SOLAR INDICES BULLETIN

MARCH 2008

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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 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.

MARCH 2008 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	0	69	480	208	130	67	61	52	35	23	11
02	0	69	482	208	115	67	63	54	36	22	11
03	7	68	483	208	122	66	61	52	34	20	11
04	0	68	480	207	114	66	62	53	36	25	12
05	0	69	482	210	115	67	64	54	36	26	12
06	8	70	483	207	120	68	63	54	36	19	10
07	0	71	482	207	115	69	64	55	36	26	12
08	0	70	483	206	115	69	63	54	36	24	11
09	0	70	472	212	115	69	63	55	36	25	12
10	9	70	485	208	116	69	64	54	36	24	12
11	0	70	481	208	117	69	65	54	36	22	11
12	0	69	484	208	114	68	63	53	36	27	11
13	0	70	485	209	116	69	64	54	35	20	12
14	0	70	483	208	116	69	63	54	35	29	11
15	7	70	476	211	114	69	65	54	37	25	12
16	7	70	483	210	116	69	63	55	37	25	11
17	7	70	474	210	114	69	66	53	36	32	11
18	0	70	477	212	115	69	65	54	35	26	12
19	0	69	477	210	115	68	62	54	36	27	14
20	0	68	482	210	113	67	65	53	36	25	12
21	0	68	478	210	115	67	63	54	36	25	12
22	0	70	483	214	115	69	65	55	38	35	12
23	0	72	482	211	118	71	69	57	38	26	12
24	19	79	488	216	126	78	76	61	37	28	14
25	32	89	488	217	130	88	83	67	39	30	19
26	36	82	488	217	129	81	83	66	38	35	15
27	35	85	481	217	128	84	82	66	39	30	14
28	34	83	485	216	126	82	79	69	40	30	14
29	30	83	486	216	125	82	79	68	40	27	14
30	31	81	486	213	124	80	77	65	40	33	13
31	25	79	490	215	124	78	77	65	39	26	14
Mean	9.3	73	482	211	119	72	68	57	37	26	12

FEB 2008 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
71.1	69.0
71.8	69.8
No Data Avail	
71.3	69.3
70.5	68.5
71.6	69.6
70.8	68.9
70.9	69.0
72.2	70.3
72.6	70.7
72.1	70.2
72.1	70.3
70.5	68.7
70.6	68.8
69.7	68.0
70.3	68.6
71.1	69.4
71.2	69.5
71.7	70.0
70.9	69.3
71.8	70.3
72.4	70.8
71.6	70.1
70.7	69.3
71.4	69.9
70.7	69.3
70.7	69.4
70.0	68.7
69.8	68.5
71.1	69.4

♦ SUNSPOT COUNTS

In 1848 the Swiss astronomer Johann Rudolph 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 Pierre Cugnon of the SUNSPOT INDEX DATA CENTER, 3 avenue Circulaire, B-1180 BRUXELLES, BELGIUM. The March 2008 observations from 60 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	7	7	8
										0	(1)	(2)	(0)
2008	8	8	9	11	12	13	15	17	19	21	24	27	15
	(3)	(4)	(5)	(6)	(7)	(8)	(10)	(12)	(14)	(16)	(18)	(21)	(10)
2009	30	34	37	41	45	49	54	58	62	66	69	73	52
	(23)	(26)	(29)	(32)	(35)	(39)	(43)	(47)	(50)	(53)	(55)	(58)	(41)

*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 September 2007 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 September 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 August 2008 prediction. There exists a 90% chance that in September 2008, the actual smoothed sunspot number will fall somewhere between 5 and 33.

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.