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.

DECEMBER 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	49	98	473	245	155	95	98	52	34	21	10
02	54	106	493	267	184	103	122	62	37	24	11
03	60	101	479	236	150	98	100	58	38	23	10
04	55	95	475	227	145	92	—	52	36	22	11
05	55	92	464	226	141	89	93	50	36	24	11
06	45	89	—	—	—	86	—	—	—	—	—
07	23	89	498	224	135	86	88	46	33	22	12
08	25	90	487	234	141	87	89	47	34	23	12
09	23	89	488	228	142	86	90	47	34	24	13
10	39	91	488	233	147	88	—	48	32	23	15
11	38	93	496	235	142	90	93	50	36	25	12
12	33	88	490	227	137	85	85	47	34	26	16
13	38	88	494	227	137	85	—	48	35	25	24
14	38	90	489	225	139	87	—	48	35	24	11
15	36	87	—	—	—	84	—	—	—	—	—
16	31	86	475	227	138	83	85	46	33	27	15
17	26	85	479	225	135	82	85	44	34	21	12
18	28	86	482	227	139	83	87	45	33	25	28
19	43	90	491	236	141	87	88	47	34	25	22
20	39	88	476	229	140	85	89	48	37	24	12
21	42	87	474	221	136	84	84	46	34	23	12
22	41	88	487	229	146	85	92	49	35	28	16
23	36	93	494	232	142	89	91	50	37	24	15
24	53	92	490	231	144	88	92	52	36	25	15
25	43	92	488	229	142	88	91	53	35	25	12
26	52	93	483	232	143	89	92	54	37	24	11
27	51	92	487	236	142	88	92	54	40	25	12
28	48	89	488	232	143	86	92	54	43	22	11
29	45	90	489	236	144	87	93	57	41	26	11
30	46	90	493	236	142	87	90	54	40	26	10
31	41	87	471	230	139	84	89	53	42	24	11
Mean	41.2	91	485	232	143	88	92	50	36	24	14

NOV 2005 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
77.3	76.1
78.0	76.8
76.8	75.5
77.4	76.1
79.3	77.9
81.7	80.3
79.4	78.0
79.4	77.9
78.1	76.6
77.9	76.4
78.6	77.0
83.1	81.4
87.8	86.0
92.4	90.4
100.0	97.8
94.0	91.8
100.5	98.2
101.1	98.8
102.0	99.6
96.4	94.1
94.7	92.4
92.6	90.3
89.7	87.5
86.6	84.4
79.9	77.9
80.8	78.7
80.7	78.6
81.9	79.7
84.7	82.4
94.7	92.0
86.2	84.4

♦ 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 December 2005 data combine observations from 40 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	28	27	26	25	24	23	29
							(2)	(3)	(4)	(5)	(5)	(6)	(2)
2006	22	21	20	20	19	19	18	17	16	15	14	13	18
	(6)	(7)	(8)	(8)	(9)	(9)	(9)	(9)	(10)	(10)	(10)	(10)	(9)
2007	13	12	12	12	12	12	13	13	14	15	16	17	13
	(9)	(9)	(10)	(9)	(10)	(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 Sep 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 June 2006 prediction. There exists a 90% chance that in June 2006, the actual smoothed sunspot number will fall somewhere between 10 and 28.

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.