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.

DECEMBER 2012 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX | NOV 2012 FINAL 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)	NOV 2012: Observed Pentic (2800)	NOV 2012: Adjusted Pentic 2800)
01	38	102	555	261	138	102	94	81	57	39	23	98.4	96.8
02	34	98	561	263	135	98	88	78	57	38	19	96.5	94.9
03	32	97	540	151	133	97	90	79	53	37	23	93.3	91.8
04	39	96	548	259	134	96	86	79	56	39	18	95.0	93.4
05	43	96	551	257	133	96	89	78	52	39	20	96.6	94.9
06	20	97	566	266	135	97	89	81	55	40	20	98.7	96.9
07	22	97	556	263	135	97	90	80	58	38	18	101.7	99.8
08	36	101	555	259	138	101	96	82	54	38	19	104.1	102.2
09	30	104	550	265	141	104	95	85	56	35	24	115.1	112.9
10	31	104	556	264	139	104	95	84	50	38	23	122.2	119.8
11	34	104	568	264	140	104	96	87	60	36	20	133.3	130.6
12	48	112	570	271	147	112	102	91	61	40	21	143.8	140.8
13	52	117	562	272	151	117	107	94	63	40	33	146.2	143.1
14	43	119	572	279	156	119	110	96	63	43	29	142.1	139.1
15	45	122	562	277	158	122	107	98	61	40	25	141.7	138.6
16	47	120	567	276	155	120	109	96	65	43	52	138.3	135.2
17	53	115	467	243	138	115	115	91	61	43	24	135.5	132.4
18	43	116	562	273	153	116	109	94	68	45	30	141.0	137.7
19	39	113	548	272	148	113	105	92	53	44	65	133.9	130.7
20	40	114	583	283	138	114	108	89	61	43	27	141.2	137.8
21	43	115	560	268	148	115	104	91	59	40	27	140.4	137.0
22	56	115	568	275	157	115	110	90	58	40	25	127.7	124.5
23	57	114	573	270	153	114	104	88	56	39	24	126.7	123.5
24	41	113	563	271	155	113	104	93	57	33	23	118.0	115.0
25	38	113	527	267	152	113	100	85	58	39	22	121.6	118.4
26	41	110	566	269	149	110	100	86	57	39	21	121.8	118.6
27	39	107	562	262	145	107	98	82	56	38	21	117.1	114.0
28	38	106	567	262	145	106	98	92	55	38	21	114.3	111.2
29	40	104	559	268	146	104	96	84	56	37	21	113.1	110.0
30	40	107	550	268	150	107	98	86	57	37	20	110.6	107.5
31	64	108	552	274	155	114	104	87	58	42	21		
Mean	40.8	108	556	267	145	108	100	87	58	39	25	120.9	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
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	65	62	59	61	63	66	68	68	70	65
							(4)	(7)	(11)	(17)	(21)	(24)	(7)
2013	72	74	75	75	75	76	76	75	74	74	75	76	75
	(28)	(30)	(32)	(33)	(35)	(37)	(39)	(39)	(36)	(36)	(37)	(37)	(35)
2014	75	74	73	73	72	71	70	69	67	65	63	62	70
	(36)	(35)	(34)	(34)	(33)	(32)	(31)	(31)	(30)	(29)	(28)	(26)	(32)

♦ 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.