SOLAR INDICES BULLETIN

JANUARY 2012

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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 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 2012 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		527	278	165	130	119	123	61	33	13
02	57	135	528	279	176	135	119	127	56	30	10
03	74	135	538	270	172	135	122	124	59	33	12
04	78	136	563	273	174	136	121	122	51	29	10
05	67	141	528	278	177	141	126	126	62	40	17
06	70	136	528	273	179	136	126	120	60	36	15
07	70	141	532	279	184	141	130	121	61	34	13
08	64	136	534	284	195	136	125	116	57	35	16
09	49	142	535	280	174	142	127	118	70	56	17
10	43	129	530	275	160	129	119	111	61	39	28
11	39	120	529	266	162	120	109	106	61	49	27
12	32	117	403	225	143	117	116	86	53	45	26
13	44	124	477	268	160	124	115	112	62	42	24
14	73	132	541	278	172	132	118	116	63	42	24
15	92	134	590	271	168	134	118	114	63	41	24
16	95	140	526	286	181	140	122	119	59	36	30
17	87	139	509	265	172	139	121	115	60	47	25
18	78	148	526	272	169	148	122	122	57	39	25
19	65	157	525	289	190	157	133	130	58	34	27
20	63	141	534	294	182	141	127	130	56	33	20
21	69	142	551	282	177	142	130	126	59	37	19
22	67	141	532	289	169	141	126	125	61	40	26
23	70	144	520	280	180	144	129	124	55	33	13
24	53	136	512	280	166	136	119	118	54	33	14
25	47	126	6	275	160	126	114	112	52	34	16
26	30	128	529	273	162	128	114	117	51	29	12
27	40	142	349	276	160	142	113	116	60	36	17
28	28	115	526	263	153	115	104	109	59	37	17
29	35	110	520	264	144	110	98	106	57	35	16
30	38	114	517	265	148	114	101	107	56	32	13
31	46	117	509	262	158	117	108	111	58	35	15
Mean	33.1	133	502	274	169	129	119	117	58	37	19

DEC 2011 FINAL FLUX

Day	Observed Pentic (2800)	Adjusted Pentic (2800)
01	152.2	148.0
02	157.3	152.9
03	164.1	159.4
04	163.7	159.0
05	158.1	153.6
06	151.1	146.6
07	148.9	144.5
08	144.8	140.4
09	143.5	139.2
10	140.0	135.8
11	134.3	130.2
12	131.5	127.5
13	133.1	129.0
14	132.0	127.9
15	124.2	120.3
16	121.0	117.2
17	119.6	115.8
18	127.4	123.3
19	128.2	124.1
20	137.4	133.0
21	144.5	139.9
22	145.8	141.1
23	138.2	133.7
24	142.8	138.1
25	144.3	139.6
26	145.6	140.8
27	140.3	135.7
28	144.8	140.0
29	147.1	142.3
30	141.1	136.4
31	132.9	128.5
Mean	141.2	136.8

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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	37	42	48	53	57	60	62	64	66	68	52
								(3)	(7)	(12)	(16)	(19)	(5)
2012	70	72	73	75	76	77	78	80	82	83	83	84	78
	(22)	(23)	(26)	(28)	(30)	(31)	(32)	(32)	(32)	(33)	(34)	(35)	(30)
2013	85	86	87	87	87	88	87	87	86	86	86	86	86
	(36)	(37)	(37)	(38)	(39)	(41)	(43)	(43)	(42)	(41)	(41)	(41)	(40)

♦ 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.
