI
1996.5	Q	12	34.2	-66	7.2	23689	23108	5155	-53506	58515	ABC
1997.5	Q	12	34.2	-66	5.6	23703	23135	5159	-53474	58492	ABC
1998.5	Q	12	34.3	-66	4.8	23706	23137	5159	-53443	58464	ABC
1999.5	Q	12	34.1	-66	3.2	23716	23148	5161	-53400	58430	ABC
2000.5	Q	12	34.3	-66	2.2	23718	23149	5162	-53365	58398	ABC
2001.5	Q	12	34.7	-66	0.9	23726	23156	5167	-53324	58364	ABC
2002.5	Q	12	35.1	-65	59.8	23730	23159	5171	-53289	58334	ABC
2003.5	Q	12	35.5	-66	-0.5	23723	23152	5172	-53261	58306	ABC

continued on page 72 …

K indices & Daily K sums at Canberra (K=9 limit: 450 nT) for 2003

Date	January	February	March	April	May	June	Date
01	1122 2111 11	1000 3343 14	2213 4332 20	2223 2332 19	D 5445 5322 30	1332 4242 21	01
02	0112 2212 11	D 4464 4553 35	2213 3232 18	2334 4233 24	2424 3311 20	D 4455 4423 31	02
03	2132 3544 24	D 2223 4333 22	2122 3443 21	2233 3334 23	Q 1224 2211 15	3334 4324 26	03
04	3322 2122 17	D 3554 3232 27	D 4344 4433 29	D 3344 5444 31	Q 2112 2111 11	3224 3332 22	04
05	1221 3321 15	2223 4312 19	2123 3423 20	D 2322 4443 24	1322 2333 19	Q 2133 3321 18	05
06	Q 1111 0111 07	2233 3433 23	2224 5523 25	Q 1212 0311 11	3224 5543 28	2123 2332 18	06
07	Q 1211 1222 12	2222 4232 19	3223 3222 19	Q 0012 3200 08	D 4355 4333 30	2334 3323 23	07
08	Q 2120 1101 08	3332 3323 22	Q 1121 3431 16	3334 4322 24	D 4445 4443 32	3343 3444 28	08
09	Q 0000 1122 06	3232 3423 22	1221 2223 15	2443 5322 25	4455 5312 29	3333 3335 26	09
10	3222 3334 22	2343 2322 21	2232 4322 20	3334 3353 27	4454 1223 25	3244 3222 22	10
11	2221 2212 14	Q 2222 3321 17	2233 2312 18	2223 2333 20	4255 5322 28	2232 2221 16	11
12	2342 2221 18	1223 2422 18	Q 2222 2113 15	Q 2122 3211 14	3334 4333 26	Q 1121 2211 11	12
13	1222 1212 13	Q 1212 2012 11	3333 4122 21	Q 3323 3111 17	3334 4333 26	Q 1001 1123 09	13
14	2332 2221 17	3323 4433 25	2244 5333 26	1212 5323 19	3443 3432 26	1235 5442 26	14
15	1122 2212 13	D 3423 4323 24	3344 4333 27	3334 3113 21	2334 4333 25	3432 4332 24	15
16	Q 1012 2111 09	2323 4323 22	2324 5442 26	D 2245 4444 29	Q 2211 2121 12	D 3525 3355 31	16
17	1233 3211 16	2223 3223 19	D 2343 5434 28	2345 4432 27	Q 1322 3110 13	D 4446 4432 31	17
18	2333 4334 25	2654 3313 27	3334 4313 24	1324 4322 21	Q 1110 0232 10	D 3457 4443 34	18
19	2443 4432 26	2212 4323 19	2322 2221 16	Q 1211 2222 13	1222 2223 16	2223 2221 16	19
20	3323 3323 22	2343 3232 22	1334 4433 25	2221 2224 17	2233 3122 18	Q 1232 2422 18	20
21	2234 3322 21	2232 1322 17	3445 4233 28	2345 2333 25	2221 3444 22	4354 2423 27	21
22	D 2222 3325 21	1122 4322 17	2233 3113 18	2235 3343 25	4343 4432 27	Q 2233 1342 20	22
23	D 3322 3234 22	Q 2212 4322 18	3244 3332 24	2434 3231 22	1334 3422 22	4434 2232 24	23
24	2233 3433 23	Q 1113 2212 13	Q 2123 1110 11	2234 3443 25	2443 3443 27	3345 5212 25	24
25	D 3354 4322 26	Q 1121 2101 09	Q 0110 0211 06	D 3344 4323 26	3333 1323 21	2243 2442 23	25
26	D 3334 4313 24	1134 3224 20	Q 0222 1222 13	2243 4333 24	3142 2112 16	3234 5222 23	26
27	3310 1323 16	D 4334 5433 29	4344 3432 27	2323 3323 21	3334 3255 28	3444 4333 28	27
28	2222 3211 15	3124 4433 24	3342 2434 25	2335 3112 20	4344 4333 28	D 2426 4333 27	28
29	2123 4333 21		D 2333 3433 24	1110 4443 18	D 3244 5577 37	3334 3323 24	29
30	D 3225 4431 24		D 4434 3434 29	D 3444 3434 29	D 5433 3433 28	2353 3221 21	30
31	2335 3321 22		D 2334 5533 28		5641 2211 22		31
Mean K-sum	17.5	20.5	21.4	21.6	23.1	23.1	

Date	July	August	September	October	November	December	Date
01	2221 2111 12	D 4345 5333 30	1332 1232 17	1112 1113 11	4343 4333 27	2222 1211 13	01
02	1233 3231 18	2233 2343 22	2112 4212 15	1221 1123 13	2323 3342 22	2332 2001 13	02
03	1112 2333 16	2323 2222 18	2334 2232 21	2322 2322 18	2322 2213 17	Q 1111 1201 08	03
04	3324 3322 22	Q 1233 1222 16	2344 4344 28	Q 1121 3000 08	2366 2232 26	1011 1123 10	04
05	2333 3322 21	Q 2121 0101 08	3433 3322 23	0010 1222 08	Q 2111 1122 11	D 2555 5543 34	05
06	2212 3210 13	3453 3211 22	1213 2211 13	1112 2234 16	1111 2243 15	3334 3332 24	06
07	2143 4221 19	1212 4455 24	Q 1100 0210 05	3224 3322 21	2312 1111 12	1211 4433 19	07
08	Q 0000 0100 01	4544 3432 29	0001 1113 07	1112 1113 11	Q 0122 3422 16	D 2445 5443 31	08
09	Q 0101 1010 04	2243 3223 21	1234 4344 25	2211 1101 09	2234 5433 26	D 3354 4434 30	09
10	Q 1112 3111 11	3113 3221 16	4224 3332 23	Q 0010 0002 03	3334 4444 29	D 4344 4544 32	10
11	D 2355 4444 31	1111 1222 11	3323 2222 19	Q 0000 0000 00	D 4455 4544 35	D 4445 4433 31	11
12	D 5553 3332 29	3344 4422 26	2322 3111 15	Q 0011 1212 08	3344 3343 27	3333 4233 24	12
13	3232 2321 18	2332 3223 20	2332 0122 15	1222 2324 18	D 2335 6443 30	3333 4433 26	13
14	1232 2233 18	3342 1232 20	Q 1120 1101 07	D 2243 5455 30	3445 4333 29	3333 4443 27	14
15	4334 2134 24	1222 1222 14	0000 0033 06	3455 4333 30	D 3454 4433 30	3333 4233 24	15
16	D 3446 5433 32	Q 2203 2211 13	D 3344 6542 31	3235 3323 24	D 3344 5544 32	2223 1321 16	16
17	3224 3333 23	0001 4444 17	D 3445 6444 34	3345 4222 25	3334 4433 27	2222 2301 14	17
18	3322 2233 20	D 4367 5654 40	D 4445 4444 33	3333 4323 24	4333 4433 27	Q 1111 1100 06	18
19	3334 4334 27	3232 2211 16	D 3355 5332 29	2244 4443 27	2233 3322 20	Q 0110 1000 03	19
20	4333 3223 23	0222 2323 16	2345 4421 25	2244 3434 26	D 1366 7876 44	1224 3534 24	20
21	Q 1210 1020 07	D 2454 4555 34	4233 4322 23	D 4344 5444 32	5563 3332 30	4343 3433 27	21
22	Q 1022 1120 09	D 4445 5433 32	2334 3331 22	3445 4432 29	4312 3553 26	3344 3332 25	22
23	2112 1321 13	D 3354 5432 29	2323 3323 21	Q 3232 1101 13	3442 4243 26	2122 2211 13	23
24	1100 1113 08	2243 3242 22	D 3454 4333 29	1123 4646 27	2212 4323 19	1220 2332 15	24
25	0133 2000 09	3443 2311 21	3345 4332 27	4332 5313 24	3233 3312 20	Q 1122 3211 13	25
26	1334 3343 24	3213 3323 20	2244 3222 21	1223 1233 17	2111 3212 13	2222 2112 14	26
27	3344 3221 22	Q 1123 3222 16	2100 0011 05	2222 2310 14	Q 1212 1012 10	1323 2223 18	27
28	1113 4432 19	2233 2323 20	Q 0002 1200 05	3433 2324 24	Q 1112 3201 11	3323 2232 20	28
29	D 3444 4444 31	0213 3242 17	Q 1002 0001 04	D 4497 7687 52	Q 1122 2112 12	Q 2112 1300 10	29
30	3344 5332 27	2223 2221 16	Q 1121 3201 11	D 6653 5788 48	2222 3333 20	0211 1133 12	30
31	D 3345 4333 28	Q 1222 3211 14		D 7866 6433 43		2233 4433 24	31
Mean K-sum	18.7	20.6	18.6	21.1	23.0	19.4	

Occurrence distribution of K-indices

K-Index:	0	1	2	3	4	5	6	7	8	9	-
January	10	56	91	66	20	5	0	0	0	0	0
February	5	25	81	74	31	6	2	0	0	0	0
March	5	28	75	84	48	8	0	0	0	0	0
April	6	26	67	84	48	9	0	0	0	0	0
May	3	34	57	76	54	21	1	2	0	0	0
June	2	20	71	79	50	15	2	1	0	0	0
July	23	48	54	79	35	8	1	0	0	0	0
August	8	36	86	63	36	16	2	1	0	0	0
September	31	38	58	60	42	9	2	0	0	0	0
October	25	44	59	53	37	12	8	5	4	1	0
November	3	36	56	76	46	13	7	2	1	0	0
December	16	49	59	74	39	11	0	0	0	0	0
ANNUAL TOTAL	**137**	**440**	**814**	**868**	**486**	**133**	**25**	**11**	**5**	**1**	**0**

Monthly & Annual Mean Values

The following table gives final monthly and annual mean values of each of the magnetic elements for the year.

A value is given for means computed from all days in each month (All days), the five least disturbed of the International Quiet days (5xQ days) in each month and the five International Disturbed days (5xD days) in each month.

CANBERRA	2003	X (nT)	Y (nT)	Z (nT)	F (nT)	H (nT)	D (East)	I
January	All days	23158.6	5166.7	-53272.2	58317.6	23728.0	12° 34.6'	-65° 59.5'
	5xQ days	23167.8	5169.7	-53271.0	58320.5	23737.6	12° 34.7'	-65° 58.9'
	5xD days	23147.8	5164.6	-53272.5	58313.4	23717.0	12° 34.6'	-66° 00.1'
February	All days	23149.4	5166.9	-53271.2	58313.1	23719.0	12° 34.9'	-65° 59.9'
	5xQ days	23155.5	5169.2	-53269.1	58313.8	23725.5	12° 35.1'	-65° 59.5'
	5xD days	23135.0	5160.7	-53274.6	58309.9	23703.6	12° 34.5'	-66° 00.9'
March	All days	23138.9	5167.4	-53269.0	58306.9	23708.8	12° 35.3'	-66° 00.4'
	5xQ days	23151.9	5171.6	-53267.2	58310.8	23722.5	12° 35.5'	-65° 59.7'
	5xD days	23119.2	5160.7	-53270.2	58299.6	23688.2	12° 35.0'	-66° 01.6'
April	All days	23134.0	5169.1	-53269.3	58305.4	23704.5	12° 35.7'	-66° 00.7'
	5xQ days	23144.7	5170.1	-53266.2	58307.0	23715.2	12° 35.5'	-66° 00.0'
	5xD days	23126.2	5166.5	-53270.5	58303.2	23696.3	12° 35.6'	-66° 01.1'
May	All days	23130.7	5168.3	-53270.0	58304.6	23701.1	12° 35.7'	-66° 00.9'
	5xQ days	23144.0	5170.1	-53267.7	58308.0	23714.5	12° 35.5'	-66° 00.1'
	5xD days	23115.3	5167.5	-53269.3	58297.8	23685.9	12° 36.1'	-66° 01.7'
June	All days	23131.1	5169.0	-53270.7	58305.5	23701.6	12° 35.8'	-66° 00.9'
	5xQ days	23143.4	5171.7	-53266.9	58307.2	23714.2	12° 35.8'	-66° 00.1'
	5xD days	23107.6	5163.9	-53278.1	58302.6	23677.6	12° 35.8'	-66° 02.3'
July	All days	23134.7	5170.5	-53266.1	58302.9	23705.5	12° 35.9'	-66° 00.5'
	5xQ days	23147.0	5172.9	-53263.4	58305.5	23718.0	12° 35.8'	-65° 59.8'
	5xD days	23110.6	5166.9	-53272.2	58298.6	23681.1	12° 36.2'	-66° 02.0'
August	All days	23134.0	5170.4	-53263.0	58299.8	23704.8	12° 35.9'	-66° 00.5'
	5xQ days	23148.4	5172.7	-53259.7	58302.7	23719.3	12° 35.8'	-65° 59.6'
	5xD days	23109.4	5164.5	-53266.1	58292.3	23679.4	12° 35.9'	-66° 01.9'
September	All days	23140.6	5171.3	-53256.4	58296.4	23711.4	12° 35.8'	-65° 60.0'
	5xQ days	23150.9	5173.9	-53253.7	58298.3	23722.0	12° 35.9'	-65° 59.4'
	5xD days	23120.3	5165.2	-53259.5	58290.7	23690.3	12° 35.6'	-66° 01.2'
October	All days	23131.4	5168.1	-53253.9	58290.3	23701.7	12° 35.7'	-66° 00.5'
	5xQ days	23152.3	5174.0	-53251.5	58296.8	23723.4	12° 35.8'	-65° 59.2'
	5xD days	23073.3	5157.8	-53254.5	58266.9	23642.8	12° 36.1'	-66° 03.7'
November	All days	23135.4	5167.7	-53255.6	58293.3	23705.5	12° 35.5'	-66° 00.3'
	5xQ days	23155.3	5172.9	-53253.9	58300.1	23726.0	12° 35.6'	-65° 59.1'
	5xD days	23111.8	5154.1	-53248.3	58276.1	23679.5	12° 34.3'	-66° 01.5'
December	All days	23153.1	5169.6	-53249.4	58294.9	23723.2	12° 35.2'	-65° 59.2'
	5xQ days	23161.3	5172.8	-53246.0	58295.3	23731.9	12° 35.4'	-65° 58.6'
	5xD days	23139.5	5169.0	-53253.6	58293.3	23709.8	12° 35.5'	-66° 00.0'
Annual	All days	23139.3	5168.7	-53263.9	58302.6	23709.6	12° 35.5'	-66° 00.3'
Mean	5xQ days	23151.9	5171.8	-53261.4	58305.5	23722.5	12° 35.5'	-65° 59.5'
Values	5xD days	23118.0	5163.4	-53265.8	58295.4	23687.6	12° 35.4'	-66° 01.5'

(Calculated: 15:04 hrs., Mon., 20 Sep. 2004)

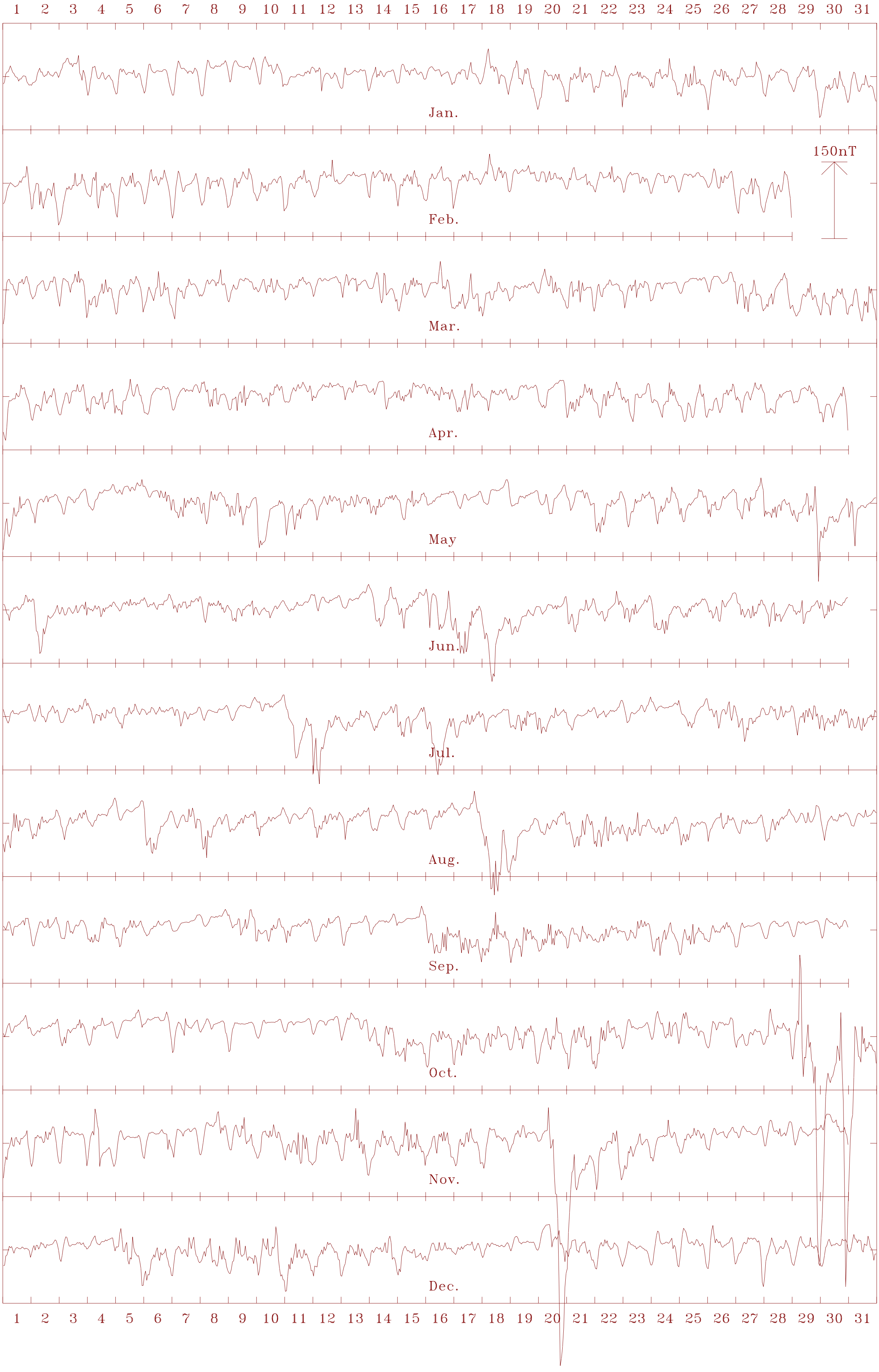
Hourly Mean Values

The charts on the following pages are plots of hourly mean values.

The reference levels indicated with marks on the vertical axes refer to the *all-days* mean value for the respective months. All elements in the plots are shown increasing (algebraically) towards the top of the page, with the exception of Z, which is in the opposite sense.

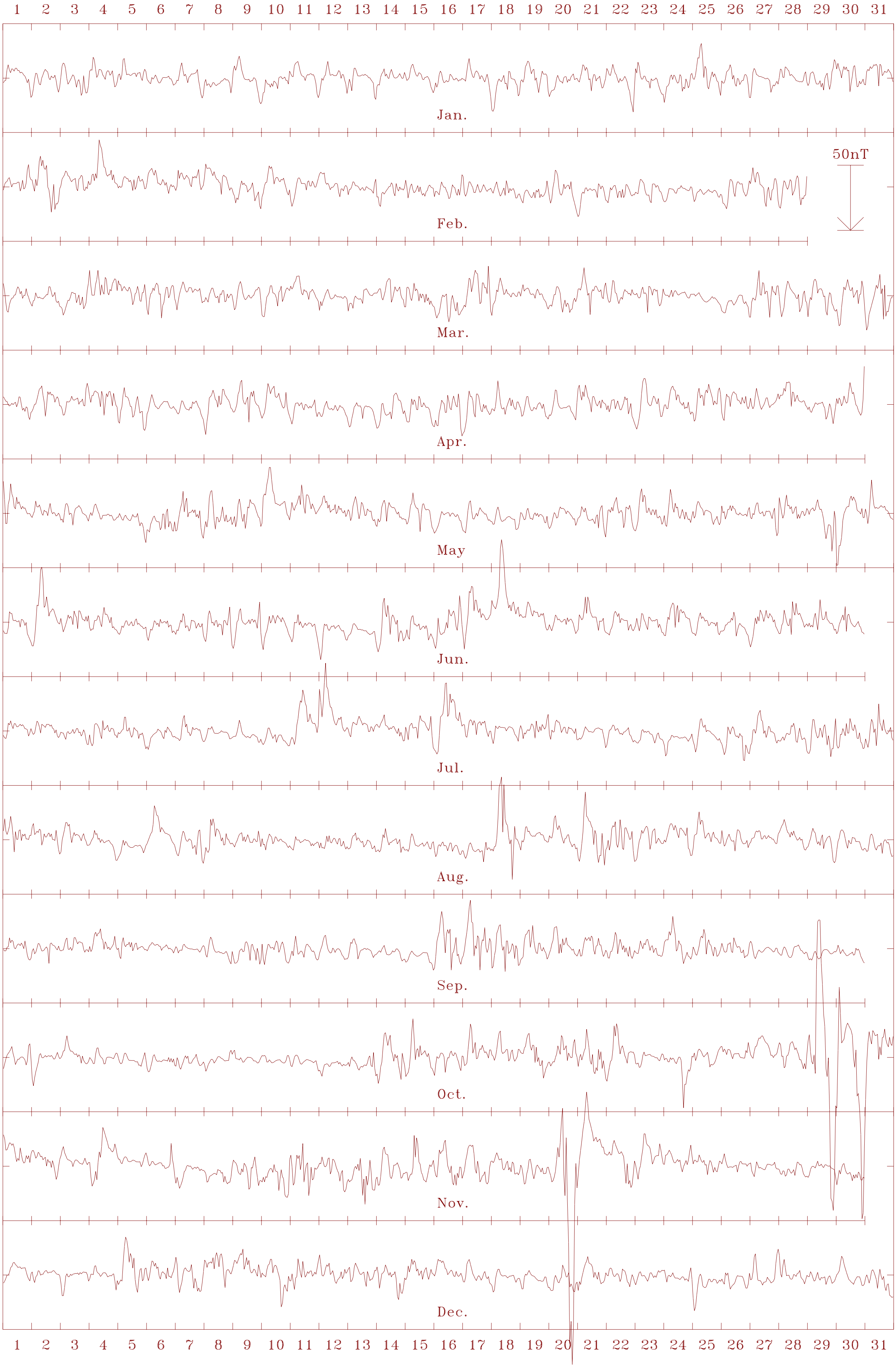
The mean value given at the top of each plot is the *all-days* annual mean value of the element.

Canberra 2003 Horizontal intensity (H). Scale: 10.0 nT/mm. Mean: 23710 nT

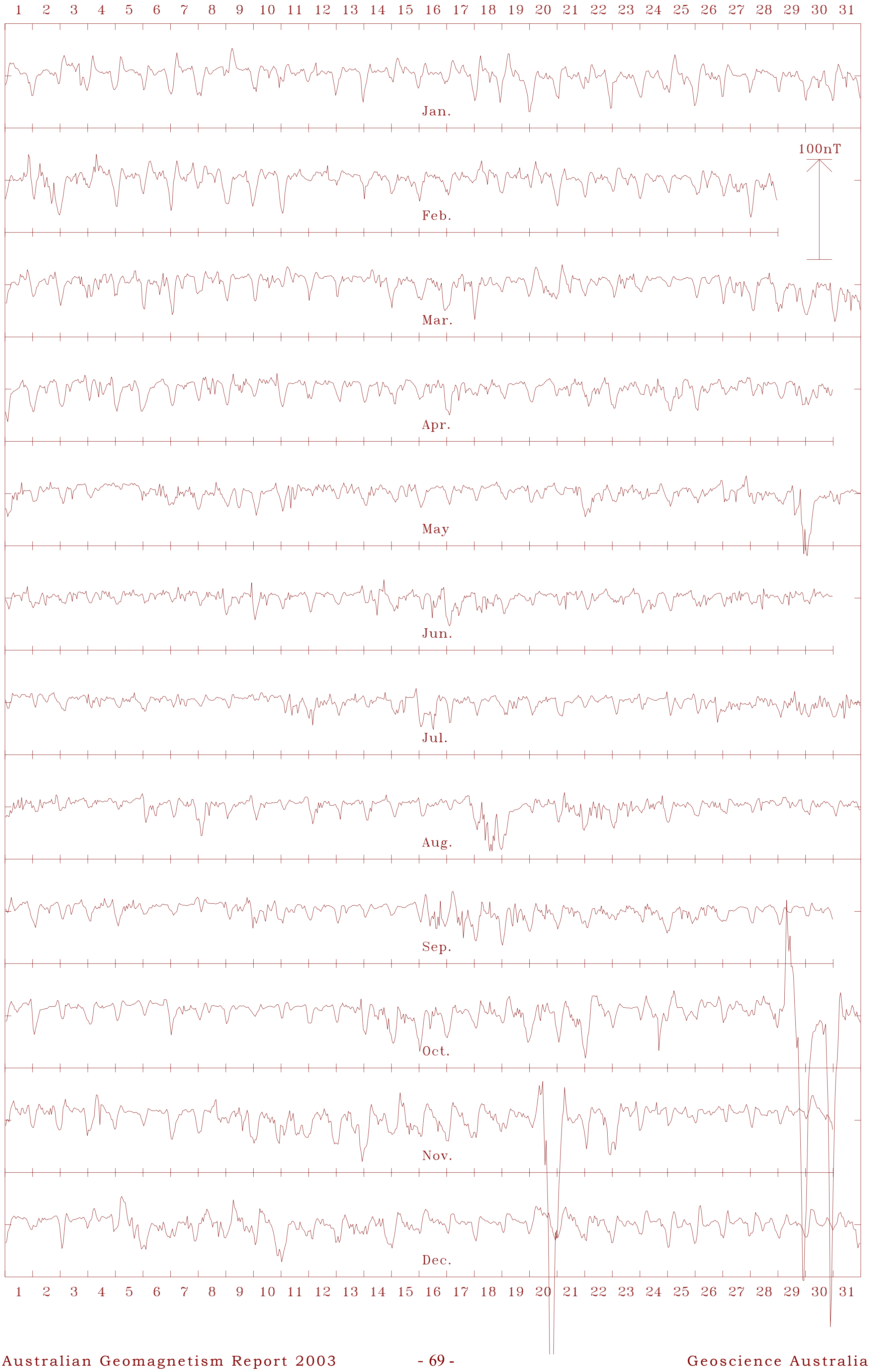


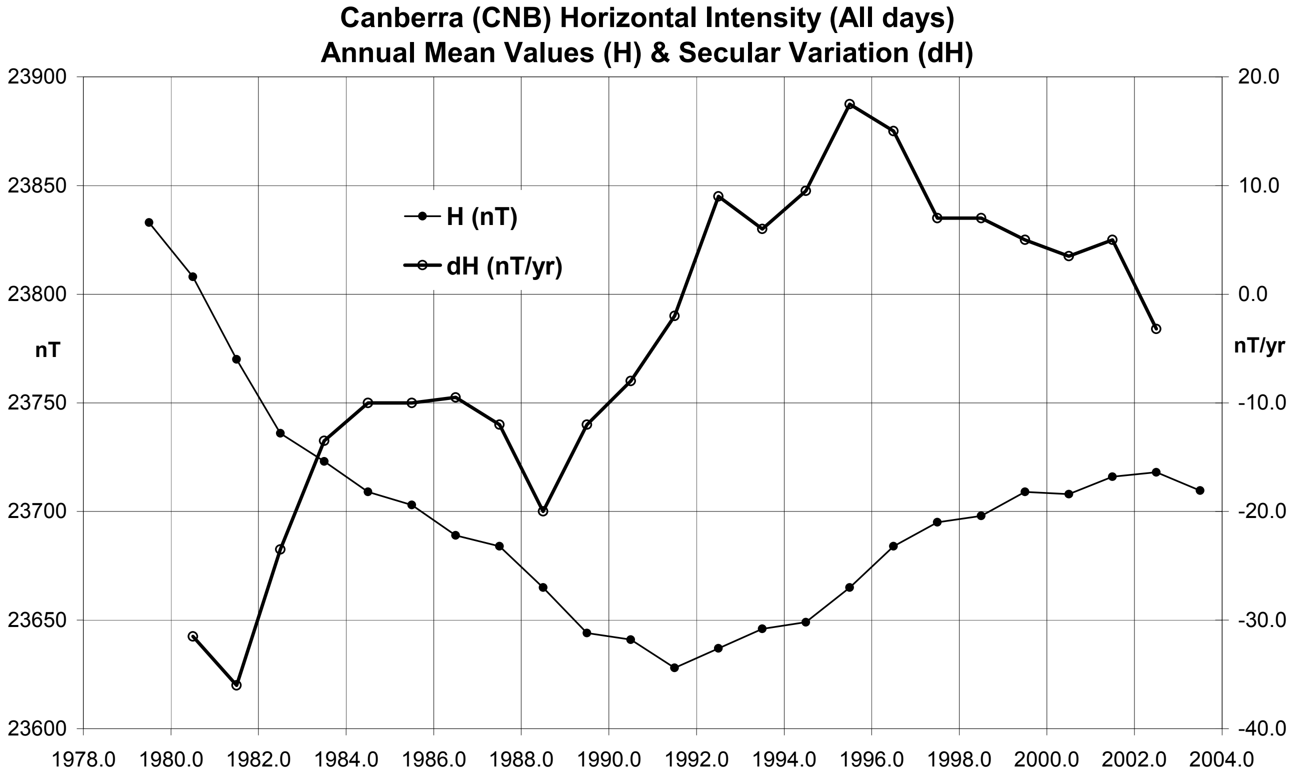
Canberra 2003 Declination (east) (D). Scale: 1.25 min/mm. Mean: 12.59 deg.

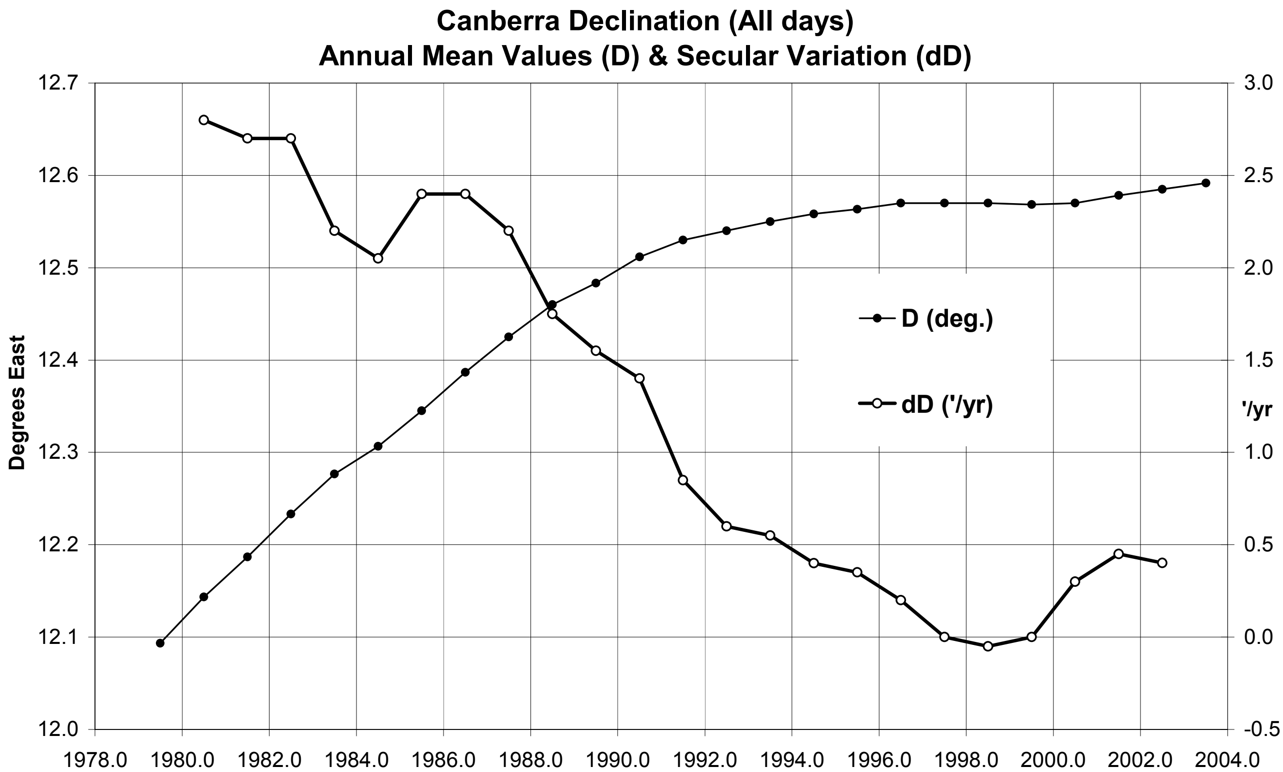
Canberra 2003 Vertical intensity (Z). Scale: 4.0 nT/mm. Mean: −53264 nT

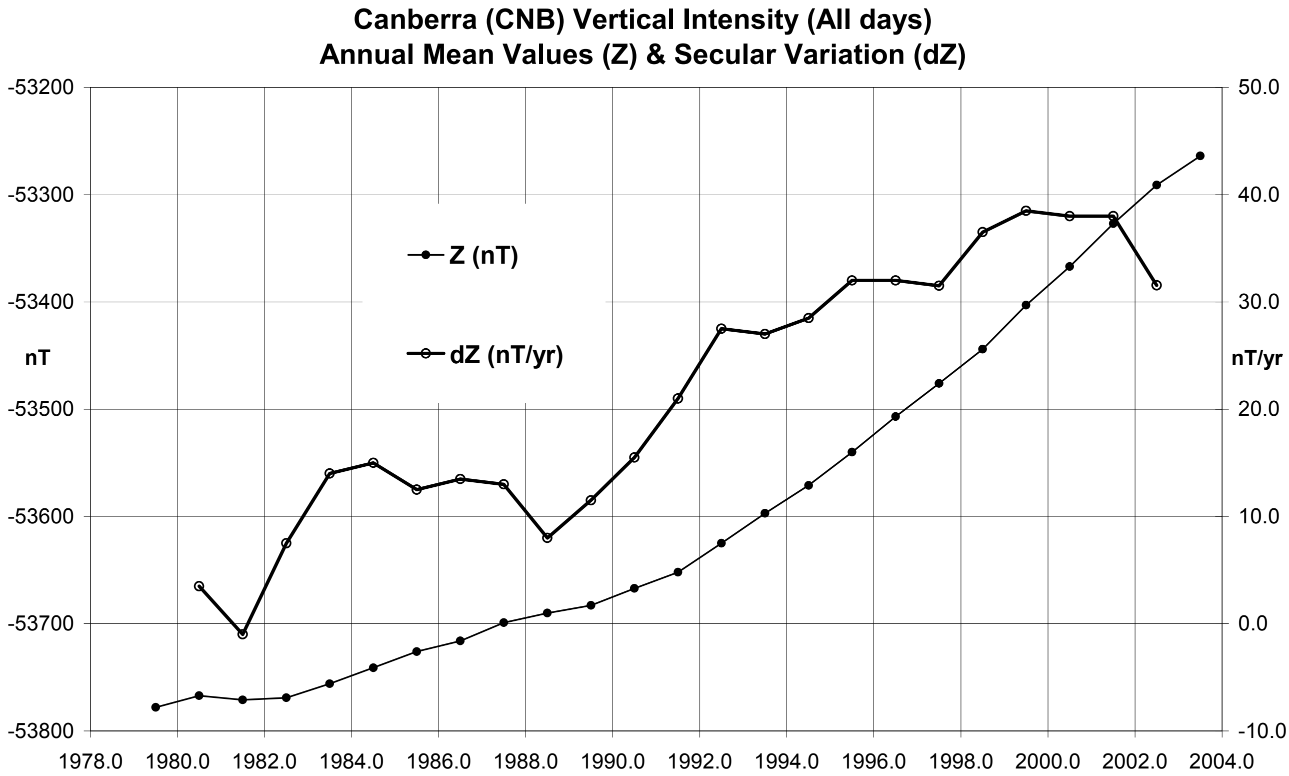


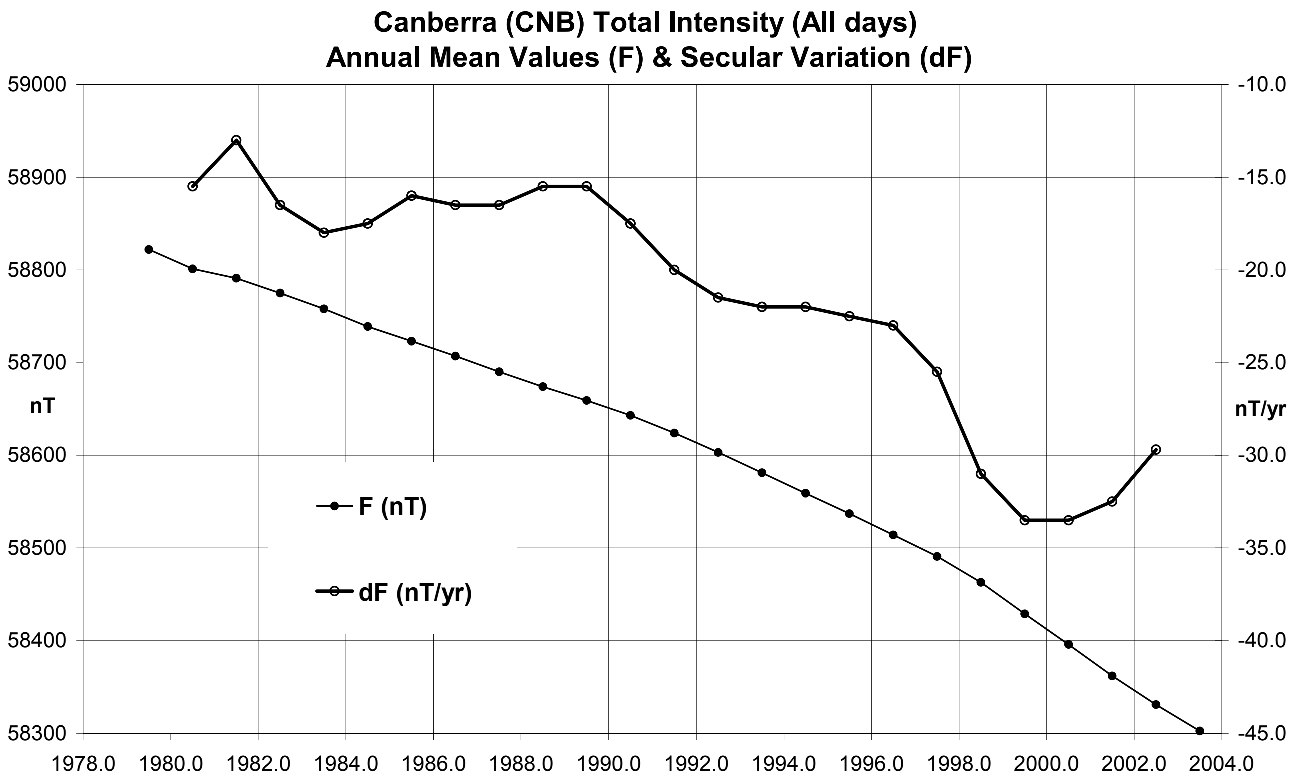
Canberra 2003 Total intensity (F). Scale: 5.0 nT/mm. Mean: 58303 nT




Canberra (CNB) Horizontal Intensity (All days)
Annual Mean Values (H) & Secular Variation (dH)
H (nT)
dH (nT/yr)
nT
nT/yr
23900
23850
23800
23750
23700
23650
23600
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
1978.0
1980.0
1982.0
1984.0
1986.0
1988.0
1990.0
1992.0
1994.0
1996.0
1998.0
2000.0
2002.0
2004.0


Canberra Declination (All days)
Annual Mean Values (D) & Secular Variation (dD)
D (deg.)
dD ('/yr)
Degrees East
'/yr
12.7
12.6
12.5
12.4
12.3
12.2
12.1
12.0
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
1978.0
1980.0
1982.0
1984.0
1986.0
1988.0
1990.0
1992.0
1994.0
1996.0
1998.0
2000.0
2002.0
2004.0


Canberra (CNB) Vertical Intensity (All days)
Annual Mean Values (Z) & Secular Variation (dZ)
-53200
-53300
-53400
-53500
-53600
-53700
-53800
nT
50.0
40.0
30.0
20.0
10.0
0.0
-10.0
nT/yr
Z (nT)
dZ (nT/yr)
1978.0
1980.0
1982.0
1984.0
1986.0
1988.0
1990.0
1992.0
1994.0
1996.0
1998.0
2000.0
2002.0
2004.0


Canberra (CNB) Total Intensity (All days)
Annual Mean Values (F) & Secular Variation (dF)
59000
58900
58800
58700
58600
58500
58400
58300
nT
-10.0
-15.0
-20.0
-25.0
-30.0
-35.0
-40.0
-45.0
nT/yr
F (nT)
dF (nT/yr)
1978.0
1980.0
1982.0
1984.0
1986.0
1988.0
1990.0
1992.0
1994.0
1996.0
1998.0
2000.0
2002.0
2004.0

CNB – Annual Mean Values (cont.)

Year	Days	D (Deg	Min)	I (Deg	Min)	H (nT)	X (nT)	Y (nT)	Z (nT)	F (nT)	Elts*
1979.5	D	12	5.6	-66	6.9	23816	23287	4990	-53782	58819	DFI
1980.5	D	12	8.4	-66	7.8	23792	23260	5004	-53770	58798	DFI
1981.5	D	12	11.1	-66	10.3	23750	23215	5013	-53776	58787	DFI
1982.5	D	12	13.7	-66	12.4	23710	23172	5022	-53773	58769	DFI
1983.5	D	12	16.6	-66	12.3	23706	23163	5040	-53760	58754	DFI
1984.5	D	12	18.4	-66	12.7	23691	23146	5049	-53745	58735	DFI
1985.5	D	12	20.5	-66	12.4	23690	23142	5064	-53729	58719	DFI
1986.5	D	12	23.3	-66	12.9	23675	23123	5079	-53717	58703	DFI
1987.5	D	12	25.5	-66	12.6	23674	23120	5094	-53701	58688	DFI
1988.5	D	12	27.5	-66	13.8	23647	23091	5102	-53693	58670	DFI
1989.5	D	12	29.0	-66	15.5	23615	23057	5105	-53690	58654	DFI
1990.5	D	12	30.5	-66	14.8	23619	23059	5116	-53671	58639	DFI
1991.5	D	12	31.6	-66	15.5	23600	23038	5119	-53658	58618	DFI
1992.5	D	12	32.3	-66	14.1	23615	23052	5127	-53630	58600	DFI
1993.5	D	12	33.0	-66	12.7	23628	23064	5134	-53601	58578	DFI
1994.5	D	12	33.4	-66	11.8	23633	23068	5138	-53574	58555	DFI
1995.5	D	12	33.8	-66	10.0	23652	23086	5145	-53542	58533	DFI
1996.5	D	12	34.2	-66	7.9	23676	23108	5152	-53508	58512	ABC
1997.5	D	12	34.1	-66	6.9	23683	23115	5154	-53479	58488	ABC
1998.5	D	12	34.2	-66	6.4	23678	23110	5153	-53450	58459	ABC
1999.5	D	12	34.1	-66	4.6	23692	23124	5156	-53407	58427	ABC
2000.5	D	12	34.2	-66	4.2	23685	23117	5155	-53372	58392	ABC
2001.5	D	12	34.6	-66	2.7	23695	23126	5159	-53331	58358	ABC
2002.5	D	12	35.2	-66	1.6	23700	23130	5165	-53296	58328	ABC
2003.5	D	12	35.4	-66	1.5	23688	23118	5163	-53266	58295	ABC

* Elements ABC indicates non-aligned variometer orientation

MACQUARIE ISLAND

Macquarie Island (Tasmania) is approximately 1,350 km. SSE of Hobart, about half way between Tasmania and the coast of the continent of Antarctica.

In December 1911 a magnetic station was first established at Caroline Cove at the southern end of Macquarie Island by Eric Webb. Another magnetic station, referred to as station A, was also established in 1911, on the Macquarie Island isthmus at the northern end of the island. Station A was re-occupied in 1930 by the British Australian New Zealand Antarctic Expedition (BANZARE) and again in 1948 by the first Australian National Antarctic Research Expedition (ANARE).

The Macquarie Island magnetic observatory was built at the ANARE station on the isthmus and magnetic recording has been continuous since 1952. The observatory was upgraded to produce digital data in October 1984. Data recording was upgraded to one second sampling rates in 1993. Details of the staffing at the observatory is in *AGR* 1994. The Macquarie Island Magnetic Observatory was accepted as an INTERMAGNET Magnetic Observatory in March 2002.

The observatory consists of a Variometer House, some 100 metres south of the office in the station's Science building; an Absolute House about 30 metres further south; and a PPM Variometer House between the Variometer and Absolute Houses. During summer, the area around the huts is used by elephant seals for breeding, so all cables and power to the huts are routed underground.

Key data for the principal observation pier (AE) of the observatory are:

- 3-character IAGA code: MCQ
- Commenced operation: 1952
- Geographic latitude: 54° 30' S
- Geographic longitude: 158° 57' E
- Geomagnetic†: Lat. -59.90°; Long. 244.04°

† Based on the IGRF 2000.0 model updated to 2003.5

- Elevation above mean sea level (top of pier): 8 metres
- Lower limit for K index of 9: 1500 nT.
- Azimuth of principal reference pillar (NMI) from pier AE: 353° 44' 13"
- Distance to Pillar NMI: ~200 metres
- Observers in Charge: Peter Pokorny (2002/03), Henry Banon (2003/04)

Variometers

The equipment employed to monitor magnetic variations at MCQ in 2003 included an Elsec 820M3 PPM for measuring the magnetic total intensity and a Narod 3-axis ringcore fluxgate (RCF) magnetometer. The RCF sensors, mounted on a marble '*tombstone'* base, were not aligned with either the standard field elements or cardinal points, but were oriented in such a way that the three mutually orthogonal components recorded were of approximately equal magnitudes. At Macquarie Island the magnetic field vector is approximately 11 degrees off-vertical and each ring-core sensor made an angle of approximately 55 degrees with the magnetic vector. Details of the *'tombstone'* RCF sensor base and the orientation of the sensors were given in the section on *Variometer Alignment* in *AGRs 1993-1996.*

The RCF sensors were located in the Variometer House and the associated electronics were in the ante-room of that building. The Variometer House temperature was controlled with a heating system. The variometer PPM sensor and electronics were situated in the PPM house, which had no temperature control. The data acquisition system and backup power were situated in the office, within the Science building.

Absolute Instruments and Corrections

Magnetic absolute measurements were performed in the Absolute House: on the principal pier AE with an Elsec 810 DIM (serial 214) and a Zeiss020B theodolite (serial 311847) and on pier AW with an Austral PPM (serial 525).

The classical QHMs (serial 177‡, 178, 179 on Askania circle 640616) were available as backup for use on pier AE.

A pier difference of:

$\Delta X = -2.6nT$, $\Delta Y = +5.1nT$, $\Delta Z = +4.2nT$ ($\Delta F = -4.1nT$)

was applied to adjust observations performed on pier Aw to be equivalent to observations on the principal Pier AE. This was adopted from pier difference absolute observations performed in 1991 and 1993 (confirmed by 2003 observations).

Instrument comparisons between the Macquarie Island absolute instruments (E810_214/311847 DIM and Austral 525) and travelling standard instruments (B0806H/100856 DIM and GSM90_003985/11690) were performed at Macquarie Island on 24 and 26 Mar 2003.

The results of the instrument comparisons were:

Travelling Stndrd		MCQ instrument		Inst. difference
GSM90_003985	–	Austral 525 PPM	=	+0.38nT (F)
B0806H/100856	–	E810_214/311847	=	+0.19' (Decl'n)
B0806H/100856	–	E810_214/311847	=	+0.04' (Incl'n)

Comparisons between the travelling standard instruments and the Australian Standard instruments were performed on 03-04 March 2003 at CNB observatory. These comparisons resulted in the adoption of instrument differences of:

0nT, 0.0' and 0.0' in F, D, and I respectively.

Corrections to the MCQ instruments are therefore:

Australian Stndrd		MCQ instrument		Inst. correction
GSM90_905926*	–	Austral 525	=	+0.38nT (F)
E810_200/353756	–	E810_214/311847	=	+0.19' (Decl'n)
E810_200/353756	–	E810_214/311847	=	+0.04' (Incl'n)

* with sensor 21867.

At the mean 2003 field values at MCQ of 10820nT, 6435nT and -63175nT in X, Y and Z respectively, the instrument corrections adopted for the absolute magnetometers used at MCQ during 2003 convert to the baseline corrections:

$\Delta X = +0.34$ nT $\Delta Y = +1.01$ nT $\Delta Z = -0.23$ nT.

These corrections have been applied to all MCQ 2003 final data including in this report.

‡ See *Absolute Magnetometers employed in 2003* on page 5 of this report.

Baselines

The standard deviations in the difference between the weekly absolute observations and the final adopted variometer model and data were:

$\sigma_X = 1.5nT$ $\sigma_Y = 1.6nT$ $\sigma_Z = 0.9nT$.

(In terms of the absolute observed components, they were:

$\sigma_F = 0.9nT$ $\sigma_D = 28''$ $\sigma_I = 5''$.)

The drifts applied to the X, Y, and Z baselines amounted to less than 10nT in any of these components throughout the 2003, with the X component showing the most drift and the Z component the least drift.

There was about 2nT variation in the difference between F measured with the fluxgate (final data model with drifts applied) and the variometer PPM throughout the year.

Operations

The magnetic observers-in-charge at Macquarie Island in 2003 were supported jointly by the Australian Antarctic Division (AAD) in the Department of The Environment and Heritage and GA. They were members of the Australian National Antarctic Research Expedition (ANARE).

The duties of the magnetic observer included maintaining the equipment, performing absolute observations to calibrate the variometers and maintaining the integrity of the observatory and reporting any changes to GA in Canberra.

During 2003, weekly absolute calibrations were performed on the observation piers in the absolute house by the ANARE communications technical officers: Peter Pokorny (from March 2002) until the end 26 March 2003, then Henry Banon from 27 March 2003 (until 26 February 2004).

The RCF variometer produced 8 samples per second that were averaged and output as 1-second data. The PPM variometer produced 10-second samples. The 1-second RCF data and 10-second PPM data as well as 1-minute means of both were recorded on an acquisition PC. All data were automatically transmitted daily, via a network connection routed through the Australian Antarctic Division in Hobart Tasmania, to GA where they were processed and distributed. Timing control at the observatory was provided by the Antarctic Division's GPS clock (which was also used with Atmospheric and Space Physics experiments).

A service visit was made to the observatory over the period 24 to 28 March 2003 by a Geomagnetism Project officer (AML). During the visit the data acquisition computer was replaced, instrument comparisons and tests were performed, pier differences and pier gradients were measured and azimuth mark angles checked.

Distribution of MCQ data during 2003

Preliminary Monthly Means for Project Ørsted

- Sent monthly by email to IPGP

Final 1-minute & Hourly Mean Values

- 2002 data: WDC-A, Boulder, USA (sent 04 June 2003)
- 2002 data: WDC-C1, Copenhagen (sent 04 June 2003
- 2003 data: WDC-A, Boulder, USA (sent 03 Apr. 2004)
- 2003 data: WDC-C1, Copenhagen (sent 03 Apr. 2004)

1-minute Values for Project INTERMAGNET

- Preliminary data daily to the Edinburgh GIN by e-mail.
- Definitive data for INTERMAGNET CD-ROMs sent:
  – 2002 data: to the Paris GIN on 04 Jun. 2003.
  – 2003 data: to the Paris GIN on 03 Apr. 2003.

MCQ, 2003 – Significant Events:

03 Feb OIC (PP) off station for 6 days beginning this day: no observation this week.

24 Feb 0559–0603: One-minute time marks disconnected to check cabling.

24 Mar to 28th: Maintenance visit by Geomagnetism Project officer (AML) from GA.

24 Mar Data acquisition PC replaced (resulting in some data losses see *Data Loss* section, this report).

25 Mar 0520 to 0336 / 26th: One-second data acquisition stalled. (The one-minute data continued unaffected.)

27 Mar The new observer (HB) arrived and took over as Observer-in-Charge (from PP).

01 Jun A large storm hit Macquarie Island causing damage to buildings and the coastline on the isthmus.

MCQ, 2003 – Significant Events (cont.)

03 Jul — No observations were performed this week as the observer (HB) was stuck in Bauer Bay field hut. (A record cold day at Macquarie Is.: −9.3°C with snow and strong wind.)

23 Jul — 0330–0400: Satellite data circuit off.

17 Sep — 2300 to 0000 / 18th: Satellite data circuit off due to satellite frequency changes.

29 Oct — K=9 magnetic storm: Declination swings through 12 degrees in 25 minutes.

08 Dec — No contact with QNX PC (used to get the data from the acquisition PC via the AAD network) or e-mail.

09 Dec — Began sending daily data to INTERMAGNET GIN in Edinburgh in IAGA2002 format.

11 Dec — QNX system working again - caught up with data downloads.

13 Dec — Absolute observations abandoned due to fog.

15 Dec — 2130–2230: Possible magnetic interference during building inspection.

MCQ, 2003 – Data losses:

24 Mar — 2152−2219 (28 min.), 2230 (1 min.), 2235 (1 min.) All channels: The data acquisition PC was replaced with a PC104 DOS PC.

16 Sep — 0153 (1 min.) RCF channels: cause unknown.

11 Nov — 0341-0343 (3 mins) RCF channels: cause unknown.

Macquarie Island Annual Mean Values

The table below gives annual mean values calculated using the monthly mean values over **All** days, the 5 International **Quiet** days and the 5 International **Disturbed** days in each month. Plots of these data with secular variation in H, D, Z & F are on pages 80-81.

Year	Days	D (Deg	Min)	I (Deg	Min)	H (nT)	X (nT)	Y (nT)	Z (nT)	F (nT)	Elts*
1993.5	A	29	57.2	-78	48.1	12558	10880	6270	-63428	64659	ABC
1994.5	A	30	02.2	-78	48.3	12549	10863	6281	-63404	64634	ABC
1995.5	A	30	06.6	-78	47.5	12559	10864	6300	-63376	64608	ABC
1996.5	A	30	11.0	-78	46.4	12574	10870	6322	-63353	64589	ABC
1997.5	A	30	15.4	-78	45.9	12580	10866	6339	-63336	64573	ABC
1998.5	A	30	20.0	-78	45.8	12579	10857	6353	-63320	64557	ABC
1999.5	A	30	23.6	-78	45.2	12586	10856	6367	-63294	64534	ABC
2000.5	A	30	28.4	-78	45.0	12585	10847	6382	-63268	64507	ABC
2001.5	A	30	33.5	-78	44.1	12595	10846	6404	-63231	64473	ABC
2002.5	A	30	39.1	-78	43.5	12600	10840	6424	-63198	64442	ABC
2003.5	A	30	44.6	-78	44.0	12585	10817	6433	-63174	64416	ABC
1951.5		23	50.8	-78	17.6	13383	12241	5411	-64589	65961	HDZ
1952.5		24	04.2	-78	17.8	13371	12208	5453	-64550	65920	HDZ
1953.5		24	14.6	-78	18.2	13360	12182	5486	-64533	65901	HDZ
1954.5		24	28.4	-78	18.4	13356	12156	5533	-64535	65903	HDZ
1955.5		24	42.0	-78	18.6	13350	12129	5579	-64520	65887	HDZ
1956.5		24	53.2	-78	19.3	13333	12095	5611	-64506	65870	HDZ
1957.5		25	05.7	-78	19.8	13319	12062	5649	-64482	65843	HDZ
1958.5		25	16.6	-78	20.1	13307	12033	5682	-64456	65815	HDZ
1959.5		25	26.3	-78	20.9	13288	12000	5708	-64436	65792	HDZ
1960.5		25	32.0	-78	22.0	13262	11967	5716	-64414	65765	HDZ
1961.5		25	50.0	-78	22.5	13240	11917	5769	-64359	65707	HDZ
1962.5		26	05.8	-78	23.3	13216	11869	5814	-64321	65665	HDZ
1963.5		26	08.5	-78	24.2	13193	11843	5813	-64294	65634	HDZ
1964.5		26	17.0	-78	24.7	13174	11812	5834	-64249	65586	HDZ
1965.5		26	28.6	-78	25.5	13152	11773	5864	-64214	65547	HDZ
1966.5		26	37.6	-78	26.7	13121	11729	5881	-64175	65503	HDZ
1967.5		26	46.5	-78	28.5	13084	11681	5894	-64166	65486	HDZ
1968.5		26	54.7	-78	29.7	13053	11639	5908	-64132	65447	HDZ
1969.5		27	02.3	-78	30.8	13026	11602	5921	-64099	65409	HDZ
1970.5		27	09.6	-78	32.1	12996	11563	5932	-64078	65383	HDZ
1971.5		27	13.3	-78	33.3	12963	11527	5930	-64032	65331	HDZ
1972.5		27	22.1	-78	34.4	12937	11489	5947	-64008	65302	HDZ
1973.5		27	27.6	-78	35.8	12905	11451	5951	-63985	65273	HDZ
1974.5		27	34.3	-78	37.6	12865	11404	5955	-63956	65237	HDZ
1975.5		27	43.2	-78	38.2	12847	11373	5976	-63926	65204	HDZ
1976.5		27	51.6	-78	39.1	12822	11336	5992	-63891	65165	HDZ
1977.5		27	59.8	-78	39.9	12802	11304	6010	-63861	65132	HDZ
1978.5		28	11.3	-78	41.1	12773	11258	6034	-63838	65103	HDZ
1979.5		28	19.6	-78	42.3	12745	11219	6047	-63807	65067	HDZ
1980.5		28	28.8	-78	43.0	12723	11183	6067	-63768	65025	HDZ
1981.5		28	37.5	-78	44.5	12687	11136	6078	-63735	64985	HDZ
1982.5		28	49.5	-78	45.4	12666	11097	6107	-63711	64958	HDZ
1983.5		28	54.9	-78	45.7	12652	11075	6117	-63674	64919	HDZ
1984.5		29	03.7	-78	46.1	12640	11049	6140	-63650	64893	HDZ
1985.5		29	12.0	-78	47.4	12608	11006	6151	-63619	64856	XYZ
1986.5		29	19.0	-78	47.5	12600	10986	6169	-63590	64826	XYZ

continued on page 82 …

Monthly & Annual Mean Values

The following table gives final monthly and annual mean values of each of the magnetic elements for the year.

A value is given for means computed from all days in each month (All days), the five least disturbed of the International Quiet days (5xQ days) in each month and the five International Disturbed days (5xD days) in each month.

Macquarie Island	2003	X (nT)	Y (nT)	Z (nT)	F (nT)	H (nT)	D (East)	I
January	All days	10844.2	6430.5	-63174.9	64420.7	12607.5	30° 40.1'	-78° 42.8'
	5xQ days	10858.8	6438.8	-63174.7	64423.7	12624.3	30° 40.0'	-78° 42.0'
	5xD days	10823.8	6422.5	-63181.6	64423.2	12585.9	30° 41.1'	-78° 44.1'
February	All days	10819.4	6425.0	-63178.0	64419.1	12583.3	30° 42.3'	-78° 44.1'
	5xQ days	10846.3	6436.9	-63176.5	64423.2	12612.6	30° 41.3'	-78° 42.6'
	5xD days	10787.0	6409.7	-63204.3	64438.1	12547.8	30° 43.2'	-78° 46.3'
March	All days	10802.1	6421.5	-63180.2	64418.0	12566.7	30° 43.9'	-78° 45.0'
	5xQ days	10836.3	6438.6	-63169.8	64415.1	12604.8	30° 43.1'	-78° 42.9'
	5xD days	10769.3	6401.5	-63184.6	64415.0	12528.4	30° 43.8'	-78° 47.1'
April	All days	10808.6	6431.3	-63176.4	64416.3	12577.3	30° 45.2'	-78° 44.4'
	5xQ days	10826.4	6435.7	-63175.6	64418.8	12594.8	30° 43.8'	-78° 43.5'
	5xD days	10777.7	6416.9	-63175.7	64409.1	12543.4	30° 46.2'	-78° 46.2'
May	All days	10811.8	6431.4	-63177.9	64418.4	12580.1	30° 44.8'	-78° 44.3'
	5xQ days	10835.7	6439.9	-63182.4	64427.5	12605.0	30° 43.4'	-78° 43.1'
	5xD days	10771.7	6418.0	-63183.2	64415.7	12538.9	30° 47.5'	-78° 46.5'
June	All days	10831.6	6441.3	-63176.0	64420.7	12602.2	30° 44.4'	-78° 43.1'
	5xQ days	10834.0	6443.4	-63176.6	64421.9	12605.3	30° 44.5'	-78° 43.0'
	5xD days	10797.0	6433.0	-63165.8	64404.2	12568.3	30° 47.3'	-78° 44.8'
July	All days	10828.3	6440.6	-63177.0	64421.1	12598.9	30° 44.7'	-78° 43.3'
	5xQ days	10841.0	6445.7	-63178.5	64425.1	12612.4	30° 44.1'	-78° 42.6'
	5xD days	10800.8	6431.6	-63169.7	64408.6	12570.8	30° 46.4'	-78° 44.7'
August	All days	10818.7	6439.0	-63171.5	64414.0	12589.9	30° 45.6'	-78° 43.7'
	5xQ days	10839.7	6445.9	-63170.2	64416.8	12611.5	30° 44.3'	-78° 42.6'
	5xD days	10744.2	6415.1	-63177.0	64404.9	12514.0	30° 50.6'	-78° 47.8'
September	All days	10814.7	6438.5	-63166.1	64408.0	12586.3	30° 46.1'	-78° 43.9'
	5xQ days	10838.6	6447.6	-63163.0	64409.8	12611.4	30° 44.9'	-78° 42.5'
	5xD days	10768.8	6418.4	-63179.2	64411.4	12536.6	30° 47.9'	-78° 46.6'
October	All days	10800.5	6429.8	-63179.8	64418.3	12569.8	30° 46.1'	-78° 44.9'
	5xQ days	10840.7	6450.5	-63160.8	64408.2	12614.7	30° 45.2'	-78° 42.3'
	5xD days	10697.8	6380.5	-63242.4	64458.6	12457.6	30° 49.1'	-78° 51.4'
November	All days	10800.4	6427.9	-63175.4	64413.8	12568.6	30° 45.6'	-78° 44.9'
	5xQ days	10841.9	6446.6	-63165.2	64412.3	12613.7	30° 44.1'	-78° 42.4'
	5xD days	10707.1	6380.1	-63201.1	64419.4	12464.3	30° 47.4'	-78° 50.6'
December	All days	10822.3	6442.3	-63156.2	64400.0	12594.7	30° 45.9'	-78° 43.3'
	5xQ days	10846.6	6455.5	-63151.8	64400.8	12622.3	30° 45.6'	-78° 41.8'
	5xD days	10785.1	6428.9	-63168.3	64404.4	12556.0	30° 48.0'	-78° 45.5'
Annual	All days	10816.9	6433.2	-63174.1	64415.7	12585.5	30° 44.5'	-78° 44.0'
Mean	5xQ days	10840.5	6443.8	-63170.4	64416.9	12611.1	30° 43.7'	-78° 42.6'
Values	5xD days	10769.2	6413.0	-63186.1	64417.7	12534.3	30° 46.6'	-78° 46.8'

(Calculated: 15:24 hrs., Thu., 12 Feb. 2004)

Hourly Mean Values

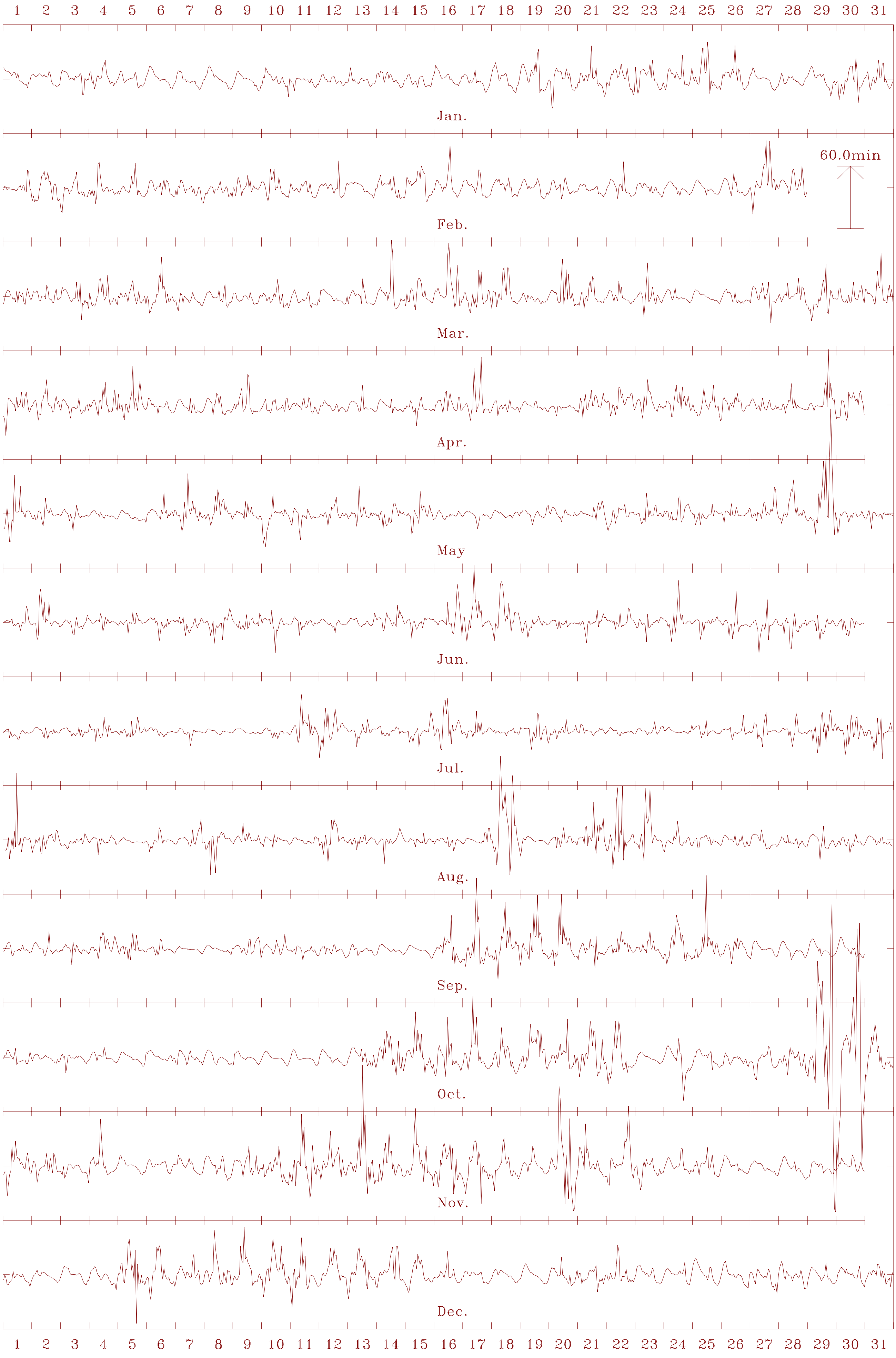
The charts on the following pages are plots of hourly mean values.

The reference levels indicated with marks on the vertical axes refer to the *all-days* mean value for the respective months. All elements in the plots are shown increasing (algebraically) towards the top of the page, with the exception of Z, which is in the opposite sense.

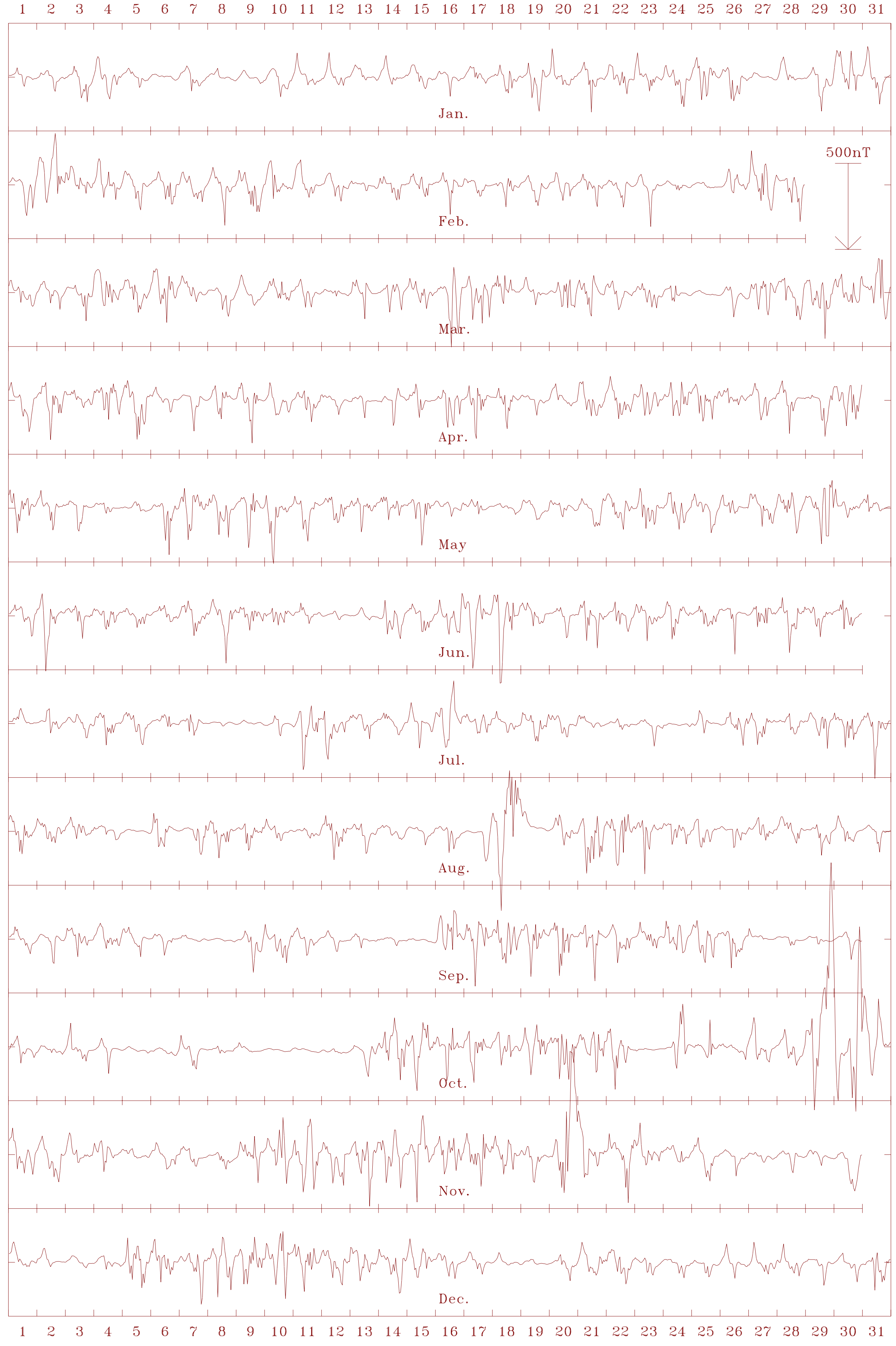
The mean value given at the top of each plot is the *all-days* annual mean value of the element.

Macquarie Is. 2003 Horizontal intensity (H). Scale: 50.0 nT/mm. Mean: 12586 nT

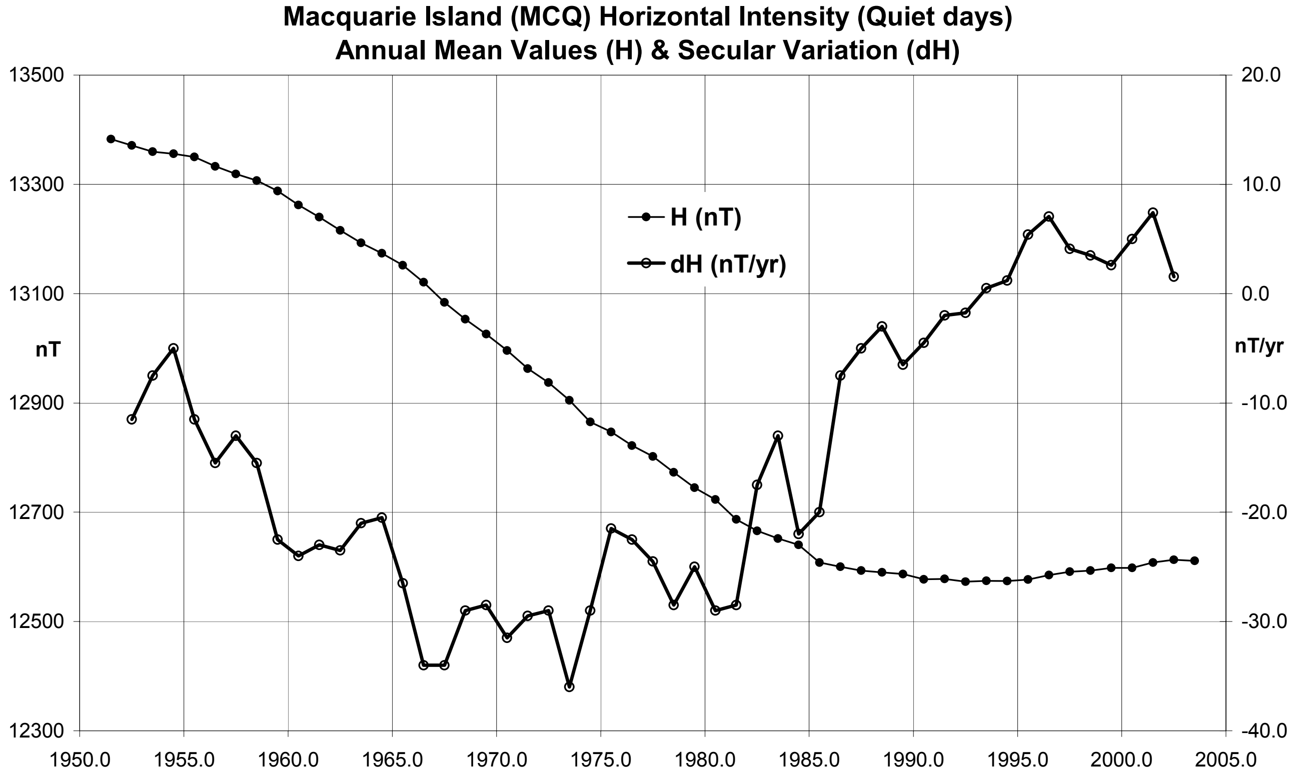
Macquarie Is. 2003 Declination (east) (D). Scale: 5.00 min/mm. Mean: 30.74 deg.



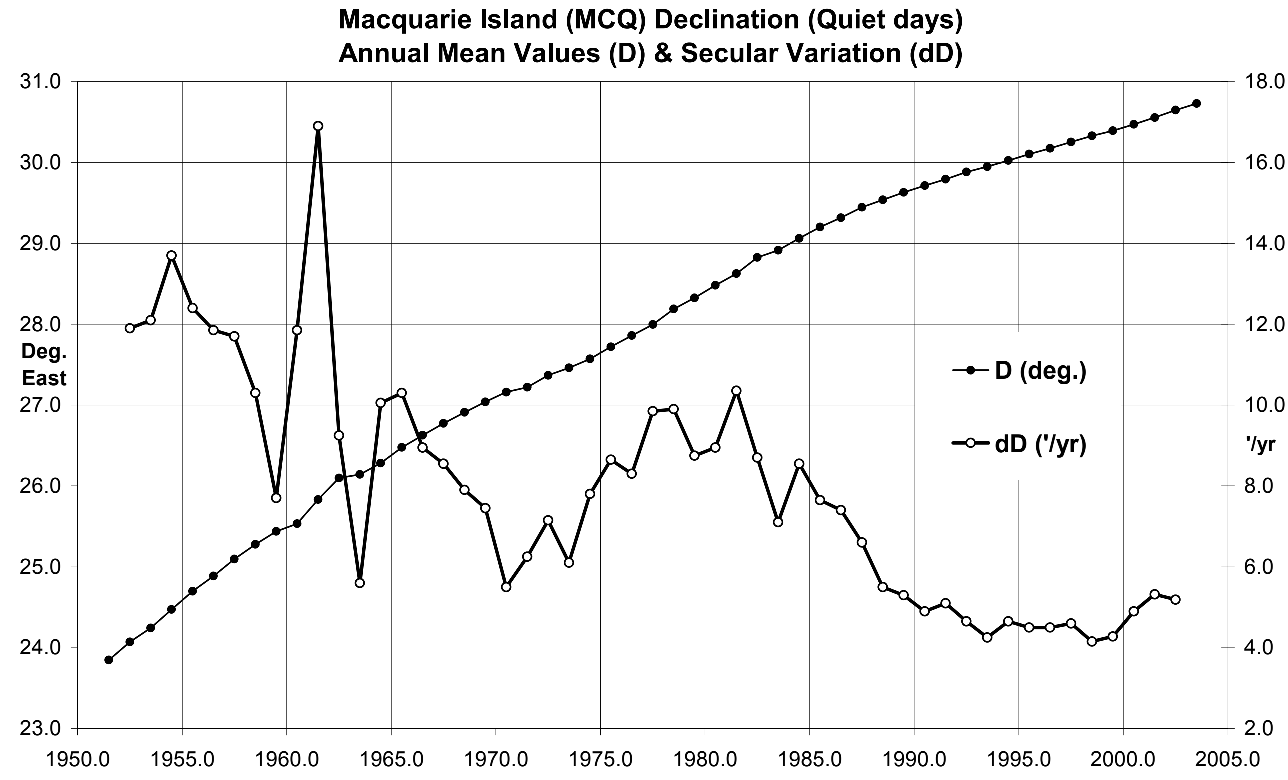
Macquarie Is. 2003 Vertical intensity (Z). Scale: 30.0 nT/mm. Mean: −63174 nT



Macquarie Is. 2003 Total intensity (F). Scale: 30.0 nT/mm. Mean: 64416 nT

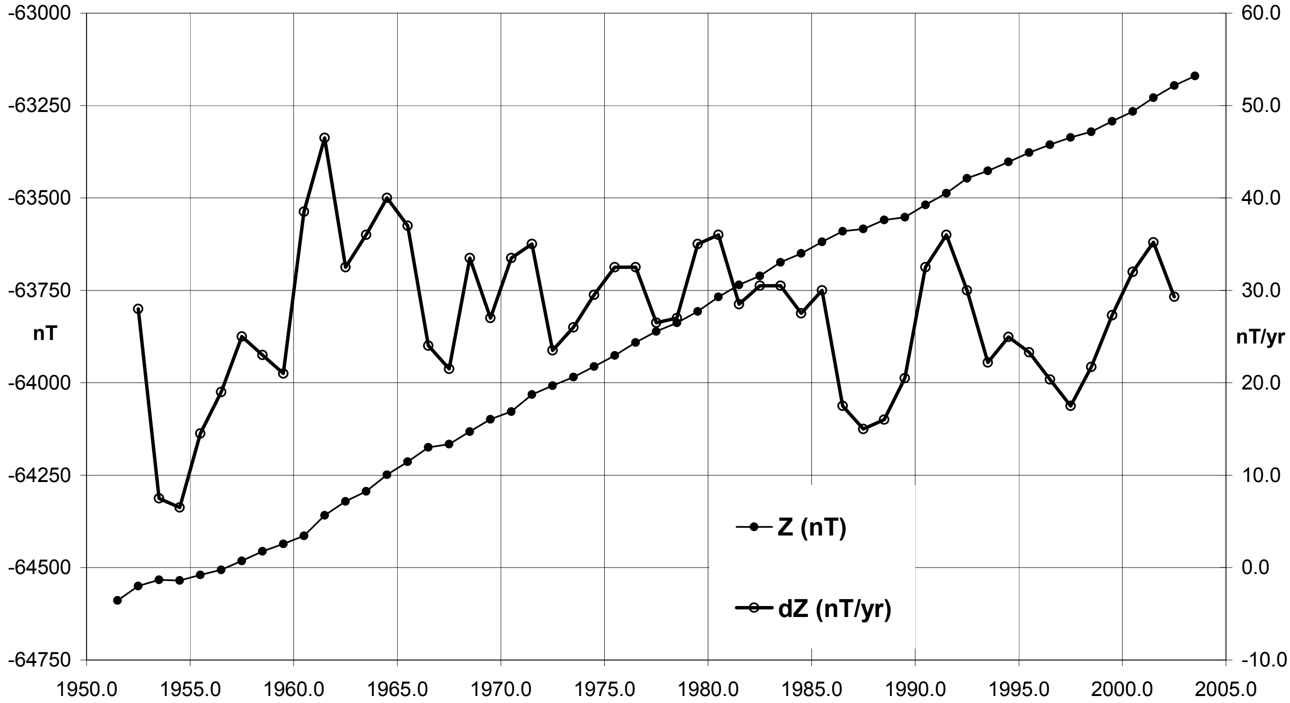


Macquarie Island (MCQ) Horizontal Intensity (Quiet days)
Annual Mean Values (H) & Secular Variation (dH)
H (nT)
dH (nT/yr)
nT
nT/yr
13500
13300
13100
12900
12700
12500
12300
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
1950.0
1955.0
1960.0
1965.0
1970.0
1975.0
1980.0
1985.0
1990.0
1995.0
2000.0
2005.0

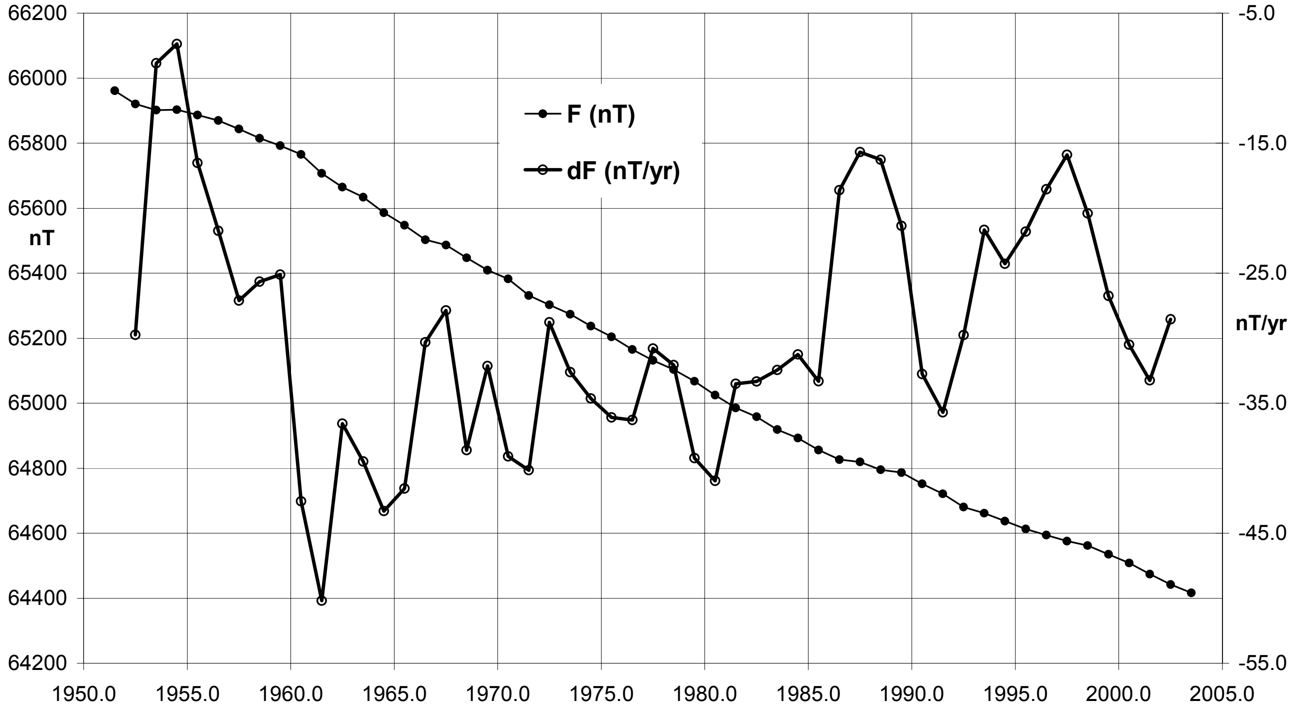


Macquarie Island (MCQ) Declination (Quiet days)
Annual Mean Values (D) & Secular Variation (dD)
D (deg.)
dD ('/yr)
Deg.
East
'/yr
31.0
30.0
29.0
28.0
27.0
26.0
25.0
24.0
23.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
1950.0
1955.0
1960.0
1965.0
1970.0
1975.0
1980.0
1985.0
1990.0
1995.0
2000.0
2005.0

Macquarie Island (MCQ) Vertical Intensity (Quiet days) Annual Mean Values (Z) & Secular Variation (dZ)



Macquarie Island (MCQ) Total Intensity (Quiet days) Annual Mean Values (F) & Secular Variation (dF)



MCQ – Annual Mean Values (cont.)

Year	Days	D (Deg	Min)	I (Deg	Min)	H (nT)	X (nT)	Y (nT)	Z (nT)	F (nT)	Elts*
1987.5		29	26.8	-78	47.8	12593	10966	6191	-63584	64819	XYZ
1988.5		29	32.2	-78	47.8	12590	10954	6207	-63560	64795	XYZ
1989.5		29	37.8	-78	47.8	12587	10941	6223	-63552	64786	XYZ
1990.5		29	42.8	-78	48.0	12577	10923	6234	-63519	64752	XYZ
1991.5		29	47.6	-78	47.6	12578	10915	6250	-63487	64721	XYZ
1992.5		29	53.0	-78	47.5	12573	10901	6264	-63447	64681	XYZ
1993.5	Q	29	56.9	-78	47.2	12575	10896	6277	-63427	64661	ABC
1994.5	Q	30	01.5	-78	47.0	12574	10887	6292	-63403	64637	ABC
1995.5	Q	30	06.2	-78	46.5	12577	10881	6308	-63377	64613	ABC
1996.5	Q	30	10.5	-78	45.9	12585	10879	6326	-63356	64594	ABC
1997.5	Q	30	15.2	-78	45.4	12591	10876	6344	-63336	64576	ABC
1998.5	Q	30	19.7	-78	45.1	12593	10870	6359	-63321	64562	ABC
1999.5	Q	30	23.5	-78	44.6	12598	10867	6373	-63293	64535	ABC
2000.5	Q	30	28.3	-78	44.3	12598	10858	6389	-63266	64509	ABC
2001.5	Q	30	33.3	-78	43.4	12608	10857	6409	-63229	64474	ABC
2002.5	Q	30	38.9	-78	42.8	12613	10851	6429	-63196	64442	ABC
2003.5	Q	30	43.7	-78	42.6	12611	10841	6444	-63170	64417	ABC
1993.5	D	29	58.5	-78	50.0	12521	10846	6256	-63429	64654	ABC
1994.5	D	30	03.3	-78	50.2	12514	10831	6267	-63408	64632	ABC
1995.5	D	30	07.8	-78	49.4	12522	10830	6285	-63376	64601	ABC
1996.5	D	30	11.9	-78	47.4	12556	10852	6316	-63350	64583	ABC
1997.5	D	30	16.0	-78	47.3	12555	10843	6328	-63334	64566	ABC
1998.5	D	30	21.0	-78	47.7	12543	10824	6338	-63320	64550	ABC
1999.5	D	30	24.3	-78	46.4	12564	10836	6358	-63297	64532	ABC
2000.5	D	30	29.0	-78	46.7	12554	10819	6368	-63273	64507	ABC
2001.5	D	30	34.6	-78	46.0	12560	10813	6389	-63238	64473	ABC
2002.5	D	30	40.0	-78	44.8	12574	10816	6413	-63198	64437	ABC
2003.5	D	30	46.6	-78	46.8	12534	10769	6413	-63186	64418	ABC

* Elements ABC indicates non-aligned variometer orientation

CASEY OBSERVATORY

Casey is the Australian Antarctic station nearest to Australia, situated 3880km south of Perth. The magnetic absolute hut is about 120 metres south of the tank house, the structure of the modern Casey station nearest to it. The old Casey station, in use until the late 1980s, lies about 1km to the north-east of the present Casey.

The crystalline rocks of Casey have unusually high concentrations of magnetic minerals producing high magnetic gradients in and around the magnetic absolute hut.

Regular magnetic observations have been made at Casey since 1975. A variation station operated from 1988 and from 1991 to 1998 it operated as a magnetic observatory although not to a high standard. Observatory standard absolute control was achieved in 1999. A more detailed history of the Casey (and Wilkes) observatory was given in the *AGR*s 1999-2002.

Key data for the principal observation pier of the Casey Station are:

- 3-character IAGA code: CSY
- Geographic latitude: 66° 17' S
- Geographic longitude: 110° 32' E
- Geomagnetic† : Lat. -76.37°; Long. 183.81°

  † Based on the IGRF 2000.0 model updated to 2003.5
- Elevation above mean sea level (top of observation pier) 40 metres
- Azimuth of reference pillar (G11) from observation pier 307° 41' 02"
- Observer in Charge: Brent Harper (AAD)

Variometers

An Antarctic Division EDA FM105B fluxgate variometer, with the data acquired by PC, operated at Casey throughout 2003. The fluxgate sensors were housed on the hill about 300m west of the Casey Science building. Their sensors were aligned close to true north, true east and vertical. The temperatures were maintained at 20°C. Further description is in Crosthwaite (1999).

Absolute Instruments and Corrections

Magnetometers used to calibrate the recording variometers at Casey were Elsec 810 DIM no. 2591 with Zeiss020B theodolite no. 356514 owned by the Antarctic Division, and Geometrics 816 no. 1024 PPM, owned by GA. A QHM and QHM circles were available as a backup in the event that one of the primary instruments became unserviceable.

For standardization with the Australian Magnetic Standard held at Canberra, a correction of +1.2nT has been applied to the absolute PPM readings. Corrections of zero were applied to the DIM readings. These resulted in baseline corrections of:

$\Delta X = -0.01$ nT $\Delta Y = -0.18$ nT $\Delta Z = -1.19$ nT.

Because of the extreme magnetic gradients at Casey, it has been necessary to apply a correction to magnetic data from the station acquired since early 1993. QHMs were used at Casey until 1993, and DIMs since that time. The 70mm difference in sensor heights of the two instruments required the following corrections to DIM/PPM readings to produce equivalent QHM/PPM readings (PPM height similarly adjusted):

$\Delta D = +15.1'$ $\Delta I = +0.2'$ $\Delta F = +45$ nT

($\Delta X = +42$ nT $\Delta Y = -11.5$ nT $\Delta Z = -44$ nT)

It desirable that a new absolute observation hut and pier is located on a more suitable site. A site with gradients of about 10nT per metre was chosen during a maintenance visit by a GA officer in the 1998/99 summer (Crosthwaite 1999).

Casey Annual Mean Values

The table below gives annual mean values for Casey station. Until 1990 these were calculated using the monthly average values of regular absolute observations, denoted by AB. From 1991 they were gained using data from the AAD's fluxgate variometer that was calibrated through regular absolute observations. Until 1997 the means were calculated over the five quietest days at Mawson station, denoted QM. From 1998 monthly means were calculated over **All** days, the 5 International **Quiet** days and the 5 International **Disturbed** days in each month, denoted A, Q and D respectively.

Plots of these data with secular variation in H, D, Z & F are on the pages 89-90.

Year	Days	D (Deg	Min)	I (Deg	Min)	H (nT)	X (nT)	Y (nT)	Z (nT)	F (nT)	Elts
1977.96	AB	-88	29.6	-81	38.7	9495	250	-9492	-64650	65344	DHZ
1978.5	AB	-89	4.3	-81	36.2	9518	154	-9516	-64488	65187	DHZ
1979.5	AB	-89	21.6	-81	35.7	9525	106	-9524	-64469	65169	DHZ
1980.5	AB	-89	31.5	-81	33.9	9568	79	-9568	-64528	65233	DHZ
1981.5	AB	-88	2.1	-81	32.0	9540	327	-9534	-64083	64789	DHZ
1982.5	AB	-90	10.0	-81	28.4	9650	-28	-9650	-64400	65120	DHZ
1983.5	AB	-90	32.0	-81	31.5	9585	-89	-9585	-64326	65037	DHZ
1984.5	AB	-90	50.0			9640	-140	-9639			DHZ
1985.5	AB	-90	50.0	-81	25.9	9650	-140	-9649	-64067	64790	DHZ
1986.5	AB	-90	52.9	-81	27.2	9634	-148	-9633	-64101	64821	DHZ
1987.5	AB	-91	18.6	-81	29.1	9596	-219	-9593	-64097	64811	DHZ
1988.5	AB	-91	28.4	-81	27.2	9630	-248	-9627	-64086	64805	DHZ
1989.5	AB	-90	45.5	-81	23.5	9672	-128	-9671	-63887	64615	DHZ
1990.5	AB	-91	55.0	-81	27.4	9601	-321	-9596	-63920	64637	DHZ
1991.5	QM	-92	1.2	-81	25.0	9642	-340	-9636	-63881	64605	XYZ
1992.5	QM	-92	10.0	-81	25.0	9637	-364	-9630	-63848	64571	XYZ
1993.5	QM	-92	7.3	-81	25.0	9638	-357	-9631	-63852	64576	XYZ
1994.5	QM	-92	17.1	-81	25.3	9629	-384	-9621	-63824	64547	XYZ
1995.5	QM	-92	27.5	-81	25.6	9620	-413	-9611	-63807	64528	XYZ
1996.5	QM	-92	35.4	-81	25.3	9625	-435	-9615	-63804	64526	XYZ
1997.5	QM	-92	42.1	-81	25.2	9623	-454	-9612	-63774	64496	XYZ
1998.5	Q	-92	55.4	-81	25.7	9614	-490	-9601	-63777	64497	XYZ
1999.5	Q	-93	4.9	-81	26.5	9595	-516	-9581	-63762	64480	XYZ
2000.5	Q	-93	12.9	-81	27.0	9584	-537	-9568	-63749	64465	XYZ
2001.5	Q	-93	21.6	-81	27.9	9564	-561	-9548	-63729	64443	XYZ
2002.5	Q	-93	26.1	-81	28.3	9553	-572	-9536	-63708	64421	XYZ
2003.5	Q	-93	37.5	-81	29.4	9534	-603	-9514	-63713	64422	XYZ
1998.5	A	-92	55.4	-81	25.7	9615	-490	-9602	-63785	64505	XYZ
1999.5	A	-93	4.8	-81	26.4	9599	-516	-9585	-63772	64490	XYZ
2000.5	A	-93	13.2	-81	27.0	9587	-538	-9571	-63759	64476	XYZ
2001.5	A	-93	21.6	-81	27.9	9566	-561	-9549	-63733	64447	XYZ
2002.5	A	-93	29.4	-81	28.4	9553	-582	-9535	-63719	64432	XYZ
2003.5	A	-93	39.5	-81	29.5	9535	-608	-9515	-63730	64440	XYZ
1998.5	D	-92	58.2	-81	25.8	9615	-498	-9601	-63805	64526	XYZ
1999.5	D	-93	10.7	-81	26.6	9599	-532	-9583	-63796	64514	XYZ
2000.5	D	-93	13.6	-81	27.0	9588	-539	-9572	-63771	64487	XYZ
2001.5	D	-93	19.4	-81	27.8	9570	-555	-9553	-63746	64460	XYZ
2002.5	D	-93	37.4	-81	28.8	9549	-603	-9529	-63747	64458	XYZ
2003.5	D	-93	47.4	-81	30.2	9525	-629	-9503	-63764	64472	XYZ

Casey Operations

The magnetic observer-in-charge at Casey in 2003 was an officer of the Australian Antarctic Division, of the Department of The Environment and Heritage. He was a member of the Australian National Antarctic Research Expedition (ANARE). GA partially funded the position to enable the operation of the magnetic observatory to continue.

The magnetic observer performed approximately weekly absolute observations on the observation piers in the Absolute House to calibrate the variometers.

The EDA variometer produced 1-second samples that were recorded on an AAD computer via their Analogue Data Acquisition System (ADAS). These were sent daily by ftp to GA where they were converted into GA 1-second format from which calibrated minute, monthly and annual means were computed.

There was no PPM variometer operating at Casey in 2003.

Throughout 2003, AAD's ADAS acquisition system performed system tests daily at UT 0001, 1200−1201 and 1630−1631 which contaminated the variometer data. The data at these times have been removed from GA's data set used in final processing.

The variometer seemed to exhibit a high drift rate around late March and again in late September but then in the opposite sense. A possible cause might be that the Science building at Casey is heated during summer and is kept at about 10°C during winter: the heating was reduced in late March and increased in September. Investigations are continuing to understand the phenomenon.

Monthly & Annual Mean Values

The following table gives final monthly and annual mean values of each of the magnetic elements for the year.

A value is given for means computed from all days in each month (All days), the five least disturbed of the International Quiet days (5xQ days) in each month and the five International Disturbed days (5xD days) in each month.

Casey Station	2003	X (nT)	Y (nT)	Z (nT)	F (nT)	H (nT)	D (East)	I
January	All days	-562.5	-9530.9	-63689.2	64401.0	9548.4	-93° 22.8'	-81° 28.4'
	5xQ days	-530.7	-9540.9	-63661.9	64375.1	9555.9	-93° 11.1'	-81° 27.8'
	5xD days	-620.9	-9515.0	-63737.9	64447.5	9536.2	-93° 44.0'	-81° 29.4'
February	All days	-588.5	-9525.6	-63700.3	64411.5	9544.4	-93° 32.2'	-81° 28.7'
	5xQ days	-626.8	-9509.7	-63708.6	64417.6	9530.8	-93° 46.3'	-81° 29.5'
	5xD days	-564.5	-9531.2	-63692.0	64403.9	9548.6	-93° 23.5'	-81° 28.4'
March	All days	-593.7	-9520.9	-63719.9	64430.2	9539.7	-93° 34.2'	-81° 29.1'
	5xQ days	-609.3	-9518.4	-63725.9	64435.8	9538.1	-93° 39.8'	-81° 29.3'
	5xD days	-587.3	-9522.6	-63721.9	64432.3	9541.0	-93° 31.9'	-81° 29.1'
April	All days	-609.5	-9514.8	-63740.5	64449.7	9534.5	-93° 40.0'	-81° 29.6'
	5xQ days	-612.7	-9510.0	-63731.8	64440.4	9529.9	-93° 41.2'	-81° 29.7'
	5xD days	-611.4	-9522.2	-63755.8	64465.9	9542.1	-93° 40.5'	-81° 29.3'
May	All days	-636.9	-9513.9	-63767.8	64476.8	9535.4	-93° 49.8'	-81° 29.7'
	5xQ days	-625.6	-9515.2	-63741.6	64451.0	9535.8	-93° 45.7'	-81° 29.5'
	5xD days	-633.0	-9488.6	-63795.9	64501.0	9510.1	-93° 49.1'	-81° 31.3'
June	All days	-636.5	-9513.2	-63763.4	64472.3	9534.7	-93° 49.7'	-81° 29.7'
	5xQ days	-623.0	-9514.9	-63748.8	64458.0	9535.3	-93° 44.8'	-81° 29.6'
	5xD days	-646.8	-9504.5	-63765.8	64473.6	9526.8	-93° 53.6'	-81° 30.2'
July	All days	-630.8	-9507.8	-63743.8	64452.1	9528.9	-93° 47.8'	-81° 29.9'
	5xQ days	-617.7	-9513.9	-63721.4	64430.7	9533.9	-93° 42.9'	-81° 29.4'
	5xD days	-659.9	-9504.6	-63764.8	64472.8	9527.9	-93° 58.4'	-81° 30.1'
August	All days	-628.5	-9507.9	-63745.1	64453.4	9528.9	-93° 46.9'	-81° 29.9'
	5xQ days	-623.1	-9506.3	-63731.0	64439.2	9526.8	-93° 45.0'	-81° 29.9'
	5xD days	-653.9	-9499.3	-63793.7	64500.6	9522.2	-93° 56.3'	-81° 30.6'
September	All days	-629.1	-9510.9	-63740.4	64449.2	9531.9	-93° 47.1'	-81° 29.7'
	5xQ days	-619.2	-9506.3	-63714.1	64422.4	9526.5	-93° 43.6'	-81° 29.8'
	5xD days	-650.1	-9508.2	-63789.4	64497.6	9530.9	-93° 54.7'	-81° 30.1'
October	All days	-603.6	-9504.9	-63729.0	64437.1	9525.4	-93° 38.1'	-81° 29.9'
	5xQ days	-598.5	-9506.0	-63699.6	64407.8	9525.0	-93° 36.2'	-81° 29.7'
	5xD days	-633.8	-9466.2	-63802.4	64505.4	9493.0	-93° 50.4'	-81° 32.2'
November	All days	-586.3	-9512.7	-63720.7	64429.8	9531.8	-93° 31.7'	-81° 29.5'
	5xQ days	-558.0	-9514.5	-63687.4	64396.7	9531.4	-93° 21.5'	-81° 29.3'
	5xD days	-626.3	-9477.0	-63778.9	64482.7	9499.7	-93° 47.0'	-81° 31.7'
December	All days	-593.2	-9514.3	-63701.5	64411.0	9533.7	-93° 34.1'	-81° 29.3'
	5xQ days	-586.2	-9514.9	-63677.6	64387.4	9533.4	-93° 31.6'	-81° 29.1'
	5xD days	-661.3	-9496.8	-63773.4	64480.5	9521.6	-93° 58.9'	-81° 30.5'
Annual	All days	-608.3	-9514.8	-63730.1	64439.5	9534.8	-93° 39.5'	-81° 29.5'
Mean	5xQ days	-602.6	-9514.3	-63712.5	64421.8	9533.6	-93° 37.5'	-81° 29.4'
Values	5xD days	-629.1	-9503.0	-63764.3	64472.0	9525.0	-93° 47.4'	-81° 30.2'

(Calculated: 16:50 hrs., Wed., 16 Feb. 2005)

Hourly Mean Values

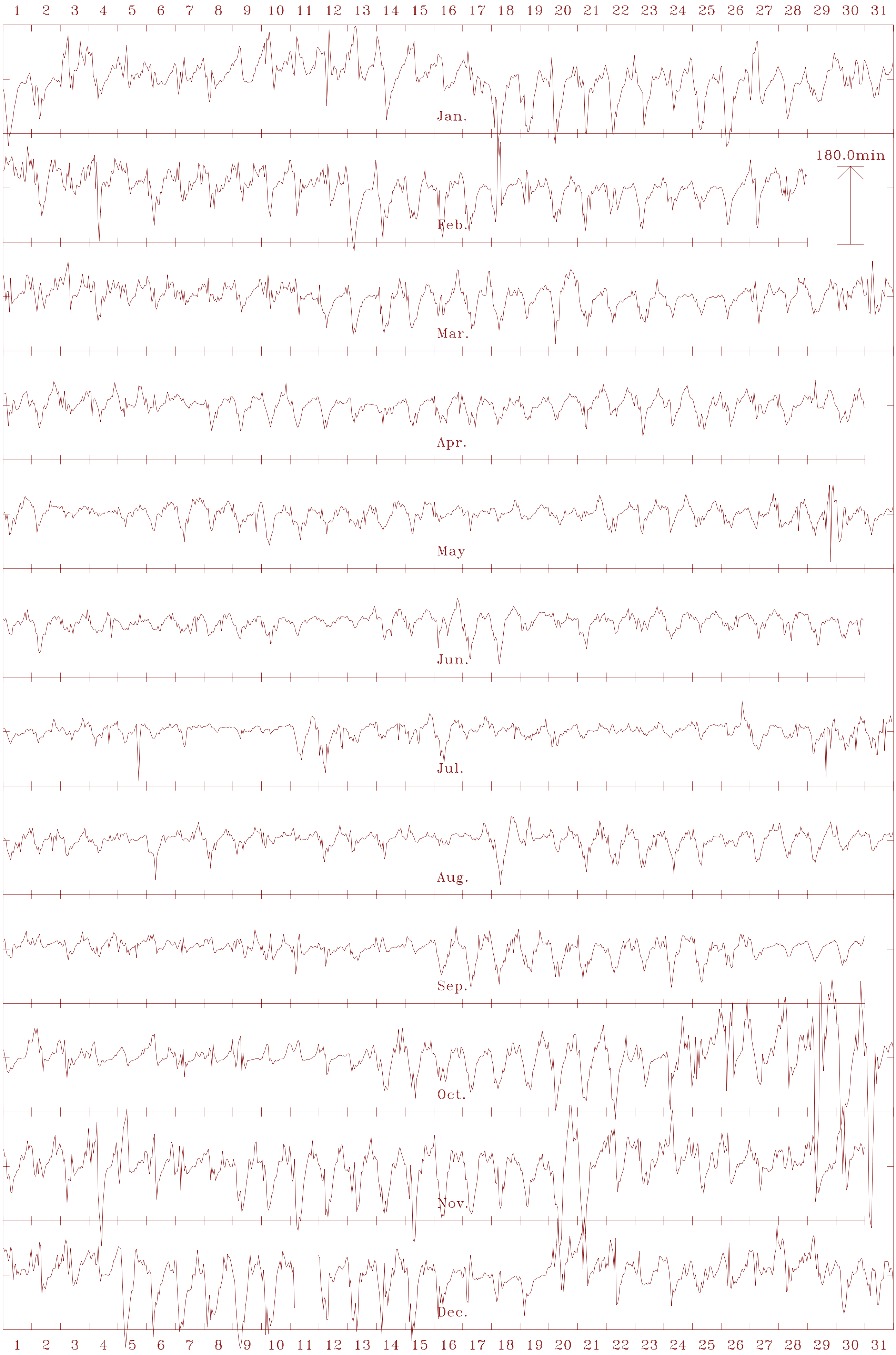
The charts on the following pages are plots of hourly mean values.

The reference levels indicated with marks on the vertical axes refer to the *all-days* mean value for the respective months. All elements in the plots are shown increasing (algebraically) towards the top of the page, with the exception of Z, which is in the opposite sense.

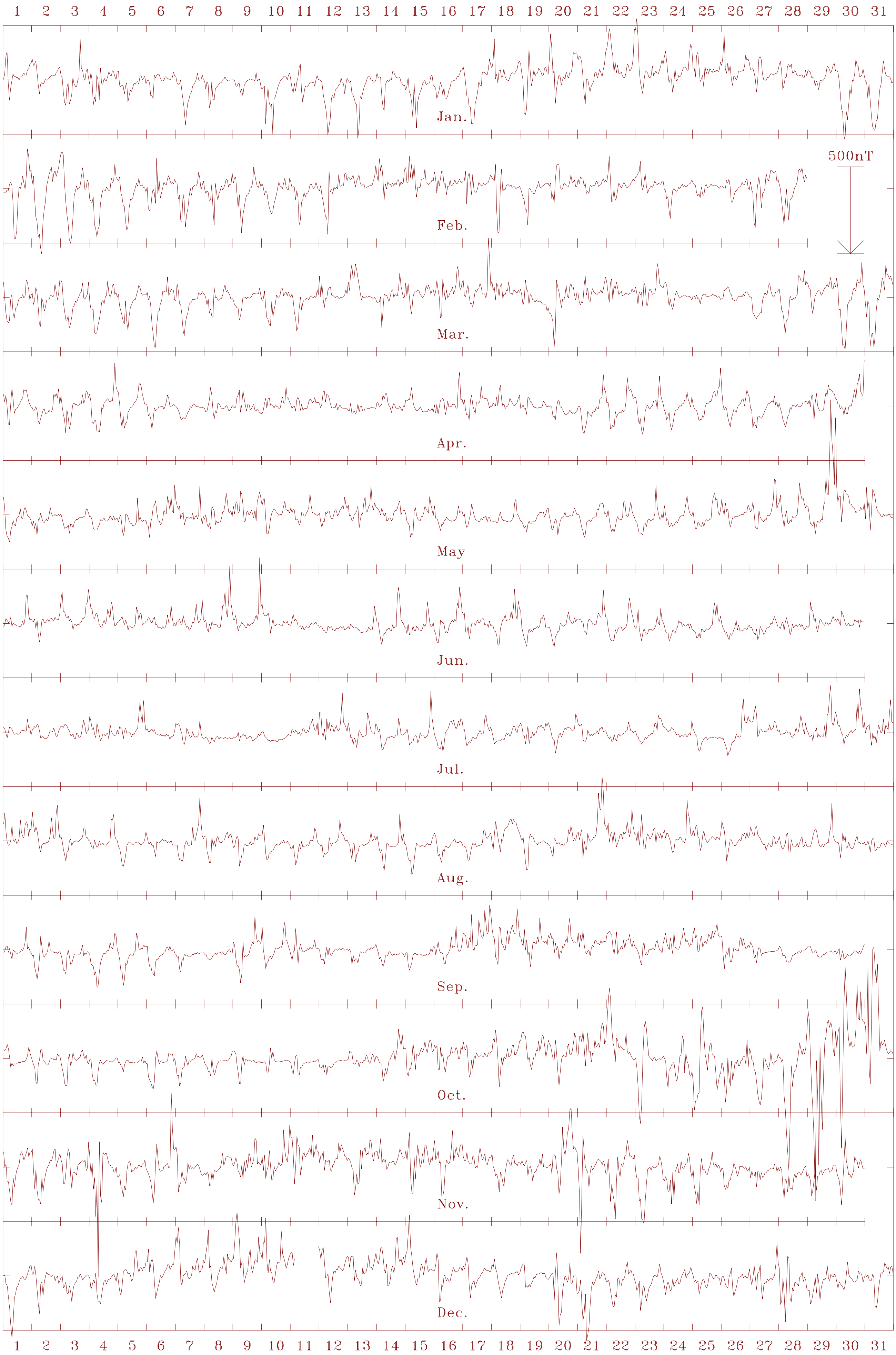
The mean value given at the top of each plot is the *all-days* annual mean value of the element.

Casey Stn. 2003 Horizontal intensity (H). Scale: 30.0 nT/mm. Mean: 9535 nT

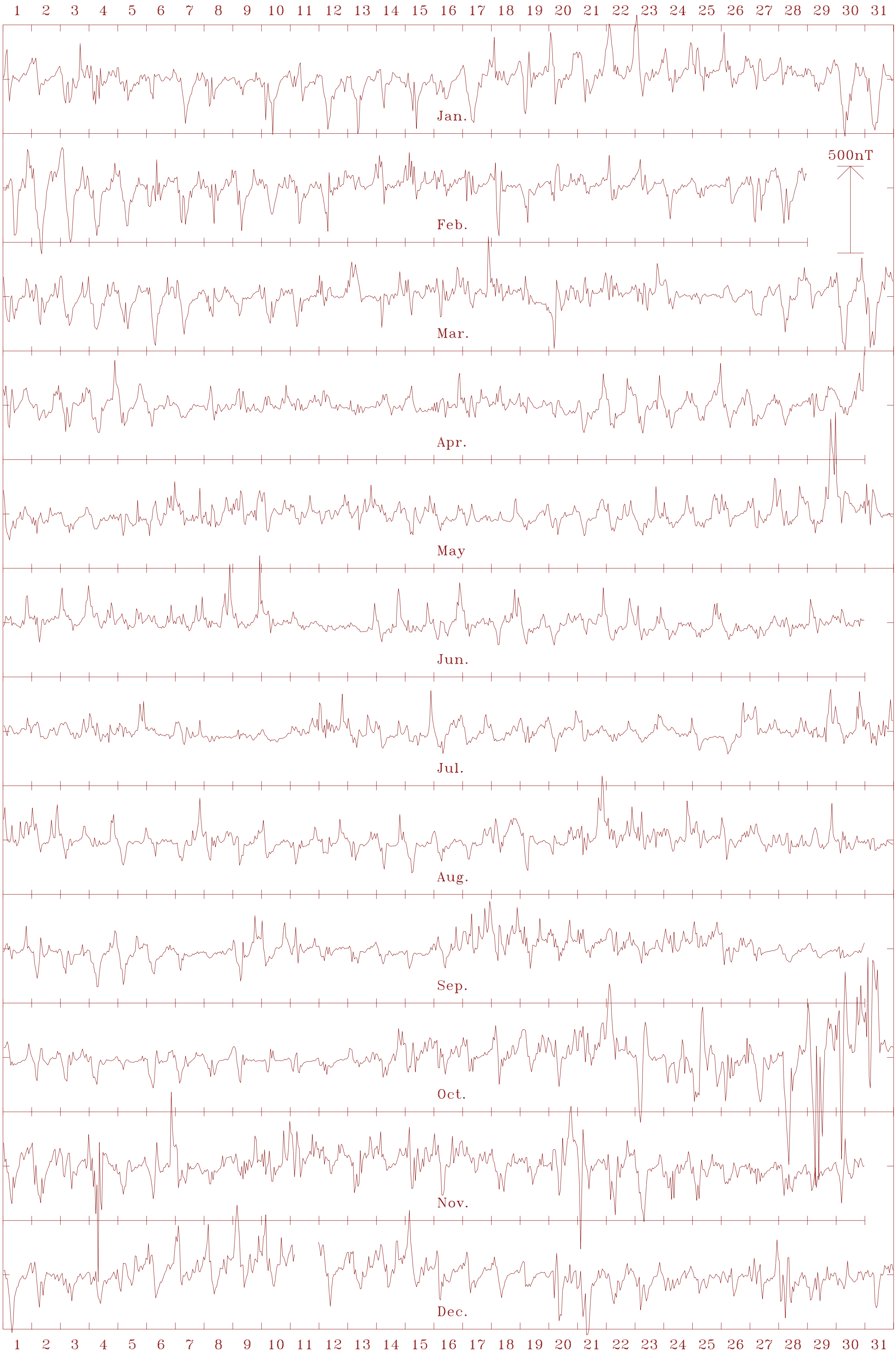
Casey Stn. 2003 Declination (east) (D). Scale: 12.0 min/mm. Mean: −93.66 deg.



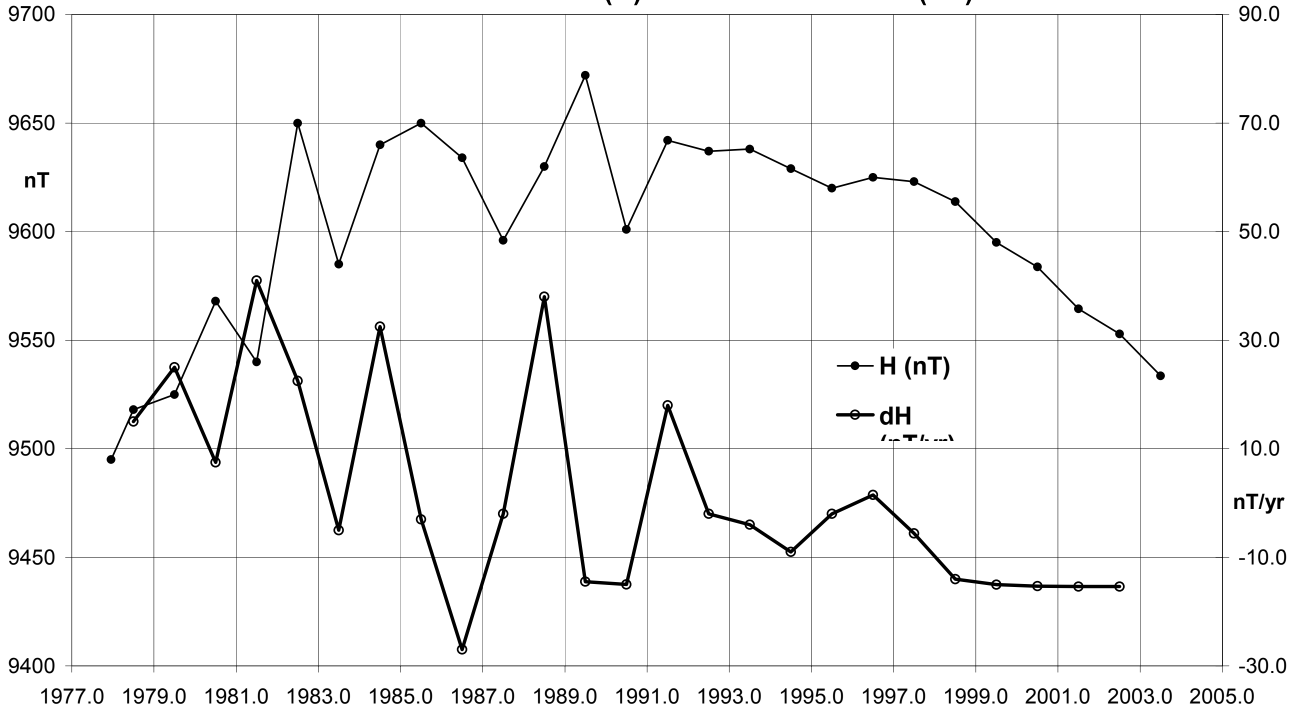
Casey Stn. 2003 Vertical intensity (Z). Scale: 30.0 nT/mm. Mean: −63730 nT



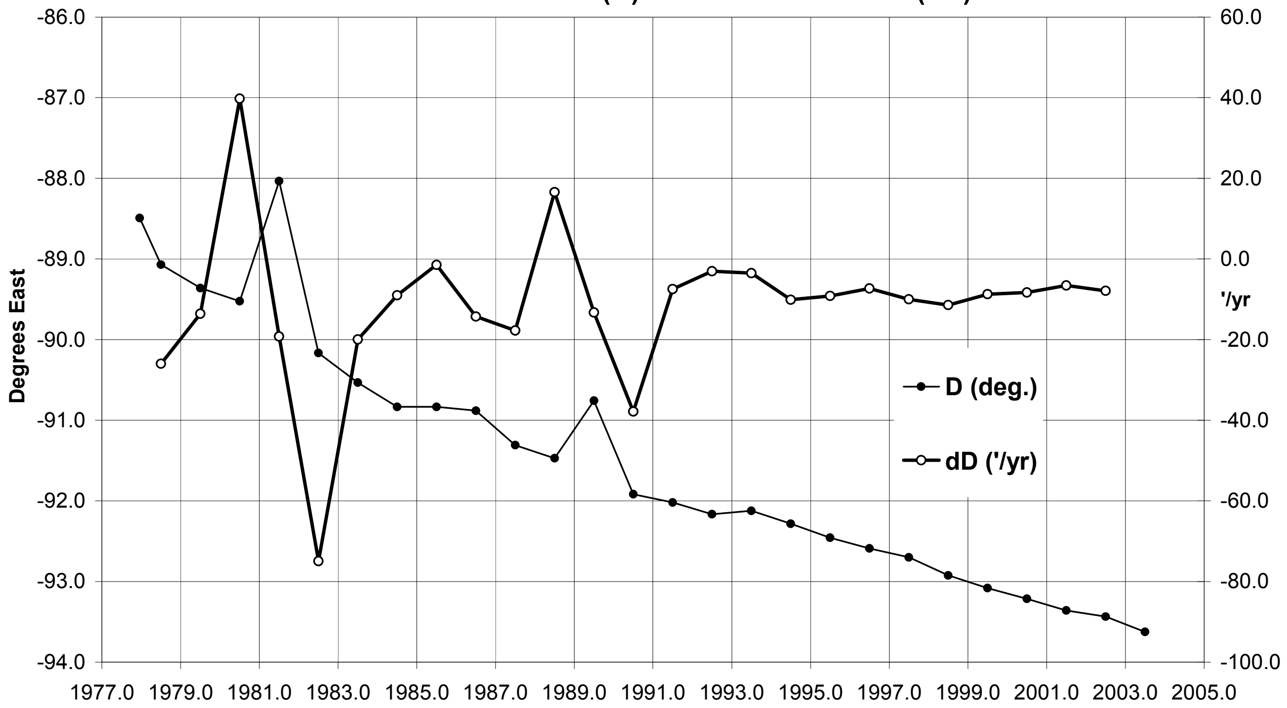
Casey Stn. 2003 Total intensity (F). Scale: 30.0 nT/mm. Mean: 64440 nT



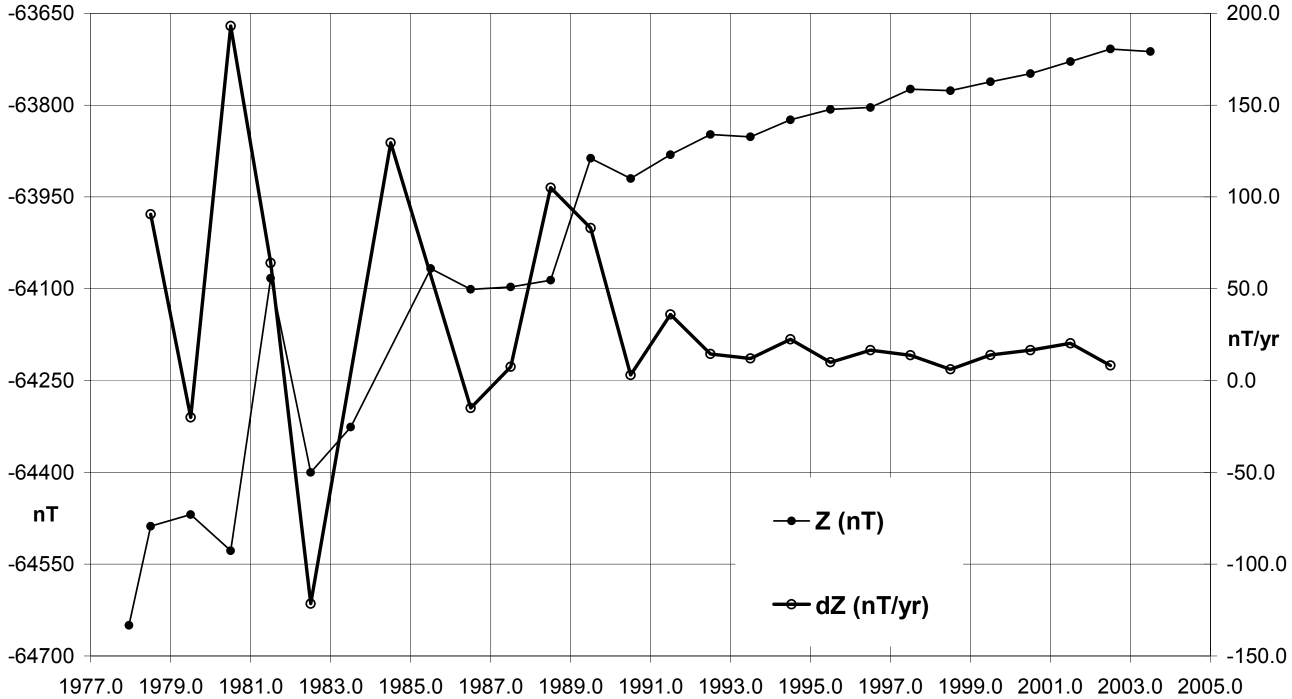
Casey, Antarctica (CSY) Horizontal Intensity
Annual Mean Values (H) & Secular Variation (dH)



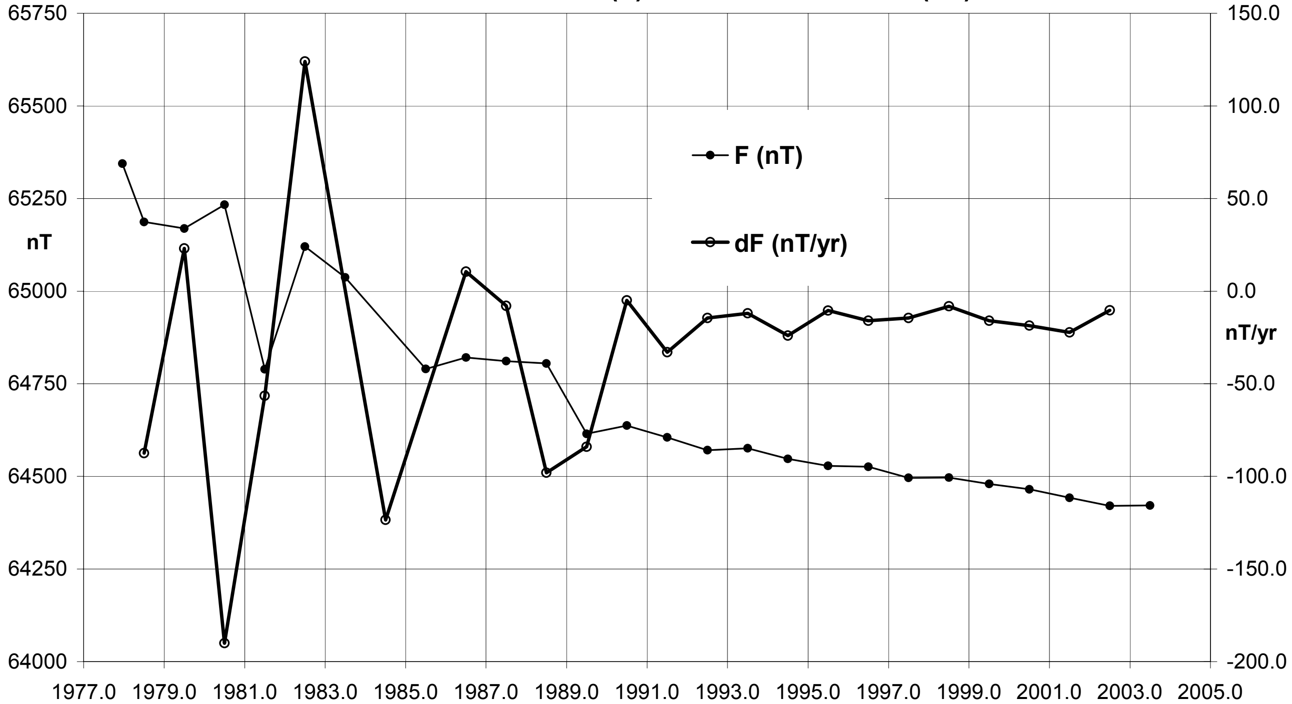
Casey, Antarctica (CSY) Declination
Annual Mean Values (D) & Secular Variation (dD)



Casey, Antarctica (CSY) Vertical Intensity
Annual Mean Values (Z) & Secular Variation (dZ)



Casey, Antarctica (CSY) Total Intensity
Annual Mean Values (F) & Secular Variation (dF)



Significant Events: CSY, 2003

Apr.10 Heater in Absolute hut broken after a blizzard. Heater repaired using a larger stainless steel coil.

Jul. 25, Sept 07, Sep. 14, Sep. 15: A 20−30 minute cyclic pattern was present in the X, Y and Z variometer components.

Nov 28 PPM G816_1024 was dropped and broken. No absolute observations until January 2004

CSY 2003 – Data losses:

Short intervals of data were contaminated by daily calibration pulses automatically scheduled by AAD to occur at 0001, 1200−1201 and 1630−1631 on all days in 2003. These data were removed from the GA data set.

There was no PPM recording variations in total intensity at Casey during 2003. The periods of data loss that follow refer to EDA fluxgate variometer data.

Aug. 31 0213−0214 (2m), 0217−0238 (22m)

Dec 11 0403−0408 (6m); 0416−2252 (18h 37m)

Dec 24 0031−0038 (8m)

Distribution of CSY data during 2003

Preliminary Monthly Means for Project Ørsted

- Emailed monthly throughout 2003 to IPGP.

1-minute & Hourly Mean Values (WDC format)

- 2002: WDC-A, Boulder, USA (sent 13 May 2003)
- 2003: WDC-A, Boulder, USA (sent 02 Sep. 2004)

1-minute Values (INTERMAGNET format)

- 2002: INTERMAGNET GIN Paris (sent 14 May 2003)
- 2003: INTERMAGNET GIN Paris (sent 03 Sep. 2004)

Enquiries for variation data from Casey for 1997 or earlier should be directed to the Atmospheric and Space Physics Section of the Australian Antarctic Division, Channel Highway, Kingston, Tasmania.

Casey & Davis Notes and Errata (cumulative since *AGR'93*)

There was an inconsistency in the Davis magnetic H component monthly means in the *AGR1996*. Corrected values were given in the *AGR1997*.

MAWSON OBSERVATORY

The magnetic observatory is part of Mawson scientific research station, built on the edge of Horseshoe Harbour, MacRobertson Land , in Antarctica. It is built on bare charnockite basement rock: there is no ice or soil cover.

The magnetic observatory buildings, comprising the Variometer House and the Absolute House, are situated on the south-east and inland side of the Mawson base, at the end of East Bay. They are in a magnetic quiet zone at an extremity of the Mason base.

In 1955 the Mawson observatory commenced recording magnetic variations with a three-component analogue magnetograph. The observatory has continuously recorded the geomagnetic field (and seismic activity) at Mawson since that time. In December 1985 the magnetic observatory was converted to digital recording. It is operated by Geoscience Australia as part of the Australian National Antarctic Research Expeditions (ANARE).

Further details of the observatory's history are in the *AGR 1994*.

Key data for the principal observation pier (A) of the observatory are:

- 3-character IAGA code: MAW
- Geographic latitude: 67° 36' 14" S
- Geographic longitude: 62° 52' 45" E
- Geomagnetic† : Lat. -73.09°; Long. 110.17°
  † Based on the IGRF 2000.0 model updated to 2003.5
- Elevation above mean sea level (top of pier A): 12 metres
- Lower limit for K index of 9: 1500 nT.
- Azimuth of principal reference mark (BMR89/1) from Pier A: 350° 36.9'
- Distance to azimuth mark BMR89/1: 112 metres
- Observers in Charge: Kerry Steinberner (2003, GA/BoM)
  Ray Hegarty (2004, GA/BoM)

Variometers

A 3-axis Narod ringcore fluxgate (RCF) magnetometer and an Elsec 820M3 PPM continuously monitored variations in the Earth's magnetic field at Mawson throughout 2003. The RCF sensor was located within the sensor room of the MAW Variometer House and the PPM sensor was in the recording room of the same building. This building also housed a global positioning system (GPS) clock, a data acquisition PC, a network PC, an Aironet ethernet radio link and a standby power supply.

MAW – Variometers (cont.)

Two of the orthogonal RCF magnetometer sensors were horizontal and oriented so that they were each at an angle of 45 degrees to the direction of the horizontal component of the magnetic field (ie 45° to the magnetic declination, D). The third sensor was aligned vertically, ie. parallel with the geomagnetic element Z.

The RCF produced 8 samples per second that were averaged and output as 1-second data. The PPM variometer produced 10-second samples.

The temperatures of the sensors and the electronics of the RCF system were monitored by its in-built dual temperature system. Temperature within the sensor room was kept close to 10°C by a fast-cycle heater and displayed by a Doric Trendicator digital thermometer with its sensor on a disused (PEM/Y) pier. The recorded variometer temperature varied by about 5.5°C during the year, and by at most 2°C between absolute observations (then only on unusual conditions).

An old EDA 3-component fluxgate magnetometer and its associated data acquisition PC were available as a standby variometer to replace the principal system should it fail. This system, also in the Variometer House, was tested during a service visit by a Geomagnetism project officer (PGC) in January 2003, but otherwise left powered off during 2003.

The F variometer performed poorly on many occasions during the latter half of 2003. It was not clear whether the problem was in the instrument or caused by some radio, electrical, or magnetic interference.

Absolute Instruments and Corrections

The principal absolute magnetometers used to calibrate the recording variometers at Mawson in 2003 were a Danish fluxgate magnetometer (D26035) mounted on a Zeiss 020B theodolite (serial 311542) and two Elsec model 770 PPMs (serial 199 was the primary instrument until 18 March 2003, and serial 210 was the primary instrument thereafter.)

All absolute observations were performed on Pier A while the azimuth mark BMR89/1 was used for a declination reference.

Absolute Instruments and Corrections (cont.)

Instrument comparisons (which were corrected to the Australian Magnetic Standard held at Canberra) performed at Mawson in January 2003 indicated corrections to the absolute magnetometers in use at Mawson:

- +1.4 ± 1.5nT to Elsec 770/199. This was consistent with the correction of +1.6nT applied in 2001 and 2002.
- −0.2 ± 1.0nT for Elsec 770/210, consistent with a correction of −0.6nT ± 0.5nT measured in Canberra in January 2003.
- inconclusive values of +0.3 ± 0.3' in D, and −0.1 ± 0.1' in I) for DIM D26035/311542

This is consistent with a measured difference throughout 2003 of

F/E770_210 = F/E770_199 + 1.7 ± 0.5nT.

Frequency tests indicated no difference between the E770 instruments and the Australian Standards, so the corrections are probably due to some small contamination in the sensors.

For standardization with the Australian Magnetic Standard held at Canberra the corrections applied in 2001 and 2002 have been retained to the end of March 2003, ie a correction of +1.6nT has been applied to the PPM readings, and corrections of zero have been applied to the DIM readings. These resulted in baseline corrections of:

$\Delta X = +0.3$ nT $\Delta Y = -0.5$ nT $\Delta Z = -1.5$ nT.

Zero corrections have been applied from April 2003.

Secondary instruments were used monthly to maintain calibration in case of failure of the primary instruments. They included an Askania declinometer (serial 630332) and three horizontal magnetometers (QHM serial 300, 301, and 302). The declinometer and QMHs were used on Askania circle 611665.

The average α-parameter and H and D corrections to make the QHMs agree with baselines determined from the primary instruments during 2003 were:

QHM300: $\alpha = +12.6 \pm 0.4'$ $\Delta H = -0.8 \pm 1.3$nT, $\Delta D = -1.2 \pm 0.7'$

QHM301: $\alpha = -12.6 \pm 0.3'$ $\Delta H = +5.8 \pm 1.7$nT, $\Delta D = +1.0 \pm 0.8'$

QHM302: $\alpha = -01.4 \pm 0.3'$ $\Delta H = -2.8 \pm 1.9$nT, $\Delta D = +0.5 \pm 0.5'$

No corrections were applied to observations with these QHMs.

These calculations used the QHM constants in the table below:

QHM	K	k_1 (e-5)	k_2 (e-10)	α-factor	collimation
300	7828.0	39.4	69.0	2.22e5	22.5'
301	8230.5	39.7	90.0	0	72.5'
302	7690.1	42.0	90.0	0	27.0'

The average E-I-parameter and D correction to make the Askania declinometer agree with baselines determined from the primary instruments during 2003 were:

E-I = +1.5' ± 0.4' $\Delta D = +0.3' \pm 0.4'$

Baselines

The standard deviations between the adopted variometer model and data, and the absolute observations, were:

$\sigma_X = 1.6$nT $\sigma_Y = 1.6$nT $\sigma_Z = 1.0$nT.

(In terms of the absolute observed components, they were:

$\sigma_F = 1.0$nT $\sigma_D = 17''$ $\sigma_I = 7''$.)

The adopted baselines fail to explain changes in F-check (the difference between the vector and scalar variometers); especially a 6nT drift from mid-January to the end of March 2003.

Operations

The 2003 observers were employed jointly by Geoscience Australia (GA) and the Bureau of Meteorology (BoM) and were members of the Australian National Antarctic Research Expedition (ANARE). The Mawson Station personnel changeover each summer, with varying amounts of overlap.

MAW – Operations (cont.)

The 2003 observer (KS) arrived at MAW in December 2002 and took over the responsibility for operating the observatory on 14 December 2002. The 2002 observer (AJ) departed in December 2002 after a brief changeover. The 2004 observer (RH) who arrived on 17 November 2003, assumed responsibility for the observatory on 20 November 2003, the day that the 2003 observer departed.

The observer was responsible for the continuous operation of the observatory and performed equipment maintenance as required. In 2003 the observer performed absolute observations once per week and forwarded them by e-mail to GA where all data processing was performed. During the observations the variometer system was also checked.

The 1-second RCF data and 10-second PPM data as well as 1-minute means of both were recorded on an acquisition PC in the recorder room. The computer was connected to a pulse-per-second input from a GPS clock to keep the clock rate accurate. A PC running QNX, also in the variometer house, that was connected to the station's radio network-hub, automatically copied files from the acquisition PC each day. The files on this PC were subsequently automatically retrieved at GA, Canberra, from a secure network by ftp via the ANARE satellite communications system. To ensure correct operation and to check system timing, the data acquisition system was routinely interrogated using a PC in the Science Building.

The recorder room also housed an uninterruptible power supply for power back-up.

In earlier years (particularly 2000) considerable effort was made to isolate the variometer system from static electricity sparks originating from the very dry blown snow during the severe blizzards that are common at Mawson. The sparks occasionally halted the acquisition computer. This seems to have improved the situation, but there are still unacceptablel data losses during blizzards which also delay attention from the local observer for a few days. Blizzard was the major cause of data loss during 2003, either corrupting data or the computer clock, or halting the computer outright as on days in March, April, June, August and September, and accounting for almost all of the 2.5% data loss for the year.

The daily data were processed at GA then distributed, usually within a few hours after UT0. Daily data plots were examined at GA for possible problems, which were usually quickly rectified by the local observer. The final data for the year were reduced and analysed by GA staff.

A GA Geomagnetism Project officer (PGC) visited the observatory from 26 January to 2 February 2003. This was the first ongoing member of the GA Geomagnetism group to visit since the observing duties became part-time in 1998. Although most of the visit was used to install seismic equipment for the Comprehensive Test Ban Treaty Organisation, some time was spent comparing absolute magnetometers, establishing a set of sites around the observatory for absolute observations to check for encroachment of contamination in the future and reorganising the variometer building. A considerable amount of obsolete equipment was finally removed from the old geophysics office known as *Wombat* – most was discarded, but the OIC (KS) was left with the task of finalising the move of the office to the Aeronomy building.

During the maintenance visit the F-differences at several sites around the Absolute Pier were measured for future reference to monitor the magnetic integrity of the observatory:

F at Pier A	=	F at BMR85/2	+ 18.7	± 0.5 nT
F at Pier A	=	F at BMR89/1	+ 15.9	± 0.5 nT
F at Pier A	=	F at BMR89/2	+ 10.3	± 0.5 nT
F at Pier A	=	F at ShortPeg	− 1.9	± 0.5 nT

All non-Pier-A measurements were at taken 1.6m above ground level (Not above mark level).

On 15 September 2003, the OIC measured the vector difference between the Absolute Pier A and BMR89/2.

MAW – Operations (cont.)

Although the DIM results had some larger than expected χ^2 values and instrumental parameter variations, they may serve as benchmarks for future measurements:

D at Pier A	=	D at BMR89/2	− 3.1'	± 0.5'
I at Pier A	=	I at BMR89/2	− 0.7'	± 0.5'
F at Pier A	=	F at BMR89/2	+ 10.4	± 0.5 nT

The F-difference is consistent with the January measurements, even though there were some changes to the Mawson station environment (the installation of some wind turbines).

Plans to measure the vector difference to the remote station at mark LEE were not realised during 2003.

In January 2003, a round of angles using 7 marks confirmed that all marks except for the disused Mark-C (sometimes known as SOH) were stable. Mark-C readings had a small difference from 1989 measurements of 0.1', but there had been physical alterations to this artificial mark in the intervening interval.

MAW 2003 – Data Loss

Jan 27 0907−0908 (2 min) All channels: Maintenance.

Jan 29 0455 (1 min) All channels: Maintenance.

Mar 16 1701 to 19 / 0300 (2d 10h 00m) All channels: Although data acquisition continued, a blizzard caused undetermined timing errors.

Apr 13 0824 to 15 / 0339 (1d 19h 16m) All channels: Blizzard.

Apr 15 0340−0540 (121 min) F-channel only: Blizzard.

Apr 15 0549 (1 min) All channels: Maintenance.

Jun 24 1540 to 25 / 0810 (16h 31m): All channels. Blizzard

Aug 16 0803 to 18 / 0358 (1d 19h 56m) All channels: Blizzard

Sep 02 2313−2314 (2 min) All channels: Blizzard.

Sep 02 2326 to 05 / 1313 (2d 13h 48m) All channels: Blizzard.

Sep 29 0501−0505 (5 min) All channels: Maintenance recovery from blizzard malfunctions.

Oct 15 0900−0939 (40 min) All channels: Maintenance.

Problems in data:

Throughout 2003 the timing on the data was sometimes in error by up to, but not more than, 2 seconds.

Mawson, Antarctica Annual Mean Values

The table below gives annual mean values calculated using the monthly mean values over **All** days, the 5 International **Quiet** days and the 5 International **Disturbed** days in each month as indicated. Plots of these data with secular variation in H, D, Z & F are on pages 101-102.

Year	Days	D (Deg	Min)	I (Deg	Min)	H (nT)	X (nT)	Y (nT)	Z (nT)	F (nT)	Elts*
1955.5		-58	38.1	-69	33.3	18272	9854	-15387	-49012	52307	DHZ
1956.5		-58	53.2	-69	32.5	18282	9927	-15352	-49006	52305	DHZ
1957.5		-59	8.7	-69	31.1	18292	9461	-15655	-48974	52279	DHZ
1958.5		-59	25.6	-69	30.3	18293	9538	-15610	-48940	52247	DHZ
1959.5		-59	42.6	-69	28.5	18293	9615	-15562	-48860	52172	DHZ
1960.5		-59	59.6	-69	25.2	18323	9708	-15540	-48800	52127	DHZ
1961.5		-60	14.6	-69	23.1	18322	9228	-15828	-48707	52039	DHZ
1962.5		-60	30.1	-69	21.1	18333	9305	-15796	-48650	51990	DHZ
1963.5		-60	45.2	-69	17.6	18356	9386	-15775	-48562	51915	DHZ
1964.5		-60	59.2	-69	15.4	18353	9449	-15734	-48460	51819	DHZ
1965.5		-61	12.6	-69	13.1	18356	8958	-16022	-48368	51734	DHZ
1966.5		-61	24.0	-69	9.6	18362	9014	-15997	-48235	51612	DHZ
1967.5		-61	34.4	-69	7.2	18374	9068	-15980	-48168	51553	DHZ
1968.5		-61	43.8	-69	5.2	18365	9107	-15948	-48060	51449	DHZ
1969.5		-61	53.0	-69	3.4	18353	9144	-15913	-47954	51346	DHZ
1970.5		-62	0.5	-69	0.4	18358	8621	-16208	-47840	51241	DHZ
1971.5		-62	5.3	-68	56.4	18375	8652	-16211	-47719	51135	DHZ
1972.5		-62	11.4	-68	53.1	18381	8683	-16201	-47600	51026	DHZ
1973.5		-62	17.6	-68	49.7	18391	8717	-16194	-47486	50923	DHZ
1974.5		-62	24.8	-68	47.2	18390	8750	-16175	-47380	50824	DHZ
1975.5		-62	31.4	-68	44.0	18397	8785	-16164	-47269	50723	DHZ
1976.5		-62	37.3	-68	40.0	18418	8823	-16167	-47157	50626	DHZ
1977.5		-62	43.9	-68	36.9	18425	8857	-16157	-47051	50530	DHZ
1978.5		-62	51.9	-68	35.5	18421	8893	-16132	-46986	50468	DHZ
1979.5		-62	57.9	-68	32.9	18425	8923	-16120	-46890	50380	DHZ
1980.5		-63	5.8	-68	29.8	18432	8396	-16409	-46784	50284	DHZ
1981.5		-63	14.6	-68	27.1	18443	8443	-16397	-46705	50215	DHZ
1982.5		-63	21.2	-68	25.5	18433	8470	-16372	-46616	50128	DHZ
1983.5		-63	26.6	-68	22.3	18439	8498	-16364	-46503	50025	DHZ
1984.5		-63	33.1	-68	19.3	18446	8532	-16354	-46404	49936	DHZ
1985.5		-63	40.2	-68	17.0	18457	8571	-16346	-46342	49882	DHZ
1986.5		-63	48.7	-68	15.1	18460	8613	-16328	-46276	49822	XYZ
1987.5		-63	56.6	-68	12.5	18470	8655	-16317	-46198	49753	XYZ
1988.5		-64	4.4	-68	10.7	18475	8120	-16595	-46142	49703	XYZ
1989.5		-64	12.8	-68	9.7	18474	8160	-16574	-46099	49663	XYZ
1990.5		-64	21.1	-68	6.4	18492	8208	-16570	-46015	49592	XYZ
1991.5		-64	28.8	-68	4.2	18502	8250	-16561	-45957	49542	XYZ
1992.5	Q	-64	36.5	-68	-1.7	18513	7938	-16724	-45885	49479	XYZ
1993.5	Q	-64	43.6	-67	-59.4	18522	7908	-16749	-45819	49422	ABC
1994.5	Q	-64	51.8	-67	-57.4	18537	7874	-16781	-45779	49389	ABC
1995.5	Q	-65	0.4	-67	55.3	18550	7838	-16813	-45731	49350	ABC
1996.5	Q	-65	9.2	-67	53.5	18561	7799	-16843	-45692	49318	ABC

continued …

MAW – Annual Mean Values (cont.)

Year	Days	D (Deg	Min)	I (Deg	Min)	H (nT)	X (nT)	Y (nT)	Z (nT)	F (nT)	Elts*
1997.5	Q	-65	18.9	-67	52.0	18572	7757	-16875	-45663	49295	ABC
1998.5	Q	-65	28.6	-67	51.3	18575	7710	-16900	-45642	49277	ABC
1999.5	Q	-65	38.5	-67	50.2	18579	7663	-16925	-45611	49250	ABC
2000.5	Q	-65	48.0	-67	49.6	18579	7616	-16946	-45585	49225	ABC
2001.5	Q	-65	56.3	-67	48.9	18577	7574	-16963	-45555	49198	ABC
2002.5	Q	-66	-5.2	-67	-48.2	18581	7532	-16986	-45540	49185	ABC
2003.5	Q	-66	14.7	-67	48.7	18570	7481	-16997	-45532	49174	ABC
1992.5	A	-64	36.9	-68	-2.8	18499	7930	-16712	-45894	49482	XYZ
1993.5	A	-64	44.2	-68	-0.7	18506	7898	-16736	-45830	49426	ABC
1994.5	A	-64	52.9	-67	-59.4	18511	7858	-16760	-45794	49394	ABC
1995.5	A	-65	0.9	-67	56.7	18532	7828	-16798	-45741	49352	ABC
1996.5	A	-65	9.8	-67	54.5	18548	7791	-16833	-45698	49319	ABC
1997.5	A	-65	19.4	-67	53.0	18560	7749	-16865	-45670	49297	ABC
1998.5	A	-65	29.1	-67	52.4	18561	7702	-16887	-45648	49278	ABC
1999.5	A	-65	39.0	-67	51.5	18561	7653	-16910	-45618	49250	ABC
2000.5	A	-65	48.2	-67	50.6	18566	7610	-16935	-45594	49230	ABC
2001.5	A	-65	56.2	-67	49.8	18567	7571	-16953	-45565	49203	ABC
2002.5	A	-66	-5.8	-67	-49.3	18568	7524	-16975	-45546	49185	ABC
2003.5	A	-66	15.6	-67	50.7	18546	7466	-16976	-45546	49177	ABC
1992.5	D	-64	39.6	-68	-5.2	18466	7904	-16689	-45907	49482	XYZ
1993.5	D	-64	45.9	-68	-3.0	18476	7877	-16713	-45847	49430	ABC
1994.5	D	-64	55.3	-68	-1.9	18476	7831	-16734	-45804	49390	ABC
1995.5	D	-65	1.7	-67	58.8	18504	7812	-16774	-45752	49353	ABC
1996.5	D	-65	11.1	-67	56.2	18525	7775	-16814	-45707	49318	ABC
1997.5	D	-65	20.4	-67	55.0	18534	7733	-16844	-45682	49299	ABC
1998.5	D	-65	30.9	-67	54.8	18530	7680	-16864	-45665	49282	ABC
1999.5	D	-65	41.0	-67	53.9	18528	7630	-16884	-45626	49245	ABC
2000.5	D	-65	49.7	-67	52.6	18543	7593	-16917	-45614	49239	ABC
2001.5	D	-65	56.4	-67	51.6	18547	7561	-16935	-45583	49212	ABC
2002.5	D	-66	-7.6	-67	-51.2	18540	7504	-16953	-45552	49180	ABC
2003.5	D	-66	17.4	-67	53.3	18510	7443	-16947	-45556	49173	ABC

* Elements ABC indicates non-aligned variometer orientation

Distribution of MAW data during 2003

Preliminary Monthly Means for Project Ørsted

- Sent monthly by e-mail to IPGP

1-minute & Hourly Mean Values (WDC format)

- 2002 data: WDC-A, Boulder, USA (sent 27 June 2003)
- 2003 data: WDC-A, Boulder, USA (sent 19 Apr. 2004)

1-minute Values (INTERMAGNET format)

- 2002 data: WDC-C1, Copenhagen, Den. (sent 27 June 2003)
- 2003 data: WDC-C1, Copenhagen, Den. (sent 19 Apr. 2004)

MAW Significant Events 2003

Dec 14 (2002) New OIC (KS) assumed responsibility for the magnetic observatory.

Jan 17 09:28:27: There was a sudden change in RCF B-channel of +300 counts (7.5nT). Unknown cause.

Jan 24 Radio modem in the variometer house failed causing communications to GA to cease.

Jan 26 to Feb 02: Geomagnetism Project officer (PGC) from GA performed inspections, calibrations, and seismic installations.

Jan 27 0900: A screen on one of the PCs in variometer house was replaced.

Jan 30 Radio modem in variometer house reconfigured to re-establish communications to GA.

Feb 04 Unexplained step in RCF variometer data. Adopted a reversal of the step on 16 March.

Mar 18 Adopted Elsec 770_210 in favour of 770_199 as the local standard-F instrument.

MAW Significant Events (cont.)

Aug 12 DIM theodolite vertical circle clamp tightened.

Aug 13 Variometer electrical cabinet door removed for replacement.

Oct 15 Variometer electrical cabinet door replaced using original hinges and screws as well as three additional aluminium screws.

Nov 17 New OIC (RH) arrived at the station.

Sep 15 Vector difference to BMR89/2 measured.

Nov 20 Finishing OIC (KS) departed the station and new OIC (RH) assumed responsibility for magnetic observatory.

Dec 16 04:38 Some undocumented disturbance to variometer just before observations.

2003 Throughout 2003, three wind turbine electricity generators were to be installed at Mawson; one of them 150m from the Absolute Pier A. The generators have a DC segment for AC/AC conversion. The expected effect is <0.1 nT at Pier A.

K indices

The table on the next page shows Mawson K indices for 2003. Using the digital data, these have been derived by a computer algorithm that calculates a simple range in the X and Y magnetic components over each 3-hour UT period. The K indices were calculated from the maximum of the X and Y ranges in the usual manner. This was suitable for Mawson as the diurnal variation is small.

K indices & Daily K sums at Mawson Antarctica (K=9 limit: 1500 nT) for 2003

Date	January	February	March	April	May	June	Date
01	3433 3334 26	5543 4476 38	6333 3366 33	6653 3664 39	D 7565 5666 46	3555 3364 34	01
02	4333 4333 26	D 7666 6756 49	3543 3255 30	4565 3666 41	3553 2365 32	D 5766 4445 41	02
03	4344 4755 36	D 5454 4675 40	4343 3576 35	4434 3356 32	Q 4534 3455 33	6554 5367 41	03
04	6554 4355 37	D 4675 3366 40	D 5664 4466 41	D 5544 4576 40	Q 3432 2113 19	5565 5665 43	04
05	3432 4446 30	5554 4445 36	5534 3566 37	D 5544 3565 37	3332 3553 27	Q 4434 3355 31	05
06	Q 3333 2335 25	4444 4645 35	6664 5666 45	Q 3442 2444 27	4443 4667 38	3554 3556 36	06
07	Q 4433 3554 31	5444 4473 35	6544 4265 36	Q 4332 4321 22	D 6666 5775 48	6655 4446 40	07
08	Q 3332 1333 21	5544 4455 36	Q 4332 3445 28	3555 4422 30	D 7675 4678 50	4655 4777 45	08
09	Q 4441 2343 25	5543 4654 36	4553 3356 34	5564 4422 32	6665 4347 41	4664 4447 39	09
10	4543 4544 33	4664 3355 36	3543 3656 35	3564 4455 36	-756 3355 --	5455 4353 34	10
11	5532 3345 30	Q 5663 2333 31	5553 3312 27	3544 3466 35	6565 5534 39	4564 3344 33	11
12	3553 3343 29	2553 3466 34	Q 4333 2125 23	Q 6433 4331 27	3565 4576 41	Q 2342 3225 23	12
13	5434 2324 27	Q 4333 3215 24	6553 4121 27	Q 363- ---- --	4555 4467 40	Q 5432 2236 27	13
14	4563 3333 30	5534 4434 32	3445 5465 36	---- ---- --	5555 4776 44	3664 4555 38	14
15	5443 3343 29	D 6645 5555 41	6454 4545 37	-564 3224 --	4564 3556 38	6655 2456 39	15
16	Q 4333 3254 27	4564 4457 39	4454 55-- --	D 5555 4487 43	Q 5443 2245 29	D 3734 4467 38	16
17	3544 3223 26	6444 4334 32	D ---- ---- --	2465 5564 37	Q 5552 4342 30	D 6775 4426 41	17
18	4454 5434 33	4754 4327 36	---- ---- --	3664 4336 35	Q 3332 1254 23	D 6655 4577 45	18
19	4565 5355 38	4333 4347 31	-553 3333 --	Q 5442 2254 28	4552 3346 32	5554 4373 36	19
20	6544 4454 36	3564 4464 36	2455 5765 39	6662 3346 36	4444 3156 31	Q 3453 3445 31	20
21	5454 3336 33	3544 3466 35	5665 4237 38	6564 2475 39	6332 3566 34	6554 3447 38	21
22	D 5644 4447 38	4334 3433 27	6664 3247 38	5655 4565 41	8455 4463 39	Q 3454 2366 33	22
23	D 6533 4435 33	Q 5443 4355 33	4555 3466 38	3566 3475 39	3644 2555 34	7554 3365 38	23
24	6444 5666 41	Q 3323 3325 24	Q 5443 2233 26	5554 5457 40	5654 4367 40	6654 4--- --	24
25	D 4675 5434 38	Q 4232 2122 18	Q 3322 2221 17	D 4555 4477 41	6656 3446 40	---3 3546 --	25
26	D 6554 4355 37	3445 3336 31	Q 2432 3255 26	5444 3576 38	7444 3166 35	5454 4344 33	26
27	4521 1324 22	D 6554 5666 43	6565 4456 41	4663 2365 35	6453 3386 38	5555 4665 41	27
28	5673 3235 34	5345 3566 37	5554 3576 40	6664 2134 32	7555 4566 43	D 5666 4646 43	28
29	4343 4566 35		D 5564 3366 38	4441 4575 34	D 6654 6688 49	6666 3355 40	29
30	D 6565 5663 42		D 6554 4776 44	D 5555 4587 44	D 6543 3477 39	4665 3334 34	30
31	6655 4554 40		D 5555 6766 45		6852 3222 30		31
Mean K-sum	**31.9**	**34.5**	**34.6**	**35.6**	**36.7**	**37.0**	

Date	July	August	September	October	November	December	Date
01	3454 2245 29	D 7675 4567 47	4562 2474 34	4343 2145 26	7654 4566 43	5653 2236 32	01
02	5444 3335 31	6554 3575 40	5443 5336 33	4422 2365 28	5654 3475 39	4453 2233 26	02
03	6434 3367 36	5554 3376 38	---- ---- --	5653 3445 35	5653 4356 37	Q 3332 3334 24	03
04	6565 4456 41	Q 4443 2253 27	---- ---- --	Q 3343 2103 19	6477 4345 40	4532 3335 28	04
05	5664 4566 42	Q 2221 0136 17	---- 2445 --	2312 0225 17	Q 4321 2346 25	D 4675 7656 46	05
06	3333 4316 26	7464 3124 31	5433 3344 29	3322 2356 26	4432 3486 34	5555 5545 39	06
07	5454 3243 30	3332 4467 32	Q 3331 1214 18	6444 3466 37	4533 2444 29	5433 5555 35	07
08	Q 1111 1110 07	5775 3455 41	4210 1135 17	5433 2135 26	Q 4333 4453 29	D 4655 6565 42	08
09	Q 1442 2124 20	3544 4347 34	4334 4467 35	5332 2123 21	4544 5575 39	D 5655 6457 43	09
10	Q 3232 3234 22	6553 3344 33	7445 4366 39	Q 2120 1124 13	3655 5566 41	D 6655 5766 46	10
11	D 5564 3347 37	3333 3456 30	5634 3265 34	Q 4211 1024 15	D 6756 6776 50	D 6665 6656 46	11
12	D 8765 3345 41	6664 4575 43	4552 2223 25	Q 4122 3334 22	6555 4664 41	6554 4566 41	12
13	4554 3335 32	4543 3237 31	4432 2155 26	5432 3344 28	D 4455 6586 43	4555 5456 39	13
14	5454 3233 29	6443 2275 33	Q 4221 2235 21	D 4565 5577 44	4765 5456 42	4644 5675 41	14
15	7654 3277 41	3443 3336 29	4210 1155 19	3565 5576 42	D 4666 6766 47	7554 5656 43	15
16	D 5754 5457 42	Q 443- ---- --	D 6673 5465 42	6555 4667 44	D 5565 7657 46	4544 3465 35	16
17	6644 4256 37	---- ---- --	D 4675 6876 49	6564 4346 38	5665 5566 44	4432 3343 26	17
18	3553 3236 30	D -545 3666 --	D 5665 5866 47	4653 4556 38	5555 5765 43	Q 3442 2223 22	18
19	6445 3446 36	5544 2322 27	D 7565 5775 47	5664 5676 45	4544 4542 32	Q 4322 2213 19	19
20	4554 3237 33	2553 3446 32	5655 4666 43	5556 4577 44	D 3678 6775 49	3335 5655 35	20
21	Q 6532 1154 27	D 5675 5676 47	5454 4565 38	D 6565 6866 48	5564 3654 38	6654 4666 43	21
22	Q 5333 2251 24	D 7565 5667 47	5454 4472 35	6665 5632 39	5553 5766 42	5665 4555 41	22
23	4433 2445 29	D 5555 4565 40	3554 3352 30	Q 4232 2211 17	5664 4455 39	4434 4363 31	23
24	3220 1226 18	5555 4365 38	D 6764 5445 41	2335 6955 38	5433 4455 33	3532 3335 27	24
25	3453 2113 22	6764 3355 39	6575 4555 42	4442 5535 32	5664 3444 36	Q 4333 4323 25	25
26	4554 4565 38	6322 3555 31	4554 3666 39	5533 2255 30	4443 4445 32	4663 3335 33	26
27	6555 4464 39	Q 3244 3367 32	5332 1125 22	6655 3544 38	Q 3433 3143 24	5654 3336 35	27
28	4545 5446 37	5545 3353 33	Q 3133 2244 22	6666 3657 45	Q 3433 4323 25	6543 4454 35	28
29	D 4665 5587 46	2333 3473 28	Q 3223 1235 21	D 6699 7887 60	Q 5343 3335 29	Q 3234 4433 26	29
30	4565 4566 41	3653 3354 32	Q 2222 3335 22	D 9754 6777 52	4532 4654 33	4431 3373 28	30
31	D 7666 4676 48	Q 3442 3232 23		D 7775 6576 50		5335 4566 37	31
Mean K-sum	**32.6**	**34.1**	**32.2**	**34.1**	**37.5**	**34.5**	

Occurrence distribution of K-indices

K-Index:	0	1	2	3	4	5	6	7	8	9	-
January	0	4	13	77	74	53	23	4	0	0	0
February	0	2	11	48	71	49	33	10	0	0	0
March	0	5	20	48	43	61	44	8	0	0	19
April	0	4	18	33	62	57	40	10	2	0	14
May	0	5	17	42	48	61	50	18	6	0	1
June	0	0	10	38	60	64	47	15	0	0	6
July	2	16	23	46	59	53	35	12	2	0	0
August	1	3	21	58	44	56	31	20	0	0	14
September	2	15	30	35	44	51	29	12	2	0	20
October	4	14	33	38	37	53	44	18	3	4	0
November	0	2	7	38	61	65	47	17	3	0	0
December	0	2	18	60	48	68	45	7	0	0	0
ANNUAL TOTAL	**9**	**72**	**221**	**561**	**651**	**691**	**468**	**151**	**18**	**4**	**74**

Monthly & Annual Mean Values

The following table gives final monthly and annual mean values of each of the magnetic elements for the year.

A value is given for means computed from all days in each month (All days), the five least disturbed of the International Quiet days (5xQ days) in each month and the five International Disturbed days (5xD days) in each month.

Mawson Antarctica	2003	X (nT)	Y (nT)	Z (nT)	F (nT)	H (nT)	D (East)	I
January	All days	7520.9	-16991.7	-45537.9	49183.3	18581.9	-66° 07.5'	-67° 48.1'
	5xQ days	7533.0	-17001.9	-45539.4	49190.0	18596.1	-66° 06.2'	-67° 47.2'
	5xD days	7502.0	-16984.3	-45528.8	49169.6	18567.6	-66° 10.2'	-67° 48.8'
February	All days	7501.4	-16979.8	-45548.9	49186.4	18563.1	-66° 09.9'	-67° 49.6'
	5xQ days	7495.0	-16985.8	-45545.3	49184.1	18565.9	-66° 11.4'	-67° 49.3'
	5xD days	7503.7	-16971.9	-45583.2	49215.9	18556.9	-66° 08.9'	-67° 50.9'
March	All days	7479.5	-16969.7	-45565.0	49194.5	18545.0	-66° 12.9'	-67° 51.2'
	5xQ days	7486.9	-16988.6	-45533.3	49172.7	18565.2	-66° 13.0'	-67° 49.1'
	5xD days	7479.3	-16959.1	-45607.9	49230.6	18535.3	-66° 12.1'	-67° 53.0'
April	All days	7459.3	-16967.8	-45559.5	49185.7	18535.1	-66° 16.2'	-67° 51.7'
	5xQ days	7481.7	-16999.8	-45536.1	49178.4	18573.4	-66° 14.7'	-67° 48.6'
	5xD days	7452.3	-16950.1	-45567.8	49186.3	18516.1	-66° 16.0'	-67° 53.2'
May	All days	7453.1	-16961.7	-45549.7	49173.7	18527.1	-66° 16.8'	-67° 52.0'
	5xQ days	7476.9	-16986.7	-45537.7	49174.6	18559.5	-66° 14.6'	-67° 49.6'
	5xD days	7437.2	-16935.9	-45546.7	49159.7	18497.2	-66° 17.5'	-67° 53.8'
June	All days	7450.4	-16971.6	-45545.3	49172.5	18535.0	-66° 18.0'	-67° 51.3'
	5xQ days	7469.1	-16986.3	-45531.3	49167.4	18555.9	-66° 15.9'	-67° 49.6'
	5xD days	7416.3	-16949.3	-45575.2	49187.6	18501.1	-66° 22.1'	-67° 54.3'
July	All days	7452.6	-16971.2	-45536.5	49164.5	18535.5	-66° 17.6'	-67° 51.1'
	5xQ days	7468.3	-16990.8	-45528.5	49166.1	18559.7	-66° 16.3'	-67° 49.3'
	5xD days	7412.7	-16927.7	-45561.4	49166.8	18479.8	-66° 21.1'	-67° 55.3'
August	All days	7446.0	-16970.1	-45546.4	49172.4	18531.9	-66° 18.6'	-67° 51.6'
	5xQ days	7463.9	-16990.0	-45517.9	49155.4	18557.3	-66° 17.0'	-67° 49.2'
	5xD days	7409.2	-16935.8	-45563.5	49171.0	18485.9	-66° 22.3'	-67° 55.0'
September	All days	7445.3	-16973.2	-45535.9	49163.6	18534.5	-66° 18.9'	-67° 51.1'
	5xQ days	7466.9	-16997.1	-45527.9	49167.6	18565.0	-66° 17.0'	-67° 48.9'
	5xD days	7410.9	-16930.2	-45541.4	49148.8	18481.4	-66° 21.6'	-67° 54.7'
October	All days	7455.9	-16977.6	-45551.5	49181.3	18542.9	-66° 17.5'	-67° 51.0'
	5xQ days	7468.5	-17001.2	-45525.6	49167.1	18569.3	-66° 17.1'	-67° 48.6'
	5xD days	7442.7	-16941.8	-45598.0	49210.7	18505.6	-66° 17.0'	-67° 54.7'
November	All days	7462.2	-16984.6	-45551.0	49184.1	18551.8	-66° 16.9'	-67° 50.4'
	5xQ days	7480.2	-17011.3	-45539.8	49185.5	18583.3	-66° 15.8'	-67° 48.1'
	5xD days	7414.1	-16909.7	-45516.5	49119.5	18464.4	-66° 19.5'	-67° 55.2'
December	All days	7468.6	-16998.0	-45524.1	49164.7	18566.6	-66° 16.8'	-67° 48.7'
	5xQ days	7475.3	-17020.6	-45525.3	49174.5	18589.9	-66° 17.4'	-67° 47.3'
	5xD days	7434.3	-16969.3	-45478.9	49108.1	18526.8	-66° 20.6'	-67° 50.1'
Annual	All days	7466.3	-16976.4	-45546.0	49177.2	18545.9	-66° 15.6'	-67° 50.7'
Mean	5xQ days	7480.5	-16996.7	-45532.3	49173.6	18570.0	-66° 14.7'	-67° 48.7'
Values	5xD days	7442.9	-16947.1	-45555.8	49172.9	18509.8	-66° 17.4'	-67° 53.2'

(Calculated: 14:10 hrs., Tue. 26 Oct. 2004)

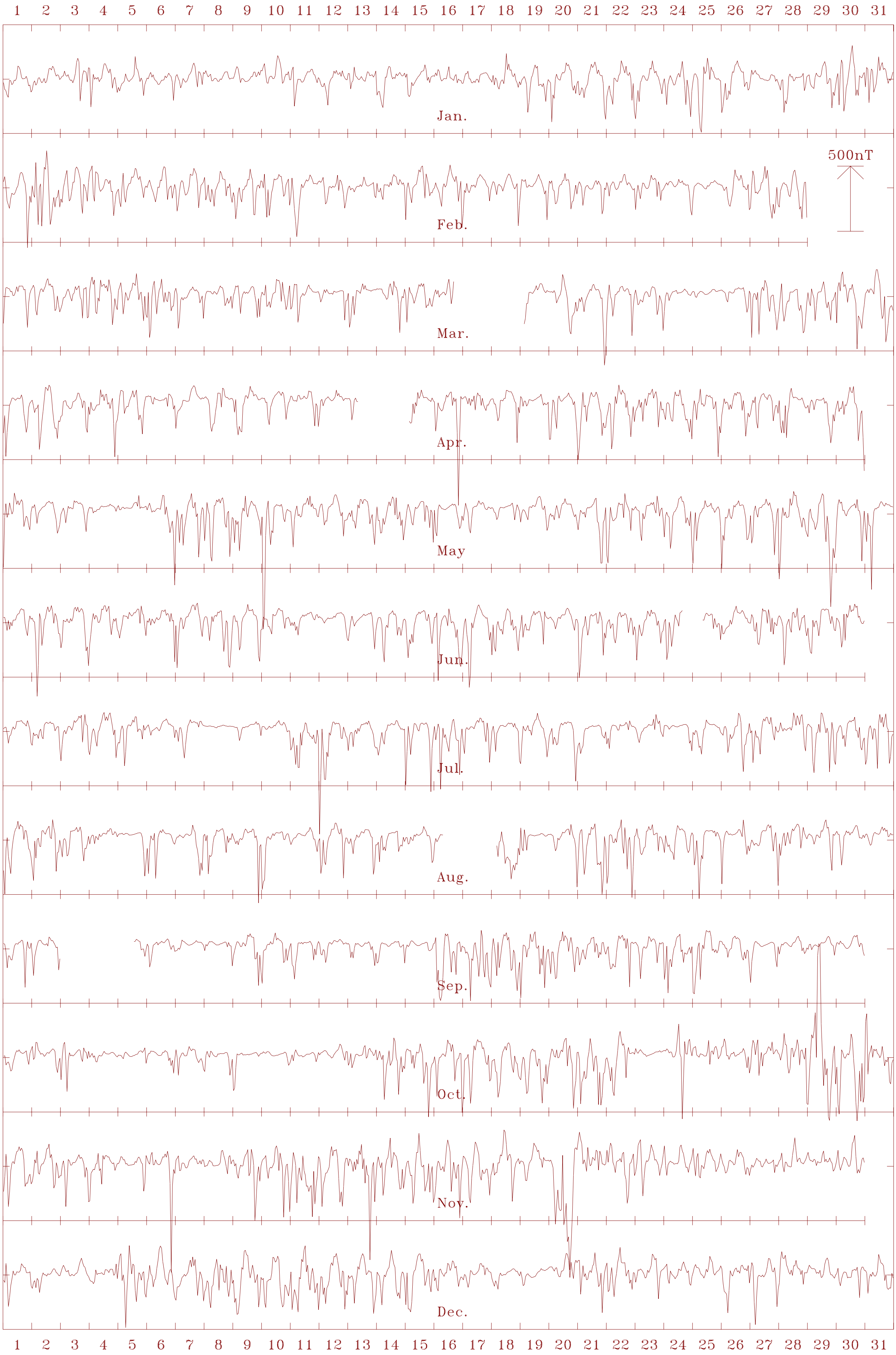
Hourly Mean Values

The charts on the following pages are plots of hourly mean values.

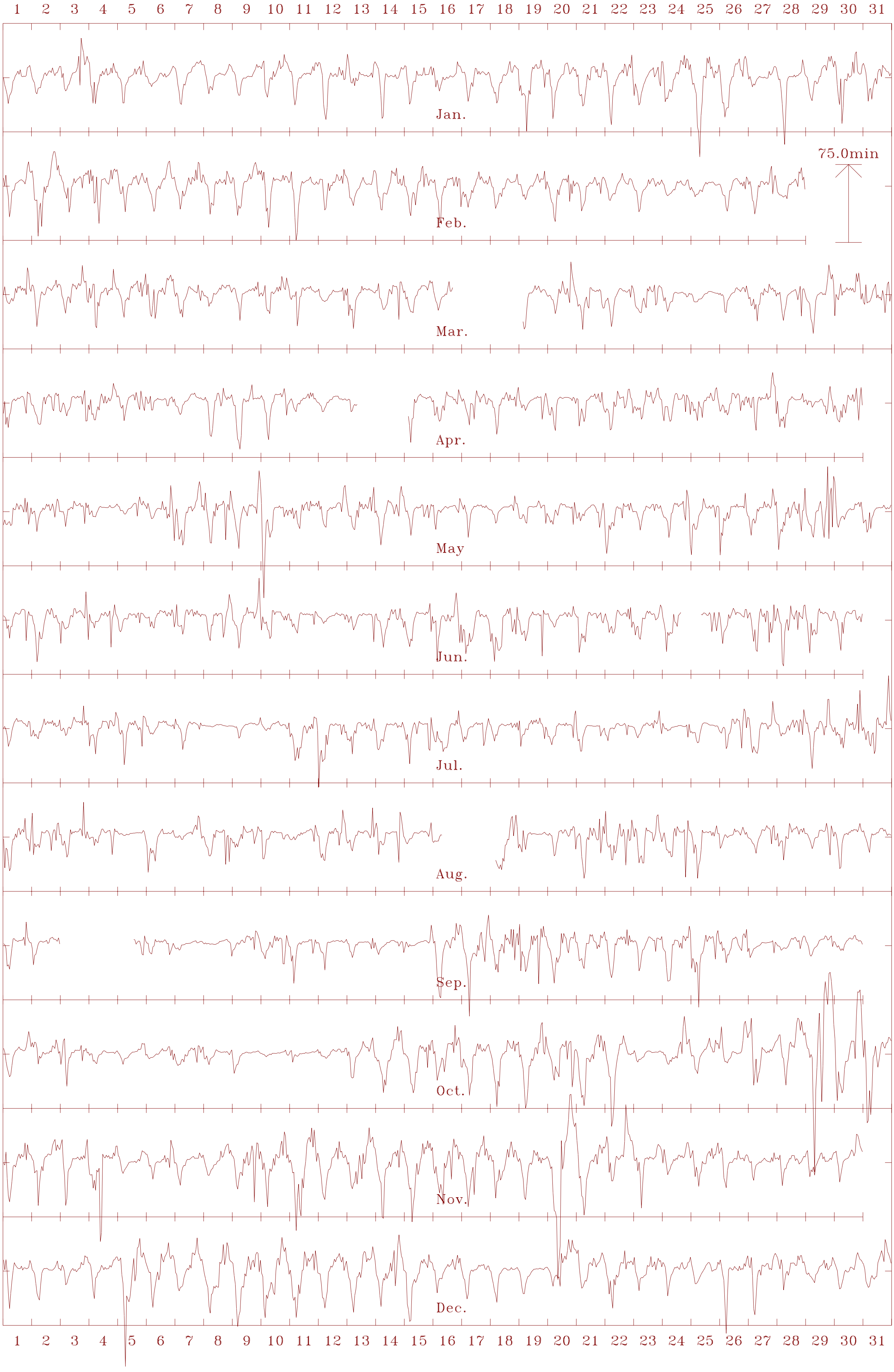
The reference levels indicated with marks on the vertical axes refer to the *all-days* mean value for the respective months. All elements in the plots are shown increasing (algebraically) towards the top of the page, with the exception of Z, which is in the opposite sense.

The mean value given at the top of each plot is the *all-days* annual mean value of the element.

Mawson Stn. 2003 Horizontal intensity (H). Scale: 40.0 nT/mm. Mean: 18546 nT

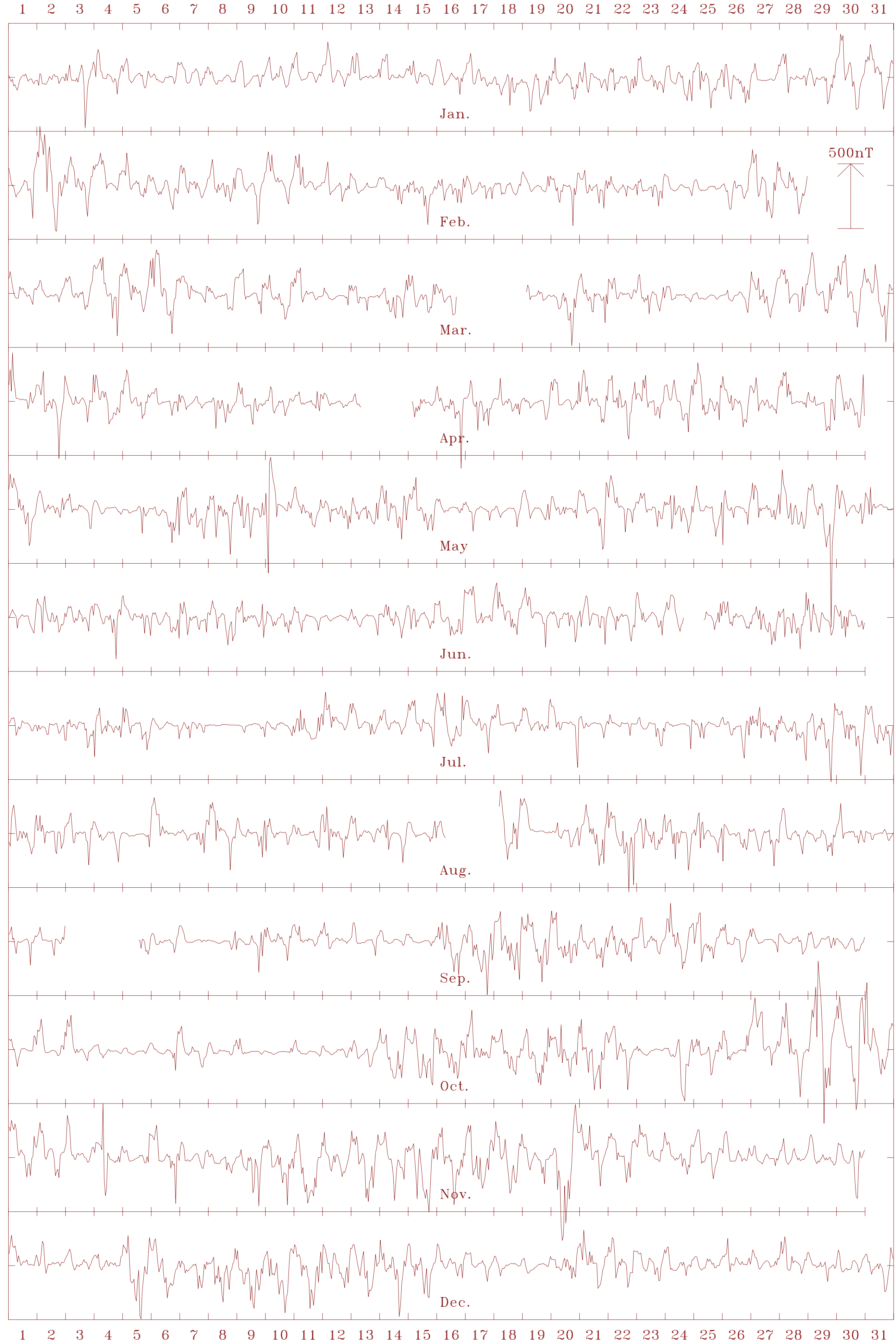


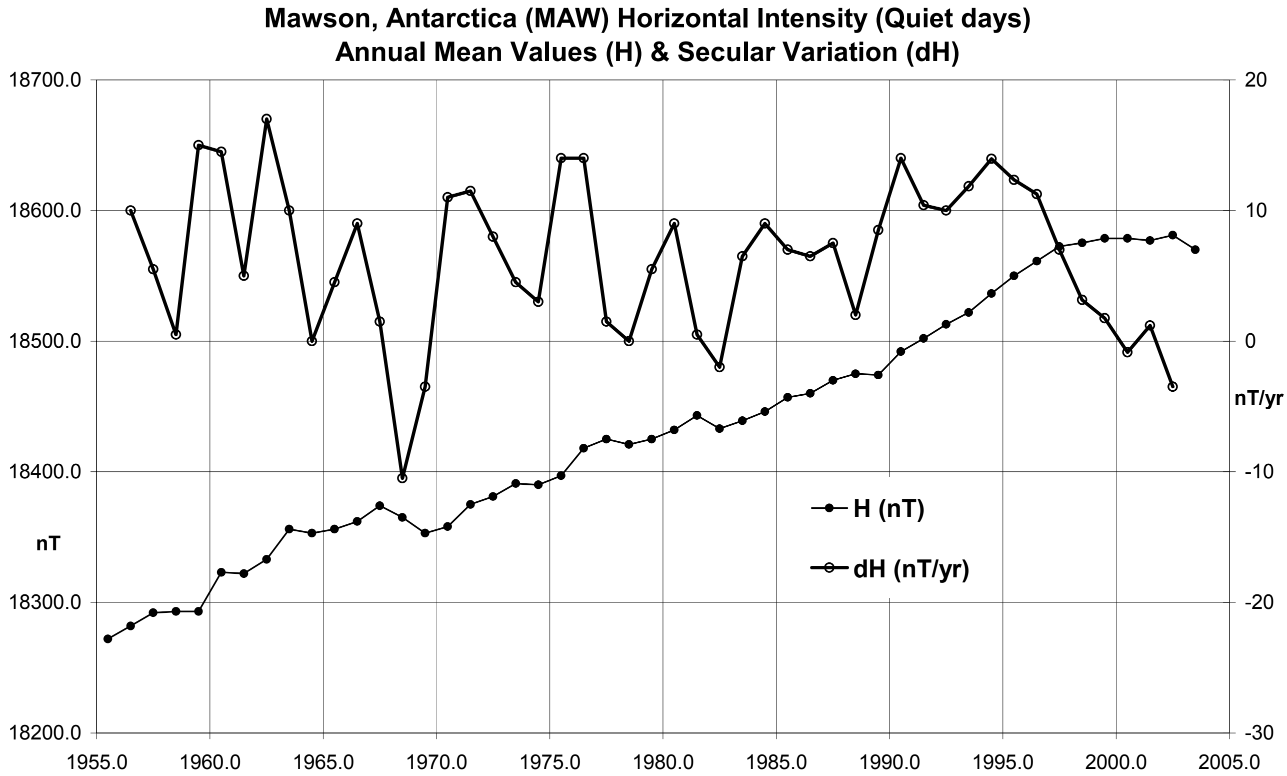
Mawson Stn. 2003 Declination (east) (D). Scale: 5.00 min/mm. Mean: −66.26 deg.

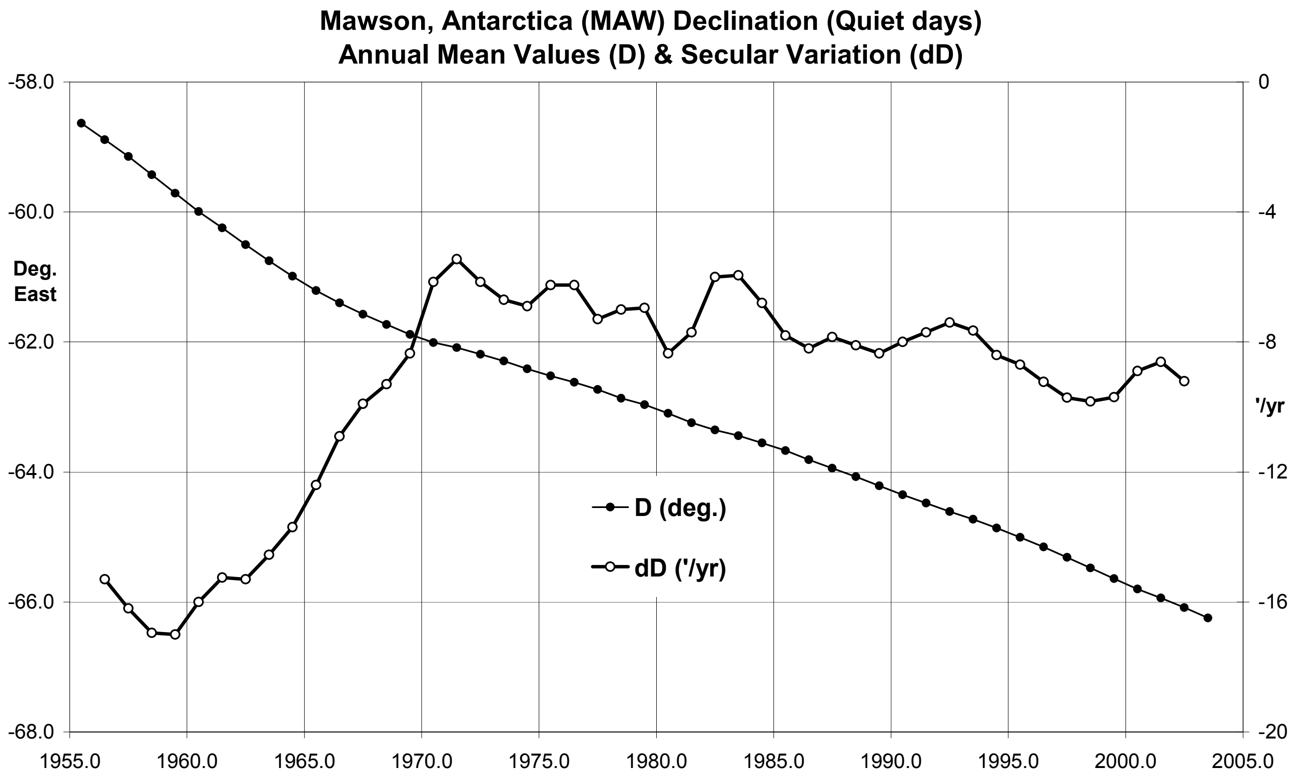


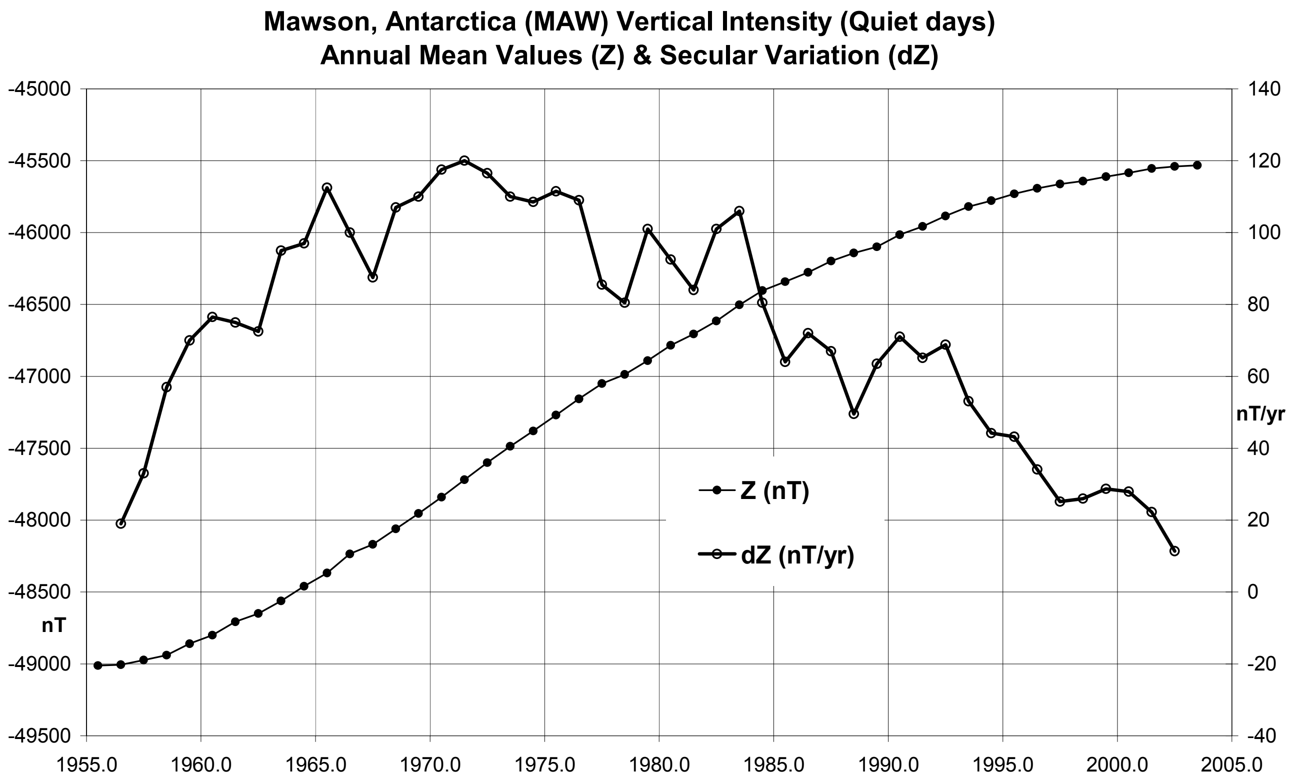
Mawson Stn. 2003 Vertical intensity (Z). Scale: 40.0 nT/mm. Mean: −45546 nT

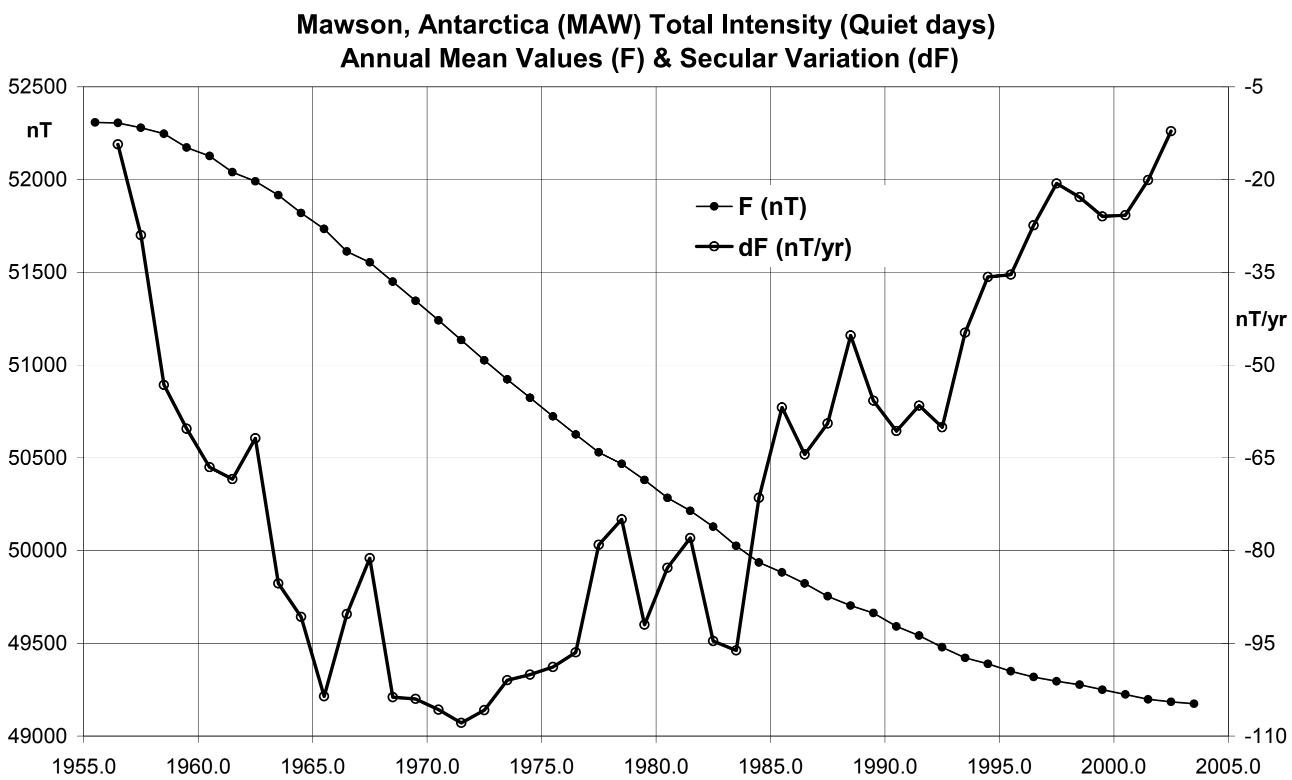
Mawson Stn. 2003 Total intensity (F). Scale: 40.0 nT/mm. Mean: 49177 nT




Mawson, Antarctica (MAW) Horizontal Intensity (Quiet days)
Annual Mean Values (H) & Secular Variation (dH)
nT
nT/yr
H (nT)
dH (nT/yr)
18700.0
18600.0
18500.0
18400.0
18300.0
18200.0
20
10
0
-10
-20
-30
1955.0
1960.0
1965.0
1970.0
1975.0
1980.0
1985.0
1990.0
1995.0
2000.0
2005.0


Mawson, Antarctica (MAW) Declination (Quiet days)
Annual Mean Values (D) & Secular Variation (dD)
Deg.
East
'/yr
D (deg.)
dD ('/yr)
-58.0
-60.0
-62.0
-64.0
-66.0
-68.0
0
-4
-8
-12
-16
-20
1955.0
1960.0
1965.0
1970.0
1975.0
1980.0
1985.0
1990.0
1995.0
2000.0
2005.0





MAW – Notes and Errata (cumulative since *AGR'93*)

In *AGR1998* through to *AGR2001* the principle azimuth mark at Mawson (MAW) was reported as being BMR89/2 at an azimuth of 19° 14.0' and distance of 105m from principle observation Pier A. This mark ceased to be used after May 1998, from when mark BMR89/1 was principally used.

Summary of data loss in the Australian observatories in 2003

The table below summarizes the 2003 monthly digital data acquisition losses, in minutes per month, at the Australian observatories. The first figure refers to the principal 3-component variometers and the second figure (in parentheses) to the recording total intensity instruments. A single figure indicates the same data loss in a month for both instruments. Annual totals and percentage losses are also shown.

For details of events that resulted in loss of data, including the contamination of data subsequently excluded from processing, see the sections entitled *Significant Events* and *Data Loss* contained in the respective observatory descriptions in this report.

2003	KDU	CTA	LRM	ASP	GNA	CNB	MCQ	CSY	MAW
Jan	0	0	0	0	0	0	0	156	3
Feb	0	0	7 (4,250)	0 (5)	0	0	0	140	0
Mar	0	0	24 (10,818)	1 (19,392)	3,373	0 (51)	30 (29)	155	3,480
Apr	0	0	0	0	10,488 (10,493)	0	0	150	2,597 (2,718)
May	0	0	18 (0)	63 (347)	0	0	0	155	0
Jun	0	0 (7,242)	144 (1)	0	0	0	0	150	991
Jul	0	0 (22,746)	0	5 (6)	0	0	0	155	0
Aug	154 (22,383)	0 (19,270)	0	0	0	0 (292)	0	181	2636
Sep	0 (43,200)	0	0	0 (27,160)	0	0 (204)	1 (0)	150	3715
Oct	0 (42,724)	0	0	1 (23,449)	6,139 (7,445)	0 (4,168)	0	155	40
Nov	0 (42,240)	0	0	0 (43,200)	0 (5,795)	0 (55)	3 (0)	150	0
Dec	10,192 (12,065)	1,370 (1,372)	0	0 (44,640)	85 (1,827)	0	0	1282	0
3-axis variom.	10,346 (1.97%)	1370 (0.26%)	193 (0.037%)	70 (0.013%)	20,085 (3.82%)	0 (0.0%)	34 (0.006%)	2,979 (0.57%)	13,462 (2.56%)
Total field	162,612 (30.9%)	50,630 (9.63%)	15,069 (2.87%)	158,199 (30.1%)	28,933 (5.50%)	4770 (0.91%)	29 (0.006%)	no PPM	13,583 (2.58%)

International Quiet & Disturbed Days

2003	Quietest days 1 - 5					Quietest days 6 - 10					Most Disturbed days 1 - 5				
January	9	8	6	16	7	2	15A	17A	13A	5A	25	30	26	23	22*
February	25	24	13A	11A	23A	22A	17A	12A	7A	19A	2	4	27	3	15
March	25	24	26A	12A	8A	9A	2A	11A	19A	13A	17	31	30	29	4
April	7	12A	6A	13A	19A	27A	20A	28A	11A	26A	30	25	16	4	5
May	4	17A	18A	16A	3A	20A	19A	5A	23A	2A	29	30	1	8	7
June	12A	13A	5A	20A	22A	11A	6A	19A	25A	26A	18	17	28	16	2
July	8	9	22	21A	10A	24A	1A	25A	23A	6A	11	16	12	29	31
August	31	5A	16A	27A	4A	10A	11A	26A	15A	3A	18	21	22	1	23
September	28	14	29	7	30	15K	8K	27K	6A	13A	17	18	24	19	16
October	11	10	12	23	4K	5K	8	2A	9A	6A	29	30	31	14	21
November	28	27	29	5K	8A	26A	7A	19A	30A	3A	20	11	13	16	15
December	19	3	18	25	29K	30K	4K	24	2A	17A	10	11	5	8	9

Notes: If any of the selected quietest days were not truly quiet, they have been identified: with an A if the daily Ap index is > 6; or with a K if either one Kp index ≥ 3_o or two Kp indices ≥ 3_- occurred during the day.

If any of the 5 most disturbed days have an index Ap < 20 they are identified with an *.

International Quiet & Disturbed Day information was supplied by the International Service of Geomagnetic Indices (ISGI), International Union of Geodesy and Geophysics (IUGG), Association of Geomagnetism and Aeronomy (IAGA), edited by Institut für Geophysik, Göttingen, Germany.

GA maintains a network of repeat stations throughout mainland Australia, its offshore islands, and the south-west Pacific region. The repeat stations are usually occupied at intervals of approximately two years to determine the secular variation of the magnetic field. During each 3−4 day repeat station occupation, four components of the magnetic field are monitored continuously with a portable on-site 3-axis fluxgate variometer and a total field magnetometer.

During 2003 a Narod ring-core fluxgate magnetometer was used to monitor variations in three (nominally orthogonal) components of the magnetic field. The digital output from this magnetometer was recorded as 1-second and 1-minute means with a portable industrial computer running an MS-DOS data acquisition system. A GEM Systems GSM90 overhauser-effect total field magnetometer was used to monitor the total magnetic intensity. The digital output from the total field magnetometer was recorded at a sampling interval of 10 seconds.

The magnetometers, acquisition and recording system were all powered by either two 12V batteries and solar panels or 240V ac mains power, depending on the location. Preliminary data processing and analysis was done on-site on a lap-top computer.

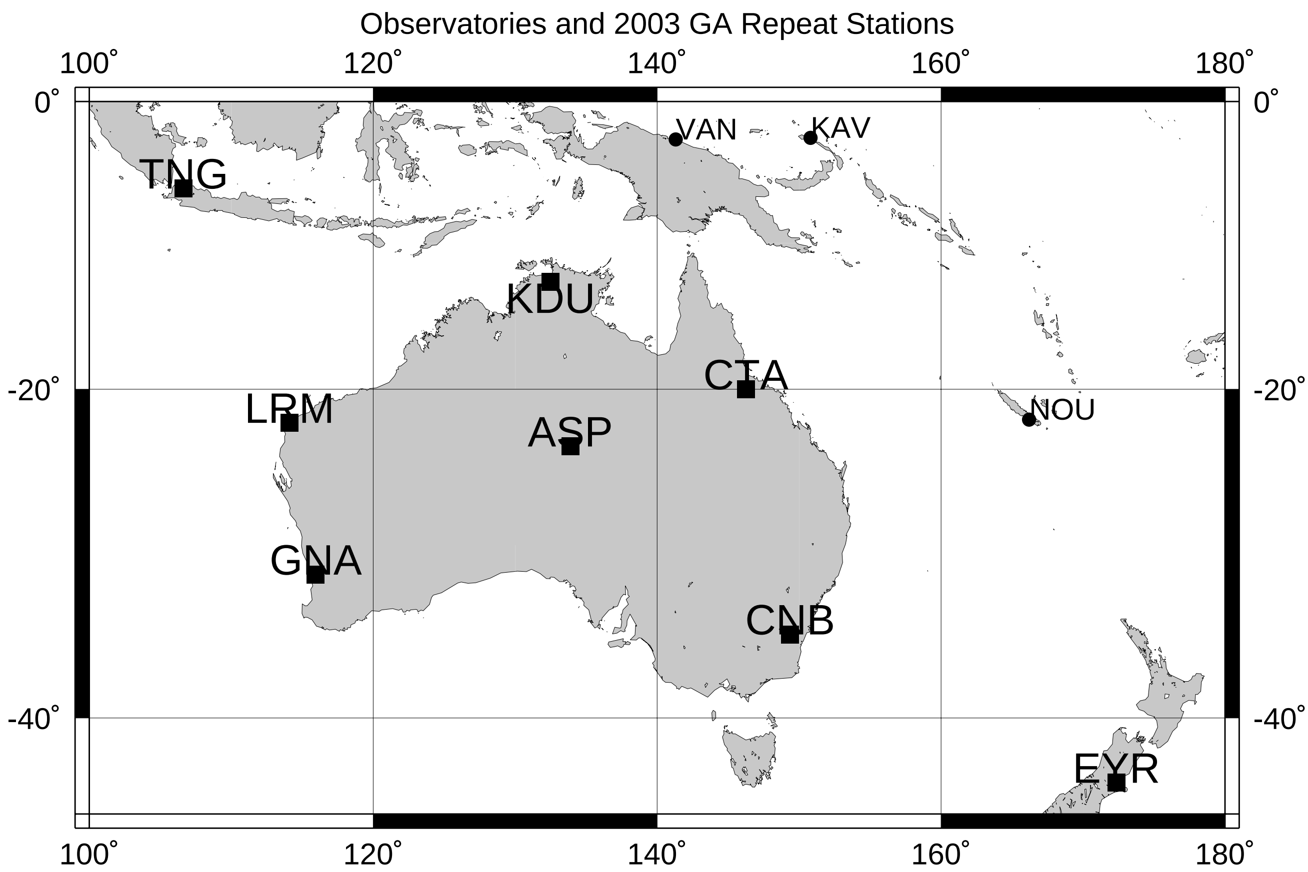
The variometer recordings were calibrated to observatory standard with a campaign of absolute magnetic observations made during each station occupation. Usually from 24 to 30 sets of absolute observations were performed on each primary repeat station. Vector field differences between the primary and secondary station at each site were also measured. Azimuths from both primary and secondary stations were checked and total field gradient surveys around each station were undertaken.

The absolute instruments used on the repeat station surveys during 2003 were Elsec 810 DIM, no. 220 with Zeiss 020B theodolite, no. 308887, and GEM Systems GSM90 no. 810881 with sensor no. 31960. The GSM90 was also used for total field surveys around each station.

The normal or quiet level of the magnetic field at each repeat station was determined by analysing the calibrated on-site variometer record with reference to the quiet level of the magnetic field derived from a three month period of suitable observatory data.

The average annual rate of change of the field over the time between station occupations was determined by first differences between the adopted normal field values at the repeat station and the adopted normal field value from the previous occupation of the station.

The distribution of permanent magnetic observatories and repeat stations occupied in 2003



Station occupations in 2003

Three repeat stations were re-occupied in October 2003: Kavieng (KAV) and Vanimo (VAN), both in Papua New Guinea; and Noumea (NOU) in New Caledonia. The map above shows the location of these repeat stations and the permanent magnetic observatories in the region.

The adopted normal field values at the time of the 2003 occupations and the average secular variation over the interval between the two most recent occupations for each station are shown in the tables below.

The results of the 2003 and earlier occupations of these stations are shown in the figures that follow the text.

Adopted Main Field Values at Time of Station Occupations

Station (site)	Occupation	X (nT)	Y (nT)	Z (nT)	F (nT)	H (nT)	D	I
Kavieng (C)	2003/10/03	36243	3923	-13340	38819	36455	06° 10.6’	-20° 05.9’
Vanimo (B)	2003/10/08	36983	2709	-14747	39907	37082	04° 11.4’	-21° 41.2
Noumea (B)	2003/10/14	31360	7007	-35577	47940	32133	12° 35.7’	-47° 54.7

Average Secular Variation between two most recent Occupations

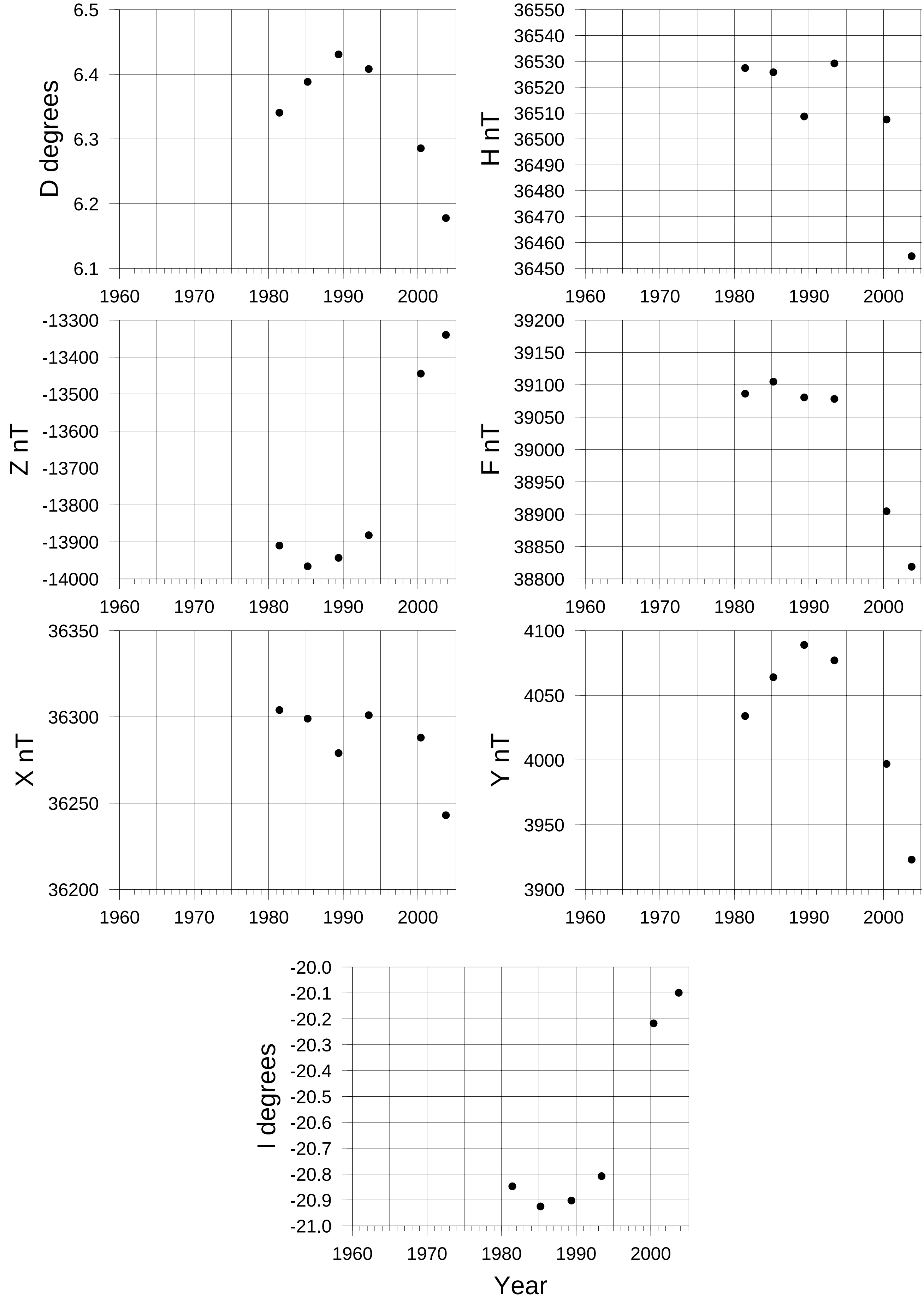
Station (site)	Previous occupation	ΔX (nT/yr)	ΔY (nT/yr)	ΔZ (nT/yr)	ΔF (nT/yr)	ΔH (nT/yr)	ΔD (′/yr)	ΔI (′/yr)
Kavieng (C)	2000/05/23	-17	19	31	-25	-15	1.9	2.1
Vanimo (B)	2000/05/30	-21	-14	25	-30	-22	-1.1	1.3
Noumea (B)	2000/05/11	-17	-17	33	-38	-20	-1.4	0.5

Australian Geomagnetic Reference Field

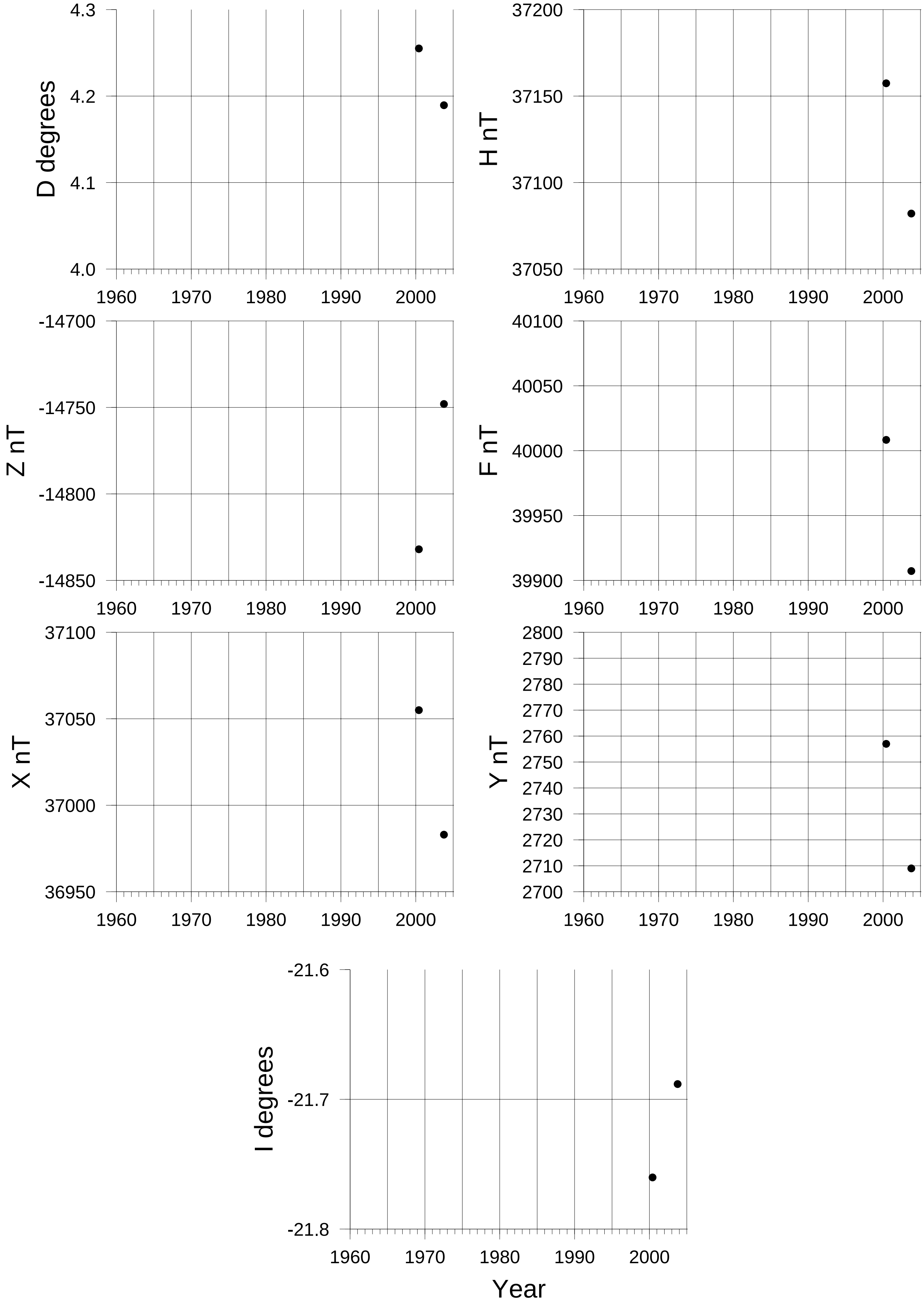
The latest revision of the Australian Geomagnetic Reference Field was for epoch 2000.0 (AGRF00) that was released in 2000 (Lewis, 2000). It is considered the best available geomagnetic field model for direction-finding applications in the Australian region. Charts in each of the magnetic elements X, Y, Z, F, H, D and I from the AGRF00 model are in the *AGR00*. The next AGRF model will be developed for 2005.0.

Epoch charts over the region have been produced on a regular basis since 1944. An Australian Geomagnetic Reference Field model (AGRF) has been produced every five years since 1980. These were listed in the *Charts and Models* table that appeared in *AGRs 1993-1997*.

KAV


D degrees
6.5
6.4
6.3
6.2
6.1
H nT
36550
36540
36530
36520
36510
36500
36490
36480
36470
36460
36450
Z nT
-13300
-13400
-13500
-13600
-13700
-13800
-13900
-14000
F nT
39200
39150
39100
39050
39000
38950
38900
38850
38800
X nT
36350
36300
36250
36200
Y nT
4100
4050
4000
3950
3900
I degrees
-20.0
-20.1
-20.2
-20.3
-20.4
-20.5
-20.6
-20.7
-20.8
-20.9
-21.0
1960
1970
1980
1990
2000
Year

VAN


D degrees
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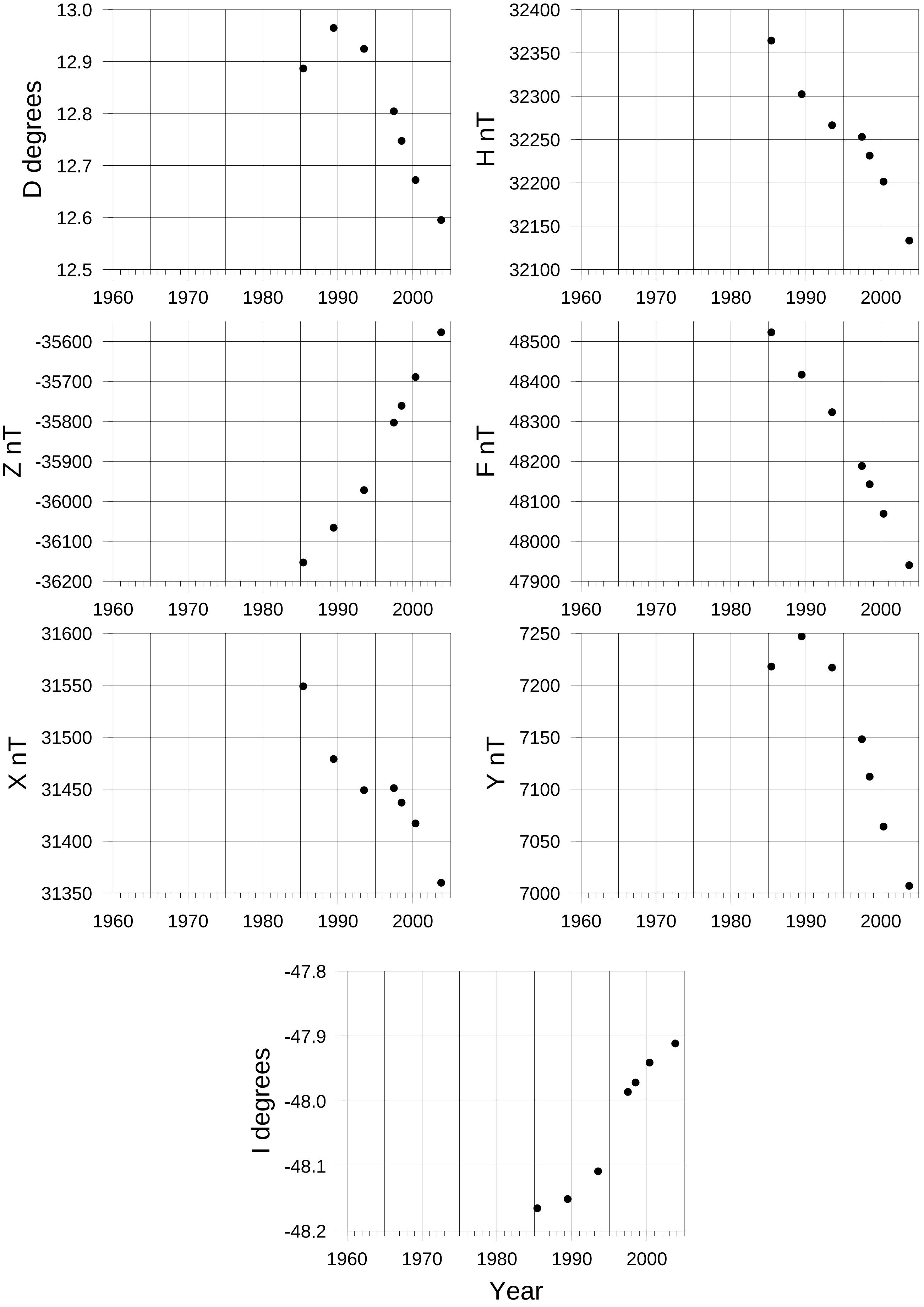
4.2
4.1
4.0
H nT
37200
37150
37100
37050
Z nT
-14700
-14750
-14800
-14850
F nT
40100
40050
40000
39950
39900
X nT
37100
37050
37000
36950
Y nT
2800
2790
2780
2770
2760
2750
2740
2730
2720
2710
2700
I degrees
-21.6
-21.7
-21.8
1960
1970
1980
1990
2000
Year

NOUMEA B


D degrees
13.0
12.9
12.8
12.7
12.6
12.5
H nT
32400
32350
32300
32250
32200
32150
32100
Z nT
-35600
-35700
-35800
-35900
-36000
-36100
-36200
F nT
48500
48400
48300
48200
48100
48000
47900
X nT
31600
31550
31500
31450
31400
31350
Y nT
7250
7200
7150
7100
7050
7000
I degrees
-47.8
-47.9
-48.0
-48.1
-48.2
1960
1970
1980
1990
2000
Year

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Geomagnetism Staff List 2003

Name	Classification	Responsibility
Charles E. Barton	GA Level 8	Section Head (until October 2003)
Peter A. Hopgood	GA Level 6	Project Leader
Peter G. Crosthwaite	GA Level 5	Digital acquisition, system and software development and maintenance; Kakadu & Gnangara observatories
Andrew M. Lewis	GA Level 5	Project Leader, Repeat Station Survey, Alice Springs & Learmonth observatories
Liejun Wang	GA Level 4	Data-base development; Canberra & Charters Towers observatories
Nick Bartzis	GA Level 2 (from 29 Oct. 2002)	Observatories
Bruce Sibson	GA Level 3	Technical support
Owen D. McConnel	GA Level 3	Technical support, Western Australia*

* The Mundaring Geophysical Observatory was closed at the end of April 2000. Only one member of staff (ODM) remained with Geoscience Australia after that time. This officer provided technical support for the Gnangara and Learmonth magnetic observatories as well as the seismograph network in Western Australia.

Non-GA Observers/OICs

Warren Serone	ACRES (contracted by GA)	Alice Springs
Jack M. Millican	Contracted by GA	Charters Towers
Graham Steward	Learmonth Solar Observatory, IPS	Learmonth
Kim Stellmacher	Contracted by GA	Kakadu (to July 2003)
Anita Hudd	Contracted by GA	Kakadu (August to November 2003)
[Rory Lynch	Contracted by GA	Kakadu (from January 2004)]
Gerard (Hans) Van Reeken	Contracted by GA	Gnangara
Kerry Steinberner	Technical Officer 2 (on contract) (shared by GA & BoM)	Mawson (2003 observer) (from December 2002)
Ray Hegarty	Technical Officer 2 (on contract) (shared by GA & BoM)	Mawson (2004 observer) (from November 2003)
Peter Pokorny	Technical Officer 2 (AAD)	Macquarie Island (2002/03 observer)
Henry Banon	Technical Officer 2 (AAD)	Macquarie Island (2003/04 observer)
Brent Harper	Technical Officer 2 (AAD)	Casey, 2003 observer

End of Part 2