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.

DECEMBER 2014 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX; NOVEMBER 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)	November 2014 Final Flux: Observed Pentic (2800)	Adjusted Pentic 2800)
01	96	168	596	324	202	168	152	125	76	51	47	119.9	118.1
02	85	168	612	324	210	168	156	130	-1	-1	-1	124.4	122.4
03	78	154	499	238	159	154	133	111	73	58	59	125.2	123.2
04	73	158	593	297	170	158	130	110	-1	53	36	129.4	127.3
05	44	137	593	313	172	137	130	110	86	73	48	145.2	142.7
06	42	129	591	293	166	129	119	102	75	54	46	135.5	133.1
07	39	132	585	294	167	132	121	102	76	53	23	145.5	142.9
08	48	133	590	295	165	133	124	106	74	49	28	132.0	129.6
09	47	140	595	287	174	140	128	111	74	45	21	131.7	129.2
10	61	150	586	297	181	150	134	115	73	45	22	136.1	133.4
11	75	148	576	323	177	148	133	115	73	43	18	142.3	139.5
12	78	154	589	327	189	154	143	121	76	45	18	152.9	149.8
13	95	160	591	337	190	160	145	126	91	55	27	153.5	150.3
14	110	166	586	308	182	166	149	124	85	51	22	161.0	157.6
15	113	169	582	361	207	169	151	131	84	50	22	160.6	157.1
16	119	185	599	362	228	185	167	129	91	56	23	171.5	167.7
17	121	199	601	388	249	192	179	132	94	61	36	167.5	163.8
18	115	213	613	399	258	213	190	142	91	60	31	167.4	163.6
19	119	216	601	378	239	216	179	138	85	69	38	169.6	165.7
20	94	203	613	361	237	203	176	133	89	66	65	168.1	164.1
21	93	206	622	373	228	206	176	134	-1	-1	-1	162.5	158.6
22	80	179	543	336	204	179	159	125	86	54	30	166.6	162.6
23	78	166	594	345	196	166	148	115	83	53	24	173.1	168.8
24	63	151	596	333	180	151	135	111	83	54	24	144.4	140.7
25	66	145	597	325	174	145	130	104	78	51	25	169.4	165.0
26	60	137	596	326	182	137	130	107	81	51	24	170.9	166.5
27	62	134	592	318	167	134	117	97	78	50	23	178.8	174.1
28	68	133	587	316	165	133	117	96	72	48	22	181.4	176.6
29	64	132	581	307	165	132	117	94	69	47	23	177.3	172.5
30	66	130	331	232	139	130	112	85	68	46	22	177.3	172.4
31	65	134	586	325	177	134	124	92	74	49	19		
Mean	77.9	159	581	324	190	159	142	115	72	50	28	154.7	151.2

♦ 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	80	78	77	74	72	71	69	77
							(5)	(7)	(7)	(7)	(9)	(11)	(4)
2015	67	65	63	62	61	58	56	54	52	51	50	48	57
	(12)	(11)	(9)	(8)	(9)	(10)	(10)	(11)	(11)	(11)	(12)	(13)	(11)
2016	47	45	44	42	40	39	39	38	37	36	34	32	39
	(15)	(17)	(19)	(20)	(21)	(21)	(21)	(21)	(22)	(23)	(24)	(24)	(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.