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.

AUGUST 1997 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

	Sunspot	Obs Flux	Solar Flux Adjusted to 1 Astronomical Unit								
	Number	Pentic	LEAR	LEAR	LEAR	Pentic	LEAR	LEAR	LEAR	LEAR	LEAR
Day	Intl	(2800)	(15400)	(8800)	(4995)	(2800)	(2695)	(1415)	(610)	(410)	(245)
01	0	71	403	191	117	73	68	49	27	20	10
02	8	71	521	205	118	73	71	50	35	24	11
03	13	72	525	207	120	74	69	50	35	24	11
04	9	73	513	205	119	75	69	50	35	24	11
05	17	75	529	206	120	77	70	52	35	24	11
06	36	77	537	209	124	79	74	53	36	25	20
07	41	78	532	206	122	80	73	52	35	24	11
08	45	78	536	208	124	80	75	52	36	24	12
09	38	78	530	209	122	80	72	55	35	23	13
10	21	78	533	209	125	80	75	54	35	24	11
11	36	80	531	210	126	82	76	55	37	25	12
12	48	81	531	208	126	83	77	55	36	24	11
13	46	82	528	208	129	84	79	57	36	25	12
14	39	80	543	209	125	82	79	57	37	25	14
15	41	78	533	212	125	80	76	56	37	25	11
16	21	78	542	208	124	80	76	56	37	25	11
17	18	76	540	208	124	78	75	56	37	26	12
18	18	76	538	207	123	78	73	54	37	25	12
19	9	74	533	207	123	76	74	55	36	24	11
20	8	75	525	208	122	77	72	53	36	25	12
21	9	75	534	205	121	77	74	53	36	24	12
22	8	76	540	202	120	78	73	51	35	25	12
23	9	77	532	211	123	79	74	52	35	25	12
24	0	78	539	211	124	80	76	53	34	24	12
25	18	82	536	211	124	84	77	54	36	25	12
26	21	84	522	209	127	86	81	59	36	27	19
27	24	82	533	214	127	84	81	59	37	25	12
28	33	91	539	219	132	93	86	61	38	26	12
29	35	92	521	221	140	94	88	66	39	27	13
30	43	92	537	221	139	94	92	67	39	27	17
31	53	96	540	213	136	98	90	65	39	26	17
Mean	24.7	79	528	209	125	81	76	55	36	25	13

SEP 1997 FINAL FLUX

Observed	Adjusted
Pentic	Pentic
(2800)	(2800)
70.0	72.4
70.1	72.4
69.0	71.4
69.7	72.0
69.7	72.0
68.3	70.6
70.2	72.6
69.8	72.1
70.0	72.3
68.5	70.8
68.6	70.9
67.4	69.6
67.1	69.3
68.1	70.3
69.2	71.5
69.6	71.9
69.9	72.2
70.1	72.3
70.5	72.8
71.2	73.5
71.3	73.6
72.2	74.5
75.7	78.1
78.7	81.2
80.4	83.0
76.6	79.0
74.5	76.8
74.2	76.5
72.7	75.0
71.0	73.2
70.4	72.5
71.1	73.4

♦ 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 August 1997 data combine observations from 48 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	11	13	14	16	18	21	23	26	30	33	36	21
	(0)	(0)	(2)	(3)	(4)	(6)	(8)	(10)	(12)	(15)	(18)	(21)	(8)
1998	40	44	48	52	57	60	63	66	69	72	76	79	61
	(24)	(26)	(30)	(33)	(36)	(39)	(42)	(44)	(45)	(45)	(46)	(47)	(38)
1999	82	84	87	89	92	94	96	97	98	100	100	101	93
	(48)	(50)	(51)	(52)	(56)	(58)	(59)	(61)	(63)	(64)	(64)	(64)	(58)

*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 thee 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 February 1998 prediction. There exists a 90% chance that in February 1998 the actual smoothed sunspot number will fall somewhere between 18 and 70.

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.