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 $10^{-22}\ J/m^2 Hz\,sec$. 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.

JUNE 2014 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO 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)
01	44	103	583	272	145	103	105	81	59	41	19
02	43	105	578	276	150	105	100	86	59	43	20
03	51	107	588	271	151	107	110	88	66	43	21
04	44	105	587	275	150	105	104	94	68	45	20
05	60	111	589	279	157	111	64	93	56	48	23
06	82	133	575	293	166	133	122	97	66	46	21
07	92	137	602	293	182	137	135	101	70	45	19
08	98	149	566	292	186	149	142	109	68	42	19
09	108	161	589	310	209	161	152	119	79	55	21
10	112	166	508	298	204	166	157	142	92	43	17
11	120	168	617	326	221	168	170	125	78	61	70
12	136	175	612	342	241	175	165	129	66	49	23
13	126	153	615	314	201	153	154	112	68	45	22
14	95	144	616	304	188	144	143	109	63	46	25
15	51	130	601	288	172	130	131	101	68	45	22
16	58	117	594	281	160	117	109	93	59	40	17
17	66	114	593	279	159	114	115	92	65	45	20
18	83	111	601	277	158	111	111	92	56	41	19
19	66	111	597	277	152	111	103	86	59	42	19
20	55	102	594	273	148	102	99	83	60	41	19
21	64	101	592	266	143	101	99	80	61	39	19
22	62	94	585	267	142	94	91	74	56	39	18
23	53	93	588	263	138	93	98	75	54	39	17
24	28	94	586	267	142	94	98	74	58	40	18
25	38	97	588	267	145	97	99	79	59	44	42
26	46	100	548	273	144	100	99	76	57	38	24
27	46	104	581	268	150	104	106	81	59	49	34
28	49	115	549	282	166	115	117	90	67	44	27
29	64	126	604	302	182	126	132	99	66	45	24
30	91	141	616	317	197	141	145	111	75	48	50
31											
Mean	72.5	122	588	286	168	122	119	96	65	44	24

MAY 2014 FINAL FLUX

Day	Observed Pentic (2800)	Adjusted Pentic 2800)
01	125.7	127.7
02	135.4	137.6
03	132.6	134.8
04	131.5	133.7
05	139.0	141.5
06	138.9	141.3
07	145.9	148.6
08	148.1	150.8
09	152.3	155.2
10	152.1	155.1
11	164.4	167.7
12	162.9	166.3
13	159.4	162.7
14	163.2	166.7
15	152.1	155.5
16	138.7	141.8
17	133.5	136.6
18	127.5	130.4
19	116.9	119.7
20	117.2	120.1
21	113.9	116.7
22	111.3	114.1
23	116.3	119.2
24	124.5	127.7
25	113.0	116.0
26	108.2	111.1
27	105.9	108.7
28	99.4	102.1
29	102.7	105.5
30	101.6	104.4
31	103.7	106.6
Mean	130.2	133.0

♦ 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	75	75	74	74	73	73	72	70	68	67	65	64	71
	(6)	(9)	(12)	(15)	(17)	(19)	(19)	(19)	(19)	(19)	(20)	(20)	(16)
2015	62	60	59	58	57	55	53	51	50	49	48	47	54
	(19)	(16)	(13)	(12)	(12)	(13)	(13)	(14)	(15)	(15)	(17)	(18)	(15)
2016	46	45	43	41	39	39	38	37	36	35	33	31	39
	(19)	(21)	(23)	(24)	(25)	(25)	(25)	(24)	(24)	(25)	(25)	(26)	(24)

♦ 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.