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 80305-3328 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 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.

OCTOBER 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	168	217	587	386	280	217	207	139	65	42	21
02	144	201	573	355	257	201	192	133	---	---	---
03	135	192	---	---	---	192	---	---	---	---	---
04	132	187	562	336	227	187	175	128	64	43	46
05	114	177	556	324	222	177	174	130	62	46	30
06	104	180	291	222	153	179	86	91	54	39	19
07	103	173	553	316	210	172	162	117	59	40	16
08	72	171	564	320	210	170	164	119	57	37	18
09	79	176	571	329	216	175	169	130	59	38	19
10	98	179	572	347	226	178	167	122	57	37	17
11	113	175	562	325	217	174	167	130	60	39	30
12	127	179	569	334	220	178	161	124	59	39	24
13	108	180	575	321	224	179	172	127	61	41	94
14	115	192	561	358	241	191	185	136	63	42	30
15	123	193	580	356	250	191	189	134	60	42	26
16	121	207	579	362	259	205	194	128	63	40	20
17	126	217	588	378	270	215	200	136	62	43	20
18	131	229	563	376	279	227	205	141	64	45	26
19	143	248	594	386	292	246	224	164	71	53	27
20	160	245	311	250	206	242	144	123	54	41	27
21	154	224	580	352	268	221	212	146	68	45	23
22	135	233	768	363	269	230	232	151	72	44	34
23	143	226	587	366	262	223	204	149	68	42	27
24	135	239	595	453	284	236	220	160	69	49	39
25	151	239	---	---	---	236	---	---	---	---	---
26	154	237	588	401	296	234	141	154	64	54	70
27	143	247	579	328	259	243	144	137	68	50	45
28	139	227	598	375	288	224	131	135	68	47	40
29	127	216	573	359	280	212	197	134	64	46	74
30	103	226	584	369	299	222	198	131	66	54	---
31	93	221	604	357	287	217	205	128	66	72	---
Mean	125.6	208	564	347	249	206	179	134	63	45	34

SEP 2001 FINAL FLUX

Day	Observed Pentic (2800)	Adjusted Pentic (2800)
01	184.1	187.4
02	182.5	185.7
03	198.7	202.1
04	218.4	222.1
05	218.3	221.8
06	222.2	225.6
07	226.1	229.5
08	249.5	253.1
09	236.2	239.5
10	244.5	247.8
11	249.7	252.9
12	235.1	238.1
13	239.7	242.6
14	236.6	239.3
15	219.3	221.7
16	207.1	209.3
17	199.1	201.1
18	203.8	205.7
19	198.8	200.6
20	226.8	228.7
21	238.6	240.5
22	255.2	257.0
23	258.5	260.2
24	279.3	281.0
25	275.1	276.6
26	282.6	284.0
27	269.5	270.6
28	284.5	285.5
29	239.5	240.2
30	235.8	236.3
Mean	233.8	236.2

♦ 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 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 2001 data combine observations from 41 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

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
2000	113	117	120	121	119	119	120	119	116	115	113	112	117
2001	109	104	105	108	107	107	106	105	104	103	102	101	105
					-6	-8	-9	-12	-14	-15	-16	-17	-8
2002	100	99	97	95	93	90	88	85	83	81	78	75	89
	-18	-19	-20	-22	-21	-20	-20	-20	-20	-20	-19	-17	-20
2003	72	70	68	66	63	61	59	58	56	54	52	51	61
	-15	-13	-13	-14	-15	-16	-17	-17	-18	-19	-19	-22	-17

*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 2001 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 2002 prediction. There exists a 90% chance that in April 2002 the actual smoothed sunspot number will fall somewhere between 73 and 117.

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.