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.

SEPTEMBER 2014 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX; AUGUST 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)	August 2014 Final Flux Observed Pentic (2800)	Adjusted Pentic 2800
01	65	127	586	280	172	127	123	104	74	52	58	168.4	173.5
02	74	136	588	287	171	136	128	101	76	49	28	155.6	160.2
03	69	138	603	302	185	138	135	85	73	49	23	151.7	156.2
04	81	146	610	310	194	146	138	109	75	47	22	139.3	143.3
05	78	144	601	308	193	144	141	114	73	47	20	139.3	143.3
06	96	157	606	315	199	157	152	118	74	46	19	136.6	140.5
07	111	160	613	320	205	151	146	114	78	50	22	136.2	140.0
08	104	164	602	325	206	164	152	120	77	57	63	123.0	126.4
09	118	159	599	316	203	159	151	121	72	54	65	113.1	116.3
10	114	175	564	303	198	160	151	115	68	47	53	108.4	111.3
11	108	151	548	297	188	151	148	114	67	40	25	104.5	107.3
12	85	152	592	294	189	152	142	117	69	39	16	104.0	106.8
13	84	145	596	298	186	145	146	118	69	39	14	102.9	105.6
14	70	139	601	294	177	139	137	112	69	40	16	102.7	105.4
15	63	133	592	292	170	133	125	106	68	46	22	113.1	116.0
16	77	133	595	291	168	133	124	112	70	45	20	112.0	114.8
17	83	133	571	279	162	125	123	99	66	42	16	115.1	117.9
18	55	120	595	286	162	120	122	107	72	45	19	110.6	113.3
19	53	122	591	279	159	122	112	100	68	43	17	110.7	113.3
20	54	119	590	281	166	119	119	101	68	43	19	118.3	121.1
21	64	124	592	286	174	124	117	97	69	44	22	128.3	131.3
22	68	136	587	289	176	130	128	100	69	46	40	126.4	129.3
23	80	138	589	286	176	138	128	106	73	47	21	132.0	134.9
24	73	145	591	294	182	145	140	113	68	43	18	140.9	144.0
25	97	167	606	316	208	158	166	123	72	44	21	151.5	154.8
26	111	170	587	306	219	170	163	116	73	46	21	128.1	130.8
27	122	181	607	315	211	181	167	133	78	51	23	122.8	125.3
28	130	181	553	326	224	181	171	118	79	51	22	118.6	121.0
29	121	175	606	325	219	175	165	128	83	54	21	120.1	122.5
30	120	162	606	307	205	162	153	123	80	50	24	123.1	125.5
31												124.8	127.1
Mean	60.6	141	592	300	188	146	140	111	72	47	26	125.2	128.3

♦ 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	78	77	76	76	75	73	71	69	68	66	74
			(5)	(9)	(11)	(13)	(15)	(16)	(16)	(16)	(17)	(18)	(11)
2015	64	62	61	60	59	56	54	52	51	50	49	47	55
	(17)	(15)	(12)	(11)	(11)	(12)	(12)	(13)	(13)	(14)	(15)	(16)	(13)
2016	46	45	44	42	40	39	38	38	37	35	34	32	39
	(18)	(20)	(22)	(23)	(24)	(24)	(24)	(24)	(24)	(24)	(25)	(26)	(23)

♦ 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.