SOLAR INDICES BULLETIN

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

JANUARY 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	87	160	598	299	194	160	147	114	70	45	22
02	93	161	596	321	207	161	147	105	70	46	27
03	107	182	608	315	216	182	161	116	73	54	34
04	95	213	649	358	253	215	196	135	84	63	37
05	94	218	628	353	260	218	196	133	83	67	135
06	117	204	598	342	250	204	183	141	82	61	81
07	98	237	600	333	245	200	183	133	142	213	272
08	75	195	606	341	240	195	174	134	97	86	141
09	84	184	599	334	225	184	167	128	86	52	156
10	96	175	600	316	210	175	158	128	75	49	33
11	99	166	591	312	204	166	148	120	80	51	26
12	93	155	582	292	193	155	142	116	76	52	37
13	82	143	582	287	177	143	133	110	77	54	26
14	67	137	591	279	169	137	125	106	74	50	21
15	65	126	582	273	156	126	113	100	70	47	21
16	56	121	577	273	158	121	110	99	72	46	19
17	52	129	581	275	157	129	110	97	68	45	24
18	81	130	578	272	163	130	119	100	65	45	23
19	77	128	587	276	160	128	118	100	66	45	23
20	93	137	595	291	177	137	135	110	73	46	21
21	90	146	587	293	174	146	133	111	70	43	18
22	108	143	592	289	173	143	131	116	73	46	19
23	102	136	576	282	167	136	126	101	73	44	19
24	81	136	578	283	170	136	136	113	70	44	18
25	70	133	582	286	163	133	121	105	70	49	24
26	68	138	582	286	163	138	121	105	69	46	20
27	53	144	603	317	194	144	133	109	72	47	26
28	59	157	608	323	204	157	141	104	70	45	22
29	66	156	600	323	201	156	142	109	69	44	19
30	69	161	615	322	214	161	155	114	77	52	25
31	65	166	618	358	215	166	150	116	73	53	93
Mean	102	160	596	307	195	157	144	114	76	56	48

DECEMBER 2013 FINAL FLUX

Observed Pentic (2800)	Adjusted Pentic 2800)
130.5	126.9
133.7	130.0
135.7	131.9
138.0	134.0
149.6	145.3
150.5	146.1
156.9	152.3
165.5	160.6
168.1	163.1
175.2	169.9
170.8	165.6
164.8	159.8
163.1	158.1
164.2	159.0
156.2	151.3
154.3	149.4
159.0	153.9
156.0	151.1
153.4	148.5
149.2	144.4
144.2	139.5
137.9	133.4
136.1	131.6
128.3	124.1
122.7	118.7
124.7	120.6
130.6	126.3
134.5	130.1
137.0	132.5
142.9	138.2
145.3	140.5
147.7	143.1

♦ 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	58	58	58	60	63	62	61	61	62	63	63	0	56
							(6)	(8)	(10)	(13)	(15)	(17)	(6)
2014	63	63	62	62	63	63	63	61	59	58	57	55	61
	(18)	(19)	(19)	(21)	(22)	(23)	(23)	(22)	(22)	(21)	(21)	(21)	(21)
2015	54	53	53	53	52	50	48	47	46	45	45	44	49
	(20)	(18)	(16)	(14)	(14)	(15)	(16)	(17)	(17)	(17)	(18)	(19)	(17)

♦ 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.