SOLAR INDICES BULLETIN

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NATIONAL GEOPHYSICAL DATA CENTER
Solar-Terrestrial Physics Division (E/GC2)
Telephone (303) 497-6346

325 Broadway
Boulder, Colorado 80305-3328 USA
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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.

JUNE 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	58	133	559	301	176	136	136	127	65	43	17
02	99	134	572	298	175	137	136	123	67	43	21
03	99	145	577	316	186	149	145	130	67	44	19
04	96	154	270	295	196	158	146	125	69	44	20
05	106	153	558	311	191	157	155	132	66	42	36
06	119	158	577	321	200	162	156	138	65	50	26
07	129	165	584	329	206	169	176	149	73	47	18
08	142	180	588	295	211	185	160	153	79	57	33
09	168	177	579	345	220	182	185	156	76	65	48
10	159	163	---	---	---	168	---	---	---	---	---
11	173	162	572	311	199	167	135	144	70	51	18
12	171	166	595	325	211	171	162	142	67	43	16
13	160	181	602	348	229	186	191	156	76	49	22
14	180	195	600	342	233	201	206	163	76	51	27
15	186	197	580	352	244	203	212	159	77	53	30
16	191	208	593	358	253	214	192	168	73	77	21
17	178	205	582	299	235	211	224	165	75	47	26
18	153	221	611	369	255	228	245	183	75	47	28
19	141	195	589	339	234	201	200	171	75	45	18
20	136	199	363	309	228	205	194	156	77	45	18
21	144	200	591	332	225	206	202	168	75	24	18
22	151	204	---	---	---	210	---	---	---	---	---
23	155	206	592	347	234	212	209	165	74	35	26
24	145	195	595	341	227	201	212	166	75	53	33
25	131	182	584	332	215	188	191	155	71	46	23
26	114	168	589	326	196	173	169	149	70	43	14
27	107	148	582	313	184	153	149	144	70	44	16
28	89	140	572	303	174	144	136	130	67	43	16
29	74	140	574	304	174	144	136	133	65	42	16
30	65	137	570	299	172	141	138	116	65	42	15
31											
Mean	134.0	174	564	324	210	179	175	149	71	47	23

MAY 2001 FINAL FLUX

Day	Observed Pentic (2800)	Adjusted Pentic (2800)
01	184.5#	187.4#
02	176.2	179.0
03	172.3	175.1
04	175.6	178.6
05	160.6	163.5
06	155.0	157.8
07	138.3	140.9
08	128.7	131.1
09	129.4	131.9
10	130.4	133.0
	# 1700UT Reading	
11	136.6	139.4
12	138.1	141.0
13	138.9	141.9
14	138.2	141.2
15	142.1	145.2
16	137.8	140.9
17	147.4	150.8
18	138.2	141.5
19	141.3	144.6
20	141.5	144.9
21	150.1	153.8
22	152.0	155.8
23	158.7	162.8
24	170.3	174.7
25	161.9	166.1
26	147.4	151.3
27	146.9	150.8
28	143.0	146.9
29	138.5	142.3
30	132.3	136.0
31	132.8	136.6
Mean	147.9	152.0

♦ 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 June 2001 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
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	112 (3)	112 (6)	112 (8)	111 (13)	111 (17)	110 (18)	109 (18)	108 (19)	107 (22)	106 (23)	105 (23)	104 (23)	109 (16)
2002	103 (22)	102 (23)	100 (23)	97 (23)	95 (22)	93 (21)	90 (20)	88 (20)	85 (20)	83 (20)	80 (19)	77 (17)	91 (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 December 2001 prediction. There exists a 90% chance that in December 2001 the actual smoothed sunspot number will fall somewhere between 81 and 127.

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.