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 2000 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	115	202	584	320	219	202	174	166	78	60	---
02	164	203	571	327	219	203	167	162	---	63	---
03	159	192	580	315	217	192	182	162	84	57	21
04	150	184	581	311	210	184	180	161	81	54	19
05	128	174	577	296	190	174	164	152	75	49	18
06	97	158	---	---	---	157	---	---	---	---	---
07	71	156	572	297	183	155	148	136	71	47	18
08	72	149	578	288	177	148	144	126	73	47	17
09	71	141	581	293	181	140	135	120	72	47	19
10	57	140	530	256	143	139	139	114	70	50	22
11	82	151	572	299	185	150	136	126	74	51	19
12	122	163	563	301	194	162	147	132	64	44	19
13	121	168	589	312	202	167	161	140	71	46	17
14	104	163	584	308	196	162	153	136	71	46	---
15	89	161	596	312	192	160	145	142	71	46	18
16	92	161	584	301	188	159	146	134	70	---	17
17	97	154	577	307	189	152	145	139	70	46	17
18	95	151	---	---	---	149	---	---	---	---	---
19	90	158	546	295	183	156	146	135	74	47	22
20	94	161	584	295	185	159	161	141	78	49	18
21	97	158	581	293	186	156	145	145	78	48	18
22	89	160	571	297	189	158	148	145	80	50	19
23	85	167	581	296	185	165	152	143	77	50	21
24	82	159	546	289	180	157	145	142	72	45	18
25	88	164	569	304	187	162	158	148	72	45	15
26	73	171	569	298	198	168	156	140	70	44	17
27	80	176	583	306	201	173	160	149	73	45	17
28	106	182	588	313	212	179	169	157	79	49	18
29	113	187	583	315	214	184	168	153	83	55	34
30	108	194	581	310	211	191	181	164	78	50	20
31	111	193	574	298	204	190	192	170	77	50	20
Mean	100.1	168	575	302	194	166	157	144	74	49	20

SEP 2000 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
157.7	160.5
154.0	156.7
154.1	156.7
170.8	173.6
180.2	183.1
178.7	181.5
173.2	175.8
163.4	165.7
150.9	153.0
140.6	142.5
134.9	136.7
132.6	134.2
133.2	134.8
150.8	152.5
159.4	161.1
174.6	176.4
181.5	183.2
203.8	205.7
207.1	208.8
211.4	213.1
225.1	226.7
232.2	233.8
225.2	226.7
224.5	225.8
225.6	226.8
223.6	224.7
204.7	205.5
202.3	203.0
192.0	192.6
193.6	194.0
182.1	183.8

♦ 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 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 October 2000 data combine observations from 37 stations. http://www.oma.be/KSB-ORB/SIDC/index.html.

♦ 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
1990	151	153	152	149	147	144	141	141	142	142	142	144	146
1991	148	148	147	147	146	145	146	147	145	142	138	132	144
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	102	108	111	111	95
2000	113	117	120	121	121 (4)	121 (7)	121 (11)	121 (17)	120 (21)	119 (24)	118 (28)	117 (30)	119 (12)
2001	117 (31)	117 (33)	116 (34)	116 (37)	115 (39)	115 (38)	114 (36)	112 (36)	112 (37)	110 (37)	109 (36)	108 (35)	113 (36)

*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 March 2000 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 2001 prediction. There exists a 90% chance that in April 2001 the actual smoothed sunspot number will fall somewhere between 79 and 153.

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.