SOLAR INDICES BULLETIN

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

SEPTEMBER 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	17	79	488	224	132	80	85	48	35	20	10
02	14	77	484	235	136	78	83	47	33	19	9
03	9	74	480	230	132	75	78	42	29	19	9
04	9	75	—	230	133	76	80	43	32	19	10
05	8	75	495	233	133	76	80	42	31	21	10
06	8	83	506	251	166	84	104	47	32	20	11
07	14	100	504	265	171	101	107	51	30	19	10
08	20	94	511	282	214	95	120	50	35	26	13
09	28	99	—	—	—	100	—	—	—	—	—
10	35	100	552	283	183	101	116	54	35	30	15
11	34	110	512	278	195	111	124	59	37	29	—
12	37	118	540	290	209	119	131	61	37	32	—
13	50	114	499	270	178	115	120	61	36	53	—
14	44	117	508	285	194	118	125	60	38	28	—
15	39	119	479	272	179	120	120	61	39	29	—
16	33	112	512	252	167	113	110	59	38	23	14
17	35	104	503	247	163	105	112	59	39	23	13
18	33	102	504	247	158	102	106	56	39	27	14
19	26	91	479	244	152	91	100	53	39	24	11
20	18	88	488	241	148	88	95	53	40	28	12
21	13	86	489	237	145	86	91	50	36	25	10
22	14	84	476	232	142	84	91	49	40	25	10
23	19	83	457	230	141	83	85	48	37	28	11
24	17	81	485	225	133	81	84	48	36	20	9
25	16	81	465	236	143	81	89	49	36	23	9
26	22	81	494	234	139	81	87	46	35	25	10
27	16	77	488	227	134	77	83	43	31	22	10
28	15	75	490	232	136	75	79	42	33	25	10
29	14	74	478	230	134	74	80	40	29	26	9
30	7	72	492	219	130	72	78	39	9	5	4
31											
Mean	22.1	91	495	247	156	91	98	50	34	25	11

AUGUST 2005 FINAL FLUX

Day	Observed Pentic (2800)	Adjusted Pentic (2800)
01	111.2	114.6
02	110.2	113.5
03	108.9	112.2
04	106.1	109.2
05	98.8	101.7
06	93.4	96.1
07	92.3	94.9
08	86.4	88.9
09	82.5	84.7
10	76.3	78.3
11	75.9	77.9
12	76.2	78.3
13	75.4	77.4
14	74.8	76.7
15	75.8	77.7
16	75.8	77.7
17	77.0	78.9
18	82.7	84.7
19	93.1	95.3
20	98.1	100.4
21	98.5	100.8
22	104.9*	107.2*
23	106.9*	109.3*
24	98.6	100.7
25	92.4	94.4
26	93.2	95.2
27	92.1	94.0
28	89.8	91.6
29	89.2	90.9
30	86.0	87.6
31	84.0	85.6
Mean	90.5	92.8

*-1700UT Reading

♦ 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 September 2005 data combine observations from 47 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	31	29	28	28	27	26	24	23	29
				(2)	(4)	(5)	(6)	(7)	(8)	(9)	(9)	(9)	(5)
2006	23	22	21	20	20	19	18	17	16	15	14	14	18
	(9)	(10)	(10)	(10)	(11)	(11)	(11)	(11)	(11)	(11)	(11)	(11)	(11)
2007	13	13	12	12	12	12	13	13	14	15	16	17	14
	(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 <u>smoothed</u> 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 March 2006 prediction. There exists a 90% chance that in March 2006, the actual smoothed sunspot number will fall somewhere between 11 and 31.

<u>The McNish-Lincoln prediction method generates useful estimates of smoothed, monthly mean sunspot numbers for no more than 12 months ahead.</u> 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.