SOLAR INDICES BULLETIN

APRIL 2001

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

325 Broadway
Boulder, Colorado 80303 USA
ISSN 1046-1914

♦ 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.

APRIL 2001 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

	Sunspot	Obs Flux	Solar Flux Adjusted to 1 Astronomical Unit								
Day	Number Intl	Pentic (2800)	PALE (15400)	PALE (8800)	PALE (4995)	Pentic (2800)	PALE (2695)	PALE (1415)	PALE (610)	PALE (410)	PALE (245)
01	186	258	---	---	---	257	---	---	---	---	---
02	166	228	671	442	332	227	265	228	116	100	---
03	169	223	629	390	278	223	206	176	89	50	23
04	134	205	618	363	244	205	183	162	76	51	19
05	133	210	645	385	261	210	217	190	89	54	17
06	110	192	407	301	218	192	154	160	110	205	143
07	110	180	584	336	216	180	170	144	72	45	24
08	115	169	581	325	203	169	147	143	72	48	22
09	110	165	592	325	194	165	161	144	74	48	64
10	114	170	584	315	202	170	150	129	72	56	25
11	115	160	576	316	198	160	127	121	66	44	24
12	103	149	554	274	167	149	133	117	62	---	20
13	98	137	570	302	171	137	125	111	59	42	22
14	92	139	565	294	170	139	123	114	62	45	61
15	75	134	576	298	170	134	114	111	62	42	16
16	63	123	569	290	160	123	112	102	---	---	---
17	28	126	581	310	178	127	141	103	59	39	16
18	38	132	560	305	179	133	128	110	63	50	---
19	62	145	576	304	186	146	127	120	64	50	23
20	86	180	578	327	206	181	153	134	69	35	33
21	116	191	587	333	229	192	172	154	78	47	17
22	109	193	587	337	274	195	234	168	78	60	26
23	106	196	572	329	217	198	169	161	72	61	62
24	109	194	595	335	230	196	178	165	75	55	---
25	119	194	570	322	218	196	180	154	75	51	53
26	119	196	601	338	226	198	197	164	74	48	33
27	128	191	504	333	215	193	159	148	72	45	22
28	107	188	596	342	227	190	194	154	72	44	19
29	113	192	596	342	227	194	194	154	72	44	19
30	112	188	594	298	215	190	172	147	74	45	20
31											
Mean	108.2	178	580	328	214	179	165	144	74	56	33

MAR 2001 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
131.4	129.0
129.7	127.4
139.6	137.3
141.0	138.7
155.8	153.4
157.8	155.4
176.6	174.0
167.2	164.8
161.4	159.2
160.1	158.0
157.8	155.8
157.6	155.7
147.3	145.6
142.2	140.7
136.1	134.7
139.9	138.5
134.2	132.9
139.8	138.5
147.0	145.7
153.3	152.1
159.4	158.2
183.0	181.8
180.0	178.9
218.7	217.5
216.8	215.7
263.7	262.6
273.4	272.4
273.5	272.6
261.7	261.0
256.8	256.3
245.6	245.3
177.7	176.1

♦ 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 April 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	114	113	117
											(6)	(9)	(1)
2001	113	113	113	112	112	111	110	109	108	107	106	105	110
	(11)	(14)	(16)	(19)	(23)	(23)	(22)	(23)	(25)	(26)	(26)	(25)	(21)
2002	104	103	100	98	96	93	91	88	86	83	81	78	92
	(25)	(25)	(25)	(24)	(23)	(23)	(22)	(21)	(21)	(20)	(19)	(18)	(22)

*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 December 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 October 2001 prediction. There exists a 90% chance that in Octobe 2001 the actual smoothed sunspot number will fall somewhere between 81 and 133.

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 80303 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.