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.

OCTOBER 2002 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	58	140	513	293	246	140	129	195	51	38	--
02	70	136	493	287	184	136	116	87	49	33	5
03	67	146	515	282	184	146	127	93	46	34	16
04	60	158	465	308	214	158	141	96	58	43	20
05	76	155	535	302	206	155	138	104	52	44	36
06	81	162	547	324	214	161	152	116	55	41	25
07	79	164	532	334	222	163	153	123	57	36	40
08	101	165	537	317	211	164	158	117	56	37	32
09	106	167	534	316	217	166	150	107	52	35	17
10	129	172	538	325	224	171	159	118	53	37	26
11	121	179	541	337	236	178	165	118	56	37	17
12	122	180	442	305	218	179	144	109	54	36	22
13	119	179	595	333	225	178	161	156	56	41	41
14	114	181	517	315	221	180	165	119	54	41	19
15	116	177	517	281	207	175	153	120	52	37	18
16	128	183	522	306	216	181	159	119	60	81	60
17	110	179	400	215	166	177	155	106	51	38	23
18	118	173	520	300	223	171	166	119	54	41	33
19	120	180	520	309	229	178	166	108	55	46	30
20	122	180	527	309	234	178	162	116	50	46	26
21	93	183	522	325	229	181	155	112	56	53	18
22	88	169	518	305	220	167	150	113	--	--	45
23	77	164	520	299	211	162	146	102	57	56	41
24	73	160	534	290	205	158	150	120	55	53	61
25	77	173	538	303	207	170	152	105	54	57	--
26	81	158	515	295	202	156	142	104	51	44	25
27	84	157	525	301	205	154	138	102	50	38	28
28	87	158	518	296	214	155	143	102	51	44	17
29	114	162	535	316	220	159	143	105	52	39	21
30	120	168	531	317	221	165	156	107	54	39	27
31	110	170	532	307	218	167	149	103	54	39	21
Mean	97.5	167	519	305	214	165	150	114	54	43	28

SEPT 2002 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
180.5	183.8
173.8	176.9
171.4	174.4
171.3	174.2
175.2	178.1
178.1	180.9
182.8	185.6
191.6	194.4
206.0	209.0
220.5	223.5
216.1	219.0
212.4	215.1
206.1	208.6
206.9	209.2
187.8	189.9
182.6	184.5
194.0	195.9
176.8	178.4
165.3	166.7
164.4	165.8
158.6	159.8
160.0	161.1
153.8	154.8
157.9	158.9
153.4	154.2
149.9	150.6
151.6	152.2
148.6	149.1
138.1	138.6
139.7	140.1
175.8	177.8

♦ 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
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 October 2002 data combine observations from 38 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
1992	124	115	108	103	100	97	91	84	80	76	74	73	94
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	121	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	108	105	102	99	96	93	90	86	103
					(5)	(4)	(7)	(8)	(9)	(12)	(12)	(11)	(6)
2003	82	79	76	74	70	68	66	64	62	59	57	56	68
	(9)	(9)	(9)	(11)	(11)	(11)	(11)	(11)	(12)	(14)	(15)	(17)	(12)
2004	55	54	53	52	50	49	46	43	41	40	39	37	47
	(19)	(21)	(21)	(21)	(22)	(22)	(22)	(23)	(24)	(25)	(25)	(26)	(23)

*May 1996 marks Cycle 22's mathematical minimum.
**October 1996 marks the consensus Cycle 22 minimum which NGDC is now using.

♦ 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 2002 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 April 2003 prediction. There exists a 90% chance that in April 2003 the actual smoothed sunspot number will fall somewhere between 63 and 85.

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.