SOLAR INDICES BULLETIN

FEBRUARY 2001

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ISSN 1046-1914

♦ 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.

FEBRUARY 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	78	161	579	281	187	156	142	128	68	44	---
02	78	166	581	329	192	161	141	138	70	44	16
03	92	164	562	298	188	159	142	133	69	42	94
04	91	164	568	297	188	159	144	131	69	45	17
05	105	165	549	304	193	160	146	135	71	54	24
06	110	170	576	284	186	165	152	133	71	47	23
07	105	164	570	328	182	159	153	144	68	45	16
08	111	157	549	289	176	152	138	136	70	44	16
09	114	162	512	286	178	157	141	135	72	43	17
10	105	161	566	299	185	156	147	138	71	45	16
11	100	151	560	288	176	147	142	131	69	46	16
12	71	145	560	287	169	141	127	133	65	44	15
13	71	141	565	292	171	137	127	118	65	44	16
14	68	138	---	---	---	134	---	---	---	---	---
15	75	135	550	287	171	131	129	108	66	46	16
16	73	130	567	280	163	126	127	108	65	43	16
17	71	130	564	285	162	126	115	107	66	42	17
18	76	132	559	281	164	128	123	115	66	43	16
19	75	137	555	288	172	133	124	117	65	43	15
20	76	146	548	291	176	142	133	117	67	43	15
21	94	144	564	292	183	140	133	126	---	---	---
22	81	146	569	288	178	142	137	130	---	---	---
23	59	145	566	298	181	141	144	136	67	43	19
24	48	137	549	324	166	134	128	125	66	42	13
25	56	135	560	287	168	132	125	124	66	39	---
26	58	135	543	281	166	132	118	123	67	40	13
27	50	131	549	281	159	128	126	117	63	42	15
28	51	132	558	289	162	129	119	119	60	15	15
29											
30											
31											
Mean	80.1	147	559	293	176	143	134	126	67	43	20

JAN 2001 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
171.0	165.3
176.1	170.2
169.9	164.2
174.6	168.8
176.3	170.5
179.4	173.4
176.7	170.9
167.1	161.5
166.3	160.8
162.8	157.4
165.9	160.5
178.3	172.5
184.3	178.3
176.3	170.6
169.2	163.8
161.9	156.6
151.9	147.0
151.5	146.6
152.5	147.7
153.2	148.3
151.5	146.7
162.1	157.1
167.1	162.0
172.5	167.2
168.6	163.4
165.6	160.5
166.8	161.8
167.6	162.6
165.4	160.5
159.6	154.9
153.3	148.8
166.6	161.3

♦ 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 February 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
2000	113	117	120	121	119	119	120	119	118	118	117	116	118
									(5)	(10)	(15)	(18)	(4)
2001	116	116	115	115	114	114	113	111	111	109	108	107	112
	(19)	(22)	(23)	(26)	(29)	(29)	(28)	(28)	(30)	(30)	(30)	(29)	(27)
2002	106	105	102	100	98	95	93	90	87	85	82	79	93
	(28)	(28)	(28)	(27)	(26)	(26)	(25)	(24)	(23)	(22)	(21)	(20)	(25)

*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 Septeptember 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 August 2001 prediction. There exists a 90% chance that in August 2001 the actual smoothed sunspot number will fall somewhere between 83 and 139.

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.