SOLAR INDICES BULLETIN

JULY 1998

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♦ SOLAR RADIO EMISSIONS

The quiet Sun emits radio energy with a slowly varying intensity. These radio fluxes, which stem from atmospheric layers high in the chromosphere and low in the corona, change gradually from day-to-day, in response to the number and size of spot groups on the solar disk. The table below gives daily measurements of this slowly varying emission at selected wavelengths between about 1 and 100 centimeters. Many observatories record quiet-sun radio fluxes at the same local time each day and correct them to within a few percent for factors such as antenna gain, bursts in progress, atmospheric absorption, and sky background temperature. At 2800 megahertz (10.7 centimeters) flux observations summed over the Sun's disk have been made continuously since February 1947.

♦ SOLAR FLUX TABLE

Numbers in parentheses in the column headings below denote frequencies in megahertz. Each entry is given in solar flux units--a measure of energy received per unit time, per unit area, per unit frequency interval. One solar flux unit equals 10^{-22} J/m^{2}Hz sec.

During low periods of solar activity, the flux never falls to zero, because the Sun emits at all wavelengths with or without the presence of spots. The lowest daily Ottawa flux since 1947 occurred on November 3, 1954. On that day the observed noon value dropped to 62.6 units; the highest observed value of 457.0 occurred on April 7, 1947.

The preliminary observed and adjusted Penticton fluxes tabulated here are the "Series C" values reported by Canada's Dominion Radio Astrophysical Observatory in Penticton, British Columbia. Observed numbers are less refined, since they contain fluctuations as large as ±7% from the continuously changing sun-earth distance. Adjusted fluxes have this variation removed; they show the energy received at the mean distance between the Sun and Earth. Gaps in the Learmonth, Australia (LEAR) data reflect equipment problems. Fluxes measured either at Palehua on the Hawaiian Islands, or at San Vito, Italy, will be substituted for frequencies at which many Learmonth values are missing.

JULY 1998 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

Day	Sunspot Number Intl	Obs Flux Pentic (2800)	ted to 1 Astronomical Unit LEAR (15400)	LEAR (8800)	LEAR (4995)	Pentic (2800)	LEAR (2695)	LEAR (1415)	LEAR (610)	LEAR (410)	LEAR (245)
01	94	127	527	255	152	131	112	95	42	31	60
02	95	120	557	250	153	124	111	97	49	36	18
03	95	128	547	246	153	132	112	96	45	32	28
04	100	129	559	244	157	133	114	95	55	38	---
05	94	124	560	244	158	128	117	96	55	37	18
06	74	121	564	239	155	125	115	94	57	39	18
07	51	115	561	236	150	119	110	91	56	43	36
08	38	112	550	229	149	116	96	88	54	40	36
09	26	114	550	230	151	118	96	86	55	38	14
10	49	109	547	226	149	113	94	84	54	37	14
11	57	108	545	224	146	112	88	81	51	36	14
12	55	99	526	216	142	102	---	---	48	34	14
13	41	106	536	214	142	109	---	---	---	---	---
14	38	103	520	214	139	106	---	---	47	33	12
15	55	105	557	204	135	108	78	67	49	35	13
16	67	106	565	239	146	109	101	75	50	35	13
17	59	100	556	237	143	103	104	78	50	34	13
18	42	99	552	236	139	102	101	79	49	34	13
19	35	102	555	235	137	105	99	77	47	33	12
20	69	112	560	242	146	116	105	77	47	33	13
21	78	110	568	251	156	114	114	84	47	34	14
22	91	114	564	253	158	118	115	84	47	33	14
23	90	115	570	252	158	119	116	84	48	33	14
24	79	125	574	252	163	129	124	87	48	34	18
25	68	122	561	260	167	126	119	87	50	37	---
26	63	119	571	266	168	123	123	88	51	37	---
27	65	120	561	263	168	124	118	90	52	39	---
28	85	121	568	269	168	125	120	93	53	39	31
29	74	120	572	259	167	124	124	93	53	37	30
30	57	115	558	259	163	119	118	93	53	35	17
31	68	114	---	228	155	117	119	91	---	39	---
Mean	66	114	555	241	153	118	109	87	50	36	20

JUN 1998 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
100.1	103.0
104.7	107.7
113.1	116.4
111.7	115.0
115.0	118.4
115.1	118.5
113.0	116.4
116.9	120.5
112.3	115.7
111.8	115.3
112.4	115.8
112.2	115.7
110.5	113.9
101.9	105.1
100.4	103.6
104.0	107.3
100.6	103.9
100.1	103.3
98.6	101.8
101.1	104.4
102.0	105.4
100.5	103.8
95.7	98.9
105.3	108.8
106.2	109.7
109.2	112.8
115.2	119.1
122.0	126.1
119.3	123.3
120.9	125.0
108.4	111.8

♦ SUNSPOT COUNTS

In 1848 the Swiss astronomer Johann Rudolph Wolf introduced a daily measurement of sunspot number. His method, which is still used today, counts the total number of spots visible on the face of the Sun and the number of groups into which they cluster, because neither quantity alone satisfactorily measures the level of sunspot activity.

An observer computes a daily sunspot number by multiplying his estimated number of groups by ten and then adding this product to his total count of individual spots. Results, however, vary greatly, since the measurement strongly depends on observer interpretation and experience and on the stability of the Earth's atmosphere above the observing site. Moreover, the use of Earth as a platform from which to record these numbers contributes to their variability, too, because the sun rotates and the evolving spot groups are distributed unevenly across solar longitudes. To compensate for these limitations, each daily international number is computed as a weighted average of measurements made from a network of cooperating observatories. The international sunspot numbers tabulated on page 1 are provisional values taken from a bulletin prepared monthly by Pierre Cugnon of the SUNSPOT INDEX DATA CENTER, 3 avenue Circulaire, B-1180 BRUXELLES, BELGIUM. The July 1998 data combine observations from 36 stations. http://www.oma.be/KSB-ORB/SIDC/index.html.

♦ HISTORICAL SUNSPOT COUNTS

How do sunspot numbers in the table on page 1 compare to the largest values ever recorded? The highest daily count on record occurred December 24-25, 1957. On each of those days the sunspot number totaled 355. In contrast, during years near the spot cycle minimum, the count can fall to zero. Today, much more sophisticated measurements of solar activity are made routinely, but none has the link with the past that sunspot numbers have. Our archives, for example, include reconstructed daily values from January 8, 1818; monthly means from January 1749; and yearly means beginning in 1700.

SMOOTHED (OBSERVED AND PREDICTED) SUNSPOT NUMBERS: CYCLES 22 AND 23

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1988	58	65	71	78	84	94	104	114	121	125	130	138	98
1989	142	145	150	154	157	158	159	158	157	157	158	154	154
1990	151	153	152	149	147	144	141	141	142	142	142	144	146
1991	148	148	147	147	146	145	146	147	145	142	138	132	144
1992	124	115	108	103	100	97	91	84	80	76	74	73	94
1993	71	69	67	64	60	56	55	52	48	45	41	38	56
1994	37	35	34	34	33	31	29	27	27	27	26	26	30
1995	24	23	22	21	19	18	17	15	13	12	11	11	17
1996	10	10	10	9	8*	9	8	8	8	9**	10	10	9
1997	10	11	14	17	18	20	23	25	28	32	35	39	23
1998	44	49	55	60	66	71	78	85	93	99	104	109	76
		(2)	(5)	(8)	(10)	(12)	(14)	(18)	(21)	(23)	(26)	(30)	(14)
1999	114	118	122	128	133	138	142	145	148	151	155	157	137
	(32)	(33)	(32)	(31)	(31)	(32)	(33)	(35)	(37)	(40)	(41)	(43)	(35)
2000	157	156	157	156	154	152	150	149	148	146	143	141	151
	(46)	(49)	(51)	(53)	(53)	(53)	(51)	(52)	(53)	(52)	(52)	(52)	(51)

*May 1996 marks Cycle 22's mathematical minimum.
**October 1996 marks the consensus Cycle 22 minimum which NGDC is now using.

♦ SUNSPOT NUMBER PREDICTIONS

For the end of Solar Cycle 22, and the beginning of Cycle 23, the table gives smoothed sunspot numbers up to the one calculated that first uses the most recently measured monthly mean. These smoothed, observed values are based on final, unsmoothed monthly means through December 1997 and on provisional ones thereafter. We compute a smoothed monthly mean by forming the arithmetic average of two sequential 12-month running means of monthly means.

Table entries with numbers in parentheses below them denote predictions by the McNish-Lincoln method. This method estimates future numbers by adding a correction to the mean of all cycles that is proportional to the departure of earlier values of the current cycle from the mean cycle. (See page 9 in the July 1987 supplement to *Solar-Geophysical Data*). We use and predict only smoothed monthly means, because we believe the errors are too great to estimate any values more precise. In the table above, adding the number in parentheses to the predicted value generates the upper limit of the 90% confidence interval; subtracting the number from the predicted value generates the lower limit. Consider, for example the January 1999 prediction. There exists a 90% chance that in January 1999 the actual smoothed sunspot number will fall somewhere between 82 and 146.

The McNish-Lincoln prediction method generates useful estimates of smoothed, monthly mean sunspot numbers for no more than 12 months ahead. Beyond a year these predictions regress rapidly toward the mean of all 13 cycles used in the computation. Moreover, the method is very sensitive to the date defined as the beginning of the current sunspot cycle, that is, to the date of the most recent sunspot minimum. The new cycle predictions tabulated above are based on the consensus minimum value of 8.8 that occurred in October 1996. For solar maximum discussions, visit http://www.sec.noaa.gov.

Although every effort has been made to ensure that these data are correct, we can assume no liability for any damages their inaccuracies might cause. The charge for a 1-year subscription to this monthly bulletin is US$17.00. To become a subscriber, you may either call (303) 497-6346 or write the NATIONAL GEOPHYSICAL DATA CENTER, Solar-Terrestrial Physics Division (E/GC2), 325 Broadway, Boulder, Colorado 80303 USA. Please include with your written order a cheque or money order payable in U.S. currency to the "Department of Commerce, NOAA/NGDC". Payment may also be made through VISA, MasterCard or American Express credit cards.