SOLAR INDICES BULLETIN

MARCH 2011

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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 $10^{-22}\ J/m^2 Hz\,sec$. 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 Radio Solar Telescope Network (RSTN) preliminary observed and adjusted 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 data are replaced by fluxes measured either at Sagamore Hill, Massachusetts, San Vito, Italy, or Learmonth, Australia.

MARCH 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	44	111	572	265	147	111	99	79	45	35	19
02	40	113	570	276	154	113	108	86	48	43	24
03	52	121	590	280	158	121	112	91	51	44	43
04	70	127	582	283	165	127	117	97	50	39	36
05	82	135	574	289	178	135	125	98	51	42	40
06	92	143	576	302	197	143	138	110	54	47	70
07	98	152	547	281	194	153	139	113	57	45	50
08	100	167	590	301	196	155	138	110	54	43	37
09	80	143	587	297	185	143	130	104	57	43	28
10	59	131	575	281	170	131	124	101	55	42	49
11	59	123	412	235	160	123	114	95	50	34	20
12	59	121	584	280	169	121	114	95	51	39	21
13	66	113	561	274	157	113	110	96	55	44	29
14	43	107	562	267	151	107	108	91	54	40	20
15	34	102	577	262	142	102	95	85	49	37	16
16	27	105	461	233	127	95	88	76	43	33	16
17	27	90	566	255	130	90	83	77	46	35	16
18	20	88	565	254	129	88	79	73	44	34	15
19	23	89	554	259	130	89	84	75	46	35	15
20	21	92	578	258	134	92	86	74	45	34	15
21	17	101	532	263	144	101	98	80	45	34	15
22	32	100	568	261	145	100	96	82	48	37	17
23	30	105	578	268	147	105	97	81	49	37	20
24	39	108	561	262	146	108	106	90	-1	42	18
25	69	113	582	267	150	113	106	92	49	43	21
26	72	115	582	272	149	115	108	97	52	41	38
27	84	116	583	273	151	117	108	100	53	38	26
28	88	119	587	273	156	119	111	103	56	40	19
29	74	116	585	272	152	116	110	102	56	38	18
30	68	118	584	261	147	116	111	106	59	41	24
31	62	113	573	271	149	113	107	106	60	42	27
Mean	54.4	116	564	270	155	112	108	92	48	38	25

FEB 2011 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic (2800)
79.9	77.6
79.2	77.0
80.4	78.1
82.1	79.8
81.0	78.7
80.2	78.0
82.3	80.1
89.7	87.3
88.7	86.4
91.4	89.0
91.2	88.9
95.6	93.1
106.8	104.1
112.6	109.8
112.8	110.0
114.1	111.4
110.9	108.3
124.8	121.9
109.4	106.9
104.6	102.2
96.7	94.6
90.9	89.0
89.3	87.4
88.9	87.0
88.2	86.4
90.2	88.4
90.4	88.7
95.8	94.0
94.5	92.2

♦ 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
1996	10	10	10	9	8	9	8	8	8	9	10	10	9
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	95
1999	83	85	84	86	91	93	94	98	102	108	111	111	117
2000	113	117	120	121	119	119	120	119	116	115	113	112	111
2001	109	104	105	108	109	110	112	114	114	114	116	115	102
2002	114	115	113	111	109	106	103	99	95	91	85	82	66
2003	81	79	74	70	68	65	62	60	60	58	57	55	42
2004	52	49	47	46	44	42	40	39	38	36	35	35	29
2005	35	34	34	32	29	29	29	27	26	26	25	23	16
2006	21	19	17	17	17	16	15	16	16	14	13	12	8
2007	12	12	11	10	9	8	7	6	6	6	6	5	3
2008	4	4	3	3	4	3	3	3	2	2	2	2	4
2009	2	2	2	2	2	3	4	5	6	7	8	8	18
2010	9	11	12	14	16	16	17	17	20	21	23	25	45
										(3)	(6)	(10)	(11)
2011	27	29	30	33	35	37	38	40	42	45	47	48	65
	(13)	(15)	(17)	(18)	(19)	(19)	(18)	(20)	(24)	(27)	(30)	(32)	(37)
2012	50	52	54	56	57	58	61	64	66	68	68	69	77
	(35)	(37)	(39)	(41)	(43)	(44)	(44)	(43)	(42)	(42)	(43)	(43)	(42)

♦ 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.