Australian Government
Geoscience Australia

AUSTRALIAN GEOMAGNETISM REPORT 2001

MAGNETIC OBSERVATORIES

VOLUME 49

Department of Industry, Tourism and Resources

Minister for Industry, Tourism & Resources:	The Hon. Ian Macfarlane
Parliamentary Secretary:	The Hon. Warren Entsch
Department Secretary:	Mark Paterson

Geoscience Australia

Chief Executive Officer: Neil Williams

Minerals & Geohazards Division

Chief of Division: Chris Pigram
Associate Chief: Wally Johnson

Australian Geomagnetism Report

2001

Volume 49

Geomagnetism Section
Geoscience Australia Earth Monitoring
Geoscience Australia
G.P.O. Box 378
Canberra, A.C.T., 2601
AUSTRALIA

Australian Government

Geoscience Australia

Magnetic results for 2001

Alice Springs

Canberra

Charters Towers

Gnangara

Kakadu

Learmonth

Macquarie Island

Mawson

Casey

Davis

Australian Repeat Station Network

Compiled by P.A. Hopgood

with contributions by

A.M. Lewis, P.G. Crosthwaite, Liejun Wang

and A.D. Costar

ISSN: 1447-5146 (Online format)

ISSN: 1035-1515 (Printed format)

SUMMARY

During 2001 the Australian Geological Survey Organisation (now Geoscience Australia) operated geomagnetic observatories at Alice Springs and Kakadu in the Northern Territory, Canberra in the Australian Capital Territory, Charters Towers in Queensland, Gnangara and Learmonth in Western Australia, Macquarie Island, Tasmania, in the sub-Antarctic, and Mawson in the Australian Antarctic Territory.

Magnetic recording also took place at the stations of Casey and Davis in the Australian Antarctic Territory. These operations were the joint responsibility of the Australian Antarctic Division of the Commonwealth Department of the Environment and Heritage and GA. Casey was operated at magnetic observatory standard. Davis magnetic station did not have sufficient absolute control to be considered observatory standard, so continued to be regarded as a variation station. In 2001 Geoscience Australia ceased support for the processing of geomagnetic data acquired at the Davis station.

The absolute magnetometers in routine service at the Canberra Magnetic Observatory also serve 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 to 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 and at Copenhagen, Denmark, as well as to INTERMAGNET. K indices, principal storms and rapid variations were hand-scaled for the Canberra and Gnangara observatories, and provided regularly to the International Service of Geomagnetic Indices. K indices were digitally scaled at 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.

No magnetic repeat stations were occupied in 2001.

Further upgrades were made to the magnetic observatory at Tangerang and the upgrade of the observatory at Manado, Indonesia took place in 2001. This was carried out by GA's Geomagnetism group under an AusAID grant. It included the purchase of instrumentation and the training of staff from Indonesia's BMG, at GA in 2000.

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 2001.

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

CONTENTS

Contents continued …

Part 2

End of Part 2

This is the third volume of the *Australian Geomagnetism Report* to be made available in electronic format only.

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

The *Australian Geomagnetism Report* will continue to be published electronically and will be available on Geoscience Australia's web site: *http://www.ga.gov.au/*

Released: 5 May 2004

Part 2

KAKADU OBSERVATORY

The Kakadu Magnetic Observatory is a part of the Kakadu Geophysical Observatory, located at the South Alligator Ranger Station of the Australian Nature Conservation Agency, Kakadu National Park, which is 210km east of Darwin and 40km west of Jabiru, on the Arnhem Highway in the Northern Territory. The observatory is situated on unconsolidated ferruginous and clayey sand. The Geophysical Observatory also houses a Seismological Observatory and a Gravity Station. Continuous magnetic recording began there in March 1995.

The observatory comprises:

- a 3m x 3m air-conditioned concrete-brick control house, with concrete ceiling, and aluminium cladding and roof, where all recording instrumentation and control equipment is housed;
- a 3m x 3m roofed absolute shelter, 50m NW of the control house, that houses a 380mm square fibre-mesh-concrete observation pier (Pier A), the top of which is 1200mm from its concrete floor;
- two 300mm diameter azimuth pillars that are both about 100m from Pier A at approximate true bearings of 27° and 238°;
- two 600mm square underground vaults that house the variometer sensors, both located 50-60m from the control house, one to the SSW and one to the WSW. Cables between the sensor vaults and the control house are routed via underground conduits.
- a concrete slab, with tripod foot placements and marker plate, used as an external reference site (at a standard height of 1.6m above the marker plate). The marker plate is 60m, at a bearing of 331°, from the principal observation pier A.

Details of the establishment of the Kakadu observatory are in the *AGR 1994* and *AGR 1995*.

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

- 3-character IAGA code: KDU
- Commenced operation: 05 March 1995
- Geographic ‡ latitude: 12° 41' 10.9" S
- Geographic ‡ longitude: 132° 28' 20.5" E
- Geomagnetic† : Lat. -21.99°; Long. 205.44°
- Elevation above mean sea level (top of pier): 14.6 metres
- Lower limit for K index of 9: 300 nT.
- Azimuth of principal reference pillar (AW) from Pier A: 237° 52.8'
- Distance to Pillar AW: 99.6 metres

† Based on the IGRF 2000.0 model updated to 2001.5.
‡ Geodetic Datum of Australia 1994 (GDA 94)

- Observer in Charge: Kim Stellmacher

Variometers

Variations in the magnetic NW, NE and vertical components of the magnetic field were monitored at Kakadu in 2001 using a suspended 3-axis linear-fluxgate DMI FGE magnetometer with sensor no. S0183 and electronics no. E0198. An analogue-to-digital converter was integrated with the electronics module.

The total magnetic field intensity, F, was monitored using a Geometrics model 856 proton precession magnetometer no. 50707.

Analogue variometer data from the three fluxgate channels, together with the fluxgate sensor head and electronics temperature channels, were converted to digital data with an ADAM 4017 analogue-to-digital converter mounted inside the fluxgate electronics module. These digital data together with the digital PPM data were recorded on an IBM compatible PC.

The recording and variometer-control equipment was located in the air-conditioned control house set to 23°C.

The variometer sensor heads were located in the concrete underground vaults: the DMI fluxgate head in the northern vault (the one nearest the Absolute Shelter); and the PPM head in the southern vault. Both vaults were completely buried in soil to minimise head temperature fluctuations. Both the fluxgate and PPM electronics consoles were placed in their own partially insulated plastic box, resting on the concrete base in the vault, with some bricks for heat-sinks to minimise temperature fluctuations. This proved to be effective in reducing the amplitude of temperature fluctuations with periods of the order of hours.

The equipment was protected from power blackouts, surges and lightning strikes by a mains filter, an uninterruptible power supply and a surge absorber. The variometer PPM cable was a double-screened marine armoured cable, with the outer shield (armour) earthed, and the inner shield attached to equipment earth. The data connections between the acquisition computer and both the ADAM A/D and the PPM variometer were via fibre-optic modems and several metres of fibre-optic cable to isolate damage from lightning entering the system through any one piece of equipment.

The observatory was also protected from lightning by an ERICO System 3000 (Advanced Integrated Lightning Protection), consisting of a Dynasphere Air Termination unit, mast, and copper-coated steel rod designed to protect an 80m radius area around the sphere. There were also lengths of copper ribbon and aluminium power cables buried in a shallow trenches towards the Absolute Shelter, in the opposite direction, and from the control hut to and around both variometer sensor pits, and a conducting loop around the Control Hut. All of these lightning protection components were connected together. (See *AGR2000* for further details.)

The DMI FGE variometer sensitivity, alignment, and temperature sensitivity model was measured at the Canberra Magnetic Calibration Facility before dispatch to Kakadu. The sensor assembly was aligned with the Z fluxgate sensor vertical, and the other two fluxgate sensors horizontal, each aligned at 45° to the declination at the time of installation. This was achieved by setting the X and Y offsets equal and rotating the instrument until the X and Y ordinates were equal. This method was found to be accurate by tests performed at the Magnetic Calibration Facility. (See *AGR 2000* for details.)

Baselines

The adopted DMI variometer baselines for 2001 have standard errors of 0.4nT in F, X, and Z, 0.9nT in Y, 5" in D and 2" in I.

When the PPM was working properly, F-check varied in a 2nT range during 2001. When the PPM was working very well, the daily range in F-check was less than 0.2nT.

F-check is more scattered during the southern summer/monsoon season because of lightning-induced spikes on the PPM data, particularly in the afternoon and evening.

Absolute Instruments & Corrections

The principal absolute magnetometers used at Kakadu in 2001 were a declination-inclination magnetometer, DIM: Bartington type MAG010H fluxgate sensor (no. B0622H) mounted on a Zeiss 020B non-magnetic theodolite (no. 359142), and a proton precession magnetometer, PPM: Elsec model 770 (no. 189).

As described in the *AGR1998*, the best way to use this DIM was to take all readings on the x10 scale, but to switch to the x1 scale while rotating the theodolite. Additionally, the theodolite should be rotated so that the objective lens passes exclusively through positive field values (or alternatively exclusively through negative field values). This method was used at KDU throughout 2000.

DIM measurements were made using the *offset* method, where the theodolite was set to a whole number of minutes to give a small fluxgate reading and then a series of eight fluxgate vs. time measurements were recorded without moving the theodolite.

All DIM and PPM measurements were made on Pier A at the standard height.

Instrument corrections that were applied to the absolute magnetometers used at Kakadu in 2001 were determined through a series of instrument comparisons performed in October 2000. These comparisons were consistent with those performed in May 1998.

KDU data in this report have been aligned with the new Australian Total Intensity Standard: Gem Systems GSM90 No. 905926 with Sensor No. 81241.

The corrections adopted for the Kakadu absolute instruments for 2001 were 0.0′, 0.0′ in D and I for the DIM, and −2.3 nT in F for the PPM. At the mean magnetic field values at Kakadu these translate to corrections of:

$\Delta X = -1.7nT \quad \Delta Y = -0.1nT \quad \Delta Z = +1.5nT.$

These instrument corrections have been applied to the 2001 data in this report. (The change in F standard from previous reports results in a change in X and Z baselines of only a few tenths nT.)

During 2000, the difference between the KDU absolute Elsec 770 PPM and variometer Geometrics 856 PPM varied smoothly within a 3nT range, the peak and trough occurring approximately in mid-summer and mid-winter respectively. This could have been due to an undetermined temperature coefficient of the absolute Elsec 770 PPM. The performance of the Geometrics 856 during 2001 was not good enough to confirm this behaviour. No corrections have been made to the data to correct this effect.

Operations

1-second and 1-minute mean magnetic data were acquired at the Kakadu observatory in 2001. Accurate timing was maintained by a GPS clock attached to the acquisition computer. Only the 1-second time pulse from the clock was used (and not the actual data stream from the clock). This kept the acquisition clock to within 0.1 seconds of UTC.

Although some lightning protection measures were included in the original construction of the Kakadu observatory in 1995, that were enhanced in both December 1998 and October 1999, the observatory has suffered damage from lightning a number of times. Damage from electrical storms was avoided during the 1998/1999, 1999/2000 and 2000/2001 wet seasons. However, on 14 October 2001, damage (probably from lightning entering through the power and/or telephone lines) caused the computer, modem, power, and telecommunications to fail.

A faulty UPS caused erratic behaviour of the DMI fluxgate variometer and degraded data quality from 0034 on 19 September 2001 until the UPS was replaced at 0346 on 30 September 2001.

No data were collected from 14 October (electrical storm damage) until 02 November 2001, when the acquisition computer and modem were replaced. It appears that the acquisition time was not set correctly at that time. A -07m06s time correction was made at 00:23:00 on 7 November. This same correction has been applied to all data from 02 November to that time. Accurate timing was not possible until 21 November when telecommunications were restored and daily remote time corrections were made. It is likely that there were clock errors of up to 10s from 2 November until the computer clock rate was adjusted on 28 November. On 8 December, a replacement GPS clock was installed and excellent timing resumed as before 14 October. (Timing is accurate to 0.1s when the GPS clock is working).

On 24 December 2001, the DMI fluxgate variometer suddenly behaved erratically: the electronics temperature increased, the baselines changed (F-check changed by 80nT and then drifted by 20nT/day) and noise on all magnetic channels developed. No vector data from 00:25:33 on 24 December is valid observatory-quality data, although it may serve as degraded variation data. The F variometer continued unaffected.

Communications to the observatory (for data telemetry and time checking & correction) were poor from 12 May 2001 throughout the rest of May and June, probably due to a line fault between the PABX in the ranger's station and the geophysics hut. Communications was lost on 14 October (following damage from electrical storm) until 21 November 2001.

During a service visit on 11 July, the fluxgate pit was uncovered by mistake (while investigating the variometer-F problem). There was some temporary disturbance to the data, but no apparent long term baseline shift.

The Geometrics total field variometer generally behaved poorly during 2001. This was particularly the case from 04-28 May and from 6 June to 11 July. Although the sensor was replaced on 11 July, it is likely that a simultaneous change in cable capacitance to 6.3nF improved signal strength and decreased noise. It failed on 9 August after a power failure and did not function again until 28 August (except for two brief periods due to hang-ups in the firmware and incorrect parameters on re-installation). The F-check data quality monitoring was therefore poor for much of 2001.

When possible, absolute observations were performed weekly by the local observer in charge. The operation of the observatory was checked weekly by the observer. Completed absolute observation forms were sent weekly to GA in Canberra by mail, and were reduced and used to calibrate the variometer data.

Data were retrieved daily by standard telephone-line modem connection, usually at 9600 to 14400 baud when it was operational, otherwise they were sent on floppy disc by mail weekly.

The control house containing the variometer electronics was maintained at a temperature of about 23°C. The DMI electronics and sensor temperatures varied with a typical daily variation of less than 0.2°C. DMI electronics no. E0198 temperature was 27.0±1.0°C during 2001.

continued …

KDU Operations (cont.)

The DMI sensor no. S0183, although buried underground, varied between 26.5°C to 33.5°C during 2001. The most rapid and prolonged temperature change was a warming during September of 0.1°C/day.

Significant Events 2001

Feb 19 until Mar 21: Observatory unattended.

Apr 04 Rain cap on northern (fluxgate sensor) vault removed and refitted to insert foam in an attempt to reduce diurnal temperature variations.

May 03 Considerable degradation of variometer PPM performance.

May 12 Telecommunications failed, apparently due to line fault from PABX to Geophysical Observatory. The connection remained poor and intermittent throughout May and June.

Jun 06 Attempt to fix variometer-F data problem by exchanging PPM electronics (from G856 #50707 to #50702) failed, and the original system #50707 left in place.

Jul 11 Visit by GA officer to correct PPM variometer. PPM variometer electronics found to be satisfactory. Fluxgate vault was mistakenly disturbed. Replaced G856 #50707 sensor with one from #50702 and changed G856 settings to capacitance 063 (=6.3nF) obtaining signal strength > 10. Both pits reburied, with no apparent change to baselines of fluxgate-variometer. The diurnal temperature range of the fluxgate electronics increased after this time, for no known reason.

Aug 09 Power failure. F-variometer did not restart when power supply resumed.

Aug 15 F-variometer reset but memory filled same day and data ceased.

Aug 23 F-variometer reset but memory filled same day and data acquisition ceased.

Aug 29 F-variometer reset.

Sep 17 UPS misbehaving. This caused the variometer baselines to change suddenly on Sep 19 and become slightly unstable.

Sep 30 UPS replaced and variometer stabilised.

Oct 14 Mains power supply and telecommunications failed during an electrical storm.

Oct 16 Mains power supply resumed (open circuit breaker outside the observatory), but still no telecommunications. Acquisition computer and modem had also failed.

Nov 02 Replacement acquisition computer and modem installed, but still no telecommunications.

Nov 07 Time check by local operator indicated the acquisition time is 07m 06s fast. Corrected at 00:23:00.

Nov 15 Acquisition computer accidentally switched off while copying data to floppy disc. Small data loss.

Nov 21 Acquisition time 6 seconds out: this was corrected. Telecommunications fixed.

Nov 22 GPS clock appears to have failed - probably on October 14.

Dec 08 GPS clock replaced and working. Receiver found to have actually failed.

Dec 18 Contract observer absent until late January 2002.

Dec 24 DMI variometer suddenly became erratic and noisy.

Kakadu 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 58-59.

Year	Days	D (Deg	Min)	I (Deg	Min)	H (nT)	X (nT)	Y (nT)	Z (nT)	F (nT)	Elts*
1995.583	A	3	42.6	-40	42.4	35364	35290	2288	-30424	46650	ABC
1996.728	A	3	42.7	-40	37.9	35397	35323	2292	-30373	46642	ABC
1997.455	A	3	42.9	-40	35.3	35409	35334	2294	-30336	46626	ABC
1998.5	A	3	43.7	-40	31.2	35416	35341	2303	-30269	46589	ABC
1999.5	A	3	44.2	-40	27.4	35432	35357	2309	-30216	46566	ABC
2000.5	A	3	44.3	-40	24.5	35431	35356	2310	-30163	46531	ABC
2001.5	A	3	44.3	-40	21.7	35437	35362	2310	-30118	46507	ABC
1995.583	Q	3	42.7	-40	41.8	35376	35302	2290	-30425	46660	ABC
1996.728	Q	3	42.8	-40	37.6	35403	35328	2292	-30372	46646	ABC
1997.455	Q	3	42.9	-40	34.7	35419	35345	2295	-30335	46634	ABC
1998.5	Q	3	43.6	-40	30.7	35426	35351	2303	-30269	46596	ABC
1999.5	Q	3	44.2	-40	26.9	35442	35367	2310	-30215	46573	ABC
2000.5	Q	3	44.3	-40	23.7	35446	35370	2312	-30161	46541	ABC
2001.5	Q	3	44.4	-40	20.9	35452	35376	2312	-30116	46517	ABC
1995.583	D	3	42.4	-40	43.1	35350	35276	2286	-30426	46641	ABC
1996.728	D	3	42.7	-40	38.3	35389	35315	2291	-30373	46636	ABC
1997.455	D	3	42.8	-40	36.1	35393	35319	2292	-30337	46615	ABC
1998.5	D	3	43.6	-40	32.8	35385	35310	2300	-30273	46568	ABC
1999.5	D	3	44.2	-40	28.5	35411	35336	2308	-30218	46552	ABC
2000.5	D	3	44.2	-40	26.0	35403	35328	2307	-30166	46512	ABC
2001.5	D	3	44.2	-40	23.1	35410	35335	2307	-30121	46488	ABC

- Elements ABC indicates non-aligned variometer orientation

Kakadu 2001 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.

KAKADU	2001	X (nT)	Y (nT)	Z (nT)	F (nT)	H (nT)	D (East)	I
January	All days	35374.9	2308.8	-30138.1	46529.7	35450.1	3° 44.1'	-40° 22.2'
	5xQ days	35387.5	2313.1	-30137.3	46539.0	35463.0	3° 44.4'	-40° 21.5'
	5xD days	35363.9	2305.1	-30138.0	46521.1	35438.9	3° 43.8'	-40° 22.7'
February	All days	35376.9	2309.7	-30132.1	46527.4	35452.2	3° 44.1'	-40° 21.7'
	5xQ days	35383.3	2312.3	-30131.1	46531.8	35458.8	3° 44.3'	-40° 21.4'
	5xD days	35366.6	2308.0	-30132.7	46520.0	35441.9	3° 44.0'	-40° 22.3'
March	All days	35357.6	2309.4	-30129.1	46510.9	35433.0	3° 44.2'	-40° 22.5'
	5xQ days	35381.7	2311.5	-30124.8	46526.5	35457.1	3° 44.3'	-40° 21.1'
	5xD days	35292.8	2302.0	-30133.2	46463.9	35367.8	3° 43.9'	-40° 25.9'
April	All days	35337.6	2309.0	-30130.3	46496.4	35413.0	3° 44.3'	-40° 23.5'
	5xQ days	35356.1	2309.9	-30126.4	46508.0	35431.5	3° 44.3'	-40° 22.4'
	5xD days	35307.9	2306.7	-30134.9	46476.7	35383.2	3° 44.3'	-40° 25.2'
May	All days	35362.2	2311.5	-30122.4	46510.1	35437.7	3° 44.4'	-40° 21.9'
	5xQ days	35373.2	2312.7	-30120.2	46517.1	35448.7	3° 44.4'	-40° 21.2'
	5xD days	35332.8	2308.6	-30125.6	46489.7	35408.2	3° 44.3'	-40° 23.5'
June	All days	35366.8	2311.9	-30118.0	46510.8	35442.3	3° 44.4'	-40° 21.4'
	5xQ days	35372.3	2313.5	-30116.7	46514.2	35447.9	3° 44.5'	-40° 21.1'
	5xD days	35354.5	2311.9	-30118.2	46501.6	35430.0	3° 44.5'	-40° 22.0'
July	All days	35369.9	2312.4	-30113.7	46510.3	35445.4	3° 44.4'	-40° 21.0'
	5xQ days	35375.4	2311.9	-30112.9	46514.0	35450.9	3° 44.3'	-40° 20.7'
	5xD days	35363.8	2311.4	-30114.6	46506.3	35439.3	3° 44.4'	-40° 21.4'
August	All days	35368.4	2311.4	-30109.7	46506.5	35443.8	3° 44.3'	-40° 20.9'
	5xQ days	35373.4	2310.9	-30109.0	46509.9	35448.8	3° 44.3'	-40° 20.6'
	5xD days	35357.6	2309.2	-30111.3	46499.3	35432.9	3° 44.2'	-40° 21.5'
September	All days	35369.2	2311.2	-30103.5	46503.2	35444.6	3° 44.3'	-40° 20.5'
	5xQ days	35382.6	2312.8	-30101.2	46512.0	35458.2	3° 44.4'	-40° 19.7'
	5xD days	35348.9	2310.2	-30106.5	46489.6	35424.3	3° 44.4'	-40° 21.6'
October	All days	35335.4	2307.4	-30106.3	46479.1	35410.7	3° 44.2'	-40° 22.3'
	5xQ days	35379.7	2311.4	-30102.4	46510.5	35455.2	3° 44.3'	-40° 19.9'
	5xD days	35282.2	2301.8	-30113.8	46443.2	35357.2	3° 44.0'	-40° 25.3'
November	All days	35350.8	2310.2	-30108.8	46492.6	35426.2	3° 44.3'	-40° 21.7'
	5xQ days	35373.9	2312.0	-30106.0	46508.4	35449.4	3° 44.4'	-40° 20.4'
	5xD days	35280.0	2304.1	-30116.4	46443.4	35355.2	3° 44.2'	-40° 25.5'
December	All days	35375.2	2311.1	-30104.1	46508.1	35450.6	3° 44.3'	-40° 20.2'
	5xQ days	35374.8	2311.1	-30105.6	46508.7	35450.2	3° 44.3'	-40° 20.3'
	5xD days	35365.2	2307.6	-30104.4	46500.5	35440.4	3° 44.0'	-40° 20.7'
Annual	All days	35362.1	2310.3	-30118.0	46507.1	35437.5	3° 44.3'	-40° 21.7'
Mean	5xQ days	35376.2	2311.9	-30116.1	46516.7	35451.6	3° 44.3'	-40° 20.9'
Values	5xD days	35334.7	2307.2	-30120.8	46487.9	35409.9	3° 44.2'	-40° 23.1'

(Calculated:10:28 hrs., Thu. 03 Apr. 2003)

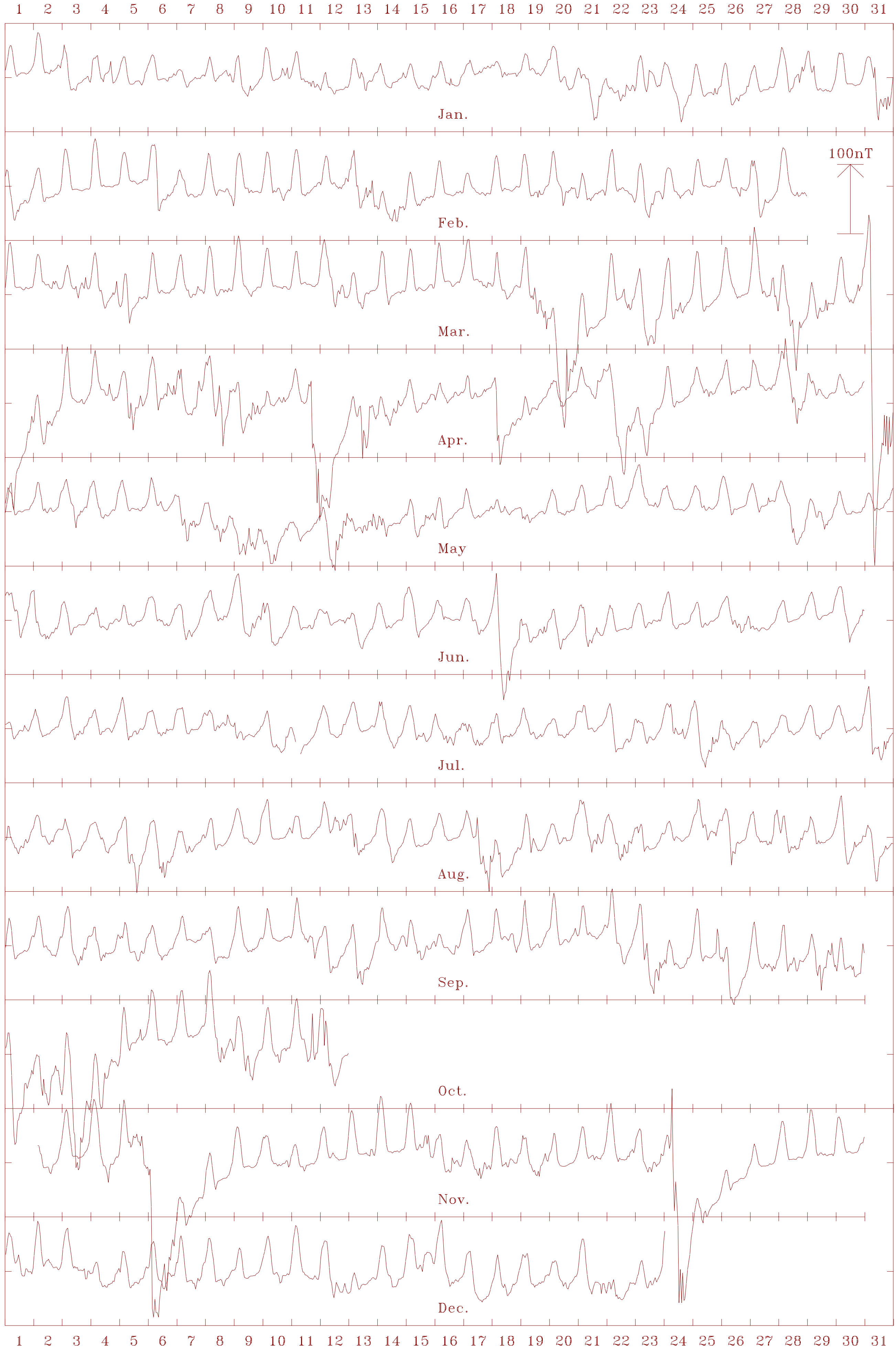
Hourly Mean Values

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

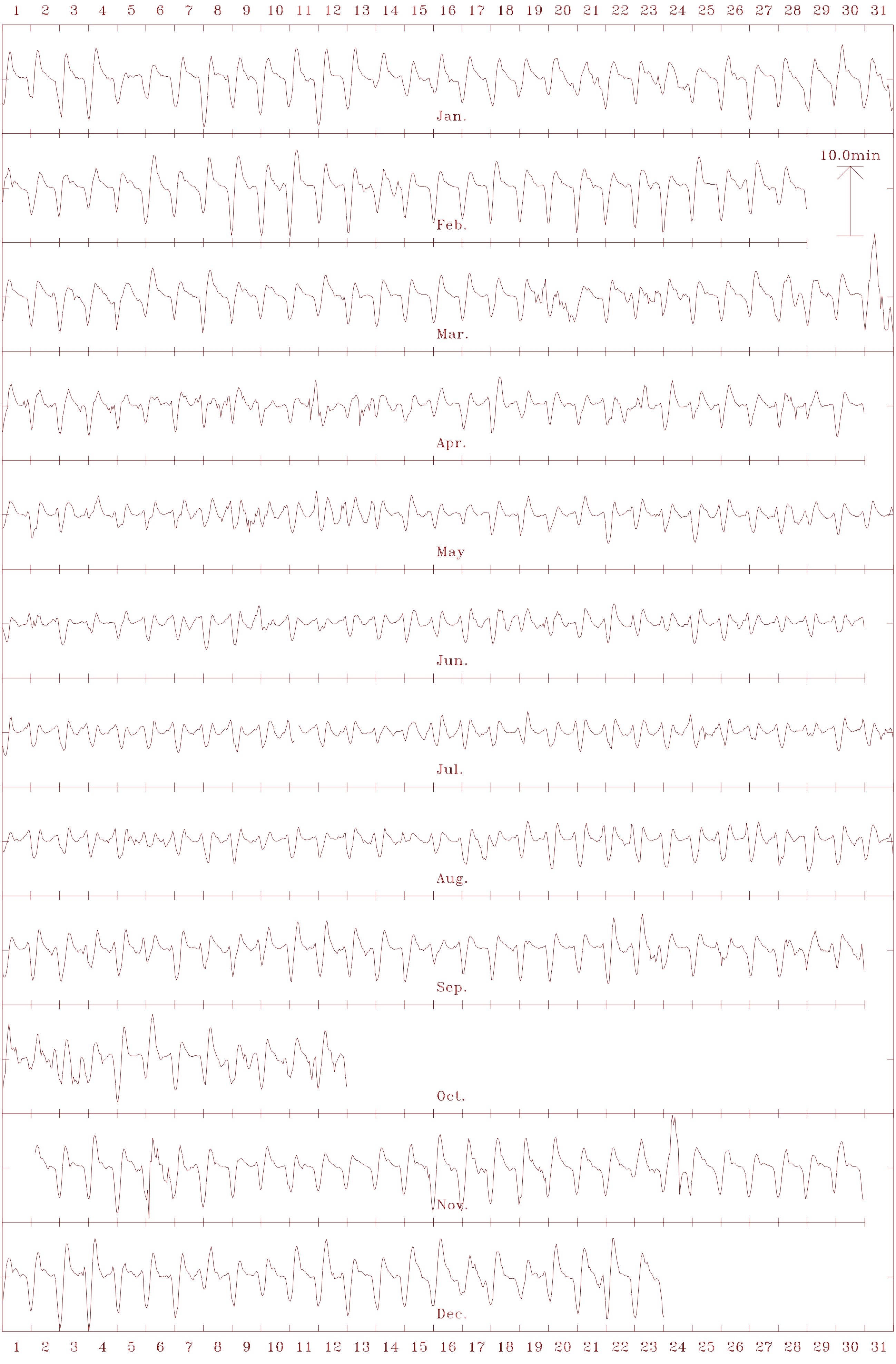
The reference levels indicated with marks on the vertical axes refer to the *all-days* mean value for the respective months. All elements in the plots are shown increasing (algebraically) towards the top of the page, with the exception of Z, which is in the opposite sense.

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

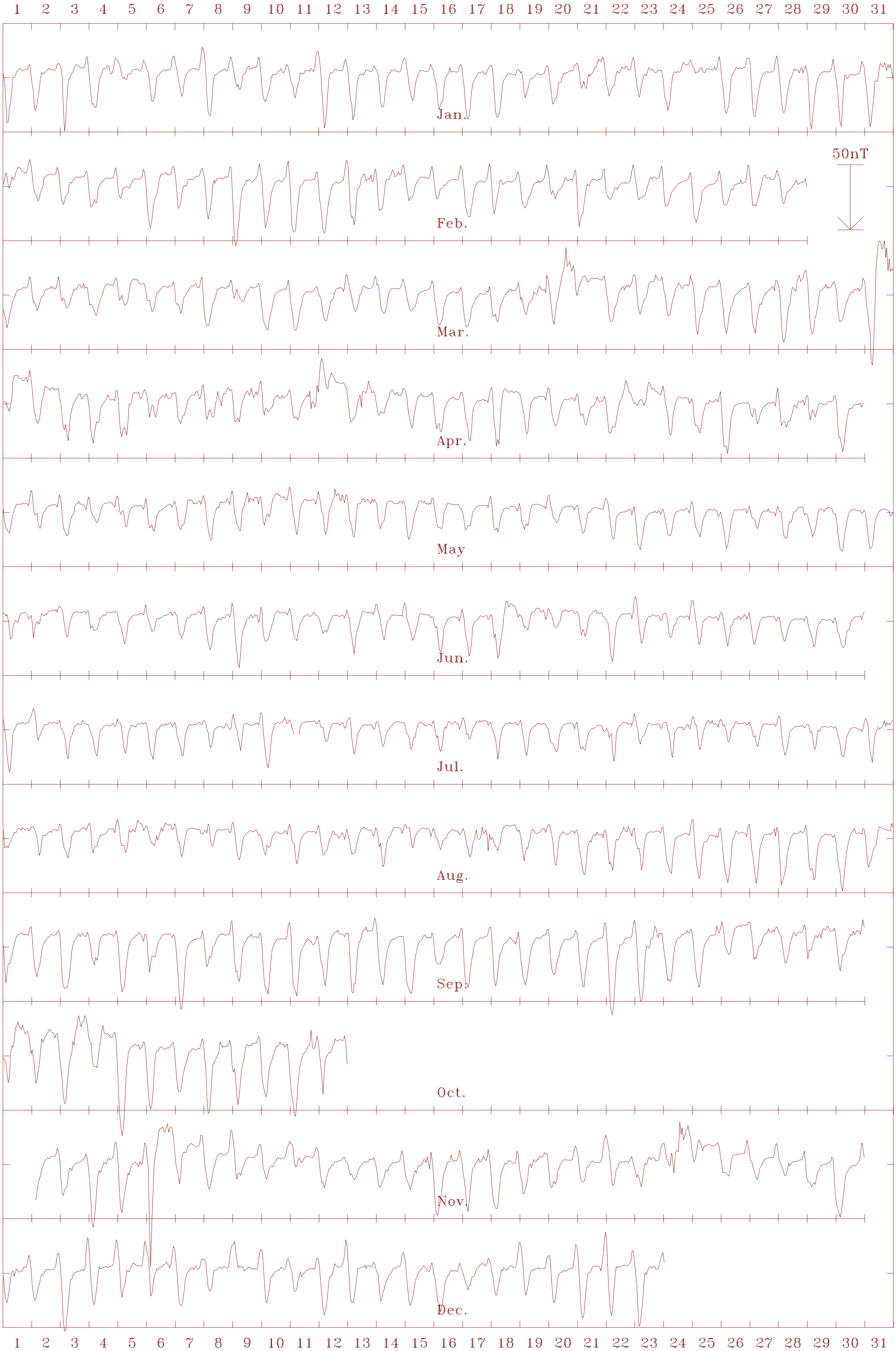
Kakadu, NT 2001 Horizontal intensity (H). Scale: 7.5 nT/mm. Mean: 35438 nT



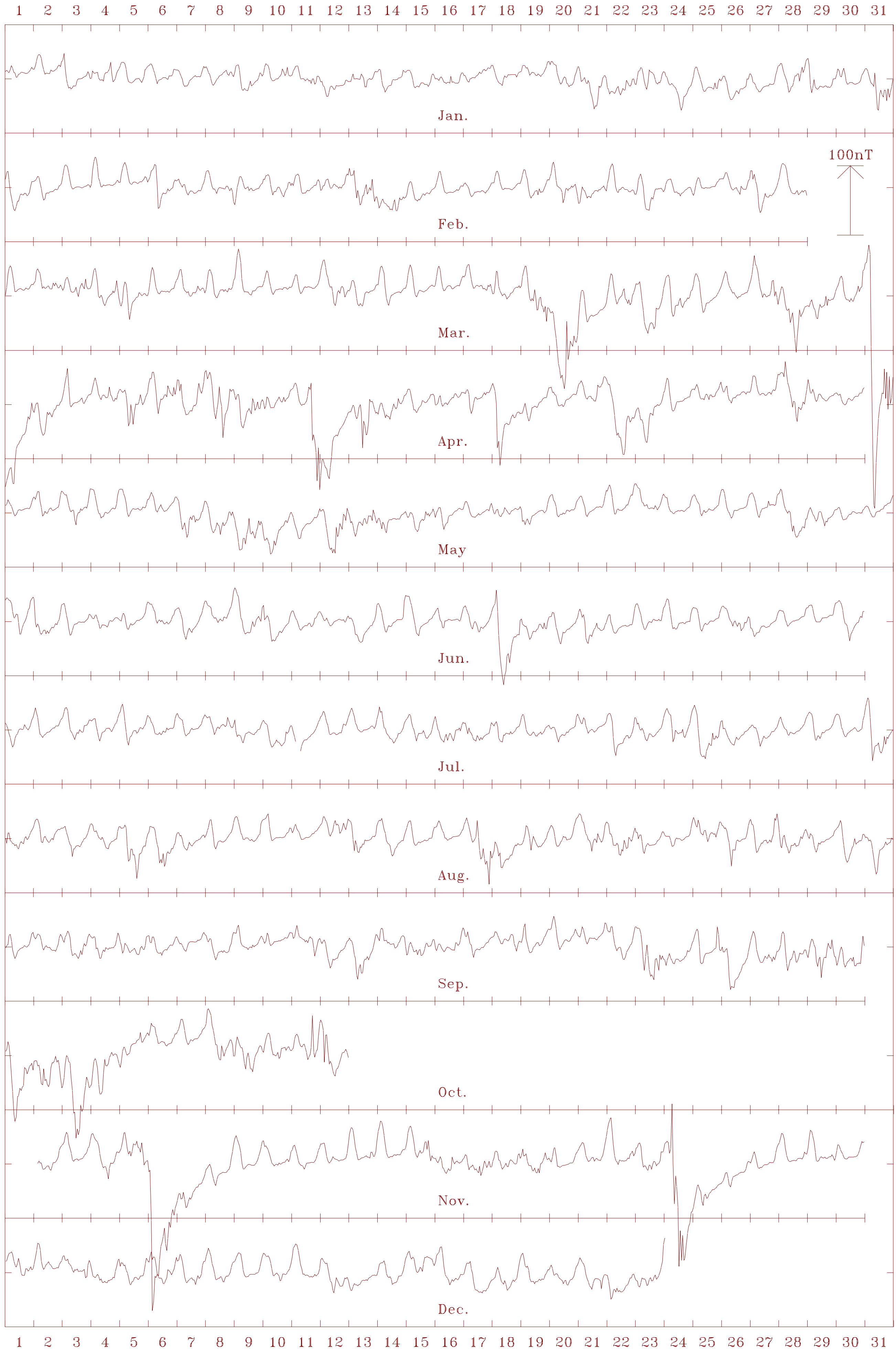
Kakadu, NT 2001 Declination (east) (D). Scale: 0.75 min/mm. Mean: 3.74 deg.

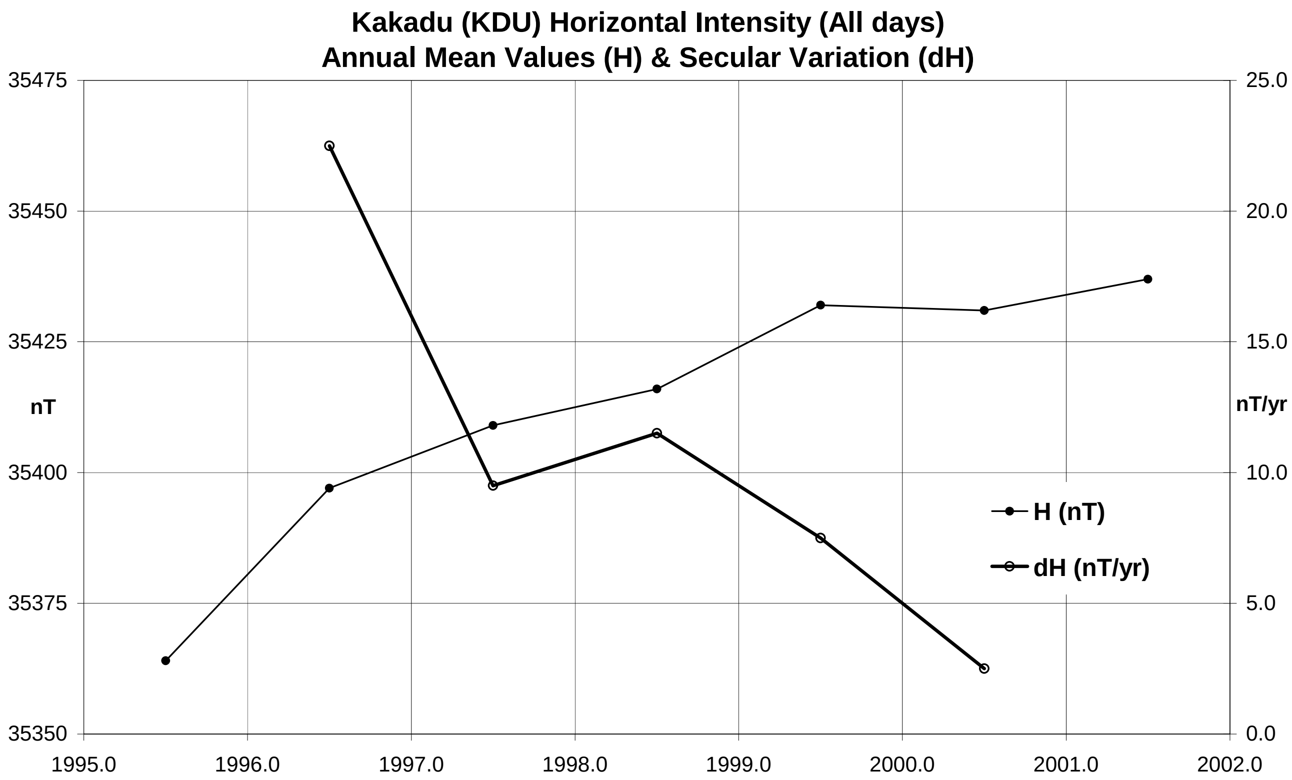


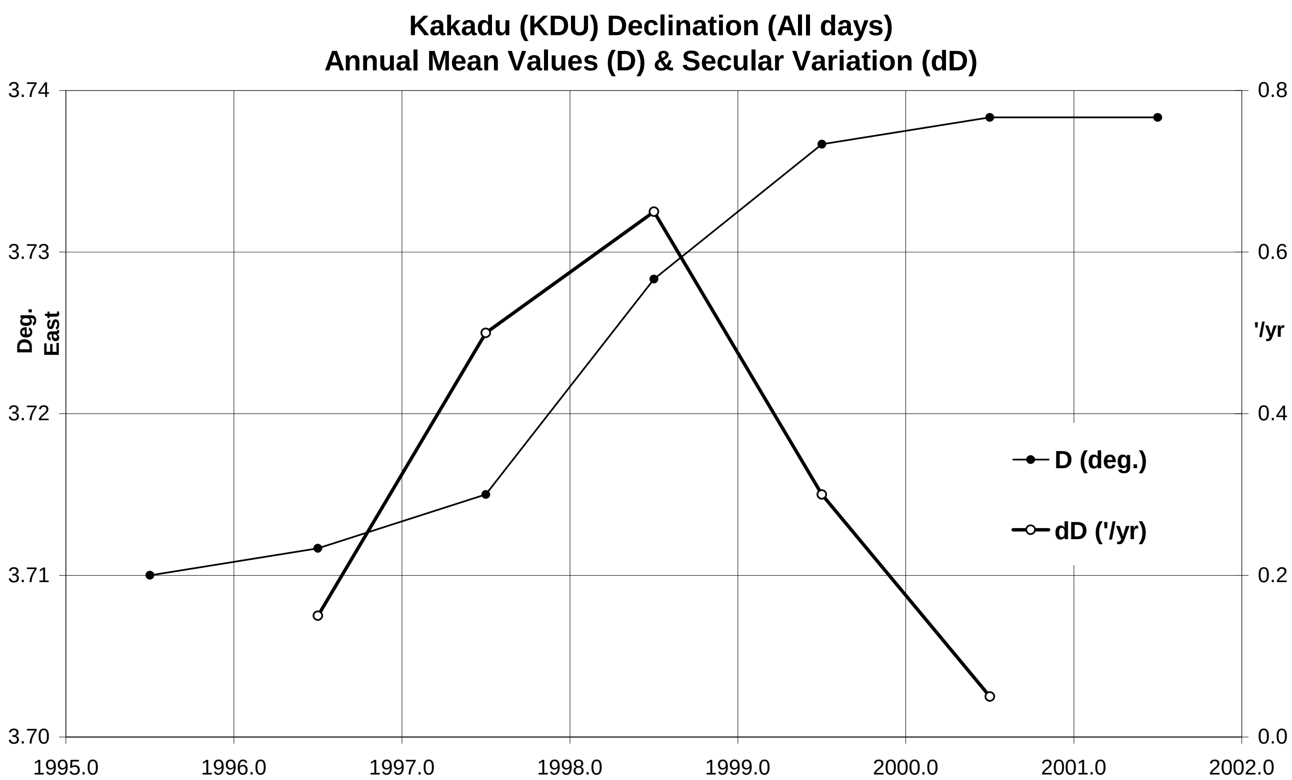
Kakadu, NT 2001 Vertical intensity (Z). Scale: 4.0 nT/mm. Mean: -30118 nT

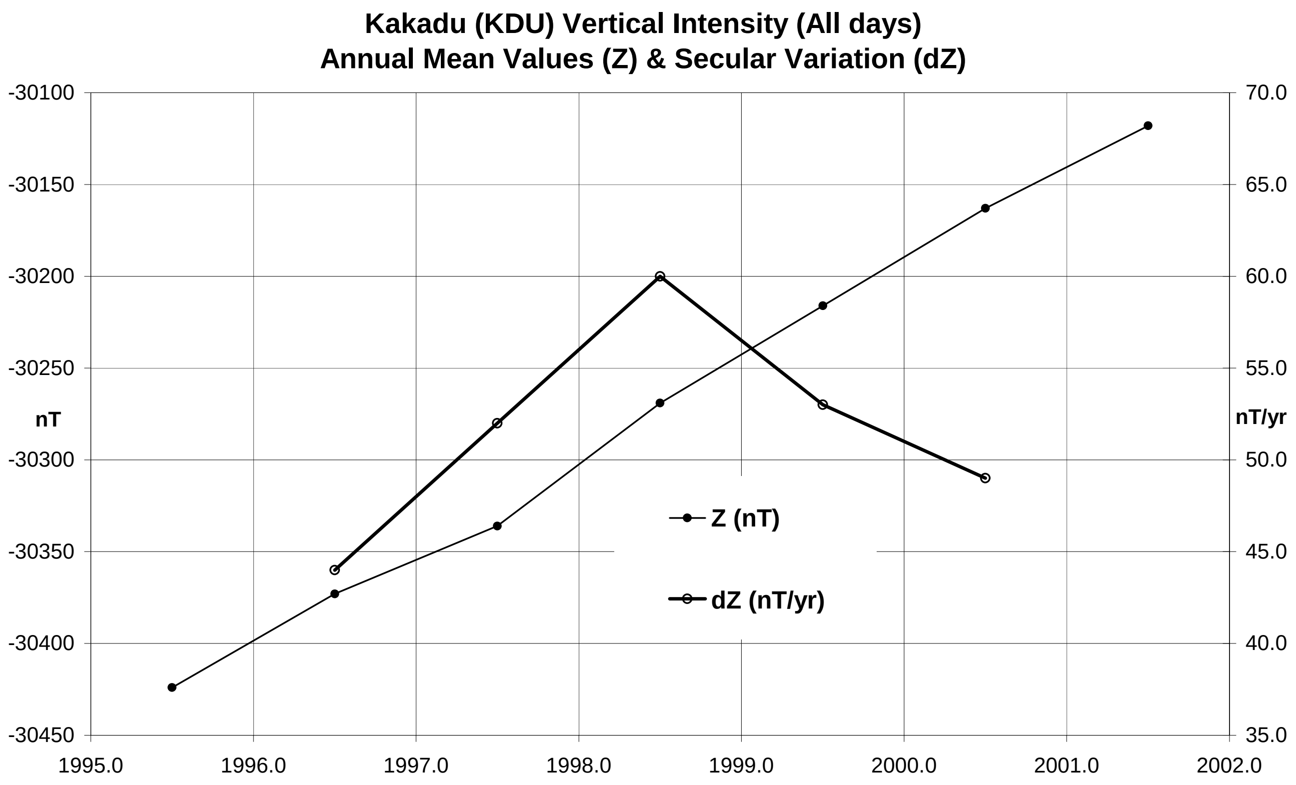


Kakadu, NT 2001 Total intensity (F). Scale: 7.5 nT/mm. Mean: 46507 nT

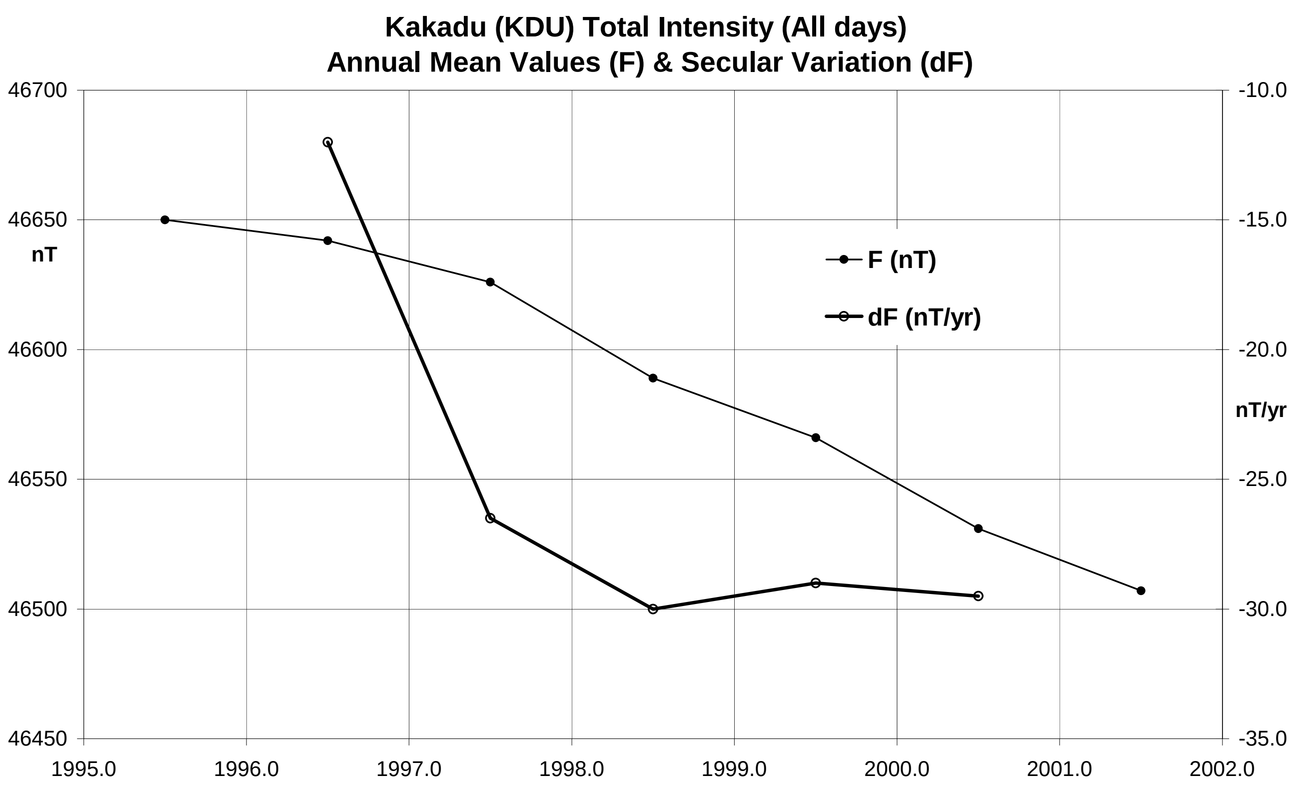



Kakadu (KDU) Horizontal Intensity (All days)
Annual Mean Values (H) & Secular Variation (dH)
35475
35450
35425
35400
35375
35350
nT
25.0
20.0
15.0
10.0
5.0
0.0
nT/yr
1995.0
1996.0
1997.0
1998.0
1999.0
2000.0
2001.0
2002.0
H (nT)
dH (nT/yr)


Kakadu (KDU) Declination (All days)
Annual Mean Values (D) & Secular Variation (dD)
3.74
3.73
3.72
3.71
3.70
Deg. East
0.8
0.6
0.4
0.2
0.0
'/yr
1995.0
1996.0
1997.0
1998.0
1999.0
2000.0
2001.0
2002.0
D (deg.)
dD ('/yr)



Kakadu (KDU) Vertical Intensity (All days)
Annual Mean Values (Z) & Secular Variation (dZ)
-30100
-30150
-30200
-30250
nT
-30300
-30350
-30400
-30450
70.0
65.0
60.0
55.0
nT/yr
50.0
45.0
40.0
35.0
1995.0
1996.0
1997.0
1998.0
1999.0
2000.0
2001.0
2002.0
Z (nT)
dZ (nT/yr)



Kakadu (KDU) Total Intensity (All days)
Annual Mean Values (F) & Secular Variation (dF)
46700
46650
nT
46600
46550
46500
46450
-10.0
-15.0
-20.0
nT/yr
-25.0
-30.0
-35.0
1995.0
1996.0
1997.0
1998.0
1999.0
2000.0
2001.0
2002.0
F (nT)
dF (nT/yr)

KDU Data losses in 2001:

Apr 04 0100 – 0120 (21 min) Maintenance.

Jul 11 0350 – 0705 (3h 16m) Maintenance.

Aug 09 0215 – 0340 (1h 26m) Power failure.

Sep 30 0342 – 0353 (12 min) UPS replaced.

Oct 13 0000 to Nov 02 / 0331 (20d 03h 32m) Lightning damage.

Nov 15 0049 – 0051 (3 min) Operational error.

Dec 24 0024 to 31 / 2359 (7d 23h 36m) Data degraded below observatory quality. Processing inhibited.

Loss of redundant F channel data

May to Jul 11 PPM variometer data very noisy most of the period.

Jun 06 0023, 0026-0038 (14 min) Maintenance.

Jul 11 0350 – 0705 (3h 16m) Maintenance.

Aug 09 0215 to 15 / 0600 (6d 03h 46m)

Aug 15 2200 to 23 / 0038 (7d 02h 39m)

Aug 23 1638 to 29 / 0024 (5d 07h 47m)

Sep 30 0342 - 0352, 0406 - 0407, 0409 (14 min) UPS replaced.

Oct 13 0000 to Nov 02 / 0334; Nov 02 0338, 2131 - 2133 (20d 03h 39m) Lightning damage.

Nov 15 0049 – 0051 (3 min) Operational error.

Dec 31 0752 – 0810 (19 min) Unknown cause.

Distribution of KDU data during 2001

Preliminary Monthly Means for Project Ørsted

- IPGP monthly (by e-mail)

1-minute & Hourly Mean Values

- 1999: WDC-A, Boulder, USA (08 Jan.2001)
- 2000: WDC-A, Boulder, USA (01 Feb.2001)

1-minute Values for Project INTERMAGNET

- Preliminary data to the Edinburgh GIN daily by e-mail from 12 Aug 2001.
- Definitive 1995-2000 data in the INTERMAGNET binary CD-ROM format to DMI (sent during March 2001).

LEARMONTH OBSERVATORY

Learmonth, Western Australia, is situated on Australia's North West Cape overlooking the Exmouth Gulf to the east and Cape Range to the west. Learmonth is approximately 1100km north of the city of Perth. The nearest town is Exmouth, approximately 35km to the north. The Learmonth Geomagnetic Observatory is situated at the Learmonth Solar Observatory, jointly staffed by IPS Radio and Space Services, Department of Industry, Tourism & Resources and the U.S. Air Force. The magnetic observatory was established on the solar observatory site in late November 1986 from when it has operated continuously. More details of the observatory's history are in *AGR 1994*.

The observatory comprises:

- Two small underground vaults that house the variometer sensors located within the perimeter of the solar observatory compound, both at approximately 40m to the east of the RSTN building. The principal (fluxgate sensor) vault is 0.6m x 0.6m concrete construction with a 25mm plastic lid and is set into the ground by about two-thirds of its 1m depth. The internal walls and top of this vault is lined with 50mm polystyrene foam sheets for thermal insulation and the vault is covered with a pile of sand and gravel. A 50mm diameter PVC conduit carrying control and power cables runs underground from the vault to the electronics console and data acquisition computer in the solar observatory Radio Solar Telescope Network (RSTN) building. A second (wooden) PPM sensor vault is approximately 10m north of the principal vault. It is completely buried beneath local sand. A PVC conduit carries the PPM sensor head signal cable to the electronics console in the RSTN building.
- A concrete absolute observation pier within a roofed shelter with brick walls on two sides to the same height as the pier. This was about 200 metres south of the solar observatory, situated on Royal Australian Air Force property.
- The control electronics and acquisition PC were located within the central or Radio Solar Telescope Network building of the solar observatory

Key data for the observation pier of the observatory are:

- 3-character IAGA code: LRM
- Commenced operation: November 1986
- Geographic latitude: 22 13' 19" S
- Geographic longitude: 114° 06' 03" E
- Geomagnetic†: Lat. -32.36°; Long. 186.28°
- Elevation above mean sea level (top of Pier A): 4 metres
- Lower limit for K index of 9: 300 nT.
- Azimuth of principal reference (west windsock) from Pier A: 283° 02' 18"
- Observers in Charge: G.A. Steward (IPS Radio & Space Services)

† Based on the IGRF 2000.0 model updated to 2001.5

Variometers

A Narod 3-axis Ring Core fluxgate (RCF) variometer (s/n 9004-04), initially installed on 12 Feb. 1999 and aligned to monitor magnetic variations in the magnetic NW, NE and vertical directions was still in service at the beginning of 2001 and continued until 12 August that year. The RCF contained its own temperature sensors. From 14 August 2001 until 12 December a Bartington MAG03MSL70 (s/n 504) three-axis fluxgate was used. The Bartington instrument was also aligned to monitor the NW, NE and vertical components of the magnetic field. From 12 December 2001 a Danish Meteorological Institute FGE suspended three axis fluxgate (s/n E0254, S0227) was used to monitor the NW, NE and vertical components of the magnetic field.

The Narod RCF instrument was replaced because the A (X) channel was faulty throughout 2001, producing noisy data that drifted rapidly and ultimately became very unstable. Upon replacement it was discovered that water damage had occurred to it. The Narod RCF was replaced with a Bartington variometer as a temporary measure only as it was not an observatory quality instrument, having poor baseline stability. It remained in service until an observatory quality instrument could be acquired.

Throughout 2001 the five channels of digital data output from the various fluxgate instruments (three orthogonal magnetic channels, sensor temperature and electronics (or A/D card) temperature) were recorded at 1-second intervals. The RCF produced digital data, the analogue output from the Bartington was digitized with a PAR24B 8 channel 24 bit converter. The analogue data from the DMI instrument was digitized with an ADAM 4017 8 channel 16 bit converter.

The data from the fluxgate instruments were also recorded by IPS on a separate system.

During 2001 a Geometrics model 856 (no. 50708) proton precession magnetometer (PPM) measured variations in the total intensity of the magnetic field, F. This served both as a backup, should any one of the X, Y or Z variometer channels become unserviceable, and as an F-check of the variometer model. The digital data from the variometer PPM was recorded at 10-second intervals.

The data from both fluxgate and PPM were recorded on an IBM compatible PC running MS-DOS-based data acquisition, control and display software. Timing was generated by the software (DOS) clock of the PC which was synchronized to 1-second pulses from a GPS clock.

The variometer and recording system was powered by 240VAC mains power. The equipment was protected from power outages and surges by an uninterruptible power supply.

Absolute Instruments & Corrections

Throughout 2001 the local observer performed regular (approximately weekly) sets of absolute observations on the pier (A) in the absolute shelter using the DIM comprising Bartington 010H no. 0702H fluxgate unit with Zeiss 020B theodolite no. 312714 together with Geometrics 856 no. 50471 PPM.

DIM absolute observations were performed using the *offset* method (see *Kakadu Observatory – Absolute Instruments & Corrections*, this report) throughout 2001.

On 14 December 2001 a new stand for the absolute PPM sensor was introduced into the absolute routine and a safety tie down bar was installed on the absolute pier to ensure that that the absolute instruments could not be knocked from the pier during observations.

The corrections adopted for the absolute magnetometers used at LRM during 2001 are: 0.0′, 0.0′ and -1.5 nT in D I, and F respectively. These values convert to corrections:

$\Delta X = -0.84$ nT $\quad \Delta Y = 0$ nT $\quad \Delta Z = 1.24$ nT.

at the mean 2001 field values at LRM of 29725nT, 155nT and -44230nT in X, Y and Z respectively. These instrument corrections have been applied to all data in this report.

The corrections were derived from a series of PPM instrument comparisons at the Canberra Observatory and the Learmonth Observatory. A travelling standard PPM, GEM GSM90_810881 was compared to the Australian standard PPM (GEM GSM90_905026) at the Canberra Observatory on 15 November 2001. The travelling standard instrument was then taken to LRM and compared with the LRM absolute PPM (G856_50471) on 14 December 2001.

No DIM comparisons were made during 2001, the LRM DIM was last compared in 1999.

Operations

The local observer at LRM magnetic observatory was a staff member of IPS at the Learmonth Solar Observatory. During 2001 the observer performed routine tasks at the magnetic observatory that included:

- performing a set of absolute observations each week;
- mailing observation sheets to GA, Canberra each week;
- instrument checks, system resets etc. as required.

1-second values and 1-minute mean value data were transferred daily through modems via telephone lines to GA in Canberra. The clocks on the acquisition PC were checked each weekday and corrected if necessary via the telephone link to GA.

Temperature coefficients for the Narod fluxgate variometer were set to zero for 2001. Any temperature dependence of the RCF sensors and electronics contributed to baseline drifts over the year which were taken into account in the data processing.

The Bartington and DMI variometers had accurately determined temperature coefficients.

The A channel (commonly called the X channel or channel 0) of the Narod RCF developed a fault from 17:00:40 UT on 01 February 2000 that remained until 14 August 2001. This meant that all calibrated 1-minute value data from the Narod instrument during that period had to be derived through recovering the A channel from the two remaining operational RCF magnetic channels and the variometer PPM. As the variometer PPM was recorded at 10-second intervals only one-minute mean data could be recovered in this way. **This also means that calibrated one-second data from Learmonth are not available from 01 February 2000 until 14 August 2001.**

The Narod instrument was replaced in the short term by the Bartington fluxgate on 14 August 2001. Baseline stability problems were well known with the Bartington instrument, but no other variometer was available at the time. In December 2001 the Bartington variometer was replaced with a Danish Meteorological Institute suspended fluxgate variometer. To enable the installation of the suspended DMI sensors and electronics the vault had to be modified. This was carried out during the service visit by staff from GA, Canberra.

The absolute observations were processed at GA in Canberra, where final data calibration and adoptions were made.

Distribution of LRM data during 2001

Preliminary Monthly Means for Project Ørsted

- Sent monthly by email to IPGP throughout 2001
- 2000 data: IPGP by e-mail (Jun. 2001)

1-minute & Hourly Mean Values

- 1999: WDC-C1, Copenhagen, Denmark (30 May 2001)
- 2000: WDC-C1, Copenhagen, Denmark (30 May 2001)
- 2000: WDC-A, Boulder, USA (30 May, 2001)

LRM - Significant Events 2001

1 Jan	Narod A (X) channel has been unusable since 01 February 2000. Data recovered using PPM until Narod was replaced with Bartington (on 14 August 2001).
14 Jun	Routine absolute observations missed.
30 Jun	Data acquisition system failure.
02 Jul	System re-booted.
26 Jul	Routine absolute observation missed.
01 Aug	Test cable inserted into NAROD to confirm source of problems with Narod data. This caused data loss 0348-0435. Modem problems also in evidence.
06 Aug	New system based on Bartington MAG03MSL70 s/n 504 PAR24b/2 and 486 PC sent to observatory
10 Aug	Modem problems still being experienced.
12 Aug	System upgraded, resulting in data loss from 0645 until 0636 on 14 August.
14 Aug	Technical officer from Perth office (OM) replaced NAROD with Bartington 504 and PAR24/2 Bartington data acquired from 0636 14 August. Bartington performed very poorly until the instrument settled down after a few days.
08 Nov	Crane working on IPS radio telescope.Data corrupted ~00:30 - 05:30 UT.
09 Nov	Data corrupted ~00-06hrs UT
10 Nov	Data corrupted ~00-05hrs UT
17 Nov	No routine absolute observations for six weeks as local observer absent on extended leave.

continued …

Significant Events (cont.)

10 Dec to 17 Dec — Service visit by staff (AML, BS) from GA, Canberra. DMI suspended variometer and safety bar on absolute pier were installed; PPM comparisons, azimuth checks, pier survey; alternate site for magnetometers with PPM and GPS were all performed.

LRM significant data loss in 2001

30 Jun — 0256 to 02 Jul / 0309 (2d 00h 14m) All channels: System stalled.

01 Aug — 0348-0435 (48min) All channels: System tests

12 Aug — 0648 to 14 / 0900 (2d 02h 13m) All channels: System upgrades

16 Aug — 1600 to 17 / 0100 (9h 01m) All channels: Fluxgate failure

08 Nov — 0015 - 0715 (7h 01m) All channels: Corrupted data not processed.

09 Nov — 0000 – 0615 (6h 16m); 2345 to 10 / 0515 (5h 31m): All channels: Corrupted data not processed.

11 Dec — 2347 - 2349 (3 min) All channels: Corrupted data not processed.

12 Dec — 0100 – 0905 (8h 06m); 2300 to 13 / 0100 (2h 01m): All Channels: System upgrades.

Learmonth 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 68-69.

Year	Days	D (Deg	Min)	I (Deg	Min)	H (nT)	X (nT)	Y (nT)	Z (nT)	F (nT)	Elts
1987.5	A	-0	34.9	-56	26.7	29480	29478	-299	-44446	53334	DHZ (1)
1988.5	A	-0	33.5	-56	27.0	29481	29479	-288	-44457	53344	DHZ
1989.5	A	-0	34.3	-56	27.1	29465	29464	-294	-44436	53317	DHZ
1990.5	A	-0	28.8	-56	25.4	29501	29500	-247	-44441	53342	DHZ
1991.5	A	-0	26.3	-56	24.5	29507	29506	-226	-44426	53333	DHZ
1992.5	A	-0	23.4	-56	22.6	29531	29530	-201	-44407	53330	DHZ
1993.5	A	-0	18.9	-56	21.2	29550	29549	-162	-44396	53331	DHZ
1994.5	A	-0	15.0	-56	20.5	29555	29555	-129	-44386	53326	DHZ
1995.5	A	-0	10.8	-56	18.2	29588	29588	-93	-44373	53333	DHZ
1996.5	A	-0	06.2	-56	15.5	29630	29630	-54	-44358	53344	DHZ
1997.5	A	-0	01.3	-56	13.3	29658	29658	-11	-44338	53343	DHZ
1998.5	A	0	04.2	-56	11.6	29676	29676	36	-44320	53338	DHZ
1999.5	A	0	09.2	-56	09.6	29696	29696	80	-44292	53325	ABZ (2)
2000.5	A	0	13.5	-56	7.9	29707	29706	116	-44260	53305	ABZ
2001.5	A	0	17.7	-56	5.7	29724	29724	153	-44227	53287	ABZ
1987.5	Q	-0	34.8	-56	26.3	29486	29484	-299	-44445	53336	DHZ (1)
1988.5	Q	-0	33.5	-56	26.3	29494	29492	-288	-44455	53349	DHZ
1989.5	Q	-0	34.3	-56	26.2	29481	29479	-294	-44433	53324	DHZ
1990.5	Q	-0	28.7	-56	24.5	29516	29515	-246	-44439	53348	DHZ
1991.5	Q	-0	26.2	-56	23.4	29527	29526	-225	-44423	53341	DHZ
1992.5	Q	-0	23.3	-56	21.7	29545	29544	-200	-44405	53336	DHZ
1993.5	Q	-0	18.8	-56	20.5	29561	29560	-162	-44394	53336	DHZ
1994.5	Q	-0	15.0	-56	19.7	29569	29569	-129	-44384	53332	DHZ
1995.5	Q	-0	10.8	-56	17.5	29600	29600	-93	-44371	53338	DHZ
1996.5	Q	-0	06.3	-56	15.2	29636	29635	-54	-44357	53346	DHZ
1997.5	Q	-0	01.3	-56	12.8	29667	29667	-11	-44338	53348	DHZ
1998.5	Q	0	04.1	-56	11.1	29686	29686	35	-44318	53342	DHZ
1999.5	Q	0	09.2	-56	09.0	29705	29705	80	-44290	53329	ABZ (2)
2000.5	Q	0	13.5	-56	7.1	29719	29719	117	-44258	53311	ABZ
2001.5	Q	0	17.8	-56	5.0	29736	29736	154	-44225	53293	ABZ
1987.5	D	-0	34.9	-56	27.3	29469	29467	-299	-44448	53329	DHZ (1)
1988.5	D	-0	33.6	-56	28.2	29461	29459	-288	-44460	53335	DHZ
1989.5	D	-0	34.4	-56	29.0	29433	29431	-295	-44441	53303	DHZ
1990.5	D	-0	29.0	-56	26.7	29478	29477	-249	-44445	53332	DHZ
1991.5	D	-0	26.5	-56	26.5	29473	29472	-227	-44431	53318	DHZ
1992.5	D	-0	23.5	-56	24.1	29506	29505	-201	-44412	53320	DHZ
1993.5	D	-0	18.9	-56	22.3	29530	29529	-163	-44398	53322	DHZ
1994.5	D	-0	14.9	-56	21.6	29537	29537	-128	-44389	53318	DHZ
1995.5	D	-0	10.9	-56	19.1	29574	29574	-94	-44374	53326	DHZ
1996.5	D	-0	06.2	-56	16.0	29622	29622	-53	-44359	53340	DHZ
1997.5	D	-0	01.3	-56	14.2	29643	29643	-11	-44340	53336	DHZ
1998.5	D	0	04.2	-56	13.0	29652	29652	36	-44322	53326	DHZ
1999.5	D	0	09.3	-56	10.7	29677	29677	81	-44295	53317	ABZ (2)
2000.5	D	0	13.4	-56	9.5	29679	29679	116	-44264	53294	ABZ
2001.5	D	0	17.6	-56	7.2	29699	29699	152	-44230	53276	ABZ

Note (1): At the near zero magnetic declination at LRM the DHZ sensor orientation closely approximated an XYZ orientation.

Note (2): ABZ indicates sensor alignments in the magnetic NW, NE and vertical directions.

Learmonth 2001 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.

Learmonth	2001	X (nT)	Y (nT)	Z (nT)	F (nT)	H (nT)	D (East)	I
January	All days	29737.4	133.4	-44239.6	53305.5	29737.7	+0° 15.4'	-56° 05.5'
	5xQ days	29746.7	139.5	-44237.8	53309.2	29747.1	+0° 16.1'	-56° 04.9'
	5xD days	29725.6	129.1	-44240.3	53299.5	29725.9	+0° 14.9'	-56° 06.1'
February	All days	29737.0	139.5	-44233.9	53300.5	29737.4	+0° 16.1'	-56° 05.3'
	5xQ days	29742.7	140.3	-44233.2	53303.2	29743.0	+0° 16.2'	-56° 05.0'
	5xD days	29726.7	138.3	-44235.2	53295.9	29727.1	+0° 16.0'	-56° 05.9'
March	All days	29711.4	152.5	-44234.7	53287.0	29711.8	+0° 17.6'	-56° 06.7'
	5xQ days	29733.7	155.5	-44230.8	53296.1	29734.1	+0° 18.0'	-56° 05.3'
	5xD days	29651.1	148.5	-44242.0	53259.4	29651.5	+0° 17.2'	-56° 10.2'
April	All days	29701.2	138.1	-44236.3	53282.6	29701.5	+0° 16.0'	-56° 07.3'
	5xQ days	29718.4	139.4	-44233.8	53290.1	29718.7	+0° 16.1'	-56° 06.3'
	5xD days	29673.2	135.5	-44240.4	53270.4	29673.5	+0° 15.7'	-56° 08.9'
May	All days	29723.9	154.2	-44229.4	53289.5	29724.3	+0° 17.8'	-56° 05.8'
	5xQ days	29733.9	150.2	-44226.3	53292.6	29734.3	+0° 17.4'	-56° 05.2'
	5xD days	29695.5	156.5	-44234.8	53278.2	29695.9	+0° 18.1'	-56° 07.5'
June	All days	29729.1	147.1	-44224.5	53288.4	29729.5	+0° 17.0'	-56° 05.4'
	5xQ days	29734.0	147.5	-44224.1	53290.7	29734.3	+0° 17.1'	-56° 05.1'
	5xD days	29716.5	147.3	-44224.9	53281.7	29716.9	+0° 17.0'	-56° 06.1'
July	All days	29733.3	153.3	-44220.6	53287.5	29733.7	+0° 17.7'	-56° 05.0'
	5xQ days	29739.4	151.9	-44219.2	53289.7	29739.8	+0° 17.6'	-56° 04.6'
	5xD days	29728.3	154.0	-44220.9	53284.9	29728.7	+0° 17.8'	-56° 05.3'
August	All days	29727.2	164.9	-44221.8	53285.1	29727.7	+0° 19.1'	-56° 05.4'
	5xQ days	29731.4	165.7	-44220.7	53286.5	29731.8	+0° 19.2'	-56° 05.1'
	5xD days	29716.4	162.2	-44224.6	53281.4	29716.9	+0° 18.8'	-56° 06.0'
September	All days	29726.3	167.1	-44218.4	53281.8	29726.8	+0° 19.3'	-56° 05.3'
	5xQ days	29737.8	169.1	-44217.6	53287.6	29738.3	+0° 19.5'	-56° 04.6'
	5xD days	29710.2	164.8	-44220.0	53274.1	29710.7	+0° 19.1'	-56° 06.2'
October	All days	29703.2	156.1	-44226.8	53275.9	29703.7	+0° 18.1'	-56° 06.8'
	5xQ days	29729.9	157.8	-44223.0	53287.5	29730.3	+0° 18.2'	-56° 05.3'
	5xD days	29653.7	153.9	-44233.4	53253.7	29654.1	+0° 17.8'	-56° 09.7'
November	All days	29712.6	168.8	-44222.6	53277.6	29713.1	+0° 19.5'	-56° 06.2'
	5xQ days	29735.9	167.3	-44220.3	53288.7	29736.4	+0° 19.3'	-56° 04.8'
	5xD days	29655.0	166.0	-44231.1	53252.6	29655.5	+0° 19.2'	-56° 09.6'
December	All days	29741.3	165.2	-44215.7	53287.9	29741.7	+0° 19.1'	-56° 04.4'
	5xQ days	29743.9	166.0	-44216.2	53289.7	29744.3	+0° 19.2'	-56° 04.3'
	5xD days	29729.4	166.5	-44216.7	53282.1	29729.8	+0° 19.3'	-56° 05.1'
Annual	All days	29723.7	153.4	-44227.0	53287.4	29724.1	+0° 17.7'	-56° 05.7'
Mean	5xQ days	29735.6	154.2	-44225.2	53292.6	29736.0	+0° 17.8'	-56° 05.0'
Values	5xD days	29698.5	151.9	-44230.4	53276.2	29698.9	+0° 17.6'	-56° 07.2'

(Calculated:13:12 hrs., Tue. 11 Dec. 2003)

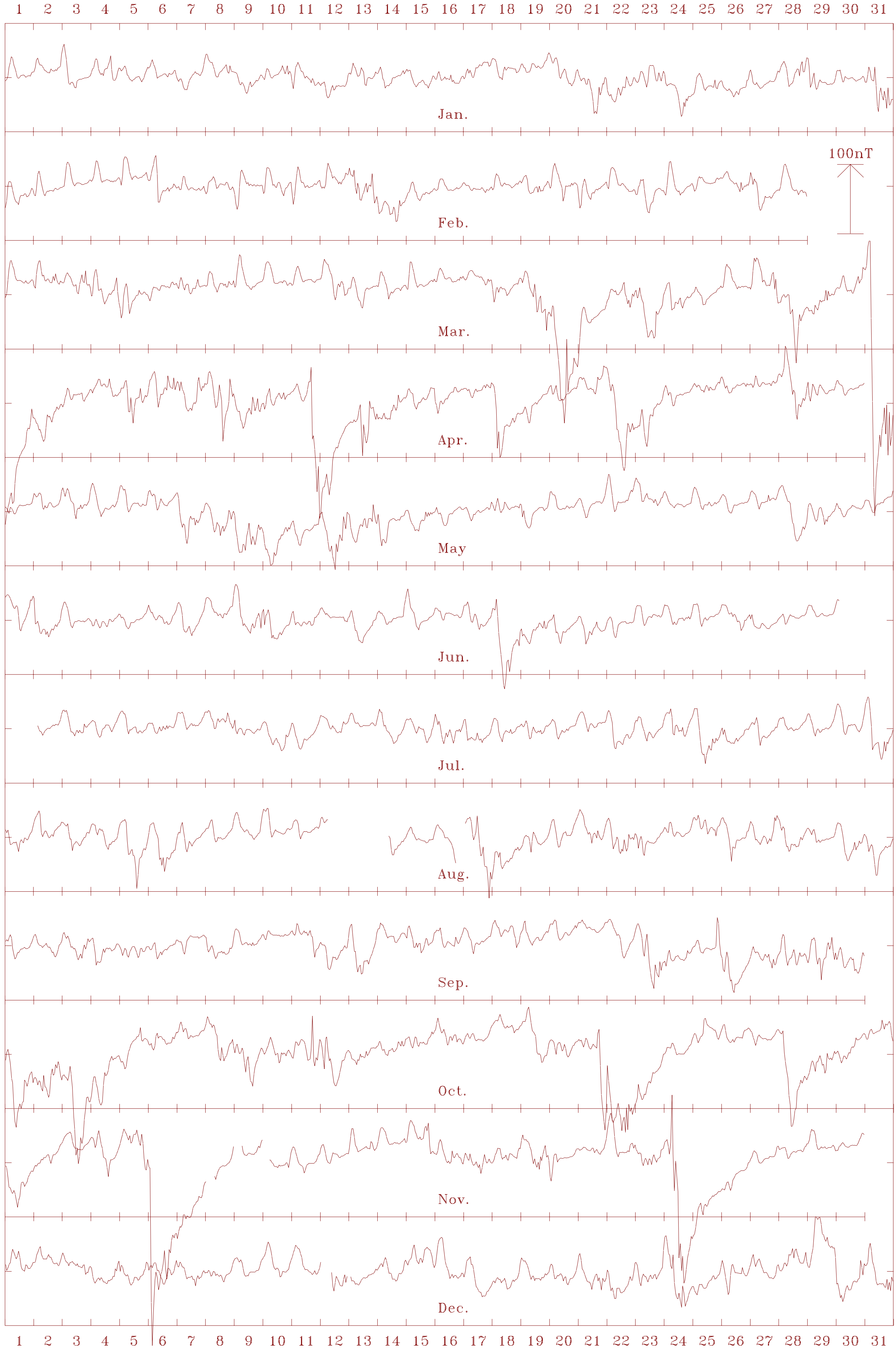
Hourly Mean Values

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

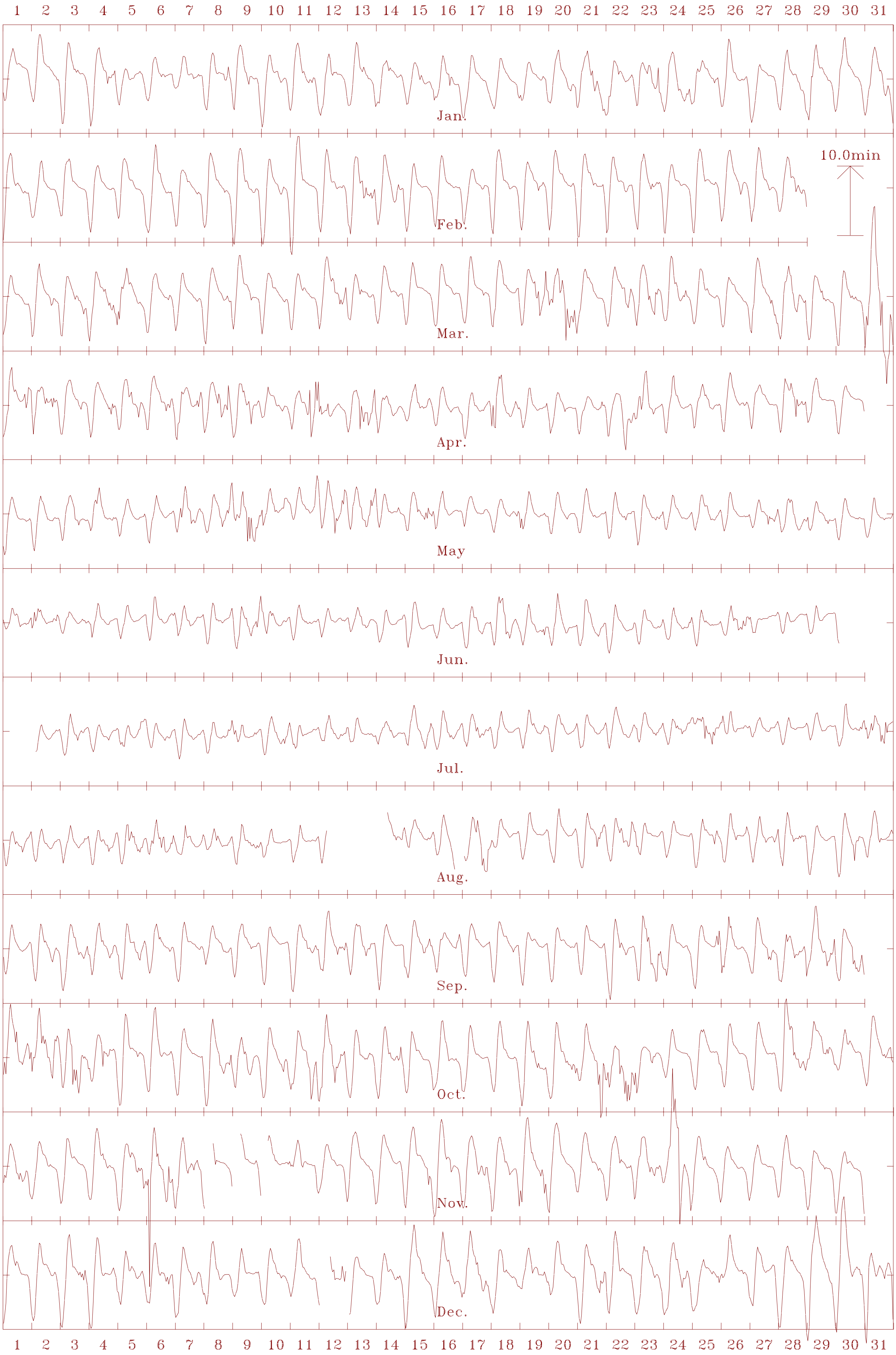
The reference levels indicated with marks on the vertical axes refer to the *all-days* mean value for the respective months. All elements in the plots are shown increasing (algebraically) towards the top of the page, with the exception of Z, which is in the opposite sense.

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

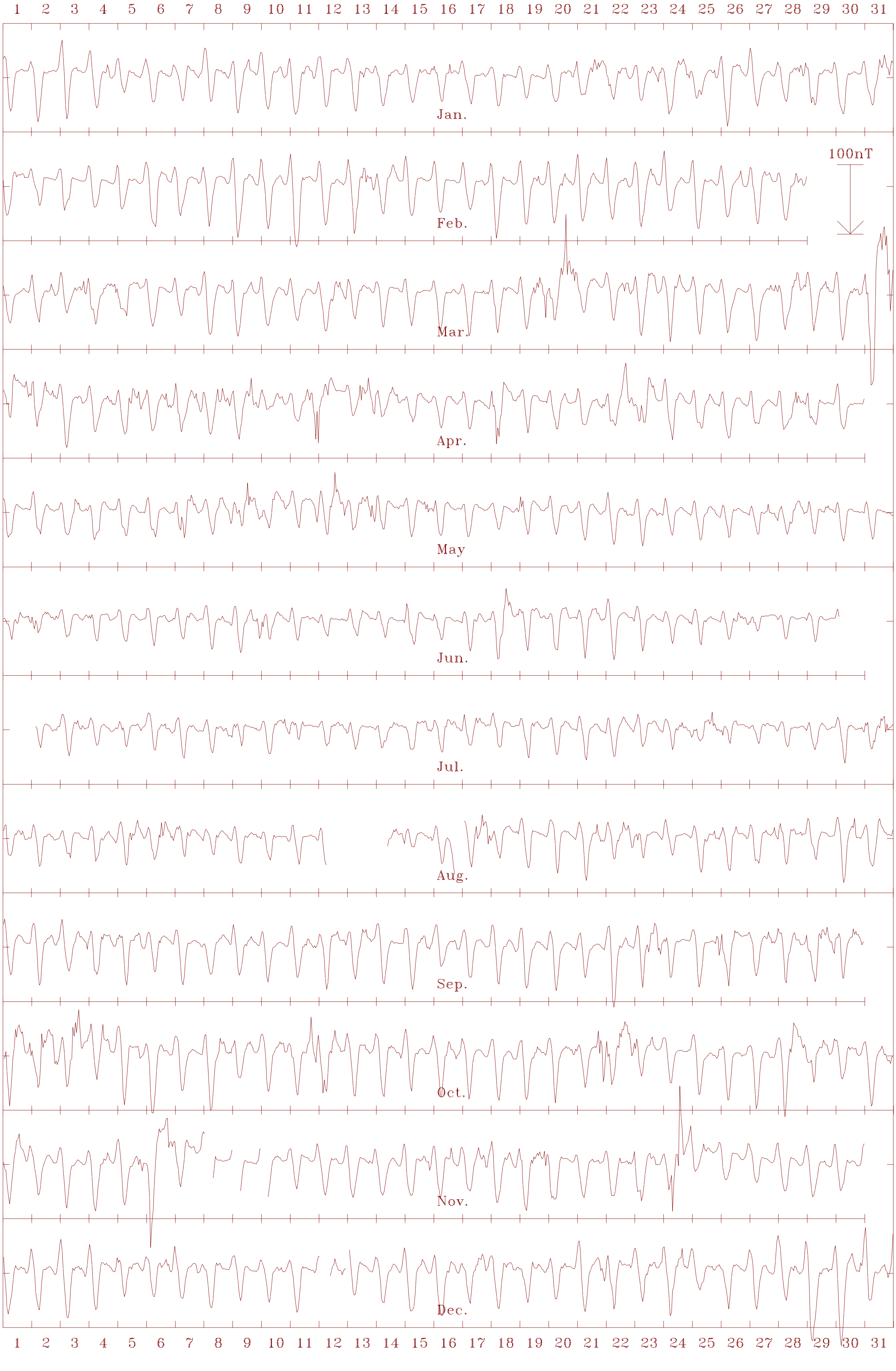
Learmonth 2001 Horizontal intensity (H). Scale: 7.5 nT/mm. Mean: 29724 nT



Learmonth 2001 Declination (east) (D). Scale: 0.75 min/mm. Mean: 0.30 deg.

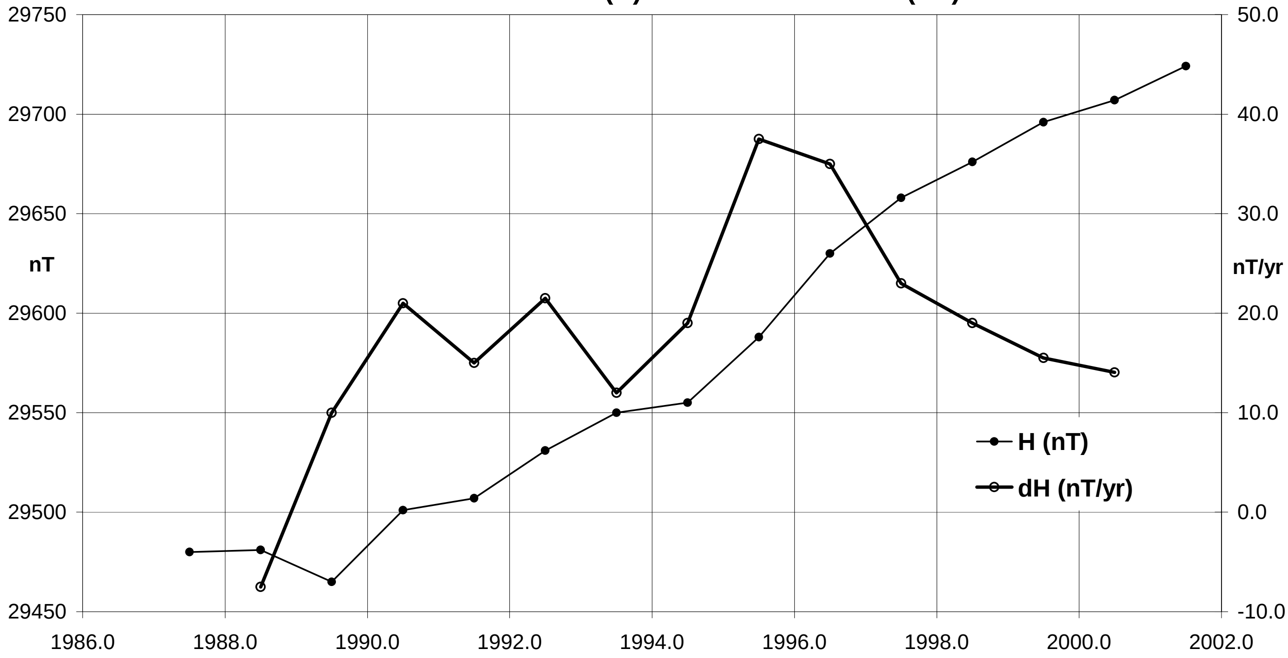


Learmonth 2001 Vertical intensity (Z). Scale: 7.5 nT/mm. Mean: −44227 nT

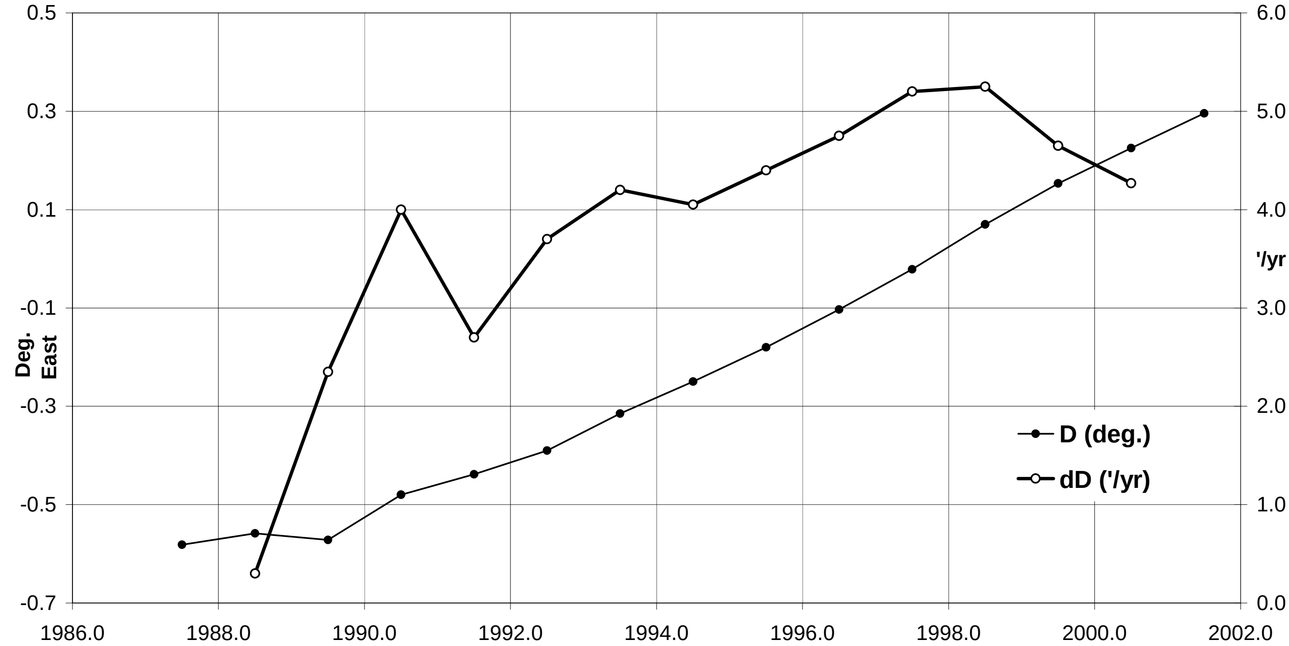


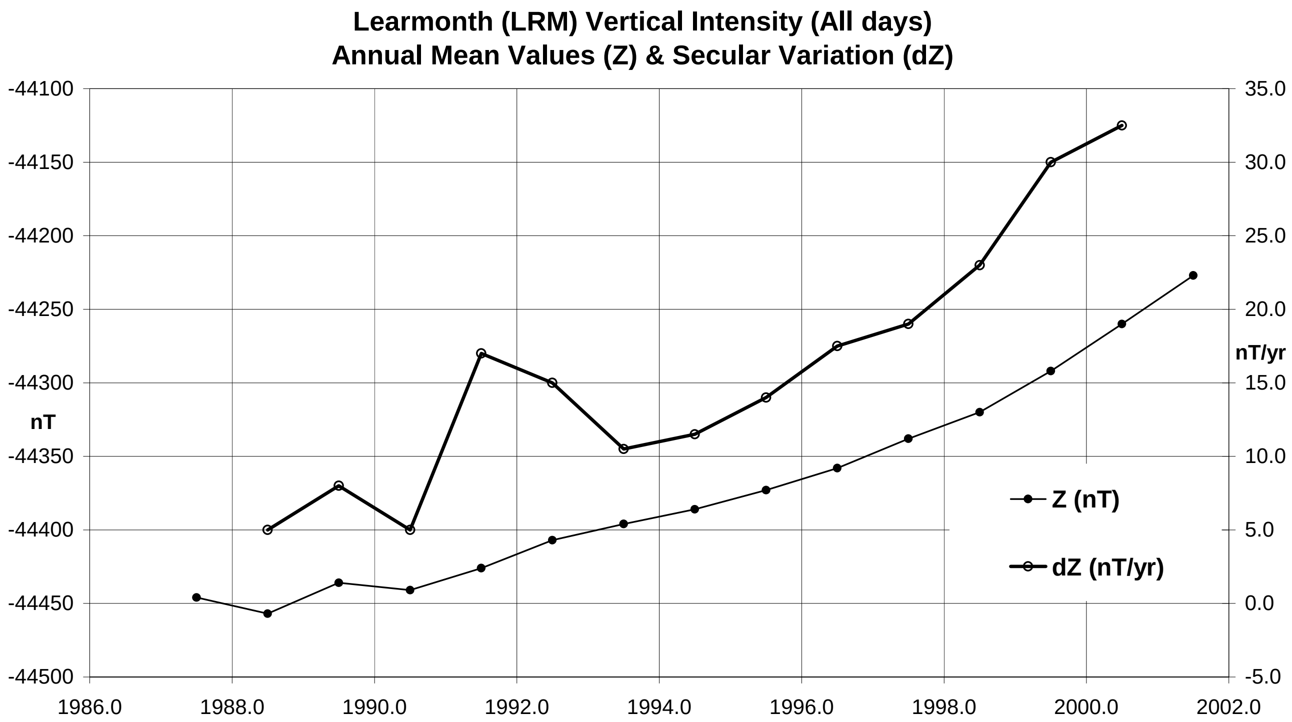

Learmonth 2001 Total intensity (F). Scale: 7.5 nT/mm. Mean: 53287 nT
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Jan.
Feb.
100nT
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

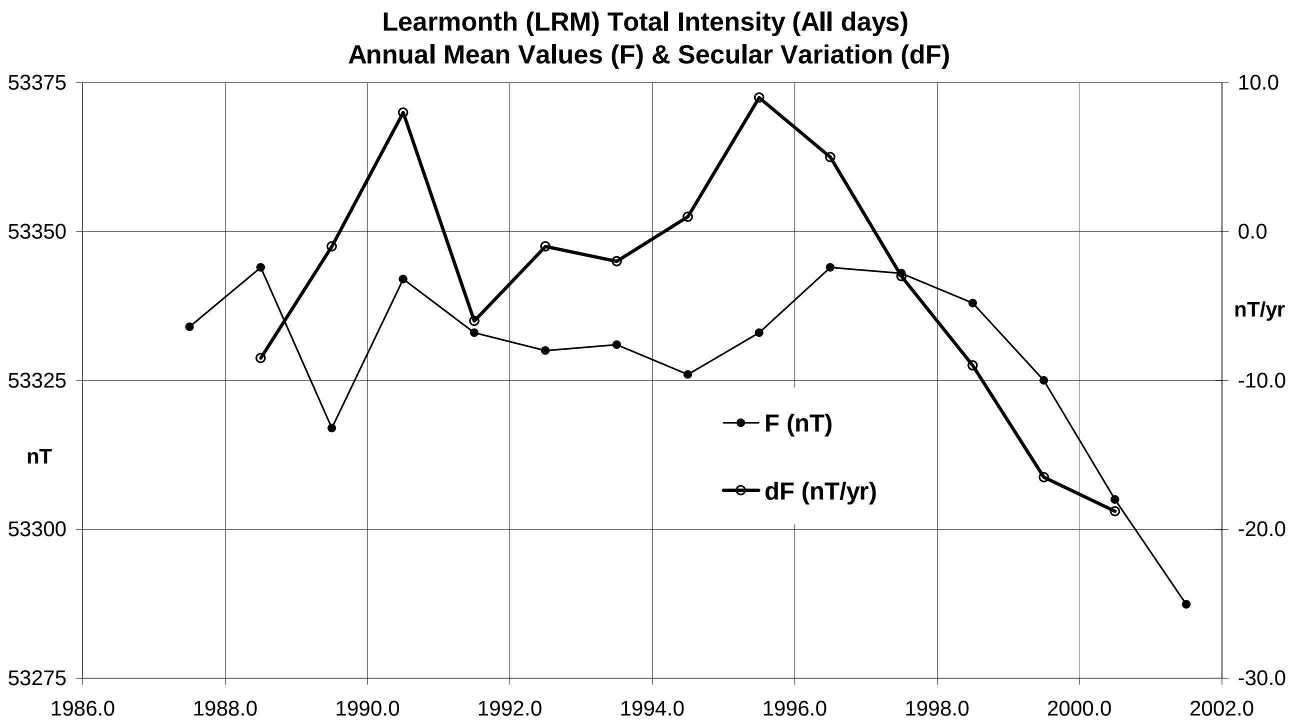
Learmonth (LRM) Horizontal Intensity (All days)
Annual Mean Values (H) & Secular Variation (dH)



Learmonth (LRM) Declination (All days)
Annual Mean Values (D) & Secular Variation (dD)




Learmonth (LRM) Vertical Intensity (All days)
Annual Mean Values (Z) & Secular Variation (dZ)
-44100
-44150
-44200
-44250
-44300
nT
-44350
-44400
-44450
-44500
35.0
30.0
25.0
20.0
nT/yr
15.0
10.0
5.0
0.0
-5.0
1986.0
1988.0
1990.0
1992.0
1994.0
1996.0
1998.0
2000.0
2002.0
Z (nT)
dZ (nT/yr)


Learmonth (LRM) Total Intensity (All days)
Annual Mean Values (F) & Secular Variation (dF)
53375
53350
53325
nT
53300
53275
10.0
0.0
nT/yr
-10.0
-20.0
-30.0
1986.0
1988.0
1990.0
1992.0
1994.0
1996.0
1998.0
2000.0
2002.0
F (nT)
dF (nT/yr)

Macquarie Island (Tas.) is approximately 1,350 km. SSE of Hobart, that locates it about half way between Tasmania and Antarctica. Magnetic recording at Macquarie Island has been continuous since 1952, becoming digital in October 1984. Details of the observatory's history are in *AGR 1994*.

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. -59.94°; Long. 244.09°
  † Based on the IGRF 2000.0 model updated to 2001.5
- 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: Dave Gilles (2000/01)
  Mick Eccles (2001)

Variometers

The equipment employed to monitor magnetic variations at MCQ in 2001 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. 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 backup power supply and the acquisition computer situated in the office. The electronic console of the RCF magnetometer was situated in a small room within the Variometer House. The Variometer House temperature was controlled with a heating system. The Elsec 820 PPM sensor was located on the pier in the PPM House.

MCQ - Absolute Instruments and Corrections

Magnetic absolute measurements were performed in the Absolute House, on Pier AW with an Austral PPM (serial 525) and on Pier AE with an Elsec 810 DIM (serial 201 from the beginning of 2001 and serial 214 from late March) with Zeiss020B (serial 311847) theodolite. Replacement magnetometer electronics, serial 214, arrived in late March 2001 to replace serial 201 which had malfunctioned in early January 2001.

The classical QHMs (serial 177, 178, 179 on Askania circle 640616) were available as backup for use on pier AE. QHMs 178 and 179 where relied upon during February and March 2001 until the replacement DIM electronics arrived.

Baselines

For consistency with the Australian Magnetic Standard held at Canberra, a correction of +1.0nT was applied to the PPM readings, while zero corrections were applied to the DIM readings. This resulted in baseline corrections of:

$\Delta X = +0.17$ nT $\Delta Y = +0.10$ nT $\Delta Z = -0.98$ nT.

Operations

The magnetic observers-in-charge at Macquarie Island in 2001 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 providing regular data reports to GA headquarters in Canberra.

Dave Gillies arrived at MCQ on 8 December 2000 and took over the absolute observations from Jean Osanz on 17 December 2000. Mick Eccles arrived on 31 March 2001 and took over from Dave Gillies on 5 April 2001.

Twice weekly absolute calibrations were performed on the observation piers in the Absolute House.

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, to GA where they were processed. Timing was provided by the Antarctic Division's GPS clock (which was also used with Atmospheric and Space Physics experiments).

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 77-78.

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

continued …

MCQ - Annual Mean Values (cont.)

Year	Days	D (Deg	Min)	I (Deg	Min)	H (nT)	X (nT)	Y (nT)	Z (nT)	F (nT)	Elts*
2001.5	A	30	33.5	-78	44.1	12595	10846	6404	-63231	64473	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
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
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

* Elements ABC indicates non-aligned variometer orientation

Macquarie Island 2001Monthly & 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	2001	X (nT)	Y (nT)	Z (nT)	F (nT)	H (nT)	D (East)	I
January	All days	10858.0	6391.3	-63234.8	64477.9	12599.4	30° 28.9'	-78° 43.9'
	5xQ days	10871.3	6399.5	-63235.1	64481.1	12615.1	30° 29.0'	-78° 43.1'
	5xD days	10811.9	6370.8	-63238.3	64471.6	12549.3	30° 30.5'	-78° 46.6'
February	All days	10858.6	6397.4	-63234.5	64478.2	12603.0	30° 30.3'	-78° 43.7'
	5xQ days	10862.5	6400.7	-63234.6	64479.3	12608.0	30° 30.5'	-78° 43.4'
	5xD days	10846.5	6390.3	-63235.5	64476.6	12589.0	30° 30.3'	-78° 44.4'
March	All days	10830.6	6391.0	-63247.4	64485.7	12575.7	30° 32.7'	-78° 45.3'
	5xQ days	10855.2	6401.4	-63234.2	64477.7	12602.1	30° 31.7'	-78° 43.7'
	5xD days	10726.3	6351.7	-63301.4	64517.9	12466.3	30° 38.0'	-78° 51.5'
April	All days	10824.7	6393.8	-63253.0	64490.4	12572.1	30° 34.2'	-78° 45.5'
	5xQ days	10846.6	6406.4	-63250.9	64493.1	12597.2	30° 34.1'	-78° 44.2'
	5xD days	10781.6	6370.8	-63261.1	64489.1	12523.3	30° 34.8'	-78° 48.1'
May	All days	10845.2	6403.9	-63236.4	64478.4	12594.7	30° 33.7'	-78° 44.2'
	5xQ days	10853.7	6408.3	-63237.0	64480.9	12604.3	30° 33.5'	-78° 43.7'
	5xD days	10810.6	6386.8	-63229.1	64464.0	12556.4	30° 34.5'	-78° 46.1'
June	All days	10853.8	6408.6	-63230.1	64474.2	12604.6	30° 33.6'	-78° 43.6'
	5xQ days	10856.7	6410.6	-63230.1	64474.9	12608.1	30° 33.6'	-78° 43.4'
	5xD days	10844.1	6407.7	-63222.5	64465.1	12595.8	30° 34.8'	-78° 44.0'
July	All days	10855.6	6409.8	-63224.0	64468.6	12606.7	30° 33.6'	-78° 43.4'
	5xQ days	10858.1	6410.5	-63224.0	64469.2	12609.3	30° 33.4'	-78° 43.3'
	5xD days	10851.1	6408.2	-63223.4	64467.2	12602.1	30° 33.9'	-78° 43.6'
August	All days	10846.5	6408.0	-63219.2	64462.2	12598.0	30° 34.5'	-78° 43.8'
	5xQ days	10854.7	6411.6	-63221.6	64466.3	12606.9	30° 34.2'	-78° 43.4'
	5xD days	10822.1	6394.9	-63211.0	64448.8	12570.4	30° 34.8'	-78° 45.2'
September	All days	10844.1	6408.6	-63221.5	64464.2	12596.2	30° 34.9'	-78° 43.9'
	5xQ days	10856.6	6414.7	-63221.8	64467.1	12610.1	30° 34.6'	-78° 43.2'
	5xD days	10814.4	6393.1	-63228.3	64464.5	12562.9	30° 35.5'	-78° 45.7'
October	All days	10826.2	6402.0	-63236.5	64475.4	12577.5	30° 35.9'	-78° 45.1'
	5xQ days	10849.1	6415.1	-63227.4	64471.4	12603.9	30° 35.7'	-78° 43.6'
	5xD days	10758.6	6368.0	-63270.9	64494.9	12502.3	30° 37.4'	-78° 49.4'
November	All days	10847.4	6413.1	-63227.7	64471.4	12601.5	30° 35.5'	-78° 43.7'
	5xQ days	10856.4	6416.5	-63225.7	64471.1	12610.8	30° 35.1'	-78° 43.2'
	5xD days	10834.3	6409.8	-63229.1	64470.6	12588.8	30° 36.6'	-78° 44.4'
December	All days	10860.7	6414.6	-63206.3	64452.6	12613.6	30° 34.0'	-78° 42.9'
	5xQ days	10863.0	6415.9	-63208.9	64455.7	12616.2	30° 34.0'	-78° 42.7'
	5xD days	10844.0	6405.7	-63196.1	64439.0	12594.7	30° 34.3'	-78° 43.7'
Annual	All days	10846.0	6403.5	-63231.0	64473.3	12595.3	30° 33.5'	-78° 44.1'
Mean	5xQ days	10857.0	6409.3	-63229.3	64474.0	12607.7	30° 33.3'	-78° 43.4'
Values	5xD days	10812.1	6388.2	-63237.2	64472.4	12558.4	30° 34.6'	-78° 46.1'

(Calculated:12:28 hrs., Tue. 16 Dec. 2003)

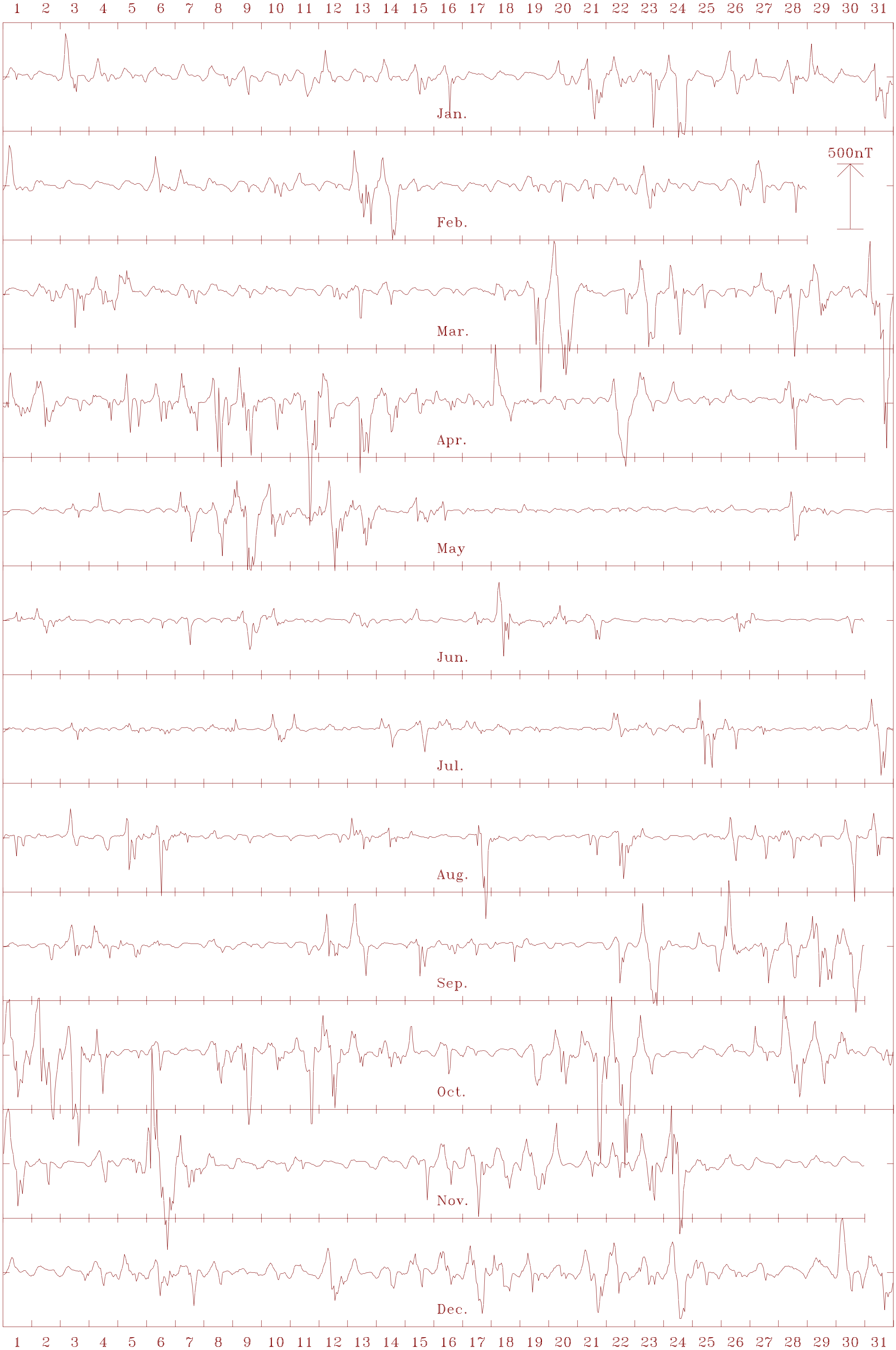
Hourly Mean Values

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

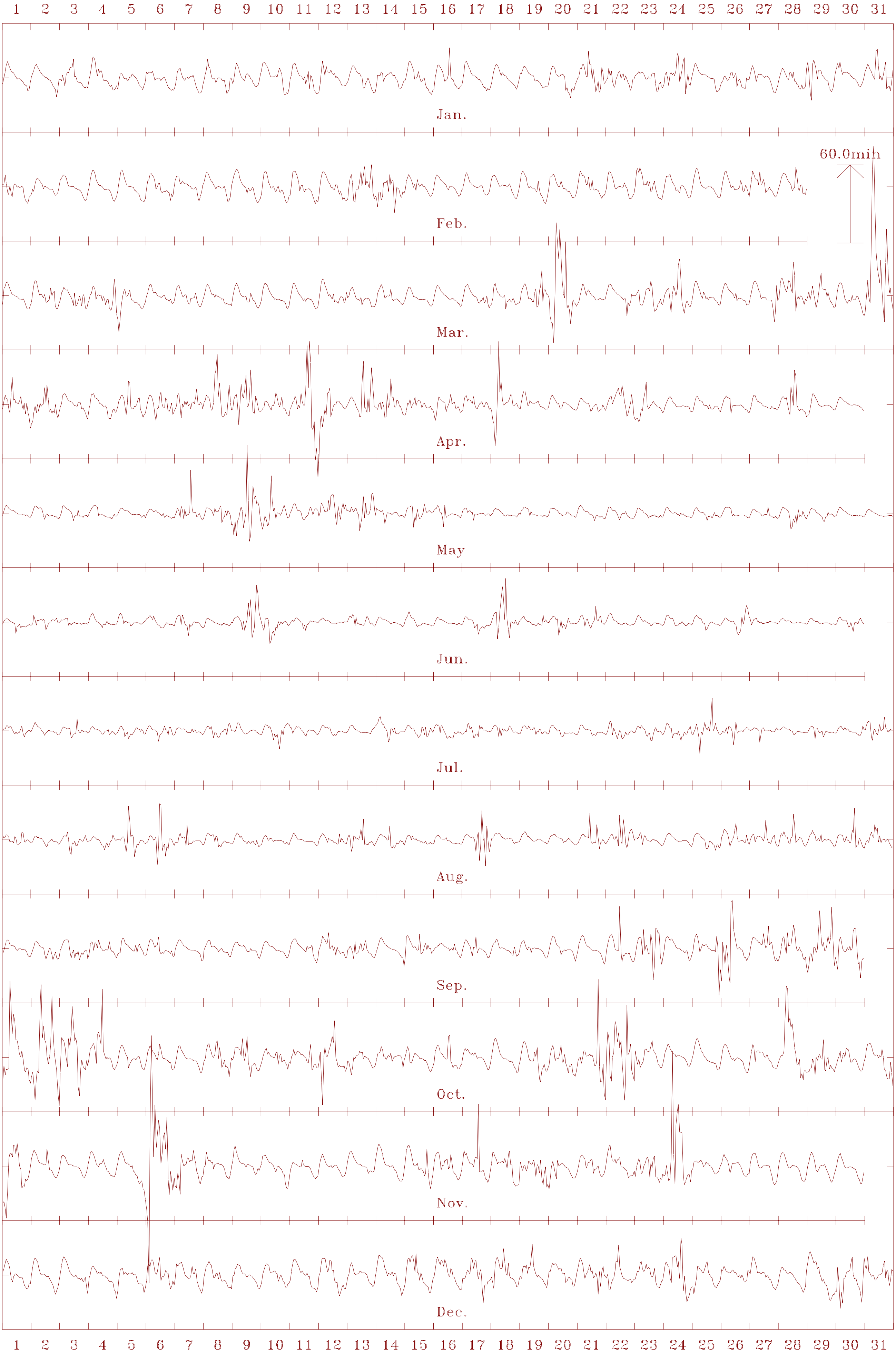
The reference levels indicated with marks on the vertical axes refer to the *all-days* mean value for the respective months. All elements in the plots are shown increasing (algebraically) towards the top of the page, with the exception of Z, which is in the opposite sense.

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

Macquarie Is. 2001 Horizontal intensity (H). Scale: 40.0 nT/mm. Mean: 12595 nT

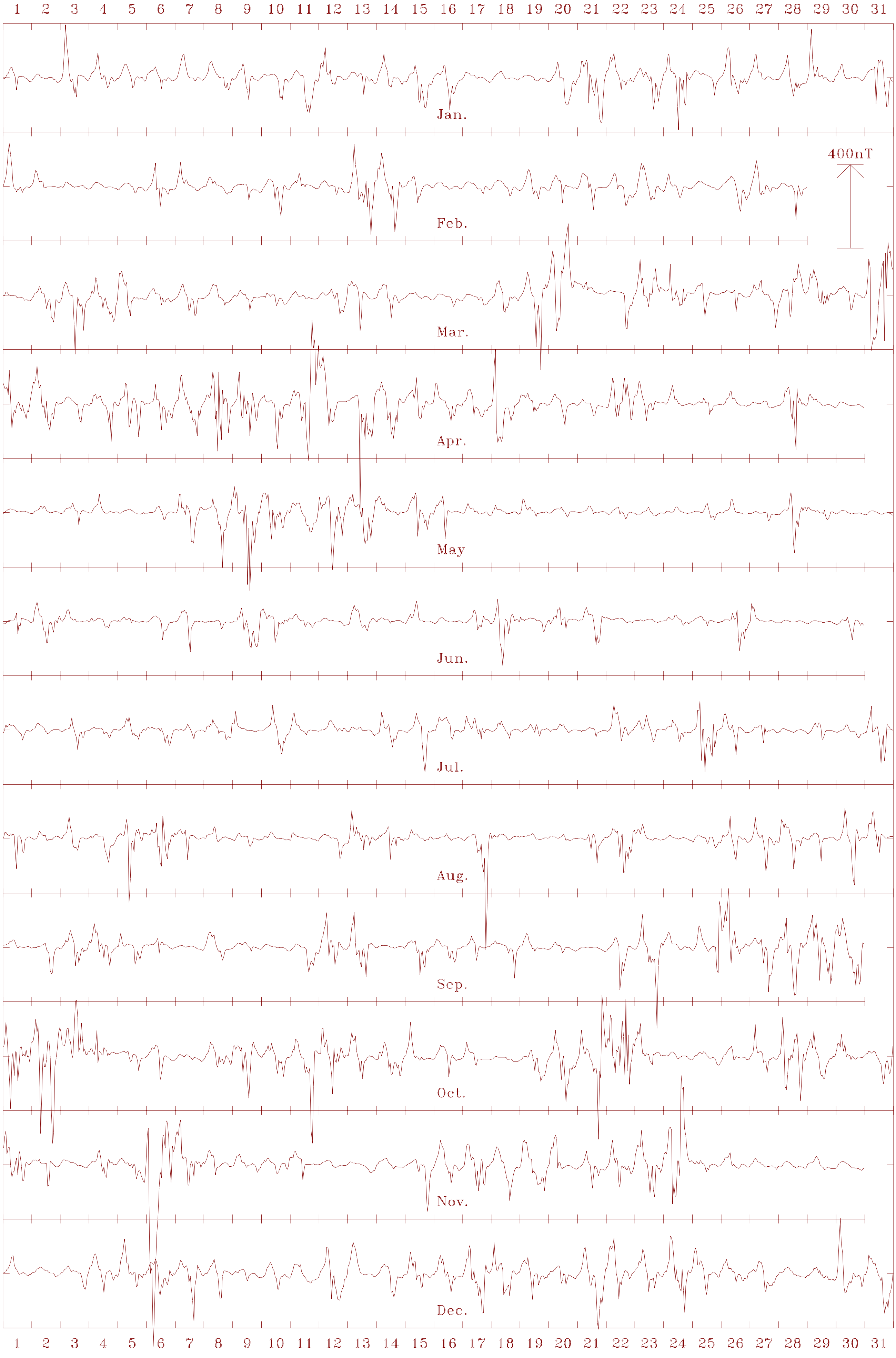


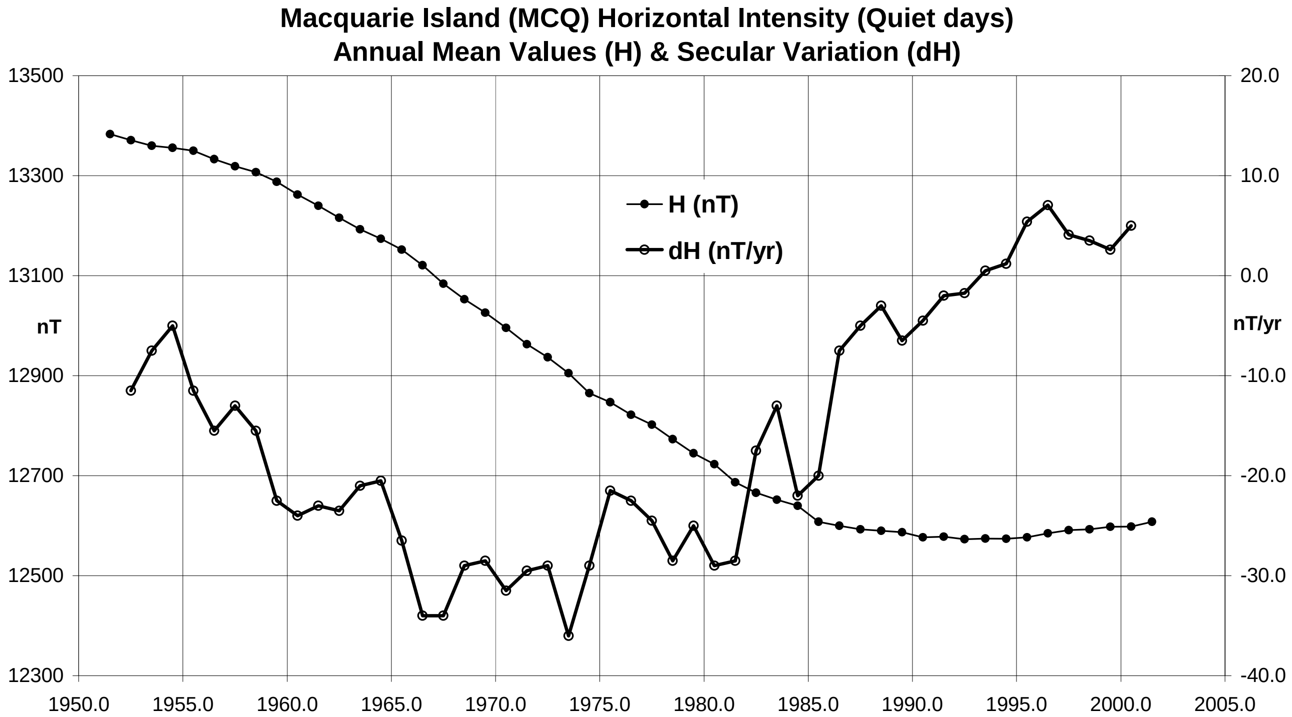
Macquarie Is. 2001 Declination (east) (D). Scale: 4.00 min/mm. Mean: 30.56 deg.

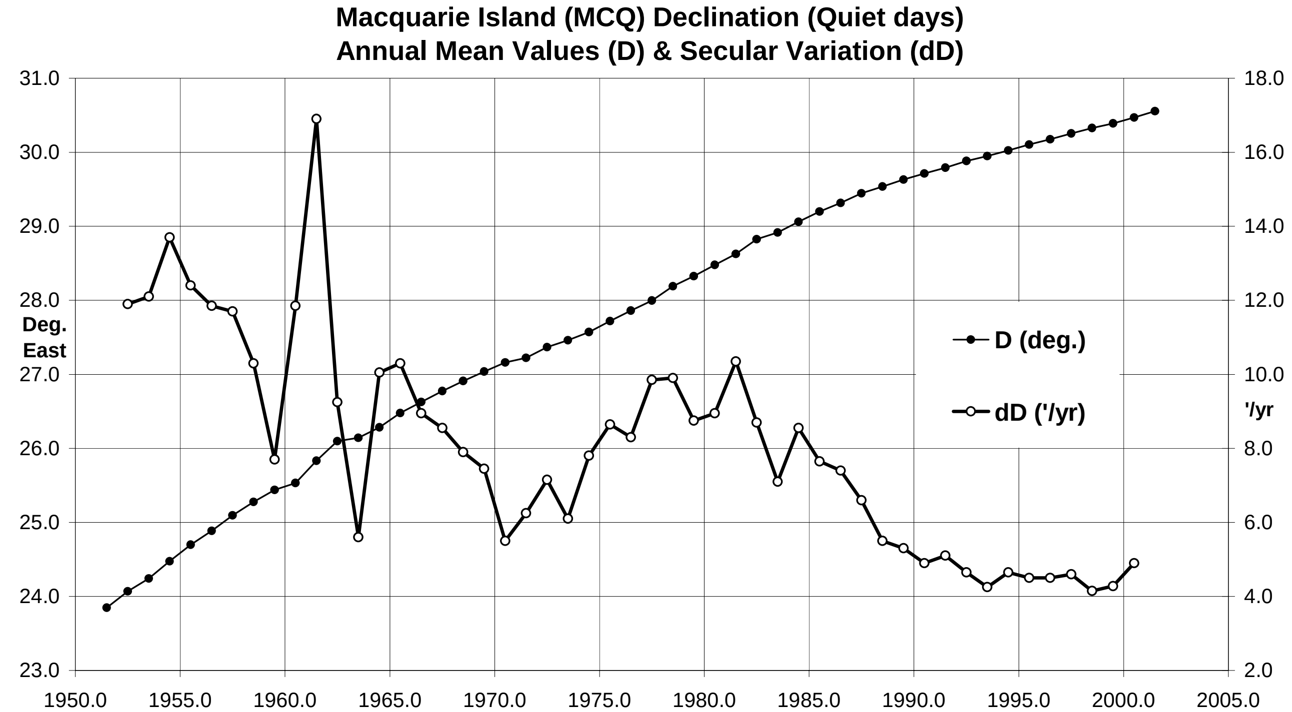


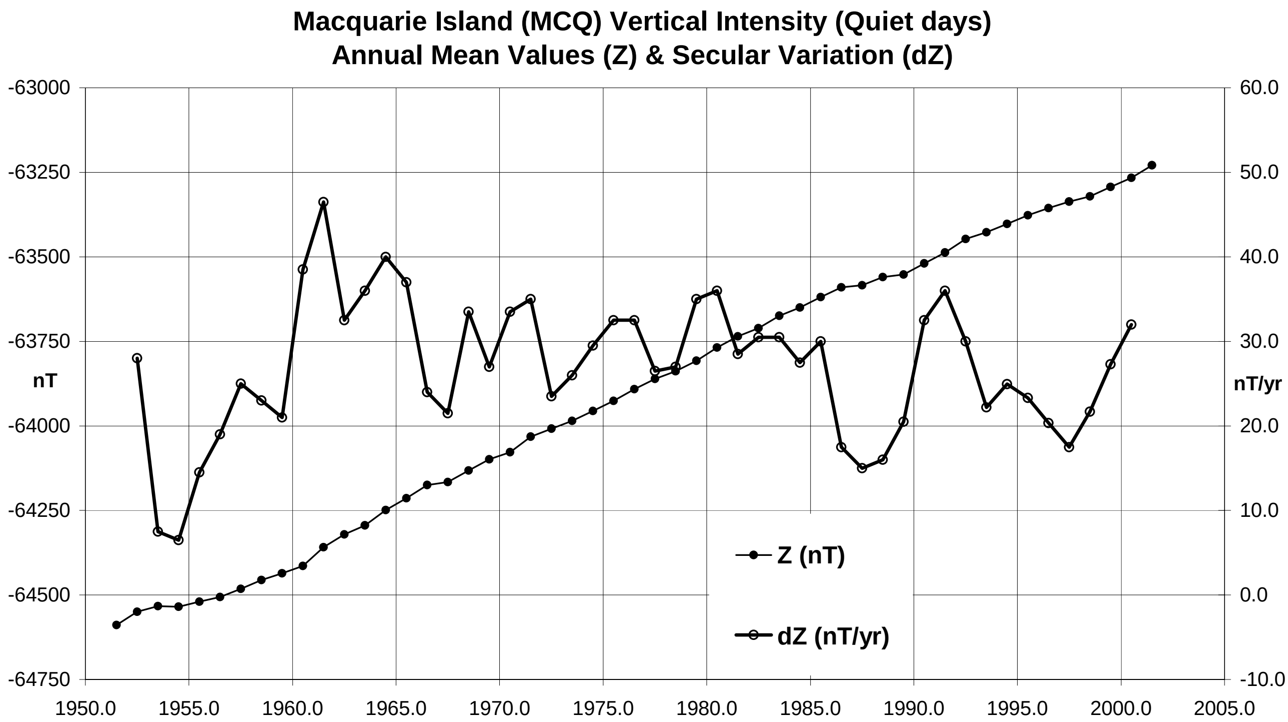
Macquarie Is. 2001 Vertical intensity (Z). Scale: 25.0 nT/mm. Mean: −63231 nT

Macquarie Is. 2001 Total intensity (F). Scale: 25.0 nT/mm. Mean: 64473 nT

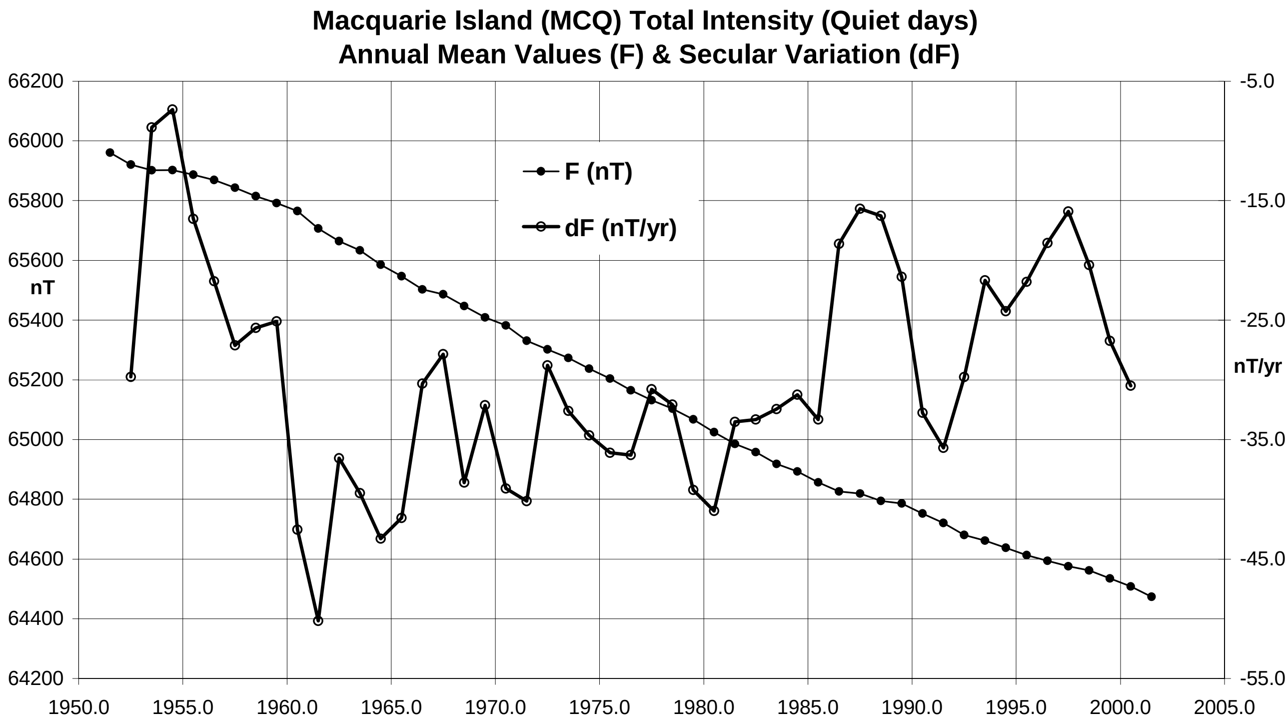



Macquarie Island (MCQ) Horizontal Intensity (Quiet days)
Annual Mean Values (H) & Secular Variation (dH)
H (nT)
dH (nT/yr)
nT
nT/yr
13500
13300
13100
12900
12700
12500
12300
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
1950.0
1955.0
1960.0
1965.0
1970.0
1975.0
1980.0
1985.0
1990.0
1995.0
2000.0
2005.0


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)
-63000
-63250
-63500
-63750
-64000
-64250
-64500
-64750
nT
60.0
50.0
40.0
30.0
20.0
10.0
0.0
-10.0
nT/yr
1950.0
1955.0
1960.0
1965.0
1970.0
1975.0
1980.0
1985.0
1990.0
1995.0
2000.0
2005.0
Z (nT)
dZ (nT/yr)



Macquarie Island (MCQ) Total Intensity (Quiet days)
Annual Mean Values (F) & Secular Variation (dF)
66200
66000
65800
65600
65400
65200
65000
64800
64600
64400
64200
nT
-5.0
-15.0
-25.0
-35.0
-45.0
-55.0
nT/yr
1950.0
1955.0
1960.0
1965.0
1970.0
1975.0
1980.0
1985.0
1990.0
1995.0
2000.0
2005.0
F (nT)
dF (nT/yr)

Significant Events: MCQ, 2001

All 2001 The variometers ran smoothly throughout the year.

Jan 15 A combination of QHMs 178 and 179 were used for this period due to unserviceable DIM electronics.

Apr 05 DIM E810_214 replaced the secondary instruments in the performance of absolute observations.

Aug 03 At approximately 0042 the door between variometer sensor and its electronics was opened to improve temperature stability.

Distribution of MCQ data during 2001

Preliminary Monthly Means for Project Ørsted

- Sent monthly by email to IPGP from July 2001
- 1998, 1999, 2000, Jan-Jun 2001 data to IPGP by email (sent Jul. 2001)

1-minute & Hourly Mean Values

- 1998: WDC-A, Boulder, USA (sent 13 Jun., 2001)
- 1999: WDC-A, Boulder, USA (sent 15 Jun., 2001)
- 2000: WDC-A, Boulder, USA (sent 27 Jun., 2001)

Data Distribution (cont.)

1-minute Values for Project INTERMAGNET

- Definitive data (not for CD-ROM) sent to the INTERMAGNET GIN, Paris:
  1998 (sent 14 Jun, 2001); 1999 (sent 26 Jun, 2001);
  2000 (sent 20 Jul., 2001)

Data losses: MCQ, 2001

There was no period in 2001 when data acquisition was interrupted.

Errors in MCQ 2001 Data

Mar 30 9 backward time jumps occurred on this day due to an adjustment of the clock. It should be noted that there are errors of about 3 secs for this day.

Apr 09 60 backwards time jumps occurred on this day due to an adjustment of the clock. It should be noted that there are errors of about 20 sec for this day.

Oct 13 36 backwards time jumps occurred on this day due to an adjustment of the clock. It should be noted that there are errors of about 12 sec for this day.

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: 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.

In 1955 the Mawson magnetic observatory commenced recording magnetic variations with a three-component analogue magnetograph. The observatory has continuously recorded the geomagnetic field and seismic activity at Mawson. 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).

Additional details of the observatory's history were given 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. -73.11°; Long. 109.84°
  † Based on the IGRF 2000.0 model updated to 2001.5
- 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 (89/2) from pier A: 19° 14.0'
- Distance to azimuth mark 89/2: 105 metres
- Observers in Charge: Peter Johnson (2000, GA/BoM)
  Martin Purvins (2001, GA/BoM)
  Andrew Jenner (2002, GA/BoM)

Variometers

A 3-axis Narod ringcore fluxgate (RCF) magnetometer and an Elsec 820M3 PPM monitored magnetic variations at Mawson throughout 2001. The sensors of both these instruments were located within the sensor room of the MAW Variometer House. This building also housed a global positioning system (GPS) clock, a data acquisition PC, a network PC, and an Aironet ethernet radio link and a standby power supply. In addition, an EDA 3-component magnetometer and its associated data acquisition PC that were installed in September 2000 were available as a standby variometer to replace the principal system should it fail.

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.

Absolute Instruments and Corrections

Several absolute magnetometers were stored and used in the Absolute House, including the primary instruments: an Elsec model 770 PPM (serial 199) and a fluxgate theodolite magnetometer. Bartington B0766H mounted on a Zeiss 020B (serial 313792) theodolite had been in service since January 2000, until it was replaced in late February 2001 with Danish DMI fluxgate magnetometer DIM (D26035) mounted on a Zeiss020B theodolite (serial 311542)

Secondary instruments were an Askania declinometer (Serial 630332), three horizontal magnetometers (QHM Serial 300, 301, and 302), and an Elsec 770 PPM (Serial 206). The declinometer and QMHs were used on Askania circle 611665.

All observations were performed on Pier A.

For standardization with the Australian Magnetic Standard held at Canberra, a correction of +1.6nT has been applied to the PPM readings. Corrections of zero have been applied to the DIM readings. These resulted in baseline corrections of:

$\Delta X = +0.25$ nT $\Delta Y = -0.54$ nT $\Delta Z = -1.48$ nT.

Operations

The 2001 observer in charge of magnetic (and seismological) observatory operations was employed jointly by GA and the Bureau of Meteorology and was a member of the Australian National Antarctic Research Expedition (ANARE).

The 2001 observer (MP) arrived and took over absolute observations from the 2000 observer (PJ) on 04 December 2000, who departed the station on 7 December 2000. The 2001 observer departed the station on 12 February 2002, after the 2002 observer (AJ) had arrived and taken charge of the observatory on 3 January 2002.

In 2001, twice-weekly absolute observations were performed by the observer in charge of the observatory on the observation pier A in the Absolute House. The absolute observations were sent to GA where they were reduced.

The observer was responsible for the continuous operation of the observatory and performed equipment maintenance as required.

The 1-second RCF data and 10-second PPM data as well as 1-minute means of both were recorded on an acquisition PC. A PC running QNX, also in the variometer house, automatically copied files from the acquisition PC. The QNX PC was connected to the station's radio network. The files on this PC were subsequently automatically retrieved at GA, Canberra, by ftp via the ANARE satellite communications system. A GPS clock provided system timing. Using a PC in the Science Building the data acquisition system was routinely interrogated to ensure correct operation and to check timing.

The final data for the year were reduced and analysed by GA staff.

MAW 2001 Data Loss

Sep 26 1751-1752 (2 min) All channels: PC re-booted.

Sep 28 0826-0832 (7 min) All channels: Power failure on station.

Oct 12 1201-1205 (5 min): All channels. Power failure on station.

Data Loss (cont.) *Errors in Data:*

Oct 8 9 backwards time jumps occurred on this day due to an adjustment of the clock. It should be noted that there are errors of about 3 secs for this day.

Oct 16 3 backwards time jumps occurred on this day due to an adjustment of the clock. It should be noted that there are errors of about 1 sec for this day.

MAW Significant Events 2001

All 2001 Numerous temperature adjustments of the order of +/- 1°C were made to the Variometer Hut throughout the year to maintain it at 10°C.

Jan 25 Aurora Australis day trippers came ashore and two of them were found to be in the 'magnetic quiet zone'.

Feb 19 DIM D26035/311542 arrived to replace the B0766H/313792.

Mar 3 DIM B0766H/313792 was forwarded to Davis aboard Voyage 7.

Apr 16 Heater was left on in Absolute Hut.

Jul 11 Foam insulation was placed over variometer.

Aug 26 Several 'E-boxes' (shipping containers) were found in the 'magnetic quiet zone', they were removed.

Sep 14 Removal of battery charger from Absolute Hut.

Sep 28 UPS was found to have low battery. Station power failure from 1026 to 1031.

Oct 5 Acquisition PC clock was adjusted by -2 secs.

Oct 8 Acquisition PC clock was adjusted by -90 ticks at 0908.

Oct 9 Acquisition PC clock was found to be 3 secs slow therefore it was adjusted by +55 ticks at 0817.

Oct 12 Station power failure from 1200 to 1205. As a result the acquisition PC was re-booted at 1206.

Oct 16 Acquisition PC clock was found to be 1 sec fast therefore it was adjusted by +50 ticks.

Dec 10 Magnetic absolute observations were contaminated due to observer wearing metallic belt and jeans.

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 88-89.

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

continued …

Year	Days	D (Deg	Min)	I (Deg	Min)	H (nT)	X (nT)	Y (nT)	Z (nT)	F (nT)	Elts*
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
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
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
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

* Elements ABC indicates non-aligned variometer orientation

Distribution of MAW data during 2001

Preliminary Monthly Means for Project Ørsted

- Sent monthly by email to IPGP from July 2001
- 1998 data to IPGP by email (sent 18 May 2001)
- 1999, 2000, Jan-Jun 2001 data to IPGP by email (sent 30 Jul. 2001)

1-minute & Hourly Mean Values (WDC format)

- 1998: WDC-A, Boulder, USA (sent 13 Jun., 2001)
- 1999: WDC-A, Boulder, USA (sent 15 Jun., 2001)
- 2000: WDC-A, Boulder, USA (sent 27 Jun., 2001)

1-minute Values (INTERMAGNET format)

- 1998: WDC-C1, Copenhagen, Denmark (sent 14 Jun., 2001)
- 1999: WDC-C1, Copenhagen, Denmark (sent 26 Jun., 2001)
- 2000: WDC-C1, Copenhagen, Denmark (sent 20 Jul., 2001)

K indices

The table on the next page shows Mawson K indices for 2001. 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 2001

Date	January	February	March	April	May	June	Date
01	Q 4332 2223 21	3663 3244 31	5331 1233 21	4573 3466 38	Q 1211 1112 10	1101 3223 13	01
02	Q 4321 2224 20	5532 2224 25	4432 2456 30	6665 3675 44	1231 2223 16	D 7543 3346 35	02
03	3773 4223 31	Q 3121 0111 10	5333 4344 29	4332 2333 23	4223 3235 24	2552 2144 25	03
04	5343 5434 31	Q 2232 2221 16	4554 4476 39	5442 5562 33	2333 1054 21	6342 2215 25	04
05	4433 2345 28	2322 2225 20	6554 2323 30	3465 3535 34	Q 1221 0134 14	5431 1144 23	05
06	Q 4432 2313 22	D 5454 2355 33	3332 2255 25	4243 2256 28	0121 1114 11	4342 2235 25	06
07	4553 2325 29	4452 2234 26	4442 3433 27	5654 4654 39	5634 3362 32	5543 2221 24	07
08	4443 3355 31	3442 1346 27	3333 2255 26	D 4345 5487 40	3224 3477 32	2222 1116 17	08
09	4333 4354 29	4233 3345 27	3332 3312 20	4565 3654 38	D 6744 5565 42	D 3544 4377 37	09
10	3321 3343 22	3332 3432 23	3432 1242 21	6333 3436 31	D 6643 3364 35	D 6664 3355 38	10
11	4322 4654 30	4342 2225 24	Q 3522 1133 20	D 6433 6767 42	5332 2346 28	3432 3343 25	11
12	5553 3322 28	4322 3345 26	2123 3354 23	D 7765 3323 36	D 5465 5676 44	Q 3331 1144 20	12
13	2334 4213 22	D 5564 5676 44	5534 3245 31	D 3347 5666 40	D 5454 3587 41	5543 3264 32	13
14	4543 2254 29	D 5553 4585 40	5433 2343 27	6654 3445 37	7442 2252 28	5211 1125 18	14
15	3233 3536 28	4333 2224 23	Q 3221 1133 16	5533 2355 31	3544 3366 34	5534 2122 24	15
16	4223 4333 24	3322 2215 20	Q 1221 1235 17	7433 3346 33	6443 2204 25	2321 0133 15	16
17	5431 3334 26	Q 4421 2343 23	Q 1222 2252 18	5542 2355 31	5432 2235 26	2222 3334 21	17
18	3233 2123 19	Q 4321 2224 20	5652 2326 31	D 9763 3336 40	5532 1116 24	D 4645 3335 33	18
19	Q 3322 2244 22	3443 2242 24	D 5443 4556 36	Q 5431 2115 22	6432 2153 26	4321 1266 25	19
20	4343 4445 31	3543 3124 25	D 7545 4666 43	5532 2234 26	2333 3113 19	5556 4325 35	20
21	D 4435 4665 37	4543 3225 28	6433 2112 22	3321 2344 22	Q 3222 1121 14	D 3564 3366 36	21
22	6554 4335 35	3332 2354 25	2222 3336 23	3664 4764 40	2331 2234 20	Q 4412 2234 22	22
23	D 4434 5475 36	D 4654 3344 33	D 7654 5364 40	6655 2124 31	3321 1244 20	Q 3311 2232 17	23
24	D 4545 5584 40	3332 4313 22	3562 3453 31	Q 2543 1013 19	4321 1145 21	5333 3244 27	24
25	4422 1343 23	Q 2221 1143 16	3334 3244 26	Q 2222 2334 20	3122 3342 20	4542 3222 24	25
26	4453 4334 30	4322 3555 29	Q 2222 2243 19	2442 1134 21	2433 1102 16	2223 3555 27	26
27	5442 2332 25	D 5653 2232 28	6534 2357 35	Q 3322 1333 20	1110 2344 16	6542 1112 22	27
28	3443 3444 29	3223 3342 22	D 3356 5646 38	4654 6555 40	D 4324 3557 33	Q 2110 0001 05	28
29	D 6543 2235 30		5664 3445 37	5443 3210 22	6312 2322 21	Q 1011 1044 12	29
30	Q 3432 2211 18		2433 3333 24	Q 1111 0011 06	Q 0000 1021 04	1312 3153 19	30
31	D 2245 5655 34		D 8786 5676 53		Q 2001 0102 06		31
Mean K-sum	27.7	25.4	28.3	30.9	23.3	24.0	

Date	July	August	September	October	November	December	Date
01	6321 2235 24	6533 3343 30	Q 4422 1232 20	D 7776 4566 48	D 4654 5442 34	3333 3223 22	01
02	Q 4531 1033 20	2333 2322 20	1112 2334 17	D 5655 3677 44	3331 4212 19	3232 3224 21	02
03	2322 3343 22	5464 2235 31	4334 3455 31	D 5577 6644 44	Q 3321 2111 14	3333 4355 29	03
04	4322 1333 21	3322 3454 26	5653 2445 34	6455 3455 37	3334 3332 24	5544 4344 33	04
05	4443 3365 32	D 5354 4354 33	6422 2442 26	2323 2331 19	2222 4456 27	4653 4454 35	05
06	3333 3232 22	D 2444 4456 33	5222 2256 26	2434 2153 24	D 7875 6665 50	5435 4445 34	06
07	Q 2222 3223 18	4533 3233 26	Q 1111 1115 12	Q 2132 2014 15	D 6654 4445 38	4433 5533 30	07
08	D 4443 2266 31	4433 3222 23	6542 2343 29	3434 4547 34	4443 1225 25	5433 5433 30	08
09	7531 2225 27	1421 2344 21	Q 2222 2101 12	6444 5422 31	3432 2354 26	Q 3233 1034 19	09
10	2434 3475 32	3332 1264 24	Q 1211 1244 16	4333 3443 27	3423 3345 27	Q 3332 4214 22	10
11	5541 1121 20	Q 6310 0116 18	4221 2343 21	4343 3665 34	4434 1223 23	Q 4333 3234 25	11
12	1233 2233 19	3433 1345 26	4553 2356 33	5745 -655 --	3422 3213 20	4445 3453 32	12
13	3321 1155 21	D 6733 2356 35	3763 2322 28	5543 3444 32	3421 2334 22	Q 5552 2311 24	13
14	5432 3322 24	3433 3545 30	2322 1113 15	3444 3455 32	Q 3331 2142 19	3334 4444 29	14
15	2333 3556 30	Q 5432 2265 29	D 6433 2475 34	5553 2403 27	3222 2463 24	4443 4224 27	15
16	D 6543 3336 33	Q 2211 1134 15	6322 2566 32	3333 3234 24	5455 3423 31	4554 3335 32	16
17	D 6644 3445 36	D 4313 5666 34	2333 3116 22	Q 5432 3133 24	4645 5446 38	D 4674 5643 39	17
18	3553 3233 27	4441 3322 23	2421 1252 19	Q 3121 2251 17	4545 3335 32	5445 4324 31	18
19	3242 3344 25	1343 1110 14	4442 2024 22	2223 3553 25	D 6544 4455 37	5444 3344 31	19
20	Q 4432 3215 24	1222 2201 12	2122 1115 15	3654 3444 33	5452 1112 21	Q 4224 4324 25	20
21	Q 3321 2125 19	2332 3335 24	Q 4221 0115 16	D 4533 4768 40	3333 4422 24	D 3465 5554 37	21
22	5453 2346 32	D 3553 4566 37	4233 3421 22	D 7556 6775 48	4445 3355 33	3655 4333 32	22
23	6424 3333 28	6543 3155 32	D 2564 4874 40	5553 3224 29	4445 5466 38	4443 3423 27	23
24	5533 4355 33	Q 2211 1100 08	5332 2233 23	Q 4322 0102 14	D 57-9 8734 --	D 3676 5535 40	24
25	D 3664 3442 32	2311 2234 18	2442 2278 31	3333 2255 26	4543 4324 29	4544 3335 31	25
26	6543 2145 30	3443 1245 26	D 7676 4-54 --	Q 4343 3225 26	4343 3122 22	4433 2443 27	26
27	2343 2325 24	4642 3276 34	4423 4575 34	5623 4333 29	Q 4321 1323 19	4433 4343 28	27
28	Q 4311 1003 13	6443 1231 24	54-3 3565 --	5875 4545 43	Q 3221 2234 19	4332 3212 20	28
29	3442 3221 21	Q 2332 2213 18	D 6556 3567 43	4553 4546 36	4332 2112 18	3443 4434 29	29
30	2121 1264 19	2544 3443 29	D 6553 3856 41	4534 3234 28	Q 3322 1222 17	D 6873 3346 40	30
31	D 6443 4746 38	5655 3325 34		3222 4346 26		D 5553 4665 39	31
Mean K-sum	25.7	25.4	25.5	30.5	26.6	29.7	

Occurrence distribution of K-indices

K-Index:	0	1	2	3	4	5	6	7	8	9	-
January	0	9	46	77	68	37	7	3	1	0	0
February	1	15	65	60	43	30	8	1	1	0	0
March	0	16	52	71	41	37	23	6	2	0	0
April	4	17	30	58	42	42	34	11	1	1	0
May	15	43	55	52	35	23	17	7	1	0	0
June	8	40	52	53	38	31	15	3	0	0	0
July	3	24	52	78	43	28	17	3	0	0	0
August	6	30	47	70	45	29	19	2	0	0	0
September	3	33	63	38	39	31	20	8	3	0	2
October	4	9	33	63	54	49	19	14	2	0	1
November	0	22	50	58	59	30	13	4	2	1	1
December	1	5	23	82	82	40	11	3	1	0	0
ANNUAL TOTAL	**45**	**263**	**568**	**760**	**589**	**407**	**203**	**65**	**14**	**2**	**4**

Mawson, Antarctica 2001 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 2001		X (nT)	Y (nT)	Z (nT)	F (nT)	H (nT)	D (East)	I
January	All days	7611.2	-16959.7	-45561.8	49208.2	18589.4	-65° 49.8'	-67° 48.3'
	5xQ days	7601.3	-16956.6	-45566.4	49209.8	18582.4	-65° 51.3'	-67° 48.8'
	5xD days	7622.7	-16955.3	-45531.2	49180.3	18590.2	-65° 47.5'	-67° 47.4'
February	All days	7592.0	-16950.2	-45568.7	49208.3	18572.8	-65° 52.4'	-67° 49.5'
	5xQ days	7594.4	-16957.7	-45560.8	49203.9	18580.6	-65° 52.5'	-67° 48.8'
	5xD days	7589.3	-16937.7	-45587.7	49221.3	18560.4	-65° 51.9'	-67° 50.8'
March	All days	7573.3	-16941.7	-45579.5	49212.6	18557.5	-65° 54.9'	-67° 50.8'
	5xQ days	7584.3	-16958.1	-45555.6	49197.7	18576.8	-65° 54.2'	-67° 48.9'
	5xD days	7549.4	-16910.2	-45629.3	49244.5	18519.1	-65° 56.5'	-67° 54.6'
April	All days	7556.5	-16933.1	-45603.6	49229.4	18542.7	-65° 57.1'	-67° 52.4'
	5xQ days	7571.7	-16955.2	-45572.6	49210.5	18569.1	-65° 56.2'	-67° 49.9'
	5xD days	7542.5	-16915.9	-45637.7	49253.3	18521.6	-65° 58.2'	-67° 54.6'
May	All days	7566.9	-16944.0	-45568.1	49201.9	18556.9	-65° 56.1'	-67° 50.5'
	5xQ days	7581.2	-16962.3	-45553.3	49196.5	18579.5	-65° 55.1'	-67° 48.7'
	5xD days	7534.2	-16901.5	-45601.4	49213.2	18504.9	-65° 58.5'	-67° 54.8'
June	All days	7567.1	-16949.3	-45556.1	49192.5	18561.8	-65° 56.5'	-67° 49.9'
	5xQ days	7577.8	-16961.7	-45549.9	49192.7	18577.5	-65° 55.6'	-67° 48.7'
	5xD days	7548.8	-16933.0	-45564.1	49191.6	18539.5	-65° 58.4'	-67° 51.5'
July	All days	7563.7	-16952.8	-45549.7	49187.3	18563.7	-65° 57.3'	-67° 49.6'
	5xQ days	7570.5	-16960.3	-45549.0	49190.3	18573.2	-65° 56.7'	-67° 49.0'
	5xD days	7554.3	-16948.2	-45554.7	49188.9	18555.7	-65° 58.6'	-67° 50.3'
August	All days	7561.9	-16951.3	-45549.1	49185.9	18561.5	-65° 57.5'	-67° 49.7'
	5xQ days	7564.1	-16960.0	-45546.4	49186.7	18570.4	-65° 57.8'	-67° 49.1'
	5xD days	7550.9	-16926.7	-45530.3	49158.4	18534.6	-65° 57.5'	-67° 51.0'
September	All days	7558.4	-16949.8	-45560.2	49195.2	18558.8	-65° 58.0'	-67° 50.2'
	5xQ days	7564.6	-16966.1	-45548.4	49190.8	18576.1	-65° 58.2'	-67° 48.8'
	5xD days	7544.9	-16921.7	-45595.7	49216.5	18527.8	-65° 58.2'	-67° 53.1'
October	All days	7552.9	-16955.7	-45576.9	49211.9	18562.0	-65° 59.4'	-67° 50.4'
	5xQ days	7554.0	-16963.9	-45564.6	49203.4	18569.8	-65° 59.8'	-67° 49.6'
	5xD days	7541.3	-16924.9	-45625.1	49244.5	18529.4	-65° 59.0'	-67° 53.8'
November	All days	7564.3	-16972.8	-45571.6	49214.7	18582.3	-65° 58.7'	-67° 49.0'
	5xQ days	7561.8	-16976.6	-45564.2	49208.6	18584.5	-65° 59.4'	-67° 48.6'
	5xD days	7572.6	-16976.4	-45611.0	49254.1	18589.4	-65° 57.6'	-67° 49.6'
December	All days	7582.4	-16986.1	-45550.4	49202.4	18601.8	-65° 56.7'	-67° 47.2'
	5xQ days	7567.9	-16980.6	-45552.0	49199.6	18590.7	-65° 58.7'	-67° 47.9'
	5xD days	7588.2	-16978.3	-45542.3	49193.2	18597.3	-65° 55.2'	-67° 47.2'
Annual	All days	7570.9	-16953.9	-45566.3	49204.2	18567.6	-65° 56.2'	-67° 49.8'
Mean	5xQ days	7574.5	-16963.3	-45556.9	49199.2	18577.6	-65° 56.3'	-67° 48.9'
Values	5xD days	7561.6	-16935.8	-45584.2	49213.3	18547.5	-65° 56.4'	-67° 51.6'

(Calculated:11:22 hrs., Wed. 17 Dec. 2003)

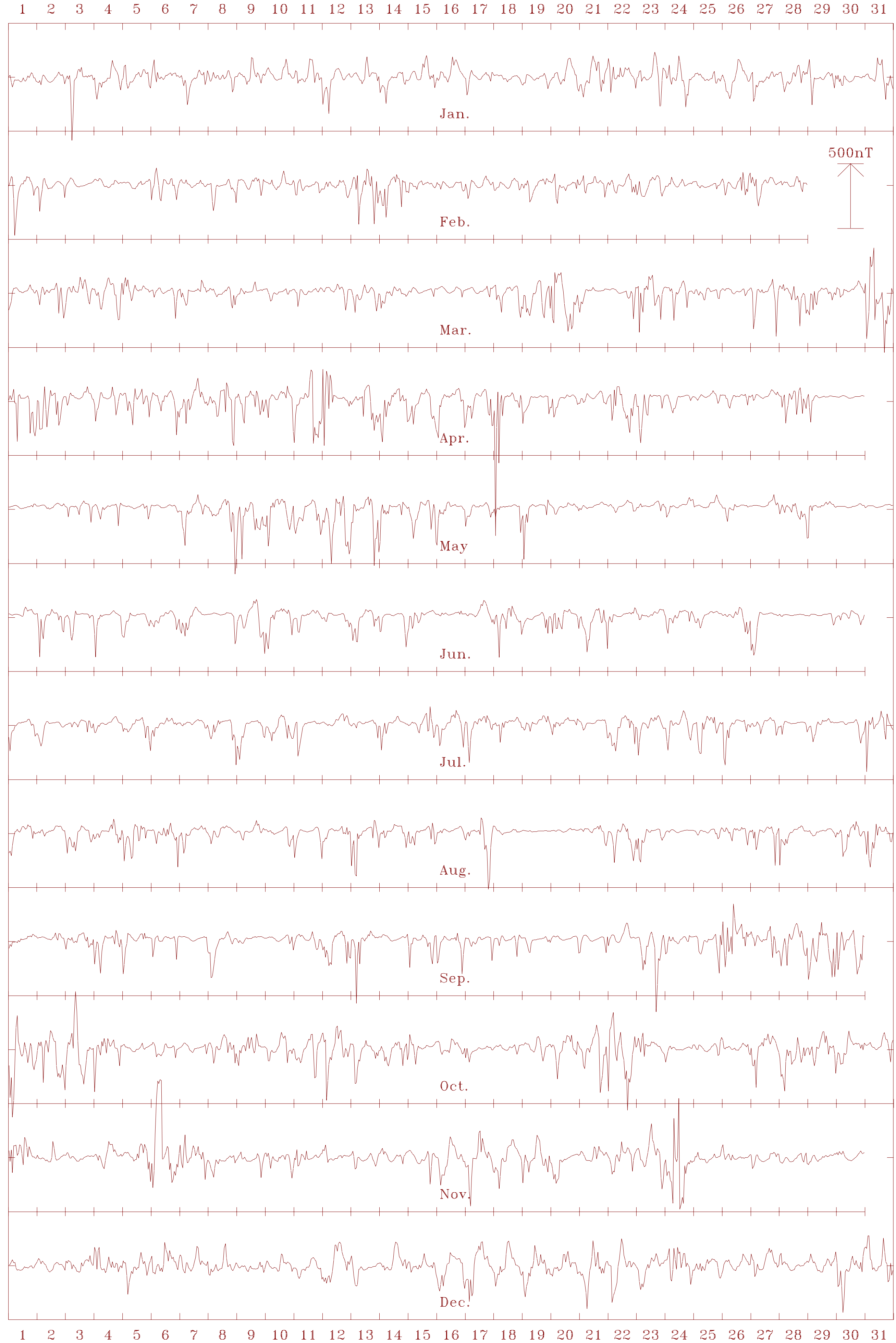
Hourly Mean Values

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.

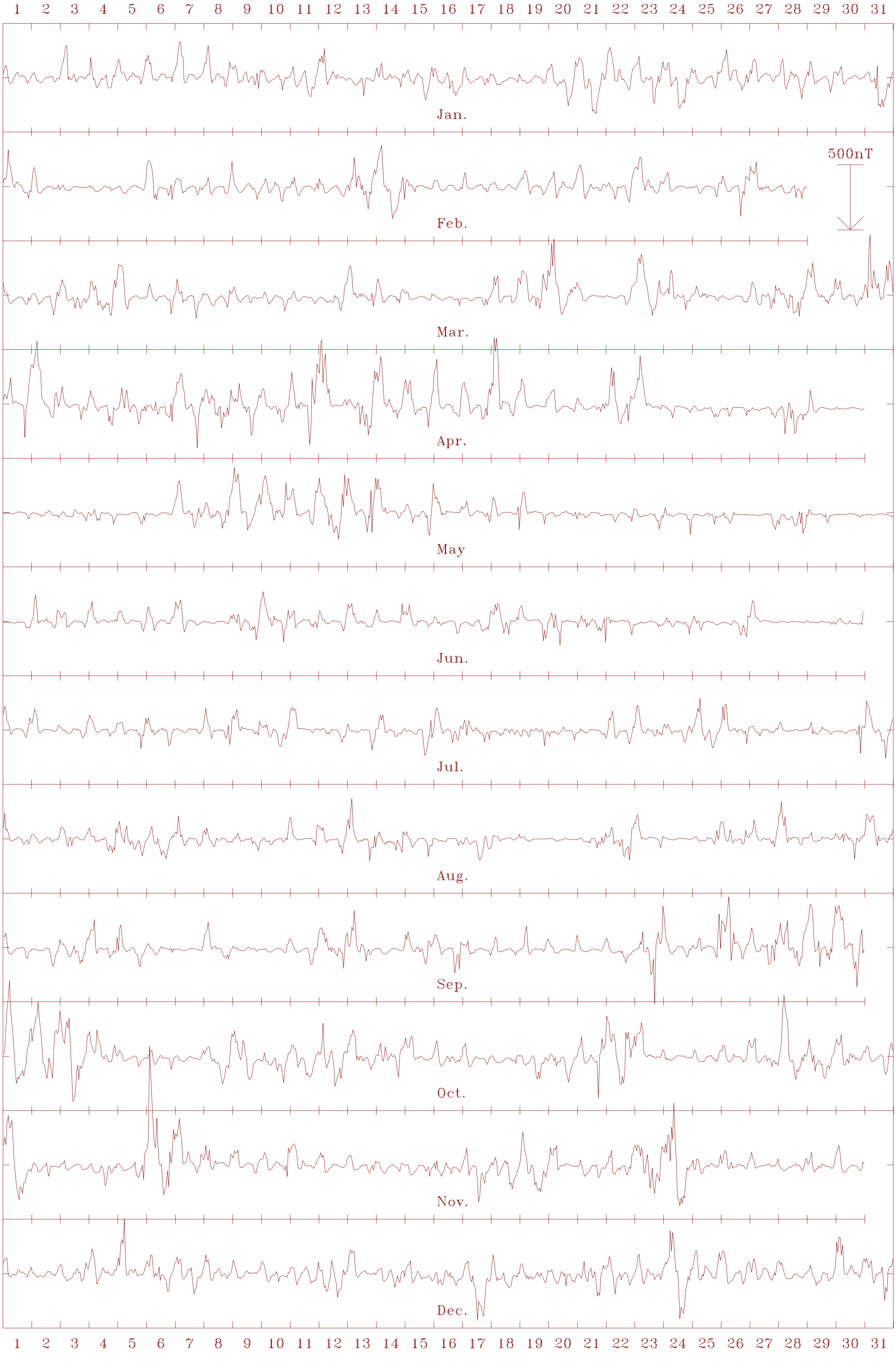
The mean value given at the top of each plot is the *all-days* annual mean value of the element.

Mawson Stn. 2001 Horizontal intensity (H). Scale: 40.0 nT/mm. Mean: 18568 nT

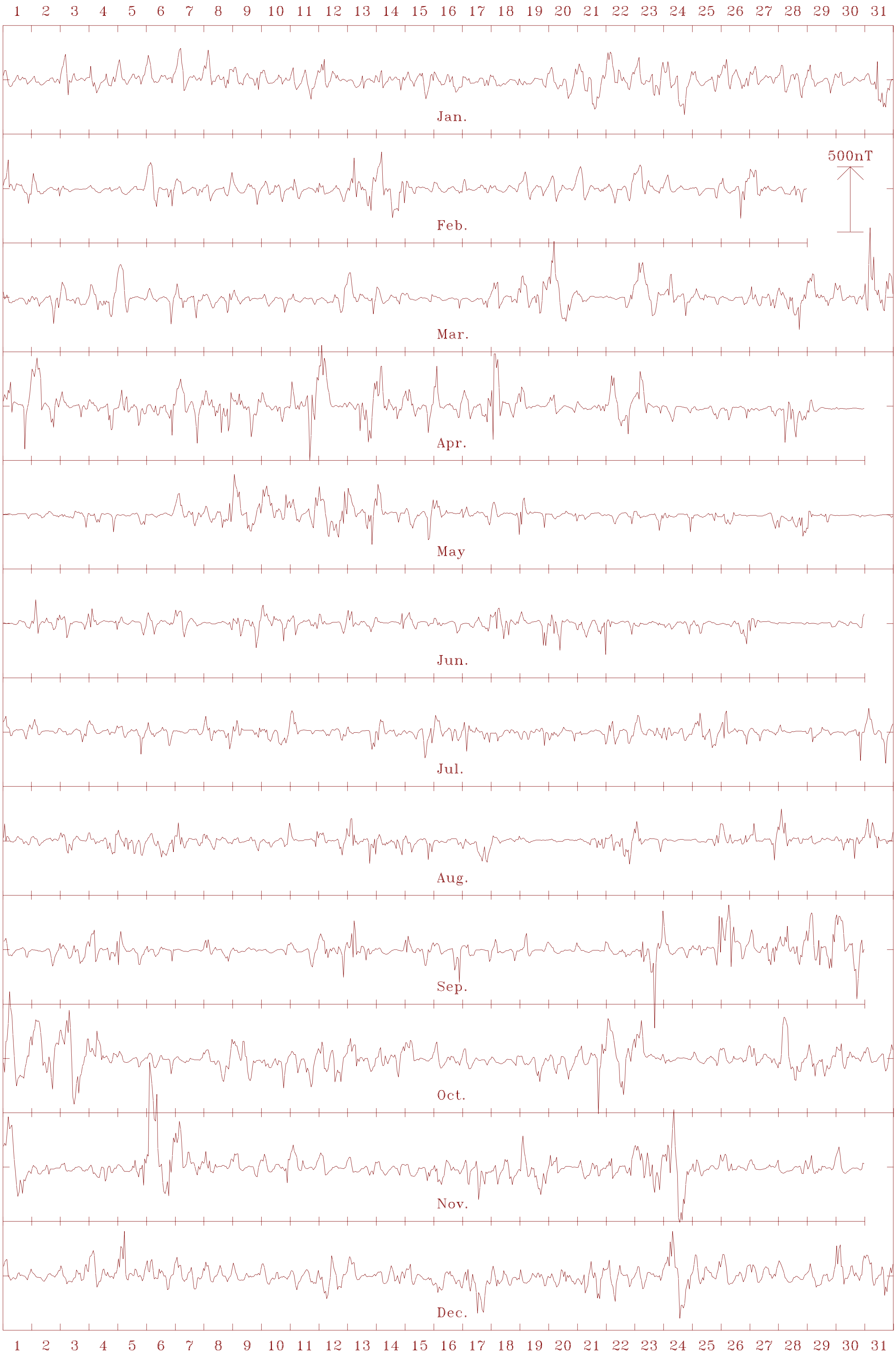


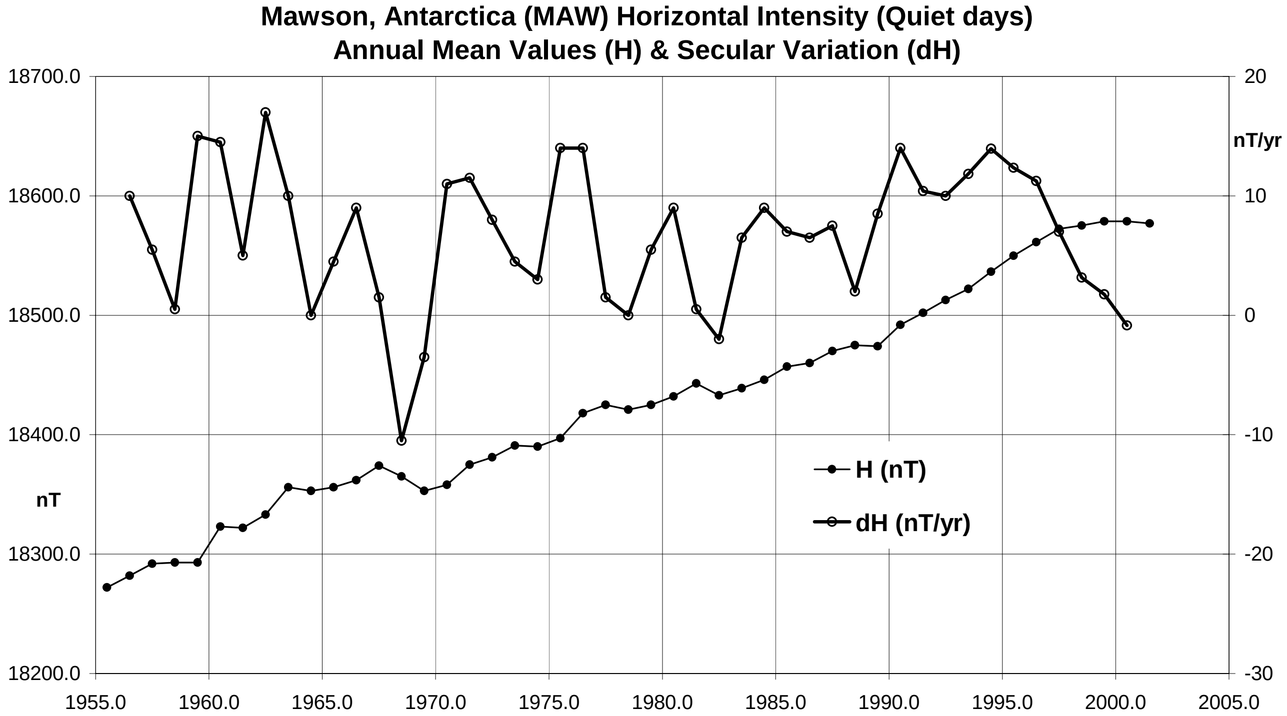
Mawson Stn. 2001 Declination (east) (D). Scale: 5.00 min/mm. Mean: −65.94 deg.

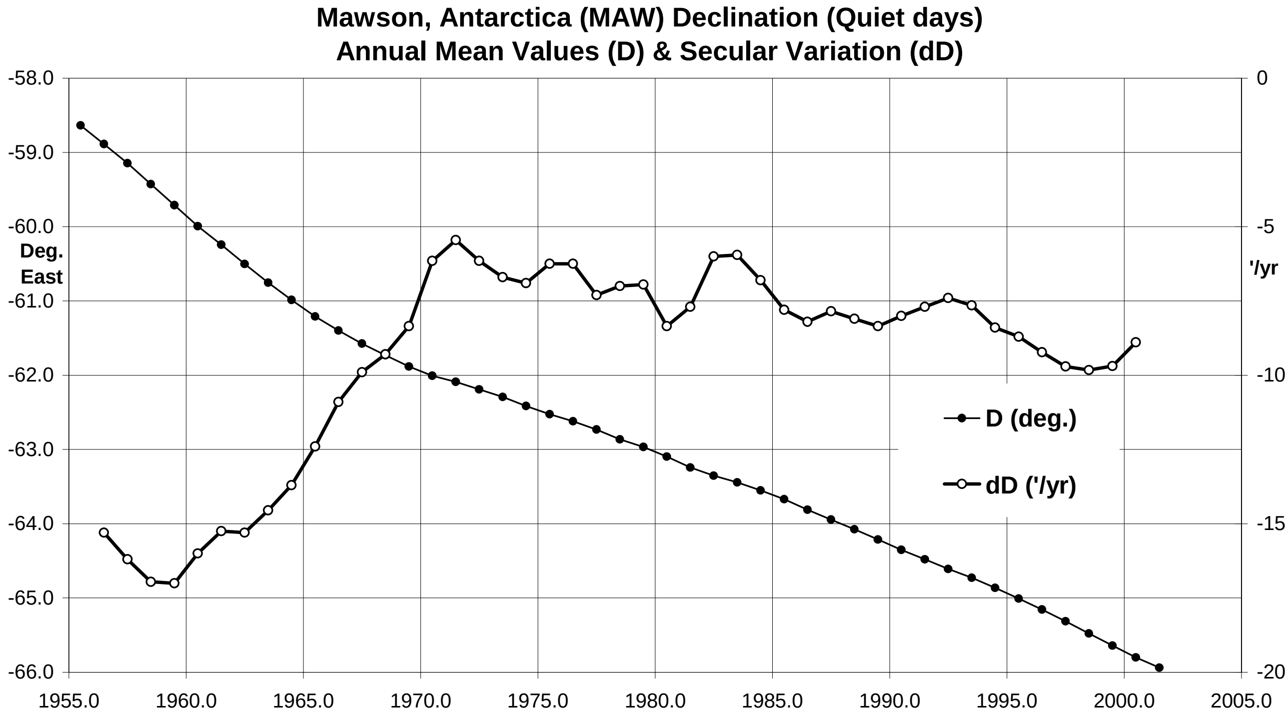
Mawson Stn. 2001 Vertical intensity (Z). Scale: 40.0 nT/mm. Mean: -45566 nT

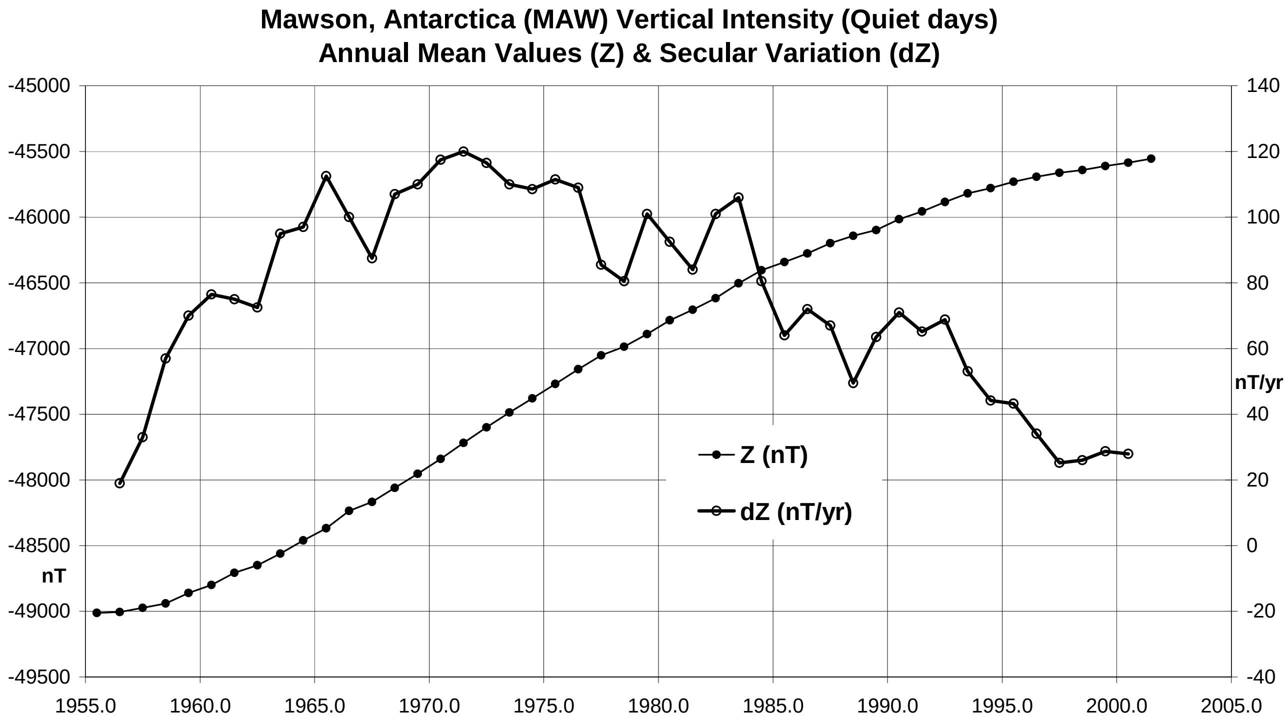


Mawson Stn. 2001 Total intensity (F). Scale: 40.0 nT/mm. Mean: 49204 nT

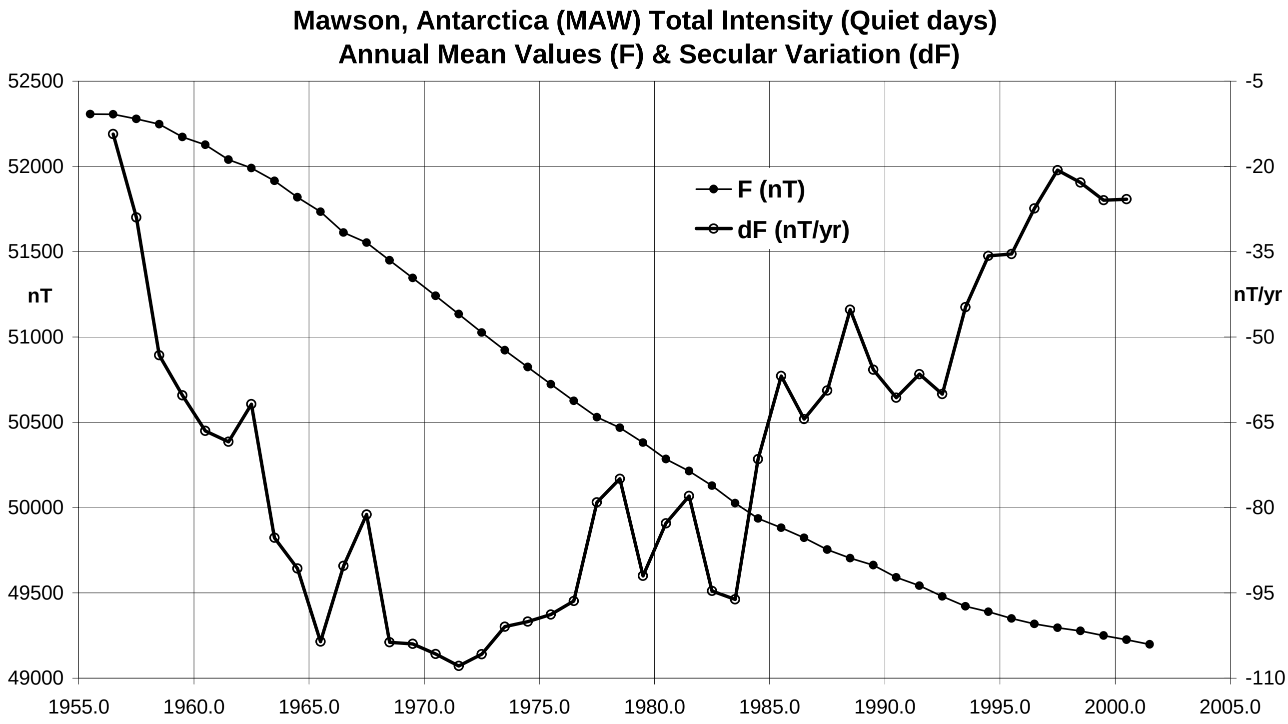



Mawson, Antarctica (MAW) Horizontal Intensity (Quiet days)
Annual Mean Values (H) & Secular Variation (dH)
18700.0
18600.0
18500.0
18400.0
18300.0
18200.0
nT
20
10
0
-10
-20
-30
nT/yr
H (nT)
dH (nT/yr)
1955.0
1960.0
1965.0
1970.0
1975.0
1980.0
1985.0
1990.0
1995.0
2000.0
2005.0


Mawson, Antarctica (MAW) Declination (Quiet days)
Annual Mean Values (D) & Secular Variation (dD)
-58.0
-59.0
-60.0
-61.0
-62.0
-63.0
-64.0
-65.0
-66.0
Deg.
East
0
-5
-10
-15
-20
'/yr
D (deg.)
dD ('/yr)
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) Vertical Intensity (Quiet days)
Annual Mean Values (Z) & Secular Variation (dZ)
nT
nT/yr
Z (nT)
dZ (nT/yr)
-45000
-45500
-46000
-46500
-47000
-47500
-48000
-48500
-49000
-49500
140
120
100
80
60
40
20
0
-20
-40
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) Total Intensity (Quiet days)
Annual Mean Values (F) & Secular Variation (dF)
nT
nT/yr
F (nT)
dF (nT/yr)
52500
52000
51500
51000
50500
50000
49500
49000
-5
-20
-35
-50
-65
-80
-95
-110
1955.0
1960.0
1965.0
1970.0
1975.0
1980.0
1985.0
1990.0
1995.0
2000.0
2005.0

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 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.

The original station in the vicinity was Wilkes, established under the US Antarctic Research Program for the 1957-58 IGY, after which it was operated by ANARE. Wilkes was abandoned in 1968, having been replaced by (the old) Casey station which lies 3km across Newcomb Bay to its south west.

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. -76.46°; Long. 183.72°
  † Based on the IGRF 2000.0 model updated to 2001.5
- 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: Anthony Breed (AAD)
  Henry Banon (AAD)

History

A magnetic observatory was established at Wilkes (a few kilometres from where Casey now stands) by the US Antarctic Research Program for the 1957-58 IGY. It was subsequently operated by BMR and ANARE (McGregor, 2000) until the instrumentation was returned to the USA in 1968.

To provide information on the magnetic secular variation in Antarctica, BMR/ASGO/GA and the Australian Antarctic Division have jointly carried out regular absolute measurements of the magnetic field at Casey since 1975. The observations have been performed by Antarctic Division personnel, who were trained in the use of the instrumentation at GA in Canberra.

Until the Australian Antarctic Division installed an EDA FM105B fluxgate variometer in January 1988 to support their Atmospheric and Space Physics research program at Casey, monthly means were calculated from absolute observations without correction for daily field variations. These data, although exhibiting scatter, enabled the estimation of the secular variation trend from year to year at the station.

From 1991 to 1998 the digital variometer data and monthly absolute observations were made available to the GA observer at Mawson, who derived baselines and produced monthly mean values of the magnetic field (De Deuge, 1992) for Casey (and Davis). These monthly mean values, based on the five quietest days of the month (at Mawson), were provided to WDC-A. Although during this period the variometers at Casey (and Davis) were not operated to observatory standards, the monthly means derived from the variometer data were a significant improvement on those derived from the previous absolute observations only. Since 1998 the calculation of monthly means has been carried out at GA using International Quiet Days.

Until March 1999 two absolute observations were performed at Casey each month. On 22 March 1999 full absolute control began that included the performance of twice-weekly absolute observations and from when the operation was upgraded to full observatory status.

Variometers

An Antarctic Division EDA FM105B fluxgate variometer, with the data acquired by PC, operated at Casey throughout 2001. The fluxgate sensors were housed on the hill about 300m west of the Casey Science building. Their sensors were aligned close to true north, east and vertical. The temperatures were maintained at 20°C. Further description can be found in Crosthwaite (1999).

Absolute Instruments and Corrections

Magnetometers used to calibrate the recording variometers were Elsec 810 DIM no. 002591 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 +2.2nT was been applied to the absolute PPM readings. Corrections of zero were applied to the DIM readings. These resulted in baseline corrections of:

$\Delta X = -0.03$ nT $\Delta Y = -0.33$ nT $\Delta Z = -2.17$ 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

The combined corrections applied in X, Y and Z were:

$\Delta X = +42$nT $\Delta X = -11.9$nT $\Delta X = -47$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 Operations

The magnetic observer-in-charge at Casey in 2001 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 twice-weekly absolute observations on the observation piers in the Absolute House to calibrate the variometers and provided regular reports to GA headquarters in Canberra.

The EDA variometer produced 1-second samples that were recorded on an AAD computer via their Analogue Data Acquisition System (ADAS). These were sent 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 2001.

Significant Events: CSY, 2001

No significant events were recorded for Casey in 2001.

Distribution of CSY data during 2001

Preliminary Monthly Means for Project Ørsted

- None sent in 2001

1-minute Values

- 1999: WDC-C1, Copenhagen, Denmark (sent 23 Oct 2001)
- 2000: WDC-C1, Copenhagen, Denmark (sent 23 Oct 2001)

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

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 97-98.

Year	Days	D		I		H	X	Y	Z	F	Elts*
		(Deg	Min)	(Deg	Min)	(nT)	(nT)	(nT)	(nT)	(nT)	
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
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
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

Data losses: CSY, 2001

Some calibration activities for Antarctic Division caused contamination of short intervals of data, as did the daily sets of calibration pulses.

Jan 23 0128-0144 (17 min) All channels

Mar 21 0001-0937 (9 hr 37 min) All channels: Change to the ADAS 2000 logging system; logging system calibration

Mar 26 0001-0613 (6hr 13m) All channels: Logging system calibration.

Mar 29 0001-0048 (48m) All channels: Logging system calibration.

Mar 31 0001-0241 (2h 41m) All channels.

Apr 01 00001-0105 (1h 5m) All channels.

Apr 11 0808-0928 (1h 21m) All channels.

Apr 13 0230-0301 (32m); 0346-0350 (5m); 0402-0413 (12m); 0416-0440 (25m); 0744-0904 (1h 21m) All channels: Logging system calibrations.

Apr 19 0921-0931 (11m) All channels.

May 05 0135-0144 (10m); 0147 (1m) All channels.

May 15 0012-0055 (44m) All channels.

May 22 0227 (1m) All channels.

May 23 0221-0222 (2m) All channels

… continued on page 99

Casey, Antarctica 2001 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	2001	X (nT)	Y (nT)	Z (nT)	F (nT)	H (nT)	D (East)	I
January	All days	-532.1	-9562.4	-63708.4	64424.4	9577.8	-93° 11.2'	-81° 27.0'
	5xQ days	-537.7	-9565.3	-63717.5	64433.8	9580.8	-93° 13.1'	-81° 26.9'
	5xD days	-548.2	-9536.2	-63725.1	64437.2	9552.9	-93° 17.6'	-81° 28.5'
February	All days	-545.5	-9564.4	-63724.8	64441.0	9580.3	-93° 15.9'	-81° 27.0'
	5xQ days	-534.9	-9562.8	-63723.4	64439.2	9577.9	-93° 12.1'	-81° 27.1'
	5xD days	-533.3	-9579.8	-63720.2	64438.7	9595.2	-93° 11.3'	-81° 26.2'
March	All days	-561.9	-9552.7	-63741.2	64455.6	9569.5	-93° 22.0'	-81° 27.7'
	5xQ days	-554.3	-9550.2	-63731.3	64445.2	9566.3	-93° 19.3'	-81° 27.8'
	5xD days	-552.3	-9547.6	-63738.8	64452.5	9564.0	-93° 18.7'	-81° 28.0'
April	All days	-575.6	-9544.0	-63764.8	64477.7	9561.6	-93° 27.1'	-81° 28.3'
	5xQ days	-582.1	-9543.4	-63762.3	64475.2	9561.3	-93° 29.4'	-81° 28.3'
	5xD days	-584.9	-9547.7	-63818.3	64531.5	9566.2	-93° 30.5'	-81° 28.5'
May	All days	-573.5	-9548.4	-63752.1	64465.7	9565.7	-93° 26.2'	-81° 28.0'
	5xQ days	-571.6	-9541.6	-63739.1	64451.9	9558.8	-93° 25.7'	-81° 28.3'
	5xD days	-577.5	-9551.4	-63786.7	64500.5	9569.0	-93° 27.6'	-81° 28.1'
June	All days	-574.0	-9539.8	-63742.6	64455.1	9557.1	-93° 26.6'	-81° 28.4'
	5xQ days	-570.4	-9536.0	-63737.9	64449.8	9553.0	-93° 25.4'	-81° 28.6'
	5xD days	-582.6	-9541.3	-63752.7	64465.4	9559.2	-93° 29.7'	-81° 28.4'
July	All days	-573.6	-9541.8	-63740.7	64453.5	9559.1	-93° 26.4'	-81° 28.3'
	5xQ days	-573.1	-9542.0	-63735.1	64448.0	9559.2	-93° 26.2'	-81° 28.2'
	5xD days	-577.7	-9539.5	-63746.7	64459.2	9557.0	-93° 27.9'	-81° 28.4'
August	All days	-570.5	-9540.4	-63733.4	64446.1	9557.5	-93° 25.4'	-81° 28.3'
	5xQ days	-575.6	-9541.2	-63737.2	64450.0	9558.6	-93° 27.1'	-81° 28.3'
	5xD days	-575.4	-9531.0	-63750.2	64461.4	9548.5	-93° 27.3'	-81° 28.9'
September	All days	-560.6	-9548.5	-63732.7	64446.5	9565.3	-93° 21.6'	-81° 27.9'
	5xQ days	-574.8	-9541.8	-63726.2	64439.1	9559.2	-93° 26.9'	-81° 28.1'
	5xD days	-536.1	-9563.2	-63738.7	64454.6	9578.9	-93° 12.5'	-81° 27.2'
October	All days	-568.7	-9550.5	-63740.8	64455.0	9568.0	-93° 24.5'	-81° 27.8'
	5xQ days	-556.0	-9557.4	-63728.9	64444.0	9573.7	-93° 19.8'	-81° 27.4'
	5xD days	-545.5	-9559.6	-63739.4	64455.0	9576.2	-93° 16.1'	-81° 27.3'
November	All days	-546.7	-9548.8	-63723.6	64437.7	9565.6	-93° 16.6'	-81° 27.8'
	5xQ days	-525.0	-9554.1	-63716.4	64430.9	9568.7	-93° 08.8'	-81° 27.6'
	5xD days	-522.7	-9569.9	-63731.4	64449.1	9587.4	-93° 07.2'	-81° 26.7'
December	All days	-542.7	-9543.4	-63694.6	64408.1	9560.1	-93° 15.4'	-81° 27.8'
	5xQ days	-570.8	-9538.2	-63690.0	64402.9	9555.9	-93° 25.6'	-81° 28.0'
	5xD days	-518.6	-9562.9	-63701.6	64417.9	9578.9	-93° 06.4'	-81° 26.9'
Annual	All days	-560.5	-9548.8	-63733.3	64447.2	9565.6	-93° 21.6'	-81° 27.9'
Mean	5xQ days	-560.5	-9547.8	-63728.8	64442.5	9564.4	-93° 21.6'	-81° 27.9'
Values	5xD days	-554.6	-9552.5	-63745.8	64460.3	9569.5	-93° 19.4'	-81° 27.8'

(Calculated: 13:25 hrs., Fri. 19 Dec. 2003)

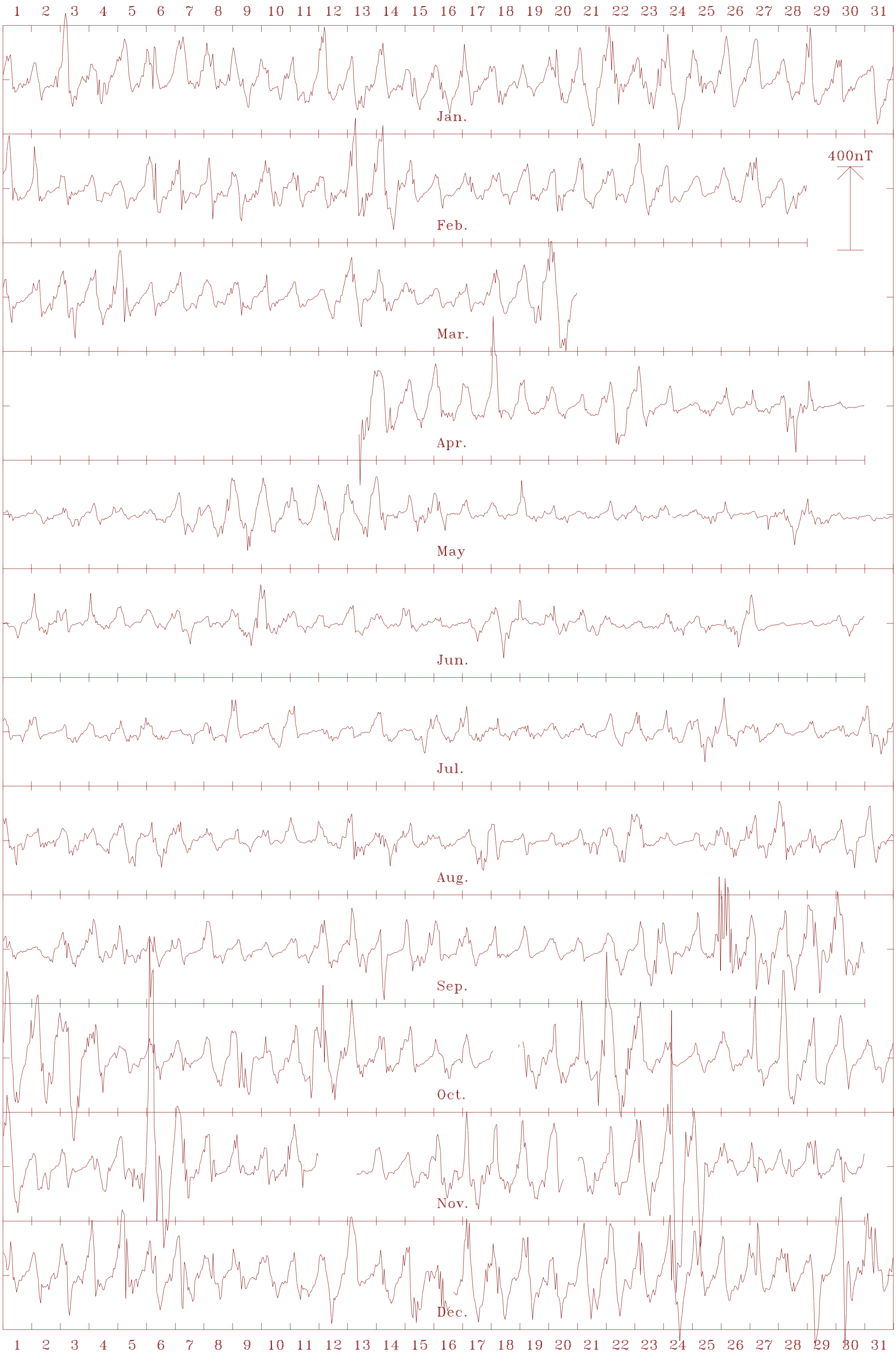
Hourly Mean Values

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.

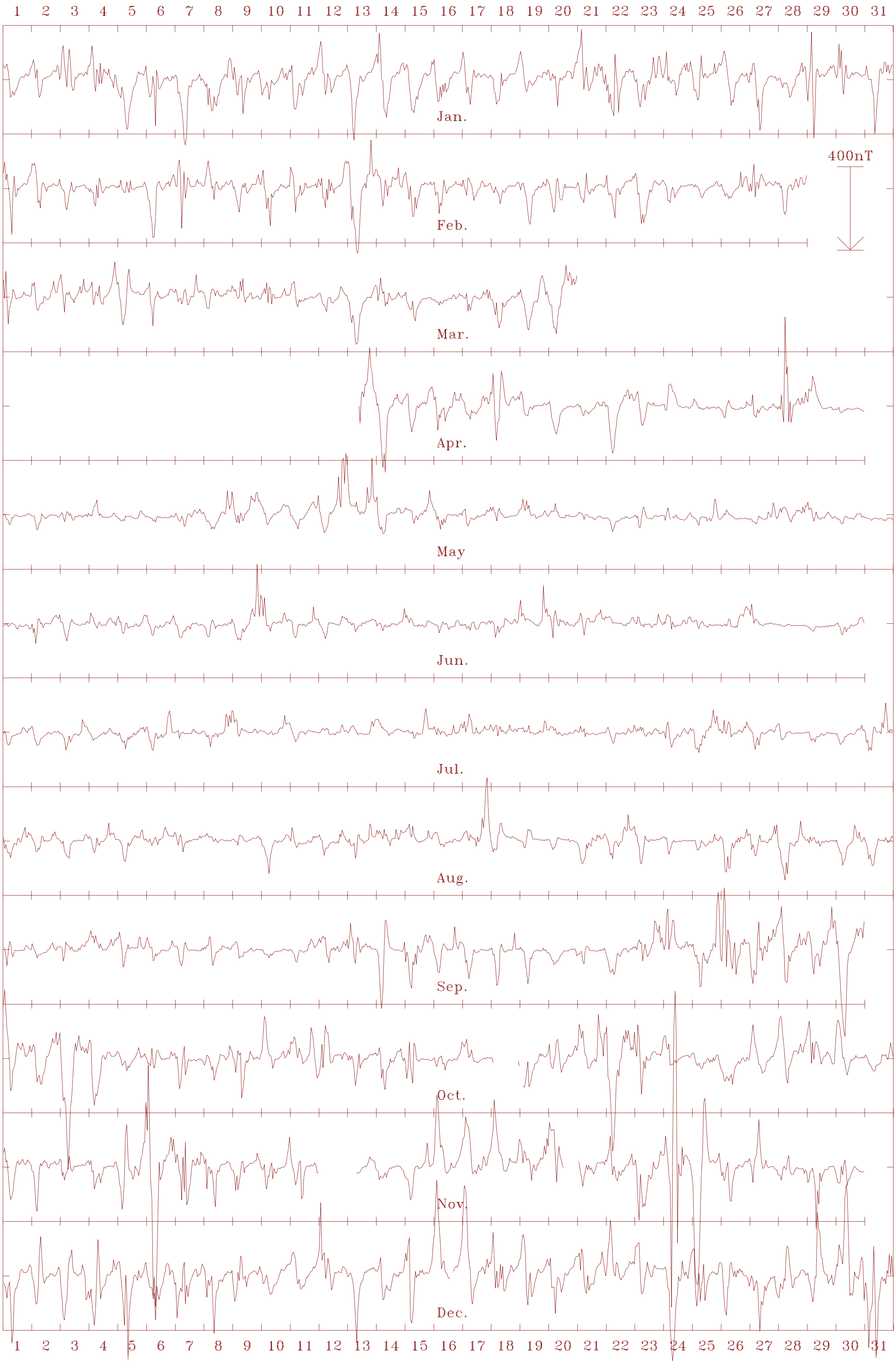
The mean value given at the top of each plot is the *all-days* annual mean value of the element.

Casey Stn. 2001 Horizontal intensity (H). Scale: 25.0 nT/mm. Mean: 9566 nT

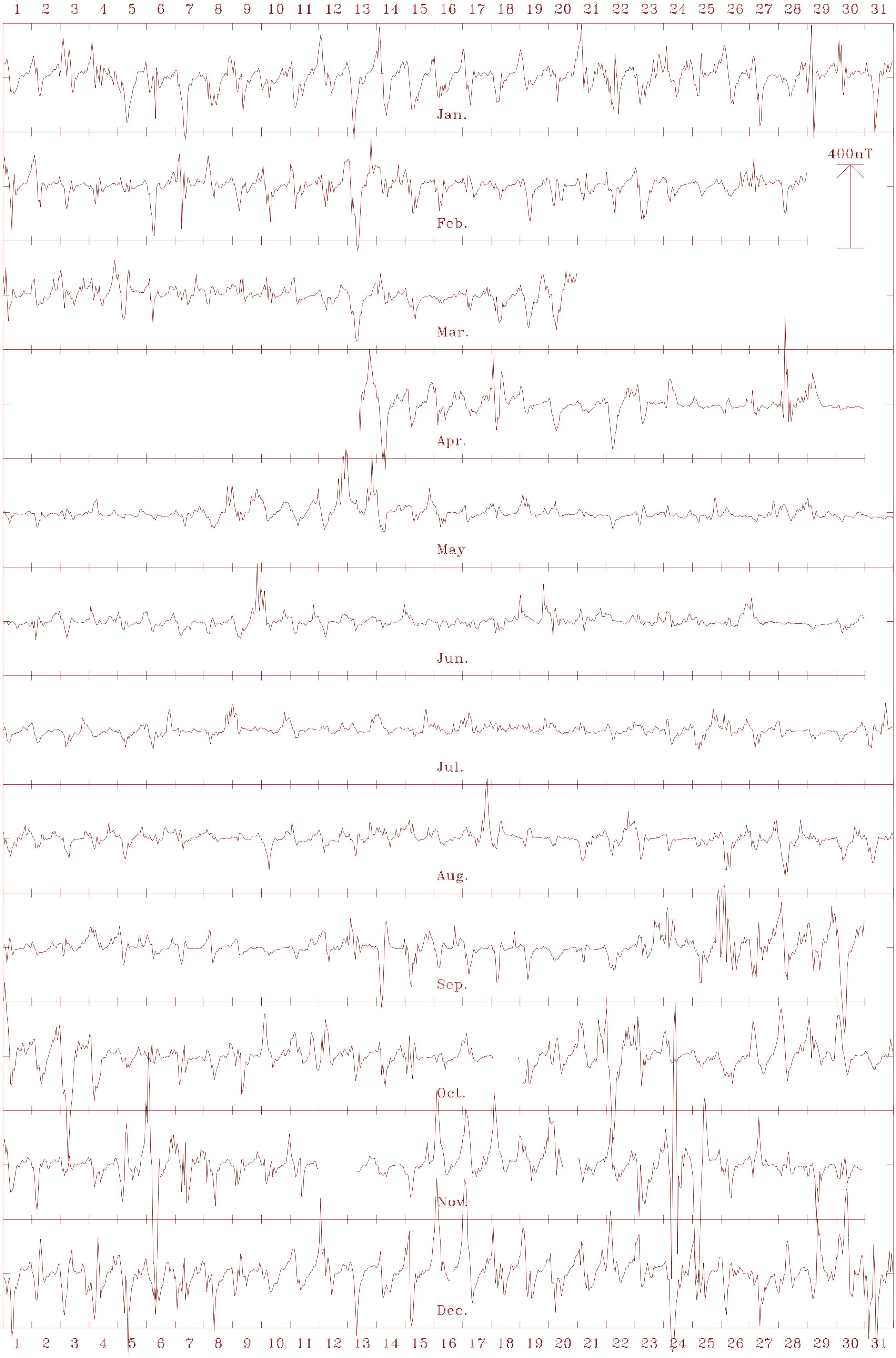


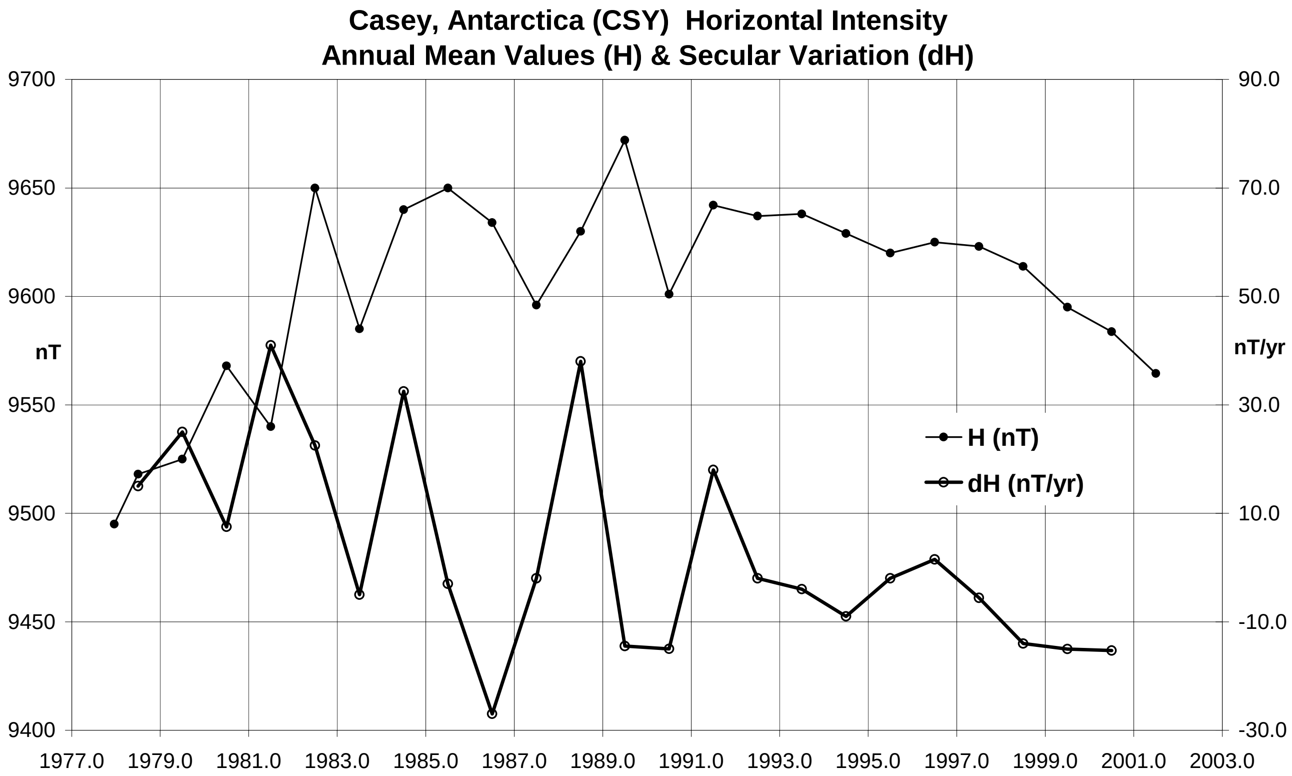
Casey Stn. 2001 Declination (east) (D). Scale: 10.0 min/mm. Mean: −93.36 deg.

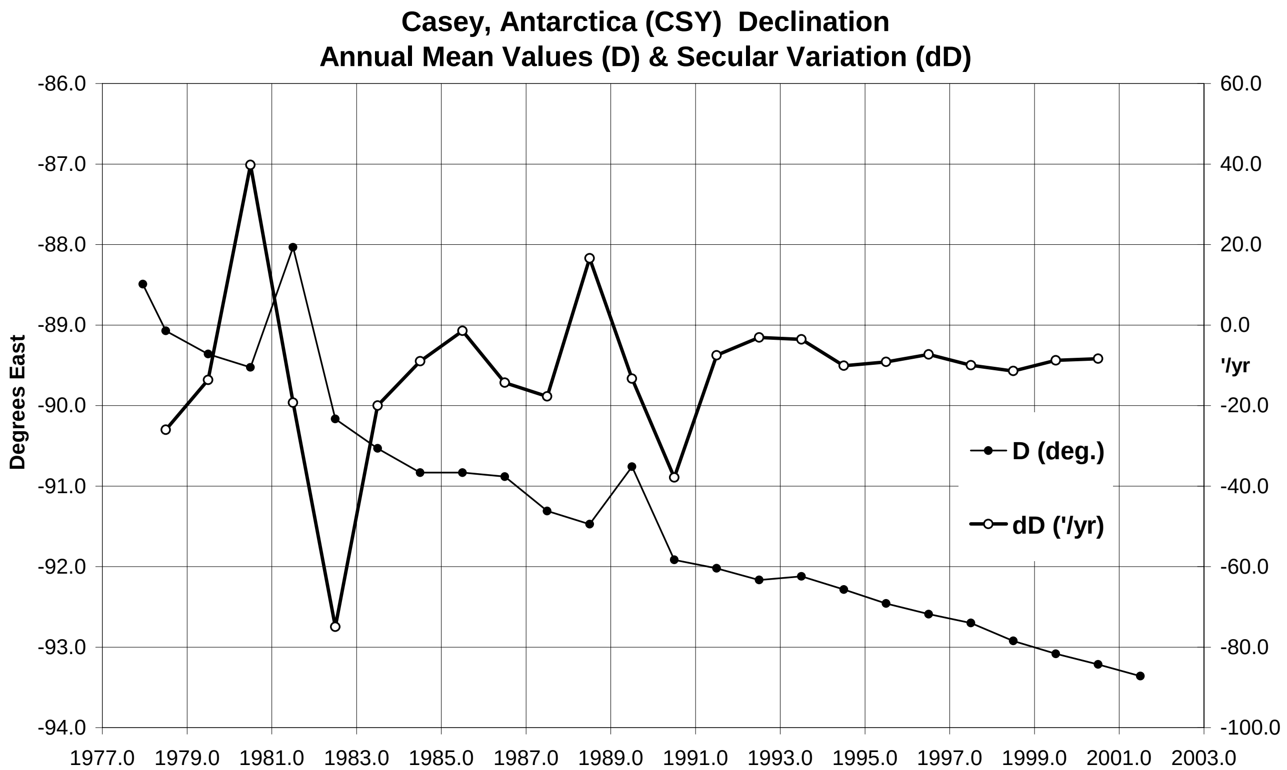
Casey Stn. 2001 Vertical intensity (Z). Scale: 25.0 nT/mm. Mean: -63733 nT

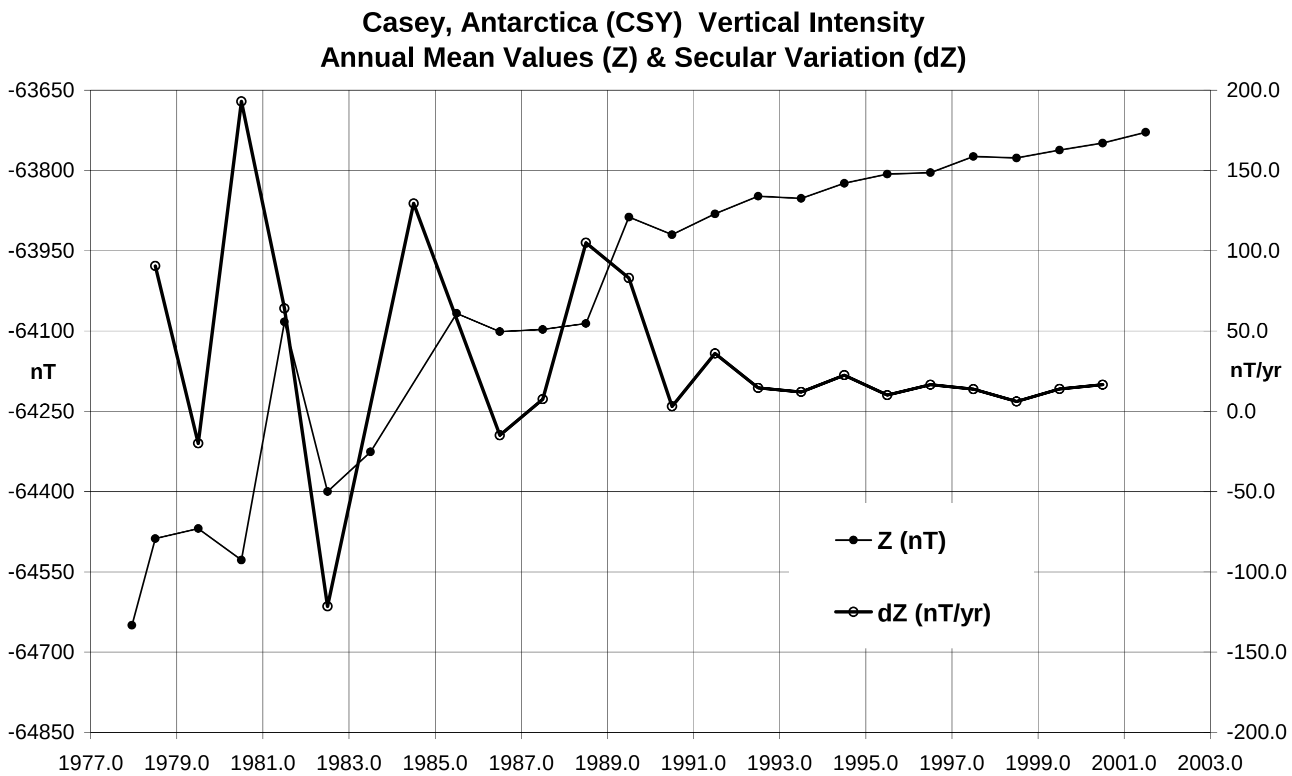


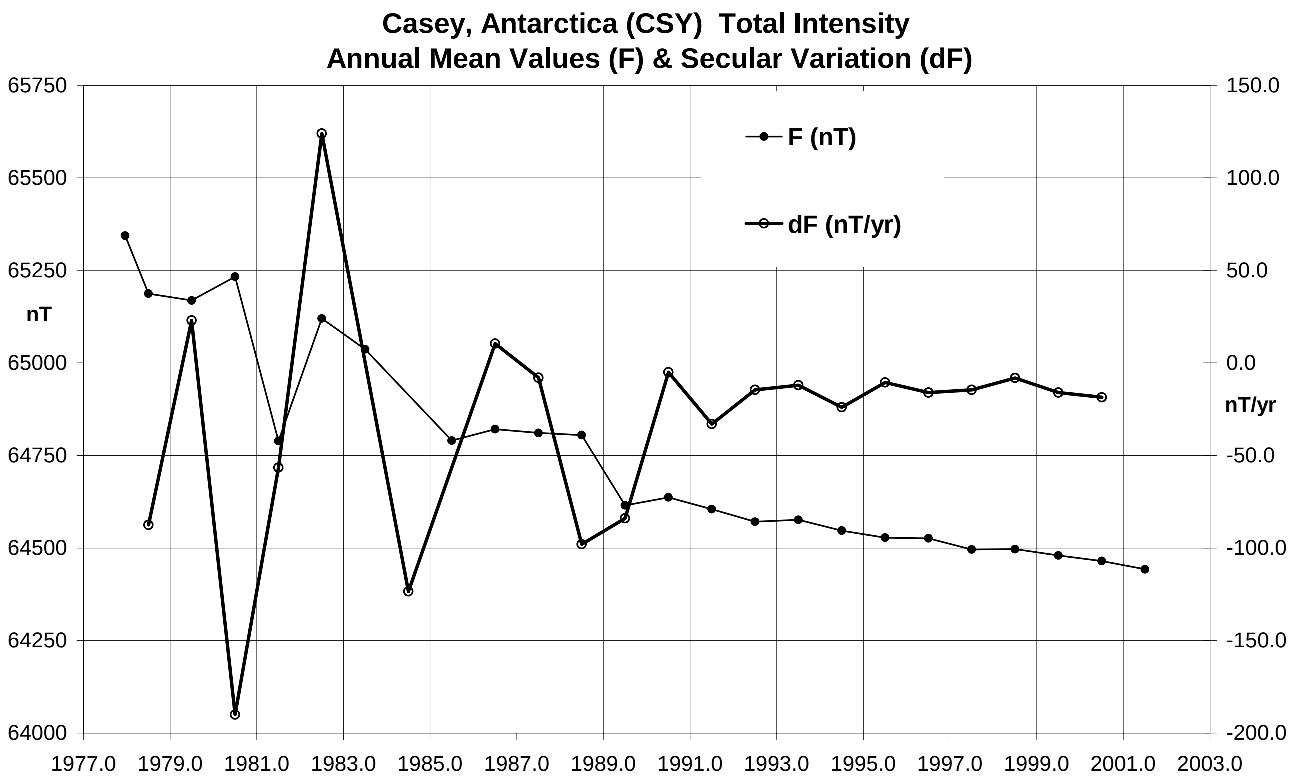
Casey Stn. 2001 Total intensity (F). Scale: 25.0 nT/mm. Mean: 64447 nT




Casey, Antarctica (CSY) Horizontal Intensity
Annual Mean Values (H) & Secular Variation (dH)
nT
nT/yr
H (nT)
dH (nT/yr)
9700
9650
9600
9550
9500
9450
9400
90.0
70.0
50.0
30.0
10.0
-10.0
-30.0
1977.0
1979.0
1981.0
1983.0
1985.0
1987.0
1989.0
1991.0
1993.0
1995.0
1997.0
1999.0
2001.0
2003.0


Casey, Antarctica (CSY) Declination
Annual Mean Values (D) & Secular Variation (dD)
Degrees East
'/yr
D (deg.)
dD ('/yr)
-86.0
-87.0
-88.0
-89.0
-90.0
-91.0
-92.0
-93.0
-94.0
60.0
40.0
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
1977.0
1979.0
1981.0
1983.0
1985.0
1987.0
1989.0
1991.0
1993.0
1995.0
1997.0
1999.0
2001.0
2003.0


Casey, Antarctica (CSY) Vertical Intensity
Annual Mean Values (Z) & Secular Variation (dZ)
nT
nT/yr
Z (nT)
dZ (nT/yr)
-63650
-63800
-63950
-64100
-64250
-64400
-64550
-64700
-64850
200.0
150.0
100.0
50.0
0.0
-50.0
-100.0
-150.0
-200.0
1977.0
1979.0
1981.0
1983.0
1985.0
1987.0
1989.0
1991.0
1993.0
1995.0
1997.0
1999.0
2001.0
2003.0


Casey, Antarctica (CSY) Total Intensity
Annual Mean Values (F) & Secular Variation (dF)
nT
nT/yr
F (nT)
dF (nT/yr)
65750
65500
65250
65000
64750
64500
64250
64000
150.0
100.0
50.0
0.0
-50.0
-100.0
-150.0
-200.0
1977.0
1979.0
1981.0
1983.0
1985.0
1987.0
1989.0
1991.0
1993.0
1995.0
1997.0
1999.0
2001.0
2003.0

Data losses: CSY, 2001 (cont.)

May 24 0601-0708 (1h 8m); 0727-0731 (5m) All channels.

May 29 0101-0113 (13m); 0718-0744 (27m) All channels.

May 30 0856-0859 (4m) All channels.

May 31 0001 (1m); 0724-0727 (4m); 0833-0835 (3m) All channels.

Jun 18 0819-0828 (10m) All channels.

Aug 10 0536-0548 (13m) All channels.

Sep 19 0414-0416 (3m) All channels.

Sep 21 0115 (1m) All channels.

Oct 02 0212-0232 (21m) All channels.

Oct 10 1236-1238 (3m); 1434-1459 (26m) All channels: Logging system calibration.

Oct 14 0936-0937 (2m): All channels.

Oct 16 0101-0127 (27m): All channels.

Oct 18 0136-2245 (21 hr 10m); 2359 to 19 / 0204 (2h 06m) All channels.

Oct 19 0211-0217 (7m) All channels.

Nov 06 0310-0310 (1m) All channels.

Nov 12 0001 to 13 / 0702 (1d 07h 02m) All channels: Power and communications failure.

Nov 20 1226-2359 (11h 34m) All channels.

Dec 16 1402-1405 (4m); 1411-1607 (1h 57m) All channels.

DAVIS Variation Station

BMR/AGSO/GA and the Australian Antarctic Division have jointly carried out regular absolute measurements of the magnetic field at Davis since 1973 to provide information on the magnetic secular variation in Antarctica. The observations have been performed by Antarctic Division personnel, who were trained in the use of the instruments at GA in Canberra.

Until the Australian Antarctic Division installed EDA FM105B fluxgate variometers at Davis in January 1986 to support their Atmospheric and Space Physics research program, monthly means were calculated from absolute observations without correction for daily field variations. These data, although exhibiting scatter, enabled the estimation of the secular variation trend from year to year.

From 1991 to 1998 the digital variometer data and monthly absolute observations were made available to the GA observer at Mawson, who derived baselines and produced monthly mean values of the magnetic field (De Deuge, 1992) for Davis (and Casey). These monthly mean values, based on the five quietest days of the month (at Mawson), were provided to WDC-A. Although during this period the variometers at Davis (and Casey) were not operated to observatory standards, the monthly means derived from the variometer data were a significant improvement on those derived from the previous absolute observations only.

Since 1998 the calculation of monthly means has been carried out at GA using International Quiet Days.

During calendar year 2001 diminishing resources from the Geomagnetism program at GA resulted in the withdrawal of support in the processing of geomagnetic data acquired at the Davis Station. The Atmospheric & Space Physics group of AAD continued the acquisition of magnetic data at the station.

Future *AGR* volumes will not contain a section on Davis.

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

- 3-character IAGA code: DVS
- Geographic latitude: 68° 34' 38" S
- Geographic longitude: 77° 58' 23" E
- Geomagnetic† : Lat. -76.36°; Long. 127.94°
  † Based on the IGRF 2000.0 model updated to 2001.5
- Elevation above mean sea level (top of observation pier) 29 metres
- Azimuth of reference mark (PP) from observation pier 312° 00.8'
- Distance to azimuth mark PP: 80 metres
- Observer in Charge: Michael Terkildsen (AAD)

† Based on the IGRF 2000 model.

Magnetometers

An EDA FM105B fluxgate variometer, with the data acquired by PC, operated at Davis. Together with the DIMs used for absolute observations, the instruments were owned by the Australian Antarctic Division. The PPMs used for absolutes and the QHMs provided for backup were GA instruments.

Operations

The observers at Davis were officers of the Australian Antarctic Division, of the Australian Department of the Environment and Heritage, and were members of the Australian National Antarctic Research Expedition (ANARE).

Two sets of absolute observations were performed on one day each month.

Distribution of DVS data during 2001

Inquiries for variation data from Davis should be directed to the Atmospheric and Space Physics Section of the Australian Antarctic Division, Channel Highway, Kingston, Tasmania.

Preliminary Monthly Means for Project Ørsted

- None sent in 2001

1-minute Values

- 1999: WDC-C1, Copenhagen, Denmark (sent 23 Oct 2001)
- 2000: WDC-C1, Copenhagen, Denmark (sent 23 Oct 2001)

Summary of data loss in the Australian observatories in 2001

The table below summarizes the 2001 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. The figures do not include data that have been excluded from processing such as contaminated data.

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

2001	ASP	CNB	CTA	GNA	KDU	LRM	MAW	MCQ	CSY
Jan	1 (8514)	1 (8)	0	0	0	0	0	0	173
Feb	6 (16)	0 (277)	5 (0)	0	0	0	0	0	140
Mar	0	0 (5637)	0	0	0	0	0	0	1314
Apr	0	0	0	0	21	0	0	0	852
May	0	0	731 (800)	0	0	0	0	0	338
Jun	0	0	0	0	0	1274	0	0	160
Jul	0	0	0	0	196	1630	0	0	155
Aug	0 (835)	0	0	8092	86	3554	0	0	168
Sep	0 (12,599)	0	0	0	12	0	7	0	154
Oct	174 (34,708)	0	0	0	27,360	0	5	0	1633
Nov	2,749 (31,517)	1494	1576 (2278)	0	1655	1128	0	0	2701
Dec	0 (24,651)	4	180 (1917)	0	11,496	610	0	0	276
3-axis variom.	2,930 (0.56%)	1499 (0.29%)	2,492 (0.47%)	8,092 (1.54%)	40,826 (7.77%)	8,196 (1.56%)	12 (0.002%)	0 (0.00%)	8,064 (1.53%)
Total field	112,840 (21.5%)	7420 (1.41%)	4,995 (0.95%)	8,092 (1.54%)	159,504 (30.3%)	8,196 (1.56%)	12 (0.002%)	0 (0.00%)	no PPM

International Quiet & Disturbed Days

2001	Quietest days 1 - 5					Quietest days 6 - 10					Most Disturbed days 1 - 5				
January	1	30	6	2	19	18	27	7	5K	9	24	21*	31*	23*	29*
February	3	4	18	25	17	16	5	24	19	9	13	6*	14*	27*	23*
March	15	16	26	11	17	10	1K	25	9	8K	31	20	28	19	23
April	30	27	24	19	25	26	17	20K	3	21A	11	8	13	12	18
May	31	5	30	21	1	2	26	6	24	20	9	12	13	10	28*
June	28	29	12	23	22	16	5	25	27K	3	18	9	2	10	21*
July	28	21	2	20	7	29	13	3	4	27	31	25	17*	8*	16*
August	16	24	15	11	29	2	8	20K	4	10	17	13	5	22*	6*
September	10	7	9	21	1	20	6	2	17	8K	23	29	30	26	15
October	24	18	7	17	26	27	25A	30A	10A	5A	22	3	2	21	1
November	3	27	30	28	14	12	29	13	21	9	6	24	1	7*	19
December	9	10	11	13	20	2	28	14	26	7	24	30	17*	31*	21*

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 $\geq 3_o$ or two Kp indices $\geq 3_-$ 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.

REFERENCES

'Australian Geomagnetism Report 1993', compiled by A.J. McEwin and P.A. Hopgood. *Australian Geological Survey Organisation.*

'Australian Geomagnetism Report 1994', compiled by P.A. Hopgood and A.J. McEwin. *Australian Geological Survey Organisation.*

'Australian Geomagnetism Report 1995' *to* 'Australian Geomagnetism Report 1998' , compiled by P.A. Hopgood. *Australian Geological Survey Organisation.*

Crosthwaite, P.G., 'Calibration of X, Y, Z, F type variometers' *Australian Geological Survey Organisation*, *Geomagnetism Note,* **1992/24**, 1992.

Crosthwaite, P.G. 'Using F in X, Y, Z, F type variometers' *Australian Geological Survey Organisation, Geomagnetism Note*, **1994/16**, 1994.

Crosthwaite, P.G., 'Casey Geomagnetic Observatory Visit, 1998/99 Summer', *Australian Geological Survey Organisation, Geomagnetism Note* (in preparation).

De Deuge, M.A. 'Mawson Geophysical Observatory Annual Report 1991' *Australian Geological Survey Organisation, Record*, **1992/57**, 1992.

Dennis, S.D., 'Macquarie Island Geomagnetic Observatory operational report, 1998' *Australian Geological Survey Organisation*, *Geomagnetism Note,* **1998/03**, 1998.

Hopgood, P.A. 'Australian Magnetic Observatories' *Exploration Geophysics,* **24**, 79-82, 1993

Johnson, Peter, 'Mawson Geophysical Observatory Operations, 2000' *Australian Geological Survey Organisation, Geomagnetism Note*, **2000-02**, 2000.

Lewis, A.M. 'The Geomagnetic Field in the Australian region – Epoch 2000' (chart) *Australian Geological Survey Organisation, Canberra,* 2000.

Mayaud, P.N. 'Atlas of Indices K' *IAGA Bulletin* **21**, 113pp., IUGG Publ. Office, Paris. 1967.

McCreadie, Heather '4th Australian Geomagnetism Workshop, Canberra, April 2000 - Abstracts' *Geomagnetism Notes* **2000/10**, 68pp, *Australian Geological Survey Organisation*, 2000.

McGregor, P.M. 'Australian Magnetic Observatories' *BMR Journal of Australian Geology and Geophysics*, **4**, 361-371. 1979

McGregor, Peter 'Observatory Geophysics, 1947-1998' *Aurora* (ANARE Club Journal*)*, **Vol. 19, No. 3**, 3-21, March 2000.

Seers, K.J. 'Handbook for Proton Magnetometer MNS2' *Bureau of Mineral Resources, Geology and Geophysics, Record* **1979/59**, 1979

Trigg, D.F. and R.L. Coles (editors). 'INTERMAGNET Technical Reference Manual 1994', 73pp. *INTERMAGNET*, 1994.

Geomagnetism Staff List 2001

Name	Classification	Responsibility
Charles E. Barton	Research Group Leader	Section Head
Peter A. Hopgood	Senior Professional Officer	Project Leader
Peter G. Crosthwaite	Senior Information Technology Officer	Digital acquisition, system and software development and maintenance; Kakadu & Gnangara observatories
Stewart D. Dennis	Professional Officer (until May 2001)	Antarctic Observatories
Andrew M. Lewis	Professional Officer	Project Leader, Repeat Station Survey, Alice Springs & Learmonth observatories
Liejun Wang	Professional Officer	Data-base development; Canberra & Charters Towers observatories
Adrian D. Costar	Professional Officer (from April 2001)	Antarctic Observatories
Peter Johnson	Technical Officer 2 (on contract) (shared by GA & BoM)	Mawson (2000 observer)
Martin Purvins	Technical Officer 2 (on contract) (shared by GA & BoM)	Mawson (2001 observer)
Andrew Jenner	Technical Officer 2 (on contract) (shared by GA & BoM)	Mawson (2002 observer)
Jean Osanz	Technical Officer 2 (on contract) (shared by AAD, IPS & GA)	Macquarie Island (2000 observer)
Dave Gillies	Technical Officer 2 (shared by AAD, IPS & GA)	Macquarie Island (2000/01 observer)
Mick Eccles	Technical Officers 2 (shared by AAD, IPS & GA)	Macquarie Island (2001 observer)
Bruce Sibson	Technical Officer 3	Technical support
Owen D. McConnel	Technical Officer 4	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 provides 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 Queensland University	Charters Towers
Graham Steward	Learmonth Solar Observatory, IPS	Learmonth
Kim Stellmacher	Contracted by GA	Kakadu
Gerard (Hans) Van Reeken	Contracted by GA	Gnangara
Anthony Breed	AAD	Casey, 2001
Michael Terkildsen	AAD	Davis, 2001

End of Part 2