SOLAR INDICES BULLETIN Corrected Copy JANUARY 2001

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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 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.

JANUARY 2001 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	89	171	557	297	202	165	154	129	71	50	---
02	94	176	578	298	201	170	150	132	70	46	14
03	88	170	578	295	200	164	142	134	73	49	36
04	98	175	558	302	202	169	163	137	72	48	17
05	101	176	550	295	198	170	147	136	70	47	15
06	130	179	567	292	197	173	166	140	72	47	2
07	131	177	581	299	200	171	143	140	73	52	---
08	105	167	579	292	193	161	144	142	72	48	---
09	115	166	563	292	188	160	148	137	70	45	15
10	95	163	554	293	185	157	180	136	68	45	16
11	115	166	536	295	188	160	185	138	69	48	20
12	117	178	558	296	200	172	---	145	66	45	18
13	111	184	513	262	184	177	159	140	72	48	21
14	92	176	572	294	200	170	147	137	75	---	---
15	92	169	546	290	189	163	175	130	71	37	17
16	75	162	557	280	176	156	127	125	---	39	12
17	59	152	543	286	180	147	132	123	65	42	16
18	60	152	574	288	179	147	172	120	65	40	14
19	73	153	572	298	179	148	143	126	61	42	15
20	61	153	554	303	186	148	132	138	67	43	14
21	81	152	560	300	191	147	159	126	72	47	14
22	93	162	566	294	187	156	---	129	---	46	16
23	112	167	560	296	196	161	153	135	---	48	---
24	118	173	557	298	191	167	152	136	73	49	19
25	106	169	562	292	189	163	148	138	71	50	20
26	84	166	578	295	187	160	133	137	71	45	17
27	97	167	578	291	194	161	145	141	73	45	17
28	102	168	557	299	192	162	156	139	74	45	19
29	90	165	561	294	187	160	142	133	69	42	18
30	70	160	560	318	195	155	141	133	68	43	24
31	93	153	575	291	176	148	134	124	68	43	16
Mean	95.1	167	561	294	191	161	151	134	70	45	17

DEC 2000 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
184.5	179.3
167.0	162.3
163.6	158.9
152.0	147.6
147.0	142.7
141.0	136.9
144.2	139.9
138.3	134.1
134.7	130.7
146.6	142.1
143.6	139.2
149.8	145.2
164.6	159.5
182.2	176.5
187.8	181.9
190.5	184.4
196.7	190.4
198.0	191.6
198.6	192.2
201.3	194.8
194.5	188.2
190.0	183.8
190.9	184.7
193.0	186.7
187.0	180.9
188.8	182.6
187.6	181.4
185.4	179.3
181.5	175.5
182.1	176.1
169.5	163.9
173.6	168.2

◆ 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 January 2001 data combine observations from 36 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
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	103	108	111	111	96
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2000	113	117	120	121	119	119	120	120	120	119	118	117	118
								(7)	(11)	(15)	(19)	(22)	(6)
2001	117	117	116	116	115	115	114	112	111	110	109	108	113
	(24)	(25)	(27)	(30)	(33)	(32)	(30)	(30)	(31)	(32)	(32)	(31)	(30)
2002	107	105	103	101	98	96	93	91	88	85	83	79	94
	(30)	(30)	(29)	(28)	(27)	(27)	(26)	(25)	(24)	(23)	(22)	(21)	(26)

*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 June 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 July 2001 prediction. There exists a 90% chance that in July 2001 the actual smoothed sunspot number will fall somewhere between 84 and 144.

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.