SOLAR INDICES BULLETIN

FEBRUARY 2005

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

325 Broadway
Boulder, Colorado 80305-3328 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 $10^{-22}\ \mathrm{J/m^2 Hz\,sec}$. 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.

FEBRUARY 2005 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	19	84	493	225	140	81	86	45	36	25	11
02	17	82	456	211	137	79	84	44	32	24	10
03	11	83	482	221	138	80	83	44	29	22	10
04	15	82	478	229	142	79	88	47	35	24	10
05	16	95	474	237	144	92	96	51	34	25	10
06	38	97	488	237	147	94	99	51	33	25	11
07	38	103	502	242	152	100	105	55	38	33	11
08	35	108	508	245	159	105	110	58	37	26	12
09	39	109	489	236	158	106	108	62	39	27	13
10	48	114	495	241	164	111	114	63	40	27	12
11	52	114	492	245	163	111	115	65	42	30	31
12	56	116	491	241	171	112	120	66	43	32	33
13	48	116	519	253	172	113	118	65	44	39	—
14	48	118	—	254	173	115	117	65	45	33	20
15	52	122	—	253	177	118	117	65	43	29	25
16	45	113	—	247	171	110	112	60	40	32	22
17	43	111	497	254	172	108	109	58	37	30	31
18	37	104	496	299	164	101	106	56	48	66	—
19	31	99	497	237	156	96	99	53	41	27	12
20	22	96	500	237	150	93	94	51	39	27	13
21	20	95	504	236	153	92	96	48	37	29	20
22	20	92	499	239	152	89	93	48	37	32	15
23	16	85	485	—	—	83	—	—	38	26	11
24	11	80	467	223	132	78	80	43	34	24	10
25	15	78	474	226	134	76	80	41	33	24	10
26	8	77	492	222	132	75	79	41	32	24	6
27	8	76	498	225	131	74	77	41	32	24	10
28	7	75	482	212	124	73	74	42	31	22	9
Mean	29.1	97	490	238	152	94	98	53	37	29	15

JAN 2005 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
98.9	95.6
100.0	96.7
94.2	91.0
88.0	85.1
88.2	85.3
83.2	80.4
83.5	80.7
88.5	85.6
87.5	84.6
90.1	87.1
94.2	91.1
102.1	98.8
115.6	111.9
129.8	125.6
144.9	140.2
144.5	139.8
137.5	133.1
124.3	120.3
132.5	128.3
122.7	118.8
113.5	109.9
102.2	99.1
95.8	92.8
94.6	91.7
94.1	91.2
89.3	86.6
86.9	84.3
84.9	82.4
86.4	83.9
85.5	82.9
86.2	83.6
102.2	99.0

♦ 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 and experience and on the stability of the Earth's atmosphere above 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 February 2005 data combine observations from 46 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
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	120.7#	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	115	113	111	109	106	103	99	95	91	85	82	102
2003	81	79	74	70	68	65	62	60	60	58	57	55	66
2004	52	49	47	46	44	42	40	39	37	36	35	34	42
									(3)	(4)	(6)	(8)	(2)
2005	32	31	30	28	27	26	25	24	23	22	21	21	26
	(10)	(11)	(12)	(13)	(13)	(13)	(13)	(14)	(14)	(14)	(14)	(13)	(13)
2006	20	19	18	17	17	16	15	15	14	13	12	12	16
	(12)	(12)	(13)	(13)	(14)	(14)	(13)	(13)	(12)	(12)	(12)	(12)	(13)

*May 1996 marks Cycle 22's mathematical minimum. **October 1996 marks the consensus Cycle 22 minimum which NGDC is now using.
April 2000 marks Cycle 23 maximun.

♦ 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 2004 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 August 2005 prediction. There exists a 90% chance that in August 2005, the actual smoothed sunspot number will fall somewhere between 10 and 38.

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.