SOLAR INDICES BULLETIN

JANUARY 2005

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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} $J/m^2Hz sec$. 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.

JANUARY 2005 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	32	99	382	194	140	95	99	53	36	26	11
02	32	100	504	235	151	96	99	54	41	31	12
03	24	94	499	231	146	90	94	50	37	26	12
04	14	88	497	222	138	85	88	48	36	27	9
05	11	88	484	227	139	85	87	47	38	25	10
06	16	83	—	—	—	80	—	—	—	—	—
07	11	84	487	218	135	81	85	46	35	23	11
08	10	89	481	229	142	86	87	47	35	23	9
09	14	88	479	210	138	85	87	46	34	20	9
10	19	90	485	229	143	87	91	47	34	25	10
11	27	94	502	232	149	90	95	50	35	26	11
12	40	102	506	251	169	98	102	54	38	29	14
13	41	116	417	283	191	112	118	56	44	31	19
14	54	130	585	334	221	125	135	64	62	71	—
15	59	145	—	—	—	140	—	—	—	—	—
16	65	145	533	333	243	140	149	71	46	30	26
17	64	138	518	297	213	133	136	67	47	40	—
18	61	124	522	274	202	120	101	67	43	29	23
19	45	133	520	285	197	128	131	67	44	32	—
20	42	123	530	272	187	119	124	63	46	27	11
21	45	114	495	248	168	110	113	61	44	27	10
22	31	102	505	234	160	98	102	55	42	27	9
23	26	96	490	233	148	93	96	53	43	27	10
24	28	95	483	231	146	92	94	53	40	27	12
25	32	94	498	231	147	91	95	52	42	25	13
26	23	89	492	232	142	86	90	49	38	26	10
27	20	87	494	226	139	84	87	47	37	25	9
28	20	85	489	228	141	82	90	47	38	25	10
29	19	86	397	194	129	83	89	45	33	20	9
30	22	86	502	223	137	83	87	47	—	—	—
31	23	86	483	228	140	83	90	46	—	—	—
Mean	31.3	102	492	244	160	99	101	54	40	29	12

DEC 2004 FINAL FLUX

Day	Observed Pentic (2800)	Adjusted Pentic (2800)
01	111.0	107.8
02	105.6	102.6
03	100.8	97.9
04	97.4	94.6
05	95.9	93.1
06	93.2	90.4
07	89.7	87.1
08	96.5	93.6
09	87.4	84.7
10	84.8	82.3
11	89.8	87.1
12	90.5	87.7
13	89.7	87.0
14	89.3	86.5
15	89.3	86.5
16	90.0	87.2
17	89.9	87.1
18	90.6	87.7
19	94.0	90.9
20	93.9	90.9
21	101.0	97.7
22	98.8	95.6
23	96.4	93.2
24	97.2	94.0
25	93.0	90.0
26	91.7	88.7
27	96.9	93.7
28	105.2	101.7
29	98.5	95.3
30	100.0	96.7
31	98.5	95.2
Mean	95.0	92.1

♦ 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 January 2005 data combine observations from 49 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
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	120.7#	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	109	106	103	99	95	91	85	82	102
2003	81	79	74	70	68	65	62	60	60	58	57	55	66
2004	52	49	47	46	44	42	40	38 (3)	36 (6)	35 (7)	34 (8)	33 (10)	41 (3)
2005	31 (12)	30 (13)	29 (14)	28 (14)	26 (15)	25 (15)	24 (15)	23 (15)	23 (16)	22 (15)	21 (15)	20 (14)	25 (14)
2006	19 (13)	18 (13)	17 (14)	16 (14)	16 (15)	15 (15)	15 (14)	14 (13)	13 (13)	13 (13)	12 (13)	11 (12)	15 (14)

*May 1996 marks Cycle 22's mathematical minimum. **October 1996 marks the consensus Cycle 22 minimum which NGDC is now using.
April 2000 marks Cycle 23 maximun.

♦ 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 September 2004 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 July 2005 prediction. There exists a 90% chance that in July 2005, the actual smoothed sunspot number will fall somewhere between 9 and 39.

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.

Although every effort has been made to ensure that these data are correct, we can assume no liability for any damages their inaccuracies might cause. The charge for a 1-year subscription to this monthly bulletin is US$17.00. To become a subscriber, you may either call (303) 497-6346 or write the NATIONAL GEOPHYSICAL DATA CENTER, Solar-Terrestrial Physics Division (E/GC2), 325 Broadway, Boulder, Colorado 80305-3328 USA. Please include with your written order a cheque or money order payable in U.S. currency to the "Department of Commerce, NOAA/NGDC". Payment may also be made through VISA, MasterCard or American Express credit cards.