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.

FEBRUARY 2011 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

	Sunspot	Obs Flux	Solar Flux Adjusted to 1 Astronomical Unit								
	Sunspot Number	Pentic	PALE	PALE	PALE	Pentic	PALE	PALE	PALE	PALE	PALE
Day	Intl	(2800)	(15400)	(8800)	(4995)	(2800)	(2695)	(1415)	(610)	(410)	(245)
01	15	80	545	227	124	77	73	67	41	31	13
02	13	79	529	227	124	76	72	67	41	32	12
03	18	80	534	227	127	77	72	67	42	32	12
04	22	82	536	224	127	79	73	68	42	33	14
05	16	81	532	226	127	78	73	68	42	33	15
06	9	80	480	230	126	77	72	67	42	33	15
07	9	82	531	227	128	79	76	69	42	33	15
08	39	90	540	239	138	87	85	76	45	36	---
09	31	89	537	235	137	86	80	73	45	34	16
10	21	91	540	238	133	88	83	77	45	36	14
11	35	91	536	233	135	88		77	46	35	16
12	37	96	539	239	142	93	90	81	49	37	15
13	48	107	---	---	---	104	---	---	---	---	---
14	53	113	577	273	154	110	102	88	---	---	---
15	51	113	541	251	161	110	101	90	51	36	24
16	48	114	545	255	162	111	103	91	53	47	---
17	40	111	546	247	159	108	101	91	50	37	22
18	49	125	544	255	166	122	110	95	72	74	---
19	50	109	538	247	155	106	97	87	49	36	17
20	42	105	538	238	145	102	94	81	47	35	16
21	29	97	537	236	140	94	90	77	46	34	16
22	23	91	530	233	136	88	84	73	---	---	---
23	19	89	568	252	131	87	82	70	44	35	16
24	13	89	569	247	129	87	81	68	44	33	16
25	10	88	288	210	121	86	79	66	42	31	14
26	26	90	567	251	127	88	85	70	42	33	14
27	27	90	552	251	129	88	84	70	43	32	14
28	31	96	356	222	125	94	87	72	41	29	13
Mean	29.4	95	525	239	137	92	86	76	46	36	15

Radio data for 14, 23-28 are from Sagamore hill.

JAN 2011 FINAL FLUX

Observed	Adjusted
Pentic	Pentic
(2800)	(2800)
*	*
91.1	88.1
92.1	89.1
90.6	87.6
87.7	84.8
86.8	83.9
86.4	83.5
84.8	82.0
82.7	80.0
83.3	80.6
82.6	79.9
80.0	77.4
79.5	76.9
79.3	76.7
80.2	77.6
80.3	77.8
81.8	79.1
81.0	78.4
80.8	78.2
82.3	79.7
87.5	84.8
87.7	84.9
84.3	81.7
82.5	79.9
80.5	78.0
80.0	77.6
80.5	78.1
80.6	78.1
81.4	79.0
82.6	80.2
81.3	78.9
83.4	80.8

* - Not Available

♦ 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 February 2011 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	16	17	17	19	21	23	25	17
									(3)	(6)	(9)	(13)	(3)
2011	27	29	30	32	35	37	38	40	42	44	47	48	37
	(15)	(18)	(19)	(20)	(21)	(21)	(21)	(22)	(25)	(28)	(30)	(32)	(23)
2012	50	51	53	55	56	58	60	63	66	67	68	69	60
	(34)	(37)	(39)	(41)	(43)	(44)	(44)	(44)	(42)	(42)	(43)	(44)	(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.

- 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 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.

Although every effort has been made to ensure that these data are correct, we can assume no liability for any damages any inaccuracies might cause. Subscriptions to this monthly bulletin are available free of charge. To become a subscriber either call (303) 497-6761, or write the NATIONAL GEOPHYSICAL DATA CENTER, Solar-Terrestrial Physics Division (E/GC2), 325 Broadway, Boulder, Colorado 80305, USA.