SOLAR INDICES BULLETIN

JULY 2002

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 $10^{-22}\ J/m^2Hz\,sec$. 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 2002 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

	Sunspot	Obs Flux	Solar Flux Adjusted to 1 Astronomical Unit								
	Number	Pentic	PALE	PALE	PALE	Pentic	PALE	PALE	PALE	PALE	PALE
Day	Intl	(2800)	(15400)	(8800)	(4995)	(2800)	(2695)	(1415)	(610)	(410)	(245)
01	58	147	---	---	---	151	---	---	---	---	---
02	61	149	544	341	216	154	137	100	54	39	---
03	80	173	532	348	232	178	153	111	55	40	26
04	82	146	532	317	199	150	137	117	55	37	24
05	88	139	530	317	190	143	127	108	50	36	28
06	75	134	511	313	184	138	122	94	51	37	21
07	66	137	529	307	184	141	129	93	51	35	20
08	63	131	490	299	183	135	122	103	47	29	18
09	68	136	495	307	186	140	122	92	46	31	20
10	64	129	---	---	---	133	---	---	---	---	---
11	61	136	520	317	195	140	124	90	46	33	20
12	52	133	498	298	189	137	119	90	47	34	19
13	72	135	507	287	181	139	119	93	47	41	21
14	78	144	---	---	---	148	---	---	---	---	---
15	96	160	595	352	256	165	161	122	53	39	31
16	99	172	536	370	262	177	160	106	53	39	---
17	91	180	535	354	254	185	158	140	66	71	89
18	92	181	537	336	245	186	171	124	55	53	41
19	83	182	518	331	246	188	161	107	59	46	40
20	77	185	585	367	273	191	175	145	56	56	72
21	77	183	523	343	252	188	173	111	54	45	45
22	91	190	549	355	255	196	182	137	56	45	57
23	121	198	552	362	270	204	176	144	60	57	---
24	129	208	528	344	263	214	---	121	57	53	---
25	133	218	578	366	286	224	202	126	60	47	---
26	164	242	572	388	339	249	239	150	59	86	---
27	182	231	543	376	306	238	213	191	63	53	---
28	192	239	556	380	321	246	230	133	57	53	---
29	181	234	541	368	318	241	220	151	62	93	---
30	174	227	543	354	299	234	211	122	56	56	---
31	148	209	527	343	286	215	198	124	56	48	42
Mean	99.9	174	536	341	245	180	164	119	55	48	35

JUNE 2002 FINAL FLUX

Observed	Adjusted
Pentic	Pentic
(2800)	(2800)
178.8	183.9
174.9	180.0
170.4	175.4
169.8	174.7
159.0	163.7
154.5	159.1
158.3	163.1
155.2	159.9
157.1	161.9
151.6	156.2
147.8	152.4
141.7	146.2
133.4	137.6
131.4	135.6
135.3	139.7
136.7	141.0
142.9	147.5
142.9	147.5
145.8	150.5
145.1	149.8
139.6	144.2
142.0	146.6
142.8	147.5
150.3	155.3
144.7	149.5
143.8	148.6
138.6	143.2
137.3	141.9
142.7	147.5
146.5	151.4
148.7	153.4

♦ 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 2002 data combine observations from 40 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
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	105	108	109	110	112	114	114	114	115	115	111
2002	114	112 (4)	109 (7)	107 (10)	104 (12)	101 (13)	98 (13)	95 (14)	92 (15)	90 (16)	87 (16)	83 (14)	99 (11)
2003	80 (11)	76 (10)	74 (11)	72 (12)	69 (12)	66 (12)	64 (13)	62 (13)	60 (15)	57 (16)	56 (17)	54 (20)	66 (14)

*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 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 January 2003 prediction. There exists a 90% chance that in January 2003 the actual smoothed sunspot number will fall somewhere between 69 and 91.

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.