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 2012 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	95	146	594	312	175	146	140	122	74	48	21
02	93	142	592	304	165	142	135	118	74	46	22
03	112	142	600	300	165	142	138	117	73	46	21
04	104	138	534	293	155	138	130	113	73	45	22
05	80	133	578	287	150	133	126	112	69	42	22
06	76	128	584	288	150	128	124	110	66	43	17
07	62	133	586	295	159	133	130	107	65	42	16
08	54	129	585	289	156	129	125	105	64	40	16
09	58	123	585	270	140	123	115	95	61	40	16
10	46	111	579	278	135	111	107	88	59	39	17
11	50	105	584	283	136	105	103	86	59	41	22
12	48	103	575	268	134	103	98	82	58	41	23
13	38	99	577	272	127	99	93	82	58	40	19
14	34	101	525	272	128	101	92	79	60	45	24
15	40	98	526	273	129	98	92	80	55	36	19
16	42	97	444	269	131	97	95	83	56	39	25
17	36	102	573	276	132	102	97	86	59	43	30
18	42	104	573	276	133	104	102	88	60	42	22
19	44	110	588	240	126	110	101	89	60	43	21
20	53	117	586	275	139	117	112	98	64	42	23
21	55	117	584	279	140	117	111	101	66	43	21
22	38	125	551	286	149	125	119	109	70	43	20
23	49	134	590	286	151	134	129	116	72	46	25
24	66	137	592	286	151	137	129	118	75	45	21
25	89	140	608	299	159	140	132	123	74	46	21
26	95	139	555	300	167	139	135	121	78	51	27
27	74	133	591	294	156	133	128	120	75	48	17
28	56	138	468	304	162	138	132	121	76	46	19
29	52	136	544	272	154	136	126	113	80	51	27
30	65	136	475	305	163	136	129	110	73	46	56
31											
Mean	61.5	123	564	284	147	123	118	103	67	44	22

AUG 2012 FINAL FLUX

Day	Observed Pentic (2800)	Adjusted Pentic (2800)
01	150.1	154.6
02	134.6	138.6
03	139.7	143.8
04	138.7	142.7
05	134	137.9
06	134.1	137.9
07	128.5	132.1
08	133.3	137
09	131.2	134.8
10	125.4	128.8
11	119.7	123
12	112.3	115.3
13	108.1	110.9
14	105.8	108.5
15	100.7	103.2
16	98.3	100.8
17	95.1	97.5
18	97	99.4
19	96.2	98.5
20	96.2	98.5
21	94.2	96.4
22	94.8	96.9
23	96.7	98.8
24	104.2	106.4
25	105.9	108.1
26	113.2	115.6
27	111.5	113.7
28	111.2	113.4
29	118.3	120.6
30	127.8	130.2
31	130.5	132.9
Mean	115.7	118.6

♦ 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	67	68	69	70	72	74	76	77	78	79	72
				(5)	(8)	(12)	(15)	(16)	(18)	(21)	(25)	(27)	(12)
2013	80	82	83	83	83	84	84	83	82	82	82	83	82
	(31)	(33)	(34)	(36)	(37)	(39)	(41)	(40)	(39)	(38)	(39)	(39)	(37)
2014	82	81	80	79	78	77	76	75	73	70	68	67	76
	(38)	(37)	(36)	(36)	(35)	(34)	(33)	(32)	(32)	(30)	(29)	(28)	(33)

♦ 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.