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.

OCTOBER 2010 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	25	87	517	234	136	87	80	72	49	39	17
02	19	85	528	231	134	85	80	70	46	37	20
03	20	80	526	231	130	80	76	67	45	33	15
04	15	76	529	227	123	76	71	65	45	34	20
05	9	75	510	223	123	75	74	65	45	32	16
06	0	74	524	223	122	73	72	64	43	32	17
07	0	75	525	225	123	74	72	65	44	32	15
08	0	75	520	227	123	74	71	64	44	32	16
09	9	76	532	225	123	75	74	65	44	35	18
10	9	76	525	225	125	75	74	67	44	34	20
11	9	75	527	222	123	74	72	65	44	32	14
12	9	75	525	229	123	74	72	67	45	32	13
13	16	78	529	226	125	77	72	68	45	34	15
14	26	80	528	231	128	79	77	70	47	32	15
15	29	82	532	233	131	81	80	72	47	34	14
16	34	87	523	234	132	86	80	73	47	32	16
17	40	84	525	242	132	83	81	72	45	33	17
18	42	91	529	236	137	90	86	77	49	35	12
19	44	87	526	231	135	86	83	74	47	35	16
20	36	84	526	231	133	83	81	73	46	35	16
21	25	84	524	231	132	83	79	73	48	34	13
22	25	82	526	240	132	81	81	74	48	33	18
23	31	84	529	230	132	83	79	72	48	33	16
24	42	82	528	229	130	81	79	71	44	31	15
25	47	86	538	240	137	84	84	72	46	31	14
26	44	86	469	223	132	84	84	70	47	34	16
27	29	88	533	235	139	86	81	70	45	35	14
28	22	86	535	237	142	84	83	70	46	34	17
29	27	86	519	236	139	84	85	69	43	31	16
30	23	85	521	234	136	83	81	68	44	32	15
31	24	81	531	233	132	79	78	66	44	33	22
Mean	23.5	82	524	231	130	81	78	69	46	33	16

SEP 2010 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
76.3	77.7
77.0	78.4
77.2	78.5
82.2	83.6
82.1	83.5
79.7	81.0
76.2	77.3
74.5	75.6
73.7	74.7
75.3	76.4
78.0	79.1
78.3	79.3
79.5	80.4
80.7	81.6
81.2	82.1
82.5	83.3
82.2	83.0
82.1	82.9
81.2	81.9
82.6	83.3
84.6	85.2
84.8	85.4
84.3	84.9
82.6	83.1
82.9	83.4
83.9	84.3
83.0	83.4
83.2	83.5
90.7	91.0
89.9	90.2
81.1	81.9

♦ 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 October 2010 observations were from 71 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	25	27	30	33	20
					(3)	(6)	(9)	(11)	(13)	(17)	(21)	(24)	(9)
2011	36	38	40	43	45	47	49	51	53	56	58	59	48
	(27)	(30)	(32)	(33)	(34)	(35)	(34)	(36)	(38)	(39)	(41)	(43)	(35)
2012	61	63	65	67	68	69	72	74	76	78	78	79	71
	(45)	(46)	(49)	(50)	(52)	(53)	(53)	(52)	(50)	(51)	(51)	(51)	(50)

*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 <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 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 April 2011 prediction. There exists a 90% chance that in April 2011, the actual smoothed sunspot number will fall somewhere between 10 and 76.

<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 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.