SOLAR INDICES BULLETIN

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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.

NOVEMBER 2005 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

	Sunspot	Obs Flux	Solar Flux Adjusted to 1 Astronomical Unit								
	Number	Pentic	PALE	PALE	PALE	Pentic	PALE	PALE	PALE	PALE	PALE
Day	Intl	(2800)	(15400)	(8800)	(4995)	(2800)	(2695)	(1415)	(610)	(410)	(245)
01	18	77	476	221	130	76	78	40	31	20	10
02	19	78	491	216	133	77	78	42	34	30	15
03	9	77	490	222	133	76	78	42	32	19	11
04	12	77	489	226	131	76	78	44	34	21	9
05	12	79	487	228	134	78	81	45	35	21	10
06	14	82	482	229	136	80	81	45	33	21	10
07	30	79	484	224	136	78	81	44	36	22	11
08	8	79	482	221	136	78	83	45	37	22	10
09	8	78	482	222	132	77	80	43	33	22	11
10	0	78	476	226	131	76	77	42	33	25	11
11	0	79	487	222	134	77	81	42	35	24	11
12	10	83	464	224	138	81	83	44	33	22	10
13	12	88	493	228	148	86	90	46	37	26	12
14	19	92	480	241	153	90	90	48	32	28	17
15	20	100	486	236	154	98	99	48	37	29	23
16	23	94	486	232	150	92	93	49	44	24	13
17	24	101	477	238	156	98	100	47	33	23	12
18	26	101	470	237	156	99	99	50	48	27	20
19	26	102	496	245	163	100	102	49	37	33	30
20	33	96	492	234	150	94	96	47	37	29	23
21	27	95	485	234	153	92	97	48	38	23	40
22	25	93	488	230	150	90	93	47			
23	24	90	476	231	143	88	90	43	20	17	9
24	27	87	481	232	139	84	85	44	28	20	9
25	20	80	478	225	136	78	83	44	18	14	10
26	15	81	468	212	132	79	81	44	19	15	14
27	16	81	477	224	133	79	83	45	34	23	11
28	17	82	481	223	130	80	81	44	35	23	11
29	16	85	432	206	132	82	85	46	28	19	10
30	30	95	487	241	151	92	95	52	35	22	10
31											
Mean	18	86	480	227	141	85	86	45	33	22	13

OCT 2005 FINAL FLUX

Day	Observed Pentic (2800)	Adjusted Pentic (2800)
01	72.1	72.3
02	74.9	75
03	74.3	74.4
04	82.7	82.7
05	81.3	81.3
06	79.5	79.4
07	78.8	78.7
08	78.1	78
09	78.9	78.7
10	79.1	78.8
11	77.6	77.3
12	76.8	76.5
13	78	77.6
14	78.4	78
15	79.6	79.1
16	79.2	78.7
17	78.1	77.5
18	78.3	77.7
19	77.9	77.2
20	76.7	76
21	75.3	74.6
22	74.7	74
23	74.2	73.4
24	73.4	72.5
25	73	72.1
26	72	71.2
27	71.6	70.7
28	73.1	72.1
29	74.1	73.1
30	75.6	74.5
31	77.8	76.7
Mean	76.6	76.1

♦ 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 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 November 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	38	36	35	34	42
2005	35	34	34	32	29	28	27	26	25	24	23	22	28
						(2)	(4)	(5)	(6)	(6)	(7)	(7)	(4)
2006	21	20	19	19	18	18	17	16	15	14	13	13	17
	(7)	(8)	(9)	(9)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(9)
2007	12	12	12	12	12	12	13	13	14	15	16	17	13
	(10)	(10)	(10)	(10)	(10)	(11)	(12)	(14)	(16)	(17)	(19)	(21)	(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 June 2005 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 May 2006 prediction. There exists a 90% chance that in May 2006, the actual smoothed sunspot number will fall somewhere between 8 and 28.

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.