SOLAR INDICES BULLETIN

MARCH 2005

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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 $10^{-22}\ \mathrm{J/m^2 Hz sec}$. 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.

MARCH 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	7	74	460	222	128	72	76	39	30	26	10
02	8	75	479	224	129	73	76	40	34	25	9
03	9	77	502	226	134	75	79	41	32	26	10
04	8	79	497	225	134	77	81	42	33	24	10
05	9	81	488	228	136	79	83	43	33	24	8
06	10	84	487	226	140	82	88	45	34	24	10
07	18	87	493	231	142	85	91	47	34	23	9
08	33	94	477	226	147	92	97	50	34	24	10
09	38	100	504	235	150	98	104	55	36	25	10
10	41	102	501	241	156	100	104	56	38	28	10
11	43	105	505	240	156	103	107	59	41	29	11
12	42	110	490	240	163	108	112	61	41	29	13
13	42	114	506	240	166	112	119	61	43	35	25
14	40	112	—	—	—	110	—	—	—	—	—
15	37	108	508	244	162	106	111	60	44	32	14
16	28	105	491	244	160	103	107	58	41	34	22
17	25	101	—	—	—	99	—	—	—	—	—
18	25	96	491	239	155	95	99	52	36	29	11
19	26	93	506	241	154	92	100	53	38	28	12
20	25	89	492	232	147	88	93	48	43	28	11
21	30	90	490	234	147	89	93	49	36	28	10
22	28	87	499	230	143	86	90	47	36	28	11
23	32	88	490	231	140	87	—	48	35	24	11
24	41	87	490	235	143	86	92	48	35	25	13
25	34	82	490	224	136	81	86	45	30	23	11
26	26	78	494	225	136	77	85	45	32	22	10
27	22	78	491	—	136	77	83	44	29	22	9
28	10	80	500	229	135	79	82	43	33	23	9
29	9	79	417	184	111	78	76	41	32	23	10
30	7	78	462	230	135	77	81	43	33	26	10
31	15	77	491	219	129	76	80	43	32	24	9
Mean	24.8	90	489	230	143	88	92	48	35	26	11

FEB 2005 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
81.3	73.2
79.4	71.5
80.7	72.6
79.8	71.8
92.0	82.8
94.3	84.9
100.3	90.3
105.4	94.8
105.8	95.2
111.1	100.0
111.2	100.1
113.5	102.1
112.7	101.4
115.2	103.7
118.7	106.9
110.2	99.1
108.8	97.9
101.8	91.7
96.3	86.7
93.6	84.2
92.5	83.2
90.4	81.3
82.8	74.5
78.6	70.8
76.7	69.0
75.1	67.6
74.4	66.9
73.6	66.2
94.9	85.4

♦ 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 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 March 2005 data combine observations from 44 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	38	36	35	34	42
										(2)	(4)	(6)	(1)
2005	32	31	30	29	27	26	25	24	23	23	22	21	26
	(8)	(9)	(10)	(11)	(12)	(12)	(12)	(13)	(13)	(13)	(13)	(12)	(12)
2006	20	19	18	17	17	16	16	15	14	13	12	12	16
	(11)	(11)	(12)	(12)	(13)	(13)	(13)	(12)	(11)	(11)	(12)	(12)	(12)

*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 September 2005 prediction. There exists a 90% chance that in September 2005, the actual smoothed sunspot number will fall somewhere between 10 and 36.

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.