SOLAR INDICES BULLETIN

JUNE 2011

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.

JUNE 2011 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	83	114	573	264	158	114	117	104	55	41	27
02	89	112	569	260	159	112	111	106	57	36	16
03	86	107	501	275	152	107	110	103	56	38	22
04	76	103	575	262	149	103	103	100	56	37	20
05	53	103	579	266	150	103	105	100	56	36	16
06	46	100	571	260	141	100	102	97	56	37	17
07	38	96	524	249	140	96	95	93	54	35	15
08	30	90	572	258	144	90	89	86	53	36	16
09	26	88	571	262	138	88	88	83	52	34	16
10	22	87	567	254	137	87	88	82	51	35	18
11	15	85	540	254	133	85	82	79	47	32	15
12	11	85	562	251	135	85	85	80	52	36	16
13	10	87	566	252	137	87	87	80	51	36	17
14	24	99	567	259	149	99	100	88	52	36	16
15	34	102	564	260	149	102	102	88	52	37	17
16	39	103	575	260	156	103	102	92	51	36	17
17	39	104	441	267	144	104	102	89	49	38	18
18	40	99	575	261	147	99	100	94	60	33	14
19	31	99	572	259	149	99	98	91	54	36	16
20	26	96	571	258	144	96	96	92	55	36	17
21	33	95	402	258	142	95	94	93	53	35	16
22	33	93	576	256	137	93	92	92	56	37	17
23	38	96	528	261	141	96	96	92	53	37	17
24	43	96	575	260	142	96	98	92	53	36	17
25	33	94	575	260	137	94	95	90	52	36	16
26	18	90	566	257	136	90	90	85	52	36	17
27	10	89	570	256	137	89	90	83	50	35	16
28	25	87	566	256	133	87	89	81	46	30	13
29	27	87	569	254	136	87	89	82	51	34	21
30	32	89	565	259	135	89	89	82	51	36	22
31											
Mean	43.8	96	554	259	143	96	96	90	53	36	17

MAY 2011 FINAL FLUX

Day	Observed Pentic (2800)	Adjusted Pentic (2800)
01	106.1	107.7
02	109.8	111.5
03	107.0	108.8
04	106.9	108.7
05	104.9	106.7
06	101.9	103.7
07	102.2	104.1
08	102.2	104.1
09	103.7	105.7
10	97.5	99.4
11	94.1	96.0
12	92.8	94.7
13	91.5	93.5
14	91.4	93.4
15	94.5	96.6
16	92.2	94.3
17	91.5	93.6
18	90.6	92.7
19	84.4	86.4
20	83.7	85.7
21	83.6	85.7
22	84.5	86.6
23	84.1	86.3
24	81.7	83.8
25	80.3	82.4
26	82.7	84.9
27	89.9	92.3
28	100.5	103.2
29	110.8	113.8
30	111.9	115.0
31	112.0	115.2
Mean	95.8	97.9

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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
1997	10	11	14	17	18	20	23	25	28	32	35	39	23
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	34	37	39	41	43	45	47	50	52	54	42
	(4)	(7)	(9)	(10)	(10)	(11)	(12)	(14)	(19)	(23)	(27)	(31)	(15)
2012	56	58	60	61	62	64	66	68	71	72	72	73	65
	(33)	(36)	(38)	(40)	(41)	(41)	(42)	(41)	(40)	(40)	(40)	(40)	(39)
2013	75	76	77	77	77	78	78	77	77	77	77	77	77
	(41)	(41)	(40)	(41)	(42)	(44)	(46)	(46)	(44)	(43)	(43)	(43)	(43)

♦ 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.