SOLAR INDICES BULLETIN

MARCH 2014

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 $10^{-22}\ J/m^2 Hz sec$. 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.

MARCH 2014 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	111	165	601	308	193	165	149	126	79	51	23
02	113	161	522	262	182	161	144	126	76	46	20
03	115	161	600	304	196	161	151	123	79	47	20
04	101	158	596	298	188	158	146	124	77	46	30
05	110	149	590	287	177	149	140	117	70	47	21
06	91	149	593	293	176	149	133	115	76	43	17
07	96	148	588	294	171	148	131	111	67	44	19
08	83	142	513	262	157	142	128	105	63	43	18
09	79	146	568	295	177	146	130	106	66	43	18
10	81	152	608	312	204	152	156	118	72	53	36
11	79	165	593	298	186	165	147	114	70	50	28
12	94	148	601	300	181	148	137	115	72	48	50
13	80	148	593	289	174	148	133	112	71	46	21
14	78	144	587	268	175	144	133	111	64	40	16
15	79	139	584	269	170	139	130	107	66	40	16
16	87	136	550	296	175	136	132	103	67	44	18
17	90	136	579	286	166	136	126	112	72	43	24
18	97	138	597	295	177	138	134	116	75	48	21
19	101	149	603	301	182	149	135	115	77	46	19
20	99	151	581	298	183	151	138	119	74	45	22
21	90	153	592	300	182	153	140	121	74	53	28
22	104	155	594	294	184	155	144	122	68	40	13
23	108	157	602	305	193	157	144	120	74	44	15
24	98	159	590	290	183	159	149	125	67	38	12
25	97	153	595	295	176	153	142	123	78	47	20
26	80	153	581	293	181	153	142	123	82	50	21
27	82	145	580	282	173	145	140	116	79	49	79
28	87	146	586	295	179	146	137	113	79	49	20
29	84	143	599	295	174	143	131	114	77	48	23
30	79	148	595	302	189	148	142	116	75	52	34
31	84	152	591	294	184	152	138	113	75	51	27
Mean	92.2	150	586	292	180	150	139	116	73	46	24

FEBRUARY 2014 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic 2800)
176.7	171.6
189.8	184.4
188.3	183.0
188.1	182.9
193.5	188.1
191.3	186.1
178.0	173.2
171.8	167.2
169.0	164.6
161.0	156.8
172.2	167.8
160.1	156.1
166.6	162.5
166.6	162.5
162.1	158.1
153.9	150.2
152.4	148.9
151.4	147.9
157.7	154.2
156.4	153.0
156.8	153.4
163.2	159.7
171.8	168.2
170.7	167.2
173.9	170.4
178.2	174.7
175.7	172.4
170.6	167.5
170.2	166.1

♦ 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
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	58	58	58	59	60	61	61
2013	59	58	58	58	60	63	66	69	69	70	70	70	64
									(5)	(10)	(13)	(14)	(4)
2014	70	70	69	69	69	68	68	67	64	63	61	60	66
	(15)	(16)	(16)	(17)	(19)	(21)	(22)	(21)	(20)	(19)	(19)	(19)	(19)
2015	58	57	56	56	55	53	51	49	48	47	47	46	52
	(18)	(16)	(14)	(13)	(13)	(14)	(15)	(16)	(16)	(17)	(18)	(18)	(16)

♦ 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.