SOLAR INDICES BULLETIN

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NATIONAL GEOPHYSICAL DATA CENTER
Solar-Terrestrial Physics Division (E/GC2)
Telephone (303) 497-6346

325 Broadway
Boulder, Colorado 80303 USA
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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.

APRIL 1995 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	16	75	533	225	126	75	76	51	30	23	12
02	17	76	524	220	125	76	74	50	33	23	12
03	19	75	508	221	126	75	72	49	31	23	11
04	10	73	527	221	125	73	71	48	29	22	11
05	0	72	510	220	123	72	70	46	32	23	10
06	0	72	525	223	123	72	68	45	32	23	11
07	0	71	509	211	120	71	68	44	32	23	11
08	0	72	510	220	121	72	67	45	32	23	11
09	8	73	537	221	123	73	67	45	31	23	10
10	7	74	—	—	—	74	—	—	—	—	—
11	10	78	516	224	126	78	72	49	32	24	10
12	18	82	523	224	128	82	75	50	33	24	11
13	31	83	536	228	133	83	79	52	33	24	12
14	38	88	518	228	132	89	81	54	34	24	12
15	42	91	520	229	138	92	88	60	38	27	12
16	46	89	538	228	139	90	90	59	40	27	13
17	48	89	540	230	138	90	87	58	38	26	11
18	37	90	—	—	—	91	—	—	—	—	—
19	34	92	528	231	138	93	88	58	37	25	13
20	25	86	527	229	136	87	86	56	36	25	11
21	13	85	536	231	136	86	83	56	36	26	13
22	11	84	532	233	135	85	81	53	36	28	16
23	0	77	533	230	132	78	78	51	34	24	12
24	0	73	508	226	125	74	73	53	34	25	11
25	0	70	518	227	123	71	66	51	33	24	11
26	0	69	525	226	122	70	67	50	33	24	10
27	8	68	504	198	116	69	67	49	32	23	10
28	0	68	502	208	117	69	67	48	30	23	13
29	0	68	516	221	119	69	66	47	31	22	10
30	0	67	514	221	118	68	65	48	30	23	11
31											
Mean	15	78	522	223	127	78	75	51	33	24	11

MARCH 1995 FINAL FLUX

Day	Observed Pentic (2800)	Adjusted Pentic (2800)
01	90.0	88.3
02	90.3	88.7
03	91.0	89.4
04	89.1	87.6
05	84.2	82.9
06	83.5	82.2
07	84.0	82.7
08	80.8	79.6
09	76.9	75.8
10	79.1	78.1
11	76.1	75.1
12	76.2	75.3
13	77.5	76.6
14	79.0	78.1
15	81.1	80.2
16	84.2	83.3
17	83.4	82.5
18	91.8	90.9
19	84.2	83.4
20	89.1	88.3
21	90.0	89.3
22	93.5	92.9
23	94.2	93.6
24	95.0	94.4
25	92.3	91.8
26	90.3	89.9
27	89.0	88.6
28	83.7	83.4
29	80.9	80.7
30	79.7	79.5
31	76.8	76.7
Mean	85.1	84.2

♦ 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 April 1995 data combine observations from 36 stations.

♦ 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 21 AND 22

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1984	60	56	53	50	48	46	44	40	34	29	25	22	42
1985	20	20	19	18	18	18	17	17	17	17	17	15	18
1986	14	13	13	14	14	14	14	13	12*	13	15	16	14
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	25	24	30
											(3)	(6)	(1)
1995	23	23	22	21	20	19	18	18	17	17	16	15	19
	(8)	(10)	(11)	(12)	(12)	(12)	(13)	(13)	(13)	(13)	(12)	(12)	(12)
1996	14	13	12	12	11	11	10	9	9	8	8	8	10
	(12)	(12)	(13)	(13)	(14)	(13)	(13)	(12)	(12)	(12)	(12)	(12)	(13)

Sep 1986 marks Cycle 21's minimum and the onset of cycle 22, which reached a maximum in July 1989.

♦ SUNSPOT NUMBER PREDICTIONS

For the end of Solar Cycle 21, and the beginning of Cycle 22, 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 1994 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 October 1995 prediction. There exists a 90% chance that in October 1995 the actual smoothed sunspot number will fall somewhere between 4 and 30.

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 12.3 that occurred in September 1986.