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 $10^{-22}\ \mathrm{J/m^2 Hz\,sec}$. During periods of low 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.

NOVEMBER 2014 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX / OCTOBER 2014 FINAL FLUX

Day	Sunspot Number Intl	Obs Flux Pentic (2800)	Solar Flux Adjusted to 1 Astronomical Unit RSTN (15400)	RSTN (8800)	RSTN (4995)	Pentic (2800)	RSTN (2695)	RSTN (1415)	RSTN (610)	RSTN (410)	RSTN (245)	October 2014 Final Flux Observed Pentic (2800)	Adjusted Pentic 2800)
01	61	120	596	324	202	168	152	125	76	51	47	155.1	155.4
02	66	124	612	324	210	168	156	130	-1	-1	-1	149.0	149.3
03	76	125	499	238	159	154	133	111	73	58	59	136.7	136.9
04	74	129	573	229	184	-1	153	120	-1	53	36	127.5	127.6
05	93	145	587	282	174	135	122	105	63	45	21	128.4	128.4
06	68	136	596	291	179	-1 +	127	103	68	43	19	130.0	129.9
07	72	146	597	283	170	146	125	108	72	45	27	125.4	125.2
08	58	132	606	296	175	132	123	106	73	49	34	126.4	126.2
09	51	132	596	289	172	132	123	107	68	46	22	118.9	118.6
10	47	136	593	286	171	136	127	108	72	43	18	120.8	120.4
11	60	142	591	287	175	142	132	110	70	43	20	112.0	111.6
12	59	153	574	295	179	153	135	121	66	40	16	110.5	110.0
13	76	154	596	299	186	154	138	121	79	47	22	113.1	112.6
14	69	161	608	306	193	161	148	130	81	53	19	132.6	131.9
15	75	161	608	304	191	161	150	132	82	53	23	125.8	125.0
16	70	172	610	327	205	172	151	139	86	56	25	138.9	138.0
17	67	168	609	312	201	168	155	137	88	55	33	145.8	144.8
18	52	167	601	329	212	167	158	134	95	50	18	172.4	171.1
19	44	170	599	329	204	170	163	122	85	50	21	173.1	171.7
20	50	168	611	331	213	168	157	132	88	52	19	204.0	202.2
21	51	163	598	325	206	163	146	129	73	42	15	199.0	197.1
22	57	167	605	309	209	167	154	127	76	49	22	216.3	214.2
23	53	173	604	306	211	173	152	126	75	50	21	227.1	224.8
24	70	144	572	314	211	172	151	120	79	53	25	217.8	215.4
25	79	169	600	307	199	169	154	125	81	54	26	219.3	216.8
26	94	171	594	315	202	171	157	131	79	51	20	216.6	214.0
27	103	179	546	295	196	179	172	122	81	51	28	187.8	185.4
28	97	181	604	329	208	181	160	133	74	48	26	167.2	165.1
29	106	177	605	324	204	177	160	131	84	60	60	150.4	148.4
30	104	177	605	326	202	177	167	134	-1	-1	-1	140.4	138.4
31												0	0
Mean	77.9	155	593	304	193	150	147	123	69	46	25	155.1	154

♦ SUNSPOT COUNTS

In 1848 the Swiss astronomer Johann Rudolf 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 the SOLAR INFLUENCE DATA CENTER, RINGLAAN 3, 1180 BRUSSELS, BELGIUM. (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 23 AND 24

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
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	116	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	39	38	36	35	35	42
2005	35	34	34	32	29	29	29	27	26	26	25	23	29
2006	21	19	17	17	17	16	15	16	16	14	13	12	16
2007	12	12	11	10	9	8	7	6	6	6	6	5	8
2008	4	4	3	3	4	3	3	3	2	2	2	2	3
2009	2	2	2	2	2	3	4	5	6	7	8	8	4
2010	9	11	12	14	16	16	17	17	20	23	27	29	18
2011	31	33	37	42	48	53	57	59	60	60	61	63	50
2012	66	67	67	65	62	59	58	58	58	59	60	61	61
2013	59	58	58	58	60	63	66	69	73	75	75	75	66
2014	77	78	81	82	81	79	78	76	74	72	70	69	76
						(4)	(8)	(9)	(9)	(9)	(10)	(12)	(5)
2015	67	65	63	62	61	58	56	54	52	51	50	48	57
	(13)	(11)	(10)	(9)	(10)	(11)	(11)	(11)	(12)	(12)	(13)	(14)	(11)
2016	47	46	44	42	40	40	39	38	37	36	34	32	39
	(16)	(18)	(19)	(21)	(21)	(22)	(22)	(22)	(22)	(23)	(24)	(25)	(21)

♦ SUNSPOT NUMBER PREDICTIONS

For the end of Solar Cycle 23, and the beginning of Cycle 24, 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 2010 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 precisely. 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 2011 prediction. There exists a 90% chance that in August 2011, the actual smoothed sunspot number will fall somewhere between 18 and 62.

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 14 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.

Although every effort has been made to ensure that these data are correct, we can assume no liability for any damages any inaccuracies might cause. Subscriptions to this monthly bulletin are available free of charge. To become a subscriber either call (303) 497-6761, or write to the NATIONAL GEOPHYSICAL DATA CENTER, Solar-Terrestrial Physics Division (E/GC2), 325 Broadway, Boulder, Colorado 80305-3328, USA. Solar Indices Bulletin can also be accessed online via the .ftp link at: ***www.ngdc.noaa.gov/stp/solar/sibintro.html***.