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 $10^{-22}\ \mathrm{J/m^2 Hz\,sec}$. 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.

MARCH 2006 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

	Sunspot	Obs Flux	Solar Flux Adjusted to 1 Astronomical Unit								
	Number	Pentic	PALE	PALE	PALE	Pentic	PALE	PALE	PALE	PALE	PALE
Day	Intl	(2800)	(15400)	(8800)	(4995)	(2800)	(2695)	(1415)	(610)	(410)	(245)
01	0	77	475	221	131	75	80	41	32	23	8
02	0	76	488	218	132	74	78	42	33	20	9
03	0	76	466	213	129	74	75	40	32	21	9
04	9	75	477	217	129	73	77	40	33	24	10
05	22	74	481	218	126	72	74	40	33	24	10
06	14	74	489	222	129	72	74	40	32	22	9
07	0	74	486	218	126	72	75	41	31	19	9
08	0	72	477	223	126	70	72	40	31	22	9
09	0	73	345	181	115	71	71	37	28	20	9
10	0	72	484	222	128	71	74	38	31	21	9
11	0	74	489	218	128	73	73	39	29	19	9
12	9	73	491	218	131	72	75	38	30	28	13
13	8	73	488	221	128	72	72	38	31	21	10
14	14	74	465	217	128	73	74	39	30	25	9
15	14	74	472	213	127	73	72	39	28	18	9
16	13	72	475	220	127	71	73	39	31	22	7
17	21	72	481	218	128	71	73	39	31	21	9
18	16	72	489	221	129	71	75	39	30	23	9
19	16	75	482	215	129	74	77	39	26	18	9
20	19	77	487	215	135	76	76	40	28	21	9
21	19	77	487	227	133	76	78	42	30	22	9
22	19	76	485	220	131	75	77	40	31	21	9
23	18	77	359	164	101	76	58	34	29	19	9
24	21	76	488	221	130	75	77	40	30	22	9
25	11	76	484	220	131	75	77	41	21	15	9
26	0	74	313	173	114	73	30	37	19	17	9
27	0	74	492	223	132	73	76	42	30	22	9
28	9	79	421	198	128	78	79	41	31	21	12
29	19	82	470	221	134	81	83	44	31	22	12
30	20	84	305	171	118	83	85	43	26	19	10
31	24	86	447	210	133	85	89	47	28	20	11
Mean	10.8	75	459	212	127	74	74	40	30	21	9

FEB 2006 FINAL FLUX

Observed	Adjusted
Pentic	Pentic
(2800)	(2800)
77.6	75.3
77.3	75.1
78.7	76.4
77.0	74.9
76.3	74.2
74.9	72.9
74.0	72.0
74.0	72.0
74.8	72.8
75.2	73.2
76.0	74.1
76.0	74.1
76.3	74.4
77.3	75.4
78.5	76.6
79.2	77.3
79.2	77.3
78.5	76.7
76.5	74.8
76.2	74.5
75.9	74.2
76.0	74.4
75.1	73.6
76.0	74.4
76.0	74.5
76.5	75.0
77.0	75.5
77.1	75.7
76.5	74.7

♦ 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 March 2006 data combine observations from 46 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	25	24	23	29
										(2)	(2)	(3)	(1)
2006	22	21	20	19	19	18	18	17	16	15	14	13	18
	(4)	(6)	(6)	(6)	(7)	(7)	(8)	(9)	(9)	(9)	(9)	(9)	(7)
2007	13	12	12	12	12	12	13	13	14	15	16	17	13
	(9)	(9)	(9)	(9)	(10)	(11)	(12)	(14)	(15)	(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 Mar 2006 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 September 2006 prediction. There exists a 90% chance that in September 2006, the actual smoothed sunspot number will fall somewhere between 7 and 25.

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.