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.

AUGUST 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	64	112	545	247	---	115	---	---	54	36	15
02	76	110	557	243	---	113	---	---	54	37	14
03	68	109	556	321	164	112	106	92	54	38	31
04	66	116	560	239	149	119	111	88	52	41	33
05	70	127	564	236	158	131	121	93	55	40	18
06	98	138	561	248	168	142	131	96	55	41	33
07	104	145	575	260	180	149	140	100	56	40	20
08	91	147	579	267	188	151	148	107	56	40	18
09	117	154	574	265	190	158	148	111	57	40	18
10	119	149	567	270	198	153	154	114	---	---	---
11	118	150	563	269	195	154	155	115	---	---	---
12	121	147	558	265	190	151	155	109	59	---	---
13	92	137	565	261	182	141	148	107	57	---	---
14	94	137	560	265	183	141	141	104	57	38	16
15	73	133	563	268	181	136	134	101	55	38	---
16	94	140	570	263	178	144	136	100	54	36	16
17	87	136	577	263	178	139	136	100	53	37	---
18	83	133	565	262	177	136	134	102	53	---	---
19	101	135	581	260	179	138	136	108	55	40	---
20	91	139	573	262	180	142	137	102	55	38	---
21	89	132	577	264	176	135	138	102	54	---	14
22	81	133	576	262	172	136	133	101	55	38	---
23	84	126	569	251	164	129	127	98	54	37	16
24	74	121	567	254	161	124	125	101	53	39	17
25	73	122	577	263	174	125	134	103	54	36	14
26	87	127	561	250	160	130	121	98	54	35	12
27	100	135	564	255	162	138	131	99	54	35	13
28	105	139	569	255	169	142	138	107	56	39	14
29	102	147	574	261	181	150	147	106	54	37	13
30	117	163	589	---	---	166	149	109	60	---	---
31	103	179	592	297	224	182	169	117	58	43	18
Mean	92	136	569	262	177	139	137	103	55	38	18

JUL 1998 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
126.8	131.1
120.4	124.4
127.6	131.9
129.1	133.5
123.5	127.6
121.1	125.2
114.6	118.5
112.4	116.2
114.3	118.2
109.2	112.9
107.7	111.3
99.3	102.6
106.1	109.7
102.9	106.3
104.8	108.2
106.2	109.7
100.3	103.6
99.2	102.4
101.9	105.2
111.8	115.4
110.3	113.9
114.1	117.8
115.4	119.1
125.2	129.2
121.7	125.5
119.1	122.8
119.5	123.2
121.3	125.1
119.5	123.1
114.8	118.3
113.7	117.2
114.0	117.7

♦ 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 August 1998 data combine observations from 40 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
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	10	11	14	17	18	20	23	25	28	32	35	39	23
1998	44	49	54	60	65	71	78	85	93	99	104	109	76
			(3)	(6)	(8)	(10)	(12)	(15)	(18)	(21)	(24)	(27)	(14)
1999	114	117	121	127	133	138	142	144	148	150	154	155	137
	(30)	(31)	(30)	(30)	(29)	(30)	(32)	(34)	(36)	(39)	(41)	(43)	(35)
2000	156	155	156	156	153	152	150	149	148	146	143	141	150
	(46)	(49)	(51)	(52)	(52)	(52)	(50)	(51)	(51)	(51)	(51)	(50)	(51)

*May 1996 marks Cycle 22's mathematical minimum.
**October 1996 marks the consensus Cycle 22 minimum which NGDC is now using.

♦ 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 March 1998 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 January 1999 prediction. There exists a 90% chance that in February 1999 the actual smoothed sunspot number will fall somewhere between 86 and 148.

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 consensus minimum value of 8.8 that occurred in October 1996. For solar maximum discussions, visit http://www.sec.noaa.gov.