SOLAR INDICES BULLETIN

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National Geophysical Data Center
325 Broadway, E/GC2
Boulder, CO 80305-3328

Solar Terrestrial Physics Division
Telephone: 303-497-6135

♦ 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.

FEBRUARY 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	66	177	632	373	233	177	158	118	74	56	69
02	83	190	664	386	245	190	171	127	77	49	29
03	96	188	555	333	217	188	166	129	73	51	26
04	108	188	630	378	249	188	176	133	74	54	37
05	117	194	643	370	251	194	174	130	72	44	23
06	120	191	630	346	237	191	172	126	72	50	39
07	103	178	590	346	218	178	160	125	72	53	23
08	103	172	587	324	209	172	153	119	73	48	28
09	103	169	624	325	211	169	162	122	77	52	30
10	96	161	591	301	187	161	144	110	73	49	23
11	111	172	597	302	201	172	154	120	68	55	58
12	113	160	596	313	202	160	149	113	64	44	26
13	103	167	575	311	201	167	147	111	67	47	21
14	91	167	471	214	163	167	141	112	71	56	38
15	79	162	593	304	197	162	147	102	74	57	33
16	72	154	580	301	187	154	138	102	75	51	23
17	74	152	588	304	187	152	137	108	74	54	34
18	89	151	588	304	187	151	139	109	70	51	29
19	88	158	579	282	191	158	143	113	67	48	21
20	93	156	587	287	186	156	144	110	69	51	48
21	95	157	587	289	188	157	144	114	70	44	23
22	102	163	592	294	196	163	145	112	69	46	19
23	111	172	596	306	205	172	156	117	70	49	26
24	107	171	598	303	206	171	158	118	71	47	22
25	120	174	610	311	205	174	160	118	68	47	20
26	145	178	604	315	201	178	163	121	70	45	21
27	154	176	604	316	207	176	163	130	70	50	21
28	137	171	606	308	197	171	161	128	81	50	18
29											
30											
31											
Mean	92.1	170	596	316	206	170	154	118	72	50	30

JANUARY 2014 FINAL FLUX

Day	Observed Pentic (2800)	Adjusted Pentic 2800)
01	159.6	154.3
02	160.5	155.2
03	182.3	176.3
04	213.3	206.2
05	217.5	210.3
06	203.9	197.2
07	237.1	229.3
08	194.6	188.2
09	184.1	178.1
10	175.1	169.4
11	166.1	160.7
12	155.3	150.2
13	143.3	138.7
14	137.0	132.6
15	126.2	122.1
16	121.0	117.1
17	128.8	124.7
18	129.6	125.5
19	127.5	123.4
20	137.4	133.0
21	146.0	141.4
22	143.3	138.9
23	136.3	132.1
24	135.5	131.3
25	133.2	129.1
26	137.9	133.7
27	143.9	139.6
28	157.2	152.5
29	156.4	151.8
30	160.5	155.8
31	165.7	160.9
Mean	160.1	155.0

♦ 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
1999	83	85	84	86	91	93	94	98	102	108	111	111	95
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	65	65	66	66	67	62
								(4)	(8)	(12)	(15)	(16)	(5)
2014	67	66	66	65	66	66	65	64	62	60	59	57	63
	(17)	(18)	(18)	(19)	(21)	(23)	(23)	(22)	(21)	(20)	(20)	(20)	(20)
2015	56	55	54	54	53	51	49	48	47	46	46	45	50
	(19)	(17)	(15)	(14)	(13)	(14)	(15)	(16)	(17)	(17)	(18)	(19)	(16)

♦ 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.