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.

JULY 2001 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	74	135	554	294	173	139	139	127	66	42	15
02	83	134	535	300	180	138	129	97	52	35	17
03	80	132	538	297	174	136	123	100	53	36	16
04	71	127	537	297	175	131	122	97	53	36	18
05	62	120	533	293	169	124	123	84	53	37	18
06	45	116	535	284	165	119	116	91	52	35	17
07	47	118	532	290	169	122	115	91	52	35	17
08	54	126	538	296	177	130	120	92	51	35	18
09	71	130	498	290	179	134	124	83	53	44	18
10	70	130	541	284	173	134	118	94	51	35	23
11	69	132	545	294	181	136	127	94	49	34	17
12	90	134	---	---	---	138	---	---	---	---	---
13	111	133	549	301	181	137	126	98	50	35	51
14	99	141	580	298	184	145	142	134	67	43	17
15	102	142	547	305	194	146	134	101	50	35	17
16	113	150	547	315	202	154	148	110	55	39	26
17	123	146	547	315	202	150	148	110	55	39	26
18	127	143	550	302	191	147	142	107	53	35	19
19	122	142	546	294	186	146	141	106	52	37	20
20	118	143	547	313	199	147	138	104	51	34	18
21	96	139	548	305	195	143	140	101	51	35	18
22	100	140	527	295	191	144	143	96	50	37	20
23	101	143	635	306	220	147	125	94	49	35	18
24	96	133	540	298	183	137	126	93	50	38	27
25	79	133	539	294	183	137	129	93	51	41	43
26	66	123	524	293	173	126	---	87	48	35	35
27	60	121	532	292	167	124	112	87	49	36	26
28	63	116	530	277	161	119	108	84	47	34	18
29	46	117	531	286	164	120	109	87	47	35	18
30	57	115	512	277	163	118	109	83	48	36	18
31	52	117	450	270	162	120	116	84	50	35	18
Mean	82.2	131	539	295	181	135	127	97	52	37	22

JUN 2001 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
133.0	136.8
134.0	137.8
145.3	149.5
153.8	158.3
153.4	158.0
157.7	162.4
164.8	169.8
180.2	185.7
177.0	182.4
163.0	168.0
162.4	167.4
166.4	171.6
181.4	187.1
194.7	200.9
196.9	203.2
207.6	214.3
204.6	211.2
221.3	228.5
195.4	201.7
198.5	205.0
200.3	206.9
203.6	210.3
206.2	213.0
194.8	201.3
182.4	188.4
167.9	173.5
147.9	152.8
140.2	144.9
139.9	144.6
136.6	141.2
173.7	179.2

♦ 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 July 2001 data combine observations from 39 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
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	103	108	111	111	96
2000	113	117	120	121	119	119	120	119	116	115	113	112	117
2001	109	109 (3)	108 (6)	108 (11)	108 (16)	107 (16)	106 (16)	105 (18)	104 (20)	103 (21)	102 (21)	101 (22)	106 (14)
2002	100 (21)	99 (22)	97 (22)	95 (23)	93 (22)	91 (21)	88 (20)	86 (20)	83 (20)	81 (20)	78 (19)	75 (17)	89 (21)

*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 2001 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 2002 prediction. There exists a 90% chance that in January 2002 the actual smoothed sunspot number will fall somewhere between 79 and 121.

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.