SOLAR INDICES BULLETIN

AUGUST 2008

NATIONAL GEOPHYSICAL DATA CENTER
Solar-Terrestrial Physics Division (E/GC2)
Telephone (303) 497-6346
325 Broadway
Boulder, Colorado 80305-3328 USA
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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 $10^{-22}\ \mathrm{J/m^2Hz\,sec}$. 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.

AUGUST 2008 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	0	66	470	210	116	67	65	55	35	23	11
02	0	66	449	208	115	67	64	53	35	24	12
03	0	66	483	208	115	67	63	53	33	23	11
04	0	66	480	208	115	67	64	53	34	23	11
05	0	67	487	209	117	68	63	53	34	25	11
06	0	67	488	211	117	68	65	54	34	25	12
07	0	66	480	211	114	67	63	53	33	23	12
08	0	66	482	208	115	67	63	53	33	15	12
09	0	66	485	211	114	67	63	53	32	23	11
10	0	66	480	209	117	67	62	52	32	21	12
11	0	66	484	209	115	67	63	53	33	23	11
12	0	65	483	206	115	66	63	53	34	23	12
13	0	65	472	206	116	66	62	53	34	24	11
14	0	66	473	210	116	67	62	52	35	24	12
15	0	65	481	209	116	66	62	53	35	21	12
16	0	66	482	209	117	67	63	54	34	19	12
17	0	67	485	210	118	68	65	53	35	24	12
18	0	66	490	210	117	67	65	56	36	22	13
19	0	67	482	210	116	68	63	54	37	24	12
20	0	66	480	208	116	67	62	53	---	---	---
21	7	67	477	208	116	68	64	54	35	22	10
22	8	68	483	211	117	69	64	55	36	22	11
23	0	68	482	209	117	69	65	56	35	21	11
24	0	67	474	213	116	68	65	54	34	22	11
25	0	67	488	209	117	68	63	54	34	24	11
26	0	67	486	208	116	68	62	53	35	15	11
27	0	67	480	208	116	68	64	53	---	---	---
28	0	66	483	209	115	67	61	53	---	---	---
29	0	67	483	209	115	68	62	53	---	---	---
30	0	67	481	209	115	68	62	53	34	17	12
31	0	67	479	209	117	68	62	53	34	20	12
Mean	0.5	66	480	209	116	67	63	53	34	22	12

JUL 2008 FINAL FLUX

Observed	Adjusted
Pentic	Pentic
(2800)	(2800)
65.6	67.8
65.9	68.2
65.5	67.7
65.4	67.6
65.1	67.3
66.1	68.3
65.5	67.7
65.5	67.8
66.0	68.3
65.4	67.6
65.7	67.9
64.9	67.1
65.2	67.4
65.6	67.8
65.7	67.9
64.6	66.7
65.0	67.1
65.3	67.4
66.4	68.5
65.9	68.0
66.2	68.4
65.8	68.0
65.5	67.6
65.4	67.5
65.8	67.9
66.1	68.1
66.3	68.4
66.3	68.3
66.0	68.1
66.5	68.5
65.5	67.5
65.7	67.8

♦ 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 SUNSPOT INDEX DATA CENTER, 3 avenue Circulaire, B-1180 BRUXELLES, BELGIUM. The August 2008 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	3.5***	4	4	4	5	6	6	7	8	9	11	6
			(1)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(9)	(10)	(4)
2009	13	14	16	19	21	24	27	30	34	38	42	45	27
	(12)	(14)	(16)	(19)	(21)	(24)	(27)	(30)	(33)	(36)	(39)	(44)	(26)
2010	49	53	56	60	63	65	68	72	75	77	79	82	66
	(48)	(51)	(54)	(57)	(60)	(61)	(62)	(64)	(67)	(68)	(70)	(71)	(61)

*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.

SPECIAL NOTE: Predicted values for Cycle 24 are **PRELIMINARY** based on FEBRUARY 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 December 2007 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 February 2009 prediction. There exists a 90% chance that in February 2009, the actual smoothed sunspot number will fall somewhere between 0 and 28.

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.