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} $J/m^2 Hz sec$.

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 Learmonth, Australia (LEAR) data reflect equipment problems. Fluxes measured either at Palehua on the Hawaiian Islands, or at San Vito, Italy, will be substituted for frequencies at which many Learmonth values are missing.

NOVEMBER 1997 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

	Sunspot	Obs Flux	Solar Flux Adjusted to 1 Astronomical Unit								
Day	Number Intl	Pentic (2800)	LEAR (15400)	LEAR (8800)	LEAR (4995)	Pentic (2800)	LEAR (2695)	LEAR (1415)	LEAR (610)	LEAR (410)	LEAR (245)
01	43	93	520	218	135	92	86	65	39	33	13
02	53	98	508	221	135	96	88	65	39	32	12
03	58	110	518	235	151	108	95	68	40	33	25
04	55	118	550	254	163	116	104	73	50	51	34
05	51	114	538	263	186	112	121	82	48	58	---
06	50	105	520	246	167	103	111	77	46	42	25
07	43	94	514	225	150	92	96	71	43	37	19
08	37	90	519	220	135	88	87	67	41	37	39
09	25	86	511	218	129	84	82	64	40	33	17
10	19	89	506	216	127	87	81	62	40	32	14
11	29	92	515	224	137	90	85	64	40	33	13
12	20	87	513	219	133	85	84	63	40	36	14
13	26	90	556	218	131	88	81	62	39	33	14
14	38	93	558	218	132	91	85	62	38	33	14
15	30	96	562	220	137	94	89	65	39	33	13
16	29	96	564	222	138	94	94	69	38	32	16
17	49	94	574	223	137	92	92	67	38	35	22
18	43	92	571	222	134	90	91	66	38	35	33
19	43	99	572	215	129	97	87	65	37	34	28
20	40	89	569	221	130	87	86	66	50	33	16
21	41	96	572	218	131	94	89	66	39	34	71
22	47	100	566	223	141	98	94	69	39	31	18
23	55	100	575	223	140	98	90	69	39	33	15
24	49	103	579	222	139	100	95	72	40	32	14
25	35	102	568	221	140	99	95	75	41	33	13
26	26	108	575	240	147	105	101	77	42	33	13
27	31	111	546	232	152	108	102	80	44	35	14
28	33	116	579	233	152	113	103	81	44	35	13
29	39	112	585	226	155	109	108	83	42	34	14
30	42	112	575	234	154	109	106	83	43	34	13
31											
Mean	39.3	100	549	226	142	97	94	70	41	35	20

OCT 1997 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
87.1	87.3
85.9	86.0
85.7	85.8
83.4	83.4
84.4	84.3
83.7	83.6
83.5	83.4
82.9	82.7
83.5	83.3
84.2	84.0
86.1	85.8
88.7	88.3
88.3	87.8
84.8	84.3
86.9	86.4
87.5	86.9
88.2	87.5
86.6	85.9
84.7	84.0
82.8	82.1
85.0	84.2
80.7	79.9
79.7	78.8
78.6	77.7
81.4	80.5
82.0	81.0
84.4	83.3
85.5	84.4
87.2	86.0
88.2	86.9
90.5	89.2
84.9	84.3

♦ 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 November 1997 data combine observations from 43 stations. http://www.oma.be/KSB-ORB/SIDC/index.html.

♦ 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 22 AND 23

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1987	18	20	22	24	27	28	31	35	39	44	47	51	32
1988	58	65	71	78	84	94	104	114	121	125	130	138	98
1989	142	145	150	154	157	158	159	158	157	157	158	154	154
1990	151	153	152	149	147	144	141	141	142	142	142	144	146
1991	148	148	147	147	146	145	146	147	145	142	138	132	144
1992	124	115	108	103	100	97	91	84	80	76	74	73	94
1993	71	69	67	64	60	56	55	52	48	45	41	38	56
1994	37	35	34	34	33	31	29	27	27	27	26	26	30
1995	24	23	22	21	19	18	17	15	13	12	11	11	17
1996	10	10	10	9	8*	9	9	8	9	9	10	11	9
1997	11	11	14	17	18	21	23	27	30	34	37	41	24
						(2)	(4)	(6)	(8)	(11)	(13)	(16)	(5)
1998	45	49	54	59	63	67	70	73	77	80	83	87	67
	(18)	(20)	(23)	(26)	(29)	(32)	(35)	(37)	(38)	(37)	(37)	(38)	(31)
1999	90	93	96	98	100	103	105	106	107	108	108	109	102
	(39)	(40)	(41)	(42)	(46)	(47)	(49)	(51)	(53)	(55)	(56)	(57)	(48)

*May 1996 marks Cycle 22's minimum and the onset of Cycle 23.

♦ SUNSPOT NUMBER PREDICTIONS

For the end of Solar Cycle 22, and the beginning of Cycle 23, 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 1996 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 May 1998 prediction. There exists a 90% chance that in May 1998 the actual smoothed sunspot number will fall somewhere between 34 and 92.

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 13 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. The new cycle predictions tabulated above are based on the minimum value of 8.0 that occurred in May 1996. For next solar maximum discussions, visit http://www.sec.noaa.gov.

Although every effort has been made to ensure that these data are correct, we can assume no liability for any damages their inaccuracies might cause.
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