Solar Bulletin

THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS - SOLAR DIVISION

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December 2000

Table I. Mean Sunspot Numbers for December

Day	N	Raw	s.d.	K-corrected	s.d.	s.e.
1	25	138	7.8	106	5.3	1.06
2	38	132	6.0	101	4.0	0.65
3	29	125	8.7	95	6.4	1.19
4	23	94	7.0	72	4.2	0.88
5	21	81	4.3	60	2.8	0.61
6	19	71	7.9	52	4.9	1.12
7	24	88	5.9	68	4.0	0.82
8	22	76	6.4	57	4.4	0.94
9	25	72	5.4	58	3.4	0.68
10	23	73	5.7	54	3.5	0.73
11	16	96	6.1	73	3.4	0.85
12	15	108	8.8	79	5.1	1.32
13	21	145	9.3	111	5.2	1.13
14	17	173	14.4	136	6.8	1.65
15	24	204	13.7	162	8.2	1.67
16	19	177	13.6	142	9.0	2.06
17	23	168	9.1	136	5.2	1.08
18	21	149	12.0	117	6.5	1.42
19	24	148	9.3	113	4.7	0.96
20	20	152	8.9	118	5.4	1.21
21	27	152	9.5	117	6.9	1.33
22	23	135	9.6	111	6.1	1.27
23	32	133	7.7	102	5.0	0.88
24	22	136	11.1	106	6.8	1.45
25	20	141	11.8	106	6.7	1.50
26	13	150	14.4	115	9.6	2.66
27	15	162	13.7	124	6.8	1.76
28	22	156	13.4	117	5.5	1.17
29	21	166	11.7	117	6.4	1.40
30	20	154	8.7	118	5.8	1.30
31	23	120	7.5	93	5.4	1.13

Means: 131.5 101.2

No. of Observations: 687

No. of Observers: 55

Table II. December Observers

9	AAP	P.Abbott
9	ATON	A.Attanasio
11	BARH	H.Barnes
6	BATR	R.Battióla
2	BEB	R.Berg
14	BRAB	B.Branchett
20	BRAR	R.Branch
2	CAMP	P.Campbell
14	CARJ	J.Carlson
24	CHAG	G.Morales
10	CKB	B.Cudnik
5	CLZ	C.Laurent
31	COLJ	J.Collins
31	CR	T.Cragg
14	DUBF	F.Dubois
22	ELR	E.Reed
13	FEEC	C.Feehrer
16	FERJ	J.Fernandez
19	FLET	T.Fleming
21	FUJK	K.Fujimori
3	GALM	M.Gallo
20	GIOR	R.Giovannoni
4	GOTS	S.Gottschalk
6	HAYK	K.Hay
27	JAMD	D.James
2	JEFT	T. Jeffries
4	JENV	V.Jennings
14	KAPJ	J.Kaplan
15	KNJS	J&S Knight
8	LERM	M.Lerman
21	LEVM	M.Leventhal
7	LIZT	T.Lizak
15	MALK	K.Malde
6	MARE	E.Mariani
23	MARJ	J.Maranon
24	MCE	E.Mochizuki
15	MMI	M.Moeller
3	MUDG	G.Mudry
8	NILB	B.Nilson
12	OBSO	IPS Obs.
11	RICE	E.Richardson
22	RITA	A.Ritchie
9	SCGL	G.Schott
2	SIMC	C.Simpson
1	STEF	G.Stefanopoulis
18	STEM	G.Stemmler
18	STQ	N.Stoikidis
21	SUZM	M.Suzuki
5	SZAK	K.Szatkowski
6	TESD	D.Teske
7	THR	R.Thompson
11	URBP	P.Urbanksi
2	VALD	D.del Valle
14	VARG	A.Vargas
10	WILW	W.Wilson

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

Table III. Means of Raw Group Counts for December 2000

Day	Mn.	Day	Mn.	Day	Mn.	Day	Mn.
1	8.4	**9**	4.8	**17**	10.7	**25**	8.1
2	8.3	**10**	5.5	**18**	9.9	**26**	7.9
3	8.8	**11**	6.7	**19**	9.0	**27**	9.5
4	6.7	**12**	7.0	**20**	10.5	**28**	8.7
5	5.6	**13**	8.7	**21**	9.5	**29**	9.4
6	4.8	**14**	10.4	**22**	8.8	**30**	8.7
7	5.8	**15**	11.9	**23**	8.4	**31**	7.0
8	5.4	**16**	11.2	**24**	8.3	**Mn.**	**8.2**

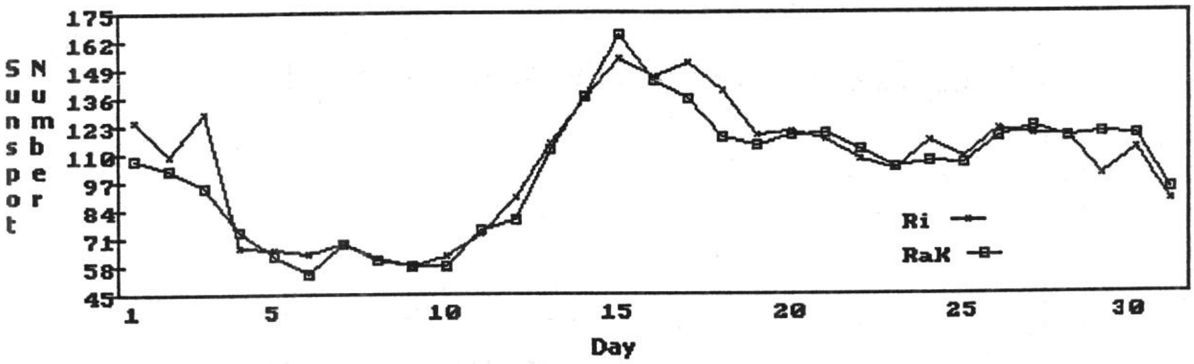

Fig. 1. Comparison of Ri (provisional) and Ra estimates for December.
(Ri Source: www.oma.be/KSB-ORB/SIDC/index.html)

Smoothed Mean Sunspot Number (Rsm) for June 2000: 122.9

Year 2000 Summaries

This final issue of vol. 56 contains, in addition to the regular compilations, two additional graphs. The first (Fig. 2) summarizes the set of monthly mean Ra values computed during the year and the smoothed means (Rsm) computed through June.

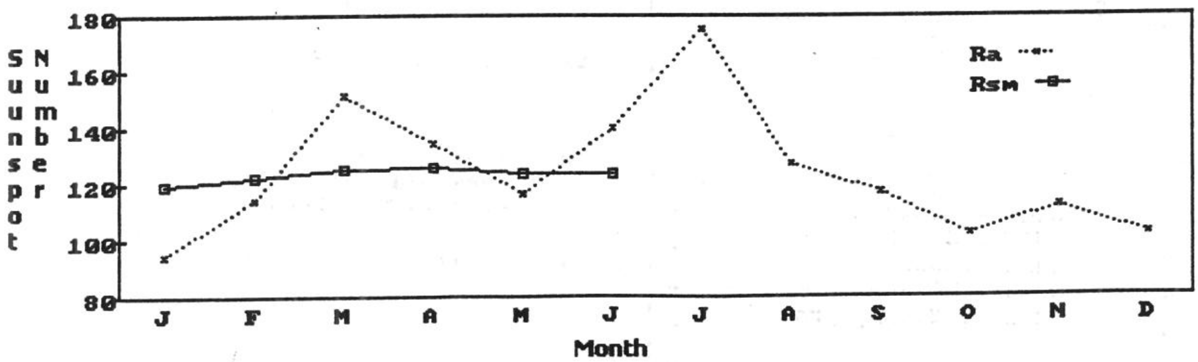

Fig. 2. American Relative Sunspot Numbers (Ra) and Smoothed Means (Rsm) for 2000

Figure 3 presents the means of group estimates made during each month of the year. Recall that, unlike the Ra values, these means are not treated with observer coefficients.

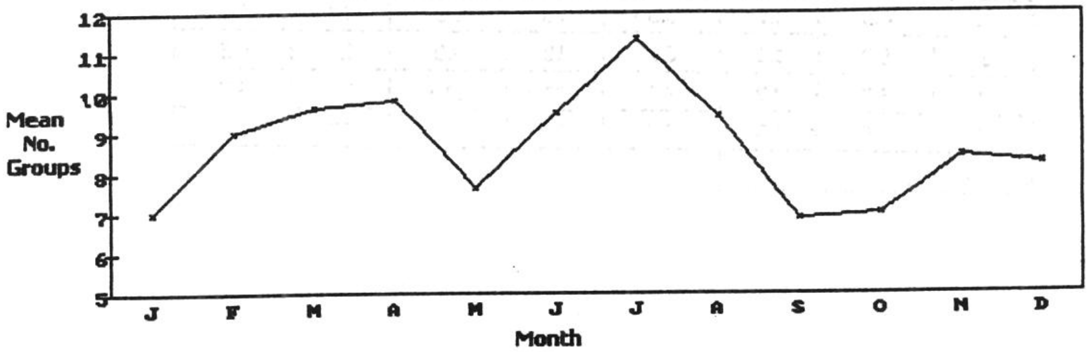

Fig. 3. Means of Raw Group Counts Reported in 2000 (see Editor's Notes)

Observers of Note

A list of observers who have contributed in excess of 100 observations during 2000 is presented in Table 4 below.

Table 4. Observers Who Have Contributed 100 or More Observations During 2000

300+ Observations	
CHAG	G.Morales
200-299 Observations	
BOSB	B.Bose
BRAB	B.Branchett
BRAR	R.Branch
BROB	R.Brown
CARJ	J.Carlson
CKB	B.Cudnik
CORA	A.Coroas
CR	T.Cragg
ELR	E.Reed
FEEC	C.Feehrer
FERJ	J.Fernandez
FLET	T.Fleming
FUJK	K.Fujimori
GIOR	R.Giovannoni
JAMD	D.James
LEVM	M.Leventhal
MALK	K.Malde
MARJ	J.Maranon
MCE	E.Mochizuki
MMI	M.Moeller
RICE	E.Richardson
RITA	A.Ritchie
STEM	G.Stemmler
STQ	N.Stoikidis
SUZM	M.Suzuki
TAKH	H.Takuma
WILW	W.Wilson
YESH	H. Yesilyaprak

100-199 Observations	
AAP	P.Abbott
BARH	H.Barnes
BATR	R.Battiola
BEB	R.Berg
BMF	M.Boschat
BRAD	D.Branchett
COMT	T.Compton
DRAJ	J.Dragesco
DUBF	F.Dubois
GOTS	S.Gottschalk
HAYK	K.Hay
IBRA	A.Ibrahim
KAPJ	J.Kaplan
KNJS	J&S Knight
LARJ	J.Larriba
LERM	M.Lerman
LIZT	T.Lizak
OBSO	IPS Obs.
SCGL	G.Schott
STEF	G.Stefanopoulis
SZAK	K.Szatkowski
TESD	D.Teske
THR	R.Thompson
URBP	P.Urbanksi
VALD	D.del Valle
VARG	A.Vargas
WITL	L. Witkowski

Editor's Notes

Solar Bulletin on AAVSO Website

I am pleased to report that the experiment with the November Bulletin, which was posted in its entirety on AAVSO's website last month, has met with considerable success. Web server statistics covering the period from 20 Dec to 8 Jan indicate that 120 requests for the complete Bulletin, along with smaller numbers of requests for specific pages of the report were satisfied. Of additional interest is the fact that substantial percentages of the requests originated from regions in which AAVSO has few or no recognized observers. The outcome of the experiment is enough to suggest that posting to the website would be of value, and we shall begin routine posting with the January 2001 Bulletin (vol. 57, no. 1).

New Observers

Quite by accident I learned this month that a near-neighbor of mine and an acquaintance of many years, Andrew Clerkin, had been an active AAVSO SID observer during the 1970's. After a telephone call, during which I encouraged him to renew his contact with AAVSO, he sent me the following email, which provides some perspective on his background:

> "I was active in the AAVSO Solar Division from 1970-1977. I used an SEA receiver from 1970-1973 (built from a design in [the] April 1969 Sky and Telescope article by Cap Hossfield) and later (1974-1977) used an SES receiver [designed and built by David Warshaw]. I am presently using the Warshaw SES receiver. For recording output from the receiver I have a Rustrak recorder but I am currently using the ADC that I recently built as designed and published on the AAVSO website."

Andy has graciously agreed to begin sending his observations to the Solar Division again, and his input is included in Mike Hill's statistics for December. Welcome back A-29!

I also want to welcome a new sunspot observer, Paul Campbell (CAMP), from Edmonton, Alberta, who sent his first report this month. Paul observes with the aid of a 12.5 inch, f4.9 Newtonian, equipped with a full aperture Baader solar filter. Thank you, Paul. We look forward to your monthly contributions to the work of the Division.

Articles About the Sun

Due at least in part to the occurrence of solar maximum, several astronomy magazines have recently published articles about the Sun. The January issue of *Astronomy* contains an excellent article on h-alpha photography by Jean Dragesco (DRAJ), a contributor of sunspot data to AAVSO, entitled "Sunsational Photography". And, beginning with its February issue, *Sky and Telescope* begins a multi-part article, "Today's Science of the Sun". I highly recommend both to interested readers.

Best Wishes for a Happy New Year (and Millennium!) to All

-CEF

Sudden Ionospheric Disturbance Report

Michael Hill, SID Analyst
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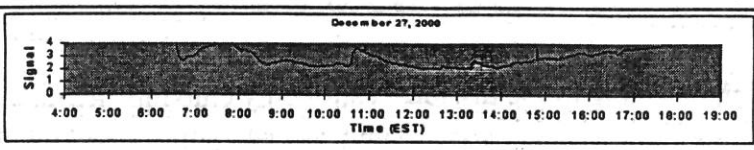

Sudden Ionospheric Disturbances (SID) Recorded During December 2000

(Analysis performed by Michael Hill, SID Analyst)

Date	Max	Imp	Date	Max	Imp	Date	Max	Imp
001202	1025	1-	001214	1102	1	001225	0557	1+
001205	0444	1	001214	1523	1+	001225	0630	1-
001205	1350	1-	001215	1114	1	001225	1600	1+
001206	0812	1-	001215	1946	1	001225	1633	2
001206	1037	1	001217	0900	1-	001226	0430	1+
001206	1515	2	001217	1202	1	001226	0523	1+
001206	1754	2	001217	1845	1	001226	0611	2
001207	0336	1-	001218	0855	2	001226	1049	2
001207	0538	2	001218	1100	1+	001226	1129	2+
001207	0727	2+	001218	1315	1-	001226	1606	2+
001208	1130	1-	001218	1340	1-	001226	1931	1
001208	1450	1-	001219	1002	2	001227	0804	2
001208	1514	1-	001219	1413	1-	001227	1535	2+
001208	1620	2	001219	1811	1+	001227	1738	1-
001209	0406	1-	001219	1859	1-	001227	1819	1+
001209	0422	1	001220	1546	1-	001228	0410	2
001209	0537	2	111223	0453	1-			
001210	1926	1	001223	1645	1+			
001211	0950	1-	001223	1722	1			
001211	1500	2	001223	1954	1			
001212	0858	1	001223	2014	1			
001212	1444	2+	001224	1106	2+			
001213	0758	2	001224	1332	1			
001213	1108	1+	001224	1718	1-			
001214	0935	2+	001224	2058	1			

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

Observer	Code	Station(s) monitored
A. Clerkin	A29	NAA
J. Winkler	A50	NAA, NPM
D. Overbeek, D. Toldo	A52	NAA, NSW
A. Stokes	A62	NAA
J. Ellerbe	A63	ICV
P. King	A80	FTA
A. Panzer	A83	NAA
W. Moos	A84	FTA, ICV, GBZ
M. Hill	A87	NAA
G. DiFillipo	A93	GBZ

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

Solar Events

At the meeting of the my local astronomy club this month a member was showing pictures of the December 25th eclipse and was lamenting about the lack of sunspots lately especially since we are at Solar Maximum. It is an observation that I have heard from more than one person in recent days. We are fortunate in that we can directly view the suns activity with two perspectives. The visual and the x-ray. As is the case with most of astronomical objects what one sees in one is not often the same as in the other. Such is the case with what the sunspot observers may be seeing and what we are measuring.

Although sunspot activity may have been low, flare activity was greater than usual - in a sense. There were no X-Class flare and only 7 M-Class flares this month. But on the other hand there were 251 flares in total registered by the Goes-8 spacecraft. This is in line with a steady increase over the last few months as evidenced in the table below.

Month	Flares Goes-8	M-Class	X-Class	SID Event count
Aug	135	3		21
Sep	197	10	1	63
Oct	141	10		42
Nov	168	14	5	38
Dec	251	7		68

As can be seen the trend certainly seems to be that of increasing activity. It remains to be seen how this trend continues but I have read that the greatest flare activity most often comes just after the sunspot peak. Since solar maximum has passed that peak, most likely last July or August, this data set at is a good indicator that this is in fact the case. There were fewer large flares but this may be due to the large number of smaller flares releasing energy in the same way small earthquakes often serve to prevent a much larger one due to the high energy buildup. I'm no solar scientist but common sense would suggest that there are parallels to both cases.

Of the 251 events in December, our observers detected 68 of them. The most active period for us was ironically centered around the 25th of December, coincident with the partial Solar Eclipse that North Eastern US observers were able to see. Of course there is no connection there but interesting to note. While the sun put on a show that attracted many observers it revealed itself to be almost devoid of sunspots and seeming activity. Our combined observations, on the other hand, showed from a different perspective that this was not the case. This speaks of the importance of your diligent work keeping SID recivers up and running, logging the daily events and reporting your observations to me in a timely manner. Your observations as always are meaningful and are an important part of solar science

SOLAR BULLETIN of the American Association of Variable Star Observers. Vol. 56, No. 12, December, 2000

SUDDEN IONOSPHERIC DISTURBANCES SUPPLEMENT

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SUDDEN IONOSPHERIC DISTURBANCES RECORDED DURING DECEMBER, 2000

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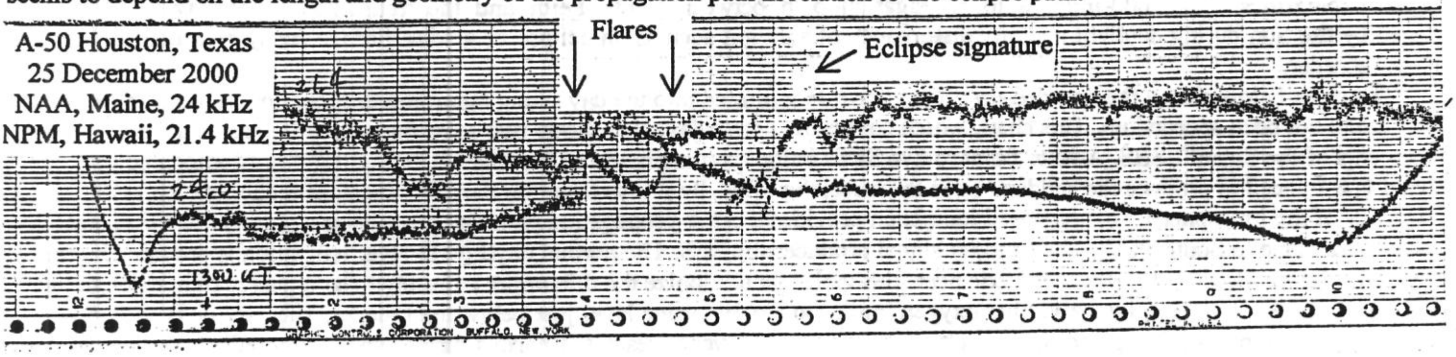
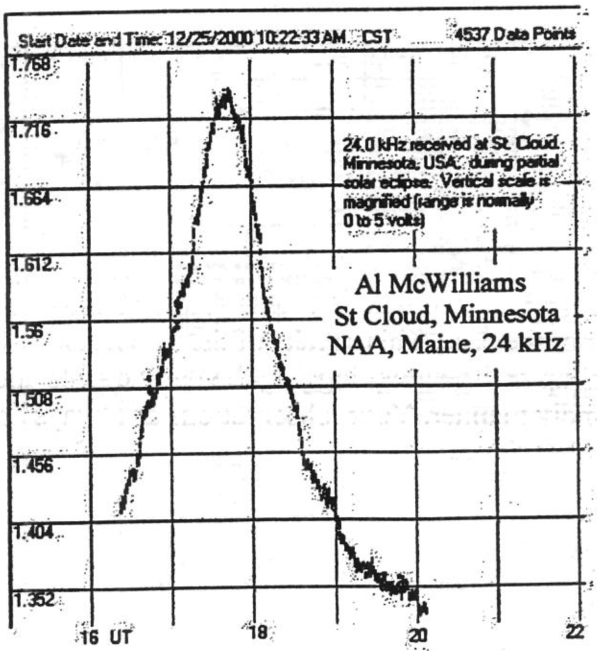
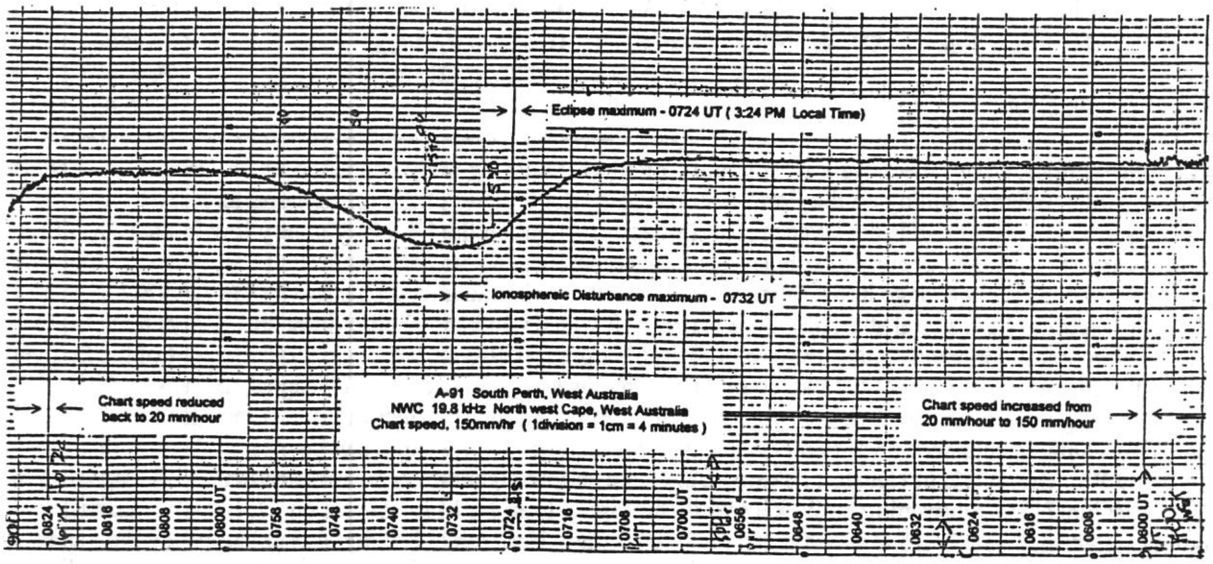
The Christmas Solar Eclipse, a partial eclipse visible in the United states during early afternoon on 25 December, decreased the amount of ultra violet radiation falling on the Earth's ionosphere. The D-layer of the ionosphere, its lowest layer, is maintained by the Sun's ultraviolet and is the layer responsible for propagating the US Navy's very low frequency, VLF, radio signals it uses to communicate with submerged submarines. The recombination rate of ions in the D-layer is very high and their density responds in seconds to any change in the intensity of solar ultraviolet radiation. This is why the AAVSO is able to detect solar flares by recording the signal strength of the Navy VLF signals. Increased ultraviolet and X-rays from flares enhances the ionization thereby increasing the strength of the VLF signal. It also lowers the effective height of the D-layer which can change the phase relationship of the two components that usually are part of a VLF signal. Because of this complicated way VLF signals are propagated, a change in ultraviolet radiation can affect the signal strength in unpredictable ways. Sometimes the signal is enhanced and at other times it is diminished. An example can be seen in the multiplexed chart below made by Jerry Winkler, A-52, in Houston , Texas, USA. The eclipse signature is an enhancement of the signal strength of NAA in Cutler, Maine, USA transmitting on 24 kHz while the signal from NPM in Hawaii on 21.4 kHz is diminished. Two flares beginning at ~1600 and ~1630 UT also enhanced the NAA signal. Here the NAA signal is enhanced by the increased radiation from the flares but also enhanced by the decreased radiation from eclipse. This is hard to explain but recordings on the following page, of a 1994 eclipse may throw some light on this mystery. The next chart below, made by Al McWilliams recording NAA also shows an eclipse enhancement of the NAA signal at about 1745 UT as recorded in St Cloud, Minnesota. This is about 20 minutes later than the maximum in Houston, Texas and can probably be attributed to the difference in longitude along the path of the eclipse.

It is interesting to compare the signatures of this eclipse with those of past eclipses. I have therefore reproduced on the following page, part of the February,1999 Solar Bulletin that compares a recording of a 16,February solar eclipse recorded by Len Anderson, A-91 in South Perth, West Australia with the recordings of a 10 May 1994 eclipse recorded in the USA. A lot seems to depend on the length and geometry of the propagation path in relation to the eclipse path.



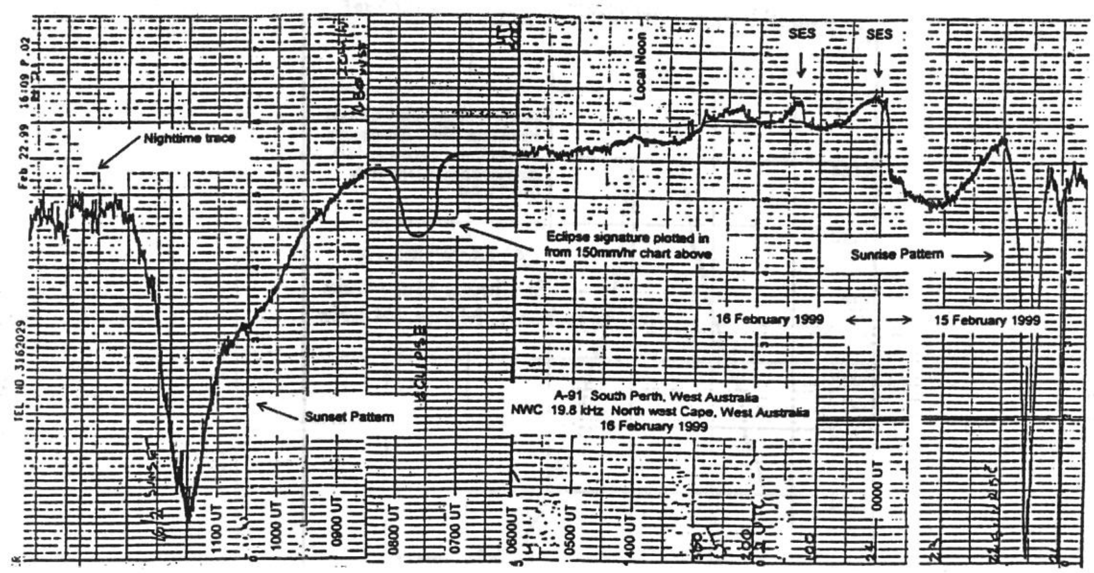




The solar eclipse of 16 February has been recorded above as a disturbance in the Earth's ionosphere. The path of this eclipse across Australia is shown in the map on the next page. The eclipse was annular and visible only in Australia. Len Anderson, A-91, lives in South Perth on the west coast of Australia near the centerline of the eclipse, an ideal spot to record its effect on the ionosphere. Len normally monitors the ionosphere to detect Solar flares but made special preparations to record the eclipse. He speeded up his strip chart recorder to show more detail during the eclipse. Normally it runs at 20 millimeters per hour but starting at 0600 Universal time he increased the speed over seven times to 150 millimeters per hour to catch the eclipse and make the chart above. After the eclipse the recording reverts to its normal 20 mm / hr speed at 0824 UT

The eclipse's signature was made by recording the signal strength of very-low-frequency radio station, NWC, 1000 kilometers northwest along the coast of West Australia. NWC's powerful 1-megawatt VLF transmitter is a communication link to submerged submarines. The 1000-mile radio propagation path between South Perth and the transmitter at Northwest Cape is maintained by the Sun during daylight and any disturbance of sunlight such as an eclipse or a solar flare is easily recorded on Len's strip-chart recorder.

The chart below shows the speeded-up eclipse recording plotted into the day - long recording to show how it would have looked if it had not been speeded up. This chart, which covers the whole day, also shows two solar flares recorded as "Sudden Enhancements of the Signal", SES. Arrows point to two SESs in the morning hours of the chart to the right of the afternoon eclipse. The signal is enhanced to produce the sudden rise in the trace, the SESs, by x-rays from the flare that increase the ionization in the lower D-layer of the ionosphere. The increased ionization provides a better propagation path that propagates a stronger NWC signal from Northwest Cape to South Perth. The stronger signal produces the SES. The normal daytime D-layer ionization is provided by the Sun's far-ultraviolet radiation. The less energetic near-ultraviolet cannot ionize the thin upper atmosphere so it passes right through the D-layer and dissipates its energy by converting oxygen into ozone in the ozone layer just below the D-layer. The even-less-energetic ultraviolet and visible part of the spectrum passes through the Ozone layer to reach the Earth's surface and is the sunlight that is the chief source of energy for all life on Earth.

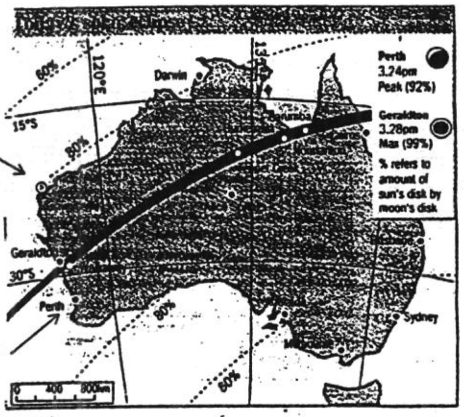


Map from the "WEST AUSTRALIAN"
16 February 1999

Lights to dim as solar eclipse dawns

NWC Transmitter,19.8 kHz
Northwest Cape, Australia

VLF monitor station. A-91
South Perth, Australia



■ By Carmelo Amalfi

THE lights will dim in WA this afternoon when the Moon shuts out the Sun's light in an eclipse visible only in Australia.

But people, particularly schoolchildren who will be heading home during the solar crossing from about 2pm to 4pm, are urged not to look up when the sky begins to darken.

Prolonged viewing can cause serious eye damage, so the safest way to watch the eclipse is by projecting it on to a screen or by using special glasses.

The best spot to watch the eclipse will be from inside the 30km-wide path of annularity — the path along which the eclipse appears as a bright ring when the Moon appears to sit inside the Sun's disc without covering it completely.

The annular phase will be visible along a line that extends from Greenough and Cue in WA to Tennant Creek in the Northern Territory and 100km north of Cairns in Queensland.

Between Greenough and Dongara, 99 per cent of the Sun's disc will be covered by the Moon. In Perth, maximum eclipse will be at 3.24pm.

Primary school students at Walkaway, which sits at the centre of the eclipse path, will be allowed to view the event when they leave school at 3.05pm.

Walkaway Primary School principal Peter Bright said the school had promoted the event in science lessons that emphasised health and safety aspects.

"We've decided that the best policy is not to be part of it," he said. "There would just be too many students around to risk holding viewing sessions."

▶ Internet eclipse sites, page 38

The map above shows the path of the eclipse across Australia. Northwest Cape and South Perth are labeled to show how the Moon's shadow crossed the propagation path almost perpendicularly so the difference between eclipse maximum and the maximum of the propagation anomaly are only eight minutes apart. Below are three recordings of an annular eclipse that crossed the United States on 10 May 1994. They were made the same way. SES receivers normally used to detect solar flares recorded the eclipse anomalies. The chart marked Indiana was made by Solar Division Chairman, Joseph Lawrence, A-82. It shows an inversion at the bottom of the anomaly. The Ohio chart was made by Diane Lucas, A-76. She recorded two signals, NAA and NSS, on a computer. Her recording of NAA shows the same inversion at the bottom of the NAA trace. Her recording of NSS is completely inverted. These increases of the signal strength when it seems like the eclipse should cause it to decrease can be explained as phase anomalies, an interference effect between the ground wave and sky wave radiated by the VLF antenna. The same thing accounts for inversions in the SES recordings published recently in the Solar Bulletin. The New Hampshire chart was made by Meddy Landry, A-81. It is a normal recording without inversions like A-91's eclipse recording of NWC during the recent Australian eclipse