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 $10^{-22}\ J/m^2 Hz\,sec$. 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 2013 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	50	104	572	271	146	104	104	90	65	41	19
02	61	106	574	272	147	106	104	90	64	59	19
03	49	106	580	282	151	106	104	75	62	44	19
04	53	109	585	279	152	109	105	91	64	42	17
05	44	110	586	281	155	110	107	92	66	43	22
06	33	101	553	275	146	101	99	86	61	42	20
07	25	99	567	270	142	99	94	84	60	43	20
08	17	96	577	279	141	96	91	81	61	42	19
09	9	94	576	270	140	94	91	75	64	43	19
10	10	95	579	268	138	95	91	82	61	42	16
11	41	93	572	266	136	93	89	79	61	40	18
12	35	93	556	268	136	93	88	79	62	42	17
13	25	92	567	271	136	92	88	79	60	42	16
14	17	93	558	263	136	93	88	79	60	40	16
15	9	93	560	258	138	93	91	80	58	41	18
16	17	95	561	265	139	95	93	75	58	40	18
17	35	99	561	261	143	99	86	78	65	42	15
18	43	104	565	269	149	104	96	79	65	45	18
19	43	108	559	272	153	108	100	85	65	43	19
20	61	109	561	258	150	109	102	87	69	55	38
21	52	110	575	279	152	110	106	91	63	47	21
22	54	111	559	269	151	111	106	91	68	44	24
23	49	108	574	278	151	108	105	93	65	43	21
24	44	110	564	278	152	110	105	91	64	42	20
25	48	111	564	276	155	111	108	94	63	42	18
26	37	110	479	264	150	110	106	91	63	41	18
27	43	108	568	272	148	108	104	89	63	41	18
28	38	106	563	266	144	106	101	80	60	42	18
29	29	103	569	277	155	103	110	91	64	42	17
30	36	105	329	230	141	105	104	80	60	41	17
31											
Mean	36.9	103	557	270	146	103	99	85	63	43	19

AUGUST 2013 FINAL FLUX

Day	Observed Pentic (2800)	Adjusted Pentic 2800)
01	112.1	115.4
02	112.9	116.2
03	107.3	110.5
04	104.8	107.9
05	104.3	107.3
06	103.9	106.8
07	105.5	108.5
08	104.4	107.3
09	103.6	106.5
10	102.5	105.3
11	110.4	113.4
12	114.1	117.2
13	122.0	125.1
14	125.2	128.5
15	122.7	125.8
16	119.9	122.9
17	149.7	153.4
18	126.1	129.2
19	128.3	131.4
20	131.5	134.6
21	130.4	133.4
22	131.6	134.5
23	124.1	126.8
24	117.4	119.9
25	112.6	115.0
26	111.2	113.5
27	109.7	111.9
28	108.1	110.3
29	108.8	111.0
30	107.5	109.5
31	107.5	109.5
Mean	115.4	118.3

♦ 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
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	57	57	58	58	57	57	58	59	60	58
				(4)	(6)	(11)	(16)	(17)	(17)	(19)	(21)	(22)	(11)
2014	60	60	59	59	59	60	59	58	56	54	54	52	57
	(23)	(23)	(23)	(24)	(25)	(25)	(24)	(23)	(22)	(21)	(21)	(21)	(23)
2015	51	50	51	51	50	48	47	45	45	44	44	43	47
	(20)	(18)	(16)	(15)	(14)	(15)	(16)	(17)	(18)	(18)	(19)	(20)	(17)

♦ 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.