Solar Bulletin

THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS - SOLAR DIVISION

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Table I. Mean Sunspot Numbers for March 2001

Day	N	Raw	s.d.	K-corrected	s.d.	s.e.
1	30	60	3.2	54	2.1	0.38
2	26	72	3.5	62	2.8	0.55
3	35	115	8.2	100	7.2	1.22
4	25	112	7.1	98	4.4	0.88
5	30	130	6.9	111	4.4	0.80
6	39	118	4.7	101	2.6	0.42
7	40	109	5.0	92	2.9	0.46
8	28	92	6.1	82	4.1	0.77
9	35	100	5.5	88	3.1	0.52
10	33	117	5.4	98	3.9	0.68
11	38	114	5.6	94	4.1	0.67
12	36	113	7.1	96	5.7	0.95
13	31	95	5.0	80	3.3	0.59
14	39	101	5.0	85	3.4	0.54
15	39	104	4.9	87	2.9	0.46
16	32	98	5.9	80	3.5	0.62
17	33	76	4.1	64	3.1	0.54
18	39	87	4.9	72	3.6	0.58
19	43	87	4.1	72	3.0	0.46
20	35	107	5.6	92	4.4	0.74
21	33	119	5.8	101	4.2	0.73
22	38	122	4.6	102	3.0	0.49
23	36	150	5.2	130	3.0	0.50
24	29	191	7.4	173	5.3	0.98
25	39	233	8.2	202	6.3	1.01
26	42	281	12.1	235	9.3	1.44
27	41	310	11.6	267	8.2	1.28
28	44	316	12.7	273	10.1	1.52
29	26	288	12.2	245	9.4	1.84
30	27	288	14.8	247	10.2	1.96
31	29	263	14.7	228	9.6	1.78

Means: 34.5 147.4 126.1

Total No. of Observers: 69

Total No. of Observations: 1070

Table II. March Observers

16	AAP	P.Abbott
3	ANDE	E.Anderson
8	ATON	A.Attanasio
19	BARH	H.Barnes
6	BATR	R.Battaiola
9	BEB	R.Berg
9	BEDJ	J.Bedient
3	BERJ	J.Berdejo
4	BLAJ	J.Blackwell
11	BMF	M.Boschat
28	BOSB	B.Bose
23	BRAB	B.Branchett
23	BRAR	R.Branch
25	BROB	R.Brown
8	CAMP	P.Campbell
13	CARJ	J.Carlson
25	CHAG	G.Morales
23	CKB	B.Cudnik
5	CLZ	L.Corp
11	COMT	T.Compton
31	CORA	A.Coroas
28	CR	T.Cragg
16	DRAJ	J.Dragesco
16	DUBF	F.Dubois
22	ELR	E.Reed
14	FEEC	C.Feehrer
20	FERJ	J.Fernandez
18	FLET	T.Fleming
19	FUJK	K.Fujimori
21	GIOR	R.Giovanoni
12	GOTS	S.Gottschalk
7	HAYK	K.Hay
5	HRUT	T.Hrutkay
5	IMPR	R.Imperi
23	JAMD	D.James
22	JEFT	T.Jeffrey
14	JENJ	J.Jenner
20	KAPJ	J.Kaplan
29	KHAR	R.Khan
18	KNJS	J&S Knight
10	LARJ	J.Larriba
12	LERM	M.Lerman
17	LEVM	M.Leventhal
4	LIZT	T.Lizak
22	MALK	K.Malde
27	MARJ	J.Maranon
24	MCE	E.Mochizuki
7	MILJ	J.Miller
18	MMI	M.Moeller
9	MUDG	G.Mudry
18	OBSO	IPS Obs.
15	RICE	E.Richardson
16	RITA	A.Ritchie
19	SCGL	G.Schott
10	SIMC	C.Simpson
8	STEF	G.Stefanopoulis
18	STEM	G.Stemmler
18	STQ	N.Stoikidis
21	SUZM	M.Suzuki
4	SZAK	K.Szatkowski
13	SZUM	M.Szulc
14	TESD	D.Teske
13	THR	R.Thompson
21	URBP	P.Urbanksi
17	VALD	D.del Valle
17	VARG	A.Vargas
8	WILW	W.Wilson
15	WITL	L.Witkowski
23	YESH	H.Yesilyaprak

Reporting Addresses

***Sunspot Reports* -- email:** solar@aavso.org
postal mail: AAVSO, 25 Birch St. Cambridge, MA 02138
FAX *(AAVSO)*: (617) 354-0665

***SES Reports* -- email:** noatak@aol.com
postal mail: Mike Hill
114 Prospect St. Marlboro, MA 01752

***Magnetometer Reports* -- email:** capaavso@aol.com
postal mail: Casper Hossfield
PO Box 23, New Milford, NY 10959
FAX: (973) 853-2588 or (407) 482-3963

Table III. Means of Raw Group Counts for March 2001

Day	Mn.	Day	Mn.	Day	Mn.	Day	Mn.
1	4.4	9	4.7	17	3.7	25	13.5
2	5.0	10	5.8	18	4.5	26	15.0
3	6.8	11	6.5	19	5.0	27	16.1
4	6.9	12	6.8	20	6.7	28	16.5
5	6.9	13	4.9	21	7.7	29	15.4
6	6.5	14	4.7	22	7.2	30	13.4
7	5.7	15	4.6	23	9.2	31	12.3
8	4.6	16	4.2	24	12.5	Mn.	8.0

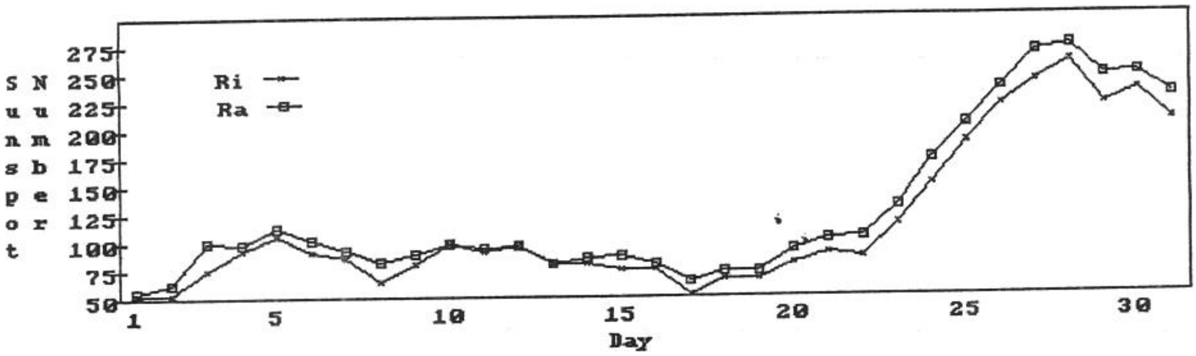

Fig. 1. Comparison of Ri (provisional) and Ra estimates for March.
(Ri Source:http://sidc..oma.be/index.php3)

Smoothed Mean Sunspot Number (Rsm) for September 2000: 120.8

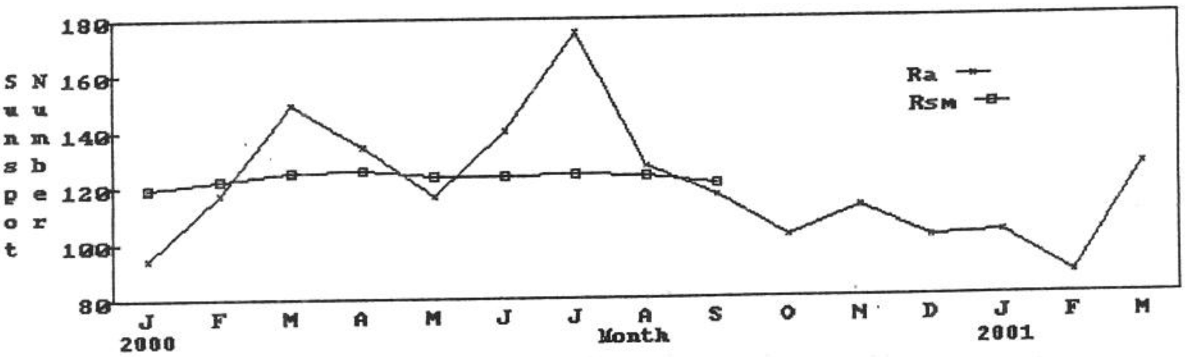

Fig. 2. Monthly Ra and Smoothed Mean Sunspot Numbers (Waldmeier method).

An interesting statistic that is infrequently mentioned in the sunspot literature is the ratio of the number of sunspots reported by an observer to the number of groups reported. Called rho [cf. Schaefer, BE (1993) *Astrophys. J.*, 411: 909-919], this statistic may vary irregularly over time but has a relatively stable range. The ratio, together with the data presented in Table I and Table III, presents a fairly comprehensive picture of what the average observer saw each day of the month.

To illustrate the statistic, the mean spot-to-group ratios for each day in March computed from the reports of AAVSO Solar Division observers are presented in Table IV. Mean monthly values from January 2000 are presented in Table V.

Table IV. Mean Ratios of Spots to Groups for Each Day of March 2001

Day	rho	Day	rho	Day	rho	Day	rho
1	3.6	**9**	11.3	**17**	10.5	**25**	7.3
2	4.4	**10**	10.2	**18**	9.3	**26**	8.7
3	6.9	**11**	7.5	**19**	7.4	**27**	9.3
4	6.2	**12**	6.6	**20**	6.0	**28**	9.2
5	8.8	**13**	9.4	**21**	5.5	**29**	8.7
6	8.2	**14**	11.5	**22**	6.9	**30**	11.5
7	9.1	**15**	12.6	**23**	6.3	**31**	11.4
8	10.0	**16**	13.3	**24**	5.3	**Mean**	**8.5**

Table V. Mean Ratios of Spots to Groups from January 2000 to Present

Month	rho	Month	rho	Month	rho	Month	rho
Jan 2000	5.9	**Sep**	10.5				
Feb	4.8	**Ocy**	7.7				
Mar	8.4	**Nov**	6.5				
Apr	6.3	**Dec**	6.0				
May	8.5	**J 2001**	7.0				
Jun	7.2	**Feb**	5.2				
Jul	8.6	**Mar**	8.5				
Aug	5.8					**Mean**	**7.1**

Editor's Notes

Misprint in February Bulletin
The smoothed sunspot value, 123.0, in the February issue was incorrectly reported to be the value for February 2000. The text should have read "August 2000".

Largest Sunspot Group in Cycle 23
On March 28, Space Weather News reported that NOAA Region Number AR9393 had become the largest sunspot complex in 10 years. At that time, the region covered an area of 2240 millionths of a solar hemisphere--well over 10 times that of the Earth. A few days later, the spot produced the largest flare to be detected in 25 years. A fine time-lapse sequence of the transit of the spot over the period from March 27 to April 2 is available for viewing as the April 11 "Astronomy Picture of the Day" at the following URL:

http://antwrp.gsfc.nasa.gov/apod/astropix.html.

GOES Satellite Data
The SID Report in this month's Bulletin contains a revised plot by Mike Hill that presents flare events detected during March by the

GOES-8 satellite. Mike has also prepared plots for the July 2000-February 2001 time period. The latter can be obtained by clicking the appropriate links in the online version of this Bulletin.

New Sunspot Report Form

Version 1.0 of the new sunspot report form has now been completed and is being evaluated by several volunteer observers. I am hopeful that a final version will be available for download and use by the end of May.

Article on Energetic Solar Events and the Solar Wind

The April 2001 issue of *Scientific American* contains an article called "The Fury of Space Storms" that may be of interest to solar observers, particularly those involved in recording SIDs.

Clear Skies,

CEF

Sudden Ionospheric Disturbance Report

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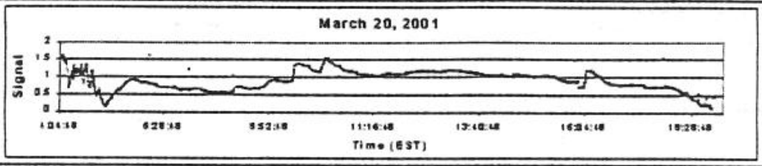


Sudden Ionospheric Disturbances (SID) Recorded During March 2001

(Analysis performed by Michael Hill, SID Analyst)

Date	Max	Imp	Date	Max	Imp	Date	Max	Imp
10301	1818	1	10311	0855	2+	10325	1111	2+
10303	1306	1+	10316	0640	1	10325	2018	2
10304	1850	1	10316	1044	2+	10326	0235	1+
10305	1000	2	10316	1555	1	10326	1324	2
10306	0915	2	10316	2046	1+	10327	0800	2
10306	1005	2+	10317	1721	2+	10327	1224	1
10306	1715	1+	10318	0525	1	10327	1455	2+
10306	1821	2	10318	0748	2	10327	1630	2+
10306	2124	1+	10318	1732	1	10327	1831	2
10307	0838	2	10320	0217	1+	10327	1918	2+
10307	1500	3	10320	0537	1-	10327	2032	2
10307	1817	2+	10320	1005	2+	10328	0640	2+
10307	1929	2+	10320	1432	2	10328	0916	2
10307	2105	1-	10320	1510	2+	10328	0948	2
10308	0857	2	10320	2105	2+	10328	1047	1+
10308	1020	2	10320	2246	1	10328	1905	2
10308	1117	1+	10321	0235	1+	10329	0256	1-
10308	1558	2+	10321	0720	1	10329	0512	2
10308	1616	1-	10321	1130	1+	10329	1008	2+
10309	0732	1+	10322	0515	2+	10329	1136	1+
10309	0845	2	10322	0822	2+	10329	1240	1
10309	1017	2+	10322	1320	2	10329	1417	1
10309	1600	2+	10322	1630	3	10329	1435	1
10309	1701	1	10322	2301	2	10329	1456	1
10309	2015	2	10323	1526	1+	10329	1525	2
10309	2325	2	10323	1900	1	10329	1738	2
10310	0403	2	10324	0815	2	10329	1816	1
10310	0950	1+	10324	0907	1	10329	1838	2
10310	1600	1	10324	1310	3	10329	2017	2
10310	1622	2+	10324	1430	2+	10329	2101	2
10310	1718	2+	10324	1735	2	10330	0515	2+
10310	1940	1+	10324	1958	2+	10330	0929	1+
10311	0543	1	10325	0420	2+	10330	1040	1
10311	0802	1+	10325	0540	2+	10331	1115	2+

The events listed above meet at least one of the following criteria

1) Reported in at least two observer reports
2) Visually analyzed with definiteness rating = 5
3) Reported by overseas observers with high definiteness rating

Importance	Duration (min)
1-	< 19
1	19 – 25
1+	26-32
2	33-45
2+	46-85
3	86-125
3+	> 125

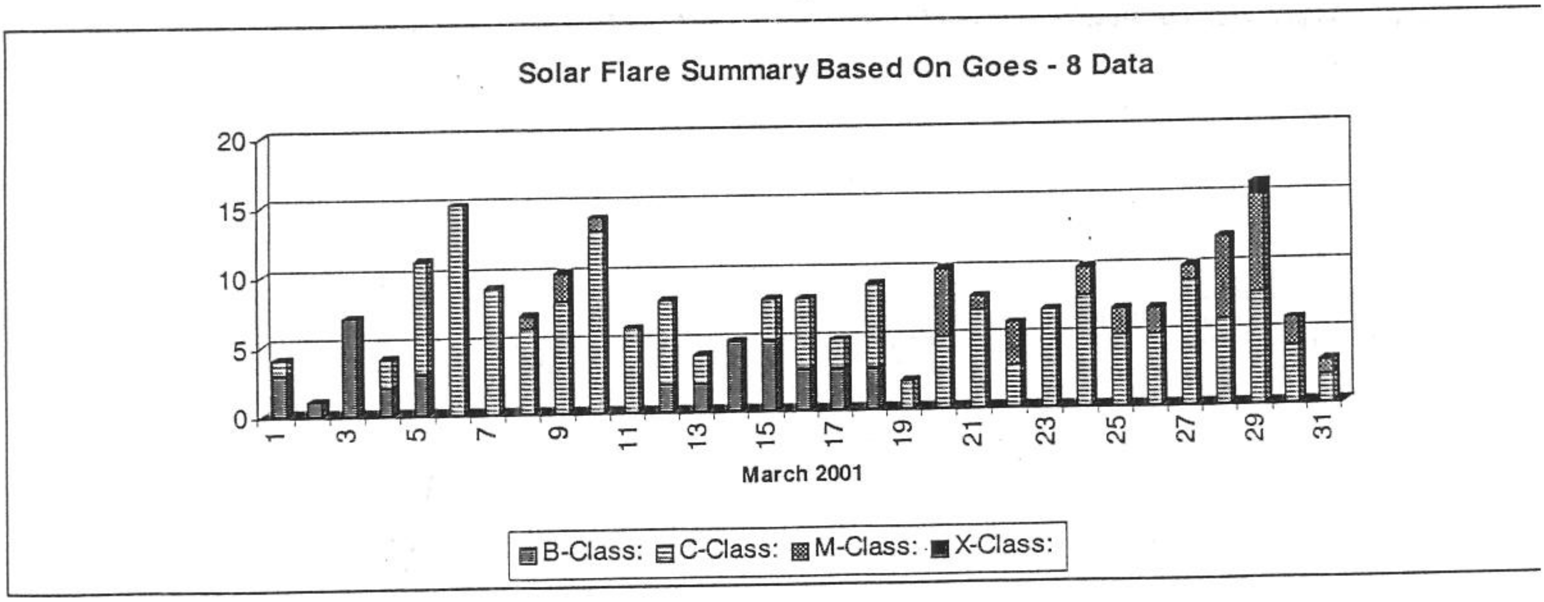
Contributing Observers

Observer	Code	Station(s) monitored
A Clerkin	A29	NAA
J Winkler	A50	NAA, NPM, xxx
D Toldo, D Overbeek	A52	NAA, NWC, xxx
Art Stokes	A62	NAA
J Ellerbe	A63	ICV
P King	A80	FTA
A Panzer	A83	NAA
W Moos	A84	ICV
M Hill	A87	NAA
G DiFillipo	A93	GBZ
T Poulos	A95	NAA
R Battailo	A96	HWU
J Wallace	A97	NAA

Solar Events

March has certainly turned out to be an active month for solar flares. There was a total of 240 X-Ray events measured by the GOES-8 satellite. Of these, 36 were M-Class events and one was a large X-Class event. The most active period was towards the end of the month with the growth of the large sunspot group 9393. This produced a strong series of bursts on the 29th , which was definitely the most active day. There were an astounding 102 measured events reported by observers this month, many of them long duration events. The occurrence of these events is spread out across the month with the most active days being the 7th, 9th, 10th, 20th, 22th, 25th, 27th and of course the 29th. Interestingly enough, there were 4 days, March 12th to March 15th that had no recorded events at all.

Last month I published a graph of measured daily GOES-8 flare events. This month I have presented the same information but in a different format, as suggested by a former AAVSO SID Analyst, Joseph Lawrence. The plot is a bar graph that stacks the totals of each individual flare class for each day on top of each other. The height of the bar is the daily total. Within the bar, however, the count of each type of flare Class can be determined. The flare categories are, from the bottom up, Class-B, Class-C, Class-M, Class-X. I have done this type of plot for all the data back to July 2000. This will eventually be posted to the web site. Otherwise, the data for each month will be presented here from now on.



SOLAR BULLETIN of the American Association of Variable Star Observers. Vol. 57, No. 3 March, 2001

SUDDEN IONOSPHERIC DISTURBANCES SUPPLEMENT

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SUDDEN IONOSPHERIC DISTURBANCES RECORDED DURING MARCH, 2001

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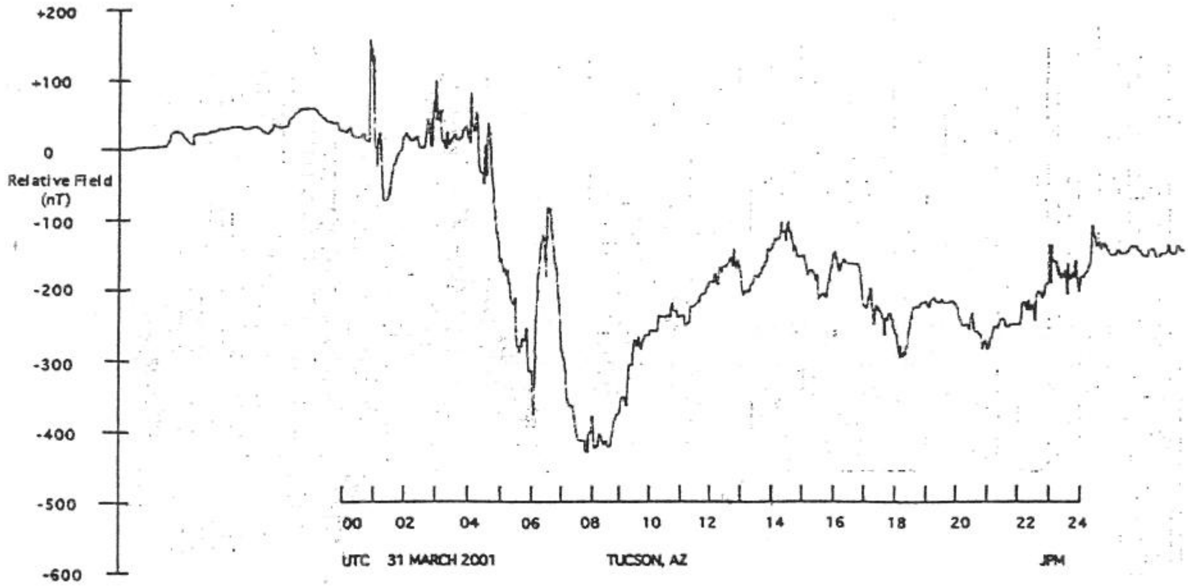
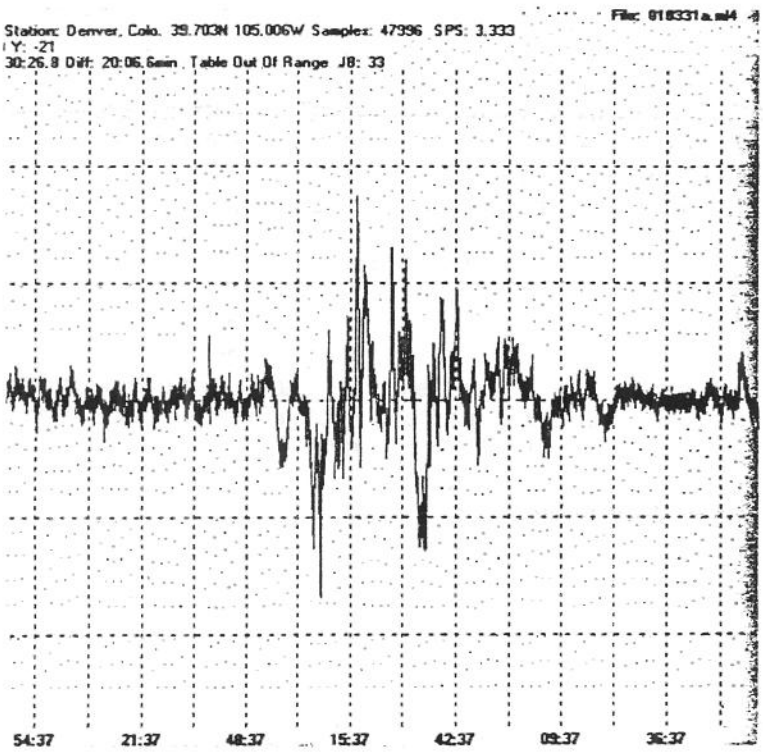
SEARCHING FOR THE SIGNATURE OF GAMMA RAY BURSTS AS SUDDEN IONOSPHERIC DISTURBANCES, SIDs, is now very easy to do. The new HETE gamma ray burst satellite started its operational phase Monday, 26 March 01, by reporting two GRBs that day. Other prompt reports of GRBs are expected to follow. Log into ... http://space.mit.edu/HETE/Bursts ... to see these announcements. Also log into .... http://space.mit.edu/HETE ... to learn more about HETE. As of 8 April no further busts had been added to the two that were announced on 26 March. Presumably the HETE site is having problems getting its operational phase going. All we can do is keep checking to see when announcements start again.

The big news in April was a huge magnetic storm that started about 0100 UT on the 31st It produced an aurora that was seen as far south as Maryland in the eastern United States. Len Anderson, A-91, reported it was seen in the southern hemisphere as far north as South Perth, West Australia where he lives. Below are magnetograms of this big storm. The first is by Jim Mandaville, A-90, in Arizona, USA. Jim calibrated his magnetometer right after the storm with a Helmholtz coil to check the accuracy of his measurements so the relative field strength in nanoTeslas shown is accurate. Jim had this to say: "The very big (and nearly instantaneous) spike at the beginning of the event near 0100 UT is most striking, and I guess it may mark arrival of the plasma shock front. I think it's the biggest I've ever recorded with total amplitude approaching 600 nT (!)". At about 0600 UT the magnetogram shows a dwell with fluctuations at its lowest point. The fine structure in these fluctuations is shown in the second magnetogram below which was made at a much faster sampling rate and chart speed that spreads the dwell out horizontally to show the fine detail. This second magnetogram was made by amateur seismologest, Meredith Lamb in Denveer Colorado, USA on his diamagnetic seismograph. For a picture of his seismometer log into his web site ... http://www.geocities.com/meredithlamb/ ... and click on "A diamagnetic seismometer experiment". Here, in his own words, is a description of Meredith's diamagnetic seismograph and how it works:

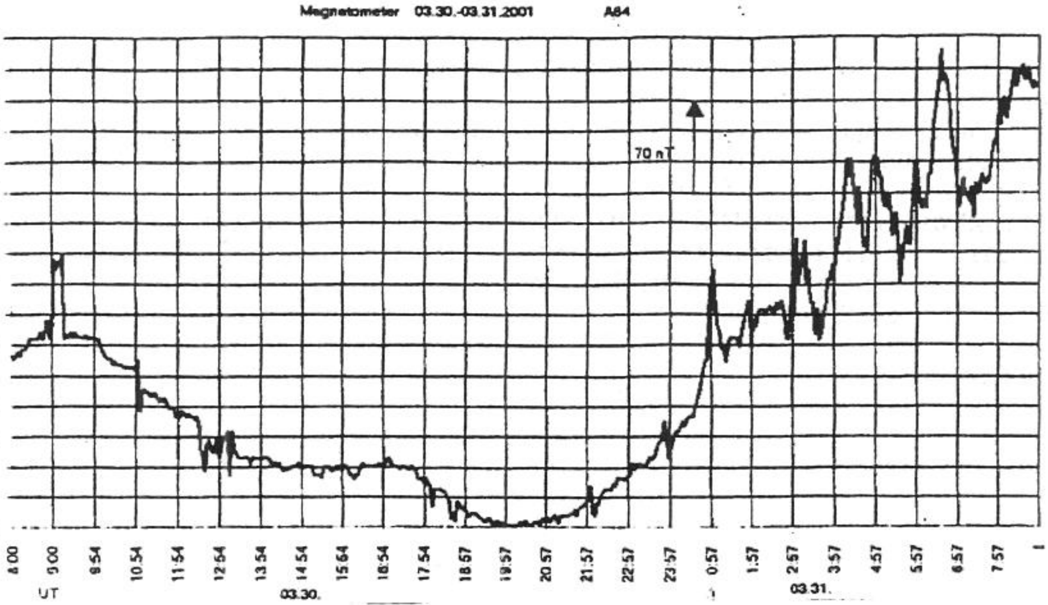
The seismometer/tiltmeter/magnetometer measures position so its output is a DC signal. The amplifier used here is capable of either a straight DC signal or a "AC" signal, but for normal seismic operation use, the "AC" portion of the amplifier is used, with its bleeder resistors and capacitors controlling the frequency of the output signal and a circuit null. The "mass" on this instrument is a diamagnetically levitated neodymium magnet, which also has a plastic extension with another much smaller neodymium magnet. The actual movement is sensed with a Hall sensor which is adjusted to be over the North-South junctions of the small magnet for maximum sensitivity. This diamagnetically levitated mass being a magnet, it does respond to both seismic waves, tilt, and magnetic outside influences, including large bus's, and the stronger geomagnetic disturbances caused by solar flares/shocks. In the physical sense its a directional "hanging pendulum" and has a limit as to magnetic influences, and can not sustain a displacement from that kind of signal indefinitely, as their is the earth's gravity also competing with any signal upon the magnet. The sensing orientation of the instrument is in a North-South direction. Because the geomagnetic changes are only a side note, there has not been any effort to go further with that; however their is also another web page, with a few samples of some of the latest solar influenced magnetic storms and graphs, and that is at: http://diamagnetic.users2.50megs.com/page061.html

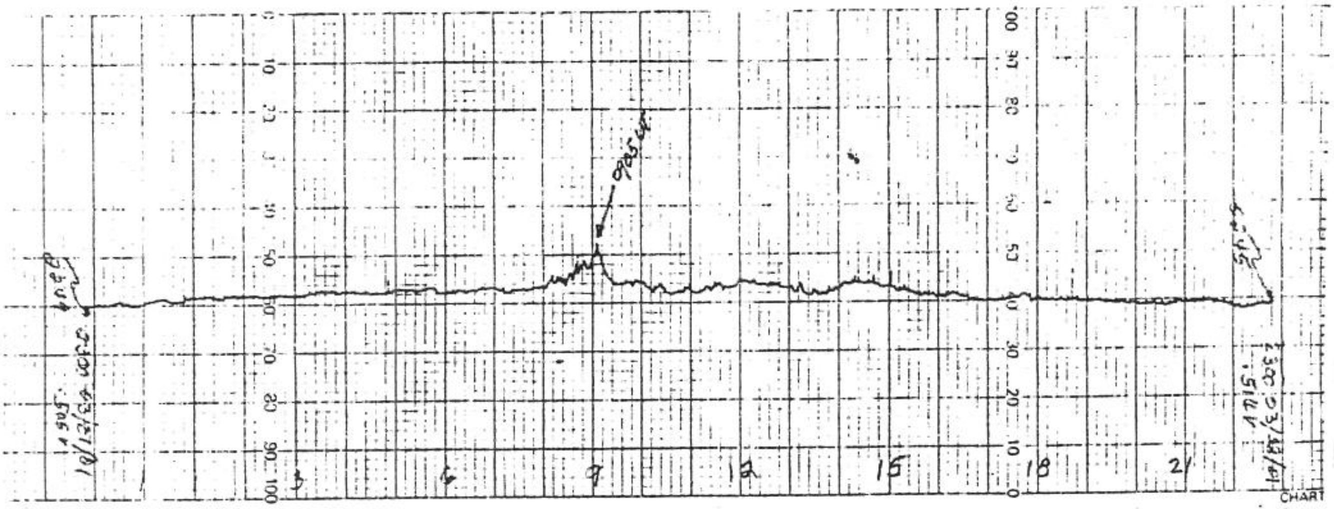


The chart below is the magnetogram made by Meredith Lamb with his seismograph in which the mass is a bar magnet diamagnetically levitated. The bar magnet lies along a north-south axis so it senses the earth's magnetic field and is displaced along that axis by an amount that depends on the strength of the earth's magnetic field. When the strength of that field changes the bar magnet changes its displacement accordingly moving along the north-south axis. A small sensing magnet is attached by an outrigger to the large levitated bar magnet. The amount of the displacement is detected by a Hall Effect sensor in the magnetic field of the small magnet on the outrigger. The output of the Hall sensor is amplified and recorded as a voltage on a computer to produce a DAT file. An earthquake would produce a very similar DAT file by responding to similar displacement of the bar magnet by the earthquake. In the case of the earthquake, however, it is the Hall sensor that moves in relation to the small magnet on the outrigger rather than the other way around. This happens because the seismic mass stands still while the earth shakes, due to the mass's inertia as a long period pendulum. The amount of shaking is very small from a distant earthquake so a lot of amplification of the Hall sensor's voltage output is needed to make the DAT file. Enough amplification is used to detect a magnitude 5.0 earthquake 4000 to 5000 km away or a magnitude 6.0 anywhere in the world. It is this high magnification that produced the fine detail in the chart below. The actual displacements recorded here probably represents distances measured in micrometers. The DAT file of this small section of the magnetic storm was plotted in "Winquake" which is plotting software used by seismologist to plot earthquakes. The distance between the vertical lines on the recording is thirteen and one half minutes so the chart shows about an hour and a half of activity. The chart is centered on about 06 hours universal time. If you compare this chart to 06 hours on Jim Mandaville's chart on the previous page you can see that it corresponds to the lowest part of Jim's chart at around 0600 UT. If you look close you can also see that the broad outline of both charts are similar at around 0600 UT Both start off going down, then up and then down again. Both charts confirm the same small changes due to the storm but Meredith's chart shows it in much finer detail due to his recording being made at a much faster sampling rate (3.3 sps) and faster chart speed plus considerably more amplification.

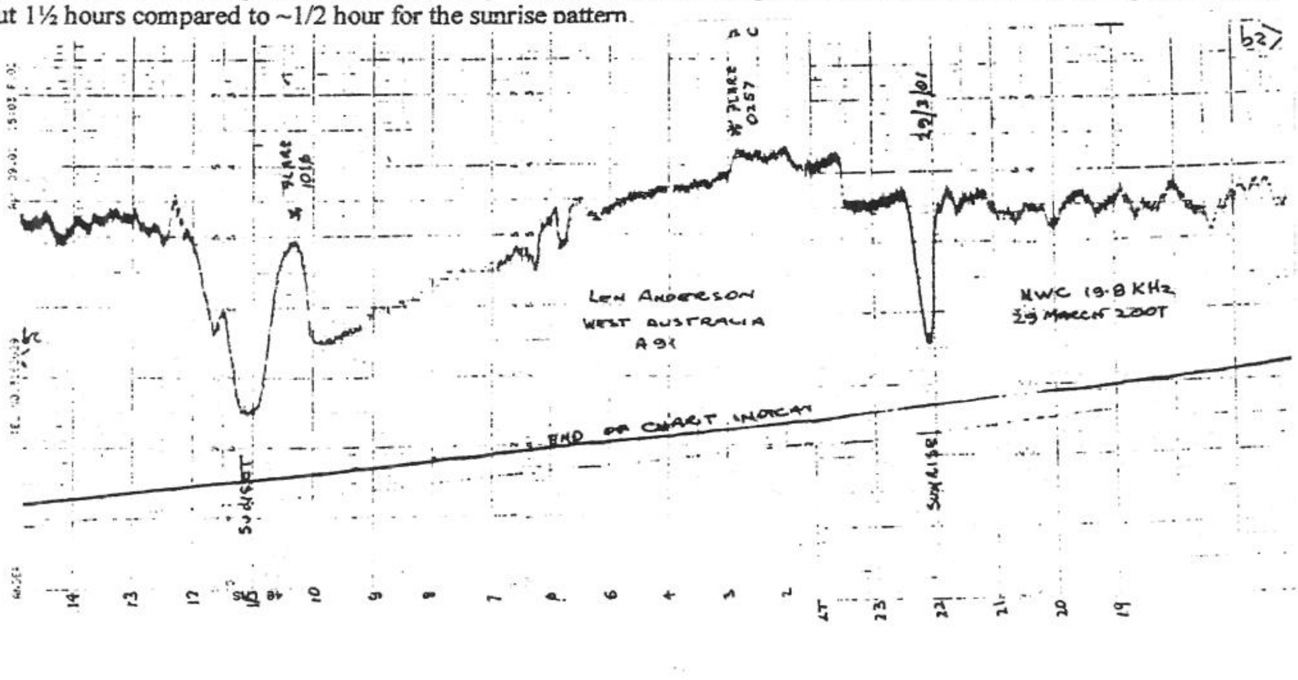


Charts below, on the next page, show more magnetograms made by other observers during March. The first was made by Dr. Walter Moos, A-84, in Switzerland. It is a recording of the same 31March magnetic storm that is shown above and on the previous page. The second was made by sunspot observer, Ed Reed, using a McWilliams torsion balance magnetometer to record the 28 March storm. Danie Overbeek, A-52 also recorded this storm and sent a recording of it but for some unknown reason my computer only prints the beginning of the chart, leaving out the part that shows the magnetic storm.

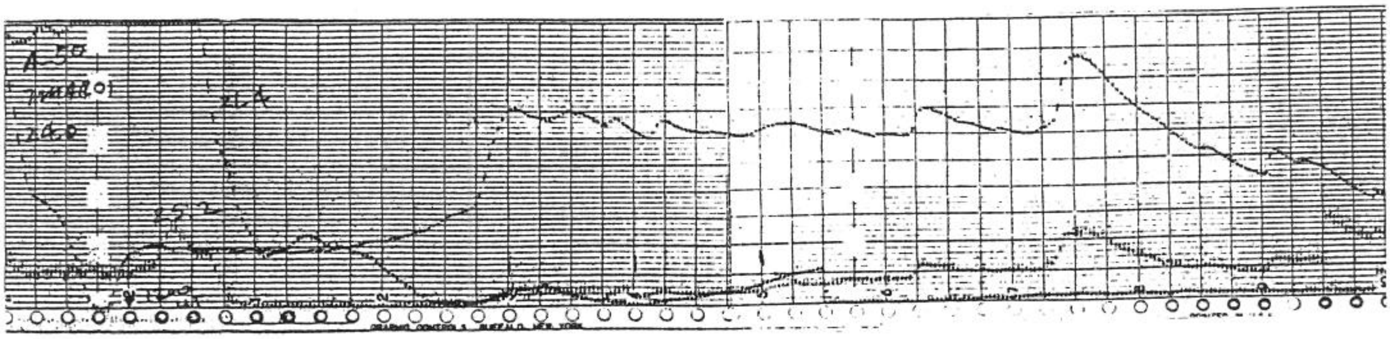


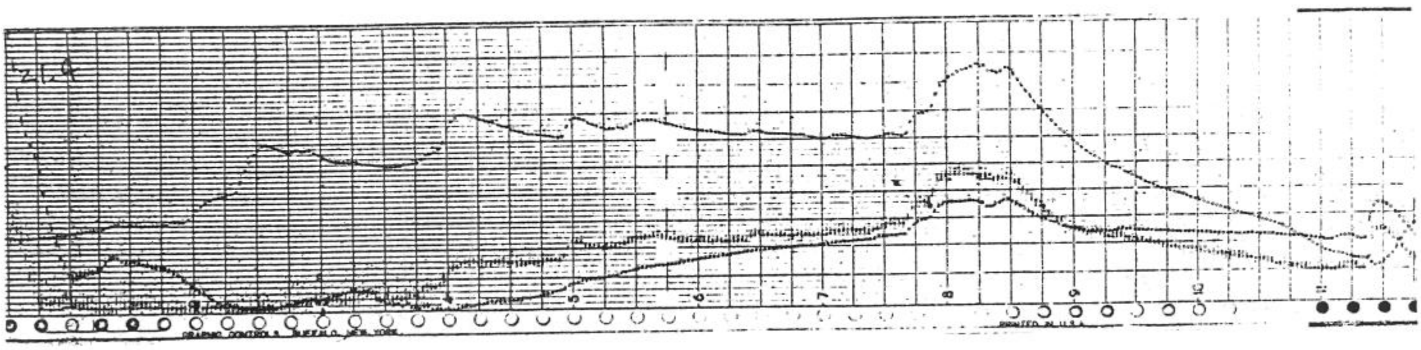


Len Anderson, A-91, in South Perth, West Australia, made the SES recording below using NWC at Northwest Cape, West Australia, on 19.8 kHz as his signal source. NWC is about 1000 km due North of South Perth which accounts for the very sharp and short duration sunrise drop at ~2300 UT on 29 March. Time advances from right to left on this chart and later the next UT day, 30 March, a nice SES starts at ~1000 UT but soon gets lost in the sunset drop which starts about one half hour later at ~1030 UT and drops to its lowest level by ~1100 UT. The sunset pattern is broader than the sunrise pattern taking about 1½ hours compared to ~1/2 hour for the sunrise pattern.



Two multiplexed charts below were made by Jerry Winkler, A-50, on 7 and 9 March. The three signals are 24 kHz, 25.2 kHz and 21.4 kHz in Maine North Dakota and Hawaii respectively. The uppermost signal which is NAA on 24 kHz is the most sensitive and shows multiple SESs both days. Notice how the events are confirmed by showing on more than one trace. A multiplexed chart records SESs with much higher definiteness than a recording of a single signal. This is why A-52's multiplexed recording of gamma ray burst 010222 was seen as a definite recording of the GRB as discussed last month in the February Solar Bulletin.





Two charts below were made by Casper Hossfield, A-5, on 27 and 28 March, made in Orlando, Florida recording NAA in Maine on 24 kHz. The first chart, 27 March, shows an SES with an unusually sudden rise lasting less than two minutes and starting at exactly 1630 UT so much of the rise is on the time line and hard to see. For such a large SES to last only 30 minutes is also unusual. The 29 March chart shows a more normal SES rising in ~6 minutes and lasting 45 minutes.