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.

SEPTEMBER 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	65	95	529	213	136	93	91	65	39	25	11
02	59	94	534	209	135	92	92	64	38	26	10
03	52	95	547	211	136	93	93	66	38	26	16
04	42	95	541	212	137	93	93	66	40	34	44
05	50	98	496	199	139	96	93	65	39	29	39
06	56	100	538	210	140	98	94	65	39	30	32
07	68	104	544	213	149	102	97	68	41	39	64
08	87	121	542	219	158	119	100	68	45	35	46
09	91	118	545	226	171	116	111	72	44	40	51
10	93	117	539	222	170	115	113	73	44	35	33
11	86	110	544	214	161	109	110	74	42	34	39
12	88	110	545	212	155	109	109	72	41	36	24
13	80	109	555	217	154	108	106	72	41	31	24
14	70	104	539	214	148	103	102	70	40	28	16
15	65	99	549	208	146	98	103	69	40	28	17
16	61	96	538	213	141	95	95	67	38	26	12
17	49	94	537	211	137	93	92	62	37	26	12
18	33	89	549	206	133	88	88	64	39	28	14
19	16	89	549	205	130	88	85	61	37	30	15
20	14	89	551	206	131	88	87	62	38	26	12
21	28	86	556	207	129	85	82	60	38	33	12
22	45	90	548	208	129	89	82	59	36	27	12
23	42	93	540	214	135	92	85	61	37	26	12
24	42	94	553	213	137	93	88	64	39	33	32
25	49	89	553	214	136	89	91	64	38	21	20
26	26	89	552	213	134	89	87	62	44	38	19
27	30	88	548	215	132	88	84	61	38	27	14
28	18	87	552	215	132	87	83	61	39	28	21
29	16	90	549	212	131	90	84	62	39	26	13
30	19	88	552	215	131	88	85	61	37	22	13
31											
Mean	51.3	97	544	212	141	96	94	65	40	30	23

AUG 1997 FINAL FLUX

Observed	Adjusted
Pentic	Pentic
(2800)	(2800)
71.0	73.2
70.8	72.9
72.2	74.3
72.7	74.9
74.8	76.9
76.8	79.0
77.9	80.1
77.8	79.9
78.1	80.3
78.3	80.4
79.5	81.6
80.8	83.0
82.0	84.2
79.5	81.6
77.7	79.6
77.9	79.8
75.6	77.4
75.8	77.7
74.3	76.1
74.6	76.3
74.6	76.3
75.5	77.2
76.5	78.2
77.7	79.4
82.0	83.7
83.8	85.5
81.9	83.5
90.5	92.3
91.5	93.3
92.0	93.8
96.4	98.2
79.0	81.0

♦ 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 September 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	15	17	19	22	25	28	32	35	39	22
				(1)	(3)	(5)	(7)	(8)	(10)	(13)	(16)	(19)	(7)
1998	42	47	51	55	60	63	67	70	73	76	80	83	64
	(22)	(24)	(27)	(30)	(33)	(36)	(39)	(42)	(43)	(42)	(43)	(44)	(35)
1999	86	89	91	93	96	98	100	102	103	104	104	105	98
	(45)	(46)	(47)	(49)	(52)	(54)	(55)	(57)	(59)	(61)	(62)	(61)	(54)

*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 March 1998 prediction. There exists a 90% chance that in March 1998 the actual smoothed sunspot number will fall somewhere between 24 and 78.

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.