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.

JULY 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	0	70	---	196	116	72	64	49	37	26	11
02	0	70	---	184	113	72	69	48	26	20	11
03	8	69	---	202	117	71	69	49	36	25	11
04	9	70	---	200	117	72	69	49	36	25	12
05	8	70	---	201	117	72	68	49	36	25	11
06	10	68	---	196	114	70	68	49	37	25	12
07	26	70	---	197	116	72	69	49	36	25	11
08	16	70	---	203	117	72	68	49	36	25	11
09	17	70	---	198	117	72	68	48	36	25	11
10	13	69	---	202	117	71	69	47	35	24	10
11	0	69	---	199	117	71	67	47	36	24	11
12	0	67	---	204	117	69	66	47	35	24	11
13	0	67	---	202	115	69	67	46	34	24	11
14	9	68	---	202	115	70	66	46	33	23	10
15	0	69	---	201	116	71	68	47	34	23	9
16	0	70	---	204	117	72	68	47	34	24	11
17	7	70	---	204	118	72	67	48	34	23	11
18	7	70	---	207	119	72	69	49	35	24	11
19	0	71	---	205	117	73	69	49	35	24	11
20	11	71	---	205	118	73	69	50	35	24	11
21	0	71	---	208	120	73	70	53	36	24	11
22	11	72	---	204	120	74	69	51	36	24	10
23	20	76	---	207	122	78	74	52	36	25	11
24	29	79	---	209	122	82	74	54	36	25	11
25	39	80	---	211	128	83	80	57	41	30	21
26	37	77	---	208	125	79	77	54	37	25	11
27	28	75	---	207	123	77	76	55	36	25	12
28	11	74	---	205	121	76	---	52	35	24	11
29	11	73	527	209	122	75	74	54	35	24	11
30	0	71	531	208	120	73	73	51	36	23	11
31	0	70	526	206	118	72	67	50	35	24	11
Mean	10.5	71	528	203	118	73	70	50	35	24	11

JUNE 1997 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
77.3	79.6
76.9	79.1
75.2	77.4
73.9	76.1
73.9	76.1
74.2	76.4
74.7	76.9
73.2	75.4
73.1	75.3
71.9	74.2
70.8	73.0
69.6	71.8
70.1	72.3
70.6	72.9
70.7	73.0
72.1	74.4
69.6	71.8
71.2	73.5
70.1	72.4
70.2	72.5
67.6	69.8
69.5	71.8
69.0	71.3
69.9	72.2
71.7	74.1
71.8	74.2
71.7	74.1
71.2	73.6
70.2	72.6
69.8	72.1
71.7	74.0

♦ 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 1997 data combine observations from 45 stations.

♦ 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	12	13	15	17	19	22	25	28	31	34	38	22
		(1)	(3)	(4)	(6)	(7)	(10)	(12)	(14)	(17)	(20)	(23)	(10)
1998	42	46	50	55	59	63	66	69	72	75	79	82	63
	(26)	(29)	(32)	(35)	(38)	(41)	(44)	(47)	(48)	(48)	(50)	(51)	(41)
1999	85	88	90	93	95	98	100	101	102	103	104	104	97
	(52)	(54)	(55)	(57)	(60)	(63)	(64)	(65)	(67)	(68)	(68)	(67)	(62)

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

♦ SUNSPOT NUMBER PREDICTIONS

For the end of Solar Cycle 21, and the beginning of Cycle 22, 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 June 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 January 1998 prediction. There exists a 90% chance that in January 1998 the actual smoothed sunspot number will fall somewhere between 16 and 68.

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.