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.

JULY 2011 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

	Sunspot	Obs Flux	Solar Flux Adjusted to 1 Astronomical Unit								
	Number	Pentic	RSTN	RSTN	RSTN	Pentic	RSTN	RSTN	RSTN	RSTN	RSTN
Day	Intl	(2800)	(15400)	(8800)	(4995)	(2800)	(2695)	(1415)	(610)	(410)	(245)
01	38	88	563	249	130	88	89	82	52	33	14
02	30	86	567	253	130	86	87	84	51	34	18
03	28	86	568	252	134	86	86	82	50	36	16
04	31	85	566	252	131	85	84	82	50	33	16
05	22	85	557	247	132	85	86	79	49	33	15
06	23	85	561	250	130	85	85	80	49	34	15
07	28	86	553	254	128	86	85	77	47	37	18
08	43	86	563	251	136	86	82	80	48	31	13
09	33	86	567	254	132	86	79	80	49	31	16
10	40	91	585	253	138	91	87	84	50	34	17
11	51	90	563	253	139	90	86	85	51	35	15
12	49	92	552	260	134	92	90	85	48	37	20
13	46	95	571	257	140	95	87	87	46	29	12
14	46	94	568	257	140	94	88	91	47	29	13
15	56	94	559	259	139	94	89	93	52	37	21
16	50	94	574	259	141	94	88	94	51	33	16
17	63	104	649	261	151	104	97	97	53	40	29
18	78	102	578	260	146	102	96	99	53	40	21
19	74	100	615	261	145	100	96	96	52	36	18
20	48	100	585	257	141	100	96	93	52	35	17
21	41	96	697	254	141	96	91	89	50	36	18
22	37	92	554	256	137	92	88	86	48	32	13
23	29	88	546	254	133	88	81	82	46	32	14
24	29	86	547	237	130	86	80	78	40	27	11
25	20	87	518	254	136	87	82	81	47	33	14
26	29	94	558	270	152	94	93	90	49	34	15
27	43	99	564	274	153	99	95	89	49	37	15
28	65	107	567	278	168	107	105	96	51	35	19
29	61	112	558	193	140	112	98	91	51	35	19
30	62	113	563	276	170	113	107	97	53	70	141
31	67	119	569	286	180	119	109	100	60	72	312
Mean	50.5	94	588	256	141	94	90	87	50	36	30

JUN 2011 FINAL FLUX

Observed	Adjusted
Pentic	Pentic
(2800)	(2800)
113.6	116.8
111.6	114.8
107.1	110.2
102.8	105.8
102.9	105.9
100.2	103.2
96.4	99.3
90.2	92.9
87.5	90.2
86.7	89.4
84.5	87.2
84.6	87.3
86.6	89.4
99.3	102.5
101.5	104.8
103.3	106.6
104.3	107.6
99.2	102.4
99.1	102.4
96.4	99.6
95.1	98.2
92.9	96.0
96.3	99.5
96.2	99.4
93.6	96.7
90.1	93.1
89.2	92.2
86.9	89.8
87.3	90.3
89.2	92.2
95.8	98.8

♦ 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 SOLAR INFLUENCE DATA CENTER, RINGLAAN 3, 1180 BRUSSELS, BELGIUM. (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
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	102	108	111	111	95
2000	113	117	120	121	119	119	120	119	116	115	113	112	117
2001	109	104	105	108	109	110	112	114	114	114	116	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	35	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	2	3
2009	2	2	2	2	2	3	4	5	6	7	8	8	4
2010	9	11	12	14	16	16	17	17	20	23	27	29	18
2011	31	33	34	37	39	41	43	45	47	50	52	54	45
		(3)	(6)	(7)	(8)	(9)	(11)	(13)	(17)	(21)	(25)	(29)	(12)
2012	56	58	60	61	62	63	65	68	70	72	72	73	65
	(32)	(34)	(36)	(37)	(38)	(39)	(39)	(39)	(38)	(38)	(38)	(38)	(37)
2013	74	76	77	76	77	78	78	77	76	76	77	77	77
	(39)	(39)	(39)	(40)	(41)	(42)	(45)	(44)	(43)	(42)	(42)	(42)	(42)

♦ 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 August 2011 prediction. There exists a 90% chance that in August 2011, the actual smoothed sunspot number will fall somewhere between 18 and 62.

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.
