SOLAR INDICES BULLETIN

JUNE

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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.

JUNE 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	85	148	574	300	187	152	135	117	69	48	24
02	79	155	574	315	199	155	150	136	72	50	36
03	75	166	583	279	189	170	144	129	66	48	22
04	101	170	554	260	190	174	153	127	64	45	35
05	95	171	598	327	218	176	163	136	73	48	19
06	99	186	610	337	232	191	182	149	78	---	---
07	105	180	586	290	203	185	158	144	77	---	---
08	120	175	577	302	210	180	161	138	77	49	20
09	122	169	572	306	208	174	167	150	73	66	38
10	119	180	571	303	216	185	176	146	73	44	18
11	151	187	581	325	221	192	171	163	83	55	---
12	147	193	598	330	234	198	196	166	81	47	19
13	156	199	595	321	231	205	189	172	83	52	23
14	171	201	603	323	230	207	183	164	81	54	25
15	158	202	598	327	251	208	192	165	78	52	23
16	142	198	589	322	236	204	180	161	79	57	22
17	139	193	592	320	228	199	176	160	77	53	26
18	147	188	588	305	224	194	181	159	77	52	---
19	145	178	585	317	216	183	168	151	76	49	26
20	159	184	507	305	215	190	174	152	75	47	17
21	147	188	447	240	183	194	147	150	76	46	17
22	127	180	555	286	199	185	158	147	68	45	31
23	124	175	573	308	206	180	153	147	37	45	15
24	119	168	588	314	225	173	159	142	72	48	18
25	111	175	569	268	189	180	153	143	---	50	---
26	129	177	581	324	235	183	170	143	76	55	---
27	138	179	584	316	214	185	157	145	72	52	31
28	115	175	589	317	214	180	164	132	68	45	19
29	109	163	579	297	199	168	157	137	70	47	19
30	114	160	576	302	198	165	157	138	70	46	16
31											
Mean	124.9	179	576	306	213	184	166	147	73	50	23

MAY 2000 FINAL FLUX

Day	Observed Pentic (2800)	Adjusted Pentic (2800)
01	157.7	160.1
02	152.8	155.3
03	137.3	139.6
04	134.5	136.8
05	129.8	132.1
06	126.8	129.1
07	130.9	133.4
08	137.0	139.6
09	149.5	152.5
10	179.2+	182.8+
	+ burst ip	
11	177.7	181.3
12	190.4	194.4
13	217.3	222.0
14	232.5	237.6
15	244.4	249.9
16	258.7	264.5
17	262.0	268.1
18	252.9	258.8
19	254.3	260.4
20	245.6	251.6
21	232.3	238.0
22	214.9	220.3
23	204.3	209.5
24	189.4	194.3
25	172.8	177.4
26	167.9	172.4
27	161.8	166.2
28	155.9	160.2
29	149.0	153.1
30	146.4	150.5
31	154.4	158.7
Mean	184.5	188.7

♦ 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 June 2000 data combine observations from 34 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	112	113	114	114	115	115	115	115	115	114	113	113	114
	(4)	(8)	(11)	(14)	(18)	(19)	(20)	(23)	(27)	(29)	(32)	(34)	(19)
2001	113	113	112	112	111	111	110	109	108	107	106	105	110
	(35)	(36)	(37)	(40)	(41)	(41)	(39)	(39)	(40)	(39)	(38)	(37)	(39)

*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 <u>smoothed</u> 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 December 2000 prediction. There exists a 90% chance that in December 2000 the actual smoothed sunspot number will fall somewhere between 79 and 147.

<u>The McNish-Lincoln prediction method generates useful estimates of smoothed, monthly mean sunspot numbers for no more than 12 months ahead.</u> 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.