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 $10^{-22}\ \mathrm{J/m^2 Hz\,sec}$. During periods of low 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.

AUGUST 2010 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	16	80	531	234	133	82	90	72	48	32	16
02	16	79	536	233	133	81	93	73	47	36	20
03	9	81	483	219	133	83	91	72	44	37	21
04	21	81	534	236	136	83	93	72	47	34	17
05	34	83	535	237	141	85	99	76	45	35	17
06	34	82	518	231	133	84	91	74	42	33	15
07	32	91	521	231	137	93	96	76	47	38	19
08	25	83	532	234	136	85	93	75	47	37	15
09	36	84	534	234	137	86	96	76	47	35	17
10	38	84	531	234	135	86	96	77	47	37	15
11	44	86	538	235	135	88	94	77	48	35	16
12	33	84	531	232	136	86	93	76	48	35	17
13	27	84	538	232	135	86	96	76	47	35	18
14	22	85	532	232	137	87	95	76	47	34	15
15	25	86	527	232	136	88	95	75	46	34	16
16	34	85	531	233	132	87	94	73	46	34	14
17	17	81	527	230	131	83	91	71	44	34	15
18	15	81	529	230	131	83	91	72	45	35	13
19	10	78	530	230	128	79	86	70	44	35	16
20	8	77	533	228	128	78	85	69	44	32	14
21	0	76	531	227	126	77	86	67	43	32	15
22	0	75	529	227	126	76	84	66	43	32	15
23	0	75	531	227	126	76	85	66	43	31	15
24	8	74	518	222	125	75	82	63	42	32	14
25	15	74	526	228	124	75	82	63	43	31	14
26	15	73	528	229	126	74	81	62	41	31	14
27	8	73	528	226	124	74	85	64	43	32	13
28	8	72	525	223	123	73	80	63	42	32	14
29	18	74	526	223	124	75	83	63	42	32	14
30	19	75	529	226	125	76	86	66	43	33	16
31	20	75	532	227	128	76	86	65	44	33	16
Mean	19.6	80	528	230	131	81	90	71	45	34	16

JULY 2010 FINAL FLUX

Observed	Adjusted
Pentic	Pentic
(2800)	(2800)
73.0	75.5
73.4	75.9
72.4	74.8
71.6	74.0
72.7	75.2
72.7	75.2
74.1	76.6
75.6	78.2
80.0	82.7
79.9	82.6
82.6	85.4
80.0	82.6
78.5	81.1
77.7	80.3
75.9	78.4
76.6	79.1
78.7	81.3
76.9	79.4
79.8	82.5
87.0	89.9
89.1	92.0
87.7	90.5
86.4	89.2
85.2	87.9
85.2	87.9
84.4	87.1
82.6	85.2
85.3	88.0
84.6	87.2
83.2	85.7
81.5	83.9
79.8	82.4

♦ SUNSPOT COUNTS

In 1848 the Swiss astronomer Johann Rudolf 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 the SUNSPOT INDEX DATA CENTER, 3 avenue Circulaire, B-1180 BRUXELLES, BELGIUM. The August 2010 observations were from 68 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 23 AND 24

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
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	16
2007	12	12	11	10	9	8	7	6	6	6	6	5	8
2008	4	4	3	3	4	3	3	3	2	2	2	1.7###	3
2009	2	2	2	2	2	3	4	5	6	7	8	8	4
2010	9	11	12	14	16	18	20	23	26	28	31	34	20
			(2)	(4)	(6)	(9)	(11)	(14)	(16)	(20)	(24)	(27)	(11)
2011	36	39	41	43	46	48	49	52	54	56	58	60	48
	(30)	(33)	(35)	(36)	(37)	(37)	(37)	(39)	(41)	(42)	(43)	(45)	(38)
2012	61	63	65	67	68	70	72	75	77	79	79	80	71
	(46)	(48)	(50)	(52)	(53)	(55)	(55)	(54)	(53)	(53)	(54)	(53)	(52)

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

- Predicted values for Cycle 24 are based on DECEMBER 2008 being minimum.

♦ SUNSPOT NUMBER PREDICTIONS

For the end of Solar Cycle 23, and the beginning of Cycle 24, 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 March 2010 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 precisely. 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 February 2011 prediction. There exists a 90% chance that in February 2011, the actual smoothed sunspot number will fall somewhere between 6 and 72.

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 14 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.