SOLAR INDICES BULLETIN

MARCH 2012

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 2012 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

	Sunspot	Obs Flux	Solar Flux Adjusted to 1 Astronomical Unit								
	Number	Pentic	RSTN	RSTN	RSTN	Pentic	RSTN	RSTN	RSTN	RSTN	RSTN
Day	Intl	(2800)	(15400)	(8800)	(4995)	(2800)	(2695)	(1415)	(610)	(410)	(245)
01	18	103	414	277	129	103	73	95	54	38	15
02	20	108	518	289	138	108	76	96	57	42	17
03	47	116	346	288	134	116	79	100	54	38	17
04	64	120	486	301	148	120	86	106	56	39	32
05	80	132	493	325	169	132	93	109	58	44	60
06	85	138	473	348	197	138	105	114	38	35	40
07	79	136	471	330	176	136	97	106	37	33	22
08	72	140	451	275	180	140	133	92	56	41	26
09	82	146	477	317	168	146	101	112	35	32	16
10	77	149	524	306	154	149	94	115	35	30	27
11	86	131	460	296	155	131	94	107	28	21	9
12	86	115	436	295	149	115	97	109	28	25	14
13	71	141	463	298	143	141	89	112	30	24	12
14	63	119	432	294	140	119	83	103	35	28	24
15	65	111	460	284	131	111	79	98	13	40	9
16	63	99	439	278	124	99	92	95	14	12	8
17	65	102	450	277	124	102	97	96	14	13	9
18	46	102	422	282	127	102	95	93	15	14	9
19	55	102	431	282	127	102	94	91	14	13	9
20	64	100	520	297	127	100	91	88	14	13	8
21	57	100	427	278	127	100	96	91	15	14	9
22	52	102	438	284	130	102	94	93	15	14	8
23	53	105	440	281	130	105	94	94	16	15	10
24	70	103	451	281	127	103	94	94	15	14	11
25	66	101	434	285	127	101	93	93	14	14	8
26	65	102	557	280	127	102	96	95	14	19	9
27	62	106	560	281	129	106	99	99	14	13	8
28	65	107	545	284	133	107	99	101	11	10	7
29	79	112	535	289	133	112	101	101	13	12	8
30	66	111	562	289	131	111	103	103	12	9	6
31	66	110	557	285	135	110	101	102	12	11	6
Mean	55.2	115	473	292	141	115	94	100	27	23	15

FEB 2012 FINAL FLUX

Observed	Adjusted
Pentic	Pentic
(2800)	(2800)
117.5	114.1
118.0	114.6
111.1	107.9
107.0	104.0
102.7	99.8
112.0	108.9
107.2	104.3
97.2	94.6
99.2	96.6
110.8	107.9
112.3	109.4
110.4	107.6
108.4	105.7
107.4	104.8
104.6	102.0
103.2	100.8
103.7	101.3
104.1	101.7
105.3	102.9
111.1	108.7
103.3	101.0
104.2	102.0
103.3	101.2
108.9	106.7
108.0	105.9
107.0	104.9
105.5	103.5
103.3	101.3
102.0	100.2
106.9	104.2

♦ 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
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	59	60	62	64	66	51
										(5)	(10)	(13)	(2)
2012	68	69	71	72	73	74	76	78	80	81	81	82	75
	(15)	(17)	(20)	(23)	(24)	(26)	(27)	(28)	(28)	(29)	(30)	(31)	(25)
2013	83	84	85	85	85	86	85	84	84	84	84	84	84
	(33)	(35)	(35)	(36)	(37)	(39)	(41)	(41)	(39)	(39)	(39)	(39)	(38)

♦ 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.
