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.

AUGUST 2002 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

	Sunspot	Obs Flux	Solar Flux Adjusted to 1 Astronomical Unit								
	Number	Pentic	PALE	PALE	PALE	Pentic	PALE	PALE	PALE	PALE	PALE
Day	Intl	(2800)	(15400)	(8800)	(4995)	(2800)	(2695)	(1415)	(610)	(410)	(245)
01	137	193	536	344	258	198	179	112	52	11	37
02	132	180	550	339	238	185	167	108	52	59	61
03	121	168	576	339	234	173	167	133	52	42	---
04	95	151	533	320	206	155	142	107	51	41	30
05	84	142	525	311	195	146	137	94	47	36	27
06	87	145	535	311	197	149	137	96	54	42	32
07	88	136	697	302	202	139	138	112	51	37	16
08	76	135	493	307	185	138	135	94	46	39	52
09	73	140	527	327	216	143	131	111	50	35	40
10	73	148	521	313	198	151	138	105	51	39	31
11	99	172	529	329	217	176	151	111	54	38	23
12	117	184	546	340	238	188	167	119	55	38	25
13	134	192	551	363	256	196	180	123	54	38	---
14	177	208	565	399	285	213	194	128	53	36	23
15	185	210	563	408	290	215	197	143	59	40	25
16	174	214	568	449	306	219	200	165	64	---	---
17	186	227	569	420	312	232	209	135	59	40	68
18	179	241	661	466	350	247	226	157	58	48	93
19	164	237	573	437	316	242	221	145	61	40	25
20	140	228	573	406	292	233	211	145	60	41	48
21	127	220	578	398	281	225	207	145	69	55	91
22	114	220	578	391	296	225	224	154	107	---	---
23	123	225	566	382	280	229	210	143	67	50	59
24	99	196	534	347	240	200	176	126	59	47	46
25	98	179	523	344	235	182	167	118	61	49	42
26	79	169	526	312	217	172	150	113	56	45	69
27	80	161	624	324	222	164	156	132	57	39	31
28	81	163	520	330	215	166	159	121	54	38	33
29	82	169	525	324	213	172	154	102	56	40	23
30	97	170	530	336	229	173	160	112	54	40	29
31	106	180	544	338	242	183	164	113	57	46	45
Mean	116.4	184	556	357	247	188	173	123	57	41	42

JULY 2002 FINAL FLUX

Observed	Adjusted
Pentic	Pentic
(2800)	(2800)
147.4	152.3
148.5	153.5
147.4#	152.4#
146.3	151.3
138.8	143.5
# 1700UT Reading	
133.5	138.0
136.9	141.5
130.9	135.3
136.3	140.9
128.8	133.1
136.4	141.0
133.2	137.7
134.9	139.4
143.8	148.6
159.5#	164.8#
171.5	177.2
180.0	185.9
180.7	186.6
182.3	188.3
184.8	190.7
182.8	188.7
189.7	195.8
198.3	204.6
208.4	215.0
217.7	224.5
241.5	249.1
230.8	238.0
238.8	246.2
234.0	241.1
227.2	234.1
208.5	214.8
173.5	179.2

♦ 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 August 2002 data combine observations from 37 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	112	109	106	103	101	98	95	92	89	85	101
			(4)	(7)	(10)	(11)	(11)	(11)	(12)	(14)	(14)	(12)	(9)
2003	81	78	75	73	70	67	65	63	61	58	56	55	67
	(10)	(10)	(10)	(11)	(11)	(12)	(12)	(13)	(14)	(15)	(17)	(19)	(13)
2004	54	53	52	51	50	48	45	43	41	40	39	37	46
	(21)	(22)	(23)	(23)	(23)	(23)	(23)	(24)	(25)	(26)	(26)	(26)	(24)

*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 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 January 2003 prediction. There exists a 90% chance that in February 2003 the actual smoothed sunspot number will fall somewhere between 68 and 88.

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.