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.

NOVEMBER 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	13	79	531	230	127	77	76	66	44	31	17
02	11	79	542	231	127	77	74	67	44	33	15
03	11	79	536	227	126	77	74	68	44	33	13
04	9	79	536	229	129	77	76	68	45	34	14
05	17	83	532	228	131	81	79	70	44	32	14
06	22	89	534	232	134	87	82	74	46	33	12
07	23	85	536	229	131	83	80	73	45	32	13
08	23	84	531	227	128	82	81	74	45	33	12
09	19	84	530	231	129	82	80	76	46	33	13
10	30	86	536	232	134	84	82	77	47	34	14
11	32	85	534	229	132	83	81	75	47	33	13
12	30	85	534	232	132	83	81	73	46	34	17
13	43	85	532	230	132	83	82	75	48	36	18
14	38	86	526	228	138	84	82	75	50	42	26
15	38	91	532	236	141	88	88	79	49	36	22
16	37	92	540	237	140	89	88	80	55	44	22
17	35	91	527	233	137	88	87	78	51	41	32
18	29	87	530	229	134	84	83	74	49	38	20
19	26	84	533	229	130	81	80	72	49	37	19
20	18	80	530	226	127	78	77	71	47	38	37
21	17	78	533	227	127	76	75	69	45	35	16
22	15	75	534	224	123	73	74	68	45	33	14
23	16	75	526	223	123	73	74	65	44	33	15
24	8	76	526	221	126	74	72	66	45	33	15
25	15	78	532	222	127	75	74	67	44	33	11
26	14	76	533	225	124	74	72	66	45	33	15
27	8	77	535	226	125	74	73	66	45	33	15
28	17	80	526	225	127	77	75	67	45	34	14
29	18	83	502	225	131	80	78	70	45	34	16
30	15	86	528	227	136	83	81	70	47	37	29
31											
Mean	21.6	83	531	228	130	80	79	71	46	35	17

OCT 2010 FINAL FLUX

Day	Observed Pentic (2800)	Adjusted Pentic (2800)
01	86.7	86.9
02	85.0	85.1
03	80.0	80.1
04	76.1	76.1
05	75.4	75.4
06	74.2	74.2
07	75.1	75.0
08	74.9	74.7
09	76.4	76.2
10	75.9	75.7
11	75.3	75.0
12	75.2	74.9
13	78.1	77.7
14	80.4	79.9
15	82.2	81.7
16	86.9	86.3
17	83.6	83.0
18	90.6	89.9
19	86.6	85.9
20	83.9	83.2
21	83.5	82.7
22	82.2	81.4
23	84.3	83.4
24	82.1	81.2
25	86.2	85.2
26	86.1	85.1
27	87.6	86.5
28	86.4	85.3
29	85.7	84.5
30	84.8	83.6
31	81.2	80.0
Mean	81.7	81.2

♦ 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 November 2010 observations were from 65 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	17	20	22	25	27	29	32	19
						(3)	(6)	(9)	(11)	(14)	(18)	(21)	(7)
2011	35	37	39	41	44	46	48	50	52	54	57	58	47
	(24)	(27)	(29)	(30)	(31)	(32)	(32)	(33)	(36)	(38)	(39)	(41)	(33)
2012	60	62	64	66	67	68	70	73	75	77	77	78	70
	(43)	(45)	(47)	(49)	(50)	(51)	(51)	(50)	(49)	(49)	(50)	(49)	(49)

*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 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 May 2011 prediction. There exists a 90% chance that in May 2011, the actual smoothed sunspot number will fall somewhere between 13 and 75.

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.