SOLAR INDICES BULLETIN

AUGUST 2012

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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.

AUGUST 2012 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

	Sunspot	Obs Flux	Solar Flux Adjusted to 1 Astronomical Unit								
	Number	Pentic	RSTN	RSTN	RSTN	Pentic	RSTN	RSTN	RSTN	RSTN	RSTN
Day	Intl	(2800)	(15400)	(8800)	(4995)	(2800)	(2695)	(1415)	(610)	(410)	(245)
01	88	150	585	304	159	150	133	136	72	47	25
02	95	135	577	303	158	135	129	132	71	45	22
03	116	140	585	301	159	140	139	138	70	46	19
04	101	139	593	301	158	139	135	134	75	47	22
05	82	134	578	292	153	134	133	130	73	45	22
06	65	134	595	305	161	134	129	131	73	53	41
07	81	129	591	300	156	129	129	127	71	45	20
08	82	133	591	292	153	133	125	123	68	47	30
09	105	131	580	298	153	131	125	122	67	46	23
10	87	125	577	290	144	125	118	114	69	45	32
11	72	120	586	284	141	120	112	111	68	41	22
12	65	112	568	282	137	112	107	105	62	40	31
13	49	108	576	276	139	108	101	99	68	48	25
14	22	106	571	284	137	106	104	99	69	44	128
15	20	101	571	280	133	101	97	91	58	40	28
16	23	98	558	276	131	98	95	88	55	37	16
17	33	95	569	271	128	95	90	88	55	37	16
18	36	97	564	273	128	97	92	87	55	37	15
19	48	96	576	272	128	96	92	89	56	37	17
20	53	96	570	270	126	96	89	90	56	38	18
21	47	94	573	272	126	94	90	89	57	38	16
22	46	95	569	271	127	95	92	91	59	38	15
23	47	97	564	271	128	97	90	94	60	39	15
24	47	104	568	282	133	104	98	101	62	41	18
25	51	106	572	277	136	106	103	104	64	42	19
26	52	113	334	279	138	113	109	108	66	44	19
27	50	112	573	241	126	112	100	104	65	43	16
28	53	111	568	278	138	111	111	110	67	43	17
29	55	118	581	262	132	118	109	110	67	42	19
30	84	128	591	299	160	128	123	124	70	45	20
31	100	131	594	301	168	131	128	107	71	45	20
Mean	61.5	116	569	283	142	116	111	109	65	43	25

JUL 2012 FINAL FLUX

Observed	Adjusted
Pentic	Pentic
(2800)	(2800)
133.4	137.9
165.9	171.4
145.8	150.7
163.2	168.6
164.6	170.1
157.7	163
158.4	163.7
177.7	183.7
173.8	179.6
173.4	179.2
161.7	167.1
165.4	170.9
147.2	152.1
147.9	152.8
140.5	145.1
154.4	159.5
127.5	131.7
109.5	113.1
100	103.2
92.3	95.3
89.9	92.8
93.7	96.7
96.7	99.8
102.4	105.7
105.4	108.7
114.7	118.3
123.3	127.1
126.6	130.5
131.4	135.4
136	140.1
139.8	144
136.1	140.5

SOLAR INDICES BULLETIN (continued)

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♦ 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
1998	44	49	53	57	59	62	65	68	70	71	73	78	62
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	68	69	70	71	73	75	77	79	79	80	73
			(4)	(9)	(11)	(15)	(18)	(19)	(20)	(23)	(26)	(29)	(15)
2013	81	83	84	84	84	85	84	83	83	83	83	83	83
	(32)	(34)	(35)	(36)	(37)	(39)	(41)	(40)	(39)	(39)	(39)	(39)	(38)
2014	83	82	80	80	79	78	77	76	73	71	69	67	76
	(38)	(37)	(36)	(36)	(35)	(34)	(34)	(33)	(32)	(31)	(29)	(28)	(34)

♦ SUNSPOT NUMBER PREDICTIONS

For the end of Solar Cycle 23, and the beginning of Cycle 24, the table gives <u>smoothed</u> 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.

<u>The McNish-Lincoln prediction method generates useful estimates of smoothed, monthly mean sunspot numbers for no more than 12 months ahead.</u> 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.