SOLAR INDICES BULLETIN

MAY 2007

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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.

MAY 2007 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	20	86	494	231	138	87	84	65	36	21	13
02	20	87	490	223	136	88	83	65	35	24	14
03	12	83	489	221	132	84	84	64	35	24	15
04	11	83	488	221	129	84	82	63	35	24	13
05	10	81	487	219	130	82	80	63	35	24	14
06	9	78	486	216	132	79	79	61	33	19	13
07	8	76	488	214	131	74	71	60	34	24	13
08	9	73	489	216	74	74	71	59	34	25	14
09	11	72	494	220	125	73	71	59	34	22	13
10	12	71	487	215	123	72	73	57	35	25	38
11	14	72	487	213	120	73	71	59	35	25	23
12	13	71	490	217	125	72	71	59	34	23	13
13	11	74	484	217	125	75	74	61	35	23	13
14	18	73	477	215	123	74	73	59	34	46	14
15	18	77	482	218	129	78	76	61	35	26	20
16	17	77	492	221	134	78	78	61	35	26	32
17	24	77	493	224	131	78	76	60	34	26	17
18	25	76	487	217	128	77	78	61	34	26	14
19	22	75	493	219	128	76	76	62	35	24	13
20	14	74	486	217	127	75	74	60	34	24	14
21	11	73	485	216	124	74	73	60	34	26	13
22	9	72	489	216	124	73	73	60	34	24	13
23	14	70	482	213	120	71	71	58	34	24	13
24	9	70	---	211	117	71	69	58	34	25	13
25	0	68	---	213	118	69	69	56	34	23	13
26	0	68	484	210	117	69	68	56	33	24	13
27	0	67	486	214	119	68	68	56	34	24	13
28	0	69	458	210	118	70	70	57	33	23	12
29	7	70	482	213	119	71	71	58	34	24	13
30	7	71	484	216	124	72	71	58	33	23	13
31	7	75	485	219	125	77	76	61	34	26	12
Mean	11.7	74	486	217	126	76	74	60	34	25	15

APR 2007 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
71.7	71.6
71.2	71.1
70.8	70.8
70.7	70.8
70.9	71.0
71.0	71.1
71.2	71.4
71.1	71.3
69.9	70.2
69.4	69.7
69.1	69.5
68.3	68.6
68.3	68.6
68.2	68.6
69.3	69.8
69.3	69.8
69.2	69.8
68.8	69.3
68.3	68.9
68.5	69.1
68.7	69.4
68.9	69.7
69.1	69.8
73.2	74.0
76.5	77.4
80.5	81.5
82.7	83.8
84.9	86.1
84.8	86.0
87.0	88.2
72.4	72.9

♦ 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 May 2007 observations from 52 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
2005	35	34	34	32	29	29	29	27	26	26	25	23	29
2006	21	19	17	17	17	16	15	16	16	14	13	12 (1)	16 (0)
2007	12 (2)	11 (3)	11 (4)	11 (6)	12 (7)	12 (9)	12 (11)	13 (13)	14 (15)	15 (17)	16 (19)	17 (21)	13 (11)

*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 Sep 2006 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 November 2007 prediction. There exists a 90% chance that in November 2007, the actual smoothed sunspot number will fall somewhere between 0 and 35.

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.