SOLAR INDICES BULLETIN

SEPTEMBER 2000

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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} $J/m^2 Hz sec$.

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 Palehua, Hawaii (PALE), data reflect equipment problems. Fluxes measured either at Sagamore Hill, Massachusetts, or at San Vito, Italy, will be substituted for frequencies at which many Palehua values are missing.

SEPTEMBER 2000 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

Day	Sunspot Number Intl	Obs Flux Pentic (2800)	Solar Flux Adjusted to 1 Astronomical Unit PALE (15400)	PALE (8800)	PALE (4995)	Pentic (2800)	PALE (2695)	PALE (1415)	PALE (610)	PALE (410)	PALE (245)
01	142	158	572	296	183	160	147	145	75	48	22
02	118	154	571	292	181	156	142	143	66	45	17
03	128	154	564	300	195	156	146	139	75	48	17
04	134	171	515	307	209	173	169	143	81	49	16
05	114	180	---	---	---	182	---	---	---	---	---
06	114	179	579	314	204	181	167	151	80	53	25
07	110	173	539	254	177	175	157	148	81	51	20
08	85	163	572	305	191	165	65	147	77	49	18
09	63	151	574	304	184	153	39	143	74	47	---
10	38	141	561	297	174	142	129	129	74	45	19
11	26	135	561	286	166	136	128	129	77	46	17
12	35	133	478	275	160	134	121	128	73	44	15
13	63	133	511	273	162	134	121	122	72	22	14
14	60	151	542	283	184	152	140	127	75	82	---
15	77	159	578	301	192	160	143	131	71	104	---
16	85	175	586	307	209	176	154	136	67	52	87
17	118	182	585	312	223	183	161	137	70	---	22
18	112	204	605	349	264	205	175	152	73	---	20
19	121	207	---	---	---	208	---	---	---	---	---
20	124	211	---	---	---	212	---	---	---	---	---
21	137	225	600	401	326	226	201	157	94	73	79
22	142	232	615	412	326	233	210	157	75	76	35
23	160	225	596	386	321	226	218	160	79	---	---
24	163	225	581	367	309	226	209	160	80	---	---
25	153	226	582	360	285	227	205	161	84	---	---
26	161	224	593	347	268	225	199	162	83	77	72
27	162	205	546	328	208	205	197	161	82	63	---
28	142	202	---	---	---	202	---	---	---	---	---
29	119	192	566	330	225	192	180	159	85	59	24
30	92	194	586	326	228	194	169	159	82	54	31
31											
Mean	109.9	182	568	320	221	183	157	146	77	56	30

AUG 2000 FINAL FLUX

Day	Observed Pentic (2800)	Adjusted Pentic (2800)
01	149.4	153.9
02	150.6	155.1
03	154.2	158.8
04	154.2	158.7
05	158.5	163.2
06	166.0	170.8
07	166.9	171.6
08	170.8	175.6
09	182.2	187.2
10	181.0	185.9
11	187.3	192.3
12	189.3	194.3
13	186.0	190.9
14	189.5	194.3
15	193.9	198.9
16	185.6	190.3
17	177.1	181.5
18	169.5	173.6
19	157.1	160.8
20	152.4	156.0
21	151.4	154.9
22	144.2	147.5
23	136.9	139.9
24	130.6	133.5
25	133.2	136.0
26	137.0	139.9
27	150.1	153.2
28	160.0	163.2
29	163.3	166.5
30	164.8	167.9
31	162.9	165.9
Mean	163.1	167.2

♦ 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 September 2000 data combine observations from 34 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
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	53	57	59	62	65	68	70	71	73	78	62
1999	83	85	84	86	91	93	94	98	102	108	111	111	95
2000	113	117	120	120 (4)	120 (8)	120 (11)	120 (13)	120 (18)	120 (22)	119 (25)	118 (29)	117 (31)	119 (13)
2001	117 (32)	117 (34)	116 (35)	115 (38)	115 (40)	114 (39)	113 (37)	112 (37)	111 (38)	110 (38)	109 (37)	108 (36)	113 (37)

*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 2000 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 March 2001 prediction. There exists a 90% chance that in March 2001 the actual smoothed sunspot number will fall somewhere between 81 and 151.

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.