SOLAR INDICES BULLETIN

FEBRUARY 2015

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.

FEBRUARY 2015 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	76	142	583	319	176	142	129	117	77	44	17
02	64	144	557	297	164	144	135	117	85	51	26
03	59	149	558	321	175	149	129	114	85	55	23
04	68	149	595	321	178	145	137	123	87	53	16
05	63	142	586	314	167	142	127	116	81	50	20
06	59	144	588	312	171	143	128	116	86	53	24
07	52	151	591	325	179	153	138	114	89	56	25
08	53	157	535	293	171	153	142	117	87	56	26
09	59	143	591	341	189	146	150	130	88	53	24
10	58	139	591	327	170	141	124	105	84	56	24
11	41	130	583	309	162	131	117	101	80	52	23
12	35	128	576	309	157	128	113	98	80	54	23
13	41	124	536	305	155	125	111	98	78	52	23
14	35	120	563	303	153	120	111	95	79	58	25
15	42	119	588	307	155	120	108	92	79	52	24
16	27	118	578	298	150	118	106	90	73	48	23
17	25	119	582	300	156	119	109	91	67	42	20
18	59	122	586	301	156	121	111	96	66	45	23
19	61	119	577	305	151	119	105	91	65	42	17
20	43	118	441	209	118	120	93	84	67	46	20
21	39	114	582	305	149	116	106	92	70	47	21
22	28	119	576	298	152	118	106	93	70	139	11
23	31	117	574	279	152	117	105	88	72	46	14
24	28	114	571	278	149	114	100	82	73	45	23
25	13	111	575	282	146	111	99	84	72	47	15
26	16	112	573	276	148	111	101	84	71	45	18
27	38	120	575	284	154	118	108	87	69	43	19
28	41	127	579	292	163	123	117	90	83	48	22
29											
30											
31											
Mean	44.7	129	571	300	160	129	117	100	77	53	21

JANUARY 2015 FINAL FLUX

Day	Observed Pentic (2800)	Adjusted Pentic 2800)
01	137.5	132.9
02	145.8	141.0
03	148.7	143.8
04	149.7	144.8
05	141.9	137.2
06	141.9	137.2
07	147.2	142.4
08	157.2	152.0
09	151.2	146.2
10	151.9	146.9
11	153.7	148.6
12	158.6	153.4
13	0	0
14	139.8	135.3
15	131.2	127.0
16	125.4	121.3
17	122.0	118.1
18	126.3	122.3
19	127.5	123.4
20	125.7	121.7
21	124.4	120.5
22	119.8	116.1
23	120.6	116.8
24	126.0	122.1
25	126.7	122.8
26	146.7	142.2
27	155.8	151.1
28	161.1	156.2
29	170.4	165.4
30	157.1	152.5
31	155.1	150.6
Mean	141.5	137.0

♦ 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
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	73	75	75	75	66
2014	77	78	81	82	81	80	79	76	73	71	70	68	76
									(2)	(5)	(8)	(10)	(2)
2015	66	64	63	62	60	58	55	53	52	50	49	48	57
	(11)	(10)	(9)	(8)	(8)	(9)	(10)	(10)	(11)	(11)	(11)	(13)	(10)
2016	46	45	43	41	40	39	38	37	36	35	33	32	39
	(14)	(16)	(18)	(19)	(20)	(20)	(20)	(20)	(21)	(22)	(23)	(24)	(20)

♦ SUNSPOT NUMBER PREDICTIONS

For the end of Solar Cycle 23, and the beginning of Cycle 24, the table gives <u>smoothed</u> 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.

<u>The McNish-Lincoln prediction method generates useful estimates of smoothed, monthly mean sunspot numbers for no more than 12 months ahead.</u> 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.