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.

JANUARY 1998 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

	Sunspot	Obs Flux	Solar Flux Adjusted to 1 Astronomical Unit								
	Number	Pentic	LEAR	LEAR	LEAR	Pentic	LEAR	LEAR	LEAR	LEAR	LEAR
Day	Intl	(2800)	(15400)	(8800)	(4995)	(2800)	(2695)	(1415)	(610)	(410)	(245)
01	39	117	573	227	150	114	106	85	43	34	14
02	31	112	567	214	146	109	109	84	43	34	15
03	25	112	569	222	149	109	111	84	42	35	14
04	20	107	572	222	143	104	108	80	43	34	13
05	10	104	571	223	138	101	99	76	42	33	13
06	13	109	573	221	136	106	96	75	38	33	13
07	0	99	581	224	140	96	101	77	41	34	14
08	0	98	577	224	136	95	90	71	32	25	8
09	0	97	577	224	136	94	93	70	35	29	11
10	10	95	575	222	135	92	89	68	35	30	13
11	27	96	577	218	133	93	91	67	36	32	14
12	38	93	581	217	135	90	91	67	36	31	13
13	36	89	585	217	132	86	90	65	37	31	13
14	30	90	579	199	126	87	84	63	34	29	13
15	32	89	578	218	132	86	86	63	35	29	13
16	52	85	581	214	129	82	84	61	36	31	16
17	52	86	574	215	127	83	80	61	35	29	14
18	46	86	574	213	126	83	82	62	36	29	13
19	42	90	578	216	128	87	81	63	36	30	14
20	17	90	584	218	131	87	86	65	41	31	14
21	16	92	583	---	---	89	---	---	40	33	15
22	16	97	581	226	140	94	89	66	37	29	12
23	40	104	---	227	147	101	94	69	37	32	14
24	66	108	578	228	148	104	98	72	38	33	14
25	75	105	583	227	147	102	99	72	38	28	14
26	67	105	584	229	148	102	98	74	36	28	14
27	61	96	579	218	143	93	98	76	36	27	12
28	53	102	578	224	143	99	99	75	38	29	13
29	47	104	571	214	142	101	96	75	38	29	12
30	28	101	546	221	142	98	98	76	39	29	12
31	13	105	540	206	135	102	97	74	40	30	12
Mean	32.3	99	575	220	138	96	94	71	38	31	13

DEC 1997 FINAL FLUX

Observed	Adjusted
Pentic	Pentic
(2800)	(2800)
117.0	113.7
112.2	109.0
112.2	109.0
107.3	104.2
103.8	100.7
108.8	105.6
99.0	96.0
98.1	95.1
96.7	93.8
95.1	92.2
96.4	93.4
92.5	89.6
89.3	86.5
90.0	87.1
89.1	86.3
84.7	82.0
85.6	82.9
86.2	83.5
89.7	86.8
89.6	86.7
92.0	89.0
97.0	93.8
104.1	100.7
107.8	104.3
104.7	101.3
104.7	101.3
95.9	92.7
102.1	98.7
104.4	101.0
101.3	98.0
104.5	101.1
98.8	95.7

♦ 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 January 1998 data combine observations from 44 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	8	8	8	9	10	10	9
1997	11	11	14	17	18	20	23	26	29	33	36	40	23
								(2)	(4)	(6)	(9)	(11)	(3)
1998	44	48	52	57	61	65	68	72	75	78	81	85	65
	(13)	(15)	(18)	(21)	(23)	(26)	(29)	(32)	(33)	(32)	(31)	(31)	(25)
1999	88	91	93	95	98	100	102	103	104	106	106	107	99
	(32)	(34)	(35)	(37)	(40)	(41)	(43)	(45)	(48)	(50)	(52)	(52)	(42)

*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 June 1997 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 July 1998 prediction. There exists a 90% chance that in July 1998 the actual smoothed sunspot number will fall somewhere between 39 and 97.

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.