SOLAR INDICES BULLETIN

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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.

SEPTEMBER 2002 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

	Sunspot	Obs Flux	Solar Flux Adjusted to 1 Astronomical Unit								
Day	Number Intl	Pentic (2800)	PALE (15400)	PALE (8800)	PALE (4995)	Pentic (2800)	PALE (2695)	PALE (1415)	PALE (610)	PALE (410)	PALE (245)
01	120	181	542	329	230	184	160	113	55	47	84
02	136	174	560	312	213	177	168	158	56	37	62
03	147	171	490	322	216	173	161	121	55	38	38
04	144	171	508	324	215	173	159	121	55	40	28
05	132	175	535	325	214	177	162	120	57	38	33
06	118	178	530	320	216	180	162	121	56	41	84
07	120	183	534	336	225	185	164	120	56	37	19
08	124	192	560	348	252	194	186	165	54	34	23
09	116	206	544	348	261	208	184	124	57	37	30
10	118	221	653	357	269	224	217	147	48	35	49
11	109	216	551	366	279	218	199	134	56	38	27
12	109	212	552	353	268	214	197	133	59	39	44
13	109	206	530	432	265	208	204	141	59	42	82
14	87	207	516	310	211	209	160	122	54	37	32
15	97	188	533	339	243	190	175	125	59	41	32
16	99	183	527	328	231	185	168	122	58	43	42
17	116	194	535	294	229	195	180	124	59	42	39
18	121	177	636	331	233	178	176	150	60	49	64
19	112	165	524	325	213	166	165	129	56	45	--
20	114	164	530	325	230	165	165	121	60	53	--
21	106	159	526	329	228	160	151	113	58	68	88
22	108	160	509	319	210	161	143	106	55	44	35
23	112	154	520	286	194	155	138	101	53	42	24
24	103	158	--	--	--	158	--	--	--	--	--
25	111	153	525	313	212	153	153	153	51	38	18
26	82	150	526	301	203	150	137	100	53	41	25
27	90	152	526	302	201	152	139	98	50	37	18
28	80	149	510	268	176	149	123	92	46	39	19
29	76	138	514	285	211	138	136	124	47	34	--
30	64	140	584	305	190	140	127	99	51	43	90
31											
Mean	109.3	176	539	325	225	177	164	124	55	41	43

AUGUST 2002 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
192.6	198.3
180.3	185.7
167.8	172.7
150.9	155.3
141.9	146.0
144.6	148.8
136.2	140.1
134.6	138.3
140.1	144.0
148.4	152.4
172.3	176.9
183.9	188.8
191.8	196.8
208.1	213.5
210.3	215.7
213.8	219.1
226.7	232.3
241.0	246.9
237.0	242.6
227.5	232.8
# 1700UT Reading	
219.9	225.0
220.1	225.1
224.5	229.5
195.6	199.8
178.6	182.4
168.6	172.2
161.4	164.7
163.2	166.4
169.3	172.6
170.2#	173.5#
180.3	183.7
183.9	188.4

♦ 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
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 2002 data combine observations from 41 stations. (http://sidc.oma.be)

♦ 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
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	109	110	112	114	114	114	115	115	111
2002	114	115	113	111	108	105	102	99	96	93	90	86	103
				(4)	(8)	(10)	(9)	(9)	(11)	(13)	(13)	(12)	(7)
2003	82	79	76	74	70	68	66	64	62	59	57	56	68
	(10)	(9)	(10)	(11)	(11)	(12)	(12)	(12)	(13)	(15)	(16)	(18)	(12)
2004	55	54	53	52	50	48	46	43	41	40	39	37	47
	(20)	(21)	(22)	(22)	(23)	(23)	(23)	(24)	(25)	(25)	(26)	(26)	(23)

*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 2002 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 2003 prediction. There exists a 90% chance that in March 2003 the actual smoothed sunspot number will fall somewhere between 66 and 86.

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.