SOLAR INDICES BULLETIN

AUGUST 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.

AUGUST 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	106	149	571	301	181	153	143	140	74	45	---
02	110	151	563	288	184	155	155	137	74	48	16
03	107	154	574	309	191	158	147	137	73	45	16
04	110	154	570	302	189	158	158	143	72	47	19
05	144	159	571	302	192	163	155	149	76	53	21
06	143	166	---	---	181	170	160	153	66	45	20
07	164	167	563	305	197	171	162	143	---	---	---
08	140	170	583	308	199	174	163	153	77	---	---
09	128	182	594	304	204	187	163	158	77	65	26
10	154	181	591	326	214	185	173	160	85	61	19
11	165	187	600	329	223	192	188	156	79	52	20
12	170	189	598	304	207	194	179	172	86	53	19
13	176	186	---	295	206	190	165	171	82	51	17
14	204	190	590	322	223	194	206	180	---	51	18
15	183	194	579	318	213	199	177	181	85	50	
16	178	186	588	316	209	190	181	176	82	48	16
17	152	177	584	314	200	181	173	171	85	49	16
18	140	170	584	304	191	174	160	156	76	46	16
19	133	157	576	305	186	160	158	153	78	48	17
20	106	152	564	296	184	155	138	137	76	47	16
21	77	151	582	303	186	154	138	131	73	44	16
22	67	144	---	---	---	147	---	---	---	---	---
23	67	137	572	292	175	140	128	120	---	---	---
24	77	131	571	297	173	133	121	114	66	46	19
25	81	133	---	---	---	135	---	---	---	---	---
26	79	137	---	---	---	139	---	---	---	---	---
27	113	150	580	300	189	153	149	129	69	44	18
28	132	160	571	302	197	163	147	131	72	---	---
29	138	163	---	---	---	166	---	---	---	---	---
30	144	165	579	306	198	168	150	144	74	50	26
31	157	163	575	302	187	166	143	137	72	47	19
Mean	130.5	163	579	306	196	167	159	149	73	49	19

JULY 2000 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
163.7	169.2
162.4	167.9
156.3	161.5
158.4	163.7
168.7	174.4
174.3	180.1
187.1	193.5
210.0	217.1
211.3	218.4
244.5	252.7
241.6	249.7
314.6+	325.1+
231.9	239.6
203.9	210.6
213.1	220.1
+ burst ip	
218.9	226.1
228.3	235.8
261.9	270.5
249.9	258.0
252.9	261.1
250.9	259.0
251.0	259.0
217.3	224.3
224.8	232.0
201.8	208.2
174.6	180.1
162.4	167.4
157.8	162.7
153.2	157.9
149.9	154.5
147.9	152.4
204.7	211.4

♦ 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 2000 data combine observations from 38 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	118 (4)	118 (8)	118 (12)	118 (14)	118 (16)	118 (20)	118 (24)	117 (27)	116 (31)	115 (33)	117 (16)
2001	115 (34)	115 (35)	115 (37)	114 (39)	114 (41)	113 (40)	112 (39)	111 (38)	110 (39)	109 (39)	108 (38)	107 (37)	112 (38)

*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 February 2001 prediction. There exists a 90% chance that in February 2001 the actual smoothed sunspot number will fall somewhere between 80 and 150.

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.

Although every effort has been made to ensure that these data are correct, we can assume no liability for any damages their inaccuracies might cause. The charge for a 1-year subscription to this monthly bulletin is US$17.00. To become a subscriber, you may either call (303) 497-6346 or write the NATIONAL GEOPHYSICAL DATA CENTER, Solar-Terrestrial Physics Division (E/GC2), 325 Broadway, Boulder, Colorado 80303 USA. Please include with your written order a cheque or money order payable in U.S. currency to the "Department of Commerce, NOAA/NGDC". Payment may also be made through VISA, MasterCard or American Express credit cards.