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}Hzsec.

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.

MAY 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	57	113	549	248	152	115	105	74	44	35	28
02	78	117	549	255	159	119	109	81	44	40	90
03	74	117	552	250	157	119	114	82	46	37	71
04	73	121	551	249	162	123	119	86	54	49	57
05	79	133	561	258	168	135	122	87	69	89	125
06	76	130	556	272	182	132	129	91	59	75	130
07	71	123	572	279	188	125	135	97	53	60	63
08	68	118	556	264	166	120	122	89	52	52	61
09	49	111	556	261	161	113	113	86	54	49	53
10	48	107	550	251	151	109	107	83	52	45	38
11	58	108	538	246	148	110	102	83	50	44	67
12	73	112	548	248	152	114	110	87	55	45	37
13	80	117	550	242	149	119	114	83	50	38	24
14	82	117	550	226	149	120	117	85	50	37	15
15	80	116	544	244	158	119	123	88	50	37	15
16	79	118	544	242	157	121	119	88	50	37	15
17	71	110	549	244	154	113	114	85	48	35	15
18	67	102	544	241	148	104	108	82	46	33	13
19	56	99	536	239	140	101	100	78	44	32	14
20	43	92	541	233	136	94	96	75	40	28	12
21	26	89	531	232	132	91	88	70	42	30	12
22	21	87	545	230	131	89	88	66	42	32	13
23	31	90	544	230	132	92	89	67	42	32	15
24	32	96	555	234	138	98	93	67	43	39	28
25	41	92	555	233	142	94	95	69	44	44	51
26	43	93	540	230	139	96	94	68	42	36	26
27	51	94	518	230	137	97	93	67	42	37	35
28	33	98	524	238	143	101	97	68	44	34	15
29	32	95	538	233	140	98	97	69	44	34	17
30	43	96	533	231	136	99	92	70	44	33	14
31	49	94	547	232	137	97	95	71	44	34	14
Mean	56.9	107	546	243	150	109	106	79	48	41	38

APR 1998 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
105.7	105.6
103.4	103.4
103.6	103.6
110.2	110.2
126.2	126.4
133.4	133.7
135.2	135.5
140.6	141.0
139.7	140.2
129.7	130.2
128.3	128.8
117.0	117.6
114.8	115.5
111.9	112.6
112.7	113.5
106.4	107.2
101.3	102.1
98.5	99.4
95.8	96.7
97.7	98.7
92.0	92.9
87.6	88.5
90.2	91.3
90.6	91.7
91.9	93.0
90.7	91.8
91.4	92.6
98.4	99.8
100.5	102.0
102.5	104.1
108.3	109.0

♦ 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 May 1998 data combine observations from 37 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	10	11	14	17	18	20	23	25	29	32	35	39	23
												(2)	(0)
1998	44	50	55	61	66	72	79	86	94	100	105	110	77
	(4)	(6)	(9)	(12)	(14)	(16)	(19)	(22)	(25)	(27)	(31)	(34)	(18)
1999	114	118	122	129	134	139	143	146	148	152	155	157	138
	(37)	(37)	(36)	(36)	(37)	(38)	(40)	(40)	(42)	(46)	(48)	(49)	(41)

*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 December 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 November 1998 prediction. There exists a 90% chance that in November 1998 the actual smoothed sunspot number will fall somewhere between 74 and 136.

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.