SOLAR INDICES BULLETIN

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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.

OCTOBER 1997 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

Day	Sunspot Number Intl	Obs Flux Pentic (2800)	Solar Flux Adjusted to 1 Astronomical Unit: LEAR (15400)	LEAR (8800)	LEAR (4995)	Pentic (2800)	LEAR (2695)	LEAR (1415)	LEAR (610)	LEAR (410)	LEAR (245)
01	25	87	555	214	134	87	84	60	37	26	13
02	21	86	533	212	130	86	81	59	36	22	12
03	21	86	550	216	130	86	84	60	37	27	12
04	21	83	548	216	129	83	84	60	37	27	13
05	21	84	542	213	128	84	79	59	37	---	12
06	18	84	540	217	128	84	80	60	37	---	---
07	17	84	544	214	127	84	80	60	39	25	13
08	16	83	539	217	129	83	81	60	37	30	12
09	20	84	609	210	128	84	81	63	38	26	11
10	22	84	592	215	128	84	82	67	42	29	16
11	24	86	528	214	128	86	82	62	39	27	12
12	25	89	523	214	127	89	84	61	37	26	13
13	34	88	512	217	132	88	87	62	37	---	12
14	27	85	521	212	128	85	85	61	37	27	14
15	26	87	520	215	127	86	82	60	36	30	15
16	34	88	506	216	129	87	84	60	35	24	13
17	40	88	524	218	132	87	85	65	41	---	13
18	35	87	520	213	130	86	85	63	41	30	13
19	25	85	501	217	127	84	83	63	42	31	20
20	21	83	503	218	128	82	81	63	40	---	14
21	20	85	521	217	128	84	80	63	39	29	11
22	9	81	521	216	124	80	78	60	38	23	11
23	0	80	513	214	124	79	78	60	40	26	12
24	10	79	518	212	122	78	76	58	38	18	11
25	11	81	502	212	122	80	76	57	38	28	12
26	11	82	512	214	124	81	79	59	39	29	12
27	32	84	516	216	128	83	81	60	40	31	14
28	33	86	509	218	130	85	84	62	39	46	13
29	30	87	520	217	129	86	83	62	39	33	13
30	38	88	518	212	132	87	85	63	38	32	11
31	35	91	507	206	129	90	84	62	39	32	13
Mean	23.3	85	528	215	128	84	82	61	38	28	13

SEP 1997 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
93.4	95.1
91.7	93.3
93.1	94.7
93.0	94.6
96.0	97.6
97.6	99.1
102.0	103.6
119.4	121.1
116.1	117.7
114.9	116.4
108.6	110.0
109.0	110.3
107.6	108.9
102.5	103.7
98.0	99.1
95.4	96.4
93.1	94.0
88.1	89.0
88.4	89.1
87.7	88.4
85.2	85.8
88.9	89.6
91.7	92.3
92.9	93.5
88.5	88.9
89.1	89.5
88.4	88.8
87.2	87.5
89.7	90.0
87.7	87.9
96.2	97.2

♦ 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 October 1997 data combine observations from 45 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
1987	18	20	22	24	27	28	31	35	39	44	47	51	32
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	9	8	9	9	10	11	9
1997	11	11	14	17	19	21	24	27	30	34	37	41	24
					(1)	(3)	(5)	(7)	(9)	(12)	(15)	(17)	(6)
1998	45	50	54	59	63	67	71	74	77	80	84	87	68
	(20)	(22)	(25)	(28)	(31)	(34)	(37)	(39)	(40)	(39)	(40)	(40)	(33)
1999	91	94	96	98	101	104	105	106	107	109	109	109	102
	(41)	(43)	(43)	(45)	(48)	(50)	(51)	(53)	(56)	(57)	(58)	(59)	(50)

*May 1996 marks Cycle 22's minimum and the onset of Cycle 23.

♦ 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 1996 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 April 1998 prediction. There exists a 90% chance that in April 1998 the actual smoothed sunspot number will fall somewhere between 31 and 87.

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 minimum value of 8.0 that occurred in May 1996. For next solar maximum discussions, visit http://www.sec.noaa.gov.