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.

AUGUST 2004 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	23	83	497	237	142	85	93	52	36	28	14
02	28	85	487	237	144	87	94	53	42	35	30
03	30	88	491	240	145	90	94	52	38	28	13
04	33	85	76	208	137	87	93	55	35	30	26
05	21	89	492	234	145	91	99	57	39	29	14
06	33	91	490	240	146	93	101	58	37	28	12
07	44	95	503	243	148	97	104	58	40	28	13
08	39	105	489	249	163	107	115	66	40	29	15
09	50	114	510	266	185	117	127	68	40	38	43
10	58	121	507	272	197	124	134	71	43	35	27
11	63	131	512	276	219	134	146	75	46	36	26
12	68	147	521	272	226	150	153	79	41	40	45
13	76	149	517	293	226	152	158	84	52	41	36
14	68	149	508	297	222	152	156	85	—	—	—
15	61	139	510	299	226	142	157	82	46	32	17
16	54	134	515	296	222	137	151	83	43	32	12
17	44	135	521	294	221	138	153	80	47	33	16
18	41	140	522	279	199	143	144	82	48	32	16
19	36	121	511	269	183	123	132	77	47	30	13
20	50	121	512	262	176	123	131	72	42	31	13
21	57	120	413	252	170	122	127	69	43	34	13
22	66	115	505	258	170	117	126	74	40	29	12
23	56	110	499	248	163	112	117	67	41	29	13
24	38	105	504	255	161	107	109	61	38	28	12
25	31	100	497	247	155	102	109	63	39	28	13
26	24	98	366	221	148	100	105	61	36	27	12
27	21	91	490	238	144	92	97	57	38	26	12
28	20	87	486	238	144	88	94	61	36	26	11
29	16	86	499	238	145	87	95	56	36	26	11
30	10	90	502	236	144	91	98	58	37	27	12
31	9	88	496	231	140	89	95	57	37	27	11
Mean	40.9	110	482	256	173	112	120	67	41	31	18

JUL 2004 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
81.3	84.0
80.7	83.4
79.5	82.2
79.4	82.1
78.2	80.9
78.9	81.6
79.3	81.9
81.8	84.6
86.7	89.6
93.3	96.4
104.4	107.9
125.0	129.2
127.3#	131.6#
138.1	142.6
145.7	150.5
# 1700UT Reading	
146.5	151.3
149.2	154.1
155.1	160.2
170.2	175.8
175.2	180.8
172.2	177.7
172.9	178.4
165.1	170.4
147.2	151.8
139.5*	143.9*
* 2300UT Reading	
128.0	132.0
118.1	121.8
100.7	103.8
99.7	102.8
88.7	91.4
86.4	89.0
118.5	122.4

♦ 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 August 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	48	47	46	45	43	40	39	37	36	35	43
			(2)	(4)	(5)	(6)	(9)	(11)	(13)	(14)	(15)	(17)	(8)
2005	33	32	31	29	28	27	26	25	24	23	22	21	27
	(18)	(18)	(19)	(19)	(19)	(19)	(18)	(18)	(19)	(18)	(18)	(17)	(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 <u>smoothed</u> 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 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 January 2005, the actual smoothed sunspot number will fall somewhere between 16 and 52.

<u>The McNish-Lincoln prediction method generates useful estimates of smoothed, monthly mean sunspot numbers for no more than 12 months ahead.</u> 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.