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 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.

JUNE 2006 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

	Sunspot	Obs Flux	Solar Flux Adjusted to 1 Astronomical Unit								
Day	Number Intl	Pentic (2800)	PALE (15400)	PALE (8800)	PALE (4995)	Pentic (2800)	PALE (2695)	PALE (1415)	PALE (610)	PALE (410)	PALE (245)
01	21	86	487	238	149	88	92	47	39	24	12
02	17	87	498	242	150	89	95	49	35	28	11
03	19	86	497	243	153	88	98	49	35	28	10
04	20	88	496	241	154	90	101	51	43	35	26
05	19	85	486	227	141	87	90	49	34	27	15
06	20	85	489	236	147	87	92	49	34	23	16
07	20	80	495	234	144	82	89	45	32	23	12
08	19	77	496	231	140	79	85	43	31	23	15
09	17	75	499	228	144	77	84	43	32	25	14
10	8	73	480	229	132	75	82	40	30	22	10
11	8	71	481	227	132	73	77	40	30	21	10
12	7	71	494	232	132	73	78	39	31	21	10
13	0	70	493	228	134	72	78	38	31	21	9
14	8	71	484	226	127	73	76	40	31	23	9
15	9	70	482	226	128	72	76	37	31	20	9
16	11	71	490	226	129	73	77	39	30	20	9
17	12	71	477	227	129	73	77	39	31	21	8
18	12	71	483	224	129	73	78	41	30	20	8
19	13	71	484	223	132	73	78	38	31	21	9
20	8	72	496	226	134	74	79	38	30	24	11
21	0	73	490	227	132	75	80	42	32	22	11
22	8	74	484	224	134	76	79	39	32	22	11
23	10	77	482	230	135	79	85	39	33	22	11
24	11	77	486	230	137	79	84	44	31	23	10
25	10	76	483	228	136	78	83	43	33	25	10
26	10	75	488	228	132	77	81	42	34	25	10
27	10	74	490	225	131	76	81	42	34	21	10
28	9	73	484	225	132	75	80	40	31	20	9
29	9	73	496	228	132	75	79	41	31	21	8
30	17	74	489	228	132	76	81	42	31	26	9
31	15	72	491	228	136	74	80	40	32	22	9
Mean	12.2	76	489	230	136	78	83	42	32	23	11

JUNE 2006 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
77.2	79.4
75.3	77.5
75.9	78.1
75.6	77.8
77.9	80.2
78.0	80.3
82.7	85.2
80.0	82.5
77.6	80.0
76.1	78.5
74.4	76.7
74.2	76.5
77.1	79.5
75.3	77.7
76.4	78.8
75.3	77.7
73.2	75.6
73.3	75.7
73.3	75.7
72.9	75.3
72.7	75.1
72.1	74.4
71.8	74.1
73.6	76.1
74.0	76.5
76.4	79.0
78.5	81.2
83.5	86.3
85.5	88.4
86.1	89.0
80.9	82.7

♦ 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 2006 data combine observations from 58 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	34	34	32	29	29	29	27	26	26	25	23	29
2006	21	20	19	18	18	17	17	16	15	14	13	12	17
		(2)	(3)	(4)	(4)	(5)	(6)	(6)	(7)	(8)	(8)	(8)	(5)
2007	12	12	12	12	12	12	12	13	14	15	16	17	13
	(8)	(8)	(8)	(9)	(9)	(11)	(12)	(14)	(16)	(17)	(19)	(21)	(13)

*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 Dec 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 2007 prediction. There exists a 90% chance that in January 2007, the actual smoothed sunspot number will fall somewhere between 4 and 20.

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.