SOLAR INDICES BULLETIN

◆ 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/m²Hz 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.

SEPTEMPER 2004 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

Day	Sunspot Number Intl	Obs Flux Pentic (2800)	PALE (15400)	PALE (8800)	PALE (4995)	Pentic (2800)	PALE (2695)	PALE (1415)	PALE (610)	PALE (410)	PALE (245)
01	8	90	244	188	138	91	94	55	39	27	12
02	8	94	471	244	150	95	106	59	37	27	12
03	18	97	494	236	149	98	107	61	39	28	13
04	20	99	502	240	148	100	109	63	38	27	12
05	37	103	505	246	154	104	115	69	41	28	12
06	32	107	467	240	156	108	120	72	42	29	11
07	38	119	516	246	169	120	123	79	—	—	—
08	47	125	—	—	—	126	—	—	—	—	—
09	51	131	414	220	166	132	135	78	44	33	23
10	44	130	504	259	174	131	134	76	44	30	15
11	42	116	501	244	161	117	124	71	40	28	13
12	43	115	506	248	164	116	126	67	43	30	12
13	39	118	—	—	—	119	—	—	—	—	—
14	32	115	499	251	165	116	123	67	42	32	16
15	39	110	497	251	166	111	121	70	43	32	18
16	38	108	495	241	163	109	117	62	45	30	14
17	36	105	500	247	157	106	110	62	41	28	12
18	33	103	507	246	158	103	115	0	42	31	12
19	34	105	504	251	156	105	114	45	45	31	15
20	27	101	504	248	156	101	109	62	40	28	13
21	24	95	492	237	149	95	102	57	39	27	12
22	17	91	491	231	143	91	96	54	37	28	8
23	10	90	494	238	145	90	100	54	39	27	13
24	10	89	499	236	145	89	94	52	34	24	11
25	10	90	491	243	147	90	97	52	38	27	12
26	15	90	504	243	146	90	96	56	38	28	12
27	15	90	487	239	146	90	96	52	36	25	5
28	8	90	491	240	149	90	97	53	35	27	12
29	25	90	493	231	140	90	94	53	37	27	11
30	31	88	474	227	140	88	93	53	36	26	7
Mean	27.7	103	484	240	154	104	110	59	40	28	13

AUG 2004 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
83.4	85.8
84.5	87.0
87.6	90.1
85.4	87.9
88.9	91.5
91.0	93.6
94.6	97.3
104.8	107.7
113.9	117.0
121.4	124.7
130.8	134.3
147.2	151.1
148.6	152.5
149.2	153.1
138.8	142.4
133.6	137.0
135.0	138.3
139.9	143.3
120.6	123.5
121.4	124.2
120.0	122.8
115.2	117.8
109.5	111.9
104.9	107.2
100.4	102.5
97.5	99.5
90.5	92.3
87.2	88.9
86.1	87.7
89.9	91.6
88.1	89.7
110.0	112.7

◆ 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 September 2004 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	45	44	42	40	38	37	36	34	42
				(2)	(4)	(6)	(8)	(11)	(12)	(13)	(15)	(16)	(7)
2005	33	31	30	29	27	26	25	24	24	23	22	21	26
	(17)	(18)	(18)	(19)	(19)	(18)	(18)	(18)	(18)	(18)	(17)	(16)	(18)

*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 June 2004 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 2005 prediction. There exists a 90% chance that in March 2005, the actual smoothed sunspot number will fall somewhere between 12 and 48.

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.