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} $J/m^2Hz\,sec$.

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 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.

FEBRUARY 1998 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

Day	Sunspot Number Intl	Obs Flux Pentic (2800)	Solar Flux Adjusted to 1 Astronomical Unit LEAR (15400)	LEAR (8800)	LEAR (4995)	Pentic (2800)	LEAR (2695)	LEAR (1415)	LEAR (610)	LEAR (410)	LEAR (245)
01	17	91	532	216	128	88	84	65	38	27	9
02	15	89	537	215	128	86	83	67	30	21	6
03	28	89	542	219	130	86	85	63	49	32	10
04	26	89	548	215	130	87	85	64	49	33	13
05	24	86	543	218	130	84	84	65	42	31	10
06	30	84	537	213	127	82	82	62	41	30	12
07	25	83	541	214	125	81	78	60	40	30	12
08	28	84	540	212	125	82	80	60	40	30	11
09	33	84	540	210	125	82	79	61	40	29	11
10	45	84	547	211	124	82	79	59	40	30	11
11	40	86	543	214	126	84	79	61	41	30	10
12	47	91	540	218	131	89	85	63	41	30	12
13	51	95	538	219	135	93	89	65	41	30	13
14	76	105	543	219	137	102	93	67	43	32	15
15	65	107	556	226	148	104	102	75	45	35	27
16	62	107	554	231	155	104	105	78	48	36	26
17	58	105	558	224	149	102	102	75	47	35	18
18	49	103	546	224	143	101	97	76	49	39	20
19	35	99	546	222	142	97	98	76	46	40	35
20	28	96	539	223	137	94	92	72	45	33	50
21	21	99	542	219	136	97	90	70	48	36	15
22	28	96	525	209	133	94	87	67	43	31	9
23	44	99	535	221	139	97	95	70	44	32	15
24	59	99	539	217	139	97	94	72	44	32	12
25	58	95	539	203	134	93	93	71	43	32	13
26	45	93	531	212	132	91	88	69	43	32	12
27	48	90	525	214	129	88	89	68	42	31	12
28	54	94	535	212	129	92	87	68	43	31	12
29											
30											
31											
Mean	40.7	94	541	217	134	91	89	67	43	32	15

JAN 1998 FINAL FLUX

Observe Pentic (2800)	Adjusted Pentic (2800)
101.6	98.3
101.0	97.6
101.1	97.7
90.7	87.7
89.3	86.3
87.0	84.1
84.9	82.1
82.2	79.5
81.6	78.9
80.7	78.0
84.8	82.0
95.8	92.7
90.4	87.5
93.9	90.8
97.8	94.6
97.5	94.4
95.9	92.8
95.1	92.0
93.5	90.5
91.4	88.5
90.9	88.0
93.0	90.1
96.9	93.9
97.5	94.5
108.3	105.0
100.0	96.9
100.8	97.7
96.6	93.7
93.6	90.9
91.0	88.4
89.4	86.8
93.4	90.4

♦ 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 February 1998 data combine observations from 36 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	25	28	32	35	39	23
									(2)	(5)	(7)	(10)	(2)
1998	43	47	51	56	60	64	67	70	73	76	80	83	64
	(12)	(14)	(17)	(20)	(22)	(25)	(28)	(31)	(31)	(30)	(30)	(29)	(24)
1999	86	89	91	94	96	99	101	102	103	104	105	105	98
	(30)	(32)	(33)	(35)	(38)	(39)	(41)	(44)	(47)	(49)	(50)	(51)	(41)

*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 August 1998 prediction. There exists a 90% chance that in August 1998 the actual smoothed sunspot number will fall somewhere between 39 and 101.

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.