SOLAR INDICES BULLETIN

OCTOBER 1995

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

325 Broadway
Boulder, Colorado 80303 USA
ISSN 1046-1914

♦ 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.

OCTOBER 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	0	73	524	226	124	73	68	54	30	21	11
02	0	73	548	228	124	73	69	53	30	21	11
03	0	71	548	224	123	71	66	52	30	21	11
04	0	71	536	230	122	71	68	52	30	20	11
05	0	70	540	230	122	70	66	51	29	20	11
06	8	71	544	218	121	71	67	51	29	20	10
07	10	73	543	227	124	73	69	51	30	20	12
08	9	74	529	225	123	74	69	51	30	21	11
09	22	76	546	230	128	76	73	54	30	20	11
10	29	82	530	235	128	82	74	54	30	20	9
11	48	89	552	239	138	89	82	60	32	22	16
12	57	92	541	242	143	92	85	61	32	22	12
13	58	88	530	244	146	88	85	65	34	25	39
14	54	87	554	242	140	87	86	63	34	24	15
15	31	83	526	241	135	83	82	62	33	24	15
16	43	86	537	238	133	85	79	61	33	22	15
17	37	85	534	238	136	84	79	61	30	20	11
18	28	82	535	237	134	81	78	60	31	22	15
19	21	80	534	237	131	79	76	58	35	22	13
20	18	83	546	234	129	82	75	57	32	24	51
21	26	81	551	237	132	80	78	57	32	22	12
22	26	80	518	233	131	79	77	56	31	21	11
23	26	77	550	231	128	76	75	56	32	21	12
24	25	74	553	229	127	73	73	55	31	21	11
25	22	74	519	231	123	73	69	54	31	21	11
26	22	74	531	232	123	73	70	54	30	21	11
27	12	74	553	230	123	73	71	54	30	21	8
28	10	74	541	231	124	73	69	53	30	21	11
29	9	74	546	231	123	73	69	52	30	21	11
30	11	73	529	235	124	72	67	52	29	20	14
	10	73	534	225	122	72	69	51	29	20	9
Mea	22	78	539	233	129	77	74	56	31	21	14

SEP 1995 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
73.7	75.0
73.3	74.6
73.6	74.9
74.4	75.6
74.6	75.9
71.8	73.0
70.2	71.2
69.1	70.1
68.7	69.7
68.0	68.9
68.0	68.9
68.6	69.5
69.2	70.1
69.5	70.3
70.1	70.9
69.6	70.4
69.8	70.5
71.6	72.3
73.6	74.3
75.5	76.2
73.9	74.5
74.5	75.1
75.0	75.5
73.7	74.2
74.0	74.5
73.5	73.9
72.3	72.6
72.7	73.0
73.7	74.0
72.8	73.0
72.0	72.8

♦ 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 October 1995 data combine observations from 45 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, 22 AND 23

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
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	26	26	30
1995	24	23	22	21	20	19	18	18	17	17	16	15	19
					(2)	(4)	(5)	(6)	(7)	(7)	(7)	(7)	(4)
1996	14	13	12	12	11	11	10	10	9	9	8	8	11
	(8)	(9)	(10)	(10)	(10)	(10)	(10)	(11)	(11)	(11)	(11)	(10)	(10)
1997	8	8	9	9	10	10	11	12	13	13	15	16	11
	(10)	(10)	(10)	(10)	(11)	(12)	(13)	(15)	(16)	(17)	(19)	(22)	(14)

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 <u>smoothed</u> 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 1995 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 April 1996 prediction. There exists a 90% chance that in April 1996 the actual smoothed sunspot number will fall somewhere between 2 and 22.

<u>The McNish-Lincoln prediction method generates useful estimates of smoothed, monthly mean sunspot numbers for no more than 12 months ahead.</u> 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.