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.

AUGUST 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	62	120	367	283	165	123	113	86	51	35	13
02	81	121	535	290	168	124	115	84	50	35	18
03	93	132	359	284	182	135	124	89	51	34	---
04	115	148	549	300	203	152	145	99	52	35	18
05	130	156	534	346	229	160	153	100	51	39	24
06	120	164	555	353	226	168	153	111	54	42	---
07	118	166	552	304	214	170	152	113	52	36	21
08	117	167	555	337	225	171	152	110	54	37	21
09	104	163	545	326	217	167	151	112	54	39	23
10	99	160	545	326	217	164	151	112	54	39	---
11	112	165	553	335	225	169	158	115	58	40	21
12	112	160	552	323	211	164	151	110	59	40	18
13	91	152	547	261	179	155	137	108	58	38	18
14	93	147	539	308	191	150	138	106	55	38	18
15	106	147	534	291	189	150	140	106	55	36	18
16	127	143	537	293	181	146	134	103	53	36	19
17	117	145	549	308	192	148	136	102	52	36	20
18	106	156	548	317	205	159	154	103	52	35	18
19	100	158	543	312	201	161	147	104	53	39	19
20	101	156	550	318	206	159	148	105	51	35	18
21	110	160	551	304	201	163	145	105	53	26	17
22	112	162	536	316	207	165	147	104	53	35	19
23	119	170	559	323	218	173	162	109	53	35	19
24	116	175	466	352	233	178	173	111	52	34	17
25	92	199	544	298	202	203	180	115	55	50	22
26	101	190	589	350	241	193	178	121	56	42	26
27	119	192	556	299	222	196	166	114	56	43	89
28	128	199	559	318	234	202	176	126	54	37	19
29	96	197	573	338	241	200	184	123	55	30	19
30	99	199	560	337	237	202	184	127	56	37	32
31	115	189	559	331	226	192	177	123	58	39	22
Mean	106.8	165	541	317	211	168	154	109	54	37	23

JUL 2001 FINAL FLUX

Day	Observed Pentic (2800)	Adjusted Pentic (2800)
01	135.4	140.0
02	134.3	138.8
03	131.9	136.3
04	127.0	131.3
05	119.6	123.6
06	116.4	120.3
07	117.8	121.8
08	126.3	130.5
09	130.0	134.4
10	130.0	134.3
11	131.9	136.3
12	133.9	138.3
13	133.3	137.7
14	140.8	145.4
15	142.1	146.8
16	149.8	154.7
17	145.6	150.4
18	143.0	147.7
19	142.3	146.9
20	142.6	147.2
21	139.0	143.5
22	140.4	144.9
23	143.2	147.8
24	132.5	136.7
25	133.3	137.5
26	123.4	127.2
27	121.4	125.1
28	115.5	119.0
29	116.9	120.5
30	114.5	118.0
31	116.8	120.3
Mean	131.3	135.6

♦ 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 August 2001 data combine observations from 36 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	104	104 (3)	103 (9)	103 (14)	102 (15)	101 (15)	101 (16)	100 (18)	99 (19)	98 (19)	97 (20)	102 (12)
2002	96 (20)	95 (20)	93 (22)	92 (22)	90 (21)	87 (20)	85 (20)	83 (20)	80 (20)	78 (20)	76 (20)	73 (18)	86 (20)

*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 February 2002 prediction. There exists a 90% chance that in February 2002 the actual smoothed sunspot number will fall somewhere between 75 and 115.

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.

Although every effort has been made to ensure that these data are correct, we can assume no liability for any damages their inaccuracies might cause. The charge for a 1-year subscription to this monthly bulletin is US$17.00. To become a subscriber, you may either call (303) 497-6346 or write the NATIONAL GEOPHYSICAL DATA CENTER, Solar-Terrestrial Physics Division (E/GC2), 325 Broadway, Boulder, Colorado 80305-3328 USA. Please include with your written order a cheque or money order payable in U.S. currency to the "Department of Commerce, NOAA/NGDC". Payment may also be made through VISA, MasterCard or American Express credit cards.