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} $J/m^2Hz sec$. 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 Palehua, Hawaii (PALE), data reflect equipment problems. Fluxes measured either at Sagamore Hill, Massachusetts, or at San Vito, Italy, will be substituted for frequencies at which many Palehua values are missing.

JULY 2005 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

Day	Sunspot Number Intl	Obs Flux Pentic (2800)	Solar Flux Adjusted to 1 Astronomical Unit: PALE (15400)	PALE (8800)	PALE (4995)	Pentic (2800)	PALE (2695)	PALE (1415)	PALE (610)	PALE (410)	PALE (245)
01	78	115	505	251	176	118	126	65	46	37	22
02	95	124	496	256	182	128	131	69	57	43	25
03	101	130	507	262	191	134	141	74	46	38	—
04	107	124	509	256	183	128	132	72	42	31	21
05	103	127	491	263	187	131	137	71	44	32	19
06	84	123	505	268	188	127	133	70	41	35	—
07	75	125	511	265	188	129	133	68	47	38	31
08	64	110	504	248	167	113	119	63	41	30	20
09	57	107	375	242	172	110	124	65	51	50	29
10	42	102	469	243	162	105	110	59	37	27	11
11	41	93	489	251	159	96	101	53	36	26	10
12	38	96	513	263	174	99	106	53	43	27	13
13	38	92	507	252	159	95	100	50	34	26	13
14	28	90	477	240	150	92	94	49	33	24	11
15	21	87	495	234	146	89	91	46	34	25	15
16	11	76	477	232	134	78	82	44	35	24	11
17	8	74	482	226	132	76	81	44	33	24	10
18	0	72	491	226	129	74	81	41	33	22	10
19	9	71	481	226	128	73	76	42	32	26	10
20	0	72	494	227	131	74	79	42	33	20	10
21	0	73	419	210	121	75	68	35	34	24	10
22	8	74	491	229	134	76	81	44	26	19	10
23	16	80	473	227	135	82	86	46	33	23	11
24	11	80	497	235	138	82	88	48	35	23	11
25	12	84	497	236	142	86	92	50	37	24	13
26	15	87	491	237	142	89	93	52	36	23	14
27	11	91	495	243	154	93	100	54	40	25	13
28	18	96	386	213	163	98	104	54	41	24	12
29	34	104	480	247	157	107	109	57	40	24	12
30	43	105	500	252	167	108	112	59	38	25	14
31	69	110	477	255	176	113	119	62	35	24	11
Mean	39.9	97	483	242	157	99	104	55	38	28	15

JUNE 2005 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
94.3	96.9
93.3	96.0
95.3	98.0
96.9	99.8
105.4	108.6
106.0	109.2
109.1	112.4
115.7	119.3
116.1	119.7
114.3	117.9
108.0	111.4
103.0	106.3
91.8	94.7
93.8	96.8
94.5	97.5
98.1	101.3
90.8	93.7
90.0	92.9
86.9	89.8
86.1	88.9
82.8	85.5
79.5	82.1
77.5	80.1
76.7	79.2
76.7	79.3
78.7	81.3
77.4	80.0
80.0	82.6
88.9	91.9
102.5	105.9
93.7	96.6

♦ 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 2005 data combine observations from 45 stations. (http://sidc.oma.be)

♦ 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
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	53	57	59	62	65	68	70	71	73	78	62
1999	83	85	84	86	91	93	94	98	103	108	111	111	96
2000	113	117	120	120.7#	119	119	120	119	116	115	113	112	117
2001	109	104	105	108	109	110	112	114	114	114	115	115	111
2002	114	115	113	111	109	106	103	99	95	91	85	82	102
2003	81	79	74	70	68	65	62	60	60	58	57	55	66
2004	52	49	47	46	44	42	40	39	38	36	35	34	42
2005	35	33	32	30	29	28	27	26	25	24	23	22	28
		(3)	(5)	(7)	(8)	(8)	(9)	(9)	(10)	(11)	(11)	(10)	(8)
2006	21	20	20	19	18	18	17	16	15	14	13	13	17
	(10)	(10)	(10)	(11)	(12)	(12)	(12)	(11)	(11)	(11)	(11)	(11)	(11)
2007	12	12	12	12	12	12	13	13	14	15	16	17	13
	(11)	(11)	(11)	(10)	(10)	(11)	(12)	(14)	(15)	(17)	(19)	(21)	(14)

*May 1996 marks Cycle 22's mathematical minimum. **October 1996 marks the consensus Cycle 22 minimum which NGDC is now using.
April 2000 marks Cycle 23 maximun.

♦ 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 March 2005 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 2006 prediction. There exists a 90% chance that in January 2006, the actual smoothed sunspot number will fall somewhere between 11 and 31.

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 80305-3328 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.