SOLAR INDICES BULLETIN

MAY 2002

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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.

MAY 2002 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	102	162	480	331	227	164	161	114	---	---	---
02	114	169	481	362	242	171	176	127	57	41	21
03	149	179	357	351	235	182	168	124	57	39	63
04	166	190	549	355	246	193	180	124	60	41	49
05	172	180	604	338	232	183	168	124	---	---	---
06	149	191	586	349	263	194	189	144	65	47	33
07	157	187	508	334	231	190	169	133	63	55	43
08	142	187	386	329	226	190	167	126	57	49	34
09	126	190	540	354	245	193	186	134	61	43	21
10	133	191	527	356	254	194	173	121	60	46	20
11	138	188	555	359	268	191	188	128	61	50	42
12	130	183	531	347	242	186	162	121	60	42	52
13	104	172	---	338	222	175	156	111	60	43	20
14	76	161	509	313	205	164	143	111	56	43	22
15	74	159	---	---	---	162	---	---	---	---	---
16	84	158	509	330	213	161	143	107	55	41	39
17	86	157	504	337	284	160	154	113	54	40	7
18	93	163	540	328	231	166	149	110	55	61	14
19	93	171	417	337	241	175	160	116	---	---	---
20	107	171	398	325	234	175	153	111	51	37	---
21	121	186	328	353	264	190	187	123	56	40	6
22	137	181	512	329	240	185	180	125	55	37	14
23	136	180	550	339	229	184	168	119	57	39	20
24	128	189	525	324	229	193	168	120	56	38	20
25	127	183	534	325	222	187	162	110	54	39	---
26	121	183	542	333	238	187	171	115	55	39	12
27	123	187	534	350	250	192	174	127	57	38	17
28	119	186	551	365	255	191	176	128	59	40	16
29	114	185	566	359	255	190	169	135	60	41	18
30	103	180	553	345	248	185	173	143	59	41	19
31	120	182	542	353	251	187	184	132	58	43	17
Mean	120.8	178	508	342	241	182	169	123	58	43	21

APR 2002 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
207.0	206.7
206.0	205.9
209.4	209.4
216.2	216.3
217.4	217.6
206.3	206.7
207.9	208.4
206.2	206.8
205.0	205.8
194.3	195.1
197.4	198.3
211.9	213.0
226.0	227.3
210.3	211.6
203.3	204.7
195.7	197.2
193.5	195.0
188.2	189.8
179.7	181.4
177.3	179.0
173.4	175.1
169.9	171.7
175.3	177.2
176.9	178.9
167.3	169.3
162.6	164.7
156.9	159.0
147.1	149.2
153.0	155.2
153.4	155.6
189.8	191.1

♦ 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 May 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	114	110
												(4)	0
2002	113	112	109	106	103	101	98	95	92	89	86	83	99
	(9)	(12)	(14)	(16)	(17)	(17)	(18)	(18)	(19)	(20)	(19)	(16)	(16)
2003	79	76	74	71	68	66	64	62	60	57	55	54	66
	(13)	(12)	(12)	(13)	(13)	(14)	(14)	(15)	(16)	(17)	(19)	(21)	(15)

*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 October 2002 prediction. There exists a 90% chance that in November 2002 the actual smoothed sunspot number will fall somewhere between 67 and 105.

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.